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POPULATION PRESSURES

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* * *

The Wildlife Management Institute wishes to express its appreciation to The Wildlife Society and to the many organizations and individuals who contributed to the success of the 26th North American Wildlife and Natural Resources Conference.

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GENERAL SESSIONS

Monday Morning—March 6

Chairman: HENRY J. ROMNEY
Assistant to the Secretary, Department of the Interior, Washington, D. C.

Vice-Chairman: ROBERT C. COOK
President, Population Reference Bureau, Inc., Washington, D. C.

PEOPLE POSE THE PROBLEM

FORMAL OPENING

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

Friends:

It is a pleasure and a privilege to open the 26th North American Wildlife and Natural Resources Conference. We are delighted to see so many here at the opening and to see all the familiar faces intermingled with the newcomers in the audience. You new people represent a progressive transition, while the many old friends indicate a continuity of interest stretching back over the years. Progressiveness and continuity are qualities that we constantly are seeking in the staging of these yearly conferences.

The North American Wildlife and Natural Resources Conference always has been an international meeting, and its scope seems to broaden each year. This year we have in attendance persons from all of the states, including those two distant additions to the Union—Alaska and Hawaii—nearly all of the Provinces and Territories of Canada; Mexico, England, Africa, and Australia; and perhaps others which I may have overlooked.

Those of us who stage these international conferences each year try to make the new one better than the last. This is not an easy task, and it gets more difficult each year; but this time I feel that we have enjoyed more than a measure of success. We have an outstanding panel of speakers, and we have made some drastic changes in the organization of the program or agenda to avoid the conflicts between the conference sessions and the related meetings that have become so serious. In previous conferences we permitted the scheduling of numerous concurrent related meetings that sapped the attendance of the general and technical sessions. This year, you will see, we have eliminated the Tuesday afternoon general session and scheduled all of the related meetings on Sunday and on Tuesday afternoon. Now, you have no excuse for not attending the main meetings. On the other hand, now that there is no competition, I can say that most of the related meetings are open to the public, and that you should consult your program and attend those that are of interest to you.

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

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

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

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

I now turn the opening general session over to the chairman, the distinguished writer, Mr. Henry J. Romney.

REMARKS OF THE CHAIRMAN

HENRY J. ROMNEY

As anyone with a working interest in conservation will agree, the problem which people pose today cannot be compared with that of any other period in our history. The sheer number of them now, and of those expected in the decades to come, and the extraordinary leverage at the disposal of each individual, have fundamentally and qualitatively changed the relationship of man to his natural environment. In many parts of the world the problem still is too many people and too few developed natural resources to feed, to clothe, and to house them. In these underdeveloped areas men and women stand more or less helpless before an all too-harsh natural world.

But here in America the problem would seem to be a different one. We have developed and managed our natural resources to yield not only the necessities of life but a handsome margin of luxury as well. We have accomplished this in so short a time, on so vast a scale, and with such human ingenuity and forcefulness that nature appears to stand helpless before man. Yet I think that you will agree with me that we, too, are the losers. There are still millions of Americans with little or no share in our natural prosperity. Through necessity their horizons are limited to achieving a decent standard of living. But among the majority whose personal needs are being met handsomely, there is nevertheless a feeling that in achieving a relatively affluent society we have missed out on something, that modern man, anchored in concrete, chrome, and durable plastics, somehow is not a whole man.

We seem to be reaching the tentative conclusion that the price of prosperity, while most certainly not excessive, has been high. There seems to be a growing concern with the disappearance, for example, of open spaces and wild things, and a demand that something be done to preserve what is left of them. There seems little doubt today that conservation is getting a popular mandate.

The problem is how to reconcile the geological force of a highly mobilized, industrialized population with a limited area of land and water, the interplay of a free and expanding economy within a limited land area.

This problem in its generalities and particulars is the responsibility of conservationists today. In the past conservation has often, and to a large extent, been the concern of prophets and scholars and, not always to its advantage, of those afflicted with acute nostalgia. Today conservation must become the concern of all who have a voice in shaping the present and the future of America.

It is never easy to take a Ph.D. thesis or a manifesto into the marketplace and to get people to act on it, to make sacrifices, to work. But that precisely is the challenge of conservationists today, and we will be judged by what we get done, and not by the purity of our intentions or the gravity of our warnings.

THE MANAGEMENT OF HUMAN POPULATIONS

WILLIAM VOGT

National Director, Planned Parenthood Federation of America, New York, N. Y.

(I should like to emphasize, at the outset of this paper, that the opinions I express, and the recommendations I make, are my own and are not necessarily shared by any of my associates.)

A quick review of the *Transactions* of these Wildlife Conferences reveals an interesting paradox. Hundreds of papers are concerned with the control of *numbers* of animals—upward, if possible, in the case of such "desirable" species as game, downward for predators, competitors and parasites—yet nowhere does there seem to be any recommendation as to the control of the number of that most dynamic animal in most contemporary environments, man. Nevertheless, the recognition that populations both of plants and of non-human animals (with the exception of such symbionts and commensals as rats, mice, and certain arthropods) cannot be maintained in the face of the pressures of human numbers is coming to be widely accepted.

Throughout all the Wildlife Conferences there has been concern with the *behavior* of *Homo sapiens*. Bag limits, seasons, farmer-sportsman relationships, and game-sales-on-the-hoof are examples of the mustard plasters with which we have been treating the deep-seated discomfort that results from ecological erosion caused by the integrated impacts of human multiplication and expanding technologies.

The automobile, airplane, outboard motor, power saw, dragline and the bulldozer have all had far greater impact on wildlife, in a wide variety of ways, than would have been possible within a short span of time by unmechanized man. Man's power tools wipe out many of the best habitats—swamps and marshes are among the areas that are likely to be attacked first—and the result is quantitative as well as qualitative deterioration. While our human population, in the United States, has increased 46 times since the founding of the Republic, and more than doubled since the beginning of the century, the impact of its technology has grown even more rapidly. Soil erosion, "clean" farming, marsh drainage and falling water tables, as is well known to this group, have turned hundreds of millions of acres into virtual wildlife deserts. What we may not be so well aware of is the fact that each year we are still losing about a million and a quarter acres to uses that make them largely unavailable for wildlife—or even water retention. This is for the spread of roads, towns, airfields and, above all, highways.

If our population continues to grow at the current rate we shall have, a mere forty years from now, some 360,000,000 Americans instead of today's 182,000,000. This will amount to more than half the present population of China.

The time has come to concern ourselves with *human* numbers.

Food for 200,000,000 more human beings may well, itself, make such demands on the land as farther to reduce its usefulness as a wildlife habitat. Much is written and said of food "surpluses" but it is rarely pointed out that, according to Floyd E. Dominy, Commissioner of the Bureau of Reclamation, only "about five per cent of the total production is in the surplus category." (7th Nat. Watershed Congress, 1960 p. 90) World surpluses amount to only about 10 million tons of grain a year out of a world consumption of some 800 million. In other words, these surpluses total only about 1¼% for a human population, half of which is underfed. *And despite hunger that affects more people than the total world population at the beginning of this century,* the human aggregation will again double by the end of the century, at its current rate of growth, and quadruple within the lifetime of many people now living.

It is not only the sportsman, and other nature lovers, who find life impoverished by this plethora of people. The deterioration of the quality of living in much of the world has been discussed in a number of publications, some of which are listed in my bibliography. Food intake, though this has suffered in Southeast Asia and Latin America, is not the sole casualty. As 100,000,000 babies are born each year, and the net population gain is about 50,000,000, illiteracy rates rise to plague attempts at developing democracy. Social stability, under the pressures of unsatisfied desires of various sorts, is shaken and rebellions develop from Cuba and El Salvador to Laos.

These effects can only be touched on in the available time, yet is is important for this group to remember them. The multiplicity of pressures on every aspect of our life, resulting from explosive population growth, means ever more vigorous competition for funds to satisfy growing needs—and less is left for the protection and enjoyment of nature, including hunting and fishing. School and college costs, to give only one example, have skyrocketed, leaving far behind the adequate increase of funds for establishment of nature reserves and wildlife refuges, protection and maintenance of national parks (at the very time that human pressures on them have also skyrocketed), research in ecology and ecological management, etc.

If other methods of saving important values from being drowned in the flood of human beings become ineffectual, the obvious next step would seem to be control of the human flood.

Some of the reasons this has not been more widely developed, and some of the difficulties that will be encountered have been discussed at considerable length in a recent book (Vogt, 1960) and need not be recapitulated here.

But certain facts, that may not be familiar to this audience, might well be recalled.

In the first place, no major religion opposes birth control—the prevention of fertilization of the egg by the sperm. It is officially sponsored by the Muslims of Egypt, Tunisia and Singapore and has been endorsed by most Protestant Christian sects, some of which have actually made its use a "Christian obligation." It is approved, under rules of varying stringency, by the Roman Catholic Church for health, social, genetic and economic reasons (Anonymous, 1960). This Church rejects chemical and physical birth control methods although, as H. L. Mencken pointed out, in the rhythm method it accepts the mathematical. In the primarily Hindu country of India birth control is deeply implanted in national policy. It is also widely available, under government auspices, in Buddhist Japan and Confucian China.

In the second place, the desire for protection against incessant pregnancies seems to be nearly universal and eternal. Norman Himes, in his classical *Medical History of Contraception* (1936) has traced attempts at contraception back some 3000 years, to the Egyptians, and identified the practice among pre-literate societies. Among the latter, as well as among such highly cultured people as the ancient Greeks, infanticide and abortion were common. Abortion has been found in a vast number of primitive people (Devereux, 1955) but it has probably been brought to the greatest development of frequency and safety by the Japanese, during the past two decades. A population of some 93,000,000 with a birth rate of 17.5 per thousand probably undergoes about 2,000,000 abortions a year.

Estimates of the number of induced abortions performed in the United States (the majority on married women) vary widely, but the number is probably not far from 1,000,000 a year. (Calderone, 1958) Abortion is, however, condemned by most Christian sects except when it is necessary to save the life of the pregnant woman.

At every meeting of the International Planned Parenthood Federation public health workers from various parts of the world appeal for help in fighting the "abortion menace." In view of the high incidence of abortion where information is available, in a world population that produces 100,000,000 births a year, an estimate of 10,000-000 abortions would seem conservative. With the spread of antibiotics and modern drugs, such mortality rates as orginally launched Margaret Sanger on her world crusade for birth control are disappearing as a health problem.

Further evidence of the desire to limit population—or at least to escape the burden of excessive child-bearing which is, at the family level, essentially the same thing—is the rather rapid spread of voluntary sterilization. This process, not to be confused with castration, is usually effected through ligation of the Fallopian tubes or, far more simply, by tying off the male's *vas deferens,* a procedure that may be carried out in a physician's office. The demand in southern India is said to be substantial.

In the United States a small private fund will pay for the operation when it is requested, and needed, for health or economic reasons by the indigent. There is, in this country, a reservoir of opposition to sterilization that may vanish once the operation is certainly reversible. In India, on the other hand, there appears to be less prejudice. Indian friends have casually mentioned the fact that they, and members of their family, have had themselves vasectomized after the birth of a second child. This operation sometimes takes the place of the customary gift of a jewel to the new mother!

Human sexual behavior is, of course, enormously complicated by many factors, conscious and unconscious, and the fact that people say, or even think. they do not want any more children, is not necessarily followed by effective behavior at the time of mating. Yet the small family pattern is characteristic of all economically advanced societies and birth rates have dropped sharply—and certainly voluntarily—under a wide enough variety of circumstances to justify confidence that deliberate population control is a feasible technique. There is clear evidence that births were controlled in 18th Century Sweden, long before the development of modern contraceptive techniques (Vogt, 1960). Our own birth rate, during the depression years of the 1930's dropped to about 17 per thousand—well below the 25 per thousand near which it has hovered ever since World War II. The Japanese, in ten years, achieved the unprecedented feat of voluntarily cutting their birth rate in half.

The widespread *reality* of population limitation, even through means that may be repugnant to many people, is perhaps more significant than what people say about it. In India, for example, "an average village woman . . . would not like to have more than three or four children," about the same as in the United States (Singh, 1956, p. 220 ff.), yet the number of children born to Indian women is far higher—though birth rates are falling. As contraceptive techniques have improved, the greatest problem has become how to get them used. Relatively few individuals recommend compulsory birth limitation though a British scientist foresees the time when our world will be so heavily populated that the sternest compulsion will be necessary—and homosexuality will have become biologically advantageous! (Clark, 1959) It is, indeed, in the hope that compulsion may never become necessary that many birth control partisans have devoted their lives to the spreading of the doctrine of voluntary and controlled parenthood.

Yet, obviously, attitudes toward family size lag far behind the ecological realities. Some theologians, though in smaller and smaller numbers of sects, still espouse the Old Testament admonition to "be fruitful and multiply," though the death rates that once entirely justified such an injunction in many parts of the world have fallen 80% or more. Life expectancies at birth have risen from the early or mid-twenties to more than the Biblical three score and ten in the most economically advanced countries. Indeed, more than nine out of every ten children born in the United States survive to the child-bearing age, thanks to medical skill—a situation that worries many geneticists. But that is another story.

Tradition dies hard, and one of those that lives longest is the belief that the only healthy population is a growing population. This belief is reinforced in this country by the pioneer tradition. More people were "needed"—though certainly not by the women killed by excessive child-bearing—and there was room for everyone on our expanding frontier.

Our social structure and our laws are still pro-natalist to an astounding degree. Although we are confronted by an early probable 360,000,000 population short of high quality food, water, timber, wildlife, open country and, above all, space—within the life expectancy of many in this room—we are subsidizing a high birth rate to an extent that few people realize. While it is true we do not pay actual maternity benefits as is done in France, Canada and Holland (where the cost has jumped from 13 to 513 million guilder in 20 years)— except in the case of indigent families, especially those without a husband "living in"—we provide all kinds of benefits that tend to encourage reproduction. For example, in various health insurance plans, designed to protect against the catastrophe of illness, the costs of confinements are included though these are not illness and need not be involuntary. The more children a family has under these plans, the more they profit from them—and the greater the charges to the other participants.

Education in this country is, of course, not "free." It is paid for by the taxpayer and represents both years of labor and the loss of the fruits of that labor in terms of disposable income, protection in old age, etc. In actuality, the family with the most children *often contributes least per capita* to the cost of their education. Along with education go tax-supported school books, buses, and often, lunches.

Some of the most substantial underwriting of large families is through the graduated income tax. A couple with three children pay no tax until their income is $3,350 or more; with four children, more than $3,900; with five children, more than $4,600, with six children, more than $5,100; with seven children, more than $6,000; and with eight children, more than $6,600. Since these children are not only non-producers, but are not even self-supporters as they would partially have been in a farm economy, they draw heavily on all kinds of community resources, from water supplies to hospitals, and are, in an economic sense, parasites. They are parasitic, that is, on the productive members of society, as many a community has learned to its sorrow when real estate developers have put up hundreds of houses, especially cheap houses, primarily for young people. The tax load for schools, sewers, water supplies, etc., so far exceeds the capacity of the local teat that they join the push for the adjoining one that has a direct pipe line to Washington. What they frequently seem to forget is that Washington is only a way station skimming off some of the cream, and that the pipe line comes right back to the source in the community.

If these families with large numbers of children are really poor, the chances are that they will be lodged in subsidized housing where they pay little or no rent. All of these subsidies are, of course, at the expense of somebody, inevitably mean higher taxes, and thus reduce the monies available for the purchase of automobiles, other hard goods, and investment. They may thus, at times, contribute substantially to recessions brought about, or at least exacerbated, by a fall in purchases of consumers' goods.

The poor bachelor who has no responsibility in increasing these expenses is disproportionately taxed to pay for them. He does not even enjoy the split income privilege of the married couple! These various economic incentives are stressed because they probably operate as important influences on the size of the human population. While few of our people are so thoughtless and irresponsible they would produce children in danger of death from starvation—this is the practice of millions of men and women around the world—a very large proportion of our population would restrict the size of their families if they realized that the burden of housing, feeding, clothing and educating them would fall directly on the family itself.

In a country that is approaching over-population, if it has not already reached this state, why should *any* further encouragement to reproduction be given? This is closely parallel to feeding deer on an overstocked range.

It is certainly obvious by this time that, in my opinion, the United States is over-populated. There are, I know, a great many people who agree with me. On the other hand, many businessmen and some economists see in a growing population a guarantee of growing prosperity, even though large populations have had exactly the opposite effect in other parts of the world. Even more pertinently, during the worst economic setbacks—panics—this country has had, the population has been growing more rapidly than during the past 20 years, through every decade up to and including 1910. (Stat. Abs., 1960, p. 5).

As long as there exists substantial disagreement as to whether or not we are over-populated or under-populated, it is probable that a national policy of drift will be followed and little done to change the trend except where the politically organized "fertility cult" is successful in getting greater school benefits, higher immigration quotas, etc. There is, however, enough consciousness of the reality of the population problem so that it would seem we might hope that sometime in the reasonably early future a national conference to develop a population policy could be held. "Optimum populations" were much discussed among demographers some years ago, but the discussions were dropped during a period of falling birth rates, in part because of the difficulty of agreeing on what an "optimum" might be. Now, however, as we may be faced with a deteriorating population, in terms of economics and the general quality of living, the electorate and their leaders may begin to recognize the desirability of considering the problem. It would seem elementary that we should avoid approaching a "pessimum" population.

It is not, in any case, too early to begin to consider methods of human population control since we may expect, probably for decades to come, that the battle for death control will be waged with ever greater vigor and success. Populations are growing not because of rising birth rates but because of falling death rates.

There is, of course, always the possibility that the host—the taxpayer—that has been parasitized so long and so successfully may demand a vermifuge to protect his investments in life insurance, government and other bonds, savings, social security, etc., but if this happens, it is likely to come first on a State or local level rather than a national basis.

Killing the human surplus is, in an historical sense, not so fantastic as it seems. Genocide, or something closely resembling it, was practiced long before the Third Reich. Moses, the Prophet, according to the record, was rescued from the bulrushes where he had been hidden after an order by the Egyptian Pharaoh to kill all male Hebrew babies.

Thomas Robert Malthus in his great *Essay on Population* (n. d.) hypothesized war as one of the solutions of over-population or, at least, as one of its consequences, but there has been a modern tendency to object to this as over-simplified. Certain it is that there was no simple cause-and-effect relationship between population pressure and war in 1918, 1939, and 1941. Indeed, the obvious aggressors were among those with the highest living standard in the world. Nevertheless, behind the Hitlerian drive was the justification of a demand for *Lebensraum* and Mussolini made some bad and bloody attempts to invest in Abyssinia. Japanese with whom I discussed the population problem made no bones of their conviction that population pressure had been at least an important justification among the country's militarists during two or three decades prior to Pearl Harbor. That they bit off considerably more than they could chew is beside the point. Had the island population been held to the 27,000,000 of the 125 years before Commodore Perry pried the lid off Pandora's box, the war in the Pacific might never have taken place.

The population of China, taking great leaps forward at the rate of some 12 to 15 million a year—at least this was probably the rate before the 1961 famine—may well create explosive pressures to send millions of foot soldiers slogging into food-rich parts of Southeast Asia, or even across the steppes toward Europe. The Chinese people have little to lose but their lives—and few commodities are as cheap as human life under the Communists—and under over-population. Such adventures could explode into the last World War.

There would seem to be better, kinder and more acceptable solutions than war, starvation and genocide.

During the 1920's and 1930's Sweden and the United Kingdom were both concerned by their low birth rates and government commissions made various recommendations intended in part to check the downward trend. Yet both urged that contraception be made widely available. Today every pharmacist in Sweden is required, by law, to sell contraceptives.

I am sure that at least 10% of the audience is ready to jump to its separate or collective feet and explain how technology can keep the wolf away from 6 to 12 billion doors—the Australian economist Colin Clark says we can feed 28 billion—which might, just conceivably, in a perfect society be true, provided people were willing to live on rice and corn meal and they could be distributed. But this is not a perfect society, nor are we likely to develop one when we are doubling our population every 40 years. The economist's promise of pie in the sky for 6 to 12 billion does not impress me one bit when from one-half to two-thirds of the 3 billion people already on earth are malnourished and on the verge of starvation, including the unfortunate victims of that most highly planned, organized and managed of all nations, Communist China.

Besides, who wants to live on rice and corn meal?

For a witty account of what the world would be like on the way to supporting 10 billion, assuming this would be possible, I commend to your attention a little book called *The Limits of Mankind* by R.A. Piddington.

If man is not to have his population limited for him by force it will only be because he limits it himself. He is not likely, in any way except those mentioned, to step up death rates, even to avert suffering among the sick and aged that make "nature red in tooth and claw" look like one of the most merciful of forces.

The one alternative seems to be the limitation of births or, better, of conceptions, since our culture at least ostensibly abhors abortions.

The process of voluntary sterilization may be expected to gain wider acceptance and in some societies to have an important impact on the birth rate. Yet the scarcity of surgeons or even specially trained technicians is likely, for a long time, to prevent this method from having a significant effect on the birth rate.

Excellent oral contraceptives are now available for the female and will probably be provided for the male before many months have passed. There is not even in sight, so far as I know, a substance that could be added to the water or food and thus cause temporary and reversible sterility (Bhabha, 1960, p. 20).

Chemical and occlusive methods are increasingly cheap, reliable and acceptable and non-appliance methods, such as periodic abstinence and *coitus interruptus*, are widely used and fairly successful.

The major problem would seem to be that of motivation.

This problem is shared by all groups of people subject to preventable and curable sickness. There are, without doubt, a number of people in this room who will die unnecessarily, and before their time, from cancer, heart and vascular diseases because they have not availed themselves of medical care, or carried out the application of health measures in accordance with the advice of their physicians. Hugh Bennett's favorite story of the farmer who didn't want to be told how to farm any better because he wasn't farming, then, as good as he knew how, is pertinent to many human activities, including health.

Getting people into birth control clinics, even when the facilities of those clinics would make it possible for a family to avert social and economic disaster, has remained an unsolved problem for a substantial percentage of Americans needing the help. Now, with simpler methods, the importance of the clinic has been somewhat reduced —though its value as an instruction center remains high—and birth control is being carried to people in their homes, migrant workers' camps and elsewhere. But the way to get people to use such preventive medicine is probably the greatest problem facing India's 800,000 villages, as it still is in the case of hundreds of thousands of American families.

Research sponsored by the Planned Parenthood Federation of America (Rainwater, 1960) has disclosed astounding ignorance of human anatomy, physiology and the reproductive process. It has been especially revealing of the inability of husband and wife to communicate with one another in matters pertaining to sex, and therefore in deciding to plan the family and the way in which to do it. A great deal more research is needed in this area and it is one for which the Planned Parenthood Federation is seeking support.

An obvious and relatively simple means of slowing our population growth would be a restriction on immigration. In view of our current rate of growth, the overcrowding of our cities (where most immigrants settle), and our relatively high rate of unemployment, we certainly need few additions to our population from abroad.

Estimates vary as to the probable increase in our labor force over the next decade. The Bureau of Labor Statistics estimates about 13,500,000 but this figure may well be too low. During the past 15 years, 60,000,000 babies were born in the U. S. For every 4 people who were born, 1 died—and a certain number of workers will voluntarily retire. However, in view of the fact that most young women work, often out of necessity even after they are married, and of the possible inroads of automation, we may well be faced with unemployment approaching that which persisted throughout the 1930's, until it was relieved by World War II. If there is even a possibility of this, it would seem only elementary common sense not to permit the immigration of additional people.

I should except only two groups: *bona fide* political refugees who had fled from their own countries. These we should accept, on a quota basis shared with other democratic countries.

And we should welcome scientists, artists, scholars, etc., of proven ability, because of their potential contribution to our national welfare.

There are a number of incentives toward lower birth rates that have been tried and/or discussed in different cultures and different parts of the world. Some of them have been highly successful.

In Japan, abortion is virtually free under government supervision, and it has been so widely used that it has halved the birth rate.

H. L. Mencken, in a characteristically sardonic article, in 1937 suggested that we offer $1000 to practically anyone who would accept it (though he was aiming chiefly at southern whites in what are now called "distressed areas") to be sterilized. As has been observed, this is not likely, at least until it is reversible, to win wide acceptance in the United States. The payment to the Indian is only about $4.00 (20 rupees) and it has been seriously suggested by economists that India, which has a per capita income of about $60.00 a year, could well afford to pay up to $100.00, as a means of slowing population growth (Enke, 1960).

In both India and Japan there have been serious proposals that taxes be used as a means of population control, in a direction the reverse of our incentive payments: that is, that taxes increase with the size of the family. (A team of Ford Foundation technicians, most of them from the U. S. Department of Agriculture, suggested a similar process of taxing excess cattle, to improve the food situation of India.) (Ford Foundation, 1959)

For example, all income tax deductions for children born might be withdrawn after due warning, with taxes rapidly graduated upward on each child after the first two. (An average of about 2.2 children is now needed for replacement.) North Ireland's Minister of Labor suggested the government should decrease family allowance for fourth and subsequent children as a means of alleviating unemployment (Belfast News-Letter, 20 April, 1959).

Such a tax pattern would have little or no effect on the very rich, since they have so much wealth they can virtually ignore taxes. But it is to be hoped, and it may not be unreasonable to expect, that as the mass of the population reduced the size of their family, sheer moral presure would help to bring down the size of all families. Should such a policy be formulated, a necessary corollary would be the universal provision of contraceptive facilities, either chemical or mechanical, or for those conscientiously opposed to these, adequate training in the rhythm method.

Professor Raymond B. Cowles has suggested, instead of upward graduated taxes, the payment of incentive grants to those restraining their reproductive enthusiasm, perhaps with a bonus "for each year of childlessness, for each woman between the ages of say 18 to 30." (*in litt*). The economics of such payments have not been thoroughly calculated but Dr. Cowles estimates seem to show a sufficient saving to cover costs without an inflationary effect. So long as there exists the general notion that the government has money to give away (and it will probably be with us for a long time), such a program would find less resistance than the graduated tax on the large family. Perhaps this "bread and circuses" approach would be inescapable, and it would have the advantage of being completely voluntary.

Various other mechanisms, economic and social, have undoubtedly played a part in regulating family size and their use should be explored. The sharp drop in the American birth rate to 1.7% during the depression, compared with the recent 2.5%, demonstrated that Americans can, and will, control the size of their families.

Why our birth rate has stayed as high as it has, ever since the end of the war, has not been satisfactorily explained, but general conditions that are the antithesis of those occurring during our period of lowest birth rate—lack of security, high unemployment, absence of many social services taken for granted today, etc.—should certainly be a partial explanation.

The drop in birth rate found among overcrowded voles apparently had a counterpart in Sweden for many years. Few houses or apartments were available, in the cities to which the population was moving, that had more than two bedrooms. This certainly tended to keep the Swedish family at three children or less.

The opportunities to motivate satisfaction with the small family, through education, are certainly great, and largely unexplored. Sex education is almost non-existent for our young people, and education for marriage not only reaches a small minority but is imbued with pro-natalist philosophy—"Of course you want children!"—that, to a considerable degree, fails to bring home to young people the seriousness of the responsibility they are incurring when, in our overcrowded world, they deliberately (or recklessly) create another human being.

We are all part of the world community and I have no doubt that were this brought home to our young people many of them would recognize, and act upon, their personal responsibility, even in such instinctive, subjective matters as determining the size of their family. Self interest, even more the interest of their children, and perhaps less the well-being of their grand-children, could be powerful motivating forces.

The wildlife manager can crop his surplus population. This is, of course, a technique that cannot be applied to human populations. The wildlife manager can destroy cover to reduce the numbers of undesirable forms, such as some predators, or by filling in food and cover gaps to protect the prey, make their predation ineffectual and thus cut back the numbers. He can sterilize certain male insects and thus prevent the fertilization of female eggs. He can reduce the number of females and set the males to fighting among themselves, and in this way reduce the birth rate.

These are not methods available to anyone concerned with optimum numbers of human beings—unless the State should step in with compulsory controls. One need not be a science fictioneer to imagine the ultimate arrival of that day, if human populations continue to double themselves every 40 years.

Yet if there is any area of human existence from which the State should be permanently barred, it is the most intimate recesses of family life. If we are wise—and I believe we are wise enough for this—we shall look far enough ahead and take necessary measures so that there will never be even seeming justification for direct government interference.

This is a problem that must be solved by each family, in every society, making its own, binding decision.

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DISCUSSION

CHAIRMAN ROMNEY: When Mr. Vogt talks about restraining the reproduction enthusiasm, you will understand what I meant when I said that his was perhaps the most difficult field that anybody could work in.

I would like to present to you at this time the Vice-Chairman of this General Session, Mr. Robert Cook. Mr. Cook will lead the discussion periods which are to follow each presentation. I know of no man better qualified to discuss the problems of population pressures than the president of the internationally known Population Reference Bureau here in Washington. Mr. Cook has firsthand familiarity with all aspects of the population explosion. He is a trained geneticist, as was his father before him, and the author of a most authoritative study, "Human Fertility, the Modern Dilemma."

VICE-CHAIRMAN COOK: Thank you, Mr. Romney. It is a pleasure to be involved with an audience that one can assume has about 100 per cent some infiuence of an ecological background. As Mr. Vogt has made clear, we are faced with ecological problems. It turns out that ecology goes back quite a ways. On reliable authority it has been reported that when Noah sent out the dove and the dove finally returned with a green leaf, and finally the Ark grounded on Ararat, and the waters subsided and the area of Noah's domain increased as a square of the radius for a number of weeks, Noah set forth one day—having got himself a good old ash plant type of cane—to visit his domain. When the animals left the Ark he told them to go forth and multiply and this seemed like an excellent idea in view of the recent high mortality applying to practically all organisms except the fishes and the whales. So the animals departed, Noah went forth to see how things were going and he noticed a large pile of driftwood. This looked as though it might be timber for making an addition to the Ark; as he examined this potential lumber pile, he was shocked to discover that it was crawling with little snakes. He took a quick double-take, but as a good sound ecologist he realized that the balance of nature was in serious danger of being badly upset, so he pounded on the log with his cane, and the old gentlemen serpent came wriggling out. Noah was badly shaken and he said, "Now look, I told you folks to go forth and increase and multiply but you're carrying this beyond any reasonable limit. Look at the progeny you've arrived at in just a few short weeks. Heavens, if this goes on our entire world is going to be covered with serpents and this is going to be neither good for the rest of the living species or for the serpents. What in the world is goin on here?"

And the serpent said, "Well, Mr. Noah, we are faced with a very serious problem. We took your advice to heart and we settled down here, but you see we have a problem. We can't multiply, we're adders, we have to do it with logs."

This is what is known as a "shaggy log" story, but it does illustrate a point that seems to be important in the world right now, that we are faced with the urgent need to do something about human population or else the world is going to be in the condition of that pile of logs that Noah was worrying about.

To project these current increases a little more in the future, we are experiencing in parts of the world today at three per cent increase in population. That doesn't make any banker go wild with glee; but a three per cent increase at compound interest—and population increase is a compound interest—gives you a 20-fold increase in population in a century. This is really an appalling problem.

We have here the curious fact that the western Christian nations invented the small family system and Lord Russell says this is our only important contribution to human culture that our western Christian civilization has made. Yet we find ourselves in the curious position, as Mr. Vogt has pointed out, that we are highly ambivalent about this matter of human reproduction. We are not willing to face up to the fact that we in this country need to give more thought to the small family system, and we need to do what we can to encourage and foster—and this is a very diffcult and delicate thing to do—the adoption of the small family system in other parts of the world. This will take the wisdom of Solomon and the wile of a serpent to work because we cannot go abroad too rapidly and too flat-footedly on this. It is a tremendous ecological problem, and you people who are aware of ecology, who are aware of the necessary balance between the various organisms which occupy this planet, can hardly let this very happily on the emerging possibility that we not only would become the dominant species, but practically the sole species on the planet with grave harm to ourselves.

BETTER LIVING THROUGH CONSERVATION PLANNING

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I am going to assume that the topic I have been asked to discuss, "Better Living Through Conservation Planning," refers to the obvious need for general environmental planning, placing emphasis upon our natural and cultural environment as a "dwelling place"—our habitation on earth.

I will further assume that you are all aware of the need for such environmental planning and that we do not have such planning in process anywhere today. We have only various kinds of disconnected, partial efforts at environmental design — metropolitan and urban planning, rural programs of various kinds and water programs mainly at the Federal level. Also, I am not going to identify the numerous and growing catalogue of defects and complaints regarding our external environment, which range from metropolitan air pollution, at one pole of our society, to continuing soil erosion at the other. Neither am I going to resume that perennial practice of trying to "adequately define conservation." Perhaps we can agree that neat, precise definitions of the broad-ranging attitudes comprising conservation thought must always be partial and to that extent misleading.

Instead I would like briefly to characterize some needed human capacities which we will have to painfully acquire as individuals before we can really achieve "conservation planning for better living," and realize vitally important conservation values in our society. If enough of us choose to personally fulfill these needs of our time we will then automatically open up possibilities for transforming our environment, which after all, is only a direct reflection of ourselves at any time.

FIRST NEED—REALIZE OUR POSITION IN HISTORY

Where do we stand today—what are some main limitations which, if overcome, can open transforming possibilities? Every age is an age of transition, but each age has certain unique characteristics. Our age and its problems properly began with the Renaissance. Man's individual awareness of himself—of his ego—then took place on a broad front for the first time. This was part of a mysterious new capacity for perception and thought. Directed inwardly it produced individualism. Directed outwardly it produced scientific behavior and knowledge. Political democracy, awareness of freedom, western scientific knowledge, our present view of nature, and technology, with all of their positive and negative qualities, are quite recent gifts of the last four hundred years—gifts which suddenly are now diffusing over and transforming the entire non-western world.

Man's present sense of himself and nature is therefore really quite new. Western culture has in fact just passed its graceful childhood period—a childhood which began in ancient, pre-Christian times and now has reached a dubious adolescence. Our present landscapes and settlement patterns are expressions of all the disharmonies, conflicts, strengths, and awkwardnesses of cultural adolescence. Much of the unconscious beauty and harmony of childhood have flowered in the settlement patterns of historical times. We travel with longing to historical examples of early landscapes, cities, towns and countrysides still present in Europe like ghosts of our forgotten past, expressing all of the profundity and completeness of uncorrupted children.

At home we confront in despair our adolescent vitality running away with us in a violent urge to produce and consume. We confront our lack of balance and sudden giantism in metropolitan growth with our embarrassing acne of urban and rural slums, our infected rivers and our eroded and scarred landscapes. We confront in dismayed surprise our recent ignorance and disregard of fundamental biological and ecological principles which earlier people often intuitively recognized and expressed in their settlement patterns.

SECOND NEED—TO DISTINGUISH CLEARY CAUSES FROM EFFECTS

We are also confused yet and do not speak clearly about cause and effect relationships. Our fathers have advised us in years past that adolescence is a difficult time, full of crises, and some of our elders still living among us have forewarned us that life is difficult, that the vine is known by its fruits, that a little knowledge is a dangerous thing, and that "know thyself" is a venerable rule of wisdom. But like true adolescents, we have refused to listen. Our inner and outer conflicts are growing, however, and the work of our hands, our cities and landscapes, are beginning to pall on us.

We are prone to identify the causal factors behind our problems as external causes—technological change, economic forces, lack of proper legislation, the structure of governmental agencies, and a host of others. In small ways though we have been forced to confront ourselves and already secretly know that we will sooner or later be forced to turn our fascinated eyes away from our settlement patterns and learn who we are and what part we had in creating them. Our secret knowledge tells us that, if we do this, it will clarify much. We can then turn our gaze back to our environment and clearly recognize ourselves in what we see.

We will then realize afresh an old principle—that man creates and is responsible for his world — that every man is an artist because everything he creates is expressive of his purposes—including the forms of his knowledge.

If our countryside and cities are ugly, it is because we lack a personal will for beauty. If our community structure has dissolved into chaos, it is because we have lost our personal capacity for community life. If our central business districts look like slick, giant supermarkets and our farms and rural landscapes look like vast factories for resource conversion, it is because we have no higher purposes than producing and exchanging commodities. If we have dishonest and shallow architecture it is because we express these qualities.

Need we go on? These points are truisms, but they are so fundamental they are easy to overlook. They bring clear a fundamental limitation facing environmental planning today—a continuing refusal to accept individual human actions as basic causal factors creating our settlement patterns and their problems. Most of the problems we identify and research are symptoms. This state of affairs raises to fundamental importance questions having to do with how we create our knowledge, our research methods, our conceptual systems and, in brief, the theory of knowledge underlying present environmental research.

THIRD NEED—MORE REALISTIC AND PENETRATING RESEARCH PROCEDURES

In research today the well-known fallacy of "misplaced concreteness"—describing and analyzing the endless multiplicity and details of land use, social organization, economic factors and so on, is in full flower.

We annunciate pious, elaborate statements about our lack of understanding of our settlement patterns and state that vast quantities of objective and theoretical research are needed. Serious evasions of reality are becoming more and more apparent as our national establishment for settlement pattern research grows in size and annual outlay.

Cultures and settlement patterns are materializations of man's thought forms. Man is given the world of natural forms and principles. Within these man creates his own forms and principles.

If we don't understand how our settlement patterns came to be, then we must study the creator of these forms—man. Every cultural artifact is an effect of human thought and purpose as cause. We can read and understand these causal factors in the forms around us if we have the will to do it. Our cities, villages, countrysides and technology are a clear, legible alphabet of forms. There is no mystery about them or need for abstract theories of settlement forms after the analogy of mechanics, physics, or organics.

Let us take our settlement patterns as our alphabet of physical forms and read them directly for what they say. Man is man because he can't help being an artist—everything he does is expressive—it has form (pattern) and meaningful content. Form is man's alphabet as well as nature's. Let us, in short, have some environmental research in terms of human purposes and meanings. Let us correlate environmental problems and forms with human thought content. We will then be able to separate effects from causes in our research and open doors to future settlement patterns truly expressive of ecological principles and of man's unfolding inner nature. It is inconceivable that man's outer world should not mirror his inner nature. The two are one.

FOURTH NEED—DEEPER PERCEPTIONS AND CONCEPTIONS OF NATURE AND MAN

If we are to create humane possibilities for environmental design—for a healthy equilibrium between man and nature in our metropolitan areas, regions, watersheds and localities—we need fresh and deeper perceptions and conceptions of both man and nature. Otherwise in our present mood we will completely ravage nature and turn ourselves into automatons.

One of the breath-taking aspects of American history is the very brief span of years required for only a handful of people to exhaust and deplete vast amounts of forests, soils and wildlife. It is apparent that formidable human purposes were inwardly acceded to and at work in the 19th century.

Let us note here, under the theme of this conference, that "People Pose the Problems" of conservation not only or primarily because of sheer quantitative population pressures, but through the purposes and knowledge inwardly selected for realization in life.

We have noted previously that man is not only responsible for his outer environment but that man, in a real sense, determines the content and forms of his knowledge and purposes. Beginning with the fundamental changes in man's consciousness in the 16th century, we in western culture have gradually permitted quantification and abstraction to spread over and dominate our perceptions and thought forms, under the impetus given by natural science.

Prior to this change there existed an intimate, concrete and personal contact between man and nature. In a sense man and nature were one. Now this oneness between man and nature is largely lost.

In our subsequent one-sided emphasis upon producing and consuming in our commercial culture we have acceded to viewing nature and ourselves almost entirely in terms of exchange value—as commodities. A commodity has no "being," no self-determination, no inner formative principle. A commodity has a "price." Commodities can be manipulated and organized as means toward monetary ends—as pure "resources." So we commonly speak in our researches and conservation work today of "natural resources" and "human resources."

The term "resources" is a narrow utilitarian concept and its widespread adoption indicates that this is the way we now prefer to view nature—as a set of commodities completely subverted to the price system and human consumption. But to view the earth as primarily a set of resources for conversion into our happiness is surely a dream of our adolescent years—now, perhaps, turning into a bad dream and possibly into a future nightmare. And we persist in speaking about ourselves as "human resources" as if man could be other than his own end.

How can we awaken to fuller thoughts and perceptions of man and nature? Surely not by simply extending quantitative methods and inorganic science. In the near future we can look forward to absorbing whole sets of regional surveys and resource inventories into exquisitely complex computers and running elaborate tests of alternative development schemes. This will bring us no further along the path toward enlightened development of our environment if our present concepts are still at work. Quantitative methods are of course necessary and are a great human achievement. What is now necessary is to go beyond them.

Western culture was the first to manipulate nature through the primary "scientific" concepts of motion and number and we have been taken in by them. We have learned to apprehend nature as matter made up of atoms, electrons, and, as of late, mysterious energy. Our perceptions of the formative living principles inherent in organic nature are almost completely repressed. Urban man under the spell of abstract monetary and physical concepts and locked up in cities, is now progressively estranged from a living experience and awareness of biological principles. The ancient bonds between man and nature are getting very weak. We cannot effectively relate our sense of responsibility, our weakened feelings or principles of ethics to nature if it is conceived of as systems of electrons, energy or atoms.

It is time for our concept makers—our researchers—to make some clearer distinctions between the inorganic, the organic and human realms. In this way we may again recover a sense of the realities in nature and man beyond the quantitative that will open new possibilities for designing our environments.

Organic nature presents itself to us not as just abstract matter or energy, but as something actively forming and expressing itself in the world. To understand it at this level we need to develop concepts adequate to these formative principles. We can then humanly relate ourselves to nature because we inwardly experience and express our own formative principles.

The kind of thought that we attach to our sensory impressions actually creates our facts, our conclusions and our meanings. In this sense when we perform research and create knowledge, we choose and determine our consciousness of the world. Up to now we have preferred to obscure our role in this regard.

The future possibilities for beautiful and balanced environments are bright if we choose to first understand and then bring into living ecological harmony the creative, formative principles evolving in both nature and ourselves. This will require, however, that we reject and then push beyond our reductive, quantitative notion of "natural resources" which is determining much of our conservation approach today. Whether we do this or not is an ethical choice we make.

FIFTH NEED—OVERCOME THE SPLIT BETWEEN URBAN ORIENTED PLANNING AND WATERSHED PLANNING AND ACHIEVE UNIFIED ENVIRONMENTAL DESIGN

Regional planning has evolved only recently and its scope and methods are still in an experimental, formative stage. City planning, on the other hand, with roots that reach back into ancient civilization, has emerged in the United States since World War II as a widespread field of activity with relatively standardized theory, procedures and scope. It is focused upon improving the physical environment and guiding the future growth of individual cities.

The beginning of *regional metropolitan planning* in America dates only from the 1920's when metropolitan problems began to receive serious attention. Los Angeles County created the first Regional Planning Commission in 1922. The first completed regional plan, "A Regional Plan for New York and Its Environs" was privately sponsored by the New York Regional Planning Association in the late 1920's.

The beginning of *regional watershed planning* is also quite recent, dating from the 1920's. Three basic and related ideas and their application have been progressively evolving since that time. These are: (1) the multiple-use concept, (2) the watershed-unit approach, and (3) unified environmental development.

The historically separate origins of metropolitan and watershed regional programs have resulted in separate and distinct education, theory, methods and institutionalization. These factors are now creating unfortunate limitations in solving environmental problems and needs when urban and watershed problems are interdependent. Unrealistic distinctions between urban and watershed concepts are being perpetuated in existing planning agencies, in university planning curricula and in the inherited structure and functions of local, state and federal resource-connected agencies.

As mentioned earlier, the first environmental planning programs in America had their origins in the city. This resulted in a deep preoccupation with urban land use problems. The postwar metropolitan regional programs of today have not overcome this limitation. They do not commonly use concepts and procedures adequate to modern environmental problems. Natural elements—land, water, space and the sustaining larger environment—have not come into full focus as important basic elements in a healthful and desirable human environment. Consequently, factors such as regional stream pollution, agricultural problems, water allocation, open space, flood plain protection, recreational facilities, waste disposal and conservation needs receive inadequate consideration in most metropolitan programs.

On the other hand, this urban one-sidedness has been paralleled by specialized water, flood control and agricultural programs of the many federal, state and local agencies ranging from the Corps of Engineers to County Soil Conservation Districts. Many of their activities are fine examples of land-water studies. However, most of their programs unfortunately ignore the growing urban character and interrelationships of the problems and needs of our society. In many of their studies and programs it appears as if urban populations and cities hardly exist. This constitutes another one-sided approach to current environmental problems.

Present trends point to a vast increase in the regional diffusion of urban settlement with a resultant intermixture and blending of rural and urban environments. It is becoming apparent that present urban-oriented regional programs and present water-land oriented programs will not be adequate to deal with the new problems. Integrative adaptations are needed in professional educational curricula, in government agency functions and in the concepts and procedures of planning agencies. Our physical environment has been excessively divided and fragmented among specialists in urban areas, agriculture, land, water, public health, recreation and so forth in both education and government. A great many subject specialists, agencies and citizens are without coordinative concepts and factual data that permit awareness of present environmental interdependencies.

Important innovations in our times are the diffusion of urban population and activities across farming areas, the urbanization of farm populations, limited access highways, mass automotive transportation, vastly increased agricultural and industrial production, intensive use and consumption of natural, urban metropolitan aggregations, large and complex sewage treatment and water supply systems, mass recreation needs and pursuits and increasing incomes and leisure time. Most of these social and technological changes are only at their beginning. The problems created and the characteristics and needs of the future are in many respects already apparent. They require unified environmental study and design, integrating the heretofore one-sided procedures and concepts of metropolitan and water-land planning, for solution. Balanced attention needs to be given to all aspects of the environment—to water, land, agricultural, urban, industrial, residential and recreational needs.

In this context, land and water emerge as closely related resources. All human activities involve the use of both elements with varying effects. Water and land can no longer be meaningfully analyzed, developed or allocated in isolation from each other. Because water resources are more critical than land resources, watershed factors and water use decisions will play a leading role in determining future environmental health conditions and economic development possibilities.

Conservation and nature management objectives in an urban age must now consider the total environmental complex as a problem in applied ecology. Conservation objectives need to be extended to urbanism in all its forms, including urban planning as one mode of land-water use and management.

And correspondingly, urban planning must extend its concept to include all conservation principles and techniques. An urban plan for a city or metropolitan area is at the same time a general plan for land-water development, use and management, although this fact is not kept in awareness or made explicit under present urban planning practices.

An urban age, with ninety percent of our future population expected to live in cities and metropolitan complexes, clearly demands some form of unified environmental design. This will also be necessary for the creative reshaping of present metropolitan environments. It is a sobering commentary and rude shock to our scientific and technological pride to realize that we have not even mastered the elementary need for providing our urban populations with pure water and air. Such an attempt would require a fundamental transformation of our urban patterns.

Because of the absence of operative ecological principles in our perceptions and thought habits we find the following contradictions.

The whole history of American urbanism has been based upon the notion of growth as indefinitely extended. A state of relative equilibrium or balance, which is central to ecological insights, is defined as something abnormal or degenerative.

Quantitative concepts convert the earth successively into resources—commodities—dollars. Nature ends up obscured and obliterated in the statistical and monetary tables of economic base studies. We no longer see the elements of nature represented or symbolized, and any sense of limits is lost.

Conservation planning holds out great promise but it is apparent there is great work to be done.

DISCUSSION

VICE-CHAIRMAN COOK: Dr. Farness has given us a challenging statement which I think gets us into one matter that we have ignored with almost hysterical activity, namely the question of an optimum population. His presentation of the need for this, the need for recognizing that our environment is more than the commodities in dollars, seems to me to be long overdue.

MR. VOGT: One of the top administrators of the New York City government was recently quoted to me by a mutual friend saying, "New York City is simply too big to handle." Now we are talking about metropolitan areas and consolidations. I wonder whether Mr. Farness would care to comment on the problem of diminishing returns on effort and thought as numbers go up and concentrations increase.

MR. FARNESS: This is a very broad question; it has many aspects. I can only make one or two general comments upon it. It is entirely possible and feasible to apply in metropolitan urban planning the same general concepts that are drawn from biology, the ideas of an optimum carrying capacity, of balance and so on. We know from our studies in urbanism that as populations increase in numbers and in density in any given finite amount of space many consequences arise out of this. There is not only a rising economic cost that after some point, which we are not aware of yet, begins to go up geometrically, not arithmetically; there is also the whole problem of resource depletion, and then resource transfer from sustaining areas to areas of consumption. These are problems that we have repressed quite successfully in our interests up until now. There is no adequate research on these problems today that I know of. We have had no research in the past. There is very little that we can say specifically about excessive size, but we do know that the whole problem exists and certainly needs a great amount of attention and exploration from many different points of view.

As urbanism takes on the forms it has taken today we sadly need to apply simultaneous, varied conceptual systems to our settlement patterns. We need to look at them through the principles and concepts of biology, of economics, of the social sciences and so on.

CHAIRMAN ROMNEY: Dr. Farness, I was wondering whether you could tell us something of your opinions on the federal role or relationship of a federal government in inter-county and inter-state regional projects.

MR. FARNESS: Out of my experience I have the impression that conservation and resource problems have been conceptionalized to date mainly on a national level. I think that sitting in Washington one develops a bird's-eye view and tends to think in terms of a national economy, a national set of land and water resources, and this becomes again some kind of an abstract entity that can be only pictured and portrayed and thought about statistically. But as we begin to talk about the problems of environmental planning we must realize we are dealing with a concrete specific location on the earth's surface with all of its local unique configurations and characteristics. It is one thing to talk about resources and population pressures in an abstract national level, balancing demands against supplies abstractly, but it is a very different thing to talk about balancing needs against supplies, in the sense of producing a spatial configuration, a spatial design or plan that would result in optimum use of natural resources and create an optimum living situation.

The second line of endeavor can only be done by having local programs that have their origin and main focus in a locality of some kind. Generally in answer to this question about the role of the federal level in this whole problem I would say we greatly need expanded federal programs, but on some kind of a decentralized basis, providing technical services, assisting in making basic surveys of natural resources. We have a great deal of this to do yet in many localities. We cannot get into this kind of work until we know what the resources are. The needs for basic mapping, for topo mapping, for ground water studies are still very great. I would say generally that the federal level could be of greatest assistance in working out a decentralized regional approach to the whole need.

THE NEED FOR LEADERSHIP IN PLANNING

THE HONORABLE STEWART L. UDALL

Secretary of the Interior, Washington, D. C.

I am very glad that you have given me this opportunity to address the General Session of this, the Twenty-Sixth North American Wildlife and Natural Resources Conference. I enjoy talking to people whose business is my business and whose interests are my interests, especially as we are about to share what I hope will prove to be some of the most far-reaching and productive years in the history of the conservation movement in this country.

The theme of this Conference, Planning for Population Pressures, is to me indicative of the breadth of purpose—and depth of understanding—of the Conference's sponsors and participants.

Not so long ago, as time is reckoned, our natural resources appeared so limitless that people were no problem at all. As recently as the middle of the last century the French observer, de Tocqueville, was able to write of "that continent which still presents, as it did in the primeval time, rivers that rise from never-failing sources, green and moist solitudes, and limitless fields which the plowshare of the husbandman has never turned. Such is the admirable position of the new world that man has no other enemy than himself."

But man did turn out to be his own worst enemy, and all too soon it became the conservationist's mission to protect and preserve our land, water, and wildlife from the barren consequences of man's conviction that he held a special place in creation and that the land and its creatures were expendable. The conservation movement has—to its good fortune—had great champions in its hours of greatest need. With almost providential timing—men of extraordinary vigor and vision have taken up the cause of conservation and made it their own. To the wise counsel of Gifford Pinchot, John Muir, the two Roosevelts and Harold Ickes—to name but a few—this generation owes a profound debt of gratitude. But more often than not their advice went unheeded.

Only four generations after de Tocqueville's visit to the "primeval continent" much of our land lay eroded. Many of our once vast forests were harvested wantonly and our great rivers ran unharnessed—and polluted—to the sea. It was not until the Administration of Franklin D. Roosevelt that the full development of our land and water resources and the careful protection of perishable natural assests truly became major expresions of national policy.

But with the coming of World War II and troubled times abroad, the attention of the public and of succeeding administrations was largely diverted from our own land. The Department of the Interior—until that time a prime mover in national affairs—slowly settled into a rut of lackluster performance, content to let others shape the country and the ideas which guided it. *It has now been more than twenty years since the United States has engaged in any massive and sustained national conservation effort.* The broad programs initiated by Franklin Roosevelt—the Civilian Conservation Corps, reforestation of public lands, sustained soil and water conservation measures—have either been allowed to lapse or to drift along on the momentum of the past.

Yet it is precisely those same twenty years that have fundamentally changed what Thomas Jefferson called "the face and character" of our land. Hundreds of thousands have pushed out from the cities into the countryside—a movement that has inevitably created vast stretches of urban sprawl.

The talk today is of over-urbanization, exploding population, and vanishing countryside. And it would seem that this is only the beginning. Inevitably we, as managers of our natural resources, are faced with acute new responsibilities. We are today in a state of long-term crisis, Although we rarely concede the point, our modern industrial society depends for its survival on an equilibrium between man and nature. As Aldo Leopold, that most perceptive and eloquent conservation prophet, once said:

> "Civilization is not the enslavement of a stable and constant earth. It is the state of mutual and interdependent cooperation between human animals, other animals, plants and soils, which may be disrupted at any moment by the failure of any one of them."

We have today a new dimension of urgency in the dependence of man on nature: I refer to the need for the human animal to recreate itself in nature. The necessity to meet the outdoor needs of our people now and in the future will in all likelihood be the sharpest and most consistent pressure on our land, water and forests in the years ahead.

The overriding mandate to conservationists today is to preserve the natural habitat of man—to preserve it against the onslaught of bulldozers, cement mixers and subdividers. Because no matter how seemingly industrialized and civilized man has become over the past two centuries, he is biologically and temperamentally rooted in the soil. To allow ourselves to be cut off from our relationship with the earth, from our relationship with mountains and lakes, forests and open places, might well cause a fundamental change in our national character.

Never before has the need for imaginative and truly national leadership been as great as it is today. On the one hand we have an almost insatiable and ever-growing population. On the other hand, a limited reservoir of land and its resources. In between, as arbiter so to speak, we have a large group of dedicated and highly trained men such as those of you here today. The need clearly is for leadership in the very highest places of our Government so that we might define our objectives and proceed posthaste with meaningful planning—and action. It is therefore a matter of satisfaction that President Kennedy, in his Special Message to Congress on Natural Resources, has set forth a charter under which all of us can work with all the ingenuity, energy, intuition, and enthusiasm we can muster.

For, in my opinion, never before has a President of the United States given such a broad and comprehensive mandate to conservation policymakers. Particularly noteworthy is that section of the President's Message which deals with recreation. It is significant indeed that for the first time in history the recreation potential of our land and water has been put on a par with, say the hydroelectric potential of our great rivers. Surely every conservationist who read the President's Message must have felt a quickening of his pulse at the vast opportunities which we can achieve under this broad Presidential charter. I think I can safely say that my associates and I at the Department of the Interior felt a surge of purpose and momentum. That very night we sat down and began to assemble our plans and programs, with the realization that now—for the first time—we could put together a truly national program for the wise development of our resources including the acquisition of still unspoiled land and water in every section of this country.

It is still too early to present here anything except a broad outline of the principles and objectives which will dominate the thinking of the new Administration.

We are first of all taking a hard new look at existing programs within the National Park Service, the Bureau of Land Management, the Fish and Wildlife Service, the Indian Bureau and the Bureau of Reclamation. We are, for example, reassessing the objectives of Mission 66. There has been some concern on the part of conservationists whether some of our national parks are not being overdeveloped at the expense of their unspoiled grandeur. We are giving these considerations attention, area by area.

As you know, the Administration has ordered an 18-month moratorium on the filing of nonmineral claims on our public domain. Among the advantages to be gained from this breathing spell is the opportunity to prepare an inventory of the recreational opportunities offered by the public domain to all. Those areas which offer exceptional opportunities must be made available, through proper development, to the men and women who own the land.

Perhaps no other outdoor sport has grown as much over the past decade as has boating and here Federal reservoirs offer opportunities which often did not exist before. The construction of Tiber Dam in Montana, for example, created Tiber Reservoir where on a typical Sunday 300 boats were counted and where on the opening day of the trout season 1,750 fishermen caught 5,000 rainbow trout. But in the past recreational values of Federal reservoirs have received altogether too little attention. It is our intention to prepare plans to fully utilize recreational opportunities of new exising reservoirs and to seek appropriations for their development.

We are giving very careful study on how we can speed up the vital wetlands acquisition program in the Fish and Wildlife Service.

We have been charged by the President to formulate plans for new starts. Obviously, a national program of this kind does not mean the acquisition of new Federal parks and recreational areas only. Inevitably, and most importantly, such a program must include devices for encouraging the States to develop land acquisition programs of their own.

The need is for a balanced program of National and State parks —wildlife preserves and local recreation areas. Our great national parks represent one of the few remaining opportunities for the leisurely enjoyment and admiration of magnificent landscapes.

But America's families should be able to spend a day in the outdoors—within an easy drive of their homes—whether they are picnickers, hunters, fishermen or just looking for a place in the sun. They should not have to rely on the Federal Government for this, but rather on their own States and community. And not so incidentally, such State areas would take much of the pressure off our national parks which now must take the impact of millions of visitors each year, some of them with only a casual interest in their significance and unique splendor.

This will be a real challenge to our States—and one that they must meet for the benefit of their citizens. Already some States—such as New York and California—have led the way with legislative programs or studies which point the way for all.

We hope to encourage not only State programs but joint ventures between neighboring States to acquire relatively large open spaces near where recreation land is most needed and hardest to come by.

We are in the process of finishing an inventory of areas of great scenic beauty which should become a part of the National Park System. At the same time, we are giving a great deal of thought to whether some of these new national parks and new national seashores should not be managed as year-round recreational areas. It may well be that some areas whose beauty is fragile will serve only as living nature centers. The best management of other areas, however, may well allow more vigorous use, and be opened up to hunters, for example. We will decide in each case how to manage each area for its own best interest and for the interests of those who visit them now and in the generations to come.

I am especially eager to see that a part of the land adjoining our great rivers and streams be set aside for outdoor recreation. Such land offers unparalleled opportunities for the active enjoyment of the outdoors.

We are currently weighing various incentive programs to make it worthwhile for private landowners to open up their land to hunters, fishermen, and others. Programs of this kind are, of course, especially needed in the Northeast and Midwest where almost all land is privately owned.

And, as you know, this Administration has urged the enactment of a wilderness protection bill, similar to the one now under consideration by the Congress.

I realize that we are about to undertake a great deal and I also realize that on each particular proposal we are going to receive encouragement from some, and criticism from others. We expect to rely substantially on the findings of the Outdoor Recreation Resources Review Commission as they become available and I intend to keep in close touch with the Commission as our plans develop. We are determined to do the best we can in consultation with all who have a working interest in these matters and we are equally determined to get the job done. The land which we save now is likely all that ever can be saved, and I know that I speak for millions of Americans when I say that this generation is willing to make the sacrifices to ensure a good life for our children and grandchildren. As President Kennedy said in his Resources Message—"We cannot delude ourselves—we must understand our resources problems, and we must face up to them now. The task is large but it will be done."

THE CHANCE FOR CONSERVATION

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

Today's opening session of the North American Wildlife and Natural Resources Conference has a striking similarity with that of the Conference held here eight years ago. The national administration had passed into different custody in 1953. A new Secretary of the Interior delivered his first official public speech on natural resources at the 18th Conference. In speaking, he reviewed the responsibilities of his department and expressed hope for accomplishment.

This morning we had the honor and pleasure of the participation of Stewart L. Udall, Secretary of the Interior under a new administration. He, too, has expressed awareness of the department's responsibilities in the field of natural resources and has voiced determination to overcome the many wildlife, park, public lands and other problems that concern all of us.

Eight years ago I observed that on the change of administrations, Washington was crowded with representatives of special interest groups who were soliciting support for efforts to get profitable use of the nation's publicly owned natural resources. Everyone in this room is familiar with the self-seeking proposals that were advanced. It is history now that few succeeded and, in the process of their rejection, conservation emerged as a persuasive and tangible voice for the restoration and improved management of the country's natural resources.

Unlike 1953, many present obstacles to natural resources accomplishments are not entirely private-versus-public interests, but are conflicts of objectives within agencies of the Federal Government. These differences are not of recent origin, to be sure, but in the last few years they have become clearly visible to the public eye. Most represent fundamental policy and organization questions, which must be resolved if avowed natural resource goals are to be achieved.

Before commenting on the apparent inconsistencies within government, I want to call attention to a substantial dissimilarity between today's session and that of eight years ago. At no other time in the early days of a new administration, and at no time during the life of most, has a President sent such a compelling and comprehensive statement of natural resources problems and opportunities to the Congress. Most of us knew it was being developed, but few dared to hope that it would be so complete.

Perhaps less should not have been anticipated, for conservation is now a vigorous force in this country. The 1960 national political campaign marked the first time that major conservation groups were invited to appear before the platform committees of both parties. Most accepted, and their advice and suggestions are evident in the platform documents as well as in President Kennedy's natural resources message of February 23. Get a copy and study it if you have not done so already. Ask your Senator or Congressman for House Document 94.

The lack of centralized review agency policies and programs for water, forest, park, public land, wildlife and other resources is responsible for contradiction in the federal effort. Special commissions have undertaken various investigations in the past, but their brief assignments have been limited in scope. Another drawback is that Congress rarely is eager to implement commission recommendations.

What has become almost a traditional practice of government is that the larger agencies are able to obtain essential program support without too much difficulty. Equally deserving, but less influential, agencies must strive to justify their requests, and they are the first to be cut when reductions are made. This situation creates and perpetuates unfortunate imbalances in resource activities.

The President's message reveals that an Advisory Committee on Natural Resources will be formed within his Council of Economic Advisers. This parallels legislative proposals which seek a natural resources advisory group in the Executive Office. Extreme care must be exercised in appointing any such Advisory Committee so that all natural resources are represented. Disproportionate emphasis would result in further expansion of present inequities.

Water is discussed in a recent report of the Senate Select Committee, which recommends immediate action to prepare for ever-mounting demands. The President acknowledged this problem in his message. Two aspects of immediate concern to conservationists include the expansion and strengthening of federal water pollution abatement activities and the renunciation of the previous administration's "no new starts" policy for water resources development.

This Congress will consider proposals for significantly expanding the existing federal pollution control program. The public is demanding that the Federal Government recognize and accept its full share of responsibility in this vital matter. The President's message, like a number of bills that have been introduced, calls for greater assistance to State and regional programs, expansion of grants-in-aid to municipalities for the construction of State-approved sewage treatment facilities, accelerated research, and broader enforcement.

The suggestion for creating a water pollution control agency in the Department of Health, Education, and Welfare is in line with public thinking. That important activity must be taken out of the fifth sub-basement of that large agency. Water pollution prevention must have equal rank with or even priority over flood control, navigation, and many other types of water programs. In addition, there should be greater research efforts to find more effective and cheaper methods of keeping pollutants out of our streams.

It is hoped that in rejecting the "no new starts" policy, the Administration will not unleash projects that will destroy important resources. Projects made possible by the expenditure of public funds should be made to produce benefits public in scope. Projects which destroy or greatly impair existing resources—for example, those that threaten valuable salmon runs on the Columbia—should not be authorized or constructed until safe fish passage is worked out. Public access to water projects, shoreline recreation, fish and wildlife, and the provision of conservation storage pools must be considered. The Federal Power Commission should be forced to recognize that recreation, fisheries, and wildlife are valued by Americans, and that their continued sacrifice at FPC-licensed projects is not in the public interest.

Long-sought reorientation of the Bureau of Land Management programs has been much in the public view in recent weeks. The millions of acres administered by that agency never have approached their capacity to produce national benefit. Many of you know from personal experience that the BLM is dominated—and frustrated—by one small group of resource users. Requests for appropriations for the worthwhile programs that dedicated employees have sought to initiate invariably run aground. Most get no further than the front office. Few persons are aware of the resource opportunities that are being wasted, because that agency has never been permitted to state its case. Appropriations for BLM and for other resources agencies are investments in the future welfare of the country. They will be repaid many times over in coming years. Efforts to make the BLM a land management agency of multiple interests will be supported by all conservationists.

Retention of wetlands of primary importance to waterfowl in the tri-state region of Minnesota and the Dakotas requires forthright action. Federal activities in that area, which is the prime waterfowl breeding and nesting habitat in the United States, exemplify the pointlessness of interagency contradiction. Responsibility for waterfowl preservation is vested in the Department of the Interior. Yet the technical and financial assistance programs of the Department of Agriculture are accelerating the destruction of good wetlands there faster than they can be acquired.

The widely publicized "treaty" joined in by the two agencies last summer held out tentative hope for progress. The Fish and Wildlife Service was to inspect potholes proposed for drainage and to recommend those that should be saved because of their importance to the national waterfowl program. This was done in 12 of the 90 counties in the three-State area. Of 1629 potholes proposed for drainage and certified as eligible for federal assistance by the Soil Conservation Service, 553 were recommended for preservation. Only 128—less than one-quarter—were saved. Privately owned waterfowl habitat will persist only if landowners can receive incentives to retain productive wetlands in their natural condition. A program must be developed without delay.

Proceeds from the sale of Duck Stamps cannot finance a large enough land acquisition program. The annual income is much too small for the ambitious action that is needed. The best plan that has been suggested is the advancing of $150 million by the Federal Government which the Fish and Wildlife Service could use to buy or lease land as rapidly as possible. Future receipts into the Duck Stamp fund would be pledged for repayment of the purchase-money loan.

Another must is that the United States initiate action with Canada and Mexico to explore opportunities for preserving vital waterfowl habitat in those countries. The State Department needs to be alerted to the serious situation that has developed with respect to the destruction of waterfowl habitat and the need for mutual action. Proposed developments, particularly in Canada, have wildlife leaders in both countries deeply concerned. Federal and Dominion leadership must be exerted in this important matter.

An interagency conflict that often occupies the headlines is the one between the Interior and Agriculture Departments over the use of toxic chemicals in large-scale plant and animal pest control programs. Most of you know the unyielding positions held by personnel of the two departments. The debates about the effects on wildlife and fish of the billions of pounds of highly toxic materials that are used annually are complex and unending, but they do emphasize one paramount point. Entirely too little is known about the real impact of these poisons on man, livestock, soil organisms, fish, wildlife, and all other living creatures. Chemical control programs receive millions of dollars of support, but the research work of both departments limps along on woefully inadequate budgets.

Pesticide research must be expanded. Future decisions cannot be made without necessary information. Much more attention should be given to the natural biological control of insects, the environmental factors that influence population outbreaks, and the useful management techniques. Little has been done in this challenging field in this country, but certain European experiments show considerable promise. We should insist upon knowing the harm that may be done by broadcasting huge quantities of powerful poisons over our lands and waters. Lack of knowledge can be serious.

A blueprint was prepared for recreation and fish and wildlife programs on the national forests a few years ago. Regardless of how good it might be, the program schedule cannot be met unless adequate appropriations are provided. The Forest Service also should seek additional funds so that it can carry out big game habitat improvement on the national forests in line with its expressed intention.

The President's message made clear that he was instructing the Secretaries of Agriculture and Interior and other appropriate federal, State, and local officials and private leaders to formulate a federal recreational lands program. An objective survey should determine where additional national parks, forests, and seashore areas are desirable. Care should be taken to select the right areas to make sure that their designation as forests, parks, or seashores takes into full account the public need and their capacity to serve that need in future years.

Other important matters demand immediate consideration. These include the complex problem of protecting Rainbow Bridge National Monument in Utah from the rising waters behind Glen Canyon Dam. This problem presents a threat to the half-century concept of the sanctity of the national park system. Its solution is made difficult by the contradictory positions taken by Congress. The Act which authorized Glen Canyon Dam bars any dam or reservoir from violating any national park unit. Congress, in a complete turn-about, subsequently refused to appropriate funds for the necessary protective works.

This is the fifth year that a national wilderness bill has been before Congress. Extensive hearings have been held in Washington and in the field. The original measure has been modified in order to incorporate suggestions that have been received and to make crystal clear that the administrative prerogatives of existing agencies will not be hampered. I doubt that those who continue to oppose the wilderness bill have read it or studied the hearing record. Communications between the Washington and field offices of one federal resources agency also appear to need repair. Field personnel have been giving speeches in opposition to the wilderness bill at a time when the central office is on record in favor of it.

This proposal has been misrepresented more than any bill that has been before Congress in many years. Those who continue to misrepresent and oppose it apparently do so because they have designs on coveted value in the wilderness areas of our national forests, parks, and wildlife refuges. The wilderness bill has the President's support. It has the people's support, and it merits immediate approval by Congress.

One of the biggest boons to wildlife and to the building of precious soil fertility and moisture against a time of actual need is the Conservation Reserve program. Congress denied its extension last year. Only specious arguments can be used in attempting to justify the expensive production of tremendous volumes of unneeded agricultural products and the sacrifice of soil nutrients, moisture, and wildlife habitat. A rational plan for land retirement should be included in any farm program that is developed.

Affirmative action on the Tule Lake and Lower Klamath National Wildlife Refuges has been avoided for years. Those refuges have been compromised to the point where their fate and that of the birds using them depends on preserving the acreage that remains. Which is the more important—a few more homesteads or the waterfowl resources of the Pacific Flyway?

I have touched on a number of the major conservation issues. Most are outlined in the President's message. Remember that they represent unfinished work. Listing them on paper means little if you and I and other conservationists fail to work vigorously for their adoption. Executive Office and departmental directives must be prepared and implemented, and legislative proposals drafted, introduced, and favorable congressional action obtained. All this lies ahead.

The paints merely have been mixed. Now they must be applied to the canvas. Only when we get our shoulders to the wheel, as we have done in the past, will there be a chance for a real advance in natural resources management.

GENERAL SESSIONS

Wednesday Morning—March 8

Chairman: Paul Oppermann
Executive Director, Northeastern Illinois Metropolitan Area Planning Commission, Chicago, Illinois

Vice-Chairman: Harry E. Radcliffe
Vice-President, American Nature Association, Washington, D. C.

AT THE EDGE OF SPACE

THE FADING EDGE OF THE CITY[1]

Lynton K. Caldwell

Professor of Government and Director, Institute of Training for Public Service, Indiana University, Bloomington, Indiana

Twentieth century technology, inadequately guided in relation to civic and humane affairs, is impairing vast areas of the American countryside and is creating equally vast unsolved problems of social behavior, political organization, and public administration.

Technology, of itself, effects no changes. It is through man's use of technology that he changes environments, his own and those of others. How technology is used depends upon the assumptions, attitudes, and values of the people and the societies that use it. The expression "you can't stop progress" is often used to discourage attempts at control over technologically induced changes. Its significance lies primarily in the attitude it reveals toward social control of the technology. It does not state a demonstrable social truth.

Quite the contrary, at various times and places progress (in the sense of economic or technical growth) has been stopped or directed along determined lines by deliberate social action. Hence, the idea

[1]In the absence of the author, this paper was read by Dr. Waldo Sommers, Public Administration Coordinator, Air Force Advance Management Program, George Washington University.

that "progress" can't be stopped is dogmatic rather than axiomatic. As commonly used in America, the expression means that the free play of economic and technical forces, with minimal exceptions, should be left free to transform society unhindered by governmental action or restraint. Often implicit in the expression is the assumption that, like the tides of the sea, economic and technological forces will follow their inevitable course, ultimately defeating all efforts to control them.

The basis in thought for this fatalistic attitude toward the social effects of economic and technological change may be found in a philosophy of economic determinism, in which a large segment of the American business and political community unintentionally shares common ground with the followers of Karl Marx. This common ground is an assumption of the primacy of economic over other values. Over the mechanism of economic control the American business community and the theoreticians and administrators of Marxism may and do differ. At the extremes, the differences may be stated as "control by the market" versus "control by society through the agency of government." In practice, these distinctions are seldom clearly defined. But they represent polar extremities toward which thought and action tend to be drawn.

In America, in most affairs the market has been the primary regulator of social action and measure of social values. Its primacy is not absolute. In particular cases it has been subordinated to other values by public action or by private choice. But in the planning and development of society generally the market remains the primary determinant of social action.

This preference for the market as opposed to deliberate planning has failed to win many adherents beyond American soil. To Americans it has been an optimistic attitude, based on the premise that left to themselves, things will work out better than any group of individuals can plan. In our historic past things seemed always becoming bigger and better and change generally happened for the best. At least this was the rationalization of a popular belief. Although this viewpoint may have been found to be more nearly consistent with reality as experienced by Americans than it has by most other people, it would be difficult to prove that it held true even for a majority of Americans. Obviously the experience of most of mankind has encouraged no such optimistic faith in the ultimate benevolence of unplanned change.

It may be argued that the history of human efforts to control the future through planning does not justify optimism. Nevertheless, tangible evidence of success in planning does exist, particularly in the building of cities, where the benefits of planning can be seen and felt and the untoward consequences of lack of planning can readily be experienced. It is also apparent, however, that success in planning implies either consensus among those people concerned or the imposition of one particular set of values over others. The market provides a mechanism for social decision in societies in which consensus regarding many matters is relatively weak, but in which effective desire for personal freedom is relatively high. A high degree of agreement regarding social values might enable planning to be effected with a minimum of coercion. To some extent, a high measure of agreement reduces the need for planning. When individuals act together in accordance with a recognized consensus, the objective of formal planning is already partly realized.

The cosmopolitan society, however, with diverse values and traditions, finds it difficult to coordinate, to plan, and to control its own development. Where planning and control are extensive, as in the USSR, coercion is likewise relatively extensive. In America, where coercion by the state has historically been relatively limited in scope, the advantages of planning have been difficult to obtain, most conspicuously in the development of great cities. For the "alabaster cities" of *America the Beautiful* gleam only in the idealized visions of poets and planners. Americans generally have shown little interest in the course of their development except as they occasionally become aware that their economic interests or personal safety are involved.

Therefore, American cities are the result of a relatively unhampered interplay of technological forces controlled mainly by the interest of buyers and sellers. It would perhaps be unfair to blame this system for failure to produce good cities—cities that are safe, healthy, economical, efficient, and attractive. To create cities of this sort has not been the objective. Rarely, as in the case of San Francisco, have nature and circumstances combined to effect a relatively pleasing result. And even as regards the problems of San Francisco, the American predilection for short-range, piece-meal, economically motivated solutions threatens the charm that this great city has enjoyed.

Whether Americans really like the cities in which more and more of them live is a moot question. To argue that they would not live in them if they did not prefer to do so is specious. Human motivation is complex. One might as convincingly argue that one presumably likes the environment in which circumstances place him if he makes no effort to escape his surroundings or to change them. To the extent that (a) the idea of changing the environment has not occurred to people, or (b) they consider efforts to change it hopeless or unwise, they may endure an environment that they consider far from ideal. Dissatisfied with what they have, they have no clear vision of what the ideal might be or have no notion of how a better environment might be attained at a price that they would be willing to pay.

Thus, as population increases and becomes more mobile, as the technology becomes more complex, as traditional social ties weaken and society becomes more heterogeneous and more fractionalized through specialization, the urban communities of America reflect these developments. American impatience with theory and American preference for the *ad hoc* and the pragmatic, and acceptance of the overriding primacy of economic values almost insures that the American response to the growing problems of urban areas will be inadequate by any test. This is so because the greater number of these problems deal with matters for which the mechanism of the market affords no solution. It might be said of Americans that as a people they are precluded by their own value structure even from preserving those very values, that the logic of history forces Americans unwittingly to create an environment that they neither desire nor can avoid. An observer of American social development has stated our situation in these terms:

> We are in the unpleasant position of watching our society change under the impact of its own technology while we stand impotently by to suffer the consequences for better or worse. And this loss of social mastery cannot be blamed only on the complexity of the technological process. It also lies with the fact that the main control we exercise over the social incursion of technology is that of economics.[1]

But although we make no adequately considered or comprehensive response to the impact of our technology upon our lives, we, nevertheless, continue to push economic and technological development. In our almost indiscriminate enthusiasm for change we are writing a new chapter in the history of urbanism in which not only does the edge of the traditional city fade into an almost indistinguishable complex of encircling satellite communities, but the city itself, in its historical, cultural, and political sense, disintegrates into a sprawling confusion that the United States Census Bureau designates as Standard Metropolitan Statistical Areas.

More and more our larger central cities are becoming mere governmental jurisdictions without focus or balance in their political affairs. Less and less are these giant urban concentrations properly

[1]Heilbroner, Robert L., *The Future as History*. New York: Harper & Brothers, 1959. pp. 158-159.

described as cities in the sense of self-conscious, cohesive, purposeful communities. Their growth is the result of accident rather than intention. These new urban concentrations, corresponding to none of our traditional political jurisdictions, vitiate yet do not replace traditional patterns of local governments: city, county, and state. The American people seemingly unconcerned about the civic consequences of unplanned economic and technical change have not as yet developed institutions adequate to provide guidance and direction to this tremendous urban growth and to control the conditions it creates.

Here we confront an apparent paradox in American behavior. Our acceptance of massive change, economically motivated and technologically induced, is matched by our resistance to change in most circumstances where the economic motivation is lacking. Even humanitarian appeal, to which Americans have been generally conditioned to respond, seems strengthened by the added assurance that helping the handicapped and unfortunate is economic good sense. Anyone who has worked to obtain public support for the establishment of public parks, libraries, art museums, symphony orchestras, or for the protection and preservation of wildlife, has discovered that Americans find it difficult to evaluate these things that cannot easily be measured in economic terms. Were it not for the benefactions that have in the past flowed from concentrated private wealth, the cultural life of America would indeed be poor in relation to the abundance of its economic resources.

Nowhere is American conservatism and indifference more obvious than in the structure and machinery of government. Again, an apparent paradox. The closer one comes to the home community, the greater the apathetic acceptance of inadequacy, the greater the resistance to change. It would be easier to reorganize the Supreme Court or the executive branch of the United States government than to reorganize the city council or the water supply system in many an American locality.

The paradox of an unchanging governmental structure in a changing society is, however, more apparent than real. This is so because (a) government has in some measure changed its form and methods to meet social needs and (b) Americans, in the main, never intended their system of government generally to guide or control social change. Proponents of positive government and comprehensive planning from Alexander Hamilton to Rexford Guy Tugwell have never been folk heroes of American politics. The improvisors of *ad hoc* solutions to whatever was troubling the American people at the time have found a more receptive public response. Whether the pragmatic approach will be adequate to cope with the now compounding problems of urban growth seems doubtful.

The gist of the argument, therefore, is that the American people are rapidly and for the most part unwittingly creating severe urban problems for themselves which their traditional habits of thought ill-prepare them to solve. The prospect for an effective attack upon the problems giving rise to urban sprawl, blight, high cost and inadequacy of municipal services, organized crime, and social disorganization is not bright. Although metropolitan problems are receiving considerable high-level attention in foundations, universities, and in certain professional planning and governmental agencies, the gap between these efforts and effective public action is very wide.

Meanwhile, the tragic consequences of unplanned or unwisely planned urban growth continue to multiply. We have at hand ideas and examples of ways in which our growing urban problems and particularly our use of our dwindling resources in physical space might be brought under more effective control. But there is not as yet sufficient public pressure or public leadership to enable us to perform as well as our knowledge and economic resources would permit. Our inability to cope with the metropolitan problem or even to arouse ourselves to its imminence and its implications is perhaps as great a hazard to the future of our society as the more readily understood threat of totalitarian aggression from abroad is to our national existence.

The challenges posed by these external and internal threats have an obvious relationship. The pattern of living that develops in America will be one of the more certain evidences of the tendencies of our social and political systems. That pattern is now being shaped in the diffusion of the city over the countryside, affecting the way in which people live and work, govern or fail to govern their public affairs, and develop their private lives. If the pattern of living that develops is one of ugliness, inconvenience, health and safety hazards, economic and social instability, and frustration, the social and political institutions of America will assuredly be held accountable, and rightly so.

For the institutions of a society are simply the means by which its people organize and conduct their collective affairs. The concept and use of an institution depends upon people, even as people depend upon their institutions to meet their social and personal needs. Failure of either is failure of both. It may be argued that failure of people to use institutions effectively does not prove that the institutions are defective. But it may be answered that institutions, however theoretically desirable they may be, are not suitable for people that are incapable of using them. Institutions are, therefore, not intrinsically good or bad except as their use or misuse brings desirable or undesirable consequences.

Thus, at the fading edge of the city there is a threat of tragedy greater perhaps than the unnecessary destruction of the countryside and of conditions conducive to physical, mental, and moral well-being. It is a threat to the integrity of the American system of government and social organization. People frustrated and unhappy over the impact of their technology and economy on their daily lives are in this respect ill-equipped to meet the external challenges to their society with confidence and vigor. Loss of a people's sense of ability to influence the course of their destiny has in past times preceded the crumbling of more than one social and political system. This disintegration prepared the way for the successful onslaught of a more positive, self-actualizing aggressor.

Clearly, the foregoing remarks are in the realm of social philosophy rather than social science. As of the present, no one knows to what extent significant numbers of Americans are or may become frustrated and unhappy over the changing pattern of their lives shaped by seemingly inexorable technical and economic forces. Prediction of the future is a risky venture. But one may project present trends into the future and may question how well people will like what seems to lie ahead. I believe that in very large numbers they will not like what present projections indicate as probable.

What they will do about it if and when unawareness and indifference give way to disappointment and dismay I am not prepared to guess. But this much is certain. The cost of restoring some small measure of what contemporary short-sightedness is destroying will be very high. It will be high in economic cost, in social disruption, and perhaps high also in justice.

Historically, human societies have always nourished the seeds of their own distintegration. No past society has indefinitely succeeded in holding its values, institutions, and actions together. The society that can correct its internal weaknesses and direct its development (even imperfectly) toward realization of liberating and creative values will surely be the society that emerges from this present time of troubles as the dominant social order of the future. More than "hope" will be required of any society that meets the test.

DISCUSSION

VICE-CHAIRMAN RADCLIFFE: It seems to me that Dr. Caldwell's paper is a very erudite dissertation on sociology in this country and on the impact of our economic system—on a free, competitive economy trying to provide for some of our spiritual and esthetic values in planning.

If I may, I would like to give you a humorous incident that occurred to me yesterday before we throw this open to discussion.

In the other room I was listening to a paper and a friend came up behind me and tapped me on the shoulder, and with a grin from ear to ear, said very softly, "Radcliffe there is no such thing as the edge of space." Of course that got me thinking, and I discovered that he is absolutely correct—that whenever we develop a bigger and better telescope, we find that probably another billion light years beyond, we have discovered stars that were never before seen.

As a matter of fact, in the papers just the other day, I noticed that in the system developed at Jodrell Bank, England, to check on satellites and guided missiles, they have developed an electronic telescope, the scanning system of which covers about five acres. The scientists in charge reported that they had discovered a collision of galaxies eight billion light years away.

All school children know that our sun is just one of a billion stars in the Milky Way galaxy, and that the nearest galaxy, the spiral nebula Andromeda is a very close 750,000 light years.

When we boil it down and try to figure our place in respect of known space, we probably live on a good-sized orange. In this perspective perhaps we can be a little more vigorous, a little more cooperative in working out these problems that Doctor Sommers has pointed out to us. I have been fiddling with this for some 25 years, and I know that a lot has been done on these subjects.

Doctor Sommers, for your benefit let me say that it comes to my mind that back in 1929, the State of Wisconsin passed legislation authorizing the counties to zone rural areas for agriculture, for forestry, for recreation, and set up the *modus operandi* to work it out. In 1951 they passed legislation setting up a commission for scientific areas, nature preserves. This type of land-use planning is designed to assure open space, parks, and recreation areas for future needs of the people.

One of your colleagues, a fellow by the name of Bernard Hillenbrand, who had a paper last year before this same conference, said that what we need is a policy. We have to establish policy, and secondly we need leadership. He pointed out that the oldest political unit in this country was the county, and perhaps at the county level would be the place to get critical action on a lot of these problems that affect cities and villages. He emphasized the fact that the county has political leadership; the county has accountability; the county has a broad base for taxation, and really might be the place to start programs of this kind.

RECREATION REQUIRES A NEW DIMENSION

CONRAD L. WIRTH

Director, National Park Service, Washington, D. C.

We Americans have a national characteristic which has never been fully appreciated, not only by the world at large but even by ourselves. More than once we have found ourselves at war because our enemy misjudged our apparent apathy. Once stirred up, however, the tremendous energies of our free society become an irresistible force.

Something similar, perhaps, is happening in conservation. For years we have used catchwords such as "urban sprawl" and "exploding population"—and, more recently, "open space"—but for all this talk and real concern not enough has been done. I believe that today we see developing a new approach—even a new dimension

—to meeting the vital issue of intelligently using our national resources.

The new dimension in outdoor recreation is the new frontier of an *action* program. The long-continuing study of what this country needs is giving way to action, dynamic leadership and a bold and imaginative program.

President Kennedy in his Special Message to the Congress on natural resources has called for specific measures in the protection of our remaining wilderness and the preservation of seashore recreational areas. Of even greater significance, he has instructed Secretary of the Interior Udall to take the initiative in drawing together all Federal, State and local officials, and private leaders to formulate a comprehensive and cooperative program to identify and solve the Nation's outdoor recreational needs.

We are sincerely heartened by this direct and personal support by President Kennedy of recreation and conservation objectives that so many of us have been struggling to achieve for so many years.

That the people are awakening to the problem, becoming alert to the need, and are beginning to take the initiative is adequately demonstrated by the response they are giving to President Kennedy and Secretary Udall in their forthright stand on these issues.

It is for the President and the Secretary of the Interior to outline their program as it takes shape. Already we see that it is not only forceful, it will for the first time coordinate conservation efforts at all levels of government. We have a mandate to expand our ideas, think creatively and come to grips with the problems, opportunities and challenges that we face.

In doing so, we are not duplicating or overlapping the work and objectives of the Outdoor Recreation Resources Review Commission. Since it was established by Congress in 1958, we have furnished the Commission with copies of all of our study reports; we have worked jointly on many new studies; and we hope to supplement and implement the recommendations of the Commission.

The new dimension in outdoor recreation exists because we have recognized the ratio between open space and man's inner strength. This new dimension—appearing as it does in the suddenly frightening crush of urbanization and population growth—must result in an inner strength for the Nation.

There are few men of sound character and significant achievements who can say that they never knew nature . . . that they had never measured their strength and endurance on a mountain or against raging waters, or that they had never sublimated themselves to the beauty and inspiration of the forest, lake and meadow.

But in comparison with the recreation opportunities which we have enjoyed—and which have helped to form the character of our Nation —what opportunities will remain for the next generation and the generations that will follow? A healthy body and mind are a natural birthright of every American. The opportunity to walk alone in the open and the chance to learn something of the strict and unyielding laws of nature is beyond measure in its worth.

We need a variety of public recreation areas, ranging in kind and location from remote wilderness to highly developed playgrounds near densely populated cities. The small city parks are as important in their way as the great expanses of many of our national parks. We must remember that parks of any size open an unlimited range of healthful and emotionally satisfying experiences to people of all ages. We need, however, to provide all segments of our present and future population with adequate nonurban areas near their homes for frequent day and weekend use, as well as remote areas for vacation use. We must do this without delay.

We need also to conserve recreation resources outside the designated recreation areas, through such measures as pollution control, zoning, and land management that adequately recognizes recreation values. Perhaps there is something we can learn from the British system, which recognizes the preeminence of recreation values in some areas of otherwise private land use. Many large tree farms in this country are already programming recreational development of their resources.

As the National Park Service is a leader in the management of public recreational resources—with a major responsibility under specific law to the people of the Nation—it seems proper to review first the new dimension as it affects the National Park System.

We are now approaching the half-way mark of that 10-year program which is familiar to all of you as Mission 66 and we hope to complete the basic elements of this program by 1966, the 50th anniversary of the National Park Service.

Much of the visible evidence of this program to date has been in the form of numerous construction projects designed to improve visitor facilities and to provide better access routes to existing National Parks and Monuments. I am glad to say that this portion of the program has met with appreciation and acceptance beyond expectations.

Less visible than the construction activities, but of even greater long-range importance has been our effort to round out the system so that it will be adequate for the needs of the Nation and truly representative of the natural, cultural, and historical examples of our American heritage.

To keep this program as dynamic and practical as possible, we have been constantly reappraising our efforts and our objectives. Within the next few months we hope to report on what we think the ultimate National Park System should be. There will be some additions to existing areas and adjustments of boundaries for administrative purposes. There also will be acquisitions of new areas.

Nowhere has the need for preserving natural, open space for park and recreation use been more dramatically evident than along the Nation's sea and lake shores, where almost every desirable area has been preempted for development. An important part of Mission 66 is to preserve outstanding examples of such areas while there is yet time, outstanding seashores such as on Cape Cod; the secluded beauty of Cumberland Island, Georgia; the wild reaches of Padre Island, Texas; the still-unspoiled Point Reyes Peninsula, only 35 miles from San Francisco; the spectacular Oregon Dunes area, and the Sleeping Bear Dunes and Pictured Rocks on the Great Lakes in Michigan.

Although the critical need for seashore preservation now has the spotlight, we must remember also the important remaining opportunities inland, opportunities which will not wait either. Some of these opportunities involve one of our most delightful and significant recreation resources, namely, clean rivers flowing freely in their natural state. Outstanding examples which come to mind are the Current and Eleven Point Rivers in Missouri, for which an Ozark Rivers National Monument has been proposed. There is also the Allagash River in Maine, which presents the last remaining opportuntiy to preserve extensive northwoods wilderness canoeing country east of the Mississippi River.

Conservation of such areas involves many values: conservation of scenic qualities is of prime importance, for instance, on Cape Cod; the opportunity to study and enjoy wildlife, an all too-infrequent opportunity in many places, is also highly valued. All of this ties in with an important basic function of the National Park System, the interpretation of the values therein preserved. The latter half of Mission 66 will also show some new ideas in this essential interpretive responsibility.

In the interpretation of those scenic, scientific, and historic areas which are the physical evidences of America's heritage we sincerely hope to make dramatic progress. Telling the story of America as revealed in the national parks, monuments, and historic places is an educational function which must be extended from the parks themselves to reach those who seldom if ever go to these areas.

The opportunities afforded us in instilling love of country and providing an understanding of all those elements which have combined to make America not only great but also the hope of the world cannot be lost.

The face of America as seen by a typical foreign national visiting our national parks is something to make us stop for reflection. One such foreign visitor wrote: "I have no hesitation in saying that the National Park System represents to me the finest symbol there is in the American way of life. During my stay in the U.S.A. I had the opportunity of studying many aspects of American life, politics, etc., but I remain with the firm conclusion that the National Park System is the most admirable aspect of American life that I encountered."

There are no politics in national parks. They cut across ideological boundaries. They present to our foreign guests a picture of America very much in contrast to that of the greedy capitalist and gangster so frequently drawn.

The National Parks may well be the center of an American effort to attract visitors from foreign lands. We are beginning to learn that the Liberty Bell, the Grand Canyon, and Old Faithful are not just ours . . . they are to be shared with the world.

It is for these reasons—not just for our own purposes—that we must make the effort and spend the relatively small sum necessary to greatly expand and improve the interpretive services demanded of us.

In the management of the areas of the National Park System we are reminded of the primary purpose for which the System was created; that is, the responsibility of providing for the public enjoyment, the scenery, the natural and historic objects, and the wildlife of those areas entrusted to our management; for only if protected and kept unimpaired would they provide the fullest degree of enjoyment and inspiration for present and future Americans.

There are two questions now being asked seriously by friends of the national parks: (1) Will the new development under Mission 66 impair values or reduce opportunities for public enjoyment of the national parks? (2) Does wilderness preservation mean discarding the tradition of national park hospitality and require the rationing of visitors or the elimination of lodges and campgrounds, or other radical changes?

While the National Park Service is determined to make no compromise whatsoever with the basic and traditional purpose of national parks, we do make every effort to reconcile conflicting points of view and meet the needs of the American people.

Both the Nation itself and the national parks have changed in some important ways in the past half century. It is to these changes that we owe most of the problems which now force us to make adjustments. We do not think these adjustments will weaken the parks. As a matter of fact, we consider the use of modern techniques as a challenging opportunity to carry out our mission more effectively.

Originally some of the first national parks were so large, the roads so poor, and methods of transportation so inefficient that centers were created within the parks to accommodate visitors. Today, many of these visitor service centers have been removed or relocated in such a way to minimize any unwelcome intrusion on the park scene. Yellowstone National Park—bigger than Rhode Island and more than half as big as Connecticut—must have "villages" within it for administrative reasons and to meet the needs of visitors. Such centers in all the parks are strictly zoned and they are not "resorts." Large wilderness areas, made accessible from these centers by roads and trails, are similarly "zoned" and protected by rigid supervision of visitors' activities.

Many people greatly desire the experience of spending a night within a park. We have a responsibility to provide for this tremendously worthwhile experience wherever possible and where such development will not jeopardize basic park values.

The numbers and pressures of mankind within the national parks substantially affect natural processes. It is the obligation of the National Park Service, of course, to protect and preserve the natural condition with all its native plants and animals in their normal relationships.

With this objective clearly in mind, the National Park Service continues its long-standing policy of interfering with natural processes as little as possible, but recognizes that corrective actions occasionally are required to repair or contain the consequences of man-caused disturbances which are beyond prevention.

Habitat changes caused by man have in many instances interrupted normal movement of certain wildlife species. Many acres have been developed outside the parks to meet human population demands. This and other restrictive features have limited the range in certain respects and overpopulations occur. Predator animals such as the wolf and mountain lion are no longer effective controls.

The Park Service does have legislative authority, of course, to control destructive animal populations by means that are scientifically sound and that will accomplish the principal purpose of protecting the natural conditions of the park. Park rangers have live-trapped and removed animals for stocking elsewhere and have also assumed the responsibility of selective shooting. Man in a word, has taken the role of predator.

Until research has provided us with the answer of how to attain a balance between deer and elk populations and the carrying capacity of their environment through biological controls and other effective means, we must continue to remove animals by live-trapping and shooting. Unfortunately, we rarely have the staff or funds to make this method as effective as we would like, and some parks still are suffering from overbrowsing. We share this problem, of course, with other land-management agencies.

In searching for a solution to the problem, it may prove necessary to seek the cooperation of responsible citizens in local areas to participate in herd reductions. Such cooperation would be undertaken in those portions of a park where, in the judgment of the Secretary, such participation is practical and desirable and may be carried out safely and effectively. Equitable rules and procedures would be devised and coordinated with State wildlife management programs in any such cooperative arrangement to meet the temporary requirements of restoring a natural balance within a park.

Another way of entering the new dimension of an action program to meet the needs of the Nation for park and recreational land was demonstrated a few weeks ago here in Washington when representatives of the American Institute of Park Executives, the National Conference on State Parks, and the National Park Service met to launch a unique and dynamic crusade called *Parks for America.* This was in response to a long-felt need for pooling the efforts of all park people everywhere to meet the crisis of vanishing open space and the mounting need for recreational opportunities.

We heartily endorse this movement and urge each of you to give it your fullest support. This isn't a "conservation club" and although it must have some administrative framework, we don't like to think of it as an organization. It is more a nationwide movement reflecting the spirit of the times and dedicated to broad conservation objectives.

Parks for America will seek to correlate park planning—dovetailing the planning effort at all levels of government so that park programs, national, State and local, can adequately complement and supplement each other. *Parks for America* is a crusade in which

(1) professional park men throughout the Nation can join park-minded citizens and organizations to seek the authority and the money to bid successfully in the competitive land market while suitable park land is yet available, and

(2) the park profession will build enough strength to defend our parks from encroachment and to keep park systems from being mere land banks for other public projects.

Its backers anticipate that *Parks for America* will encourage and support the development of a broad national program covering all levels of government which would incorporate the forthcoming recommendations of the National Outdoor Recreation Resources Review Commission, the nationwide plan of the National Park Service, and master plans developed by the individual States.

In addition to the role of presenting the park story to America through an effective information program, *Parks for America* will take an active part in exploring the possibilities of obtaining Federal aid for the acquisition of park and recreation lands by State, regional and local governments on a matching fund basis.

This would certainly be the most forward-looking move yet taken in the fight for the preservation of open space, and I personally feel that we need a Federal aid program for land acquisition that would insure adequate park and open space for the future.

We must remember that although the land acquisition will be for the States and local use, the problem remains a national one, and Federal aid now is actually an investment in the future welfare of the country.

While we have no way of predicting conclusively what our recreation needs will be 50 or 100 years from today, we can certainly draw on past experience to prove that whatever the specific needs, the general need will be for publicly owned open space.

Finally, there must continue a united effort to tell the "park story" —an information program by all friends and supporters of outdoor recreation—to break down any remaining apathy toward public action and to encourage the enthusiastic cooperation of all citizens and civic groups throughout the Nation.

While some may always measure "progress" in terms of concrete and asphalt, shopping centers and sprawling suburbia, there is much more to civilization than this. Construction projects must be balanced by cool, clear streams running between wooded hills, quiet lakes, and the opportunity to hike deep into a wilderness unchanged by man. Let generations to come measure American civilization by our dedication to these values.

DISCUSSION

VICE-CHAIRMAN RADCLIFFE: After listening to Connie's outline of the programs and problems of the National Park Service, you can see why this gentleman who has spent most of his life in the public service was, a year or so ago, given the highest civilian award that can be given by a government, and only recently was given the Rockefeller Award, which carries with it a nice honorarium.

While Connie was giving his paper I ran across two paragraphs that I think are salient.

One of them is: "The long-continuing study of what this country needs is giving way to action, dynamic leadership and a bold and imaginative program." Most of you who have been in the conservation business are aware of the snowballing effect that has been going on in recent years on land use programs.

Last year the Governor put out a report and a water policy for the State of Ohio, one of the most splendid programs I have seen. It sets up a water policy; it sets up a commission to run this policy; it breaks down the state by 18 natural watersheds; it sets up methods of financing, of regulating, or distributing water; it sets up judicial procedures, and this sort of thing is indicative of what Connie just announced.

In New York State, a year or so ago, the Department of Conservation published a report—"Now or Never." It was a very complete report on the recreation situation in the State of New York, with all the usual statistics on economic income and the travel attitudes of people.

Later the Park and Recreation Project of the Tri-State Metropolitan Area came out with another study that had been underway for a couple of years, pointing out the need for recreation areas in and about metropolitan New York. This mushrooming effect — this dynamic leadership — this bold imaginative program had its fruition in the last elections in New York State when the people voted almost unanimously for a 75-million-dollar bond issue to be used to acquire park and recreation areas in the State of New York; 20 million for the outright purchase of areas of state park quality; 15 million for areas for recreation, fishing, and conservation; 40 million to counties, cities, on a matching basis, paying up to seventy-five per cent of the cost of these things.

This is the type of dynamic leadership—this is the type of political action that is necessary. I could cite three or four more. The Outdoor Recreation Resources Review Commission has just come up with an advance draft of their report; the Select Committee on Water Resources, Senator Kerr's Committee. These things are vast, voluminous, and represent great engineering, research, and planning.

Then there is another—the Open Spaces Bill—recently introduced by Harrison Williams of New Jersey. This may take five years, like the wilderness bill that has been refined and gone through the furnace.

MR. HOWARD ZAHNISER: I am an individual friend of Conrad Wirth. I live in Hyattsville, Maryland, and I am speaking here as an individual.

I feel very cautious about entertaining the concept of using recreational hunting as a wildlife management tool within the national parks.

In the first place, the hunters that I know—and some of my best friends through the years have been and are hunters and I think I am a friend of hunters—wouldn't feel very comfortable to find themselves in the open spaces as management tools, and in the second place, I am suspicious about a temptation to let my wife or anybody else trim fingernails in the food disposal. The risk is too great.

I am afraid, in our present state of public opinion with our attitudes toward some of these things, that we may make a mistake with regard to the sancity of the national parks, if we don't enter this discussion very cautiously. I wonder, Connie, whether you think my cautions are misplaced and how fast you are moving into this somewhat controversial area. I repeat, I do this as a friend and as an individual. I am not representing any organization. I speak only with the prestige of somebody who has worked in this field of wildlife, especially of the preservation of wildlife for a good many years and who has regard for hunters and the importance of wildlife management but also a deep regard for national parks as wildlife sanctuaries.

MR. WIRTH: Well, Zahny, I'll say this: I appreciate your warning and we are trying to move into it as cautiously as possible in trying to analyze the problem.

The effect of development and encroachment and use of land on our park boundary lines by people around the parks is causing us more trouble than the inside. We find ourselves more and more confined as far as range is concerned, and the wildlife are smarter than the public. They stay inside the line.

I think one of the most disagreeable jobs that the park ranger has is the reduction of a herd in order to keep a balance between the herd and the range. We are looking for a solution and certainly I did not mean to imply that the entire park system was all going to be opened to hunting. I meant that we wanted to see what we could work out with some controls and with the assistance of the people around us—our neighbors and our conservation friends in the state game and fish commissions and so forth—try to make a balance.

I go on this principle—that ninety-nine per cent of the state game and fish people are just as anxious to preserve the national parks in their natural condition. But when we get to the point where we have destroyed a balance between wildlife and the plant life there, we haven't got a natural condition, and that is the thing that is worrying me. I wish I knew an easy solution and if anybody has a solution to the problem, we are looking for it. I can assure you, we are approaching this cautiously—in fact I think this is the first time I have mentioned the subject in public, and I fully expect to get a considerable amount of flak from both sides. That's where we usually get it. We never get it just from one side; we usually get it from both. But we've got to be practical on this; we've got to look ahead. What is our problem ahead? What is the solution? How are we going to solve it? I don't know.

VICE-CHAIRMAN RADCLIFFE: Thank you very much. I am sure we all cherish the concept of the national parks and sanctuaries in all forms. We appreciate the problem that you are facing.

MR. DAVID BROWER: I have a comment that relates to both Doctor Wirth's speech and later comments.

One is a chance to make a correction. The Secretary, in the opening general session quoted a remark which I think is pertinent in connection with the dynamic preservation we are faced with when he quoted something he had seen in some publication, one we are all familiar with—"What we save in the next few years will be all that will be saved." I want to attribute that to the man who wrote it—George Fell. We misquoted him in our own bulletin and it has been misquoted ever since. I can't overstress the importance of this concept, that "what we save in the next few years is all that is going to be saved."

Thirty-five miles north of where I live in San Francisco, is the peninsula. While we think and try to figure out whether to put the left foot forward first, or put the right foot forward first, the real estate boys don't hesitate a moment. They are sub-dividing part of the strip of beach there and not long ago in the San Francisco papers there was a photograph of sewer lines that had been put in the subdivision.

You don't have to get much subdivision going—if real estators think the land is worth ten thousand dollars an acre—before the chance of making any permanent reservation is gone, permanently. So my only comment is to hope that we can move fast enough to get what we want. I make the same plea here that Holly White, the author of the Organization Manual, made for retroactive planning—acquire the land you need now, and figure out later, if you're right. If you're wrong, you can sell it at a handsome profit, but if you don't get it fast, you won't get it. If we want parks for the future, and I am sure we do, we have to move fast.

DR. CLARENCE COTTAM: I have been on most of our national parks that Connie refers to and I am forced to say that I can agree with him. Protection of some of these areas must take place because it is just foolishness to have a beautiful park and let that park be emasculated by deer in poor health. I have a whole stack of Kodachromes to show this very vividly.

There is another angle, however, and that is that some of the grazing in past years hasn't been done by wildlife quite as much as by domestic livestock, and I wonder if we have domestic livestock in some of these areas that ought to be eliminated.

For example, I saw just the other day, in a paper from Utah, that Bryce Canyon is over-grazed by domestic livestock. After twenty-five years I know some of the problems and responsibilities of our administrators—namely, that when they take over these areas, oftentimes they have to take them with restrictions, or they wouldn't get them. As I remember, there are places where grazing was permitted for a certain period, but for Heaven's sake, after that period is past there should not be public grazing of domestic cattle and sheep in those areas.

I must agree with you, that in certain areas, when you have an oversupply of deer, or elk, in a limited pasture, you must destroy some. There is no question about that and I think no exception. I think the question is going to be on how you reduce them.

If you bring in a bunch of novices, and they break their limbs, you're going to suffer bad public relations. So you had better deputize all the people you bring in, and I hope they are hunters, and that they know the front end from the rear of what they are shooting at.

I would like to make one point with regard to the statement: all that is to be saved must be saved in the next few years. I have said this, too, many times in the last few years. I would call attention to one point that is often overlooked, and that is that our population is moving into the cities rapidly, even though we have increasing suburbs. The amount of land needed per capita and per family is going down. The emphasis has to be on land close to the city, in the long run, allowing for the population increase. You are not increasing the land needed for actual living purposes per person because of urbanization. I think the thing we have to say time and time again is that land that is to be saved close to the cities must be saved now, because in the long run, in spite of the increase in population, it is not working in this direction. The amount of land actually occupied per family—the land needed for recreation, must be picked up, and picked up fast where the people are living, and I think it is quite evident, in more compact areas. But I think we put out an understatement when we say that all good land that is to be saved must be saved now—in the next few years. I don't hear this emphasized much, and I would like to bring it out.

VICE-CHAIRMAN RADCLIFFE: Thank you very much. The chairman has given me a minute and 13 seconds to say something with reference to the first paper where he mentioned some old civilizations. Arnold Toynbee in researching his great history of the world discovered that 19 out of 21 notable civilizations passed not from being conquered from without, but from decadence from within. More than likely a debasement and misuse of their renewable natural resources. Too often when discussing these problems we get talking about economics to the detriment of the spiritual values of health, happiness, contentment, cooperation, tolerance, compassion,—all these spiritual values that you can't measure—you can't put them in a tort—you can't put a ruler on them.

The one great trouble I think is that we gag on the use of this word—continuously, I mean—we shy away from these values. What we have to do is to rediscover and reassert these moral values and go out and fight for these things. Because after all, in order to get even the smallest piece of land, you have to prove a public benefit. To do it, you've got to be sold on the project. And then you have to pull out all the stops—use your papers—use your magazines—use your women's groups—use your service clubs, your chambers of commerce, your boards of trade, Boy Scouts, youth organizations, and so on. Go out and fight for it and you'll get something accomplished. This is something we should do.

THE COMING END OF THE SUBURBAN BOOM

FREDERICK GUTHEIM

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The increasing urbanization of the United States has been frequently reiterated in recent years. About two thirds of the national population already lives in 212 standard metropolitan areas as defined by the Census. These metropolitan areas are cities embracing at least one central city with a population of fifty thousand or more and typically embracing a number of separate political jurisdictions. But beyond the fact that we are now a nation over two-thirds urban, substantially the whole of the anticipated future population growth is destined to occur in these great urban complexes.

The nature of the modern city is such that its growth has been taking place largely at the periphery. The central city, as it is only too clear from the 1960 Census, in most places is not growing or, as in the case of Washington, is actually losing population. As room has been found in the central city for new forms of transportation, parking, commercial and industrial growth; as the older congestion in slums has been removed; and especially as families with children have escaped the unfavorable environment of older cities and migrated to new suburban communities—these changes have left their mark on the central city. Most central cities in metropolitan areas today find they contain predominantly a daytime population of employees and customers rather than a resident population. Those who make their home in the central city tend to be the very young and the very old, the very rich and the very poor.

The predominant characteristic of our postwar growth has been the development of the modern American suburban community. We think of the suburbs as residential areas. While it is true that many of them are predominantly residential, it would not be accurate to neglect the equally great growth of decentralized manufacturing plants, shopping centers, or other forms of activity and institutions. Yet in most cases this related decentralization has taken place as business has followed its customers to the suburbs and established suburban and regional shopping centers; or as much business, requiring types of labor that exist in good supply in suburban communities, has found it easier to operate there than under the more congested or competitive conditions that prevail in the central city. It must be concluded that the suburban movement has been predominantly one of families seeking homes in the outlying parts of our large cities, and that the larger part of other suburban growth is related to this fundamental movement.

During the last fifteen years, since the end of the war, this suburban movement has taken place on an enormous scale. It has been estimated that four thousand families a day have been moving into new suburban communities. In general they have been occupying new homes built by the nation's builders who, during this period, have produced a million to a million and a half houses a year, almost all of them in suburban communities. These have been almost entirely single-family houses, at densities typically of four homes to the acre. Each has been thought of as occupying a large suburban lot, within whose limits many family activities, especially those connected with child care, could be accommodated. This type of housing consumes vast amounts of land, far more than row houses or apartments, and broad-front lots greatly increase housing costs, particularly in streets, water and sewer lines, and other land development items. The uniformity with which this relatively low-density housing development has been taking place, and the thousands of square miles that have been consumed by this process, coupled with the leap-frogging or by-passing of substantial tracts of vacant land in the process, has generated the descriptive term "urban sprawl" to describe this relatively unstructured suburban development. As an illustration of the rate at which open land has been consumed by suburban home-building, it is reported that if all the land withdrawn for urban use in the Santa Clara Valley since 1947 were consolidated, it would approximate twenty-six square miles; however, subdivisions have been placed in such a manner as to commit a total area of two hundred square miles to urban development.

It is the uniformity of the appearance of today's suburban community that has given rise to the visceral apprehension of over-standardization. The San Fernando Valley, seen from the air, is such a thought-provoking spectacle. It is true that the external appearance of uniformity accurately reflects the relatively uniform age, marital condition, family size, per capita income, and social status of those who have purchased the homes.

The suburb of the last fifteen years has been the place in which the marriages and children that were deferred during the war are found. During this fifteen years of postwar growth, an exceptionally large number of families in the age group from thirty-three to fifty-five years came into being. These were also years of housing shortage in which government mortgage insurance and other forms of assistance and planning directed the concentration of housing activity to overcome the postwar housing shortage, predominantly in suburban areas where other market conditions dictated the production of single-family houses.

Given the relatively long period over which this type of urban growth and housing production has been the predominant characteristic, it has been assumed by many people, including such experts as urban planners and housing specialists, that the future would see more of the same. Our future population growth has been translated, therefore, into identical terms yielding the image of future metropolitan areas that, like Los Angeles, can be described as "one hundred suburbs in search of a city."

It has also been assumed that the principal problems that cities face in the future are predominantly those associated with overcoming the deficiencies that have become increasingly apparent in suburban growth. One of the most important of these is the failure to preserve any parks or open spaces adequate to meet the needs of our present and future population, whose numbers are also associated with such characteristics as greater per capita income, higher educational status, far greater leisure, and substantially greater mobility as the result of widespread automobile ownership. Such parks and open spaces as had been provided in our recently developed suburbs are almost exclusively in small tracts of land suitable for playgrounds, many of them actually related to schools. While there has been a substantial addition to the total recreation areas of the nation, little of these recently acquired parklands have been located in metropolitan areas or are the type suited to the recreational and cultural needs of the new suburban population. In the great and nameless cities that have come into being as urban growth has become interurban in character, these deficiencies have become pronounced. It has been found, for example, that the seventy thousand suburban residents of Fresno, California, are not served by a single park.

As has been noted previously, the expectation of the character of future urban growth has been based almost exclusively upon the projection of the type of growth that has occurred during the spectacular past fifteen years. To an even more precise degree we have projected the abnormal growth of the four years 1947-1950, years in which an average of 1,100,000 new urban households were being added. This rate may be compared to a figure of 300,000 new urban households annually in the decade of the 1930's. In criticizing such projections, the economic consultant Robinson Newcomb has pointed to a number of circumstances that are not likely to be characteristic of future growth but which explain much of the magnitude and character of past growth. He has noted, for example, that while nearly 15 per cent of the increase in urban population has been due to migration from farms, this source of urban growth has largely been exhausted. Dr. Newcomb has also noted that up to 1956 marriages exceeded deaths, but the dissolution of households as the result of deaths has been taking place at an increasingly rapid rate, thus reducing the total number of households. This authority has also pointed to the very substantial demand for housing units by "other-than-married couples," a factor of importance in the period 1950-55, but one of greatly diminished significance today.

Of the many social and economic changes that may be responsible for a different pattern of future housing and urban development than what we have known in the past fifteen years, however, probably the most important is the changing age composition of the population. In the next decade there is not expected to be a significant increase in the number of households headed by people between the ages of thirty-five and fifty-five—the age group that had been responsible for the greatest housing demand in the past. There will be a big increase in young households—those just getting formed—and in old households—those containing individuals who have retired from active life. These latter groups whose numerical significance is increasing require a quite different type of housing than the suburban home that has earlier been described. This changing housing demand has already been reflected in the markedly increased emphasis upon apartment houses of all types, both in central cities and in suburban communities, and in special types of housing for the elderly.

It is quite possible that we have at the present time substantially all of the conventional suburban housing that will be required for another decade or two. Not until 1980 do demographers anticipate any recurrence of the spectacular rate of family formation that characterized the period 1947-50.

If the demand for conventional suburban homes appears to be slackening, the difficulties that suburban communities have been facing have also been increasing to such an extent that the attractiveness of this way of living has been markedly affected. We have already entered a period of disenchantment with the image of suburbia that was so attractive ten years ago. Among the dissatisfactions that have been mentioned are the increasing cost of suburban life, particularly the cost of suburban governments due to their small size and general "balkanization" coupled with the abnormally heavy financial requirements of an extensive new school system; the low standard of public services in suburban communities, dramatically exemplified by such rudimentary problems as removing snow from highways; the low cultural and leisure standard of suburban communities where the capacity to make extensive outlays to build libraries, museums, concert halls, and other cultural institutions is weak and where even the provision of outdoor recreation facilities has been conspicuously inadequate; the increasing difficulties of transportation, especially the journey to work whether on crowded expressways or an obsolescent mass transportation system. The suburban communities of a metropolitan area have shown little ability to deal with their problems or even to find an over-all view of them; and their spot deficiencies are many. The catalog of dissatisfactions could be greatly expanded, and it is steadily being enlarged.

The trek back to the central city from the suburbs has already begun. The principal factor seems to be greater choice in the housing market. Cities are also fighting back with urban redevelopment programs, proposals for rehabilitating central business districts and for generally strengthening their ability to provide a high standard of service for the central requirements of a much larger metropolitan area. They have the money. They are getting more Federal aid. Increasingly, suburban communities are being committed to the generally helpless image of themselves as specialized residential communities. Yet the diversification of suburbs is one of the principal future trends that are already discernible.

Diversification is taking many forms. There is, within the framework of the residential suburb, a growing diversification of housing types and a greater range of housing costs. More apartment houses are being built. In some cases these are tall buildings; and in others, garden apartments. The significant thing is that they all represent far higher densities than any form of single-family dwellings that we have known. They also represent the advent of renting rather than home ownership in the suburban economy. The repercussions of this in local fiscal policy and tax debates have already become evident.

The second form of diversification in the suburbs is economic. The residential suburb is now being replaced in many areas by one that is more balanced in activity. It contains substantial areas devoted to manufacturing, services (other than local business, which has always been well established in the suburban community) and the development of other specialized economic activities associated with transportation, leisure, or cultural activity. Contrasted to the 1950 suburb, as it came raw from the hand of the builder, even the advent of churches, schools, and other rudimentary community institutions has been a notable development, bringing with it the pressure to find housing accommodation for such individuals as school teachers, ministers, and others who cannot typically afford high suburban home ownership costs. The diversification of economic status has also become evident. Today's suburb is increasingly less one of families with relatively uniform incomes, as was the case a decade ago, and increasingly marked by a range of incomes. Racial diversification is also a feature of many suburbs, especially the older ones, as Negro families of the central city have acquired sufficient capital to enter the suburban home-buying market and as they, like other immigrant groups, seek to share in the prevailing demand for suburban community living.

A revolution in transportation is making up which, taken in association with these other changes, may have the effect of reducing the exclusive reliance upon travel by private automobile, chiefly on urban expressways, and substituting instead, at least for the journey to work, such forms of express mass transportation as electric railways, express buses in reserved rights of way in expressways, and perhaps even such advanced technological types as the low-pressure "air-car" that hovers over a barely improved right of way, or the monorail—both capable of speeds roughly twice that attainable by the private automobile.

The image of the future suburb thus is wholly different from the suburban community we have been creating, and making jokes about, during the last fifteen years. So far as that type of suburb is concerned, we can say with some assurance that the suburban boom has ended. The future suburb—whether as developed from existing communities, or as new towns—will be markedly different, so much so as to demand a new word for it. Nowhere is this difference likely to be more conspicuous than in the distribution of population and the amounts of land required.

We are now on the threshold of metropolitan development in which suburban communities will be far more self-contained and independent from each other, and from the central city, to which they will always be linked for certain essential purposes. The free-standing satellite community may range from 25,000 to 100,000 in population. At the upper ranges it will be able to provide for virtually all of its basic needs, including a substantial part of the cultural activity that was formerly reserved for the central city.

Perhaps the most important distinction will be that the future satellite suburb will contain its population in a far smaller area than the older and more wastefully sprawling suburb. This development can be greatly furthered and will itself facilitate the retention of large areas of open land within the metropolitan area that are held free from urban development. Let me at this point call to your attention Senator Harrison Williams' bill to authorize loans for the acquisition of metropolitan regional open spaces, the principal Federal measure that has been offered, and which I regard as the first step in a more ambitious long-range program.

Metropolitan open spaces will be constituted by the aggregate of public and private open uses of the land. These include not only publicly-owned parks but conservation areas, watersheds, and natural areas maintained for scientific or cultural purposes. They will also include agricultural and other privately-owned land that may be restricted by public regulation or through the acquisition of some form of easement or development right. These privately-owned tracts could also embrace swamplands, flood plains, watersheds, or a multitude of types of land whose open character is required by some form of conservation such as the maintenance of water tables or flood control. It could include golf courses, or areas for hunting and riding. The provision of large areas of land for outdoor recreation and such typical uses as fishing and hunting, indeed, is a further requirement if the metropolitan city of tomorrow is to offer its inhabitants a rich variety of leisure-time opportunities. Perhaps one of the most significant of these is the use of lakes and waterways for recreational boating.

The city of the future, we can increasingly discern, is one that will be better articulated, organized into more solid and more open pieces, less sprawling, although covering perhaps a still wider area than at the present time. Where it is developed, it will be intensively developed; in other places it will be held firmly in its open character.

It remains necessary only to comment that the future city that I have sketched, and its suburban communities in particular, offer greater social and cultural advantages as well as inherently greater economies than the suburbs we have known in recent years. They offer, to begin with, a greater variety of housing types and tenures that are more consistent with the economic facts of life as we know them. The experience of living in a socially diversified community of this kind is certainly a richer one to both children and adults. Communities of such heterogeneous character are inherently more democratic and offer more satisfactions and wider choice to their inhabitants than the more narrowly structured, older suburb. The tax base of satellite communities of the type I have described should be larger and stronger than the wholly residential suburbs of today. There are greater business opportunities and more satisfactions to the consumer in that type of community. Architecturally we should recover the urbanity of space in plaza and sheltered areas, the excitement of crowds and social purpose. From the point of view of the land itself, there are major gains. Instead of the relentless and inexorable chewing up of the best agricultural lands and the resulting pattern of nine acres lost to either human or natural use for every acre required by urban development, it is possible to substitute a pattern where open space in its aggregate form is large enough, strategically located, and of such a character that it can contribute positively both to maintaining natural balance in metropolitan areas, and to providing room for the human activities and enjoyments that belong in our increasingly leisured and educated society.

From the viewpoint of the conservationist this consummation can be furthered by steps that will encourage the planning and management of open spaces in metropolitan areas in an over-all fashion. There will not only be the immediate benefit of structuring and concentrating the developed areas which urban growth will require, but each use of the open space itself will gain strength from the other open uses and from being allocated according to its particular needs of area and type as well as location. We need a total strategy, if not a plan, for open space in each metropolitan area.

We are far from being organized to contribute as strongly as necessary to the creation of a future urban America along the lines I have mentioned. The urban programs of Federal, state, and local governments have tended to ignore the reciprocal need for well-planned urbanization and firmly held open spaces. We have yet to make a beginning at inventorying the necessary open uses of the land and of giving them a corresponding importance accorded the developed portions of the area. In few metropolitan areas do we know what particular pieces of land should be preserved because of their value as natural scenery, as habitats for wildlife, as recreation areas qualified by location and character, much less by their contribution to an over-all plan of open spaces. The making of such metropolitan open space inventories is an immediate national need, one to be undertaken as speedily as possible in metropolitan areas with the aid of all possible and appropriate state and Federal assistance.

To reflect in such inventories the greatest conservation wisdom and the broadest spectrum of interest in open space is an intellectual challenge that should enlist a response from our universities, museums, and other scientific communities, from our more thoughtful educators, conservation and recreational leaders, and cultural authorities, and from that widespread network of citizens' organizations that have in the past been the mainstay of all our conservation and outdoor recreation programs. Working together, these groups can be counted upon to provide for each of the future cities in which our American population will be so largely concentrated the appropriate pattern of open spaces that will direct and concentrate the necessary urban growth into a wholly new and far more desirable pattern than the formless, sprawling, monotonous, wasteful, and inhuman suburbs that we have so heedlessly planned and built during the past fifteen years and which offer nothing in the way of a pattern for future urban development.

We have yet to determine what the urban areas in which the next sixty million Americans will live will look like or how they can be brought into being during the next forty years. But one thing is certain—the challenge must be faced in a creative spirit and not by assuming that we can project the older suburbs that we have known. Bold visions and humanistic ideas of the future city are what we need.

TECHNICAL SESSIONS
PART II

TECHNICAL SESSIONS

Monday Afternoon — March 6

Chairman: William H. Elder
Professor, Department of Zoology, University of Missouri, Columbia

Discussion Leader: Jessop B. Low
Leader, Cooperative Wildlife Research Unit, Utah State University, Logan

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WETLAND AND INLAND WATER RESOURCES

WATERFOWL FEEDING STATIONS FOR CONTROLLING CROP LOSSES

Merrill C. Hammond

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Waterfowl damage to small grain crops is still a most urgent management problem in the Canadian Prairie Provinces, in northern North Dakota, and northwestern Minnesota. The present drouth, and a reduced number of mallards and pintails, may be a temporary blessing. We may have time to prepare for the next wet cycle, when duck depredations will strike again in full force. The duck hunter may awaken to the fact that this sport will be increasingly more expensive each year and that he must be concerned about problems beyond the range of his 10-gauge magnum.

Seventeen years ago, Day (1944) described some United States trouble areas to this group; for ten years we have been aware of Canadian difficulties (Colls, 1951). We now recognize that a serious problem exists. Each year a few more individuals are getting brief exposures to the simultaneous combinations of ducks, swathed grain, foul weather, and irate farmers.

While cranes and geese cause restricted damage within the area delineated above, mallards and pintails alone form threatening concentrations on most large water bodies. The terms *ducks, birds, grain-eaters, crop-losses,* etc., are used in this paper as synonyms for these two duck species and their activities.

The shotgun, rifle, mechanical exploder, and scarecrow are presently accepted control "tools." A number of other frightening devices have been tried with varying degrees of success. The use of feeding stations at Lower Souris Refuge in North Dakota; Delta, Manitoba; and in California present new approaches to the problem. Modified hunting regulations may have helped to a degree in Canada (Hochbaum, Dillon and Howard, 1954:179). The limited investigations made into chemical deterrents, new crop varieties, and modified crop harvest methods have been less fruitful. The farmer now has the primary responsibility for application of these practices.

CONTROL WORK IN OTHER AREAS

In discussing waterfowl population levels, Munro and Gollop (1955:120-121) pointed out some years ago "...the limiting factor at present is crop damage in the Canadian section of the Big Duck Factory during August and September." They suggested that, even then (1955), mallard and pintail populations were higher than "carrying capacity."

The Province of Saskatchewan experimented with lure crops (Stephen, 1959) and has a Government-sponsored, partly hunter-financed insurance program (Paynter, 1955). Manitoba supported a feeding program on the Delta marsh in each of the three past years.

The Federal and State feeding-scaring programs in California have been well documented since 1944 (Day, 1944; Horn, 1949; Biehn, 1951; Scouler, 1952; and Lostetter, 1956). The effectiveness of the operation has been limited principally by the quantities of food available. Biehn (1951:62) estimated that California's problem could be handled with 81,000 acres of land devoted exclusively to growing crops for waterfowl. He concluded (p. 69) that ". . . these feeding and resting areas will eventually solve the greatest part of the problem of waterfowl depredations in California." A year ago Lostetter (1960) again emphasized their recent importance.

HISTORY OF LOWER SOURIS FEEDING PROGRAM

The Lower Souris Refuge marshes were restored and first partially flooded in 1936. In 1939 an estimated 150,000 to 200,000 grain-eaters caused serious losses of shocked (stooked) grain. At that time the refuge share of agricultural crops was left standing and was not used by ducks during harvest season. In the succeeding years, part of the crop was dragged down, mowed, or burned to make it available.

After learning that much of the grain was wasted when fields were burned, mowed, or dragged, threshed grain was hauled and spread in those used by ducks. Spectacular concentrations sometimes developed, but much grain remained uneaten. In wet weather tractors were needed to pull loads in and out of the fields. Some populattion segments never found the grain. During one bad season, in desperation, grain was carried by barge and fed in shallow water areas. Later on, fall-flooded domestic crops were tried, but found to be expensive and undependable. Despite intensive patrol by a crew of ten to fifteen U. S. game management agents and refuge personnel, birds still caused damage. Aerial hazing claimed the lives of one refuge manager and one pilot.

A program reappraisal led to the establishment of eight shoreline feeding stations in 1953. Three more were added in troublesome areas by 1955, and the eleven have met the needs since then. Patrol time has been reduced to the point that most employees can attend to regular duties. Additional emphasis has been given to demonstration of control techniques and initiation of self-help programs among land owners. Earlier farmer "uprisings" have disappeared.

Do not get the impression that everyone except the truck driver goes fishing during harvest! Field flights by ducks still occur. A Bureau pilot stays on the job. Some ground patrol is carried out regularly, with additional help used in stormy weather and when the pilot observes field-feeding birds.

There were various combinations of prolonged harvest seasons, large mallard-pintail populations, heavy rains, snow, and flooded fields in 1954, 1956, and 1959. In the latter year, some 40,000 birds moved into a hundred square mile area where many fields of standing grain, swaths, and stubble were covered with water. Even under these unfavorable conditions, the combination of feeding and intensive hazing limited losses to an estimated 2,500 bushels in both 1954 and 1959; to only 300 bushels in 1956. The estimated average, 1953 to 1960, was 800 bushels total damage annually on the 700-square-mile trouble area within ten miles of the refuge. For the four years when damage estimates were made prior to 1953, the average loss was nearly 20,000 bushels annually.

Since 1941 the peak area population ranged from a low of 81,000 to a high of about 250,000. The main harvest period varied between 30 and 90 days, the season's total duck-days use between two million and fourteen million. Since shoreline stations have been operated, the minimum number of bushels of grain fed and consumed was 5,925 (1953), the maximum 25,115 (1956).

At Lower Souris the feeding-hazing technique has gradually improved to the point where crop losses on neighboring lands are now of negligible proportions. Except in a very wet season, or during stormy weather, early morning and evening aerial patrols by a Refuge Branch pilot are usually successful in locating occasional field-feeding flocks and hazing them back into the refuge. The technique has now been well tested under a variety of adverse harvest and weather conditions and could undoubtedly be used at many other localities where crop depredations occur.

The following sections present a brief description of the method used, its effectiveness and limits, an analysis of costs as compared with crop damage which might otherwise be expected, and general information to guide the novice feeding-station operator.

FEEDING STATION OPERATION

1. *Site selection.* The better sites for feeding stations are natural feeding, loafing, or "gathering" areas, but good sites can be developed elsewhere. They should be near the flight lines of known field-feeding birds. Over a period of years, new traditional flights of six miles or more along the marsh to feeding stations have developed, however. Many adults must remember station locations from one season to the next. Depending upon the character of the marsh and upland, Lower Souris stations are 2 to 10 miles apart. (See Figures 1 and 2.)

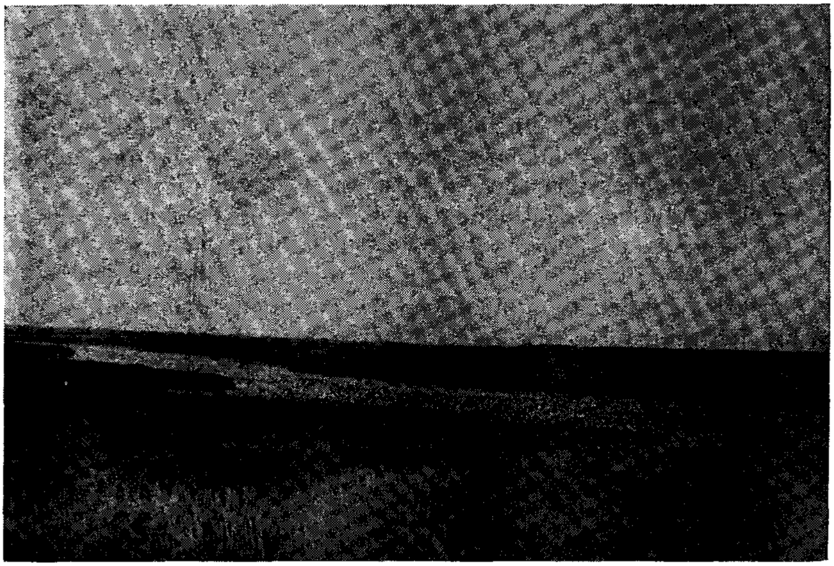

Figure 1. Feeding station along shoreline at Lower Souris Refuge

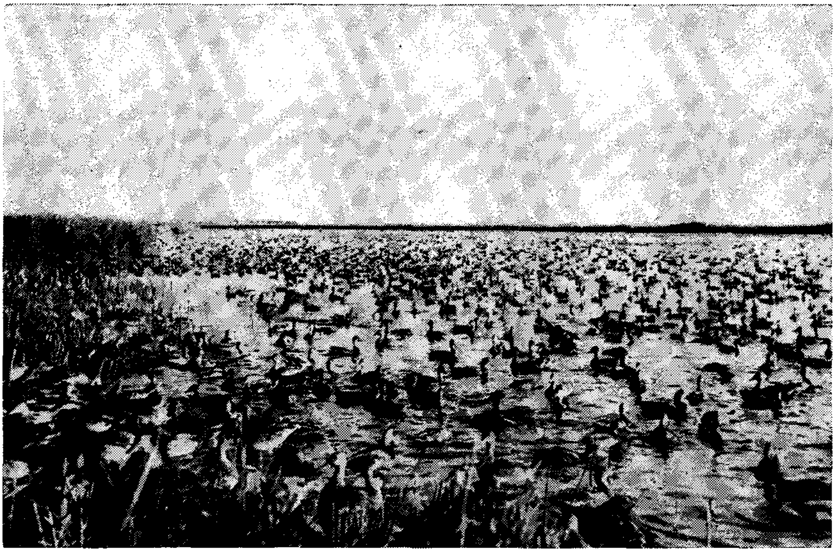

Figure 2. Pintails and mallards at feeding station
W. F. Kubichek—1953

Size of water area adjacent to the station seemed to limit the number of birds using it during 1955 to 1960. Channels 400 to 500 feet or more wide accommodated 12,000 to 17,000 birds; those 200 to 300 feet wide, less than 10,000. Water depth did not seem to be important within the ranges of about 1 to 4 feet. If there were pondweeds, they attracted birds to the station vicinity in early season and provided an alternate food. Sloping shorelines with a firm bottom and a gravel layer were needed so trucks would not become mired during wet weather. Ducks used the sites for grit and loafing from early spring through fall. One station is on a graded road near the water's edge and three are on large dikes. It is desirable to have an upland area measuring at least 100 feet on each side, although this may not always be possible. An all-weather access road or trail is more important than some other site characters.

2. *Site preparation.* Emergent vegetation should be removed from the shore and water and tall vegetation from the station and immediate surroundings. This seems to be important in promoting a "feeling" of security among the ducks. Use of nonselective herbicides and soil sterilants will reduce annual maintenance. Leveling is usually necessary for rapid unloading and to prevent damage to truck hoists when raised.

3. *Feeding.* Grain is stored at refuge headquarters, where trucks

are kept, and also near feeding stations. It is loaded with portable elevators. The dump-type trucks have adjustable end gates, which permit even, rapid spreading. A season's maximum expected need of 30,000 bushels is kept on hand, if possible, by hauling from other Federal refuges after the harvest is completed.

Feeding is started in early August soon after the first barley is swathed. About 2 to 10 bushels per station are spread along the shore and in the water. From this time on, grain should always be present for morning and evening periods, gradually increasing the amount as the population increases.

Stations should be inspected daily to estimate numbers of ducks using them, to determine the quantity of grain needed, and note possible disturbances. A good truck driver who understands the program can handle the feeding fairly well. Sudden population increases, as migrants arrive with stormy weather, should be anticipated by increasing the quantity of grain.

The question of how much and how long to feed will depend upon several local considerations:

(a) The quantity of grain available. If feedings are short, pintails arriving first in afternoon or evening, will clean up the feed before mallards arrive. This is apt to encourage mallard flights to grain fields.

(b) If patrol is adequate, the amount fed daily can be reduced and total season's feeding period can be shortened.

(c) Local farming practices—how much stubble is available, how rapidly it is plowed.

(d) Weather and rate of harvest progression.

(e) Availability and use of natural foods.

(f) Traditional feeding habits established in the grain-eating segment of the population.

All locally raised grains were used in palatability experiments. Wheat and barley are acceptable, but barley has higher yields and is cheaper. Wheat is consumed more rapidly than barley, either because it is preferred, or because the lack of awns permits faster feeding. Oats are much less acceptable to the ducks, but can be used if mixed or spread with wheat or barley. Shelled corn, millet, and speltz, usually mixed with wheat or barley, were all eaten readily. Ducks avoided ear corn in a single trial made.

4. *Grain consumption rates.* Adult male mallards consume small grains at rates of 2.5 to 7.0 ounces per day according to several writers (Jordan, 1953:121; Horn, 1949:583; Bihen, 1951:51; Bossenmaier and Marshall, 1958:24). Some of their records were for captive wild birds; others are measurements from field-feeders. Collections,

experiments, and feeding-station records at Lower Souris indicate that maximum daily consumption may approach 10 ounces, and at stations may average somewhat more than 8 ounces. Pintails have about half the storage capacity, but consumption based on body weight (Jordan, 1953:122) should be about 80 percent that for mallards (Bellrose and Hawkins, 1947:424). This suggests that pintails must spend more time feeding each day, either at stations or on natural foods, which our field observations verify.

The mixed populations at Lower Souris, with the pintail portion varying between 25 and 80 per cent during the harvest season, consumed an average of 6 to 8 ounces daily; about 7 ounces in each of three years. A bushel of grain (mostly barley) fed about 125 ducks a day. When grain supplies were short (prior to 1952) it was possible to hold birds reasonably well on stations during favorable weather with a 4- to 5-ounce average per bird. Obviously some birds did not get any grain at times under these conditions.

Variations occur with feed shortages, disturbances, changes in sex, age, and species composition, changes in air temperature, and kind of grain used. Our experiments with penned birds showed that disturbance halted digestion, but that full gullets would normally be emptied between feeding periods. Some birds filled their gullets in a minimum of ten minutes time on a station; but they averaged fifteen to twenty minutes there, sometimes making several trips to water and back.

5. *Populations.* With peak area populations of 87,000 to 187,000 since 1953, most of the Lower Souris individual station peaks have been between 5,000 and 20,000 birds. If bad weather strikes or equipment trouble prevents grain distribution, extremely large numbers are a definite hazard to fields in the immediate area.

The rate of response following first station feeding varied considerably between years. It was influenced primarily by pondweed productivity and weather. During 1953 to 1959, considering the total refuge and off-refuge population, percentages using feeding stations were:

Within 5 days— 1 to 35 per cent
Within 10 days—10 to 75 per cent
Within 15 days—10 to 70 per cent
Within 25 days—30 to 80 per cent
Within 35 days—50 to 90 per cent

The peak use of 50-90 per cent occurred as early as 10 days and as late as 35 days after feeding was begun. For 1953 to 1960, about 55 per cent of the total harvest season's duck-days use was on natural foods; 45 per cent on grain obtained mostly from feeding stations.

6. *Limitations.* There was no evidence that feeding at Lower Souris increased the population size above that normally present. We found that, when intensively hazed, birds abandoned scattered water areas and moved 10-15 miles to the refuge, where they soon learned the location of feeding stations. Waterfowl migration through Lower Souris is generally correlated with weather patterns regardless of artificial feeding.

Stations should not be located on sites subject to botulism losses. In some instances, it appeared that feeding reduced mortality by shifting concentrations to safer parts of the marsh. Large numbers of birds feeding regularly on a small area may favor disease transmission. There is no evidence, however, that this has occurred at Lower Souris. In reality, the actual density of birds is not much greater than that on favored loafing sites.

The feeding concentrations needed to be watched closely so that adequate warning and patrol can be established if field flights begin. Feeding may reduce the use of natural food and grain in stubble fields during the period stations are operated—to some extent this may be wasteful. On the other hand, at Lower Souris natural foods are almost completely utilized by all waterfowl during the normal spring to fall season. We cannot depend on the field-feeders limiting their flights to stubble only.

Fairly large numbers of blue-winged teal and baldpates fed upon grain at the Delta stations. Coots have occasionally used some of those at Lower Souris. These species may be discouraged by: (a) spreading grain farther from the water after pintails and mallards start appearing in good numbers; (b) late afternoon feeding in quantities that will be entirely consumed during the evening and early morning periods; (c) locating stations on the edges of larger open-water areas where teal and baldpates may be less inclined to use them; (d) dispersing their concentrations and early season gatherings if they are segregated on the marsh; (e) omitting feedings at stations where their numbers become excessive.

7. *Publicity.* Before harvest begins, farmers should be reminded of the duck damage potential, the feeding program, and any form of assistance available Current information on duck populations, operation progress, and numbers of ducks being fed should be repeated during harvest. Farmers should be warned to watch late maturing crops when feeding is reduced or stopped. Without this, they are apt to believe that there are no ducks in the area. Invite and accompany small farmer groups on an occasional evening tour of stations to assure greater alertness and appreciation on their part.

FEEDING STATION COSTS

The true cost of any control program is difficult to determine; feeding is no exception. Some expenses, such as grain value, labor for hauling and feeding, gasoline and oil, and equipment repairs are directly proportional to the number of bushels fed. Costs for feeding station maintenance, equipment depreciation, salaries, etc., may be about the same each year whether the total duck-days use is high or low. The time factor further complicates matters since such items as supervisor's salary and costs of patrol would be greater for longer depredation season, even though duck numbers were relatively small.

In recent years the Lower Souris expenses directly connected with feeding have averaged about $17,000 annually (Table 1). The average costs for aircraft patrol were about $1,750; costs of frightening materials, transportation, and ground patrol, calculated at a local labor rate of $1.50 an hour) about $1,000. To this might be added the crop losses to farmers with the program in operation, about $1,200 annually. Thus the total has been about $21,000 average per season. No allowance was made for time and expenses contributed by farmers to the program.

TABLE 1. AVERAGE FEEDING STATION COSTS, LOWER SOURIS REFUGE, N. D.

	Operation and Maintenance	Value of feed barley at 57¢ per bushel	Total
Cost per day per 1,000 ducks:			
All at feeding stations	$ 1.40	$ 4.60	$ 6.00
Half using natural foods	.70	2.30	3.00
Cost per season*	$3,937.50	$12,937.50	$16,875.00

*Based on 45-day period and 125,000 total population, with half of the ducks using natural foods.

Prior to 1953, when feeding was less efficiently carried on in the upland refuge grain fields, the average costs for patrol time, transportation, frightening devices, etc., were about $4,000 more than at present. Direct losses to farmers were more than $25,000 greater and they also contributed more time and money to prevention. The change to shoreline stations resulted in annual savings estimated at nearly $30,000. In 1944, the fifth year that mowed or swathed grain was available in refuge fields, the loss by farmers was estimated at 37,500 bushels ($72,000) based on field surveys.

For the years when little or no feeding of any kind was done, we can estimate the possible range in losses from certain information now available: (1) population size; (2) the population segment that was feeding in grain fields (undoubtedly more than 50 per cent); (3) the grain consumption rate (125 ducks per bushel per day); (4) the ratio of total grain eaten and damaged or wasted to grain consumed (ranging from 1.5 in wet weather to 5.5 in dry, from limited samples); and

(5) the cash value of grain in the field. Under a combination of unfavorable factors, the loss could have been $44.00 per day per thousand ducks; with all factors favorable, including use of frightening devices, the loss could have been as low as $3.00. The median value, $20.00, was probably near the actual loss considering all likely variables. At this rate, an area population of 125,000 birds could cause losses in excess of $100,000 during a 45-day harvest season.

There can be no doubt that a feeding station program which handles 50,000 birds or more is a good economic investment. When smaller populations are fed, the cost per bird is greater. Even so, there may be circumstances where, lacking effective alternate control measures, feeding may be desirable even though the costs exceed the total losses. Supplemental benefits may include: (1) greater use of natural foods, (2) reduced field feeding tendencies, and (3) improvements in local attitudes toward wildlife.

In the United States, surplus grain can be obtained through the Commodity Credit Corporation for emergency use under Public Law 654. There has been an adequate supply of refuge-grown grain to meet the situation at Lower Souris and a need for CCC grain has not occurred. It is reassuring to have this source available, should serious problem areas appear in the future.

SUMMARY AND CONCLUSIONS

The seriousness of waterfowl damage to agricultural crops in the Canadian Prairie Provinces, northern North Dakota, and northwestern Minnesota is now generally recognized. In both Califorina and on the Lower Souris Refuge in North Dakota, a combination feeding-scaring program has been effective in reducing losses. On the latter area, a technique was developed which appears to be especially well adapted to the mallard-pintail concentration points of the northern Great Plains.

At Lower Souris, small grains (mostly barley) are spread by truck on specially prepared feeding stations along the water's edge. These are made naturally attractive by supplying gravel, removing marginal shoreline and upland vegetation, and locating them to intercept field-feeding duck flights. Grain is supplied throughout the main harvest season. In addition, daily patrol trips are made by a Bureau plane and pilot to watch for and haze field-feeding birds. Ground patrol is maintained as needed, especially during wet and stormy weather.

The mixed mallard-pintail population at Lower Souris Refuge consumed an average of six to eight ounces of grain daily per bird; a maximum total of 25,000 bushels per season. Shoreline feeding appears to have encouraged greater use of natural foods, such as pondweeds. With peak numbers sometimes approaching 200,000 birds, about half the total duck-days feeding during harvest has been in aquatic habitat. The stations also appear to have reduced field feeding as a local population trait some years.

No serious limitations or objections to the program have appeared so far. An information program to correlate Bureau-farmer control activities is a necessity. From a cost standpoint, there has been a savings of about $30,000 annually, compared with earlier years when refuge grain fields were mowed or swathed, then fed. The net economic gain, compared to a program of frightening alone, has been about $80,000.

Even where feeding may not be economically justified, the supplemental benefits may be important, e.g.: (1) greater use of natural food, (2) reduced field feeding tendencies, and (3) improvement in land owner attitude toward wildlife.

Feeding and all successful control measures are expensive. At present there is no painless device to extract large funds from the principal waterfowl beneficiaries in the United States, or to transfer them to the distressed localities north of the border if such action is desirable.

We in the United States seem to have two alternatives: (1) adjust to a much lower mallard-pintail population as the normal level to meet the increasing demands of present and future waterfowl hunters; or (2) meet our full obligations to the farmers now making the largest individual sacrifice to perpetuate our sport.

ACKNOWLEDGMENTS

Many individuals worked on the waterfowl depredations problem at Lower Souris during the past twenty years. Most of them contributed their best thoughts toward finding a satisfactory solution. The present successful program was largely developed through suggestions from Harry A. Jensen, U. S. Game Management Agent. J. B. Gollop of the Canadian Wildlife Service spent the 1950 season at Lower Souris, when several facets of feeding and waterfowl behavior were explored because of his interest.

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DISCUSSION

DISCUSSION LEADER LOW: We are off to a good start this afternoon in this day of possible waterfowl shortages and increasing shortages of waterfowl breeding and wintering habitat. It is significant that we turn to means of caring for these waterfowl that we do have.

When we are striving to produce more waterfowl on diminishing habitats, we find it rather paradoxical that the waterfowl that we do have are in conflict with other interests and causing crop damage.

If we are going to continue to nurture this resource of ours and can do so by such a feeding program that has been described by Mr. Hammond, I am sure that we are indeed making progress.

I'd like to turn this discussion now to the floor for possible questions and other points that the audience may have.

MR. VERNE E. DAVISON [U. S. Soil Conservation Service, Athens, Georgia]: Some of the earlier records on choiceness of foods indicated that barley was not as attractive a food as wheat grain. Mr. Hammond, do you see any evidence to indicate that one of them is preferable to the other?

MR. HAMMOND: We use barley almost entirely in our feeding program, and I think that is true at Delta. One, I think, is as acceptable as the other; barley because of its awns probably isn't eaten quite as rapidly.

We have tried local millet varieties, such as proso, shelled corn and oats. The ducks tended to slow down on their consumption of oats although when it was mixed with wheat or barley, they consumed a fairly large quantity of oats. So that is another possibility if it is used with more acceptable grains. In general, we can feed what is adapted to the native soils and climate.

DR. J. J. HICKEY [University of Wisconsin]: I would like to ask Mr. Hammond the total value of the crop that was subjected to this attack; and second, if he was able to put a dollar-and-cents value on the savings per duck.

MR. HAMMOND: In regards to the first question, the total area that is subject to damage is around 500 square miles. The average yield is something in the neighborhood of 20 bushels to the acre, say, in barley and wheat. The price of barley is 57 cents a bushel and wheat in the neighborhood of $2; if you take it on from there you can figure the total value yourself.

With 125 ducks consuming a bushel of grain and grain in the neighborhood of 57 cents a bushel, the grain costs, of course, are a fraction of a cent per duck. The cost per thousand ducks is around $6.

MR. ROBERT C. WALKER [Alexandria, Virginia]: Mr. Chairman, we recognize the conflict in interests between the wheat farmers and the sportsman, each seeking his own interest. In view of that, it seems to me it might be pertinent to suggest some compromise between the excessive cost of direct feeding and the various other projects that have been outlined here.

It also seems to me it might be possible to recognize some responsibility on the sportsman's part for a partial contribution of funds from the Duck Stamp to finance some of this feeding program in the protection of crops.

I'd like to ask what your interest might be, or what your feeling might be with respect to that suggestion and what the relative cost would be between the artificial feeding, the use of acetylene cannon to frighten birds from the areas and the alternate of an insurance plan partially financed by some of the proceeds from the sale of duck stamps.

MR. HAMMOND: I think we should leave that question perhaps until we have heard a little more about the effectiveness of the frightening devices from Mr. Stephen, if that will be agreeable.

MR. WALKER: I'll defer answer until we hear the other paper. I'd like to have an answer.

MR. FRED GLOVER [Fish and Wildlife Service]: Can you give us some idea of what effect the location of the feeding stations had on the movement of birds southward, or how did it affect the concentration or the movements of waterfowl?

MR. HAMMOND: We have been unable to find that there have been any major effects on fowl movements at all. At the beginning of the season, the population is composed of about 75 per cent pintails and 25 per cent mallards, and during the time that we are feeding, the pintails largely move on south. Later on the composition drops to around 25 per cent pintails and 75 per cent mallards and, even during the time when feeding stations have been in operation, we have had major departures and influxes of mallards.

The question had been brought up from other quarters as to whether we might not keep drawing in more birds year after year, year after year until perhaps we ended with several million birds, but there have been no indications in the more than 20 years since we started the feeding program that this has happened. Populations tend to follow the trend of flyway populations through the area.

A HISTORY OF THE DELTA DECOY

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In most techniques used in the wildlife-management field, structural methodology or adaptation may be new, but the principle is usually old. This paper describes a waterfowl-trapping technique based on an old principle, but adapted to modern investigational methods; it also discusses the results obtained.

The duck-decoy trap functions because waterfowl can be lured by a live dog into a cul-de-sac from which they cannot, as a rule, escape.

The word "decoy" appears to be an Anglicized version of the Dutch word *ende-kooi* meaning duck cage (or enclosure), although the philological method by which it came to be decoy is often disputed (Southwell, 1904). Since this duck-capturing device came to England via Holland, we are disposed to believe that the name has its root in the Dutch language.

DESCRIPTION OF A DECOY

A decoy may be described as follows: A pond from 2 to 20 acres, usually in a wooded location, or in some way secluded, is the basic attraction for ducks as a loafing site. Radiating from this pond and confluent with it are two to ten (usually four) curved ditches 150 to 200 feet long. They are a foot deep and about 25 feet wide at the mouth, diminishing to 2 feet in width at the distal end. Each ditch is curved in such a way that, looking directly into the ditch, one cannot see beyond about two-thirds of its length (line of sight). The sides of the ditch are cribbed with timber or stone to prevent bank erosion. Over the ditch are placed a series of half-circle hoops of metal or wood. The first hoop, where the ditch and pond adjoin, is about 20 feet in height. At intervals of about 5 feet, subsequent hoops in ever-decreasing size span the ditch until, at the far end, the hoop may be only 2-3 feet in height. These are covered with netting, usually of the heavy fish-seine type. Only the first six to eight hoops are roofed with the netting; then as they approach the curve in the ditch the netting comes down over the sides of the hoops to the ground. The hoops are usually set back from the edge in the front half of the ditch so as to create a "walk" which is used by a decoy dog. At the narrow end of the ditch a holding pen is attached to the small hoops.

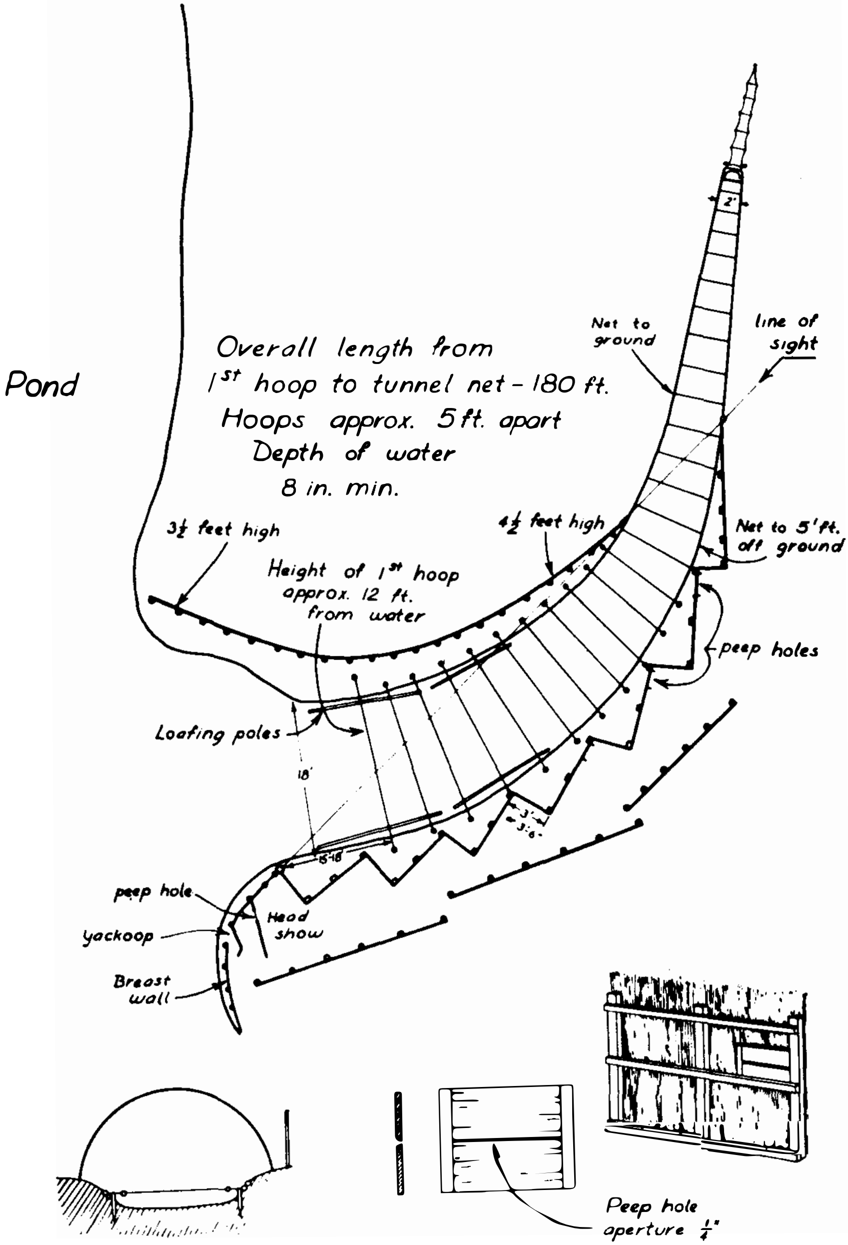

Figure 1. Construction sketch for the Delta decoy by Peter Scott.

This much of the decoy (including the holding pen) is called "a pipe" (Figure 1).

On the concave side of the pipe are a series of reed screens. These are about 6 to 8 feet long and 7 feet high, and are set obliquely outside the hoops from 4 to 6 feet apart. The number of screens depends on the length of the pipe. As a rule, there are 6 to 10 such screens. This arrangement allows the decoy man to observe the ducks on the pond through openings in the reeds and to see ducks that have entered the pipe, without himself being seen. It also allows him to direct the activities of the dog in secret. A second set of screens is commonly used. These are long screens behind which the decoy man retreats after he has made certain the ducks are well into the pipe. These screens are outside the oblique screens paralleling the curvature of the pipe. The decoyman can, by circling behind these barriers, bring himself behind the ducks, thus cutting off their escape to the pond. By stepping from behind the oblique screens, thus showing himself to the birds in the pipe but not to those still on the pond, he flushes the birds in the pipe toward the closed end while those on the pond remain oblivious of his activity.

At the extreme end of the ditch is a ramp that guides the ducks up out of the water into the holding pens. This ramp is hinged at its juncture with the holding box, and is closed from a distance by the decoyman. Additional screens may be constructed anywhere in the decoy area at points where visual isolation is best served.

There were as many variations of this simplified scheme of decoy operation as there were functioning decoys. The same may be said of decoy construction. For example, some decoys in Europe were constructed in special ways in the hope of enticing certain species, like teal, pochard, or shoveler. Mulder saw a shoveler decoy in Holland where, because shovelers have a tendency to turn and fly back past the decoyman, the hoops were very low (ca. 6 feet) at the pipe mouth.

One other aspect of the pipe worthy of mention is the small reed-protected compartment from which the decoyman first checks to see if there are any birds to catch, and if so, where they are situated on the pond or in the pipe. The observation booth is called the "head show" and is placed at the mouth of the pipe where both the ditch and the pond can be viewed to best advantage. The decoyman is also concealed by screens leading to the head show.

This is an abbreviated description of a decoy. Far better are to be found in Payne-Gallwey (1866) and Folkard (1859).

Operation of a Decoy

The first activity in the decoy is to appraise the ducks on the pond and to decide which pipe to use. If the decoy is polypiped, the pipe operated will be the one where the wind is blowing out of it or at right angles to it, since ducks are most apt to take wing against the wind. Should there be any ducks in the pipe, either feeding or loafing, they arc flushed toward the end of the ditch and into the holding pen. Attention is now directed to the birds on the pond. The decoy dog, trained to do the decoyman's bidding on hand signals, darts out onto the open walk area at the mouth of the pipe and back again behind the head show screen. This activity usually alerts the ducks, and a second appearance by the dog causes the birds to swim toward the mouth of the pipe. As they approach, decoyman and dog move to the oblique screens on the side of the pipe. The decoyman observes the ducks through the screen closest to the moving ducks as he sends his dog around the next screen down the pipe. In the process, the dog shows himself briefly along the walk area on the edge of the ditch. Once the ducks begin to move, they swim steadily toward the always retreating dog that pays no heed to the birds and acts only on his master's silent command. The decoyman moves from behind one oblique screen to another while his dog circles the one beyond. During this time the ducks swim deeper into the pipe. When the ducks are well into the pipe, the dog is put to heel behind the screen, and the decoyman slips behind the long screens paralleling the pond. While the ducks are waiting for the dog to reappear, the decoyman cuts off their escape to the pond by a quick wave of his hands or arms from his exposed position *between* two of the oblique screens. This is accomplished noiselessly and without the decoyman's presence being made known to the ducks in the pond, some of which may in a few minutes be in a position to come under the lure of the dog and be tolled into the trap.

A small fawn-colored female cocker spaniel was trained by Mulder to circle the screens as described above. A sausage (wiener) sliced to the thickness of a nickel was used as a reward, and portioned out during a run. This training scheme had been used by Mulder's family to train dogs used in their decoy at Hippohytushoef in North Holland.

In Europe, where wild birds may be found some distance from the decoy, locally reared mallards act as a decoy flock or "lead" (Folkard 1859; Eygenraam 1954). These birds are accustomed to the decoy but they leave it to fly to open waters, mingle with wild birds, and usually return to the pond with some of their wild companions to loaf and rest. At this time the decoyman attempts to catch the newcomers but avoids or releases ducks of the lead.

CONSTRUCTION OF THE DELTA DECOY

The idea for the Delta decoy, which was to become the first functioning decoy in North America, had its origin in 1948 when Peter Scott, director of the Wildfowl Trust, Gloucestershire, England, visited H. Albert Hochbaum at the Delta Waterfowl Research Station in October of that year. During this visit, Scott suggested the idea and staked out the ditch outline. The blasting technique employed in the excavation left the ditch in reasonable form, although the bottom was irregular in depth. This later proved to be no disadvantage. The sides of the ditch required some trimming in order to maintain consistently decreasing dimensions for the pipe.

In the summer of 1949, Peter Scott, returning from the Perry River expedition (Scott, 1951), spent several weeks at the Delta Station. He drew up the decoy plans during his stay. These plans served ultimately as the guide for the decoy construction, although slight modifications were necessary. During this summer an attempt was also made to begin construction with locally procured materials. The ash and willow saplings to be used as netting supports proved to be too difficult to handle for inexperienced hands, and so, lacking time and with the press of other duties, the station staff was forced to abandon the decoy project for 1949.

Director Hochbaum asked R. A. McCabe to take over the project in June 1950. Work was begun on July 1, 1950. The curvature and width of the ditch were determined, the bank was cut accordingly, and the screen area leveled.

The narrowest end of the ditch was used as the test site for constructing the net-supporting hoops. Attempts to make symmetrical hoops from ash and willow saplings of uneven size were unsuccessful, so metal pipe was used. The first experimental hoop was made from ½-inch iron pipe fastened to 6-inch cedar posts on either side of the ditch. Perforated metal strap was used to attach the hoop to the two posts. These cedar posts protruded above the ground to a height of 18 inches. The ease in handling and rigidity of the first hoop indicated that metal was the best material to use.

New iron pipe was too expensive; used pipe of varied prices appeared to be within acceptable costs (avg. $.08/foot for ½" and ¾" pipe). It soon became evident that even used pipe would be difficult to obtain in sufficient quantity. Then, through a series of interesting circumstances too long to relate here, aluminum tubing was found at a reasonable price.

The aluminum tubing came in two diameters, 1-inch and ¾-inch, and in standard 10-foot lengths. Whenever necessary, lengths of like diameter were connected by means of a standard electric-conduit coupling. Aluminum tubing is too soft to be threaded, and the cast-iron couplings therefore were of the friction type. A prime requisite for each hoop was even curvature. This was accomplished by measuring the circumference of the hoop and marking this distance on the floor of the main room of the Kirchoffer Lodge at the Delta Research Station. Attaching a length of string at the center point and a piece of chalk at the free end, we drew a half-circle on the floor of the room. The tubing, with the aid of a hickey (pipe-bending tool), was bent to conform with the various chalk lines.

Bending was comparatively easy, and the hickey allowed for mistakes in the bending to be corrected. Those hoops at the wide end of the ditch were made with 1-inch pipes on either side and a single ¾-inch pipe as the crown of the hoop. The ends of the ¾-inch tubing sleeved into the 1-inch tubes on either side. The amount of sleeving determined the size of the hoop. The lengths of tube were held together by striking the overlap sleeving with the rounded end of a ball-peen hammer. This produced a depression in both the outer and inner tubes of the overlap and, although the knit was not always snug, the tubes thus dented could not be pulled apart.

Cedar posts used to anchor the ends of the hoop were driven into the ground at intervals of four to six feet. At the wide end of the ditch, where the hoops were high, the posts were placed closer together. At the mouth the last two hoops were about 16 inches apart to afford maximum strength at that point. After five hoops were set up, a midrib of ¾-inch pipe was attached to the top of each hoop. On the ninth hoop, a lateral support between the midrib and anchor posts was run down either side of the hoops to the mouth of the ditch.

After all hoops were in place and secured by the three lateral supports, the netting was attached. This was discarded rough-fish seine donated by the Wisconsin Conservation Department. The net was chemically treated and quite stiff, although durable and long-lived. A heavy-gauge wire run from one post to another an inch or two above the ground worked quite well as a support to anchor the net. From the elbow to the funnel end of the pipe the netting was raised somewhat abruptly until at the very end it was 5 feet, 6 inches above the ground on either side. Only the top portion of the hoops was covered. This allowed the ducks to see the decoy dog unobstructed.

Cribbing the banks of the decoy ditch was done simultaneously with the net stretching, so the two jobs were completed about the same time. After the ground was leveled, the screen locations were laid out. Heavy cedar posts, like those used as hoop anchors, were halved or quartered and used as screen supports. The framework was made of 1 x 3 inch boards 10 and 12 feet long. Phragmites (*Phragmites communis*) stems were used as the reeds for screening. A mat of reeds was sandwiched between the framework timbers and an outside board of the same dimension, and the two boards then bolted together. Three such horizontal strips for each screen sufficed for a permanent sturdy structure. Three individual screens of this type were made from green phragmites by the end of the summer in 1950. These screens, made from green-cut reeds that held their leaves, looked very shaggy after the reeds had dried.

The catching end of the decoy had only a frame constructed over the outlet. An English-type tunnel or fyke net was to be used to hold the catch. Instead, the catching end of the decoy pipe was constructed by Mulder and patterned after the Dutch decoy cul-de-sac, which is in the form of a double holding box. The decoyman flushing a catch of ducks into the holding box raises the ramp, drawbridge fashion, by pulling (over a pulley) a cord attached to the base of the ramp, thus closing off the entrance to the holding box. A sliding door in the center of the box allows the catch to be divided into two parts for ease of handling and to prevent trampling. The sides and top are built of slats spaced to allow maximum light and ventilation. The catch is removed through two top-opening doors.

The cost of construction of this decoy with its single pipe offers no basis for price comparison today. As a matter of record, it cost about $200 to build the Delta decoy in 1950, not including the cost of ditch blasting. Cost of labor was nominal, since much of it was donated. The upkeep costs are about $50 per year.

THE CATCH

The Delta marsh of Manitoba, situated on the extreme south shore of Lake Manitoba, is part of the vast Canadian waterfowl-production complex, and enjoys ducks in varying numbers from April through the first half of October and sometimes into November. During this period, the decoy has been operated for the past 10 years, except for brief periods when the decoyman was on vacation, and when Mulder worked part time for the Manitoba Game Branch in 1955 and 1956. In 2 of the 10 years, namely 1955 and 1956, the decoy was operated under the severe handicap of unprecedented high water which virtually inundated the entire Delta community. In spite of the low catch in those 2 years, 21,211 ducks were caught between 1951 and 1960. Even a cursory review of the annual breakdown of the total catch (Fig. 2) shows that, once the high water receded, the catch

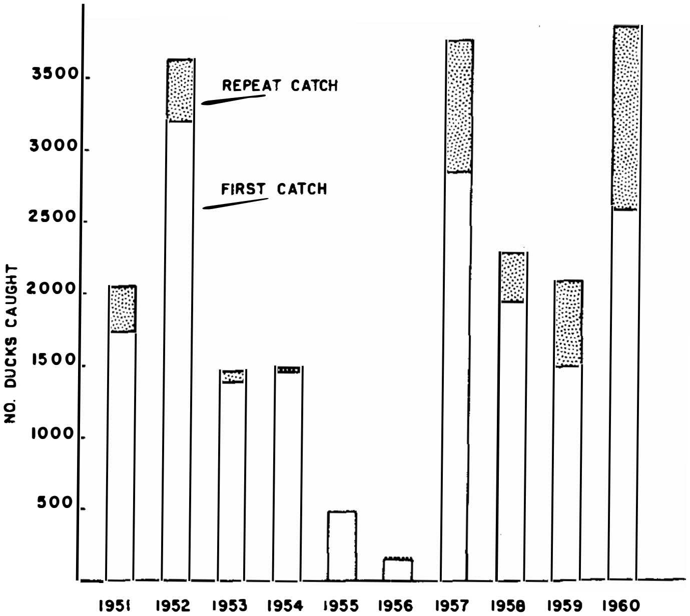

Figure 2. The annual distribution of the duck catch in the Delta decoy, 1951-60.

returned to its pre-flood numbers. The number of repeat catches varies among the years, and is not correlated with any major aspect of the operation.

Time of Catch

The decoy at Delta catches the bulk of its ducks in late summer and fall, in contrast to Dutch decoys which function well into the winter. For example, Lebret (1952) discusses the catch of six Dutch decoys in North Holland with an aggregate operation time of about 190 years. Sixty-four percent of the catch was made from November 1 through February. The same may be said for the Wildfowl Trust decoy at Slimbridge, Gloucestershire, England (Scott, 1951), where the catch curve levels off in mid-October and remains high through March. September is the peak month for the Delta decoy (Fig. 3). In some years, 1952 and 1957, for example, the catch was early, whereas in 1953 and 1958 the bulk of the birds were caught late in the decoying season. Since there is no flowing water in the decoy ditch, this pipe is frozen into inactivity relatively early (Oct. 25±). However, the decoy is often kept open by chopping or otherwise clearing the pipe of ice. In several of the last 10 years good catches were made as late as mid-November.

The blue-winged teal that account for about one-third of the decoy catch are, as might be expected, caught primarily in August and September (Fig. 4). The other two principal species, namely mallard and redhead, show parallel increases in numbers with peak catches in October. The large catch of blue-winged teal influences the early over-all peak, as shown in Fig. 3. Ducks may be taken at any time during the day, but this decoy has been very effective in catching birds late in the afternoon. This is a feeding period for ducks and a relatively inactive time for people in the area of the decoy. The pre-dawn period might also have been productive, but no regular runs were made at that time of day.

COMPOSITION OF CATCH

In 10 years of operation, 14 species of ducks have been taken (Table 1). The yearly catch by species is shown in Fig. 5. Blue-winged teal, mallards and redheads are the most abundant species taken. Only the blue-winged teal and mallards were taken (over 5 percent of total catch) in all of the 10 years. The redhead missed only the high-water year of 1955. The blue-winged teal, mallard, redhead, green-winged teal, and pintail each contributed over 5 percent of the catch in more than 1 year. The 10-year summary shows

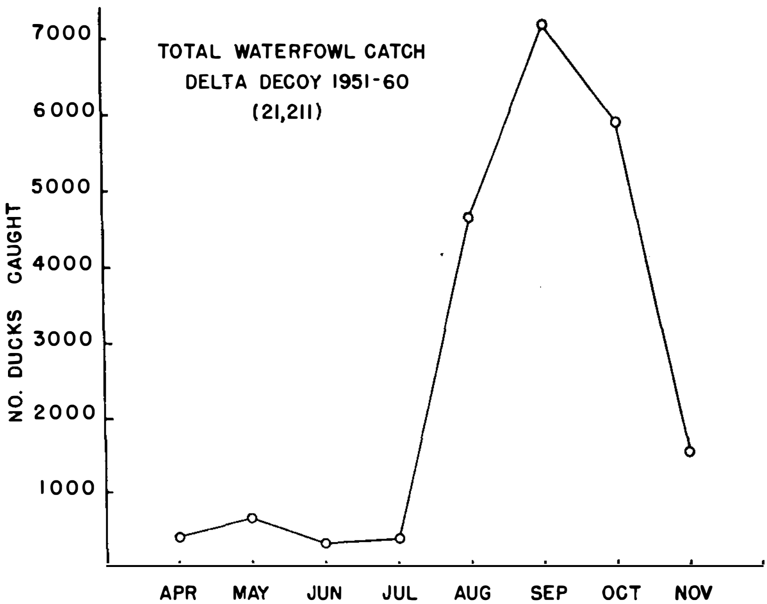

Figure 3. Monthly distribution of the duck catch in the Delta decoy, 1951-60.

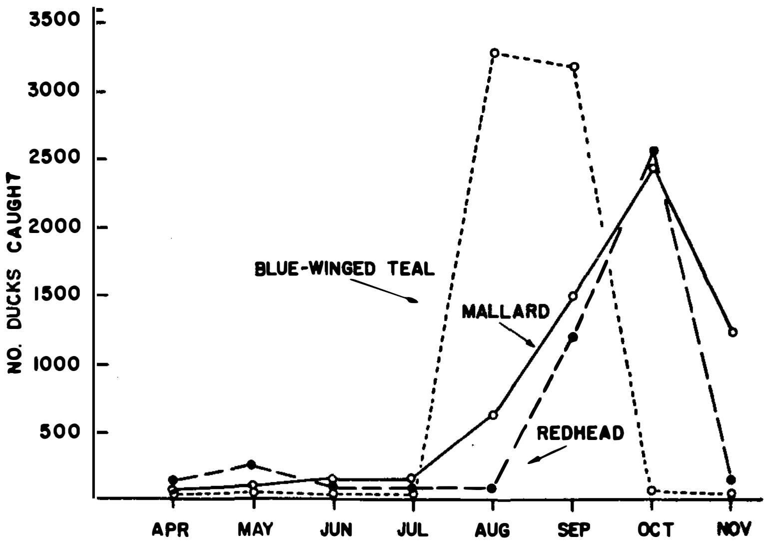

Figure 4. Three species, distribution during the months of operation of the Delta decoy in the ten-year period, 1951-60.

that the blue-winged teal comprised 31 percent of the catch, the mallard 30 percent, redhead 20 percent, green-winged teal 6 percent, and all other ducks combined 13 percent.

The fall hunting bag on the Delta marsh (Sowls, 1955) finds the mallard the number-one species ahead of the canvasback, lesser scaup, redhead, and gadwall, in that order. In only 1 year in 10 were canvasback and lesser scaup caught by the decoy in numbers that amounted to more than 5 percent of the catch. Except for the mallard and redhead, there is apparently no relationship between the

TABLE 1. THE DELTA DECOY CATCH BY SPECIES

Species	First Catch	Percent	Repeat Catch	Percent of Total	Percent of First Catch
Blue-winged teal (*Anas discors*)	5,316	30.9	1,451	36.5	27.3
Mallard (*Anas platyrhynchos*)	5,231	30.4	1,176	29.5	22.5
Redhead (*Aythya americana*)	3,376	19.6	1,040	26.1	30.8
Green-winged teal (*Anas carolinensis*)	1,025	5.9	86	2.2	8.4
Pintail (*Anas acuta*)	776	4.5	96	2.4	12.4
American widgeon (*Mareca americana*)	487	2.8	36	0.9	7.4
Shoveler (*Spatula clypeata*)	254	1.5	5	0.1	2.0
Gadwall (*Anas strepera*)	188	1.1	11	0.3	5.9
Wood duck (*Aix sponsa*)	178	1.0	56	1.4	31.5
Canvasback (*Aythya valisineria*)	160	0.9	5	0.1	3.1
Lesser scaup (*Aythya affinis*)	156	0.9	5	0.1	3.2
Black duck (*Anas rubripes*)	50	0.3	9	0.2	18.0
Ring-necked duck (*Aythya collaris*)	30	0.2	4	0.1	13.3
Common goldeneye (*Bucephala clangula*)	4	0.0	0	0.0	0.0
Totals	17,231		3,980		23.1

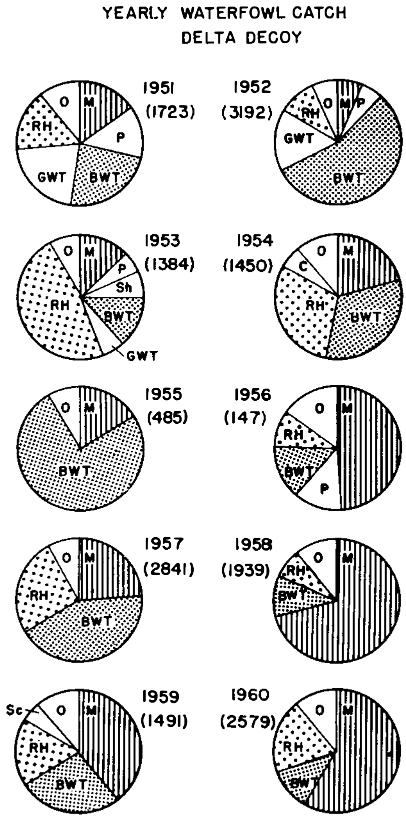

Figure 5. Composition of the annual catch of ducks in the Delta decoy. All species contributing less than 5 percent of the total are grouped in the section *O* meaning "other."

decoy catch and the fall bag, despite a considerable overlap in the two periods of activity.

THE CATCH-EFFORT

The decoyman at the Delta Waterfowl Research Station has responsibilities other than running the decoy. Only rarely, however, is he so far away from the trap that he cannot operate it at his pleasure. The number of times per day when the pond and pipe are inspected varies with the season and the birds available for trapping. On an average, the pond is inspected for trapable ducks 8 times per day and an attempt to catch ducks is made about 5 times out of the 8. The time required to catch and record data on species, sex, age and band numbers of recaptured birds amounts to about 4 hours per day when

TABLE 2. TRAPPING EFFORT AND SUCCESSFUL TRAP-DAYS FOR THE DELTA DECOY

Year	No. of Days	Days 1* or More	Percent Successful	Days 5** or Over	Percent days with 5+	Ducks per Trap Day
1951	101	89	(88)	79	(78)	20.3
1952	220	145	(66)	102	(46)	16.5
1953	219	141	(68)	66	(30)	6.6
1954	228	109	(48)	74	(32)	6.5
1955	161	47	(29)	26	(16)	3.0
1956	173	40	(23)	9	(5)	0.8
1957	215	123	(57)	89	(41)	17.5
1958	222	133	(60)	79	(36)	10.3
1959	204	131	(64)	89	(44)	10.2
1960	229	162	(71)	101	(44)	16.8
Average	197.2	112.0	(57)	71.4	(36)	10.8

*Days in which 1 or more birds were caught.
**Days in which 5 or more birds were caught.

large numbers of ducks are taken and to 2 hours per day when the take is small.

In the 10-year period, the Delta decoy was operated on an average of 197 days per season (Table 2). Of the days in which an effort was made, 57 percent (112) were successful in catching at least one bird and 36 percent (71) were successful in catching five or more birds. Strangely, the first year that the decoy was operated the percentage of successful days was greatest, although the most recent year (1960) also has a fine record. The number of ducks per day of trap operation has varied from 0.8 in 1956 to 20.3 in 1951. Eleven ducks were caught per trap day over the 10-year period. An ordinary run, even with a group of birds that responds slowly to the dog, seldom takes over 5 minutes. By far the greater effort is in removing the birds from the holding pens, separating them by species and sex while putting them into holding boxes, aging, and checking the sex, plus banding and recording data. On one run, Mulder records processing and releasing a bird per minute for 90 minutes.

It is common knowledge that ducks are most readily caught when the wind is blowing either out of the pipe or at right angles to it. Virtually all published accounts of decoy operation echo this fact. Mulder asserts it emphatically, but, try as we might, we found no correlation between wind direction at the closest weather station (Macdonald Air Force Base, 12 miles distant) and the decoy catch for any day. Prairie winds are known to be variable, particularly near large bodies of water. This fact alone could account for the lack of correlation.

SEX AND AGE COMPOSITION OF THE CATCH

All birds caught for banding by the decoy are sexed and aged (Table 3). Our percentage of adults in Table 3 for some species may be slightly higher than summer- or fall-catch figures reported in other

TABLE 3. THE SEX AND AGE COMPOSITION AMONG THE SPECIES OF DUCK CAUGHT IN THE DELTA DECOY, 1951-60

	1951			1952			1953			1954			1955		
	No. in	Percent		No. in	Percent		No. in	Percent		No. in	Percent		No. in	Percent	
Species	Sample	M	Juv.	Sample	M	Juv.	Sample	M	Juv.	Sample	M	Juv.	Sample	M	Juv.
Blue-winged teal	348	42	97	1,809	52	96	171	54	68	468	51	96	365	46	98
Mallard	201	52	88	187	48	75	177	52	75	301	49	62	78	64	65
Redhead	279	47	99	304	41	92	687	46	92	429	54	74	3	....	....
Green-winged teal	373	52	91	503	59	92	76	55	79	23	....	....	....	....	....
Pintail	201	47	94	170	42	73	74	45	58	17	....	....	19	....	....
American widgeon	55	49	95	143	57	64	46	....	....	24	....	....	2	....	....
Shoveler	8	....	....	21	....	....	94	38	81	62	35	98	13	....	....
Gadwall	74	27	100	38	....	....	6	....	....	3	....	....	2	....	....
Wood duck	5	....	....	1	....	....	1	....	....	1	....	....	....	....	....
Canvasback	2	....	....	11	....	....	38	....	....	88	50	65	....	....	....
Lesser scaup	4	....	....	1	....	....	6	....	....	16	....	....	....	....	....
Black duck	....	....	....	4	....	....	6	....	....	3	....	....	1	....	....
Ring-necked duck	....	....	....	....	....	....	2	....	....	13	....	....	....	....	....

	1956			1957			1958			1959			1960			Totals		
	No. in	Percent		No. in	Percent		No. in	Percent		No. in	Percent		No. in	Percent		No. in	Percent	
Species	Sample	M	Juv.	Sample	M	Juv.	Sample	M	Juv.	Sample	M	Juv.	Sample	M	Juv.	Sample	M	Juv.
Blue-winged teal	21	....	....	1,197	52	98	197	50	74	391	49	54	287	54	70	5,254	50	91
Mallard	72	54	36	679	61	32	1,357	58	39	564	57	33	1,499	53	51	5,115	56	47
Redhead	14	....	....	735	49	96	152	50	80	264	58	25	487	52	85	3,354	50	84
Green-winged teal	2	....	....	8	....	....	6	....	....	15	....	....	10	....	....	1,016	50	89
Pintail	18	....	....	54	52	24	53	45	72	40	....	....	95	41	49	741	45	70
American widgeon	7	....	....	109	45	83	48	....	....	26	....	....	27	....	....	487	55	59
Shoveler	2	....	....	7	....	....	15	....	....	3	....	....	28	....	....	253	44	74
Gadwall	5	....	....	18	....	....	14	....	....	12	....	....	14	....	....	186	46	70
Wood duck	....	....	....	4	....	....	65	95	14	58	90	12	37	....	....	172	92	10
Canvasback	1	....	....	10	....	....	5	....	....	2	....	....	3	....	....	160	50	77
Lesser scaup	4	....	....	1	....	....	3	....	....	79	78	0	42	....	....	156	78	4
Black duck	1	....	....	9	....	....	3	....	....	4	....	....	19	....	....	50	78	26
Ring-necked duck	....	....	....	6	....	....	2	....	....	3	....	....	4	....	....	30	....	....

studies. Since the Delta decoy is operated in April, May, and June, only adults are available to the trap. The numbers taken in spring are small, however, as is shown in Fig. 3.

In order to evaluate the decoy catch, a series of comparisons was made with trapping data for several species gathered in the same time period and in comparable areas. An additional comparison was made with data on mallards taken in Dutch decoys in the same year.

The first of these (Table 4) compares the Delta decoy catch of mallards from 1951 through 1956 with bait-trap mallards taken in a radius of 5 miles around the Delta station and also with those from a trapping program in the three Canadian prairie provinces. The percentage of males in each of the 6 years showed no significant (above 0.95) difference between the two trapping methods. Glegg

TABLE 4. A COMPARISON OF THE DELTA DECOY MALLARD CATCH WITH BAIT TRAPS IN COMPARABLE TIME PERIODS AND FIELD SITES

	Delta Decoy			Bait Traps		
	No. in Sample	Percent Male	Percent Young	No. in Sample	Percent Male	Percent Young
				USFWS Delta Area[1]		
1951	78	47	96**	1151	47	82
1952	98	44	90**	1568	53	77
1953	126	50	80	1359	55	73
				Prairie Provinces[2]		
1954	286	45	66**	6535	53	78
1955	68	59	75	4357	53	83
1956	55	73	93**	7898	60	71

[1]U. S. Fish and Wildlife Service banding program within a radius of 5 miles of the Delta station. Unpublished data furnished by Arthur S. Hawkins.
[2]Prairie Provinces of Manitoba, Saskatchewan, and Alberta (Low, 1957).
**Differs at the .99 level from corresponding percentage found in bait traps.

(1943) states that, in decoys worked with dogs, the females are more easily tolled than males. Petrides (1944) on the other hand says that bait traps tend to be more attractive to males than females. Our data do not support either position. Although the true sex ratio in waterfowl for the trapping years is not known, it seems unlikely that the two trapping methods would consistently show the same biases.

The age ratios were significantly different in 4 of the 6 years. In 3 of the 4 years in which there was a difference, the bait traps took more adults and in 1 year the decoy took more. Thus we have in the 6 years more adults, less adults, and no difference between young and adults, in the catch of the decoy over bait traps. The lack of pattern here may reflect variable productivity in the duck populations sampled. If one age group is more susceptible to one of the two trapping methods, our data do not show it.

A second comparison between decoy catches of mallards in two

TABLE 5. A COMPARISON OF THE MALLARD CATCH IN THE DELTA DECOY WITH CERTAIN DUTCH DECOYS

	Delta Decoy			Dutch Decoys[1]		
	No. in	Percent		No. in	Percent	
Year	Sample	Male	Young	Sample	Male	Young
1951	201	52	88*	8,162	54	82
1952	187	48	75	11,402	55	77
1953	177	52	75**	4,516	52	84
1954	301	49	62**	8,648	54	78

[1]Eygenraam (1957).
*.95 significance level.
**.99 significance level.

continents is made in Table 5. Between 1951 and 1954 mallards taken in certain Dutch decoys and those taken in the Delta decoy showed no significant difference (over 0.95) in sex ratios. This is virtually the same as shown in Table 4, and testifies to the uniformity of the sex ratio of this species. The age ratios varied as did they in our first comparison. In 3 of the years there was a significant difference in the age ratios between the Dutch and the Delta decoy; in 2 of these years the Delta decoy caught more juveniles; in 1 year, it caught more adults. And in 1 year, there was no difference in age ratios between the Delta decoy and the Dutch decoys. Here, too, the likely explanation is that there is variation in productivity.

The final comparison (Table 6) is between the Delta decoy and bait traps operated by the U. S. Fish and Wildlife Service at sites within a 5-mile radius of the Delta station. Trapping data from 1951 to 1953 for mallards, blue-winged teal, redheads, and pintail show that there was no significant difference between the sex ratios in the decoy and in bait traps. The age ratios, however, were significantly different in each of the four species. The decoy caught more juvenile mallards, blue-winged teal, and redheads but more adult pintails than did the bait traps. Apparently male and female ducks enter these two trapping devices in the same proportions, but there is

TABLE 6. THE DELTA DECOY CATCH AND THE DELTA AREA BAIT-TRAP CATCH COVERING THE SAME TRAPPING PERIODS IN 1951-53

	Decoy			Bait Traps[1]		
	No. in	Percent		No. in	Percent	
	Sample	Male	Young	Sample	Male	Young
Mallard	302	47	87**	4078	52	77
Blue-winged teal	2180	50	97**	9043	51	93
Redhead	355	39	98**	2372	41	88
Pintail	254	43	85**	1265	39	93

[1]Data from the files of the U. S. Fish and Wildlife Service. The traps were operated in a 5-mile radius from the Delta Station, Manitoba. These data were furnished by Arthur S. Hawkins.
**.99 significance level.

no discernible pattern of trapping for age groups either within years or between years in these traps.

GENERAL COMMENTS

Not all species react in like manner to decoy pond, pipe, bait or tolling dog. In general, ducks react the same way to the dog in North America as they do in Europe. Shovelers and American widgeon are not easily tolled, whereas ringneck ducks and scaup frequent the pond only when ice conditions elsewhere force them to do so. Mallard, black duck, and gadwall can be trapped readily if handled properly in the decoy. The same may be said of the redhead, although it responds better to bait than to the tolling dog. Blue-winged teal are relatively easy to catch, particularly if there is a good crop of duck weed (*Lemna* sp.) in the decoy pond. Green-winged teal are also easy ducks to trap. Canvasback do not frequent small decoy ponds, and hence are caught only rarely in the Delta decoy. The goldeneye was the rarest of the ducks caught. Only four were taken since the trap began operating. The wood duck is peculiar in that the bulk of the catch is made up of adult males. This is also the only sex and age group observed in the Delta area.

European decoys list a great variety of other birds captured, and in this respect the Delta decoy is no exception. Table 7 lists the birds inadvertently captured in this single-pipe decoy.

TABLE 7. BIRDS CAUGHT INADVERTENTLY IN THE DELTA DECOY

Common snipe (*Capella gallinago*)	8
Belted kingfisher (*Megaceryle alcyon*)	2
Pied-billed grebe (*Podilymbus podiceps*)	1
Sora rail (*Porzana carolina*)	1
Black tern (*Chlidonias niger*)	1
American bittern (*Botaurus lentiginosus*)	2
Lesser yellowlegs (*Totanus flavipes*)	1
Killdeer (*Charadrius vociferus*)	1
Spotted sandpiper (*Actitis macularia*)	2
Least bittern (*Ixobrychus exilis*)	1
Ruddy duck (*Oxyura jamaicensis*)	1
	21

The European decoymen consider coot (*Fulica atra*) extremely difficult to catch. The American coot (*Fulica americana*) were taken in the Delta decoy as follows:

	1953	1954	1955	1956	1957	1958	1959	1960	Total
Coot	8	62	238	58	6	39	10	29	450
Percent Juv.	—	—	85	81	—	82	90	100	83

The curious high of 238 coot taken in 1955 corresponds to a general high in the Prairie Provinces. Banding crews captured 280 coot in 1954; 533 in 1955; and 239 in 1956 (Low, 1957).

Could the Delta decoy with its single pipe have increased its catch with additional pipes? Nan Mulder feels that with one or two additional pipes, the catch could be increased by only one-third.

The analysis of the return catch for the decoy (*e.g.* birds banded in a previous year) was not undertaken. The return records available included ducks banded in previous years in the decoy, ducks banded in bait traps in previous years, and ducks banded in bait traps but caught during the same year in the decoy. Time did not permit a survey to separate these three groups, which would be necessary for such an appraisal. This evaluation is contemplated for a later date. In all, there are 839 ''returns'' on record.

We would like to have compared the decoy-trapping effort on a handling-time-per-bird and on a cost-per-bird basis with bait-trapped birds or European decoy-caught birds, but the data contained so many variables and contingencies that a realistic comparison was not possible. We feel, however, that a decoy operation compares favorably with any bait-trap operation on both a time and cost basis. At any site where a decoy trap could be constructed, its value as a data-gathering research technique would be worth the cost and effort to construct and operate.

ACKNOWLEDGMENTS

In addition to those acknowledged in the text, the writers are grateful to Orrin J. Rongstad who did yeoman's service in extracting catch data from field ledgers; to the meteorological staff of the Southport and Macdonald Air Force Bases for supplying wind-direction data; to Frank McKinney for prompt response to requests for information from the Delta files; to Marie S. McCabe and J. J. and Margaret B. Hickey for manuscript suggestions; and to the Delta station students and staff who gave time, energy and moral support to the construction and operation of the Delta decoy.

SUMMARY

A decoy is an old European trapping device that catches ducks by luring (tolling with a dog) them from a pond into a net-covered ditch with a closed end. The ditch is wide at its juncture with the pond, and narrow at the far end. It is curved and the covering netting is supported by hoops of decreasing size from the wide to the narrow end. The narrow end has a partitioned holding box as the final cul-de-sac. From behind a series of screens, a decoyman guides a dog in such a way that the ducks see the dog on the ditch edge for only brief periods. The ducks swim toward the dog as it retreats along the narrowing ditch. After the ducks are well into the ditch, the decoyman tethers his dog and by moving behind a shielding screen brings him-

self between the pond and the birds, thus forcing the ducks to flush toward the closed end of the ditch into the holding box. Why the ducks are attracted to the dog, we do not know.

Such a decoy with a single pipe was built at the Delta Waterfowl Research Station in 1950. In 10 years' operation, 21,211 ducks of 14 species were caught. All birds were aged, sexed, banded and released. Eleven other species of birds were also caught in the decoy including a ruddy duck not shown in the duck list.

Mallards, blue-winged teal and redheads were the most abundant species caught. Mallards captured in the decoy were compared as to sex and age with mallards taken in bait traps near Delta, and with some taken in the Prairie Provinces. The sex ratios were not significantly different between the two kinds of trapping in the catch for the years examined. The age ratios showed variation among the years. The same general results were obtained when the Delta decoy catch of mallards was compared with the mallard catch in certain Dutch decoys and also when the catch of mallards, blue-winged teal, redheads and pintail from the Delta decoy was compared with the catch of the same species in bait traps operated in the Delta area.

The decoy can be used instead of bait traps in waterfowl research if a proper site is available and a trained decoyman can be employed.

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DISCUSSION

DR. GREELEY [University of Massachusetts]: Bob, as an ex-student of yours I seem to remember that no such technique ever got by your course without the question being asked, What does it cost me?

DR. MCCABE: The cost of this pipe was minimal because of the gratuities involved and the free labor but it was built for between $185 and $200. I suspect if one were to start from scratch and pay for all the materials at the current prices, plus paying for labor, it might run around $600 or even more.

DISCUSSION LEADER LOW: Bob, I might ask just one question. This is the only pipe in North America. There must be some reason why it hasn't been more widely used. Can you give us an idea?

DR. MCCABE: I think that there is no tradition for its use in the United States. It is very common in the Low Countries where it originated and was then taken to England where it was adapted to the English countryside. The present pipes in Holland, certainly under 100, are still operating on a commercial scale. That is, the ducks are captured and sold on the English market.

The few remaining traps and decoys in England, which I would number less than ten, are used for banding purposes. We have no tradition for this type of market trapping. So the method has not been used. We just haven't had the occasion to try it as a research technique because of the need for pond seclusion and skill in operation.

DISCUSSION LEADER LOW: Perhaps your paper might stimulate some to think more seriously of its possibilities.

EXPERIMENTAL USE OF ACETYLENE EXPLODERS TO CONTROL DUCK DAMAGE

W. J. D. STEPHEN

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Each harvest season flocks of ducks cause losses estimated in millions of dollars to barley, oats, and wheat crops on the Canadian prairies (Elkins 1957:1). In the Prairie Provinces hunting season dates and bag limits are influenced by the threat of grain-eating species of waterfowl. In a further effort to reduce crop damage, many ducks are shot under authorization of Sections 32 and 33 of the Canadian Migratory Bird Regulations. Successful control of duck damage on individual fields through the use of firearms and scarecrows has been reported by Hochbaum *et al.* (1954:181) and Bossenmaier and Marshall (1958:28). However, the latter suggest (*op. cit.*:28) that in unfavorable years harassment would simply shift ducks from one vulnerable field to another. If the interests of scientific waterfowl management are to be less in conflict with those of agriculture, it is essential that a method of controlling duck damage be developed which may be universally applied by farmers.

In 1958 following a discussion by the Waterfowl Advisory Committee it was proposed that Canadian and United States agencies cooperate in an attempt to assess and alleviate problems caused by ducks damaging grain in Canada. Research reported here is a direct result of that proposal. In August and September of 1958, personnel loaned from seven Canadian and United States agencies began exploratory work on the Canadian prairies. It was decided in 1959 that co-operators investigating duck damage alleviation should test both known and new methods for preventing depredations. Results obtained that year indicated that automatic acetylene exploders held most promise as a practical means of damage control. Acetylene exploders are machines which create an explosion by igniting a small amount of acetylene gas. In some models, the noise of the explosion is amplified to a decibel level similiar to that of a shotgun blast.

Objective of the 1960 experiment was to test use of exploders as a means of controlling duck damage in a large district.

Acknowledgment for assistance with field work in the experiment is due the following persons: Atlantic Flyway—A. Florio, Delaware; Mississippi Flyway—D. Adams, Iowa, G. Arthur, Illinois, G. Brakhage, Missouri, J. Burbank, Tennessee, D. Donaldson, Arkansas, R. Harmon Louisiana; U.S.B.S.F. & W.—E. Cofer, R. Hanson, and C. Rollings; Saskatchewan Wildlife Branch—J. Donovan and S. Prystupka; Ducks Unlimited (Canada), R. Caldwell and G. Staines; and Canadian Wildlife Service, P. Dean, J. Millar and L. Sugden. I wish to thank J. B. Gollop, Canadian Wildlife Service, for assistance in the study and critical review of this manuscript.

DESCRIPTION OF STUDY AREA

The study area of Meadow Lake was selected for two reasons. First of all, it has a history of being subject to severe duck depredation. Secondly, it is in a large agricultural district (2,000± square miles) which is a clearly defined ecological unit since it is separated from other grain-growing areas of Saskatchewan by a band of mixed-wood forest about 40 miles wide. The 2,000-square-mile area is made up of smaller blocks (200± square miles) of cultivated land which are also separated from each other by mixed-wood forest. One of those smaller blocks, in the vicinity of the town of Meadow Lake, was chosen as an experimental area. Duck damage was then compared in treated and untreated areas which were ecologically similar.

An outline of the 209.5-square-mile experimental area used in 1960 is shown in Figure 1. As an agricultural district the Meadow Lake area includes some of the most fertile soils in the province (Mitchell *et al.* 1950:85). Since a short frost-free period tends to limit productivity of the area, barley and other short-season crops are grown predominantly. Topography of the area is smooth. As in typical parkland, cultivated areas are interspersed with trees (aspen and associated understory), often at the edges of fields and usually around water areas and farm buildings.

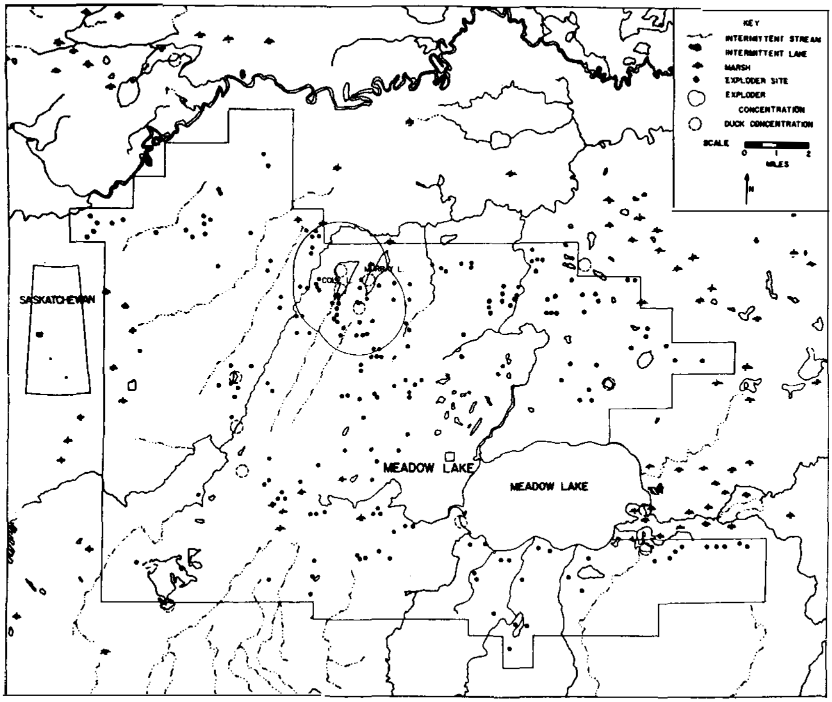
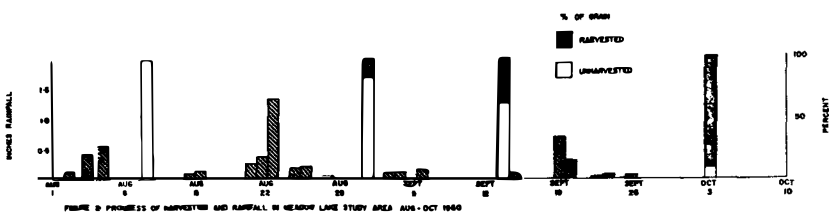


Figure 1. Map of 1960 study area near Meadow Lake, Saskatchewan, showing water area and exploder sites.

1960 HARVEST PHENOLOGY IN STUDY AREA

Damage to wheat, barley and oat crops occurs most frequently while they are in a swathed condition. Although swathing allows more uniform drying and therefore an earlier harvest, it increases vulnerability of grain crops to duck damage. In general, severity of damage is related to the length of time that crops are swathed and the number of field-feeding ducks in the area. Normally, small-grain crops mature at approximately the same time — late July or early August—that flocks of young-of-the-year and post-breeding adult ducks begin to congregate. Twenty to thirty days are usually required to harvest mature grain in a district using the swathing method. In the Meadow Lake experimental area in 1960, swathing was delayed a week to ten days by a wet spring, and harvesting was prolonged over a period of 62 days because of frequent rain (Figure 2).

A comparison of number of waterfowl available and progress of harvesting is given in Figures 2 and 3. Mallards (*Anas platyrhynchos*) and pintails (*Anas acuta*) were the most abundant species,



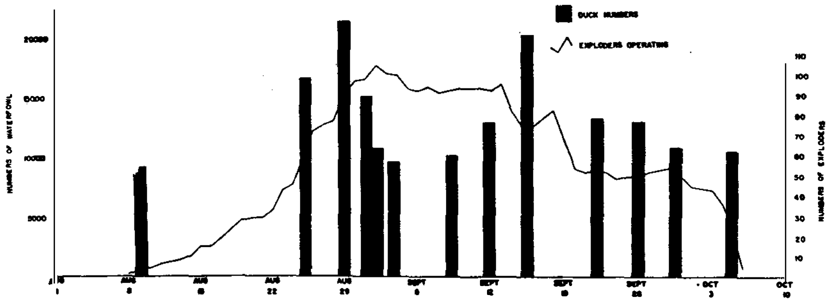


Figure 2. Progress of harvesting and rainfall in Meadow Lake study area, August-October 1960

Figure 3. Dabbling ducks censused Meadow Lake study area, August-October 1960, and number of exploders operating daily.

while green-winged teal (*Anas carolinensis*), blue-winged teal (*Anas discors*), and baldpate (*Anas americana*) made up 5 to 10% of the waterfowl counted. Fluctuations in waterfowl numbers, apparent in Figure 3, are considered normal. Ground observations of species composition of field-feeding flocks suggest that disappearance of pintails, which normally migrate early, accounted for the reduction of waterfowl numbers during the first week of September. Although it is difficult to compare the magnitude of depredation problems from year to year and between areas, it may be concluded, on the basis of the length of the harvest period and the numbers of ducks available to do damage, that duck depredation was potentially a serious problem in the study area in 1960.

METHOD

A daily patrol of the study area was made to observe waterfowl flights and field-feeding, and to service exploders. During the peak depredation period, from August 22 to September 20, eight to ten men patrolled the 209.5-square-mile study area. Each observer was assigned to a segment varying in size from 15 to 36 square miles, depending on field-feeding activity. During the rest of the study period, from August 2 to August 21 and September 21 to October 7, one to four observers made daily patrols. Daily observations were made at two periods, the first beginning approximately one-half hour before sunrise and ending four or five hours later, the second beginning four or five hours before sunset and ending at dark. Observations were also made during the mid-day period when field-feeding occurred then.

In this experiment an exploder was set in a field after ducks were observed landing there and permission of the crop owner had been obtained. Additional exploders were installed if needed until ducks were discouraged from landing in that field. Small flocks (less than 25 ducks) landing in susceptible fields were dispersed with exploding shotgun shells; if they persistently attempted to land in the same site, an exploder was installed. It was not considered practical to install an additional exploder if only one or two ducks were observed landing.

Periodic counts were made of the number of unharvested fields of barley, wheat, and oats in the study area. Numbers of dabbling ducks were counted by aerial census on water areas from which field-feeding flights in the study area originated. Rainfall records were obtained from the Saskatchewan Department of Natural Resources Regional Office at Meadow Lake. Data on Wildlife Insurance in the experimental and surrounding areas were obtained through the courtesy of Mr. A. O. Smith, Chief Farm Underwriter, Saskatchewan Government Insurance Office, Regina. Mallard and pintail ducks were bait-trapped and banded in the period August 11 to September 5 on water areas within the study block in an attempt to measure population turnover, which might be related to harassing activities.

DISTRIBUTION OF EXPLODERS

Within the study area in 1960 there were a total of 922 fields under cultivation. Of those, 530 were sown to wheat, barley, and oats (not including those grain crops grown for forage). The distribution of sites in which exploders were used is shown in Figure 1. A total of 201 exploders were put in 141 fields. In the remaining 389 fields either ducks were not observed landing or the owner did not wish to have an exploder installed. There were five fields in the study area on which wildlife insurance claims were paid which did not have exploders installed in them. Fields with exploders in them ranged in size from 20 acres to 220 acres with a mean of 73.2±3.5 acres. Only 43 of the 141 protected fields (30.5%) required more than one exploder. The mean acreage of the 98 fields protected with one exploder was 67.3±3.9 acres. The mean acreage of 30 fields requiring two exploders was 83.8±7.7 acres. The mean acreage of 11 fields requiring three exploders was 86.3±17. acres. Those data indicate that the number of exploders required to protect a field from duck damage is not directly proportional to field size.

Differences in susceptibility to duck damage on particular sites have been reported by Hochbaum *et al.* (1954: 181). In the 1960 study particular attention was paid to field-feeding flights originating from the complex of loafing areas afforded by Cole and Murray Lakes. During most of the aerial censuses the largest proportion of ducks counted were concentrated there. Ground observations made throughout the study indicated that field-feeding flights of ducks originating there attempted to land within one or two miles. Observations of such feeding-flight patterns were recorded for that one segment only. The mean acres of fields protected by exploders within 1.5 miles of the loafing areas was 44.6 ± 6.0 acres per exploder compared to 60.4 ± 3.4 acres per exploder for protected fields in the rest of the study area. That difference is significant at the 90% confidence level indicating an increased susceptibility within 1.5 miles of the loafing areas mentioned. It is not known whether that increased susceptibility was due to attractiveness of those particular sites or related to a larger number of ducks available to do damage. It is of interest to note, however, that not all grain fields within the 1.5 mile radius were damaged by ducks.

The mean length of time that exploders were used for protection of a field (from installation of first exploder until the field was harvested) was 15 days, with a range from one to 41 days. In some fields it was found that one exploder would prevent ducks from landing for a period of time, then additional exploders had to be installed.

In Table 1 a comparison is made of the per cent grain harvested, peak duck numbers, mean numbers of exploders per field, mean numbers of fields requiring protection, and numbers of fields in which additional exploders were required. It can be seen that the number of fields requiring protection increased with an increasing duck population as long as the ratio of unharvested fields to harvested fields remained 4:1 or more. However, the number of exploders per field increased steadily until the last week of September. In part, that was due to the procedure of leaving a maximum number of exploders in a field until it was harvested. For example, on August 14 ducks might have been observed landing in a field and one exploder installed. On August 29 further landings in the same field might have been observed, and two additional exploders installed. The three exploders were then operated until the field was harvested, whether or not ducks were ever observed attempting to land there again.

The addition of exploders to fields in which exploders were already operating reflects a change in susceptibility of those fields. The dates on which peak numbers of additional installations were made coincide with duck population peaks. The highest number of additional installations was made during the period when there were relatively few unharvested fields available to ducks for feeding.

TABLE 1: MEAN NUMBER OF FIELDS REQUIRING PROTECTION, MEAN NUMBER OF EXPLODERS USED, NUMBER OF FIELDS REQUIRING ADDITIONAL EXPLODERS, PEAK DUCK NUMBERS, AND PERCENT GRAIN HARVESTED BY WEEKLY PERIODS, MEADOW LAKE, 1960.

Date	Mean No. fields	Mean No. exploders	No. exploders per field	No. fields requiring additional exploders	Peak duck numbers	Per cent grain harvested
Aug. 8-14	4.8	5.6	1.15	0	11,200*	0%
Aug. 15-21	19.3	22.7	1.18	2	15,600*	— **
Aug. 22-28	49.3	58.4	1.19	6	18,500*	— **
Aug. 29-Sept. 4	72.3	98.7	1.38	13	21,600	20%
Sept. 5-11	62.4	98.7	1.50	3	12,500	— **
Sept. 12-18	53.8	83.6	1.55	7	20,000	38%
Sept. 19-25	33.6	54.0	1.61	3	16,200*	— **
Sept. 26-Oct. 2	32.0	49.7	1.55	0	10,600	90%

*by interpolation
**no data for given period

Observations made in this study and also reported by Hochbaum *et al.* (1954: 181) suggest that wariness of field-feeding flocks increases with progression of the season. Hunting activity undoubtedly contributes to increased wariness of shotgun-like noises. There was no evidence collected during the study to indicate that the necessary increase in the number of exploders per field was a result of ducks becoming less wary of exploders as time went on.

The need for additional exploders on particular sites might be attributed to several factors. Some of them are as follows: (1) increased attractiveness of the field in relation to other fields, which may have been plowed or in which ducks are prevented from feeding by exploders or hunting disturbance; (2) increased numbers of ducks field-feeding; (3) new individuals in the field-feeding population. It is not possible to state categorically from the data presented in Table 1 which, if any, of those factors were of most influence. However, it may be suggested that it is to a farmer's advantage to maintain undisturbed feeding areas in the form of stubble fields in order to reduce the attractiveness of his unharvested crops.

RESULTS

There was no evidence collected during the study to suggest that mallards and pintails stopped flying out to fields. Throughout the study, observations were made of ducks feeding in harvested fields adjacent to susceptible fields in which exploders were operating.

Ducks would usually continue to use harvested field until disturbed by hunters or the field was turned over with a mould-board plow. Tillage with a discer or cultivator does not make waste grain completely unavailable, so ducks would continue to use fields tilled in that manner.

The value of automatic acetylene exploders as a means of preventing damage in a large district may be assessed by comparing the number of claims made on Wildlife Insurance in the study area and the adjacent area. The adjacent area encompasses approximately 2,000 square miles. It includes agricultural areas which are usually referred to by town names such as: St. Cyr, Dorintosh, Rapid View, Makwa, Loon Lake, Goodsoil, Beacon Hill, and Pierceland. In the years 1956 to 1959 inclusive, the study area consistently had a higher proportion of Wildlife Insurance claims. In 1960 in the adjacent area, claims were made on 48.0% of the policies issued (47 out of 98). In the study area, claims were made on 34.8% of the policies issued (8 out of 23) for fields protected by exploders. Claims were made on five additional policies issued for fields not protected by exploders. The owners of three of those five fields did not wish to have exploders installed. The other two claims were for $100 or less so that they might have been caused by small flocks which went undetected by daily patrols. The difference in proportion of claims between the study area and adjacent area in 1960 was tested for significance (Dixon and Massey, 1951: 191). It can be concluded that the probability is only 0.12 that such a difference would be exceeded by chance alone. If harassment had caused damage to be spread among more farmers in the study area, then an increase in the number of claims would have been expected.

It might be reasoned that the decrease observed in the number of claims on the study area was effected by a movement of ducks into adjacent areas. Re-traps and recoveries of mallards and pintails banded during the study suggest that such a shift did not take place. Of 73 pintails banded, 17 were re-trapped on the study area at periods varying from 1 to 12 days after banding. Of 72 mallards banded, 10 were re-trapped from 1 to 9 days after banding; four were recovered on the study area 10, 17+, 18 and 36 days after banding; a fifth was recovered approximately five miles from the study area 23 days after banding; and a sixth was recovered approximately 150 air miles from the study area 27 days after banding. All bandings, re-traps, and recoveries were made within the period that exploders were used on the study area. Those data suggest that exposure to harassment did not drive ducks out of the district.

All species of ducks were not discouraged from feeding in fields with equal ease. It was more difficult to prevent green-winged teal from landing in a field than either mallards or pintails. To my knowledge field-feeding activity by green-wings has not been reported previously. Fortunately, their abundance at Meadow Lake, and on the prairies generally, in relation to mallards and pintails, makes their economic value as crop destroyers rather small. Green-wings were observed feeding in only three susceptible fields on the study area. In those fields they appeared to act as decoys so that more exploders had to be installed than might have been needed for mallards or pintails alone.

There seemed to be different responses of ducks to exploders in relation to flock size. Very small groups of field-feeding ducks (single's, two's, and three's) were often flushed from fields or were seen to land in fields at very short distances from exploders. It was difficult to make accurate measurement of those distances.

Small flocks (10 to 100) took less time to enter a field than a large flock (100 or more). As a result, it was found necessary to operate exploders at a rate of approximately one explosion per minute so that small flocks would not land between explosions. Once on the ground, ducks seemed harder to scare than while in flight.

EXPLODER OPERATION AND DEFECTS

Exploders used for this experiment were the ''Zon'' model M 60 as shown in Figure 4. Both ''Zon'' and 'Scare-away'' brands of automatic acetylene exploders were tested in 1959. The ''Zon'' was chosen for 1960 experiments because it appeared to be sturdier, with cast iron and welded construction compared to the stamped and riveted construction of the other exploder.

In exploders of which ''Zon'' and ''Scare-away'' are examples, mixtures of acetylene and air are ignited in an explosion chamber situated behind a megaphone so that sound made by combustion is amplified. Energy derived from the flow of acetylene gas actuates the ignition and explosion interval-control system. Flow of gas is regulated either by the rate of generation when operated from a carbide and water acetylene generator, or by a throttle valve when operated from bottled gas. Flowing gas expands a diaphragm which is mechanically linked so that it cocks a flint-and-wheel ignition system. When an appropriate amount of acetylene is accumulated, a lever is tripped which releases the gas through a check valve into the explosion chamber and allows a spark to be struck. A small but loud explosion results.

Operating costs vary with the rate of explosion. If an exploder were operating around the clock at a rate of one explosion per minute,

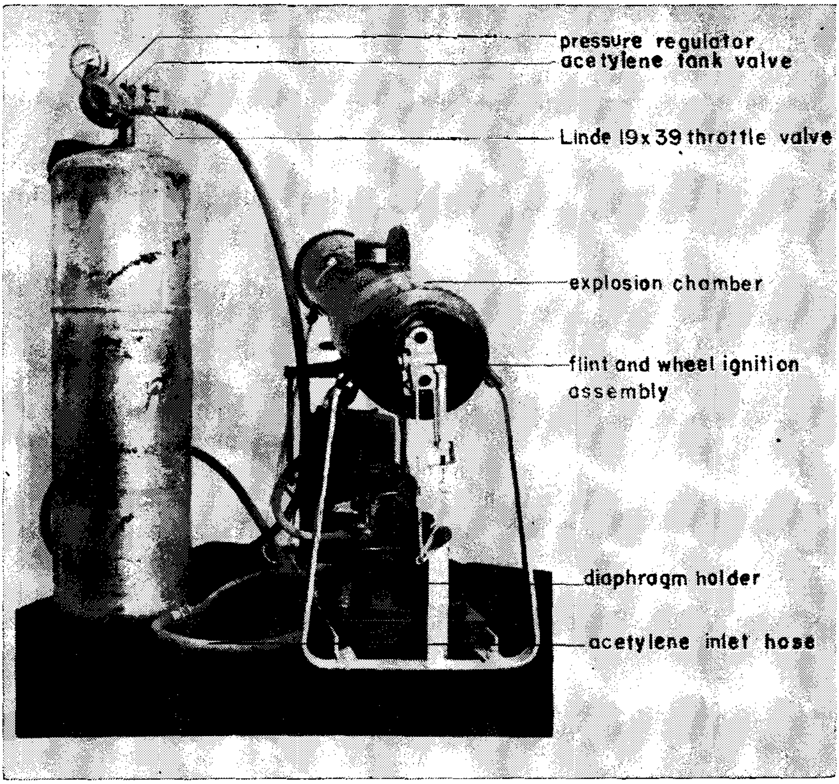


Figure 4. Zon model M60 showing explosion interval control system.

bottled acetylene, worth about four dollars, would last about a week. The daily operating cost would then be approximately 57 cents. The seasonal cost of operation of exploders for a 15 day mean period, as at Meadow Lake in 1960, would be about $8.50. That cost would be reduced even more if a suitable timing device were used which would shut the exploder off at night.

Difficulties were experienced in operating "Zon" automatic acetylene exploders. The exploders will only operate for a period of four to six hours at a rate of approximately one explosion per minute from the amounts of carbide and water recommended for use with the generator supplied. A farmer would have to replenish both carbide and water twice a day in order to ensure suitable operation during peak depredation periods. As a comparison, bottled acetylene supplies would last about one week. However, when operated from bottled gas, the valve on a tank of acetylene, and available acetylene throttle valves, such as "Linde 19 x 39," are too coarse to allow easy adjustment of flow. The range from zero explosions to a three-explosion-per-minute maximum (determined by the mixing rate of acetylene and air) is regulated by approximately one-eighth to one-sixteenth of a turn of either the acetylene tank valve or the throttle valve. That range makes the interval of explosion hard to adjust. Once the valves were adjusted the interval of explosion was also affected by changes in atmospheric pressure and temperature because of their effect on flow rate.

Maintenance of exploders in operating condition was also a problem. Almost every machine that was installed required at least minor maintenance during its period of use. Minor maintenance was that done while the machine was still in the field. Most frequently, repairs of that type were made to the lighter assembly. Examples of causes of trouble are as follows: (1) relaxed tension on spring holding flint against wheel; (2) clogging of flint wheel with flint dust; (3) uneven wear on flint so that it no longer faced the wheel; (4) loosening of nut holding flint-cocking mechanism to diaphragm linkage. Any of those defects would result in no explosion, and the possibility of ducks landing in the field concerned. Major maintenance involved replacements of parts. Such replacement was made necessary by fractures of welds or castings, and excessive wear on moving parts. Forty-six per cent of the 150 machines available requiring major maintenance in the first season of operation.

DISCUSSION

The usefulness of harvested fields as alternate feeding areas could not be fully evaluated during the Meadow Lake study. No effort was made by the experimenters to discourage hunting on stubble fields nor to discourage farmers from tilling stubble. Despite those limitations, it was obvious throughout the study that ducks were using harvested fields as substitute feeding areas when driven from susceptible fields.

In many parts of the prairies where wind erosion is a problem and there is relatively little straw to be decomposed, spring cultivation of stubble, as recommended by the Federal Department of Agriculture, is the rule. In order to prevent duck damage in those areas, it may only be necessary to harass ducks on susceptible fields and to enforce legislation designed to ensure that ducks are not disturbed on harvested fields by hunters until threat of depredation in the vicinity is past.

In many northern areas of the prairies, including the Meadow Lake district, there is a short growing season and little threat of wind erosion; it would therefore seem to be to the farmer's advantage to cultivate stubble in the fall although this would encourage duck depredation in unharvested fields. In those areas there may be times and places where alternate feeding sites are in short supply, and the cost of preventing duck damage by exploders alone may be more than an individual farmer is willing to pay for protection from a "publicly owned" hazard. In areas of the prairies where fall cultivation is the rule, it seems advisable to investigate the need for provision of alternate feeding sites to be used in conjunction with harassment for duck damage control. Information on adequate type, optimum size, location and number of feeding areas is needed.

If abatement of conflicts with agriculture is to be part of a continental program of scientific waterfowl management, it is my opinion that the first step in such a program is to develop a dependable exploder. I believe that the next step will be to pinpoint the areas which are susceptible to duck damage and establish priorities for action. A flexible program can then be designed to cope with problems which are related to land use, farmer's attitude, and waterfowl resources.

SUMMARY AND CONCLUSIONS

1. Evidence is presented to show that under conditions in which crops were susceptible to duck damage for about twice the normal period of time there was a reduction in the number of insurance claims in this study area and that ducks did not move out of the district. It follows that automatic acetylene exploders, operating at a rate of approximately one explosion per minute in all fields requiring protection can be used to reduce duck damage without simply spreading the losses among other farmers in the same or adjacent districts. It is probable that duck damage losses could be made negligible by systematic, prolonged harassment in unharvested fields if ducks were allowed to feed undisturbed in stubble or lightly cultivated fields nearby.

In 98 of 141 susceptible fields (69.5%), only one exploder per field was required. More than two exploders per field were needed in only 9.2% of the susceptible fields.

2. The difficulty experienced in regulating the interval of explosion and maintenance necessary to ensure continued operation are thought to be serious limitations to the usefulness of the model of acetylene exploder tested.

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DISCUSSION

MR. ROBERT WALKER: I would like to amend my previous question in view of Mr. Stephens' excellent paper and suggest that it might be feasible to divide the cost of insurance premiums between the interested farmer and some government agency.

Also, I suggest the possibility of utilizing surplus grains, which are glutting the American system at the present time, at much less cost to the conservation departments and to the Federal Government than the purchase of grains in the open market.

I feel that sharing the cost of the insurance policy between the farmer and the conservation department to represent the sportsman's interest would be a fair and reasonable one.

DISCUSSION LEADER LOW: Very fine, and Mr. Stephen, have you a comment to make on that particular point?

MR. STEPHEN: In the Province of Saskatchewan, wildlife insurance is contributed to heavily by hunters. The hunters contribute $13 to every $1 contributed in the form of premiums by farmers and, as I understand it, surplus grain is being utilized in various parts of the United States.

MR. GILBERT HUNTER [Colorado Game and Fish Department]: I appreciate you can't advertise a particular exploding gun; we call them "Zon Guns." We have used these for quite a long time. However, we have not carried on a study like you have as to their effectiveness in a particular area.

Now, I would like this question because I understand there is a new gun manufactured, I believe, by a Belgian concern. The one we are using is the Zon Gun.

We use these on geese, deer and naturally ducks. We have found them very effective. We ask the farmer to take care of them. We give him a gun and the first tank of acetylene, and he handles it from then on. I would like to know just which type of gun you showed, if you please.

MR. STEPHEN: That was Zon Model M-60 which is—if you like the 1960 model, but these don't change like automobiles. It was the most recent model of the Zon gun.

"Zon" is the Dutch word, meaning sound, so this is undoubtedly the same machine. There are several—I think there are at least nine or ten automatic acetylene exploders available on the market. We felt that this one had the best construction.

We have tested these in previous years. In 1959 we tested several models of exploders and felt that this one was better because of its welded construction and cast-iron parts. However, most of the effective ones operate on this principle in which the interval of explosion is determined by the flow rate of acetylene gas, whether it is generated by carbide and water, or whether it comes from a bottled supply.

Since the flow rates are small, they are subject to the influence of barometric pressure and temperature and they are very hard to adjust to a suitable rate. We feel that one explosion per minute is a critical feature, especially when you have an area saturated with field-feeding ducks which, when chased from one field, will potentially land in another. We found that the most serious drawback of the machine was the difficulty with which the interval of explosion is regulated either by carbide and water or by operating from a bottled acetylene supply.

MR. JOHN SEUBERT [Fish and Wildlife Service]: Did you find the gun worked more satisfactorily with acetylene gas from the tank than when used with calcium carbide?

MR. STEPHEN: The decibel level of the explosion is the same. It doesn't affect the noise made by the machine. Is that what you mean?

MR. SEUBERT: No, I meant adjusting the regularity of explosion.

MR. STEPHEN: It is slightly easier to adjust the interval of explosion using carbide and water. However, the other limitation comes in operating it at a rate of one explosion per minute. The amounts of water and carbide which fit into the generator supplied with the machine will not last more than 4 to 6 hours, and this means that a farmer would have to replenish the carbide and water twice a day. Under Canadian conditions, most of the farmers are non-resident; that is, they live in town and farm a piece of land as much as 10 miles away. If it rains, they can't get there, but the ducks can.

SHOOTING AREA MANAGEMENT OF PIN OAK[1]

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The establishment of the Mingo National Refuge in the period 1939 through 1942 and the subsequent establishment of the adjacent Duck Creek Wildlife Area in 1950 has posed many ecological and land management problems. These administrative units of 22,000 acres and 6,000 acres respectively are located in the Mingo Basin which is located in southeastern Missouri near the town of Poplar Bluff.

In its original state this land area was an outstanding example of an abundance of renewable natural resources. Barrels of fish and game were shipped to large cities, and several large sawmills were established that processed impressive volumes of cypress and hardwood stumpage. The swampy habitat of the basin (originally encompassing approximately 35,000 acres) was created by poor drainage conditions that developed as a result of the eastward diversion of the Mississippi River channel during the Quaternary Era (Marbut 1902). At one time the river entered the basin near the present site of the town of Cape Girardeau, and from here it swung westward through the limestone deposits and bluffs of the valley. Because of the activities of the Ohio River the Mississippi became located in its present channel to the east. Somewhat later the St. Francis River formed a

[1]Journal Series Number 2276. Contribution from the Missouri Agricultural Experiment Station. Approved by the Director.

delta across the basin, thus creating an effective drainage barrier and a great swamp.

Prior to 1880 there was very little settlement or farming in the Mingo Swamp or its environs because of the formidable hords of mosquitoes and the attendant malaria hazard. About this time some low ridges were cleared for agriculture, but large-scale clearing and drainage activities did not extend into the trough or swamp proper until about 1890 and these activities were greatly accelerated with the organization of the Little River Drainage District in 1907. The major drainage ditches were usually spaced one mile apart in a general north and south direction. Farther east in the "bootheel" region such drainage patterns proved to be very effective in promoting soil drainage and a very prosperous farming economy developed. In the Mingo, however, the generally plastic impermeable soils could not be properly drained and this, combined with low soil fertility and unpleasant living conditions, accounts for the gradual abandonment of most of the farms.

Fire has played a prominent role in greatly altering the vegetational patterns of the basin. For many years burning was used to provide early greening up of pastures and it was also used as a means of combating the rapid invasion of trees and shrubs on cleared land. This repeated burning has changed the food and cover relationships of the vegetation and it has greatly lowered the value of many residual stands of timber.

At the present time the federal and state agencies are engaged in an intensive land rehabilitation program with emphasis on the wildlife and timber potential. The Missouri Conservation Commission has had the additional objective of providing public hunting of ducks as one of the first developmental phases. From a wildlife and forestry standpoint an ecological interpretation of the presently constituted vegetational patterns is extremely difficult because of clearing, burning and agricultural practices of the past superimposed upon which are present management practices that prescribe the impoundment of water on some tracts. Of immediate consideration has been the recognized waterfowl resources of the area (particularly ducks), in conjunction with the strategic location in the Mississippi Flyway. Peak concentrations of 250,000 ducks, almost all of which have been mallards, have been observed on the federal and state areas. Part of the attractiveness of the area for ducks appears to be related to mast production of the oak species in the area. Korschgen (1952) has found in Missouri that acorns are a major food item for four species of ducks: mallards, pintails, ringnecks, and wood ducks. The most important oak is pin oak (*Quercus palustris* Muenchh.) because of its widespread occurrence in essentially pure, even-aged stands that are in close proximity to water or where flooding can be accomplished quite easily. The soils in the pin oak tracts are generally of the Waverly type, which is characterized by a whitish color that is largely due to excessive leaching and lack of organic matter. The subsoil is commonly characterized by iron concretions or "buckshot" that is indicative of poor internal drainage.

In developing the Duck Creek Wildlife Area for public duck shooting it was apparent that a reliable water source would have to be provided so that blinds in the pin oak stands would be attractive to birds. To this end an 1800-acre permanent reservoir was established by means of a levee construction and a seven-mile diversion canal to the Castor River. A system of gates allows the flooding and draw down of the adjacent 600-acre tract that has been intensively developed for shooting. The wildlife management objective of a 50-70 day duck season has meant that the pin oak stands would be subjected to from one to three feet of water through the fall and early winter. Without artificial flooding this area would flood one to four times a year for two to four days' duration at a time. The pin oak stands were 25-35 years old, and in 1956 the dominant and codominant trees were 62-67 feet tall; site index at 50 years was estimated to range between 75 and 85 feet. Several questions immediately arose in regard to what effects the artificial prolonged flooding would have on (1) survival and vigor of the trees, (2) the amount and quality of mast production, and (3) the regeneration of trees, especially pin oak. Accordingly, studies were initiated to determine these relationships (Minckler and McDermott, 1960). Parallel investigations were established to determine the feasibility of pruning and the effects of stand density and diameter distribution on pin oak quality and growth. The pruning and growth studies are to be reported on in the future.

EXPERIMENTAL PROCEDURES

Plot locations were established to test two site variables—one the *Flooded* conditions in the shooting area developed by the Missouri Conservation Commission, and the other the *Normal* or essentially unflooded stands in the Mingo National Wildlife Refuge. In each area 18 half-acre plots were laid out. Nine of these plots were located in stands where small trees predominated (two-thirds of the basal area in trees 10 inches d.b.h. or less) and nine were located in stands where larger trees predominated (two-thirds of the basal area in trees more than 10 inches d.b.h.). In both the small-tree and large-tree stands, three plots selected at random were reduced to 40 square feet basal area, three were reduced to 60 square feet basal area, and three

TABLE 1. DIAMETER DISTRIBUTION OF TREES IN STANDS BEFORE TREATMENT AND TREATMENT GOALS AFTER CUTTING (IN PERCENT OF TOTAL BASAL AREA)

Tree diameter class (Inches)	"Small-tree" structure			"Large-tree" structure		
	Normal area	Flooded area	Treatment goals	Normal area	Flooded area	Treatment goals
5-7	28	26	25	13	14	10
8-10	38	41	45	28	28	25
11-13	21	24	25	31	35	35
14-16	7	9	5	18	19	25
17+	6	0	0	10	4	5
Basal area per acre (square feet)	86	74	—	86	81	—

were left as checks with 75 to 90 square feet basal area (Table 1). The reductions in basal area were accomplished by application of a hormonal herbicide in March of 1956 and the trees treated were effectively eliminated as growing stock about July or August of the same growing season. In the summer of 1957, half of each plot was disked to ascertain whether exposing mineral soil would stimulate acorn germination and establishment.

Twenty-five bushel-basket seed traps were mechanically or evenly spaced in each of the 36 plots—a total of 900 seed traps (Fig. 1). This method of measuring mast yield was used instead of the prediction techniques described by Gysel (1958) and Sharp (1958) because a precise quantitative production figure was needed for positive cor-

Figure 1. Bushel-basket seed traps in place in the shooting area.

relations with the site variable of flooding and the effects of treatments related to stocking and structure. It was for this same reason that the individual tree sampling technique described by Moody (1953) and Reid (1957) was not employed. Preliminary testing determined that bushel baskets provided an accurate, inexpensive method of sampling in a comparison with the ¼ milacre trap described by Downs and McQuilkin (1944). The baskets were mounted four feet high on inclined stakes, and they were screened against pilfering by fastening 1-inch mesh wire screen about half-way down in the basket. In the early phases of the study some of the basket traps were destroyed by the deadened tree tops. After this period of loss from tree top breakage it was found that by predipping the baskets in a preservative they would last for three or four years.

The traps were numbered and recorded by position in relation to individual tree crowns in the canopy as (1) under a crown, (2) edge of crown, and (3) in an opening. Seedfall for 1956, 1957, 1958, and 1959 form the basis of analysis. On the average, collections were made weekly and the acorns were counted and classified as follows:

(1) Well developed, sound, and undamaged.
(2) Well developed and sound, but damaged by animals or mechanical means.
(3) Well developed, but insect infested.
(4) Underdeveloped or deformed, usually aborted.

Class 1 acorns would be highly valued duck food and/or could germinate and become established as seedlings if conditions were favorable. It seemed likely that many if not all of the class 2 acorns would be as valuable as the class 1 acorns. It appeared evident, however, that class 3 and 4 acorns would be useless for wildlife food and for regeneration of seedlings.

In the summer of 1959, 20 circular subplots each 10 feet in diameter were established in each plot (half in the disked portion and half in the undisked) to sample reproduction.

RESULTS

Late-fall and early-winter flooding of pin oak stands over a period of four years did not result in any discernible evidence of injury to the trees.

Of the four seed crops 1956 through 1959, there was one good crop, in 1957, when an average of 188,000 sound, well developed acorns (classes 1 and 2) were produced per acre on the *Normal* area and 201,000 acorns of the same classes were produced on the *Flooded* area (Table 2). Tree size appeared to be the major factor influencing seed production; stands of large trees consistently produced more

TABLE 2. PIN OAK ACORN PRODUCTION, CLASSES 1 AND 2, 1956-59.

Year	Number acorns per acre	
	Normal area	Flooded area
1956	8,000	400
1957	188,000	201,000
1958	24,000	96,000
1959	2,200	12,700

mast than small-tree stands, and in 1957 the denser stands produced more mast. These relationships applied to both classes 1 and 2, and classes 3 and 4.

Stand density and tree size relationships did not influence seed quality (percentage of acorns in classes 1-4) but flooding and the size of the seed crop had a direct relationship to percentage of sound acorns. The *Flooded* area consistently had a higher number and higher percentage of sound, undamaged acorns. In 1957 the *Flooded* area produced approximately 25 percent more classes 1 and 2 acorns than the *Normal* area, and in 1958 the *Flooded* area produced 15 times more classes 1 and 2 acorns than the *Normal* area. Both insect-infested and underdeveloped acorns (classes 3 and 4) were consistently more numerous on the *Normal* area than on the *Flooded* area. Of the 1957 crop, 66 percent of the total production on the *Normal* area, and 78 percent on the *Flooded* area, was classified in classes 1 and 2. In 1958 only 33 percent of the acorns produced on the *Normal* area were sound, while in the *Flooded* area 68 percent were sound.

In general, most of the acorns were collected in traps located directly under tree crowns, and a smaller amount was collected from traps in canopy openings. However, sufficient acorns fell in the openings for purposes of regeneration especially in the stands of the smaller trees.

It was evident that fall and winter flooding in conjunction with waterfowl management objectives is detrimental to new oak regeneration. In a survey made in July of 1959, 3,500 seedlings were found to be established per acre on the *Normal* area, and on the *Flooded* area there were only 58 new seedlings per acre. This, despite the production of more sound acorns on the *Flooded* area or a ratio of 2,100 acorns to 1 established new seedling. On the *Normal* area the ratio was 1 established seedling to 26 sound acorns. Thus, it was apparent that something had happened to the acorns produced on the *Flooded* area between the period of seedfall and the period of germination and establishment, or that something had eliminated the seedlings soon after germination.

Reproduction that had become established prior to the management program of flooding was slightly more numerous on the *Flooded* area than on the *Normal* area which indicates that for older and larger reproduction fall and winter flooding did not have a detrimental effect.

DISCUSSION AND CONCLUSIONS

There was some possibility that the fall and winter flooding technique necessary for waterfowl management would result in damage to the pin oak stands. And, if this was the case a continuation of this program could in time eliminate the pin oak stands. These stands had developed under normal drainage conditions in the swmp and the introduction of water impoundment well over the individual root collars of the standing trees up to 18 inches in diameter could conceivably have been damaging. Such does not appear to be the case, and by the end of the 1960 growing season no damage symptoms have been noted. Thus, unless manifestations of stand injury become evident at some future date, it appears likely that the duo land management objectives of waterfowl management and timber management are quite compatible in terms of endurance or stand longevity and maintenance when flooding is confined to three to four months in the dormant season.

Young pin oak stands 25-35 years old are capable of producing large acorn crops. This is a prime consideration in the development of duck shooting areas. Seed production is cyclic although the present study has not been conducted over a long enough period to determine the cycle. From the limited number of years that the mast samples have been taken, however, it is plain that an extremely poor year can be followed by an extremely good one. It is also probable that forecasting techniques based on flower and seed set estimates could anticipate the relative crop one or two years in advance. Such information might be helpful to wildlife management personnel in an appraisal of the relative carrying capacity or attractiveness of a shooting area. Advanced seed crop information would be most helpful for timber mnagement objectives of pulpwood or piling rotations. Minckler (1957) states that because pin oak is intolerant, the silvicultural system used must be some form of clear-cutting, group selection, or shelterwood. Cutting should be done during winter or early spring following a good year or one year after establishment of new reproduction.

For the two good seed years (1957, 1958) approximately three times as many acorns were insect-infested on the *Normal* area as on the *Flooded* area. The greater number of classes 1 and 2 acorns on the *Flooded* area could be a result of the effect of flooding on the nut weevils (*Curculio* spp.). Breznor (1960) has shown that this group of insects is by far the major cause of damage to acorns. Females account for the initial rupture in the pericarp and it is through these breaks that other insect larvae as well as fungi commonly found in infested acorns gain access. McDermott and Enns (1956) have found that the *Curculio* pupae can remain in the ground two years before emerging in late summer. It is conceivable, then, that continuous flooding for three to four months in the fall and winter may have an adverse effect on the pupae and thus account for the consistently smaller proportion of weevil infested acorns on the *Flooded* area. This is an interesting and logical argument but in contradiction it is also possible that migration of the *Curculio* adults from the unflooded area surrounding the 600-acre shooting area would tend to reduce any effect flooding might have on either the current or longterm *Curculio* population. Perhaps another explanation for the marked increase of insect-free acorns as well as total number on the *Flooded* area was the more favorable residual soil moisture in the summer which might account for greater set and subsequent development of acorns. Thus, the greater number of acorns produced might lower infestation rate as this is a function of a stable insect population.

The low count of new oak seedlings on the *Flooded* area, despite the production of more sound mast on the area, suggests that the bulk of these acorns were consumed by ducks. Certainly large numbers of ducks have been observed in the shooting area and the harvest of ducks has been within the management objectives. Evidence of heavy use of the mast was readily discernible because of extensive patches of muddied water after flocks had flown. There are, however, some additional factors that might have a bearing on the discrepancy of new reproduction in the shooting area such as (1) the acorns may have deteriorated under water, (2) conditions may have been unfavorable for germination after draw down of the water and (3) fall and winter flooding may have eliminated seedlings established in the previous spring and summer. However, acorns do not normally deteriorate in cold water and the advanced reproduction established prior to the fall-winter flooding program was not injured. Disking and exposing mineral soil did not increase seedling establishment on the *Flooded* area but did on the *Normal* area. These considerations are subject to further research, but it seems likely that no single factor will prove significant.

The great abundance of acorns in good seed years helps explain the frequent occurrence of dense stands of pin oak seedlings under pin oak stands. In fact, two to three years after cutting, stands with 40 square feet of basal area produced nearly as much mast as those stands with 60 or more square feet basal area. This further substantiates the compatibility of wildlife management objectives of adequate or increased mast production with timber management objectives of increasing growth rate by creating less dense stands although it may be necessary to prune trees to realize quality increment. However, pin oak duck-management areas may require one to three years without flooding to regenerate the area with pin oak.

SUMMARY

In the central Mississippi Flyway, one of the important considerations for provision of duck food and cover is the characteristics of pin oak (*Quercus palustris* Muenchh.). This species occurs in essentially pure, even-aged stands on poorly drained sites.

With the establishment of public shooting areas in dense pin oak stands, successful area management hinges in part on three basic questions—

(1) Can pin oak stands survive flooded conditions?

(2) How does flooding affect mast production in terms of quality and quantity in various stand conditions?

(3) Can pin oak be regenerated under flooded conditions and subsequent heavy use by ducks?

During the past four years stand and mast characteristics of pin oak stands 25-35 years old have been analyzed at the Duck Creek Wildlife Area and the Mingo National Wildlife Refuge in southeastern Missouri.

Four years after the beginning of fall-winter flooding there are strong indications that wildlife management objectives and timber management objectives are compatible. Pin oak trees do survive under the conditions of fall and winter flooding that are necessary for shooting area development. Stands on the ***Flooded*** area had greater amounts of sound acorn mast and there was less insect infestation. Pin oak regeneration is greatly reduced by flooding probably because of consumption of the sound acorns by ducks, and flooding may have to be discontinued for one to three years at the time of stand regeneration.

Reduced basal areas of pin oak stands is an acceptable management practice because within two to three years thinned stands produced nearly as much mast as the unthinned stands. Such practices may create a more favorable habitat for ducks and the timber values may be improved with further cultural operations.

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DISCUSSION

MR. PAUL SPRINGER [Fish and Wildlife Service, Laurel, Maryland]: You mentioned that you lost no trees because of flooding. Could you state the months of flooding and also whether, in your opinion, flooding could have been accomplished over a longer period and still not cause mortality of trees?

MR. McDERMOTT: The formal shooting season is anywhere from 50 to 70 days but, of course, they start moving water in on that area in early October, and sometimes they don't get it off until March.

Ordinarily they try to get it off by the 1st of February, but there have been years when it has been on much later. We know that impounding takes timber out, and on the 1800-acre tract that was developed as a permanent reservoir you could almost see the timber thin out.

It took about a year for most of the oaks to die; the cypress hung on for two or three years. I think, particularly through the growing season, flooding will knock timber out but in the dormant season it doesn't appear to hurt it.

I say this with caution, since we have only been watching these things for five years. Radial growth is excellent; height growth is good. I am amazed frankly. I went into this thing with some trepidation that we were going to lose a lot of timber, but we didn't.

MR. VERNE DAVISON: Do you know whether the larvae in acorns are drowned if they are submerged under water?

MR. McDERMOTT: Your first question, on the pupae in the water; yes, sir, it kills them. Of course, the female moth has quite a range and so this probably isn't the main reason why infestation rates went down. A female could fly a considerable distance from the surrounding timber.

MR. DAVISON: Do the common grackles eat a lot of acorns off the dry, unflooded land?

MR. McDERMOTT: Yes, they seem to, and why I am not sure. I am not sure whether they are after the insects that might be in them or whether they are actually eating the nuts, but we do get a lot of bird damage and some of it appears to be by grackles.

MR. DAVISON: May I comment? We have some indications from our study of submerged acorns that you might not have had much damage from insects if they had been submerged long enough. In other words, the nuts seem to show almost no deterioration from insects as long as they are under water and the effect of insect damage on your dry collection might not have been real in terms of duck food.

FOOD AVAILABILITY AND PREFERENCES OF JUVENILE MALLARDS

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Wildlife literature is noticeably deficient in publications concerning the food habits of juvenile waterfowl, particularly food availability and preference, or selective utilization studies. Knowledge of food availability and utilization during the critical juvenile stage in the life cycle of waterfowl will furnish basic ecological information of marsh-waterfowl relationships previously unknown. Research on a species level will allow the determination of differences in food requirements between species. Habitats may then be managed to support the most efficient combinations of species to properly utilize habitat potentialities on a common use basis. Also, when the details of dietary needs are collected, research may begin on the effect of chemical poisons to essential food items and consequent influence on young waterfowl.

The ubiquity of *Anas platyrhynchos platyrhynchos*, the common mallard, is sufficient justification for using this species for the beginning step into the realm of juvenile waterfowl-marshland food supply relationships.

Acknowledgment is hereby made for the financial aid furnished by the Wildlife Management Institute, the use of facilities and equipment given me by the entire staff of the Bear River Migratory Bird Refuge, Utah, and particularly for the guidance, encouragement, and advice of Dr. Jessop B. Low, Leader, Utah Cooperative Wildlife Research Unit. To these organizations and associates—my deepest thanks.

STUDY AREA

The Bear River Migratory Bird Refuge, Brigham City, Utah contains approximately 65,000 acres. About 35,000 acres are surrounded by dikes to form five separate artificial lakes or units, the water of which varies from zero to about three feet in depth. Borrow ditches adjacent to the dikes and channels through large stands of vegetation vary in water depth to about 6 feet and 75 feet in width. Water is furnished by the Bear River, the flow of which is greatly reduced in late spring and summer because of its use as irrigation water upstream. The south dikes prevent the Bear River waters from flowing directly into Great Salt Lake.

PROCEDURES

Sampling stations were established on a restricted randomized design basis in a one acre rectangular plot for the intensive study of terrestrial and aquatic organisms during May through July in 1959 and 1960. The habitats sampled were the borrow ditch, open water shallows, *Distichlis stricta* (salt grass), *Scirpus paludosus* (alkali bulrush), and *Scirpus acutus* (hardstem bulrush). Observations were made in other marsh areas to supplement data acquired from the study plot. Juvenile mallard ducklings were collected from various parts of the refuge to obtain gullet-gizzard samples for analyses.

Invertebrate samples were taken weekly by means of a square foot frame and pump to measure aquatic organisms, a sweep net for flying insects and plant clinging forms, ground traps for ground crawlers, and sticky board traps to determine the levels of concentration of flying insects above the ground and water surfaces. The number of items in the samples served as the basis for the calculations of all percentages.

FOOD AVAILABILITY AND ABUNDANCE

Aquatic Organisms

Twenty-five different aquatic invertebrate forms were found in the marsh water habitats of the study area throughout the three month sampling period. Seventeen of these organisms occurred as less than 1 per cent of the population. Cladocera (water fleas) comprised 54.18 per cent of the population, Corixidae (water boatmen) 12.96 per cent, Copeopoda (copeopods) 8.16 per cent, Ostracoda (seed shrimps) 7.48 per cent, Cladocera ephippia (resting stage) 5.01 per cent, Tendipedidae larvae (midges) 4.49 per cent, Oligochaeta (aquatic earthworms) 3.12 per cent, Gastropoda (snails) 1.70 per cent and the other 17 forms combined 2.90 per cent.

Corixidae (nymphs and adults) and Tendipedidae (larvae) are important foods for mallard ducklings. The abundance of Corixidae varied greatly between habitat types. The relative abundance in each habitat was as follows: borrow ditch 2.25 per cent, open water 18.04 per cent, *D. stricta* 0.97 per cent, *S. paludosus* 7.65 per cent, and *S. acutus* 35.30 per cent.

The abundance of Tendipedidae remained relatively stable between habits as follows: borrow ditch 2.55 per cent, open water 5.41 per cent, *D. stricta* 4.15 per cent, *S. paludosus* 3.59 per cent, and *S. acutus* 5.51 per cent.

Flying and Plant-Clinging Organisms

At least 40 different flying and plant-clinging invertebrate forms occupied the emergent vegetation habitats. Thirty of these organisms occurred as less than 1 per cent of the population. Tendipedidae adults (midges) comprised 54.76 per cent of the population, Phloeothripidae (thrips) 14.84 per cent, Araneae (spiders) 6.96 per cent, Drosophilidae (vinegar gnats) 4.50 per cent, Cicadellidae (leafhoppers) 2.69 per cent, Dolicopodidae (long-legged flies) 2.49 per cent, Hydracarina (mites) 2.46 per cent, Ephydridae (ephydrids) 2.42 per cent, Miridae (plant bugs) 1.88 per cent, Coccinellidae (ladybird beetles) 1.43 per cent and the other 30 forms combined 5.57 per cent.

Tendipedidae (adults), an important duckling food item, predominated throughout the season in all habitats. In *D. stricta* Tendipedidae occurred as 44.21 per cent of the population, in *S. paludosus* 63.80 per cent and in *S. acutus* 63.71 per cent.

Dolicopodidae, somewhat important as duckling food, occurred in *D. stricta* as 1.11 per cent of the population, in *S. paludosus* 3.90 per cent and in *S. acutus* 2.47 per cent.

Ground-Crawling Organisms

Nine different forms of ground-crawling invertebrates were sampled in the high ground area of the study plot within the *D. stricta* habitat. Seven of the ground crawlers occurred as less than 1 per cent of the population. Myrmicinae (ants) predominated as 93.58 per cent of the population while Silphidae (carrion beetles) occurred as 5.10 per cent and the other seven forms combined 1.32 per cent.

Observations on various parts of the refuge also revealed that Helophorinae (mud beetles) predominated in the drying mud which was being exposed by receding water levels along the sides of borrow ditches, canals, islands, and lake shores.

Concentration Levels of Flying Insects

Flying insect concentrations increased in direct proportion to the height above the ground surface in the emergent stands of *D. stricta, S. paludosus,* and *S. acutus.* Conversely, concentrations decreased with increased height over open water and open mud where insect numbers were highest just above the surface.

In the emergent stands insects were most active and concentrated on a level corresponding with the top portion of the vegetation. Below this level insect numbers progressively decreased. The denser the vegetation the greater was the over-all abundance and sharper was the decline in numbers between any two levels from the upper to lowest portion of the plants. Thus, concentrations decreased most noticeably in the dense *D. stricta,* less so in *S. paludosus* and the least in *S. acutus.* Over-all abundance of the flying insects, which were primarily Tendipedidae, occurred in each habitat as follows: open water 33.15 per cent, *D. stricta* 31.13 per cent, *S. paludosus* 18.17 per cent, and *S. acutus* 17.55 per cent.

Vegetation

Potamogeton pectinatus (sago pondweed) predominated as the most abundant aquatic plant species. *Zannichellia palustris* (horned pondweed), *Ruppia martima* (widgeon grass), and *Chara* species were other common species of the open water areas. *S. paludosus, S. acutus, D. stricta,* and *Typha* species were the common emergent species on the higher ground mainly south and also northwest of headquarters. *S. acutus* was dominant along the dike roads adjacent to the lake shore frequented by mallard broods. *D. stricta* generally bordered both sides of the borrow ditches located opposite the lake side of the dike roads.

FOOD CONSUMPTION

Selective Utilization

Newly hatched mallard ducklings begin to feed soon after leaving the nest, even though the internal yolk sac is large and still capable of furnishing nourishment. This earliest of feeding may be so voracious that the excess ingested food items must be stored in the esophagus, which is capable of expansion to several times its normal volume.

Class Ia mallards consume animal foods almost exclusively. Proportionately fewer invertebrates and more plant foods are taken as the birds mature (Fig. 1). Thus, in Class I mallards the amount of fauna consumed amounts to 90 per cent in Ib's and 75 per cent in Ic's. The quantity of flora, mainly seeds, increases accordingly.

Class IIa mallards can be considered to be at the "threshold of maturity." At this stage in the life cycle: (1) the diet is now composed of half flora and half fauna, (2) the fauna now consumed are almost entirely aquatic forms, (3) this rather instantaneous switch to aquatic forms may be caused by a sudden maturing in feeding behavior involving the head submersion and tip-up feeding of the adults, (4) the duckling is now one-third the age and weight it will be when

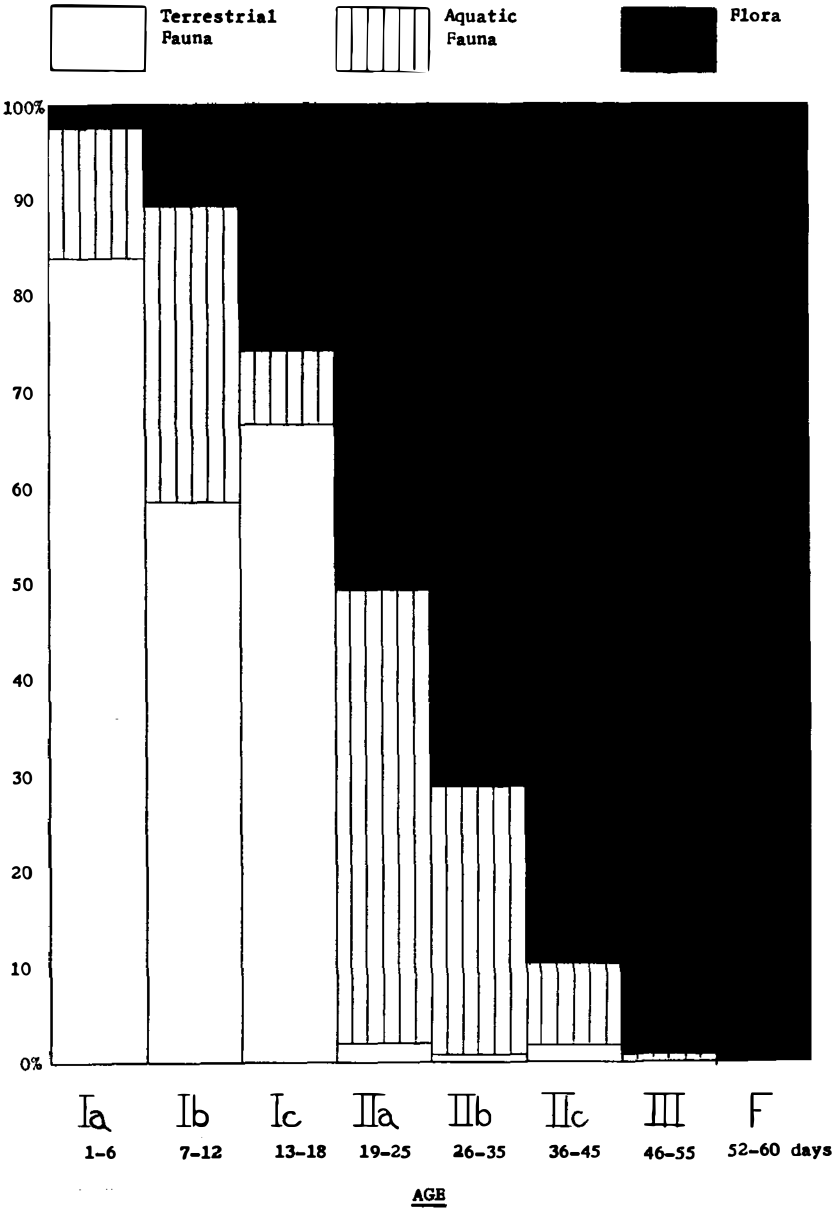

Figure 1. Comparison of food types consumed by each age class of mallard duckling collected on the Bear River Migratory Bird Refuge.

the flight stage is reached, and (5) the first true feathers are appearing on the body of the bird to replace the covering of down.

Class IIb mallards, following the general feeding pattern, consume about 70 per cent flora and the IIb's about 90 per cent flora. The change over in diet is complete in Class III mallards where less than 1 per cent fauna now appears in the juveniles' diet.

Of a total of 45 different food items consumed by mallard ducklings of all age classes, 32 constituted less than 1 per cent of the total diet. The 13 major items can be arranged according to food types: terrestrial invertebrates, including flying insects and ground crawlers; aquatic invertebrates; and plant foods, to show their importance to the four age divisions of mallards (Table 1).

Each of the eight mallard duckling age classes showed a certain selectivity for certain quantities and kinds of food items based on their requirements and the available foods (Table 2).

DISCUSSION

Food Accessibility Factors

The season of the year, by virtue of the existing environmental conditions, aids in regulating the availability of organisms in a habitat. On the study area, abundance of invertebrates occurs at a peak

TABLE 1. MAJOR FOOD ITEMS TAKEN BY 94 JUVENILE MALLARD DUCKLINGS OF ALL AGE CLASSES COLLECTED IN 1959 AND 1960 ON THE BEAR RIVER MIGRATORY BIRD REFUGE, BRIGHAM CITY, UTAH

Age importance		Item	Per cent
		FAUNA	
	Terrestrial		
	Flying insects:	Tendipedidae adults	20.33
		Dolicopodidae adults	1.96
	Ground Crawlers:	Helophorinae	7.81
CLASS I		Myrmicinae	2.19
		Heteroceridae	1.25
	Aquatic		
		Tendipedidae larvae	10.03
CLASS II		Corixidae eggs	4.39
		Corixidae nymphs and adults	4.30
		FLORA	
		Scirpus acutus seeds	13.20
CLASS III & FLIERS		*Zannichellia palustris* seeds	12.69
		Potamogeton pectinatus seeds	12.34
		Scirpus species seeds	3.16
		Potamogeton pectinatus tubers	1.02
Other 32 items occurring as less than 1% of the diet			5.33
		TOTAL	100.00

TABLE 2. FOOD ITEMS CONSUMED AS AT LEAST 1 PER CENT OF THE DIET FOR EACH AGE CLASS OF MALLARD DUCKLING COLLECTED DURING THE 1959 AND 1960 REARING SEASON ON THE BEAR RIVER MIGRATORY BIRD REFUGE, BRIGHAM CITY, UTAH

Item	Per cent
CLASS Ia	
FAUNA (97.41)	
Tendipedidae (a)[1]	63.75
Corixidae eggs	8.73
Dolicopodidae	8.00
Helophorinae	6.43
Myrmicinae	3.89
Corixidae (n & a)[1]	3.20
Curculionidae	1.00
Other	2.43
FLORA (02.59)	
Distichlis stricta seeds	1.03
Other	1.56
	100.00
CLASS Ib	
FAUNA (89.49)	
Helophorinae	29.93
Tendipedidae (a)	13.74
Corixidae eggs	11.48
Tendipedidae (l)	10.77
Corixidae (n & a)	7.40
Heteroceridae	5.90
Myrmicinae	5.11
Lygaeidae	2.47
Other	2.69
FLORA (10.51)	
Zannichellia palustris seeds	2.82
Scirpus species seeds	2.67
Scirpus acutus seeds	1.94
Distichlis stricta seeds	1.52
Potamogeton pectinatus seeds	1.41
Other	.15
	100.00
CLASS Ic	
FAUNA (74.69)	
Tendipedidae (a)	63.48
Tendipedidae (l)	5.92
Myrmicinae	2.64
Other	2.65
FLORA (25.31)	
Potamogeton pectinatus seeds	14.73
Scirpus acutus seeds	8.69
Other	1.89
	100.00
CLASS IIa	
FLORA (50.60)	
Zannichellia palustris seeds	30.40
Potamogeton pectinatus seeds	13.58
Scirpus acutus seeds	2.54
Scirpus species seeds	2.07
Potamogeton pectinatus (galls)	2.01
Other	.04
FAUNA (49.40)	
Tendipedidae (l)	41.20
Cyprinus carpio fry	3.30
Corixidae (n & a)	2.07
Tendipedidae (a)	1.00
Other	1.83
	100.00
CLASS IIb	
FLORA (71.00)	
Scirpus acutus seeds	37.62
Zannichellia palustris seeds	20.58
Potamogeton pectinatus seeds	12.52
Other	.28
FAUNA (29.00)	
Tendipedidae (l)	12.55
Corixidae (n & a)	9.85
Dytiscidae	3.92
Other	2.68
	100.00
CLASS IIc	
FLORA (89.36)	
Potamogeton pectinatus seeds	44.25
Scirpus acutus seeds	23.72
Scirpus species seeds	16.40
Potamogeton pectinatus tubers	2.74
Distichlis stricta seeds	1.08
Other	1.17
FAUNA (10.64)	
Tendipedidae (l)	5.71
Hyalella azteca	1.35
Tendipedidae (a)	1.30
Other	2.28
	100.00
CLASS III	
FLORA (99.08)	
Scirpus acutus seeds	80.27
Potamogeton pectinatus seeds	18.12
Other	.69
FAUNA (00.92)	
Other	.92
	100.00
FLYING CLASS	
FLORA (99.92)	
Potamogeton pectinatus seeds	70.70
Scirpus acutus seeds	13.94
Potamogeton pectinatus tubers	8.14
Scirpus paludosus seeds	4.45
Rumex crispus seeds	2.69
Other	.00
FAUNA (00.08)	
Other	.08
	100.00

[1] a = adults; n = nymphs; l = larvae.

in May or earlier and decreases thereafter. The seasonal availability of invertebrates is in turn regulated by the time of day and weather conditions. Less activity occurs during periods of excessive heat and cold, wind, and precipitation.

Water levels are influenced directly by wind and temperature. Wind action, also aiding in evaporation, forces water from the shallow lakes onto adjacent high ground areas to be absorbed and held in the soil. Evaporation may amount to approximately one-third inch of water loss per day during the summer months. Resultant receding water levels of the marsh eliminate aquatic habitat and the inhabitants thereof. Water which remains in the lake beds without the inflow or outflow becomes increasingly more saline, and intolerable salt limits may be reached for the remaining organisms.

As water levels decrease certain organisms are made more accessible. Helophorinae frequent the drier exposed mud areas and are easily acquired by those ducklings utilizing this type of food. Tendipedidae larvae are exposed and readily accessible in mud recently exposed and still saturated. These larvae are also made accessible to the younger ducklings in the extremely shallow waters of the lakes and borrow ditches as drying occurs, along with Corixidae nymphs and adults.

Different habitats naturally produce different kinds and numbers of organisms. The open-water areas of the marsh generally produce a dense stand of *P. pectinatus* and other lesser important species, plus a large variety and abundance of aquatic invertebrate foods. The borrow ditches produce sparse vegetation and few organisms. Emergent stands with their respective populations of invertebrates influence the concentration of the flying insects at various plant heights by virtue of their respective densities. More flying insects are accessible just over the surface of open water and mud than at a corresponding level in the emergents.

Seeds of both aquatic and emergent vegetation are primarily available to the ducklings during the rearing season from the previous season's crop. Except for *Z. palustris* the aquatics, such as *P. pectinatus,* generally do not mature early enough to furnish many seeds for juvenile mallard consumption before flight occurs. The same situation occurs with the emergents where the added factor of seed drop also prohibits the acquisition of fresh seed until fall or winter.

Conspicuousness of a food item is important. An item may be abundant and available to a duckling but its acquisition may be limtied. The size of an object, coloration, transparency, camouflage, movement, and any combination of these factors determine the accessibility of an abundant available food to a feeding duckling.

Food Consumption Factors

The change from the faunal diet at birth to the one of flora near maturity is directly correlated with age and related body requirements. Various-aged mallard ducklings, feeding in the same area at the same time, tend to feed on the type and proportions of the food items most characteristic of their respective ages regardless of the fact that the other foods are present. The food pattern is also at least partly correlated with changes in duckling behavior.

Experience, the basis for learning, increases with age and the behavior of the bird manifests itself accordingly. The younger juvenile mallards feed primarily on the highly accessible and abundant terrestrial organisms. They are aided in their choice of foods by a behavior pattern preventing them from feeding much beneath the water surface in early age. Class I ducklings tend not to submerge their bill above the nares, a negative act which naturally limits the acquisition of aquatic organisms to those items close to, or on, the water surface. Terrestrial feeding and dabbling on the water are apparently gradually replaced with successful attempts at head submersion and tip-up feeding as the birds mature.

Regardless of their terrestrial feeding habits Class I mallards, under the pressure of pursuit, do not hesitate to submerge completely and swim under water for some distance when escaping from enemies. Class Ia mallards are so adapted to terrestrial feeding that, from a firm footing, they can jump and reach over three times their normal standing height to snap at objects above them.

High winds and storms have a depressing effect on the feeding activity of juvenile ducklings whenever they happen to occur. In fair weather however the time of day influences the quantity of the foods consumed. Mallard ducklings definitely feed more heavily during the evening hours than in the afternoon. Greater feeding activity appears true for morning hours also. Data on three different age classes of mallard ducklings showed that the number of items consumed in the evening was much greater than the number taken during the afternoon (Fig. 2). The amount of freshly ingested material in the food samples of afternoon collections indicates that the ducklings apparently do not abstain from feeding completely but simply feed more sparingly during the hotter part of the day.

The habitats visited by mallard ducklings, and the conditions therein, also influence the food consumption regardless of the time of day. The utilization of aquatic invertebrates by Class Ia, and particularly by Class Ib mallards (Fig. 1) is a result of collecting some of these birds from borrow ditches and lake areas with low water and adja-

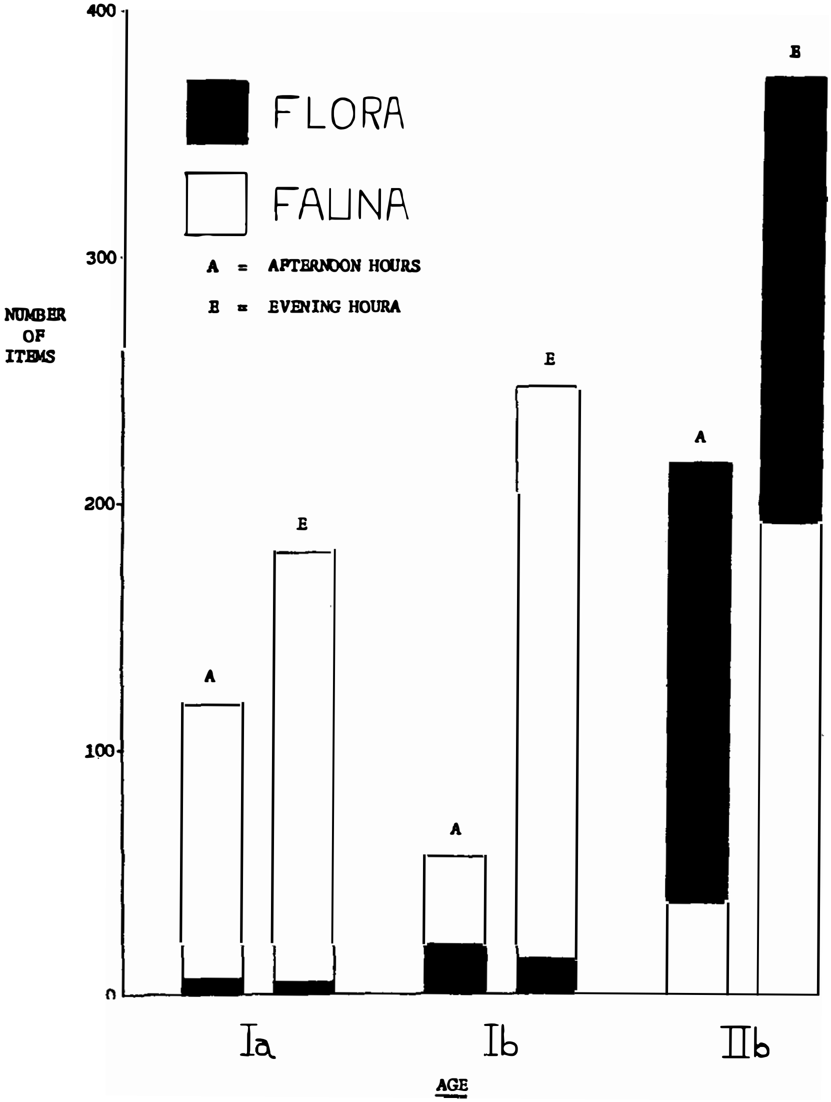

Figure 2. Comparison of the average number of items consumed between afternoon and evening hours in three age classes of mallard ducklings.

cent, exposed mud flats where Corixidae and Tendipedidae larvae were readily accessible. Mallards collected from areas where water levels were not extremely low showed more characteristically the feeding habits of their respective age class.

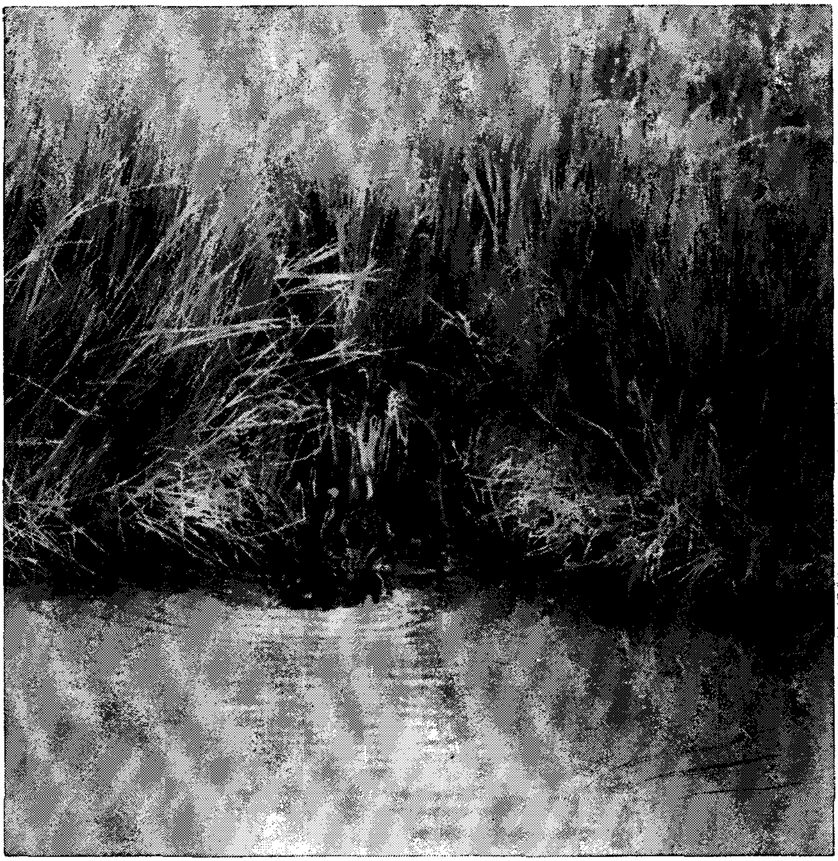

Figure 3. Class I mallard ducklings feeding in a borrow ditch during high water. The bird in the foreground illustrates surface feeding, the one in the middle aerial feeding and the duckling in the background shows how insects may be picked off of the vegetation along water areas.

CONCLUSION

Although many different varieties of potential food items are present on a marsh, few are highly abundant, and few are important to mallard ducklings. An abundant food may not necessarily be indicative of its importance because of the accessibility factor. An item less abundant but highly accessible can be acquired more readily and frequently than an organism highly abundant and not readily accessible.

The invertebrates consumed by Class I mallards are primarily terrestrial, but low water levels allow easy access to aquatic forms and these are taken when the opportunity occurs. Conversely, a sharp

Figure 4. A drying borrow ditch such as this provides young ducklings with: Myrmicinae (ants) in the ***Distichlis stricta*** (salt grass) on either side of the channel; Helophorinae (mud beetles) on the drier mud near shore; Tendipedidae larvae (midges) in the saturated mud and under the extremely shallow water adjacent to the mud.

change occurs between Class Ic and Class IIa when quite suddenly the aquatic invertebrates are immediately favored even though terrestrial forms are accessible. The gradual shift from fauna to flora is complete in Class III, just before flight, at which time the diet is similar to the mother hen's, as opposed to complete dissimilarity just after hatching.

Various factors affect the presence, abundance, and ease of access of food items. The environmental factors combined with the basic drives governing the behavior of the maturing bird regulate the selection of food items. Thus, the food availability-preference relationship is indeed complex.

Figure 5. *Potamogeton pectinatus* (sago pondweed) forms a dense stand in open water areas, providing cover for many organisms including free-swimming Corixidae (water boatmen) and the Tendipedidae larvae in the mud below. Corixidae eggs are laid attached to the floating leaves, which makes these items quite accessible to the surface feeding mallard ducklings.

DISCUSSION

DISCUSSION LEADER LOW: The strength of a chain is measured by its weakest link, and in waterfowl we constantly must consider all phases in the life of a duck as we try to build or maintain populations. This paper then is one of those links which we must seriously consider.

MR. VERNE DAVISON: Did your food studies give any indication of relative digestibility of those plant seeds?

MR. CHURA: No. Most all of the seeds which I found were either whole or partially broken into quarter sections. The only observation that I made was on *Zannichellia palustris* which is quite soft when it is fresh, and these seeds were pretty well mashed when I counted them in the stomach samples; but for the most part, I found the seeds in the gizzard to be whole.

DISCUSSION LEADER LOW: The young duck and the adult mother stay together, but what are the food habits in the young and adult?

MR. CHURA: It is quite evident that the mother hen does not have anything to do with the food habits of the juvenile mallard. I have collected several hens with their broods and have seen, for instance, one Class Ia brood just off the nest with the gullets crammed with invertebrate items. These invertebrate items were primarily terrestrial and the mother hen had a 60 per cent diet of *Potamogeton pectinatus* seeds. Whatever invertebrates she had eaten were primarily aquatic. So it is quite evident that when the birds are young, their food habits are immensely different from those of the adult mother. As they get older the food habits tend to reach a similarity to that of the mother hen approximately when they become Class III's.

COOT AND DUCK PRODUCTIVITY IN NORTHERN UTAH

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The American coot (*Fulica americana*) is an abundant nester in many Utah marshes, usually nesting and rearing its young in close association with several species of game ducks. A study of coot-waterfowl relationships was initiated in March 1956, to obtain quantitative data regarding the effects of coots upon the production of ducks. Emphasis was placed on comparative breeding behavior, nesting, and success of rearing young. The territorial aspects of coot intolerance of ducks have already been reported (Ryder, 1959).

Observations were made during 1956 and 1957 on various marshes in northern Utah but primarily on Ogden Bay Refuge, one of six waterfowl management areas developed by the Utah Fish and Game Department. A detailed description and history of this important waterfowl area has been published by Nelson (1954). Most findings relate to five study areas, varying in size from 15 to 76 acres. Three of these were on Ogden Bay Refuge and two on the Bay View Club, two miles west of Westpoint in Davis County. Coots were reduced on the smallest area by shooting and trapping; their hatch was delayed and reduced by systematic egg destruction on another. Unsuccessful attempts were made to increase coots on a third area by introducing wild-caught coots. The remaining two were control areas (Table 1).

Weekly behavioral observations of about four hours continued from late March until mid-August from semipermanent blinds erected on three areas (Unit 3, Check Station north pond, and Westpoint north pond). Weekly censuses, routine nesting surveys, and frequent brood counts were conducted. Nests were marked and visited approximately every ten days. A few of the coots discussed in this paper were marked with plastic neck tags such as those used by Gullion (1951), while most were identified by their location on the areas and by the shape and size of their frontal shields.

TABLE 1. GENERAL DESCRIPTION OF STUDY AREAS, WEBER AND DAVIS COUNTIES, UTAH

Study area	Total acreage[1]	Percentages[1] Open water	Emergents	Upland	Treatment applied
Unit 3	76.4	45	49	6	Control, no treatment
Check station					
North pond	17.3	21	48	31	Control, no treatment
South pond	14.8	16	46	38	Coots reduced by shooting and trapping
Westpoint					
North pond	48.0	38	13	49	Coots increased by introduction
South pond	44.5	28	28	44	Coot hatch delayed by nest destruction

[1]Based on planimetering cover maps prepared from aerial photos and ground inspection.

BREEDING POPULATIONS

In addition to coots, various shorebirds and herons, mallards (*Anas platyrhynchos*), gadwalls (*Anas strepera*), pintails (*Anaes acuta*), green-winged teal (*Anas carolinensis*), blue-winged teal (*Anas discors*), cinnamon teal (*Anas cyanoptera*), shovelers (*Spatula clypeta*), redheads (*Aythya americana*), and ruddy ducks (*Oxyura jamaicensis*) nested on the study areas. Total breeding pairs of coots exceeded those of ducks, but the ratio of coot pairs to 100 duck pairs varied from 67 to 225 on the five areas observed.

COOT AND DUCK NESTING

Nesting Chronology

Each season mallards nested first, followed closely by the coots, then cinnamon teal, with redheads and ruddy ducks coming later. Too few nests of gadwall, pintail, and green-winged teal were found upon which to base any nesting sequence (Figure 1). There were few differences in the weather or the peaks of nest initation between 1956 and 1957.

Nesting Densities

Nesting densities varied considerably on the study areas. Coot nest densities were remarkably constant on the same study areas for the two years. Fewer duck nests were found in 1957 than in 1956 and, consequently, densities of duck nests were lower on most areas in 1957. However, duck hatching success was higher in 1957 and greater production was achieved from fewer nest attempts.

There seemed a definite relationship between coot nesting densities and the amount of open water in proportion to available nesting cover. Excluding the areas where coot nesting was artificially stimulated by nest destruction (Check Station south pond and Westpoint south pond), coot nest densities increased as the proportion of open

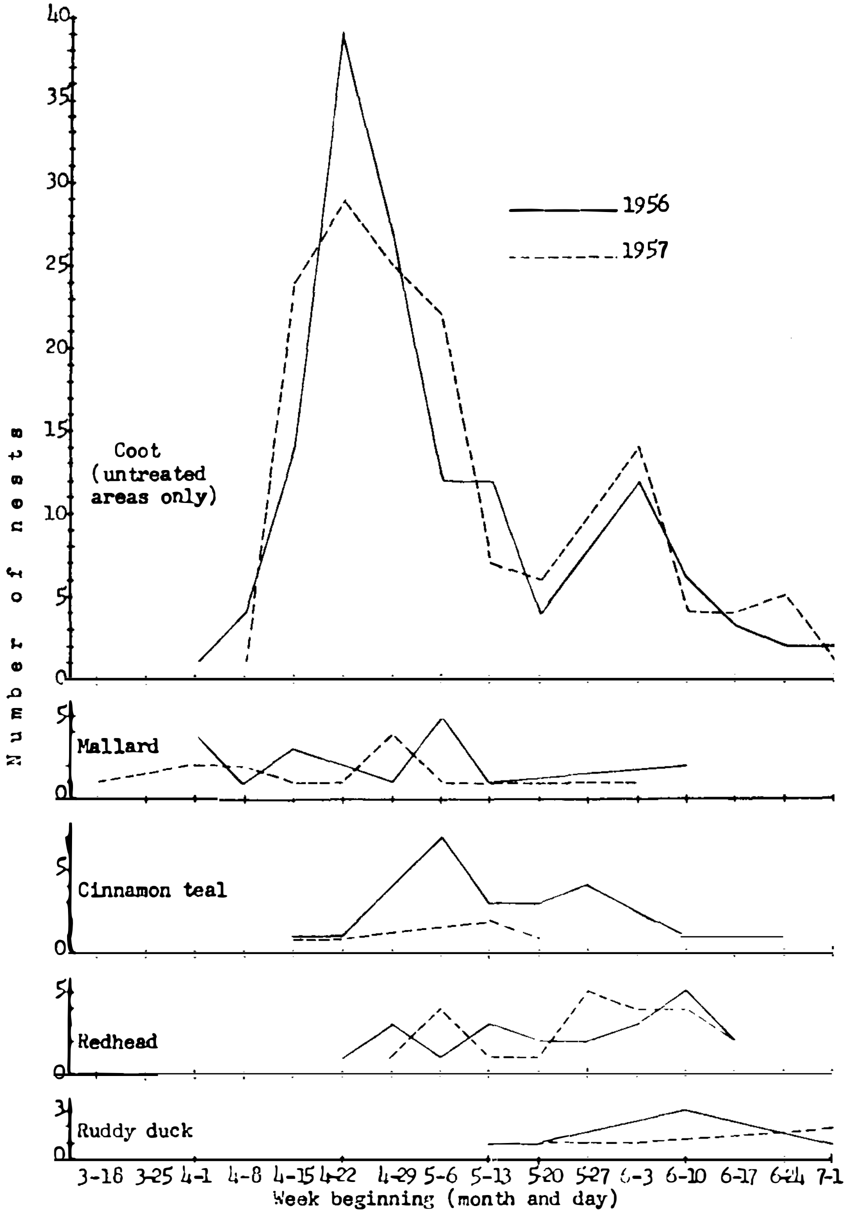

Figure 1. Nesting chronology of the coot, mallard, cinnamon teal, redhead and ruddy duck for the years 1956 and 1957, determined by the number of clutches started by weeks of the season

water to available nesting cover increased. The coot breeding-pair densities on all five areas considered in relation to the open water to cover ratios, seem to show a positive relationship. Coot pairs per unit area increased with an increased proportion of open water to cover (Figures 2 and 3).

In contrast, there seemed an inverse relationship between duck nest densities and the ratios of open water to cover for the areas upon which coot nesting was not increased by artificial nest destruction.

Cover Preferences

All but two of 480 coot nests were in emergent vegetation. Two were on a dike in mixed weeds. All 70 diving duck nests were in emergent vegetation, whereas 65 percent of the 88 dabbler nests were

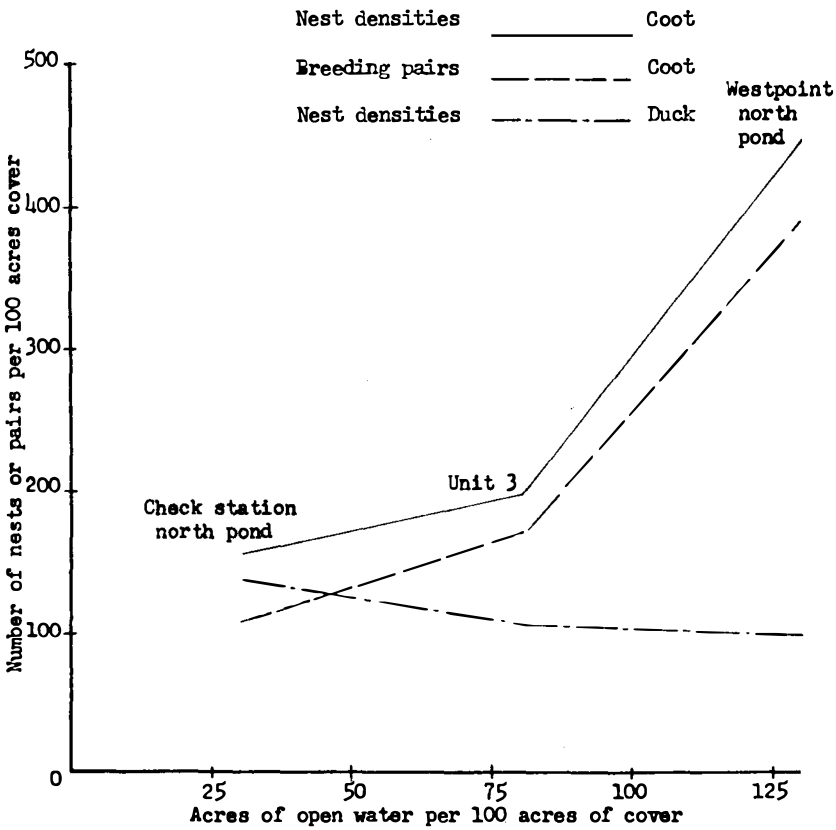

Figure 2. Relationship of coot and duck nest densities to the ratios of open water to cover on the study areas in 1956

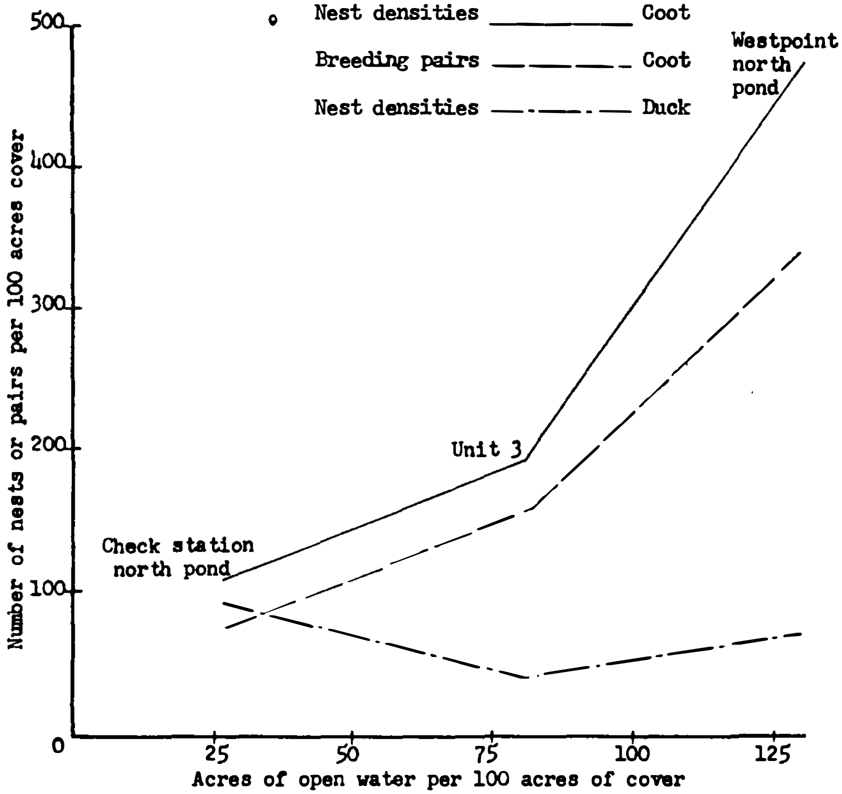

Figure 3. Relationship of coot and duck nest densities to the ratios of open water to cover on the study areas in 1957

in emergents and 35 percent in upland cover. Nests of coots and diving ducks were concentrated close to open water, while dabbling duck nests were farther from water.

Cattail (*Typha* spp.) was dominant on all five areas. Saltgrass (*Distichlis stricta*) was next in abundance, greasewood (*Sarcobatus vermiculatus*) third, and alkali bulrush (*Scirpus paludosus*) fourth. Four other vegetative types made up the remainder (Table 2).

Coot and duck nests were found in all types except Olney's bulrush (*Scirpus olneyi*). The percent-acreage utilization of the cover types (Williams and Marshall, 1938) indicates that cattail was used by coots, mallards, redheads, and ruddy ducks in slightly greater proportion than it occurred in the study areas, whereas it was much less preferred by cinnamon teal. Coots preferred cattail to all other cover types (Table 2).

TABLE 2. PERCENT-ACREAGE UTILIZATION OF COVER TYPES ON STUDY AREAS, 1956 AND 1957 COMBINED

Cover type	Coot	Mallard	C. Teal	Redhead	Ruddy
Cattail	1.52	1.53	0.65	1.38	1.28
Alkali bulrush	1.00	0	0	0.14	1.34
Hardstem bulrush	0.20	0	0	15.07	11.70
3-square and rush	0.01	0	8.40	0	0
Olney's bulrush	0	0	0	0	0
All emergents	1.42	1.24	0.69	1.43	1.43
Greasewood	0	0.36	1.86	0	0
Saltgrass	0	0	1.46	0	0
Mixed weeds	0.08	18.14	5.84	0	0
All upland types	0.01	0.45	1.72	0	0

Only the ruddy ducks showed any preference for alkali bulrush, although coots utilized this type in direct proportion to its abundance. At Ogden Bay Refuge, coots seemed to use alkali bulrush more later in the season, after its density increased wth the addition of new growth.

Nest Construction

There are many obvious differences in the manner of nest construction between coots and ducks. Both sexes of coots share in nest construction, bringing nest materials from some distance and building rather elaborate, semi-floating nests, usually in emergent vegetation. Duck nests, however, are constructed entirely by the hens and contain apparently only vegetation within reach of the females as they sit on the nest (Sowls, 1955). On the study areas, coots normally built their own nest foundations and were thus able to utilize open emergent vegetation in deeper water than could ducks. Ducks nesting in emergent vegetation seemed more dependent upon dense plant growth for nest foundations. Some used muskrat houses, abandoned coot platforms, or muskrat feeding stations as foundations. Dabbling ducks preferred nesting on dikes, but some mallards, cinnamon teal and pintails nested over water in emergent vegetation, as did diving ducks.

During both seasons diving ducks laid in abandoned coot nests or platforms. Six redhead broods (53 young) hatched in abandoned coot structures. Although coots provided some nest foundations for ducks, they also competed for existing foundations and, especially late in the season, commandeered duck nests for brood platforms. The nests of seven redheads, one ruddy duck, and one pied-billed grebe (*Podilymbus podiceps*) were used by coots.

Clutch Sizes and Potential Number of Eggs

During both years coots had smaller average clutches than ducks. Eggs of redheads and ruddy ducks found in nests of other species were not included in the duck average. However, the average clutch for all ducks was exaggerated by the large redhead clutches, which in many cases undoubtedly represented the combined efforts of several females. The average clutch for all ducks exclusive of redheads was closer to that of coots. In 1956 this mean clutch size was significantly greater than that for coots, but not in 1957 (Table 3).

Apparently 13 percent of the coot pairs on the untreated coot-duck study areas were double-brooded. In all, 38 pairs attempted second clutches, and renesting attempts were a usual occurrence on both treated and untreated areas. Individual coots laid as many as 55 eggs on areas where clutches were repeatedly destroyed by the observer. Thirty-five coots laid 20 or more eggs (renests and second clutches). Sooter (1941) removed eggs from coot nests during laying and found that some females laid 14 to 18 eggs. Gullion (1954) observed one female that laid at least 37 eggs during one season.

Comparative Nest and Egg-Hatching Success

Coots had much higher hatching success than either dabbling or diving ducks. Duck nesting studies usually provide unreliable information because of several types of bias introduced by the observer. Some of these biases are: (1) the likelihood of increased predation by mammals that follow the observer's tracks and trails, and by avian predators attracted by nest markers and flushed hens; (2) increased desertions arising from activities of the observer; and (3) failure to obtain a representative sample of all nests.

The easily found nests probably are the most likely destroyed by predators. The dabbling duck data, in particular, are probably distorted because most of these ducks were found nesting along dikes, especially in 1956. Predation was unusually high along these natural routes for skunks and long-tailed weasels. Nevertheless, based upon both nest and brood data, coots definitely had better hatching success

TABLE 3. COMPARATIVE MEAN CLUTCH SIZES FOR COOTS AND DUCKS ON STUDY AREAS, 1956 AND 1957

Species	1956		1957	
	Mean clutch	Sample size	Mean clutch	Sample size
Coot	8.7±0.2*	136	8.9±0.1	135
Mallard	9.6	19	8.4	11
Cinnamon teal	8.6	12	14.5	22
Redhead	13.4	23	9.0	3
Ruddy	10.8	4	9.0	5
Pintail	10.0	1	....	....
Gadwall	8.0	1	....	....
All ducks	9.5±0.3	60	11.3±0.7	41
All ducks but redhead	11.0±0.6	37	8.6±0.5	19

*Mean, plus or minus standard error.

than ducks, although probably not as much better as the nest data alone would indicate.

Each year coots ranked first in both nest and egg-hatching success, diving ducks were second, and dabbling ducks third. On the three areas where coots were not reduced nor their clutches destroyed by the observer, coot nest success was higher in 1956 (94 percent of 157 nests) than in 1957 (88 percent of 161 nests.) Any nest hatching one or more eggs was called successful. The reduced hatching success for coots in 1957 was largely due to increased predation on the Westpoint north pond. The better nesting success of coots was probably due to several factors, such as: (1) coots seemed less likely to desert than ducks; (2) coots nested more over water and were less subject to mammalian predation than ducks; and (3) both coots of a pair shared in incubation and actively defended the nest.

Dabbling ducks had extremely poor nest success in 1956 (9 percent of 64 nests) compared to 1957 (46 percent of 24 nests). In 1956 most dabbler nests were found on dikes, where predation was high. In 1957, few dabblers seemed to use the dikes, and a higher nest success was observed. Diving duck nests were found in about equal numbers each year and had similar nesting success (58 percent of 36 nests in 1956; 53 percent of 34 nests in 1957). Elsewhere coots have had greater nesting success than ducks in the same areas (Kiel, 1955; Anderson, 1955 and 1957; Hunt and Naylor, 1955; *et al.*)

Causes of Nest and Egg-Hatching Failures

The greatest cause of nest failure in both coots and dabblers seemed to be predation; in diving ducks, abandonment before nest discovery seemed to be the primary cause. Desertion due to nest hunting was responsible for nest failure in both coots and ducks.

Many duck eggs failed to hatch because of social parasitism, mainly by redheads laying in other ducks' nests. Other causes of nest or egg failure included flooding, drought, livestock trampling, females dying on the nest, eggs covered with nest material or knocked in the water, infertility, and embryos dying during incubation. Although coot nests were preyed upon by the same predators as duck nests, little evidence was collected that coots were an important buffer lessening losses of duck nests.

Renesting and Second Broods

Ducks were not known to have renested on the study areas, although some late mallard and cinnamon teal nests may have been second attempts. Renesting and second broods in coots were verified by observation of specific pairs.

Coot clutches of more than four eggs were destroyed weekly on the Westpoint south pond. In late June, coot nesting was permitted to proceed unmolested. Although only two marked pairs were involved, it seemed from repeated nest visits and observation of several territorial coots that most coots renested at least once, and some two or three times, after nest destruction. On this area, approximately 28 pairs of coots nested each year but, following repeated nest destruction, 57 nests were found in 1956 and 71 in 1957. Most coots renested within 50 feet of their earlier nest sites.

On control areas, 18 pairs of coots in 1956 and 20 in 1957 attempted second broods after successfully rearing one brood. Second clutches averaged one or two eggs fewer than the first clutch. In most cases a smaller percentage of the eggs in the second clutch hatched than in the first clutch; however, eight exceptions were noted. Although no marked birds were involved, repeated observations from blinds verified that six pairs raised two broods. To my knowledge, double broods have been reported for coots only in California (Gullion, 1954; Miller, *et al.,* 1956).

JUVENILE MORTALITY

Some idea of juvenile mortality was gained from periodic brood counts, observations from blinds, and finding sick and dead young in the field. In general, coots seemed to suffer greater juvenile mortality than ducks. From blinds I gathered reasonably accurate data concerning 52 coot broods observed over a period of several weeks. There are various difficulties in counting coot broods, because the parents tend to split up the broods and feed them in different parts of their territories (Gullion, 1956). From repeated observations, however, it appeared that these 52 broods dwindled from 419 to 249 young during the brood-rearing season, or that roughly three out of an average brood of eight were lost. In all, 16 young coots were found dead in or near nests or brood platforms less than one week after they had hatched. Most of the juvenile mortality in coots occurred in the first week or two after hatching, when the coots were weak and dependent upon their parents for food and warmth.

Predation of duck broods by California gulls was witnessed twice on the Unit 3 study area. In both cases, the observer had been in the blind for two hours or more, so human interference was not thought to contribute to these examples of predation. Elsewhere on Ogden Bay Refuge, California gulls were twice observed to catch and swallow young coots. In these cases, the coots were from flocks of juveniles unaccompanied by adults. Predation was undoubtedly influenced artificially because the observer had frightened the coots from a ditch bank while driving past. Unsuccessful attempts of gulls to catch young coots were seen from the blinds. Other investigators in Utah have observed California gulls catching young ducks or coots, or found their remains in gull stomachs (Odin, 1957; Johnson, 1952; Greenhalgh, 1952). In view of the greater observed loss of juvenile coots, they may act as a buffer lessening predation upon ducklings.

FLEDGING SUCCESS

Lack (1954) has emphasized that, in assessing the replacement rate of a bird, the figure required is the average number of young successfully raised per adult, not merely the percentage of eggs or nests that hatch successfully nor the average hatch or brood. The fledging success for a limited number of coot pairs was determined from nest histories and repeated brood counts. These data indicate that 18 pairs fledged an average of 4.3 young in 1956, and 30 pairs fledged an average of 5.7 young in 1957. The 1957 data include four pairs which reared two broods each, which accounts for the higher number of young produced per pair in 1957. These fledging successes compare closely to that reported by Gullion (1954) in California and are considerably higher than those reported by Sooter (1941) for Iowa and Alley and Boyd (1947) for the European coot.

Little information regarding fledging success of duck pairs using the study areas was obtained, nor was much found in the literature. However, when one considers the comparatively few ducklings believed produced in relation to the breeding pairs using the study areas, it appears that ducks had a much lower fledging success than coots on the control areas.

ANNUAL PRODUCTION

Production in terms of young per 100 acres of available cover varied considerably from area to area (Tables 4 and 5).

Nesting data gave little evidence that duck production was significantly greater on treated (coots reduced) than on untreated areas (Table 4). However, there was greater use by duck broods of the area on which coot hatching was delayed or reduced by nest destruction (Table 5).

MANAGEMENT IMPLICATIONS

Coot-duck populations can probably be managed to achieve the maximum production of the desired species largely by habitat manipulation rather than actual control of coots by hunting regulations, nest destruction, or other artificial methods. At Ogden Bay Refuge increased production of ducks in proportion to coots might be achieved

TABLE 4. COOT-WATERFOWL PRODUCTION ON THE STUDY AREAS BASED ON NEST DATA, 1956 AND 1957

Study area and year	Young produced per 100 acres of available cover			
	Coots	Dabblers	Divers	All ducks
1956				
Unit 3	1,460	98	110	208
Westpoint				
North Pond	3,655	0	376	376
South Pond	139	0	237	237
Check Station				
North Pond	964	73	124	197
South Pond	218	48	32	81
Untreated areas[1]	1,748	73	167	240
Treated areas	170	19	157	176
1957				
Unit 3	1,589	38	122	160
Westpoint				
North Pond	2,899	71	284	355
South Pond	252	72	180	252
Check Station				
North Pond	920	73	146	219
South Pond	40	137	97	234
Untreated areas[1]	1,722	52	159	211
Treated areas	170	97	148	245

[1]Untreated areas were Unit 3, Westpoint North Pond and Check Station North Pond. Treated areas were Westpoint South Pond and Check Station South Pond.

TABLE 5. COOT-WATERFOWL PRODUCTION ON THE STUDY AREAS BASED ON BROOD COUNTS, 1956 AND 1957

Study area and year	Young produced per 100 acres of available cover			
	Coots	Dabblers	Divers	All ducks
1956				
Unit 3	957	84	115	199
Westpoint				
North Pond	2,129	128	405	532
South Pond	62	77	694	772
Check Station				
North Pond	723	44	168	212
South Pond	48	24	0	24
Untreated areas[1]	1,148	85	184	269
Treated areas	57	57	424	481
1957				
Unit 3	838	84	194	278
Westpoint				
North Pond	1,597	213	546	759
South Pond	242	118	381	499
Check Station				
North Pond	708	95	219	314
South Pond	16	73	97	169
Untreated areas[1]	966	112	270	382
Treated areas	154	101	270	371

[1]Untreated areas were Unit 3, Westpoint North Pond and Check Station North Pond. Treated areas were Westpoint South Pond and Check Station South Pond.

by: (1) continued control of cattail, plus hastening the establishment of more desirable emergents by plantings; (2) construction of more small ditches through saltgrass flats, the spoil banks of which should provide more loaf sites and nesting cover for dabbling ducks without greatly increasing coot habitat; (3) increased predator control, especially along dikes; and (4) continued educational campaigns to obtain greater hunter utilization of coots.

ACKNOWLEDGMENTS

This investigation was sponsored by the Utah Cooperative Wildlife Research Unit (Utah Fish and Game Department, Wildlife Management Institute, Utah State University, and U. S. Fish and Wildlife Service, cooperating). Dr. Jessop B. Low's encouragement, supervision and guidance throughout the various phases of this study is most appreciated. I am especially indebted to Noland F. Nelson, waterfowl project leader, Utah Fish and Game Department, for permission to use study areas on Ogden Bay Refuge. The Bay View Club, Harry Nelson, president, granted me access to its property near Westpoint, Utah, for which I am grateful. I wish to express my thanks to John M. Gates and Fant W. Martin, both of whom were conducting waterfowl investigations at Ogden Bay Refuge during the course of my studies, for their companionship, cooperation and advice. Professors D. L. Gilbert, H. W. Steinhoff, J. V. K. Wagar and L. E. Yeager made many worthwhile suggestions and comments on this paper.

SUMMARY

1. A two-year study was conducted on and around Ogden Bay Refuge, Utah, to obtain quantitative data regarding the effects of coots upon the production of ducks. Emphasis was placed upon comparative breeding behavior, nesting and young-rearing success.

2. Observations were limited mainly to five study areas. Coots were reduced by killing adults and destroying nests on two areas, while unsuccessful attempts were made to increase coots on one area by introducing wild birds. Two areas were left untreated as controls.

3. On the study areas, the total breeding pairs of coots exceeded those of ducks, but the ratio of coot pairs per 100 duck pairs varied from 67 to 225 on the various areas. In addition to coots, seven species of dabblers and two species of diving ducks nested on the study areas.

4. Coot nesting densities were greatest on areas with considerable open water in proportion to available nesting cover. Duck nesting densities, in contrast, seemed somewhat greater on areas with a higher proportion of cover.

5. Coots had considerably better nesting success than ducks probably due to several factors, such as: (1) coots seemed less likely to desert than ducks; (2) coots nested more over water and were less subject to mammalian predation; and (3) both coots of a pair shared in incubation and actively defended the nest. Coots were also persistent renesters and approximately 13 percent of the coot pairs on the untreated areas hatched second broods.

6. Juvenile coots seemed to suffer higher mortality the first few weeks of their lives than ducklings. Because of their better nesting success, however, coots still fledged more young per pair than ducks.

7. On a unit-area basis, many more coots than ducks were produced on the untreated areas. Based on nest observations, duck production per 100 acres of cover was not appreciably greater on treated areas (coots reduced) than on untreated areas. However, there was greater use by duck broods of the area on which coot hatching was reduced by nest destruction.

8. Possible management implications include: (1) continued cattail control; (2) construction of more small ditches through saltgrass flats; (3) increased predator control and (4) continued educational campaigns to obtain greater hunter utilization of coots.

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DISCUSSION

DISCUSSION LEADER LOW: Normally coots nest over water and I am wondering if they are a more serious threat to diving ducks than to puddle ducks.

DR. RYDER: Although not mentioned in the paper, some food habits studies were conducted. Coots certainly seemed to be more directly in competition with the diving ducks, such as redheads and ruddy ducks on my study areas, than with the dabblers. Their food habits were similar and, if any competition exists, at least for food, it would be greatest with these. For nesting locations and territories, I don't believe there is much competition between the two groups.

THE EFFECTS OF CARP POPULATIONS ON THE PRODUCTION OF WATERFOWL FOOD PLANTS ON A WESTERN WATERFOWL MARSH[1]

ROBERT J. ROBEL
Utah Cooperative Wildlife Research Unit, Utah State University, Logan[2]

Waterfowl habitat is becoming more scarce because of accelerated drainage programs, increased need for irrigation water, industrial requirements, growing demands for culinary water, and chronic droughts. Many western marshes designed chiefly for waterfowl are mainly expensive man-made areas. They play a strategic role in the Central and Pacific waterfowl flyway systems of North America. Other than these man-made and man-controlled marshes, the amount of suitable waterfowl habitat has decreased rapidly in many of the western states (Shaw and Fredine, 1956).

In order to acquire the best waterfowl production from a marsh, a thorough understanding of complex marsh relationships must be obtained. One of the important factors which plays a part in the waterfowl marsh environment is waterfowl food production. Many of the waterfowl food plants are totally submersed. Their growth and production often exert a great influence on the waterfowl carrying capacity of a marsh. Fish are suspected of adversely affecting the growth of submersed plants, both by actually consuming the vegetative and reproductive portions, and by increasing water turbidities through their movements, which in turn reduces light penetration, a requirement of plant growth.

For many years, carp (*Cyprinus carpio*) have been blamed by biologists for reducing and sometimes completely eliminating vast stands of waterfowl food plants. In many cases, carp may be convenient scapegoats. The relationship between carp activity and food plant production is not completely understood. The purpose of this study was to ascertain the influence of carp on some valuable submersed waterfowl food plants.

The author wishes to acknowledge the assistance of personnel of the Utah Fish and Game Department; U. S. Fish and Wildlife Service,

[1]Contribution from Pittman-Robertson project W-29-R-13, Job No. I-1, the Utah Department of Fish and Game and the Utah Cooperative Wildlife Research Unit cooperating.
[2]Now Department of Zoology, Kansas State University, Manhattan.

Bureau of Sport Fisheries and Wildlife; and the Bear River Club Company. The help of Drs. Jessop B. Low and William F. Sigler in the initial planning of this project is sincerely appreciated. Sincere thanks are extended to Mr. Max McGraw for financial assistance which assisted in making the presentation of this paper possible.

LITERATURE REVIEW

Accounts of carp damage to waterfowl marshes are abundant in wildlife literature. The majority of these reports, however, are based on circumstantial evidence. The studies which have been conducted to determine the effect of carp on waterfowl and waterfowl food plants have been for the most part nonconclusive in so much as statistically sound data are concerned.

As early as 1905 (Cole, 1905) carp were recognized as potential destroyers of marsh vegetation. Wetmore (1921) observed large numbers of carp in the Bear River delta, and stated that they often frequented open bays, destroying vast stands of sago pondweed (*Potamogcton pectinatus*).

Nelson (no date) conducted one of the first controlled experiments to discover the effects of carp on waterfowl food plants in 1941. His study involved four carp enclosures located on the Clearlake Waterfowl Refuge in Utah. His data were not conclusive since all four of his enclosures exhibited reductions in vegetation production, even the control pen which had no carp confined within it.

Black (1946) also conducted an early controlled experiment to determine the relationship of carp to waterfowl food plants. He found that high populations of carp do destroy aquatic vegetation. Other studies have shown similar results (Tyron, 1954; Threinen and Helm, 1954).

Smith (1957) while reviewing some results of poisoning carp on federal waterfowl refuges reported that the major change following a carp removal program was the reduction in water turbidity. Many of the statements made regarding carp damage are based on such post-poisoning observations (Moyle, 1949; Anderson, 1950; Cahoon, 1953).

STUDY AREA

The investigation was conducted on the marsh of the Bear River Club Company, a private hunting club, located on the delta of the Bear River at the north end of Great Salt Lake, Utah.

By constructing a dike and water control system, the Club has been able to inundate several thousand acres. The main sources of water for this marsh are the Malad and Bear rivers. Both streams are considered as being fresh for most of the year; however, total dissolved salts were measured in concentrations in excess of 10,000 ppm during the summer of 1959. The Club is able to regulate water levels and even in the driest seasons, the marsh water level remains fairly constant. The marsh is usually partially drained each winter.

This investigation was conducted in Brownlee Bay of the Club marsh, an area where water depth remains about 12 inches during the summer months.

Soils of the Bear River delta are principally clays and sandy clays (Jensen, 1940). This study was conducted on a sandy clay soil. A calcium carbonate hardpan lies about 12 inches below the soil surface.

METHODS

Carp Enclosures

Four carp enclosures were constructed in Brownlee Bay of the Bear River Club marsh during the early part of July 1959 and an additional 12 pens were erected in mid-May of 1960. Specifications of the enclosures were drawn up after reviewing methods used by other investigators who had conducted similar experiments (Nelson, no date; Threinen and Helm, 1954; Tyron, 1954). Square pens, 50 x 50 feet in size were used in this study. Four-foot welded wire fencing with 2 x 4 inch mesh was used for the sides of the enclosures. Seven-foot steel fence posts spaced every 10 feet supported the fencing material.

The bottom of the fence was buried in the soil approximately one foot, until it came in contact with the calcium carbonate hardpan. The fencing extended above the water approximately two feet.

Enclosures were arranged in a grid-like pattern. A 50-foot space was left between each carp enclosure to eliminate inter-pen influences (Fig. 1).

Introduction of Carp, 1959 Season

Immediately following the erection of the four carp enclosures in 1959, known populations of carp were introduced into each pen. The weight of each carp was recorded prior to its release inside the pen, and so the total weight of fish per pen was obtained.

Three of the pens received carp while the fourth received no carp and served as a control. Carp populations of zero, 200, 400, and 600 pounds per acre equivalent were to be confined to the pens. The number and weight of carp introduced into each pen on July 14, 1959 are shown in Table 1.

Introduction of Carp, 1960 Season

Carp were introduced into the enclosures about two months earlier in 1960 than they were in 1959; May 17, 1960, as opposed to July

Fig. 1. View of carp enclosures which confined different carp populations during the 1959 and 1960 seasons.

TABLE 1. NUMBER OF CARP, WEIGHT PER PEN, AND POUNDS PER ACRE EQUIVALENT OF CARP INTRODUCED INTO FOUR CARP ENCLOSURES, JULY 14, 1959.

Pen number	Number of carp	Total weight of carp	Pounds per acre equivalent
I	0	0.0	0
II	5	33.8	589
III	4	22.1	385
IV	3	11.6	202

14, 1959. The procedure of handling the carp and the predetermined population concentrations were identical to that described above for 1959, only in an expanded form.

Pens I through IV, erected in 1959, received approximately the same carp concentrations each in 1960 as in 1959. Of the 12 enclosures erected in 1960, V through XVI, nine received carp while three served as controls. The number and weight of carp introduced into each of the 16 pens on May 17, 1960 are shown in Table 2. The weights per pen again approximate the 200, 400, and 600 pounds per acre series.

TABLE 2. NUMBER OF CARP, WEIGHT OF CARP, AND POUNDS PER ACRE EQUIVALENT OF CARP INTRODUCED INTO 16 CARP ENCLOSURES, MAY 17, 1960.

Pen number	Number of carp	Total weight of carp	Pounds per acre equivalent
I	0	0.0	0
II	4	35.9	625
III	3	24.4	425
IV	2	11.4	199
V	3	25.9	451
VI	0	0.0	0
VII	4	34.9	608
VIII	2	12.1	211
IX	3	35.0	610
X	3	21.5	375
XI	2	13.1	228
XII	0	0.0	0
XIII	2	22.9	399
XIV	2	11.9	207
XV	0	0.0	0
XVI	3	35.1	612

Turbidity Samples

Each year, immediately after the confinement of carp to the study pens, water samples were periodically collected for turbidity analysis. A water sample was taken from each enclosure every four days during the field seasons. In 1959, three additional series of samples were collected between the four pens to determine whether or not any interpen influences were present. In 1960, in addition to the 16 samples collected every four days from the carp enclosures, four additional series of water samples were collected from sites located approximately 50 yards from the center of the enclosure grid. This latter series was analyzed to determine the overall effect of the carp on the turbidity of Brownlee Bay.

All water samples were analyzed for relative turbidity with a Klett-Sumerson photoelectric colorimeter equipped with a number 42 blue filter.

Vegetation Sampling

At the end of each field season, vegetation samples were collected from each carp enclosure. The 1959 samples were taken on September 23 while those for the 1960 season were collected on August 18, 19, 20, and 21.

The vegetation samples were randomly selected. Each enclosure was divided into 2,500 square-foot sections and numbered. Numbers chosen from a table of random numbers were used to select 10 sampling locations for each enclosure. A square-foot sampling frame was lowered into the water at the predetermined location and all vegetation confined within its square-foot area was clipped and each sample placed in a separate container: marked according to pen and sample number.

Vegetation yield, composed of approximately 95 per cent sago pondweed, was determined on an oven-dry weight basis. All vegetation samples were dried for a 48-hour period at 90° C.

RESULTS

Vegetation Production, 1959 Season

After the carp had been confined to the enclosure for 72 days, July 14 to September 23, a series of 40 vegetation samples was collected from the enclosures. Ten square-foot samples[1] were taken from each enclosure (Table 3).

TABLE 3. ANALYSIS OF VEGETATION SAMPLES COLLECTED ON SEPTEMBER 23, 1959, FROM FOUR ENCLOSURES CONFINING VARIOUS CARP POPULATIONS.

Pen number	Carp weight (pounds per acre equivalent)	Vegetation Samples		
		Mean weight[1]	Standard deviation	Standard error
I	0	25.5	2.4	0.76
II	589	13.2	5.9	1.88
III	385	17.4	4.2	1.45
IV	202	23.3	4.6	1.31

[1]Oven-dry weights in grams.

A strong negative correlation (correlation coefficient of –0.89) exists between the vegetative yield and the population of carp confined in each of the four enclosures. Because of the small sample size, this correlation coefficient is not statistically significant, even though the relationship is quite evident (Fig. 2). The control pen, having no carp, and pen number IV, confining 202 pounds of carp per acre, have a comparable vegetative yield, 25.5 grams and 23.3 grams per square foot respectively. Pen number III with 385 pounds of carp per acre had 17.4 grams of vegetation present per square foot while pen number II had only 13.2 grams of vegetation present per square foot under a carp population of 589 pounds per acre.

Uniformity of vegetation density decreased when carp were present in the pens. The greatest variation was exhibited in pen II which contained 589 pounds of carp per acre while the least amount of variability was found in pen number I, the control pen with no carp (Table 3).

Vegetation Production, 1960 Season

Following a carp confinement period of about three months, May 17 to August 18, 10 post-season vegetation samples were collected

[1]Sample size required was calculated from pre-study vegetation samples of each year and were of sufficient size to give a degree of confidence of 95 per cent, protection against Type I Error of 90 per cent, and protection against Type II Error of 80 per cent.

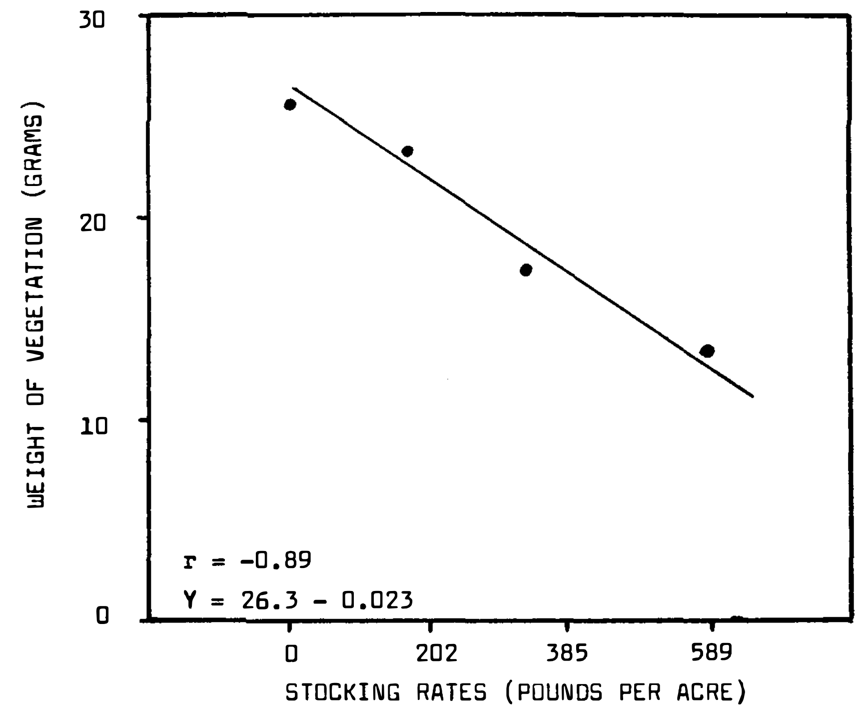

Fig. 2. Relationship between oven-dried weight of vegetation present per square foot in 1959 and carp stocking rates. Data from four enclosures erected in 1959.

from each of the 16 carp enclosures (Table 4). Data collected from the four pens erected in 1959 were analyzed separately from the data collected from the 12 pens constructed in 1960.

A strong negative correlation exists between carp stocking rates and vegetation productivity in the four carp enclosures erected in 1959 (pen numbers I, II, III, and IV). The calculated correlation coefficient of —0.91 is significant at the 90 per cent confidence level (Fig. 3).

Likewise, a very strong negative correlation was found between the carp stocking rate and the amount of vegetation found in the 12 enclosures constructed in 1960 (Fig. 4). The correlation coefficient of —0.97 is significant at the 95 per cent level.

In all of the 16 pens, low vegetation productivity was found in enclosures having high carp population concentrations while greater amounts of vegetation were found in enclosures having low carp populations. The highest plant yield was found in pen number I, a control pen with no carp, where 18.5 grams of vegetation was present per

TABLE 4. ANALYSIS OF VEGETATION SAMPLES COLLECTED ON AUGUST 18, 19, 20, AND 21, 1960 FROM 16 ENCLOSURES CONFINING VARIOUS CARP POPULATIONS.

Pen number	Carp weight (pounds per acre equivalent)	Vegetation Samples		
		Mean weight[1]	Standard deviation	Standard error
I	0	18.5	2.49	0.80
II	625	5.0	4.26	1.36
III	425	8.0	3.80	1.21
IV	199	11.8	3.48	1.11
V	451	4.1	3.28	1.04
VI	0	11.9	2.19	0.69
VII	608	2.4	1.96	0.62
VIII	211	9.6	3.94	1.26
IX	610	2.7	3.10	0.98
X	375	6.2	4.42	1.41
XI	228	7.1	4.55	1.44
XII	0	12.8	2.78	0.89
XIII	399	6.0	4.22	1.34
XIV	207	8.1	3.72	1.18
XV	0	12.1	1.97	0.63
XVI	612	2.8	3.03	0.96

[1]Oven-dry weights in grams.

square foot. The least amount of vegetation, 2.4 grams per square foot, was present in pen number VII under a carp population of 608 pounds per acre.

As in the 1959 season, uniformity of vegetation density decreased when carp were present in the pens (Table 4). The standard devia-

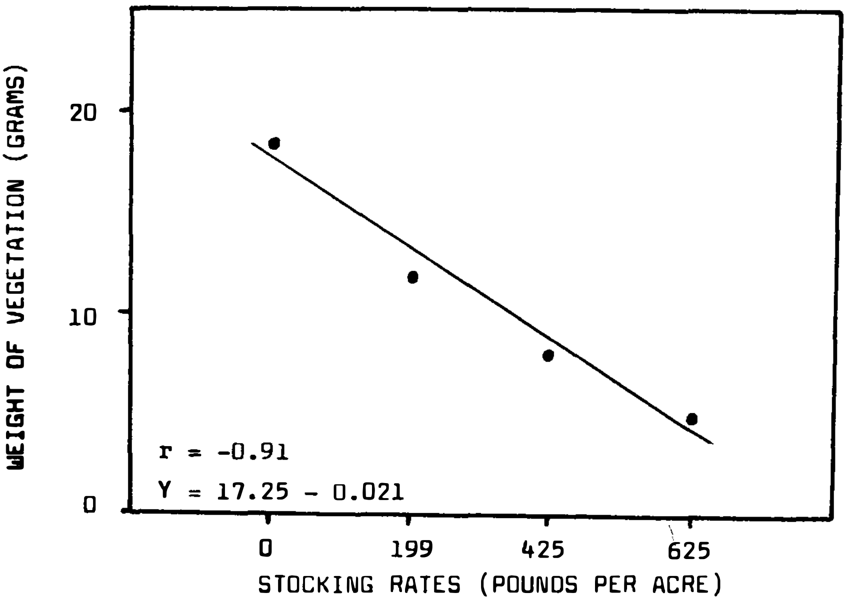

Fig. 3. Relationship between oven-dried weight of vegetation present per square foot in 1960 and carp stocking rates. Data from four carp enclosures erected in 1959.

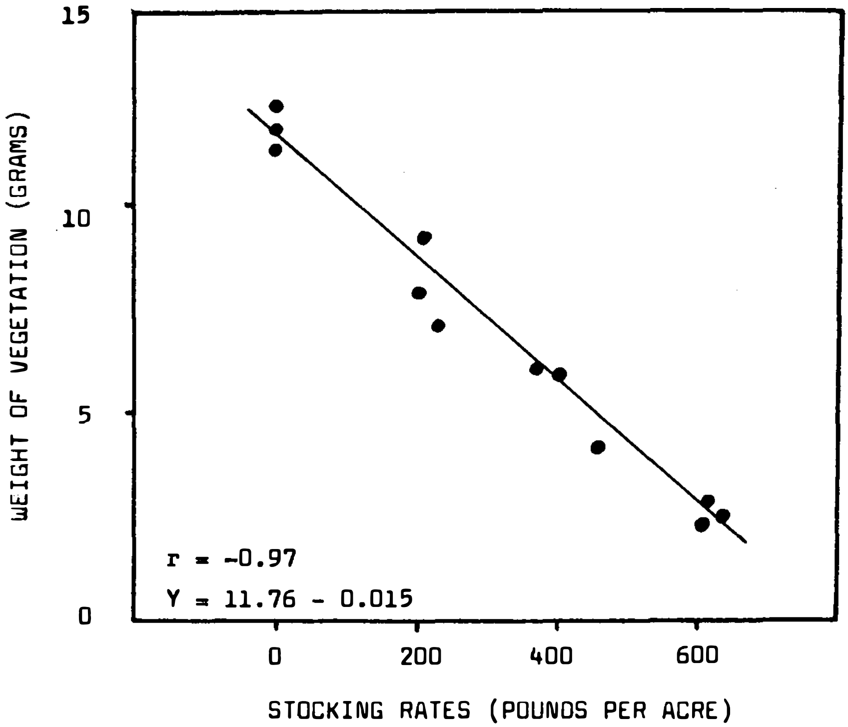

Fig. 4. Relationship between oven-dried weight of vegetation present per square foot in 1960 and carp stocking rates. Data from 12 carp enclosures erected in 1960.

tions exceeded the mean weights of vegetation collected in pens IX and XVI where carp populations of 610 and 612 pounds per acre were confined respectively. In all cases, relatively large standard errors were associated with vegetation samples collected from enclosures in which carp were confined.

Turbidity Measurements

Analyses of water samples collected from the carp enclosures during the summers of 1959 and 1960 disclosed no significant differences in relative turbidity which could be attributed to the actions of carp.

The amount of water turbidity in all pens remained relatively low until the latter part of July; then began a gradual increase which persisted throughout the balance of the summers. Aquatic vegetation matured during the mid-part of June, attained its full development by the end of July, then began to die back. The increase in relative turbidity coincided with this vegetation decomposition.

DISCUSSION AND CONCLUSIONS

The results of this study support the contention that high carp population concentrations reduce aquatic vegetative yields. Data from both seasons, 1959 and 1960, show strong negative correlations between carp stocking rates and the amount of aquatic vegetation present. Thus, statistical analyses support preliminary observational conclusions.

Vegetation samples collected during the 1959 season weighed more than did the 1960 samples because of one or more of the following reasons: (1) carp were introduced into the enclosures almost two months later in the 1959 growing season, allowing the vegetation a chance to attain a more advanced growth, (2) carp were confined for a 2½-month period in 1959 compared to a 3-month period for the 1960 season, and (3) vegetation samples were collected a month later in the 1959 season than in the 1960 season.

Vegetation samples taken in 1960 from pens I through IV were significantly heavier than the balance of the 1960 samples because these four enclosures served as exclosures early in the spring of 1960 and thus allowed the vegtation to reach a greater development before carp were introduced into them on May 17, 1960. It could well be that early spring is one of the more critical periods when carp exert a great influence on plant growth. These pens which were protected from carp activity in the spring of 1960 had approximately one-third more vegetation present than did similar areas which were exposed to carp activity.

Statistical calculations involving the "t" test indicate that vegetation productivity is significantly greater in the control enclosures when compared to vegetative yields in the pens confining carp populations of over 400 pounds per acre. No significant differences could be detected between the vegetation productivity of the control pens and the pens with carp populations of less than 200 pounds per acre. It appears therefore that in this study, carp populations greater than 200 pounds per acre adversely affected the vegetative yields while population concentrations lower than this level did not appreciably reduce the vegetation productivity.

Since no differences in turbidity could be detected which could be ascribed to carp activity and carp are not known to feed extensively on vegetation (Sigler 1958), it is concluded that the reduction in vegetation productivity was the result of the combined effects of carp rooting, digging, and practicing other mechanical feeding activities in quest of aquatic oranisms. Increased water turbidity would have resulted in an overall decrease in the growth of aquatic vegetation; however, such was not the case in this study. Carp in the course of their feeding activities would often completely eliminate the vegetation from an area (Fig. 5). A strong correlation was found between the stocking rate of carp and the amount of area void of vegetation in the carp enclosures.

For many years it has been a common management practice on waterfowl areas to initiate a carp control program when the water becomes turbid. This study has shown that vegetation production can be adversely affected long before water turbidity is increased. The relationship between carp concentration levels and increased water tubbidity is no doubt greatly influenced by soil type. The sandy clay soils of the Bear River Club study area are fairly resistant to becoming suspended in the water, thus low concentrations of carp are not able to markedly affect the turbidity levels. Observations during this study indicate that carp concentrations estimated at about 2,000 pounds per acre were capable of radically increasing water turbidity. Such concentrations are not uncommon because of the schooling behavior of carp while feeding and spawning. Sigler (1958) asserts that an aver-

Fig. 5. A carp resting in an area which was made void of vegetation through carp activity, 1960 season.

age weight per acre may be an erroneous method of measuring carp population levels due to the schooling behavior of these fish.

Obviously more research is needed to answer all questions which originate in the carp/waterfowl habitat relationship. This study in showing some correlations between carp stocking rates and vegetation productivity is but a small step in acquiring an understanding of the whole complex of marsh relationships.

SUMMARY

A study was initiated in 1959 to determine the relationship between carp and waterfowl food plant productivity. The marsh of the Bear River Club Company in northern Utah was selected as the site of the study. The extent and manner in which carp affected submersed aquatic plants were the objectives of the investigation.

Three stratifications of carp populations of approximately 200, 400, and 600 pounds per acre equivalent were confined to enclosures constructed of welded-wire fencing.

Turbidity measurements were made throughout the summers. Vegetation surveys were conducted at the beginning and end of each summer period.

Data indicated no relationship existed between carp stocking rates and water turbidity. A close negative correlation existed between the amount of vegetation present and the carp population levels. No significant reductions in vegetation productivity were noted when carp populations were below 200 pounds per acre; in contrast, however, carp population concentrations in excess of 200 pounds per acre greatly reduced the amount of vegetation present.

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DISCUSSION

MR. F. M. UHLER [Patuxent Wildlife Research Center, Laurel, Maryland]: What was the deepest water in which the carp were confined?

MR. ROBEL: All of these carp enclosures were constructed in one area, and the water depth was maintained at 12 inches throughout the summer.

MR. UHLER: That, of course, is very important in considering the effects of turbidity. In other words, the deeper the water, the more drastic the efforts of turbidity are. In water as shallow as one foot in depth, you would expect very little effect from turbidity on plant growth because the light is not excluded to the same degree that it would be in deeper waters.

MR. ROBEL: That is true, although in the Utah marshes and in those of most of the western states, the average depth is 12 inches or less, so we use this for our depth here.

MR. UHLER: I have noticed in many areas in the Middle West and in the East that when you had a colloidal clay bottom, even in the shallowest zones, even eight to twelve inches in depth, we were getting moderate production of submerged vegetation in heavily infested carp areas, but when we got beyond that depth, the vegetation became very sparse and then disappeared. So apparently, depending on the depth and the nature of the bottom, you can have great variation in the effects of turbidity in carp habitat.

MR. MATHIESON [Nebraska]: What did you have in the way of algae in these enclosures?

MR. ROBEL: Only one form of alga was found although perhaps there were others present. The one we identified belonged to the genus *Cladophore.* It was almost straight *Potamogeton pectinatus.* We had a little *Chara* but it occurred in less than two per cent of the area.

CHAIRMAN ELDER: I would like to thank all those that participated for very interesting papers and for their careful preparation, and to thank Dr. Low for his help and cooperation.

TECHNICAL SESSIONS

Monday Afternoon—March 6

Chairman: Frank A. Hayes
Director, Southeastern Cooperative Wildlife Disease Study, University of Georgia, Athens

Discussion Leader: W. R. Pritchard
Head, Department of Veterinary Science, Agricultural Experiment Station, University of Florida, Gainesville

DISEASE, NUTRITION, AND CONTROLS

PRINCIPLES FOR POPULATION CONTROL BY GAMETOCIDES

David E. Davis
The Pennsylvania State University, University Park

The objectives of a management program must be defined in terms of the level of population desired. For the control of pest species, it might be desirable to attempt to exterminate the animals but it more likely is desirable to manage the population at a level that will not permit damage. Often the level is determined largely by the realistic appraisal of the budget. This paper outlines population principles and practical features that may be involved in the use of gametocides to control populations. A gametocide may be defined as a chemical that prevents the formation of gametes or destroys them at any stage of development. Use of gametocides permits control of reproduction in a subtle manner that follows population principles. First, the basic principles for control of populations will be mentioned and then results of use of gametocides will be cited. Finally, an evaluation of the future potential will be made.

Acknowledgments: Dr. J. M. Reugsegger of Lederle Laboratories supplied the TEM. A Fish and Wildlife Service contract provided funds for cages and technical help for the studies on blackbirds. The School of Hygiene and Public Health of the Johns Hopkins University

provided facilities for the initial work and the Pennsylvania State University provided opportunities for the later research. Numerous persons helped to capture starlings.

Among the basic principles governing the management of a population is the concept of density dependence (Nicholson, 1957). In recent years this idea has attracted attention and now is rather generally known. Although various authors differ somewhat in detail of expression, the proposition always includes the concept that a mortality factor increases percentagewise in its effect on the population as the density of the population increases. In brief, this means that in a sparse population some pathogen might remove ten per cent, but in a dense population it might remove twenty per cent. It now seems quite clear that a density dependent factor is the only kind that can catch up with the growth of a population and actually restrict it in its growth. Examples of density factors are usually parasites and disease as well as competition among the individuals. The importance, of course, of density dependence is that there is a changing relationship to density as the density changes.

Another basic population principle now relatively well known is that the numbers of animals increase along some sort of a sigmoid curve. The most frequent form of the sigmoid curve is the special case (logistic) in which the birth rates and mortality rates change linearly with time. The logistic is a symmetrical curve with the maximum rate of increase at half of the upper carrying capacity. An important feature of the sigmoid curve is that growth of a population is self-limiting and this self-limitation occurs in part through the action of density dependent factors. The discussion of the proper level of control of a population must take into account the two principles that have been very briefly sketched here.

The level to which the population should be reduced will be determined by economic considerations. First there is the question of the extent of damage. In some cases a species will cease to be a problem if it is reduced by a small amount. In other cases it could seem desirable completely to extirpate the species. However, another feature of the problem is the cost of reducing the population. While it might be desirable to extirpate a species, still the cost of reducing it to the zero level might be excessive for the practical means involved. Under these circumstances some additional level should be considered.

The methods for reduction of a species or for the prevention of damage can be classed into several types. First, many methods increase the mortality rate of the species by killing, using various means such as traps, poisons, or guns. Killing methods have been elaborated to great perfection, and it seems possible now that *given ample funds* almost any species could be killed in sufficient numbers to reduce it to a low level. The second method available consists of frightening the animals away by one means or another. Included here are methods for simple protection of the property from direct damage by fencing or some other device. These methods, of course, do not directly change the mortality rate but may indirectly affect it by preventing the animals from feeding or resting and thus set the stage for other factors actually to kill the animals. Frightening in its broad sense may sooner or later increase the mortality rate.

However, a defect of these two approaches is that for many species when the mortality rate is increased then compensation occurs in terms of increased survival and also increased productivity. For example, some work that we have done recently on woodchucks shows compensations that occurred while the population remained numerically constant. When animals were removed from an area, the birth rate increased from 1.3 to 1.6 young woodchucks per adult in the population (Davis *et al.,* unpublished). To attain this increase, almost as many animals were removed during each of the second and third years as were present at any one moment in the population. Movement into the area was another compensatory change. For example, in one area about 125 young were born (based on counts of placental scars), but 178 young of the year were trapped from July to November. A further change was an increased survival of the young-of-the-year so that almost twice as many were available in the fall as had previously been true. Persons familiar with fish, birds, and reptiles can cite many examples to show that the general principle of compensation applies to mortality of a wide variety of species.

The third method is to reduce the birth rate. It is perfectly clear that destruction of eggs or new-born young increases mortality although it is usually included under the category of birth rates. However, the gametocide method reduces the birth rate at the inception of the reproductive process. Therefore, compensatory factors rarely have a chance to act. However, prevention of formation of gametes will be exempt from compensation if the animals fail to start a new breeding cycle. Destruction by some means of the production of young without change in breeding behavior will reduce the number of young and prevent compensation. This principle is the basis for the control of insect populations by the use of sterilized males (Knipling, 1960; Simpson, 1958). This principle was applied to foxes (Lord, 1956) by hysterectomyzing vixens at the start of the breeding season. These foxes remained paired and stayed in a restricted area so that no replacement occurred. For birds a compound that prevents production or hatching but does not alter behavior should reduce the production without any compensatory effects.

Recently some experiments have been conducted with a gametocide. The chemical triethylenemelamine (TEM) has been shown to prevent proper development of sperm in a number of mammals. Furthermore, effects occur in ova as well. Work that will be reported elsewhere (Davis, sp. rep.) in detail has shown that this chemical is effective in very small doses in starlings and also in redwings. The particular problem concerning the effectiveness of the gametocide was not whether the chemical would destroy the sperm but whether compensations on a population basis might occur.

For mammals it seemed quite clear that the male would either copulate with the female but not produce progeny or that defective sperm would result in a high loss of embryos. Under these circumstances as long as the males were sterile or defective, reproduction could not occur. However, if the males left the population permitting new animals to enter, then a persistent use of the chemical would be necessary to sterilize constantly the immigrants. To test this program in 1957-1958 work was done with rat populations in the city of Baltimore. The results were inconclusive. In four blocks the chemical was used and the number of rats declined gradually over a period of two months. In the three control blocks one declined and two remained constant. The work was discontinued for practical reasons even though the results were promising.

For birds more detailed studies were possible, using starlings (*Sturnus vulgaris*) as the model species. The dosage of TEM was worked out with captive birds both in terms of quantity and in number of days. This research was performed under a contract with the Fish and Wildlife Service, designed to evaluate this gametocide. Some results (Table 1) show the effect of various dosages on gonads of starlings. The birds in March were placed in a regime of 15 hours of daylight a week before TEM was placed in the food. Testes less than 1000 mg. rarely possess sperm. Ovaries less than 100 mg. are usually abnormal. Note that while the gonads of the reference birds (no TEM) regularly increased and decreased the gonads of the 1 mg.—seven-day group remained small but then increased somwhat. Other work (Davis, sp. rep.) shows that the testes do not recover in time to produce sperm during the breeding season. Further tests showed that birds fed TEM in the winter when the testes are completely regressed do not recover for several months.

TABLE 1 EFFECT OF DIFFERENT DOSAGES OF TEM ON ADULT MALE AND FEMALE STARLINGS. (MEAN WEIGHT IN MG. OF PAIRED TESTES OR OF OVARIES FROM TWO BIRDS ON EACH DATE.)

Days after start	1		7		14		21		28	
Dosage duration	M	F	M	F	M	F	M	F	M	F
0.1 mg—7 days	468	58	685	45	436	117	834	144	1114	107
0.1 mg—3 days	979	66	654	51	1338	69	384	32	96	60
0.025 mg—7 days	969	81	1624	97	1847	192	1896	115	929	81
None	492	81	1759	123	1356	158	1469	141	153	64

Actually the details of dosage are relatively unimportant because what actually counts is whether the bird in nature gets enough of the chemical. It is clear that in the field the dosage will vary under some circumstances from none to an adequate dose under other circumstances. Thus after the initial laboratory stage of determination of dosages, the really important work was to try the chemical in field experience. To test the chemical, the redwinged blackbird (*Agelaius phoenecius*) for a variety of reasons was the most suitable species. In the spring of 1960 corn treated with TEM was exposed to the birds in one marsh and corn without TEM was made available to birds in another marsh. The production of young in the marsh with the chemical was significantly smaller than that in the reference area. Since other factors (density) differed, it will be necessary this spring to do the switchback experiment and use the chemical in the reference marsh of last year. These results appear promising not only because some reduction appeared possible but more importantly because no evidence of compensatory behavior was obtained. Measurements of territories and of defensive behavior showed that the males maintained a territory throughout the season even though in one proven case the testes completely lacked sperm. Thus it would appear that a male which was unable to sire progeny would maintain a territory and keep the females under control for the entire breeding season. Under these circumstances the reduction of the birth rate would be uncompensated.

One qualification about compensations must be made. If pairing behavior is maintained then, as in foxes and redwings, the production of young will actually decline. However, the reduction in number of young will reduce competition among the ones that are produced and their survival will improve. But the competition that occurs among young is unimportant compared to the competition of adults against young. Thus in the first year compensation will be trivial but in subsequent years competition among the new adults will develop only to a low level corresponding to a low population.

The prospects for the development of gametocides for management of populations appear bright. Several features are desirable. Inhumane treatment of animals is avoided. Furthermore, the cost is probably trivial except for the labor involved. Perhaps more important is the fact that the extent of control can certainly be measured with considerable precision. If we assume that experience with the extent of damage indicates where the population should be kept then the sensitive use of gametocide in certain years or in certain places should permit holding the population to a particular level. The reason that it should be easiest to keep the population at a level is again the lack of compensatory mechanisms when the birth rate is reduced at the stage of formation of the gametes. Thus the effect is rather prompt and direct and does not have complicating counteractions.

In particular the use of gametocides should avoid the persistent failure of measures that increase mortality. Regularly a method of killing, poisoning, or trapping reduces the population from the carrying capacity of the area down to a level near the inflection point on the sigmoid curve. When a population is below the inflection point, costs of removing animals rapidly become greater and the effectiveness of the control measures drops. Thus many of the killing procedures merely reduce the population to the point of maximum rate of increase, thereby providing the large number of young animals coming into the area. Also such procedure may set up movement of individuals. However, the use of gametocides in contrast would actually reduce the reproductive rate at the same time that it reduces population. The compensations that can occur are movement of animals into the area and improved survival of progeny from parents that escaped the chemical. To account for these individuals some repeat treatment will be necessary if enough animals appear.

Naturally no method will be a panacea and provide all of the answers for the reduction of economic damage. It is clear that at special times and places killing procedures and frightening procedures will have an essential role. However, the use of gametocides provides an additional tool for the management of populations. This approach is new and requires much more work. In particular field trials to evaluate the effects under various ecological conditions are essential.

SUMMARY

For the reduction of a population, the control of the birth rate shows great promise. Chemicals that may be called gametocides prevent the formation of gametes. Based on the population principles of density dependence and sigmoid growth, it is apparent that a method that does not allow for compensation will be most effective. A chemical, triethylenemelamine (TEM), prevented formation of gametes in starlings and, when used on wild populations of redwings, appeared

to reduce productivity. Since the birds maintained their reproductive behavior, no compensation occurred. The use of a gametocide promises to add sensitivity to control measures.

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DISCUSSION

MR. STOCKDALE [Ohio]: Is the sterility a permanent thing, or is it a one-season sterility, or does this depend upon rate?

DOCTOR DAVIS: Most of the work has been done upon mammals, but depending on the dosages, they are not permanent. They can be worked out to give you a 30- or 60-day period. We do not know the answer to that in starlings. What has really bowled us over is that we gave starlings this in the winter and they did not come into reproduction in the spring, but they did in September, and they have remained in spermatogenesis ever since.

MR. REX NORD [Ohio]: I judge that you got better than a 20 per cent reduction in redwing blackbirds. Do you consider that this would be an adequate reduction for the type of control you are interested in?

DOCTOR DAVIS: No; that is not an adequate reduction. I know that we would have gotten a larger reduction if we hadn't had two heavy rainstorms that washed out all the TEM just when it would have been most effective.

MR. COWAN [Michigan]: I would like to ask whether you have any idea of the percentages of the population which you are working on that actually took treated bait?

DOCTOR DAVIS: I cannot answer that exactly. The males that were defending territories all took treated bait, and we color-banded those birds and collected two of them at the end of the season. We didn't want to collect more because we wanted to carry it out the following year.

Those two birds had seminal tubes that were completely destroyed. There was nothing in them. Those males had up to five females each, and I know from color-banding that four out of five males fed on the TEM. To summarize my answer I would say that it is a high proportion, if you work out your application procedures in relation to territorial behavior.

DOCTOR SHELDON [Massachusetts]: Did I understand correctly that TEM affects the ova, as well as the sperm?

DOCTOR DAVIS: Yes.

DOCTOR SHELDON: Were the females collected on the marsh?

DOCTOR DAVIS: We did not collect any females.

DOCTOR SHELDON: If we did develop an effective chemical that would last over a period of a month, for practical application, do you think the winter roost might be the logical place to use it, or would it have to be applied to the breeding grounds?

DOCTOR DAVIS: The winter roost would be the preferable place on a practical basis. I do not believe that the breeding-ground application that we used is a practical control procedure. This is an experimental program to see how the program works; how the gametocide works. But if I interpret your thinking correctly, I agree with you that the winter ground would be the best.

MR. W. H. LAWRENCE [State of Washington]: Has this approach been tried in field rodent control work?

DOCTOR DAVIS: Yes, it has been tried. In 1956 and '57, when I was in Baltimore, we tried it on rats. The results were inconclusive. It was at a time of declining populations throughout the whole area, but we got a greater decline in those areas where it was used than in those where it was not used. But I wouldn't conclude anything from this particular work. To my knowledge it has not been used to control rodents.

STUDIES OF SMALL-MAMMAL POPULATIONS ON THE RADIOACTIVE WHITE OAK LAKE BED

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AND
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With the advent of the atomic age and the benefits that it holds for mankind came also the problem of radioactive waste disposal. The two basic concepts of radioactive waste disposal are: (1) concentration and containment and (2) dilution and dispersion (USAEC Annual Report to Congress, 1960). High-level wastes are concentrated and contained, but the low-level wastes are often present in such large volumes that it is necessary to discharge these wastes to the environment for dilution and dispersion. Because ionizing radiation can cause damage to organisms, we need to know the possible effects on the biota of an area caused by the ionizing radiation from radioactive wastes released into the area.

Pioneering research was initiated by Oak Ridge National Laboratory to determine (1) how radionuclides move in natural environments and (2) whether there are discernible effects of the resulting radiation, with the radioactive White Oak Lake bed being used as the principal site for investigation. Clinton Laboratories and, later, Oak Ridge National Laboratory discharged low-level and intermediate-level radioactive wastes for 12 years after 1943 into part of the White Oak Creek drainage basin in Roane County, Tennessee. White Oak Lake was impounded in the summer of 1943 to serve as a final settling basin for the radioactive liquid effluents. The dam is located 0.6 mile upstream from the confluence of White Oak Creek and the Clinch River. At full pool the lake extended for about a mile upstream from the dam and inundated 44 acres, but the water was normally held at a level that covered 36 acres. Radioecological surveys were made on the lake from 1950 to 1953 (Krumholz, 1954). The lake was drained

[1]Operated by Union Carbide Corporation for the U. S. Atomic Energy Commission.

in the fall of 1955, and the alluvial material which remained was contaminated with radionuclides such as strontium-90, cesium-137, cobalt-60, and ruthenium-106. The drained lake bed is shown in Fig. 1. Distribution of radionuclides in the lake bed soil was heterogenous (Graham, 1948).

The lake bed is divided naturally into two parts by White Oak Creek, which flows diagonally from the south shore to the north shore (line a-b of Fig. 1). For convenience the two areas will be referred to as "upper lake bed" and "lower lake bed." In the lower lake bed the radiation field ranged from 5 to 35 millirads per hour (mrad/hr) shortly after draining, while in the upper lake bed the radiation field ranged from 10 to 80 mrad/hr (Auerbach and Crossley, 1958). Recently, however, the radiation field has increased in places in the upper lake bed because of seepage of radionuclides, principally radioruthenium, from nearby waste-disposal pits containing intermediate-level wastes (Cowser and Parker, 1958; de Laguna *et al.,* 1958).

Vegetational succession proceeded rapidly after the lake was drained (Crossley and Howden, 1961). During the first year a luxuriant growth of smartweed (*Polygonum* spp., especially *P. lapathi-*

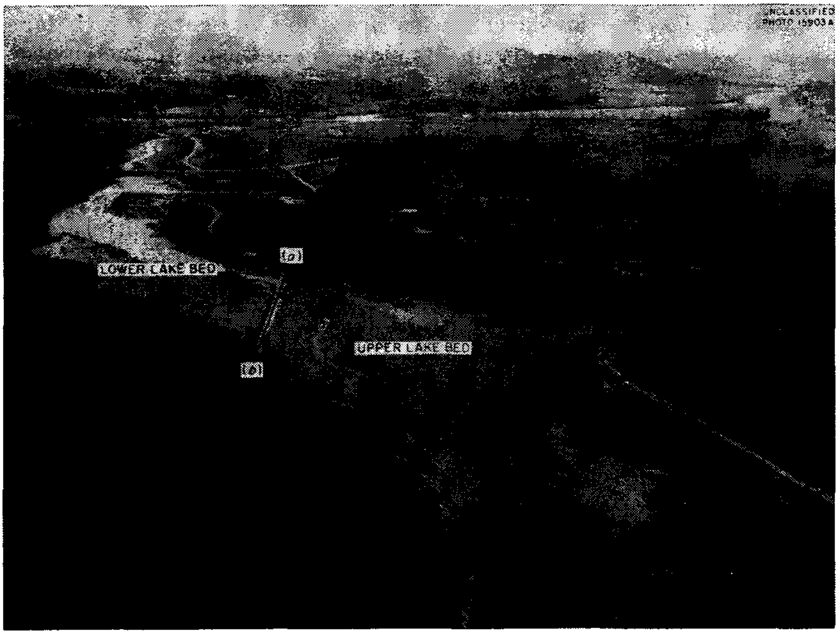

Fig. 1. Aerial photograph of White Oak Lake Bed immediately following drainage of the Lake in October 1955.

folium) covered much of the lake bed near the creek, rushes (*Juncus* spp.) and sedges (*Cyperus* spp. and *Carex* spp.) were near the shore, and several bare areas were present. In the succeeding years the rushes and sedges became dominants over much of the lake bed, but the vegetation became more complex and in places other herbaceous plants and black willow (*Salix nigra*) become dominant. Some of the forbs of importance were jewelweed (*Impatiens pallida, I. capensis*), eupatorium (*Eupatorium serotinum*), and beggar-ticks (*Bidens frondosa*). Because of a standing pool of about 10 acres impounded behind the dam in 1959, some areas in the lower lake bed reverted to a dominance by sedges and rushes.

A preliminary study of the small mammals of the lake bed was made during 1956 and 1957 (Auerbach *et al.,* 1958). In the spring of 1958 a routine study of population dynamics was begun and continued until the summer of 1960. This study was conducted to provide baseline information for designing proposed studies of the fates and biological effects of radionuclides in areas contaminated with radioactive wastes. At the same time that the program was begun on the lake bed, a similar study was initiated on the small mammals of an uncontaminated old field located less than one mile from the lake bed.

THE STUDY AREAS

The lake-bed and old-field study areas were marked off into a grid system, with 10 meters between the equidistant lines. Metal fence posts were placed at the points where the surveyed grid lines intersected. The lake bed study area is located on the lower lake bed, covers 7.4 acres, and is irregular in shape because of the irregularities of the creek and a road which form its northern and southern boundaries, respectively. A narrow strip of trees, bushes, and associated vegetation occupies the bank between the lake bed and the road. The study area is flooded occasionally during heavy rains or when the dam is closed in order to dilute radioactive wastes to a permissible level before they are released into the Clinch River. In general, radiation fields in the area are highest near the creek and lowest near the shoreline. The radiation field in 1958 is shown in Fig. 2. That part of the grid area south of the creek is the mammal study area discussed in this report. Radiation fields in the area ranged from <1 to 30 mr/hr (Lee and Auerbach, 1960).

The nonradioactive old-field study area is square and encompasses 10.0 acres. Of the large areas available on the reservation, the old field was most similar to the lake bed area. A plantation of young pines (average height about 5 ft.) was cleared from the area in the

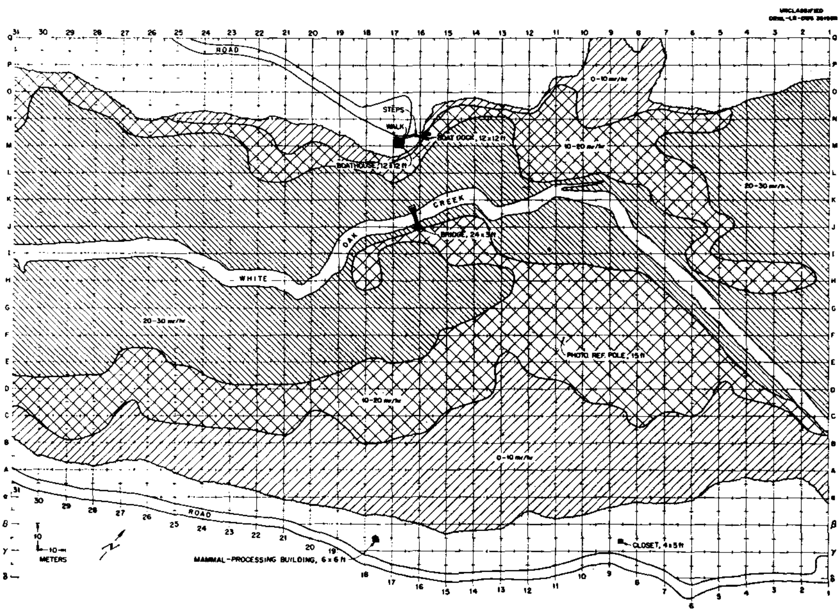

Figure 2. Radiation field 25 cm above surface of mammal study area on White Oak Lake bed.

fall of 1957, and it was not until the summer of 1958 that the open areas formerly occupied by the trees were completely filled in by herbaceous vegetation. The vegetation of the area was heterogenous during the study. Bentgrass (*Agrostis* spp.), broom-sedge (*Andropogon virginicus*), goldenrod (*Solidago* spp.), aster (*Aster pilosus*), brambles (*Rubus* spp.), cudweed (*Gnaphalium* spp.), and Japanese honeysuckle (*Lonicera japonica*) were among the common species. Red cedar (*Juniperus virginiana*), pines (*Pinus echinata* and *P. virginiana*), sumac (*Rhus glabra, R. copallina,* and *R. toxicodendron*) and "red willow" (*Cornus amomum*) were common woody species scattered through the area. Old hedgerows of osage orange trees (*Maclura pomifera*) and hackberry trees (*Celtis occidentalis*) are located about 80 ft. from both the northwest and the southeast edges of the study area. A thicket of switch cane (*Arundinaria tecta*) grows along about half the length of a wet-weather stream about 60 ft. to the southwest and a few elm (*Ulmus* spp.), hackberry, and maple (*Acer* spp.) trees are scattered along the stream. To the northeast the vegetation is similar to that of the study area. Beyond the lines of trees to the southwest and southeast the vegetation is also similar to that in the study area.

METHODS AND MATERIALS

The field procedure involved marking the live-trapped animals for identification, releasing them, and recapturing them for as long as conditions permitted. Biological information was recorded at each capture and transferred to IBM cards for rapid machine processing of data. More than 4300 examinations were made on over 1400 different small mammals. Recorded information included species, identification number, sex, point of capture, estimated age (young, subadult, or adult), weight, reproductive condition, and abnormalities.

Traps were set as late in the day and checked as early in the morning as practical. Normally, the trap setting was finished about dusk and the checking of traps was begun before sunrise. Trapping in the areas was conducted alternately; that is, traps were set in one area for one night and in the other area during another night. The traps were placed at every third stake on alternate lines. This arrangement was varied until, after twelve nights of trapping, traps had been placed at all stations. The number of traps set during a night ranged from 49 to 55 at the lake bed and was either 70 or 77 at the old field, depending upon the pattern used. These trapping patterns were utilized so that traps could be set throughout an area during a trapping period and yet the number of traps involved could be handled conveniently. Also, the shifting about of the traps may have foiled trap-prone individuals to some extent. Trapping was conducted from 1 to 8 times a month on each area.

Traps made of tempered masonite (11 in. long, 3 in. wide, and 3⅛ in. high—inside dimensions) were used throughout the study. Special metal cans, slightly larger than the traps and sprayed with a water-resistant medium-green paint, were employed to house the traps and prevent trapped animals from becoming wet during heavy rains. (The cans were manufactured by George D. Ellis and Sons, Inc., Philadelphia, Pa.) Cotton batting served for nesting material during cold weather. Bait consisted of a mixture of rolled oats and peanut butter. Thick slices of carrots were put in the traps to supply the trapped mammals with moisture when eaten.

Work on the radioactive lake bed necessitated special field procedures and equipment. To reduce the radiation exposure time of workers, traps containing mammals were collected and taken to the mammal-processing building located out of the radiation field for weighing and examination. Trapped mammals at the old-field area were also collected and taken to the building on that area so that the procedures on both areas would be the same. After examinations were complete, the animals were returned to the station at which they were captured. Coveralls, rubber boots, gloves, and caps were worn on the lake bed to minimize contamination of the skin. Film badges and pocket ionization chambers were always worn by workers to measure their accumulated radiation dose.

SUCCESSION OF SMALL MAMMALS

Small-mammal succession on the lake bed was similar to plant succession in that more species and greater total populations were present in later years than in the first year. Similar findings for small-mammal populations on floodplains were reported by Wetzel (1958). The increases noted in our study may be attributable to the increasing coverage and complexity of the vegetation. Succession of the small mammals is shown in Fig. 3. House mice (*Mus musculus*) and white-footed mice (*Peromyscus leucopus*) were the first small-mammal invaders on the lake bed. During the summer of 1957 the cotton rat (*Sigmodon hispidus*) became a dominant species, and by early 1958 the rice rat (*Oryzomys palustris*) was second in abundance to the cotton rat. Eastern harvest mice (*Reithrodontomys humulis*) appeared by the winter of 1958-59 but were never caught in large numbers. Pine mice (*Microtus pinetorum*) became an invading species by the spring of 1960. The house mouse was the only species that disappeared during the succession from the fall of 1956 to the summer of 1960. However, after 1957 the white-footed mouse was usually trapped in or near the periphery of the former lake and should be regarded as a species lost from the succession of the lake bed proper. Hamilton reported (1943) that the white-footed mouse has a habitat preference of woods and brushlands, but occasionally ranges into more open areas. A few small mammals of other species were trapped occasionally. These species and the numbers caught were: short-tailed shrew, *Blarina brevicauda* (14); golden mouse, *Peromyscus nuttalli* (12); least shrew, *Cryptotis parva* (4); southeastern shrew, *Sorex longirostris* (2); Norway rat, *Rattus norvegicus* (2); and eastern chipmunk, *Tamias striatus* (1). The golden mice and the chipmunk were caught in the strip of bushes and trees on the bank.

Pine mice and white-footed mice were the species first found at the old field, but harvest mice appeared in the summer of 1958 (Fig. 3). A few cotton rats appeared during the fall of 1958, but they did not persist through the winter, and it was not until 1959 that a population became well established. The white-footed mice ranged out into the area from the hedgerows to the northwest and southeast and from the line of trees and switch cane to the southwest. Thirty-seven least shrews, 5 rice rats, 4 house mice, and 2 southeastern shrews were also caught at the old field during the study.

During the unusually severe winter of 1959-60, populations of most species declined sharply, and by spring the cotton rats of both areas and the harvest mice of the old field were exterminated. By the summer of 1960, the population of harvest mice in the lake bed also had almost disappeared.

COTTON RAT POPULATIONS

Trapping Success

The cotton rat, *Sigmodon hispidus komareki* Gardner, was the most evenly distributed and abundant small-mammal species on the lake bed during most of the study. This species will be used as an example for further discussion of population dynamics. *Sigmodon* were first recorded on the lake bed in the summer of 1957 (Fig. 3). Greatest trapping success from 1957 to 1959 was in the summers; average numbers caught per 100 trap-nights in the summers of 1957, 1958, and 1959 were 9.8, 26.8, and 43.1, respectively. On the old-field area, greatest trapping success in 1959 was in the fall (12.6 per 100 trap-nights).

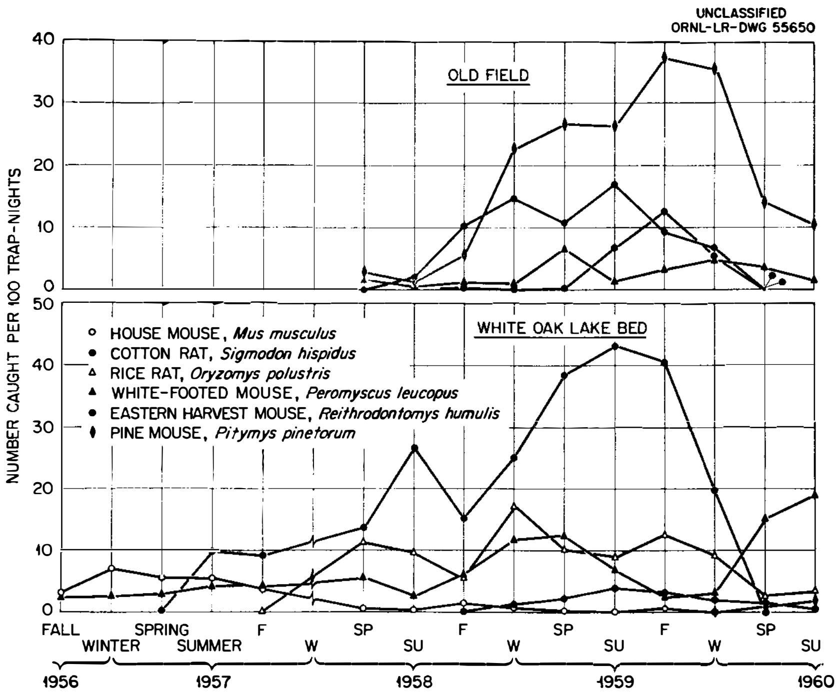

Figure 3. Numbers of small mammals caught per 100 trap-nights in the lake-bed and old-field areas.

At the lake bed, trapping success in the fall of 1958 and 1959 was only slightly greater than in the spring of those years. Odum (1955) found that a markedly greater number of cotton rats was caught in the fall in 6 out of 7 years. Perhaps the differences between his study and our results from the lake bed may be due to differences in vegetation of the two areas. The area that he studied was located in an old field near Athens, Georgia, and, judging by the description in his report, the field was somewhat similar to our old-field area. Vegetation in our old field and similar areas near the lake bed was largely killed, at least to the basal areas, with the first freezes, but on the lake bed the rushes continued to be green on through the winter. The highest percentages of new captures on the lake bed were in the winters, except for when trapping was first begun. It may be that cotton rats moved into the lake bed area when green vegetation was winter-killed in surrounding areas. Previously uncaptured individuals entered the area during the winter of 1958-59 and early spring of 1959 so that, in spite of winter attrition, the lake bed population in the spring of 1959 was relatively large before the breeding season began. The histories of the rats caught in the spring of 1958 are not known because trapping was not conducted during the winter of 1957-58.

The *Sigmodon* of both study areas were exterminated by spring of 1960 (Dunaway and Kaye, 1961) after a period of unusually cold weather, but the species was not exterminated throughout the region. An individual was trapped in an area of dense Japanese honeysuckle near the lake bed in April 1960, another rat was caught on the lake bed in August 1960, and several have since been captured in other areas.

Movements

Movements of adult males show striking differences from movements of adult females when these movements are considered on a seasonal basis. One way of expressing movement or range is "greatest distance between points of capture" (Burt, 1940, and Holdenreid, 1940). Individuals were selected which were over 70 g and which were caught from 5 to 15 times in inside lines of traps only. Eight males and ten females in the lake bed population satisfied these conditions in the months from May through October during 1957-1959. The average greatest distance for the males was 573±76 ft. S.E. (extremes, 312-892 ft.) and for the females, 236±17 ft. (131-305 ft.) During the months from November through April (1957-1959) the average distance for 9 males was 276±32 ft. (105-397 ft.) and for 4 females, 175±33 ft. (118-266 ft.). It is apparent that males moved farther than females during all seasons. The movements of both sexes were least during the

November-through-April period. Presumably the increased size of the ranges of adult males during the warmer months was related to their mating activities, because it is probably more than coincidental that captures of adult males during that time were in or near the ranges of several females. The ranges of adult females showed very little overlap, but the ranges of adult males overlapped greatly with each other as well as with the ranges of the females. Howell (1954) estimated that the home ranges of seven adult males in the summer of 1951 were, on the average, almost twice as large as the home ranges of seven adult females (0.85 ± 0.13 acre vs. 0.44 ± 0.07 acre). He also noted that the ranges of the adult females showed little overlap but the ranges of the males overlapped broadly with each other and with the ranges of the females.

Hayne (1949) and Stickel (1954) have discussed the many methods that have been used to calculate home range size. We have deliberately avoided a discussion of home range size in this paper because, after considering the movements of individuals over periods spanning several months, we question the advisability of estimating areas of home ranges for individuals over such long periods. Also, work of Kaye (1961) with eastern harvest mice tagged with radioactive gold wire shows that for that species, at least, many parts of an area may not be utilized by an individual and that most of the activities of the mice seem to take place in "home areas" near the nests.

Shifts of the ranges of several adult males were noted. These individuals lived for a while in one part of an area and then shifted their activities to another part of the area. For instance, one male was caught for the first 5 times in the western part of the lake bed study area, but 15 of the next 16 captures were located near the eastern part of the area. Ranges of some adult females were observed to change also, but not in the same way that the ranges of the adult males changed. The alterations in the female ranges were caused by a more amoeboid shift; that is, by vacating one part of the range and extending the range into a contiguous area.

Movements of young were less well-defined than the movements of the older rats because, of 53 young born in traps or found in nests at the lake bed, only 14 were recaptured later, and, of 40 neonates at the old field, only 8 were retaken. Of these 22 young that were recaptured, only 9 were recaptured 3 or more times. Probably much of the disappearance of the young was due to dispersal, because 4 of the 8 recaptured at the old field and 5 of the 14 recaptured at the lake bed were absent (as judged by lack of recapture) for over 60 days, but appeared later on the areas. However, not all young disappeared quickly from maternal ranges. At the old field, 2 young of one litter and 4 young of another litter lived for average times of 74 and 92 days, respectively, in the maternal ranges. Five of these six individuals were females; one had a litter in a trap located within the original maternal range, one had a litter within 24 hr. after being removed from a trap within the maternal range, and the remaining three females apparently had litters in or near the original maternal ranges. Although the young females of some species may stay in the maternal range in certain circumstances (Frank, 1957), the "condensation potential" phenomenon shown by Frank does not seem to apply here because cotton rat populations in the area were low and seemingly suitable large areas in the vicinity were available for occupancy. Possibly the time of year may have been important (evidence indicates that litters of the former litter mates were born in the first or second week of October), and a breakdown of territoriality may have been in effect. We agree with Frank (1957) that in some small mammal species territoriality may break down as cold weather appears and that huddling may become important, because we have found huddling groups of cotton rats (Dunaway and Kaye, 1961), white-footed mice, and harvest mice during cold weather.

Trap-Revealed Longevity

Survival of cotton rats on the two areas can be inferred from the trapping results. Figure 4 shows that few individuals were trapped on the lake bed for periods of over six months between first and last captures. In fact, only 28 out of the 180 represented on the curve were present for over six months. Five females and two males were present for over 10 months, and only one of these, a female, was present for over a year (403 days). Of course, most of the animals trapped for the first time were at least a month old and many were probably several months old so that perhaps several of the 180 individuals were actually over a year old. The population at the old field was not present long enough for comparisons of trap-revealed longevity to be made with the lake bed population. Many of the animals trapped in the areas were probably transients. Of the total 248 rats trapped on the lake bed, 35 per cent were caught only once. On the old-field area, 27 per cent of 48 rats were trapped only once.

Sex Ratios

The sex ratios of the old-field *Sigmodon* were equal when the total numbers for both sexes are considered (41 males, 39 females). However, the total numbers for the lake bed cotton rats from 1957 to 1960 were 178 males and 137 females; the Chi square test showed these differences to be significant ($\chi^2 = 5.336$, P $= 0.025$). More females

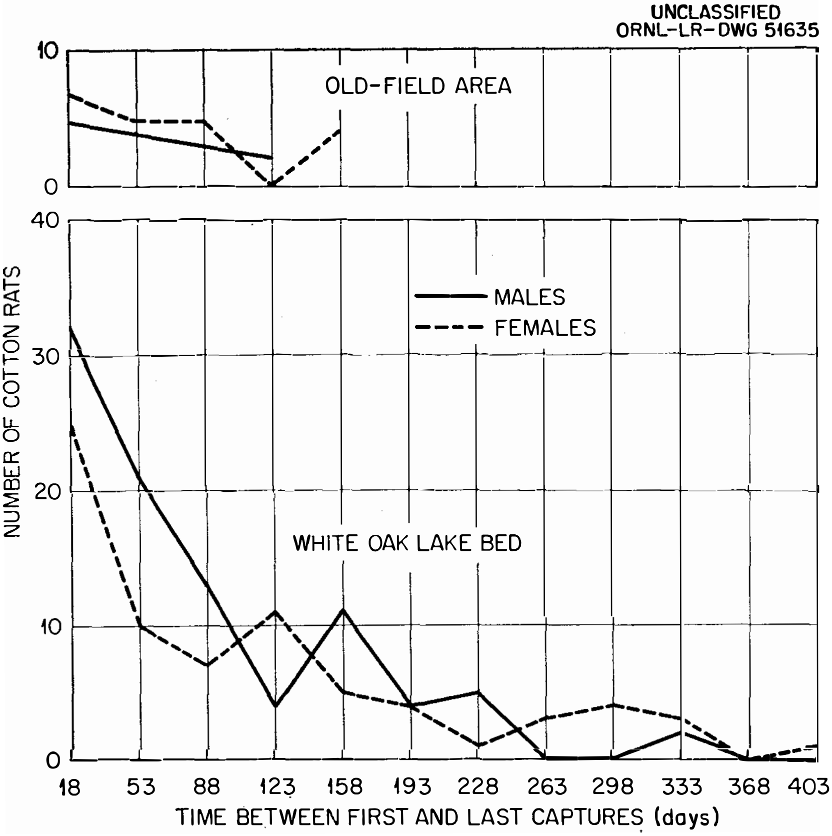

Figure 4. Times between first and last captures for cotton rats. Only those individuals with more than 7 days between captures are included.

than males were caught from July to December in 1958 and from May to November (except July) in 1959 (Fig. 5). Although these monthly differences were not statistically significant when tested by the non-parametrical runs method, there seemed to be a tendency for females to be more numerous from late spring or summer to late fall or early winter. Komarek (1937) found cotton rat males in Georgia to be more numerous than females during 1936 and part of 1937 except for June and July of 1936, when females were more numerous.

Determining the relative abundances of the sexes in an area is apparently a difficult process, considering that we found that adult males range for distances covering hundreds of feet during the warm months of the year and that adult females are relatively sedentary. If small study areas or lines of traps are used to sample populations, then

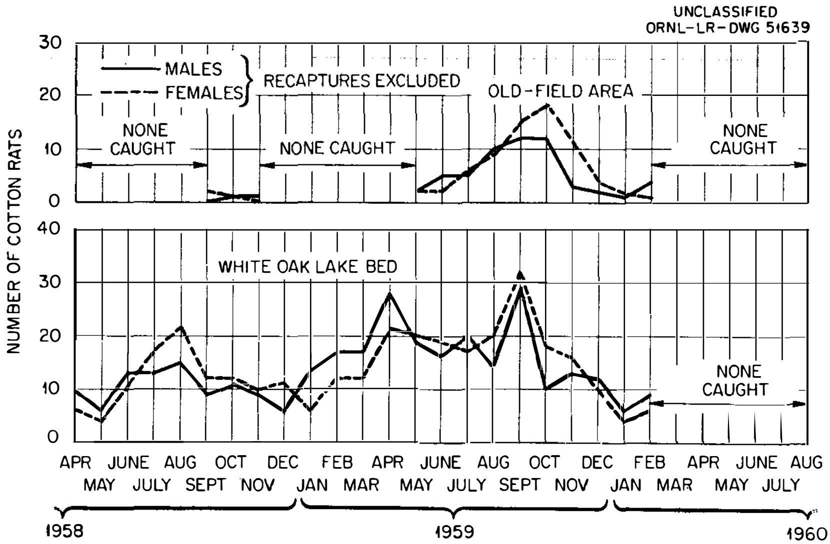

Figure 5. Cotton rat males and females caught per month on the White Oak Lake bed and old-field areas.

more males than females may be trapped simply because of the greater mobility of the males. More males than females were trapped only once at each area (lake bed—55 males vs. 32 females, old field—9 males vs. 4 females). On the other hand, more females were trapped a greater number of times. In general, the reason for the greater number of captures for females is that more females lived longer on the areas (Fig. 4). It seems somewhat paradoxical that more females than males were caught during most of the breeding season in view of the greater mobility of the males during this time. However, males were more numerous during the first part of the breeding season, and it may be that they are exposed to more predation, because of their travels, and eventually become less numerous than the females.

Reproduction

Reproduction occurred chiefly from about April to October (Fig. 6). Pregnancies were determined by consideration of weights before and after a suspected pregnancy, palpation, and condition of mammae. Testes were noted as "descended" or "undescended." Percentages of males with descended testes are usually much higher than the corresponding percentages for pregnant females because of the time necessary for pregnancies to become apparent (Fig. 6). In general, there is a correspondence between pregnancies and descended testes. Sporadic breeding occurred on the lake bed area during the winter of

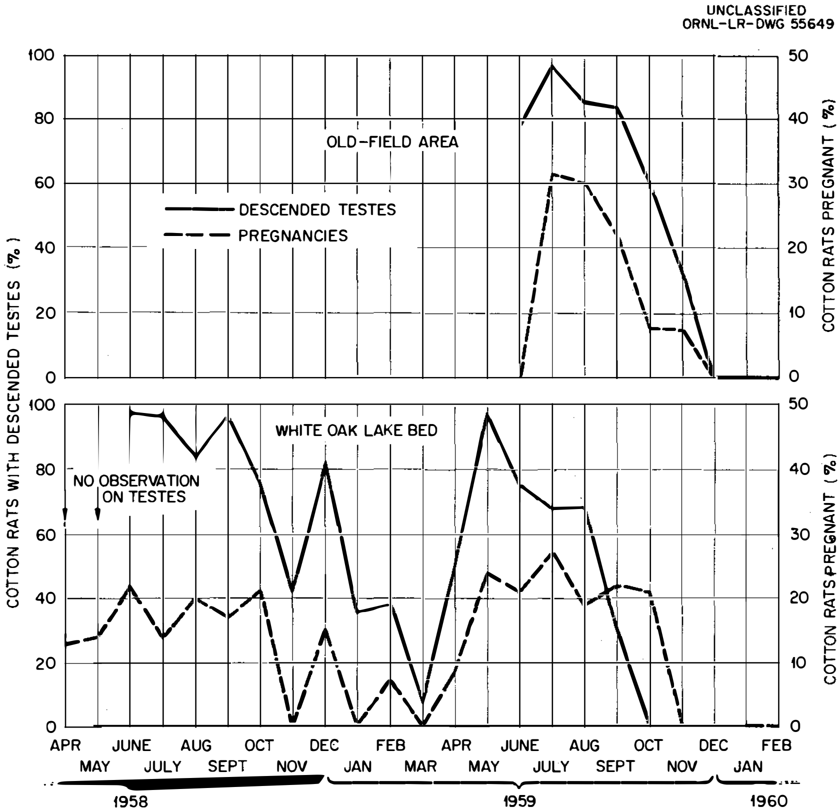

Figure 6. Cotton rats pregnant and cotton rats with descended testes.

1958-59. A pregnancy in February followed a period of warm weather from 26 January to 15 February, during which time temperatures were below freezing only four times. More than temperature is apparently involved at times, however, because no pregnancies were recorded in November 1958 although temperatures had been below 40° F. only 6 times during all of October and the first week of November. No pregnant females were noted in June 1959 at the old field; the reason for this lack of detectable pregnancies may have been that the small females (all were less than 101 g) that appeared on the area in June had not bred in time for the pregnancies to be apparent. A pregnant female was present at the old field in November 1959, one month later than pregnant females were present at the lake bed. Males with scrotal testes were recorded at the old field also in November, *two* months later than at the lake bed.

Litters were born in traps, born in cages to pregnant females removed for a few days from the areas, and some were born in the field and found in nests. These litters are listed in Table 1. The average number of young per litter was smaller at the lake bed (5.40±0.28) than at the old field (7.67±1.12). More males than females were born at the lake bed (42 males, 32 females), while at the old field the division was more nearly equal (22 males, 24 females). A noteworthy record of litter size was obtained at the old field on 13 August 1959 when a litter of 12 was found in a trap. Also on the same day, a litter of 9 was found in a grass nest. These two litters were the largest recorded during the study. The litter of 12 may be a record for cotton rats although Komarek (1937) noted a range of from 1 to 12 embryos in his studies. Meyer and Meyer (1944) recorded litter sizes ranging from 2 to 10 for 44 litters of *S. h. hispidus* born in the laboratory. All of the young in the litter of 12 were alive except for one which had a fatal wound in its head, which may have been inflicted by an adult male cotton rat also in the trap with the mother and her litter.

TABLE 1. COTTON RAT LITTERS BORN IN TRAPS, CAGES, AND ON THE STUDY AREAS

WHITE OAK LAKE BED				OLD FIELD			
Date (Day-Mo.-Yr.)	No. in Litter	♂♂	♀♀	Date (Day-Mo.-Yr.)	No. in Litter	♂♂	♀♀
Born in Traps				Born in Traps			
2 Sept. 57	7	..	..	13 Aug. 59	12	7	5
18 June 58	5	3	2	9 Oct. 59	4	3	1
30 June 58	5	3	2				
13 Aug. 58	6	4	2				
1 April 59	3	1	2				
12 May 59	6	3	3				
25 Sept. 59	5	2	3				
25 Sept. 59	5	5	0				
	42	21	14		16	10	6
Born in Cages				Born in Cage			
14 Sept. 59	4	3	1	12 Oct. 59	6	4	2
5 Oct. 59	5	4	1				
16 Oct. 59	6	3	3				
4 Nov. 59	7	1	6				
	22	11	11		6	4	2
Born on Area				Born on Area			
3 June 59	7	5	2	13 Aug. 59	9	3	6
1 July 59	5	4	1	29 Sept. 59	7	3	4
16 Sept. 59	5	1	4	9 Oct. 59	8	2	6
	17	10	7		24	8	16
Grand Totals	81	42	32		46	22	24
Av. No. in Litter	5.4	3.1	2.3		7.7	3.7	4.0

Injuries and Abnormalities

Notes on external injuries and abnormalities were recorded as mammals were examined. The ears of most of the adult and many of the younger cotton rats were the sites of most injuries. Damage ranged from small notches in the margins of the pinnae to one case where practically all of a pinna was missing. Other injuries are listed in Table 2. The weighted incidence of injuries and abnormalities for the two areas is about the same. It might be argued that some of the items cited are not abnormalities. For instance, in view of the well-known propensity of the tail skin of *Sigmodon* to slip off when the tail is seized, perhaps it is not an abnormal situation for many individuals of a wild population to have parts of their tails missing. The part of the tail exposed when the skin slips off disappears, usually within a few days, and healing may be complete within a month. Predation, fighting, and accidents may result in tail injuries. It is not very likely that any of the injuries were caused by trapping. No "freaks" were noticed among the cotton rats examined, although one individual from the lake bed did have an area of white hairs around its nose.

Nuclear Radiation

Tissues and contents of the gastrointestinal tracts of four cotton rats from the lake bed were scanned with a gamma spectrometer equipped with a flat 3 x 3 in. NaI crystal and a 200-channel analyzer. After scanning was completed, radiochemical analyses were performed for strontium-90. Results of these radioassays indicate that a considerable burden of radioactivity was present in the cotton rats (Table 3). The most abundant radionuclide was strontium-90, followed by ruth-

TABLE 2. INJURIES OR ABNORMALITIES OF COTTON RATS

	Number of Cases		
Condition	Lake Bed*	Old Field**	Comments
Missing, swollen, or twisted toes	19	3	Missing all or part (10), swollen (6), twisted (6).
Part of tail missing	12	8	Losses ranged from missing tip to practically all of tail.
Large cuts or scars	11	2	Located at various places, six cases on head.
Broken or badly swollen leg or foot	3	0	In one case, front leg twisted up and out so that individual walked on "elbow." Rat trapped 3 times (41 days) after condition appeared.
Swollen area around pectoral mammae	2	0	Small areas localized around nipples, swelling disappeared in one case.
Subcutaneous lump anterior to vagina	2	0	Lump known to have disappeared in one case.
Miscellaneous	10	1	Includes "pink urine" (2 cases), "bump" in tail (2 cases), white spots on tongue (1 case), etc.

*Total number of examinations—1153.

**Total number of examinations—199.

TABLE 3. CONCENTRATIONS OF RADIONUCLIDES IN FOUR COTTON RATS FROM THE WHITE OAK LAKE BED STUDY AREA.

Radionuclides	Average Concentration ($\mu\mu c$/g, dry weight)		Average Total Body Burden ($\mu\mu c$)
	Stomach Contents	Whole Animal (excluding contents of GI tract)	
Sr^{90}	132	625	12,000
Ru^{106}	460	62.4	1,130
Cs^{137}	700	57.6	1,070
Co^{60}	320	29.1	531

enium-106, cesium-137, and cobalt-60 in that order. Strontium-90 was the only radionuclide present in greater concentrations in tissues than in food (stomach contents). Strontium-90 is the most biologically dangerous of these radioisotopes because of its long physical and biological half-lives, and because it is a bone seeker. When it is deposited near hematopoetic tissues its densely ionizing beta rays can injure these blood-forming tissues. Gamma rays of the other radionuclides are potentially dangerous because of their ability to penetrate deeply into tissues so that an animal living in an environment contaminated with gamma emitters is irradiated from external sources, from ingested radioactive materials, and from radionuclides deposited in the tissues.

No effects of radiation were detected during the study of the small-mammal populations of the lake bed. Although the study was designed to investigate population dynamics, external examinations were made to determine if radiation effects possibly were manifested. Analyses of population data for cotton rats show that some differences did exist between the populations of White Oak Lake bed and the old field. It is well known that reproduction is a process which seems to be relatively sensitive to radiation (Casarett and Hursh, 1955; Lorenz *et al.*, 1947; Kalmus *et al.*, 1952; Russell *et al.*, 1959; Rugh and Wolff, 1956; Cole *et al.*, 1960; and many others). No males with descended testes were recorded at the White Oak Lake bed during October and November 1959, but males with scrotal testes were present during these months at the old field. No pregnant females were noted during November 1959 at the lake bed, but a gravid female was present during this month at the old field. The average litter size in the lake bed was 5.4 as compared with 7.7 in the old field. More males than females (42 males—32 females) were found in the litters at the lake bed, while at the old field the division was more nearly equal (22 males—24 females). More males than females were trapped at the lake bed. Most of the differences noted were not statistically significant. In addition, the effects produced by the differences in habitat, location, and population densities and structures would be difficult to separate from the effects of radiation.

If possible effects of low-level atomic radiation are to be demonstrated at the population level, a more intensive study of several years' duration will be necessary. Habitat manipulation on controlled areas may be necessary to duplicate the ecology of contaminated study areas. Design of the study should be such that the populations are subjected to a minimum of disturbance. Detecting effects of low-level nuclear radiation will require suitable experimental and control areas, adequate numbers of mammals in the areas, careful handling of the animals, and, above all, selection of appropriate criteria for the detection of radiation effects.

SUMMARY

1. Populations of small mammals were studied on the radioactive White Oak Lake bed after the lake was drained. The lake served for 12 years as a holdup basin for radioactive wastes until it was drained in 1955. Small-mammal populations were also studied on an uncontaminated old field.
2. More species and a greater total number of small mammals were present in later successional stages on the lake bed than in earlier stages.
3. The cotton rat was the dominant small-mammal species on the lake-bed area from the summer of 1957 to the winter of 1959-60. The populations of cotton rats were exterminated on the lake-bed and old-field areas during the severe winter of 1959-60. This species is used as an example for further discussion of population dynamics.
4. Greatest trapping success at the lake bed was in the summers. The number of animals caught on the lake bed in spring was only slightly less than in fall because of immigration during winter and early spring.
5. The average greatest distance between points of capture was 573 ± 216 ft. for males and 236 ± 54 ft. for females in the months from May through October (1957-1959). The average greatest distance from November through April was 276 ± 96 ft. for the males and 175 ± 65 ft. for the females.
6. Only 28 out of 248 rats were captured for over six months at the lake bed and only one was trapped for over a year. About 35 per cent of the 248 rats were apparently transients.
7. Significantly more males than females were caught at the lake bed (178 males to 137 females; $\chi^2 = 5.336$, $P = 0.025$). More females than males were trapped from late spring or summer to

late fall or early winter, while more males were captured during the remaining time.

8. The reproductive season occurred mainly from about April to October.
9. Strontium-90 was the most abundant radioisotope in the tissues and was the only radioisotope present in greater concentrations in the tissues (625 $\mu\mu$c/g, dry wt.) than in the food (132 $\mu\mu$/g, dry wt.).
10. Effects of atomic radiation were not detected in this study.

ACKNOWLEDGMENTS

We wish to express our appreciation to V. I. Dodson and J. A. Payne for their assistance in the field and laboratory during parts of this study. We also wish to thank M. A. Kastenbaum of the Mathematics Panel, Oak Ridge National Laboratory, for his assistance with statistical analyses. Thanks are due to our colleagues, S. I. Auerbach, D. A. Crossley, Jr., D. J. Nelson, and J. S. Olson for their aid and advice during the study and for their criticism of the manuscript. Radioanalyses were made by the Low-Level Radiochemical Laboratory of the Analytical Chemistry Division of Oak Ridge National Laboratory.

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DISCUSSION

MR. PROVOST [University of Georgia]: I would like to ask the speaker if any examinations were performed on the gonads. Did they determine basic effects on reproduction?

MR. DUNAWAY: The only examinations of tissues that were made were some gross examinations for pathologies. Some suspicious tissues were taken but we don't have the results available yet.

MR. CORDING [Wisconsin]: Did you consider the use of dropping boards to follow populations over a large area?

MR. DUNAWAY: I considered this. What I was trying to do was follow each individual every month, all through the year, and I thought that I would have difficulty identifying individuals by the dropping board technique.

DISCUSSION LEADER PRITCHARD: I wondered if you tried to develop anything on the blood indices of the mammals in the lake bed.

MR. DUNAWAY: It is strange that you should ask this. I know it sounds as if this was a put-up job, but you and I actually did not discuss this. We are gearing up to start a fairly large-scale examination of the effects of low-level, chronic radiation on blood.

DR. KARSTAD [Ontario]: Did you make any tissue section studies of the bone marrow, or anything? I wondered if you made any histopathological or chronological studies.

MR. DUNAWAY: We plan to take sections of tissues as part of the routine examinations during the study of blood.

REPTILES AS POSSIBLE RESERVOIR HOSTS FOR EASTERN ENCEPHALITIS VIRUS[1]

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Present knowledge of the epizootiology of eastern encephalitis virus (EEV) does not explain the inter-epizootic survival of the virus within the enzootic areas of the United States. A number of hypotheses have been put forth, among them the following: (1) that virus may be reintroduced into such areas in the spring through the agency of infected birds in northerly migration Kissling *et al.,* (1955); (2) that virus may be maintained throughout the winter by a continuous low-level of viral transmission between wild birds and a mosquito vector, *Culiseta melanura* (Schaeffer *et al.,* 1958); (3) that EEV may be maintained as a quiescent infection within the body of some reservoir host, vertebrate or invertebrate (Kissling *et al.,* 1957). There is no conclusive support for any one of these views. The first would seem to be too much dependent upon chance to account for the regular seasonal activity of EEV among mosquitoes and birds within enzootic areas.

The second hypothesis would require the almost continuous activity of *Culiseta melanura* plus an inexhaustible supply of susceptible birds throughout the winter months in order for the virus to be maintained. It has been suggested that these conditions might be found in rather restricted foci in fresh-water swamps of the Southern States, where there are an abundance of small wild birds and favorable breeding habitat for *Culiseta melanura* (Stamm, 1958). That these conditions could be maintained through an average winter, even in the south, has not been established. Apart from this, the latter hypothesis is totally inadequate to explain the apparent over-wintering of EEV in more northerly areas, such as Wisconsin.

The virus reservoir hypothesis seems to be most tenable in the light of present knowledge. It has been suggested that EEV may over-winter in hibernating mosquitoes. Limited attempts to support this view have been unsuccessful. Chronic or latent infections in wild birds, another suggested means of over-winter survival of the virus, have not been reported with EEV. The fact that additional naturally susceptible hosts of EEV continue to be identified (Karstad and

[1]The studies reported herein were conducted in the Virus Research Laboratory, Georgia Department of Public Health, Waycross, Georgia, under support of a grant from the Institute of Allergy and Infectious Disease, National Institutes of Health, United States Public Health Service.
[2]The technical assistance of Michael Reeves and William Holt in these studies is gratefully appreciated.

Hanson, 1959; Spalatin *et al.*, 1960; Dougherty and Price, 1960) suggests that animals may yet be found which either experience prolonged infections with the virus or which carry it in a quiescent state during hibernation. Antibodies to the virus have been reported in bats (Karstad and Hanson, 1958) and in rodents (Karstad *et al.*, 1960).

The recently reported studies of Thomas *et al.* (1959) and Thomas and Eklund (1960) on experimental infections in garter snakes with the virus of western equine encephalomyelitis suggested the need for an examination of reptiles as possible reservoir hosts of EEV.

MATERIALS AND METHODS

Snakes, turtles, lizards and alligators were collected from April, 1960, to January, 1961, in the general vicinity of the Okefenokee Swamp in Georgia. Some of the poisonous snakes, cottonmouths and rattlesnakes, were killed at capture by decapitation and blood was collected from the severed neck directly into a sterile vial. All other reptiles, except some of the alligators, were taken alive to the laboratory where they were bled by heart puncture with a sterile needle and syringe, wet with a solution of heparin. In a few of the snakes in which cardiac puncture was not possible, due to their small size and great mobility of the heart within the rib cage, blood was collected by cutting off a small portion of the tip of the tail. In these cases blood was either collected directly into a vial or by saturation of small paper discs (Karstad *et al.*, 1957).

Animals were retained alive in the laboratory in metal tanks on a layer of damp peat moss. Because of limited holding facilities it was often impossible to keep them in individual tanks. They were fed their natural foods insofar as possible. Rat snakes were maintained satisfactorily on a diet of white mice; water snakes and hog-nosed snakes fed readilly on frogs and toads; black racers were found to relish small tree frogs. Some of the reptiles, however, refused to eat or drink in captivity.

Blood samples collected from reptiles at the time of capture were tested for the presence of EEV by subcutaneous inoculation of newly-hatched chicks (Chamberlain *et al.*, 1954), and for the presence of EEV-neutralizing antibodies, by inoculation of whole blood or serum mixed with equal quantities of selected dilutions of EEV into chicken embryos by the allantoic route, or subcutaneously into newly-hatched chicks. Whole blood was most frequently used in these tests, preferably undiluted, but in cases of insufficient volume, in dilutions up to 1/10. Serum was tested in cases where it was possible to draw large volumes of blood. Paper disc-adsorbed samples were used to prepare eluates which were then tested as fourfold dilutions of whole blood (Karstad *et al.,* 1957). Heat-inactivation of blood and serum was carried out only in cases where some degree of virus neutralization was observed. In these cases, reacting specimens were heated for 30 minutes at 56°C before they were retested.

Reptiles were experimentally exposed to EEV by subcutaneous inoculation, usually with approximately 100 chicken embryo 50 percent lethal doses of virus (LD_{50}). Blood, taken at intervals of one to four days or longer after inoculation, was tested for viremia and for neutralizing antibodies. Most of the tests on post-inoculation blood samples were conducted by subcutaneous inoculation of newly hatched chicks, four chicks per dilution; occasionally by allantoic inoculation of eight to ten-day chicken embryos, six embryos per dilution. In either case, death of the chick or embryo within three days after inoculation, in the absence of bacterial contamination, was taken as evidence of viral multiplication. EEV recovered from the blood of experimentally inoculated reptiles was identified by neutralization with specific hyper-immune rabbit serum. Samples of blood to be used in tests for viremia and EEV-neutralizing antibody were treated with antibiotics (500 micrograms of dihydrostreptomycin and 5000 units of penicillin) to minimize the growth of bacterial contaminants. The number and frequency of bleedings after EEV-inoculation was arranged to give the necessary information on development and duration of titers of virus and antibody in each individual case.

All of the EEV used in reptile inoculations was in the form of infective allantoic and amniotic fluids from the second to the ninth chicken embryo passages of a strain of EEV isolated in Georgia in October, 1959. This virus was obtained initially by inoculation of chicken embryos with brain tissues from a horse which died with characteristic signs of encephalitis. The isolated virus appeared to be typical in its behavior in laboratory animals and in neutralization by antisera prepared in rabbits against other strains of EEV. This strain of virus, employed in experimental infections, was also used in most of the tests for antibody in reptile blood specimens. On two occasions a strain of EEV isolated from mosquitoes (*Culiseta melanura*) in Georgia in 1960 was used in neutralization tests, giving entirely comparable results.

In several instances animals were observed over a period of time sufficiently long to allow the antibody titer, which arose in response to the first inoculation, to decline to zero. When this was observed a "booster" dose of EEV was given, consisting of 100 to 1000 LD_{50} by the subcutaneous route, after which blood samples were taken at intervals and examined for a second period of viremia or a second appearance of EEV-neutralizing antibody. Occasionally two or more such booster doses of EEV were given and the response noted.

RESULTS

Blood or serum specimens from a total of 99 reptiles collected in the vicinity of the Okefenokee Swamp, Georgia, were examined for neutralizing antibodies to EEV. Seven of these specimens, representing three species of snakes, one turtle and one alligator, were positive in titers of $10^{2.0}$ or greater. These results are summarized in Table 1.

All of these reptiles, with the exception of the alligators, were collected from their natural habitat. Fifteen of the 16 alligators sampled had been kept in open concrete pits in the Okefenokee Swamp Park. All had been collected over the space of several years in the swamp and its environs. They ranged in size from two to more than ten feet in length. The animal which yielded a high titer of EEV-neutralizing antibody was slightly more than six feet long and was thought to have been kept in the park for three or four years.

The sixteenth alligator sampled was collected within the city limits of Waycross, Georgia, several miles from the Okefenokee Swamp but near an artificial drainage canal which empties into the nearby Satilla River.

TABLE 1. RESULTS OF EASTERN ENCEPHALITIS VIRUS (EEV) NEUTRALIZATION TESTS ON SERA OR BLOOD OF REPTILES COLLECTED IN SOUTHERN GEORGIA

Species	Common Name	EEV-Neutralization Test Results[1]
Elaphe guttata	red rat snake	1/5 (2.0)
Elaphe obsoleta	gray rat snake	0/1
Coluber constrictor	black racer	1/5 (2.1)
Natrix sipedon	banded watersnake	0/8
Farancia abacura	mud snake	0/1
Opheodrys aestivus	keeled green snake	0/2
Haldea valeriae	smooth earth snake	0/2
Diadophis punctatus	ring-necked snake	0/1
Drymarchon corias	indigo snake	0/1
Thamnophis sauritus	eastern ribbon snake	0/2
Heterodon platyrhinos	hog-nosed snake (eastern)	0/4
Lampropeltis getulus	king snake (eastern)	0/1
Masticophis flagellum	coachwhip snake	0/1
Crotalus adamanteus	diamond-backed rattlesnake	0/1
Sistrurus miliarius	pygmy rattlesnake	0/2
Ancistrodon piscivorus	cottonmouth moccasin	3/18 (2.0-2.2)
Gopherus polyphemus	gopher tortoise	0/10
Sternotherus carinatus	musk turtle	0/1
Pseudomys scripta	yellow-bellied turtle	0/3
Trionyx ferox	soft-shelled turtle	0/1
Terrapene carolina	box turtle	0/4
Kinosternon subrubrum	mud turtle	1/2 (2.0)
Chrysemys picta	painted turtle	0/1
Malaclemys terrapin	diamond-backed terrapin	0/1
Eumeces spp.	five-lined skink	0/3
Ophisauris attenuatus	legless lizard	0/1
Anolis carolinensis	anole	0/1
Alligator mississippiensis	alligator	1/16 (3.0)
		Total—7/99

[1]Number of animals positive (numerator) over the total number tested (denominator) Log_{10} neutralization indices are given in brackets in positive tests.

Fifty-six animals, representing a total of 21 species, were experimentally exposed to EEV by subcutaneous inoculation. The dose of virus in the first two animals exposed, a ring-necked snake and a skink, consisted of approximately one million chicken embryo LD_{50} units. After the susceptibility of reptiles to EEV was established, smaller doses, consisting of 10 to 1000 LD_{50} units, were given. It was felt that such quantities of virus would more truly measure the susceptibility of the various reptile species to EEV, in doses of virus similar to those which might be encountered in nature.

Signs of illness attributable to infection with EEV were not observed. The possibility that this occurred however, can not be denied, since many of the animals would not eat in captivity and experienced a progressive loss of condition which terminated in death. Minor infections of the skin with bacteria and fungi were a common occurrence. It was impossible to determine what effects, if any, such lesions had on the duration of survival of the animals. The fungus *Geotrichum candidum* was isolated from caseous subcutaneous nodules in one of the banded watersnakes.

Tortoises (*Gopherus polyphemus*) would neither eat nor drink in confinement. As a result, they experienced severe dehydration, marked by an increasingly viscid condition of the blood, which in terminal stages finally reached the consistency of syrup.

All but 12 of these 56 animals gave evidence of infection with EEV, either by development of viremia after inoculation or by the production of antibodies, or both. The highest viremic titers observed were in a ring-necked snake ($10^{10.5}$ chick LD_{50}/ml) and in a gopher tortoise ($10^{10.3}$ chick LD_{50}/ml). Viremic titers of $10^{4.0}$ to $10^{8.0}$ units per ml of blood were commonly observed. Many of the well developed viremias endured for about two weeks before the animals died or produced virus neutralizing antibodies. In such cases the average measured duration of viremia was 12 days and the maximum titers in these 12 animals ranged from $10^{2.0}$ to $10^{10.5}$ LD_{50} units per ml, with an average maximum viremia of $10^{6.2}$ chick LD_{50} units of EEV per ml of blood. The longest observed duration of viremia (38 days) was in the alligator inoculated with 10 LD_{50} units of EEV. In this case the viremia was either interrupted or fell at times to undetectable levels. These results are summarized in Table 2.

An immune response to EEV was noted in 25 of 36 inoculated animals examined. Frequently the detection of antibodies to EEV came subsequent to the development of a demonstrable viremia. However, 11of 25 animals which gave evidence of infection responded to EEV inoculation by the development of measureable titers of virus neutralizing antibody without observed viremia. Measurement of antibody

TABLE 2. DETECTION OF VIREMIA AND VIRUS NEUTRALIZING ANTIBODY IN REPTILES INOCULATED SUBCUTANEOUSLY WITH EASTERN ENCEPHALITIS VIRUS (EEV)

SNAKES

Species	Body Length (in.)	Dose EEV (1)	Examinations for Viremia and Antibody Days Post-inoculation (2)	Highest Viremia (3)	Antibody titers (4) 1st	2nd	3rd	4th
Elaphe guttata #1	47	100	[0] 1, 2, 4, (8) (9) (13) (16) [22] 26, 29, 36, 136, B-139, [143] 147, B-159, 165, [214]	3.7	0.0	3.0	1.5	2.3
Elaphe guttata #2	54	70	[0] [5] 9, 12, 19 [89] B-91 (95) [99] 107, B-109, 117, 167, 229	1.3	0.0	3.2	0.0	0.0
Elaphe guttata #3	24	20	[0] 4 (6) (8) died in induced hibernation	2.5	0.0			
Elaphe guttata #4	60	100	[0] 3, 6, 10 [42]	0.0	0.0	0.0		
Elaphe guttata #5	40	10	[0] 5, 7 [14] [69] [131]	0.0	2.0	0.0	3.3	0.0
Elaphe obsoleta	24	10	[0] 5, 7, 16, 22 [24] [33] B-77 [131]	0.0	0.0	0.0	0.0	0.0
Coluber constrictor #1	23	100	[0] 1, 2 (4) (8) (9) (13) (16) 22, 26, 29, 36 died	5.1	0.0			
Coluber constrictor #2	39	100	[0] 1, 2, 4, 8, 9, 13, 16, 22, 26, 29, 36 [59] 136	0.0	0.0	4.0		
Coluber constrictor #3	59	10	[0] 4, 8, 11, 18 [56] 88	0.0	0.0	1.8		
Coluber constrictor #4	55	10	[0] 3 [11] 80	0.0	2.1	2.0		
Coluber constrictor #5	36	100	[0] 5, 7, 14 died	0.0	0.0			
Natrix sipedon #1	32	200	[0] 2, 4, 7, 10, 14 [17] 22, 24, B-51, 57 [64] 114 [137]	0.0	0.0	0.0	1.5	0.0
Natrix sipedon #2	47	100	[0] 3, 7, 10, 15 [17] B-31 (35) [39] [52]	1.7	0.0	0.0	0.0	0.0
Natrix sipedon #3	49	100	[0] 2, 7, 9, 20 [24] B-31 [37]	0.0	0.0	0.0	2.0	
Natrix sipedon #4	37	100	[0] 2, 7 [9] B-16 (20) [24] 29 [38]	1.7	0.0	0.0	1.2	1.0
Natrix sipedon #5	37	100	[0] 2, 7 [9] B-16 [20] 24, 29, 38 [100]	0.0	0.0	0.0	2.3	3.3+
Natrix sipedon #6	24	100	[0] 5, 8, 11, 15 [20] B-27 [33] [83]	0.0	0.0	1.8	3.0	3.3+
Natrix sipedon #7	36	100	[0] 5 (8) (11) [15]	1.7	0.0	1.5		
Natrix sipedon #8	46	100	0 5 (8) (11) (15) [20] [29] [83]	4.7	1.0	2.6	3.3+	
Farancia abacura	36	10	[0] 4, 8, 11, 18 died	0.0	0.0			
Heterodon platyrhinos #1	33	100	[0] 3, 5, 8 (12) 26, 30, 33	4.3	0.0	2.8		
Heterodon platyrhinos #2	24	10	[0] 4, 8, 11, 18 [60] 113	0.0	0.0	2.0		
Heterodon platyrhinos #3	30	20	[0] 2, 4, 7, 9 died	0.0	0.0			
Heterodon platyrhinos #4	6	100	0 (5) (12) 14, 19, 29 died	5.5				
Heterodon platyrhinos #5	24	1000	[0] 4, 13, died	0.0	0.0			
Heterodon platyrhinos #6	6	10	0 (5) (7) (11) 18, 24 died	5.0				
Opheodrys aestivus #1	27	10	[0] (5) 7, 11 died	3.5	0.0			
Opheodrys aestivus #2	26	10	[0] 5, 7, 11, 24 died	0.0	0.0			
Haldea valeriae #1	8	100	[0] (5) (8) (20) (22) eaten by cage mate	8.0	0.0			
Haldea valeriae #2	11	10	[0] (3) (6) (9) (13) (16) died	5.8	0.0			
Diadophis punctatus	8	10^6	0 (2) (3) (6) (7) died	10.5				
Drymarchon corias	86	100	[0] 4, 8, 12, 15, 21 [39]	0.0	0.0	0.0		
Ancistrodon piscivorus	24	100	[0] 5, 7, 14 [24] 69 B-77 [92] [134]	0.0	0.0	0.0	0.0	0.0

TURTLES

Species	Body Length (in.)	Dose EEV (1)	Examinations for Viremia and Antibody Days Post-inoculation (2)	Highest Viremia	1st	2nd	3rd	4th
Gopherus polyphemus #1	12	10	[0] 3 (11) killed	5.8	0.0			
Gopherus polyphemus #2	10	20	[0] 2, 4, 7, 9, 14, 16, 18, 21 [24] B-24, 28 [31] 36	0.0	0.0	0.0	0.0	0.0
Gopherus polyphemus #3	8	20	[0] (4) (6) (8) died in induced hibernation	5.8	0.0			
Gopherus polyphemus #4	10	100	[0] 3 died in induced hibernation	0.0	0.0			
Gopherus polyphemus #5	10	100	[0] 3, 6, 9, 13, 21, 24, 29 [31]	0.0	0.0	0.0		
Gopherus polyphemus #6	8	100	[0] (4) (7) (12) (14) (19) 21, 26 [36] [50]	6.3	0.0	2.0	3.0	
Gopherus polyphemus #7	8	100	[0] (4) (7) (12) (14) (19) died	10.3	0.0			
Sternotherus carinatus	3	100	[0] 3 (5) 8 (12) [26] 30, 33, 40	3.7	0.0	0.0		
Pseudomys scripta #1	9	100	[0] 3, 5, 8, 12, 26, 30, 33 [40]	0.0	0.0	2.2		
Pseudomys scripta #2	9	100	[0] 3, 5, 8, 12, 26, 30, 33 [40]	0.0	0.0	1.0		
Pseudemys scripta #3	7	10	[0] 5, 7, 18 [24]	0.0	0.0	2.0		
Trionyx ferox	18	70	[0] (5) 9 [12] 19 [20]	3.3	0.0	0.0	0.0	
Terrapene carolina #1	6	70	[0] [5] 9, 12 [19]	0.0	0.0	3.0	2.3	
Terrapene carolina #2	6	10	[0] 3 [11]	0.0	0.0	2.0		
Terrapene carolina #3	6	1000	[0] (4) (8) (13) (15) 21 [26] [41]	6.3	0.0	3.0	4.+	
Terrapene carolina #4	6	10	[0] (5) (7) (11) (18) [24] [33]	5.1	0.0	1.0	4.+	
Kinosternon subrubrum #1	4	10	[0] 5 (7) (11) (18) [24] [33]	2.0	2.0	0.0	2.2	
Kinosternon subrubrum #2	4	10	[0] (5) (7) (11) (18) [24] [33]	7.0	0.0	1.0	2.2	

LIZARDS

Eumeces laticeps #1	8	10^6	[0] (2) (3) (6) 9, 20, 46, 72	6.0	0.0			
Eumeces laticeps #2	6	100	[0] 1, 2 (4) (8) (9) (13) 16 died	5.1	0.0			
Anolis carolinensis	4	100	0, 7, 9 (10) died	3.0				
Ophisaurus attenuatus	12	100	[0] (5) 20 [29]	3.0	0.0	1.5		

ALLIGATOR

Alligator mississippiensis	30	10	[0] 3 (6) 9, 13 (16) 23 (43) [66] [87] [106]	2.3	0.0	0.0	1.0	1.3

(1) The primary dose of EEV inoculated in each case is given in chicken embryo LD_{50} units.

(2) Numbers indicate the days after EEV-inoculation on which blood was drawn for attempted EEV isolation and tests for virus neutralizing antibody. Days on which EEV was recovered are enclosed in round brackets. Square brackets indicate some of the days on which tests for antibody were performed, corresponding to antibody titers given in the table. Numbers prefixed by "B" indicate days on which "booster" doses of EEV (100-1000 LD_{50}) were given.

(3) Viremia is recorded as $\log_{10}$ chick LD_{50} units of EEV per ml whole blood.

(4) Neutralizing antibody titers are recorded as $\log_{10}$ LD_{50} units of EEV neutralized.

in a number of the smaller reptiles was not attempted when it was found that the quantities of blood obtainable were insufficient. In other cases examination for antibody was prevented when death supervened. Three of the reptiles inoculated with EEV were found to have had significant levels of virus neutralizing antibody prior to inoculation (see Table 2; *Elaphe guttata* #5, *Coluber constrictor* #4, *Kinosternon subrubrum* #1). Two of these, the rat snake and the turtle, appeared to lose their titers within 24 days after subcutaneous inoculation of 10 chicken embryo LD_{50} units of EEV. The turtle, *Kinosternon subrubrum,* experienced viremia between days 7 and 18 post-inoculation with a maximum titer of $10^{2.0}$ chick LD_{50} units of virus per ml of blood. It may be noted that a second turtle of the species inoculated at the same time with the same dose of virus, but which did not posses an antibody titer prior to inoculation, developed viremia of much higher titer ($10^{7.0}$ LD_{50}). This viremia appeared two days earlier and lasted two days longer than did the viremia in the turtle which possessed antibody before inoculation. Neutralizing antibody titers in the two turtles were found to be of equal magnitude (2.2) when measured on the 33rd day after inoculation.

A rat snake (*Elaphe guttata* #2) and a box turtle (*Terrapene carolina* #1) evidenced what appeared to be an "anamnestic-type" response to EEV inoculation. Their antibody titers were observed to rise very quickly from zero on the day of inoculation to 3.2 and 3.0 respectively, on the fifth day post-inoculation. Viremia was not observed during this time. The antibody titer in the snake was observed to fall again to reach an undetectable level on the 89th day after inoculation. On day 91 post-inoculation the snake was given a "booster" dose of EEV, consisting of approximately 1000 LD_{50} units. On the fourth day following this second inoculation the animal experienced a low level of viremia ($10^{1.3}$ LD_{50} units/ml) but no detectable antibody production. On the 109th day after the first inoculation of virus, a second booster dose of 1000 LD_{50} units of EEV was administered, again by subcutaneous inoculation. Eight days later there was still no measurable antibody. However, at 50 and 112 days later, on the 167th and 229th days after the first experimental inoculation of virus, antibody titers of $10^{2.0}$ and $10^{2.5}$ were recorded. These data are sumarized in Figure 1.

Many of the snakes were found, at the time of capture, to be heavily parasitized by small red mites attached between their scales. Collection of these parasites for identification and attempted viral isolation was not attempted at once. In is unfortunate that when the snakes

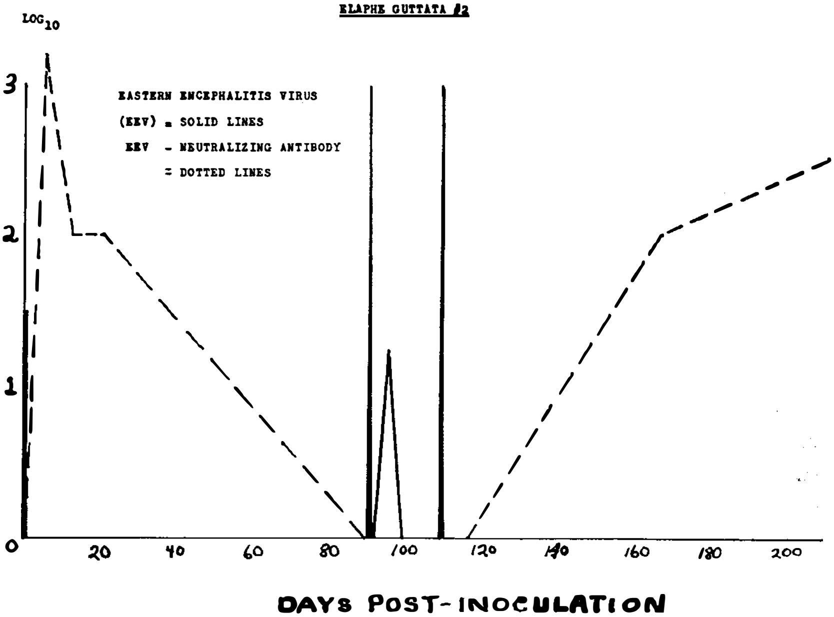

Figure 1. Response of red rat snake (*Elaphe guttata* #2) to eastern encephalitis virus (EEV) inoculated subcutaneously on days 0, 91 and 109. Doses of virus (vertical lines), levels of viremia (solid line) and levels of EEV neutralizing antibody are given in $\log_{10}$ LD_{50} units, graduated on the ordinate.

were examined after being held in the laboratory for varied lengths of time the mites were no longer present.

All of the gopher tortoises collected were parasitized by ticks, tentatively identified as *Amblyomma tuberculatum.* On several occasions these were removed from recently captured animals and examined for the presence of viral agents lethal to chicken embryos or newly hatched chicks, all without success.

Two partly engorged female ticks, removed from *Gopherus polyphemus* #3 eight days after the animal was inoculated with EEV, titrated $10^{4.3}$ LD_{50} of EEV when triturated in two mililitres of diluent. At the time of removal the animal had a viremic titer of $10^{5.8}$ LD_{50}.

Gopherus polyphemus #7 was found dead on the 20th day after viral inoculation. Two male ticks removed at this time titrated $10^{4.0}$ LD_{50} when triturated in 2 ml of diluent. A blood sample taken from this animal on the day before death titrated approximately $10^{8.0}$ chick LD_{50} units of EEV and seven days earlier a peak viremic titer of $10^{10.3}$ chick LD_{50} had been measured.

Attempts were made to recover EEV from the tissues of many of the inoculated reptiles which died in captivity. Virus was recovered in approximately equal titers from the blood, brain, and visceral organs (heart, lung, liver) of those animals which died during the period of viremia. All other attempts to isolate EEV from body tissues were negative.

On several occasions attempts were made to isolate EEV from eggs laid by experimentally inoculated snakes (hog-nosed snakes and rat snakes) and from the new borne young of EEV-inoculated water snakes, all without success. Three young snakes were hatched in the laboratory from eggs laid by an inoculated hog-nosed snake. Attempts to recover EEV from two of these young snakes which died during the first week of life also failed.

DISCUSSION AND CONCLUSIONS

The area from which reptiles were collected is situated in the lower Coastal Plain of Georgia. Studies involving birds, mammals, and arthropods in this region in several successive years have established its enzootic status with respect to eastern encephalitis. In the present studies evidence of natural EEV infections in reptiles was obtained in the form of EEV-neutralizing antibodies found in approximately seven percent (7 of 99) of the reptiles tested. These findings were not restricted to any single reptile group, antibodies being found in 1 of 5 red rat snakes, 1 of 5 black racers, 3 of 18 cottonmouth moccasins, 1 of 2 turtles and 1 of 16 alligators (see Table 1).

Blood samples which neutralized EEV when first tested were retested after heating for 30 minutes at 56° C. Titers obtained were approximately the same, thereby ruling out the possibility that the observed virus neutralization was merely the result of some non-specific heat-labile substance. A second blood sample, drawn a month after the first, from the alligator which possessed a high titer ($10^{3.0}$) of EEV-neutralizing antibody, neutralized in excess of $10^{3.7}$ LD_{50} units of EEV.

The time of viral exposure of this alligator is open to speculation. Park attendants stated that animals in the six-foot-size range had been collected in the swamp a matter of years previously. This being the case, the observed high titer of EEV-neutralizing antibody at the time of sampling (January, 1961) would either be resultant from EEV exposure some two or more years previously, or the result of exposure to the virus while in captivity. Alligators in the pits were fed a diet composed largely of fresh or frozen fish. It is perhaps possible that EEV was brought to the animal in some item of diet. An alternative, and perhaps more logical hypothesis is that virus was introduced by the bite of some arthropod vector, since the pits are open year around and they are situated within a few yards of the swamp proper, suitable breeding habitat for several potential vectors of EEV (Favorite and Davis, 1958). Repeated bleedings of reptiles in such situations, in addition to arthropod studies, might perhaps provide valuable information on the mode of transmission of EEV to reptilian species.

The possibility of very prolonged EEV infections in alligators must also be borne in mind, since an alligator inoculated subcutaneously with 10 chicken embryo LD_{50} units of EEV was observed to circulate EEV intermittently over a 38-day period of time and to have produced no antibody up to 66 days after inoculation (see Table II). However, this animal possessed EEV-neutralizing antibody titers of $10^{1.0}$ and $10^{1.3}$ at 87 and 106 days post-inoculation, respectively.

Four experimentally inoculated animals (two snakes and two tortoises) were placed in a mechanical refrigerator maintained at 4°C. in an attempt to determine the effects which hibernation might have on the course of EEV infections in reptiles. When returned to room temperature after several weeks, both snakes were found dead and the tortoises died without regaining consciousness. Perhaps the temperature changes were too abrupt, or the temperature selected was too low for successful hibernation. The results obtained by Thomas and Eklund (1960) using garter snakes inoculated before hibernation with western equine encephalomyelitis, suggest that hibernation favored longer survival of the virus, either by prolonging the period of active infection or by delaying its inception. If EEV infection in reptiles is similarly modified by hibernation, it is theoretically possible that individual animals could carry the virus through the winter, providing a source of highly infective blood for arthropod transmission at the onset of warm weather.

It is of interest that the titers of viremia in experimentally infected reptiles ($10^{10.5}$ LD_{50}, maximum) were found to be as high or higher than those obtained in EEV-infected wild birds (Kissling *et al,* 1954) and of longer duration. Reptiles, therefore, may circulate as much EEV during experimental infection as any other wild animal thus far studied. It remains to be determined whether similar levels of circulating virus occur in reptiles which may become infected in nature.

Not all animals which experienced viremia after experimental inoculation developed antibodies during the period of observation. Usually EEV-neutralizing antibody appeared at the end of the viremic phase, but in three cases (*Natrix sipedon #2; Sternotherus carinatus; Trionyx ferox*) levels of viremia of $10^{1.7}$, $10^{3.7}$ and $10^{3.3}$ LD_{50}/ml were measured without the appearance of antibody during the subsequent observation periods of 21, 14 and 15 days, respectively.

In the experimentally inoculated alligator, 44 days elapsed from the end of the viremic phase before antibody could be detected.

Antibody titers in some of the reptiles appeared to be temporarily depressed after subcutaneous inoculation of EEV (Table 2). Fourteen days after inoculation, blood from the red rat snake (*Elaphe guttata* #5), which had a pre-inoculation antibody titer of $10^{2.0}$, failed to neutralize appreciable quantities of EEV. This temporary suppression of antibody formation was followed, however, by a high antibody titer ($10^{3.3}$) at 69 days post-inoculation, which declined once more to an undetectable level by the 131st day after inoculation.

The turtle, *Kinosternon subrubrum* #1, developed a viremia of low magnitude after EEV inoculation although possessing a $10^{2.0}$ titer of neutralizing antibody at the time of exposure. At 24 days post-inoculation a blood test revealed no measurable antibody; however, at 33 days post-inoculation an antibody titer of $10^{2.2}$ was again observed. It is of interest that a second turtle (*K. subrubrum* #2) which was without antibody at the time of exposure developed viremia more promptly and of higher titer.

Anamnestic antibody response may occur when an animal encounters a small quantity of an antigen to which it has been exposed previously. The antibody produced in response to this repeated dose of antigen appears much more quickly and it is produced in greater amounts than that which was produced in response to the initial exposure. Three logs or more ($10^{3.0}$ or more) of neutralizing antibody appearing within five days of virus inoculation would seem to be an immune response greater than could be expected to first exposure to the virus. Thus, it may be suggested, that the snake (*Elaphe guttata* #2) and the turtle (*Terrapene carolina* #1) which responded so actively to first inoculation of EEV in the laboratory, probably had prior experience with this virus in nature and that at the time of capture any previously held antibody titer had fallen to an undetectable level.

The data obtained in these experiments are the result of an attempt to examine the susceptibility of as many reptile species as possible to infection by peripherally inoculated EEV. This approach prevented detailed studies with any one species. The finding that 3 of 18 cottonmouth moccasins collected possessed EEV-neutralizing antibody at the time of capture, plus the fact that these snakes are numerous in fresh-water swamps which seem to be enzootic foci for EEV, makes it important that they be given further consideration as possible reservoir hosts for the virus.

It is unfortunate that only one snake of this species (*Ancistrodon piscivorus*) was experimentally inoculated with the virus and that this particular individual appeared to be refractory to infection. In the present state of our knowledge of the immune responses of snakes, no adequate explanation for this apparent refractiveness can be given. It is possible that the animal was in a state of unresponsiveness, having been infected earlier and having subsequently suffered repeated exposures to EEV. A suggestion that this may occur was obtained by observing the antibody responses to repeated booster doses of EEV in a red rat snake (*Elaphe guttata* #2, Table 2). In this case two booster doses (1000 LD_{50}) of EEV given 18 days apart, after the first-observed antibody titer had declined to zero, failed to produce the expected prompt rise in antibody titer. On the contrary, the only response to the first booster dose of EEV was a transient low-level viremia and antibody was not detected during the space of 28 days. It is a curious fact that the first response of this snake to experimentally inoculated EEV was a prompt anamnestic-like rise in antibody to a titer of $10^{3.2}$ within 5 days after inoculation. These observations have been summarized in the form of a graph (Figure 1).

It is of considerable interest that titers of EEV-neutralizing antibody were seen to decline more rapidly in the reptiles studied than has been observed in experimentally infected birds and mammals. It is, therefore, at least theoretically possible for reptiles to be repeatedly infected at suitable intervals, perhaps annually, with the development of a succession of viremic periods. The appearance of viremia in the red rat snake (*Elaphe guttata* #2), exposed to repeated doses of EEV in the laboratory, lends support to this idea. Also, the short duration of neutralizing antibody titers in reptiles suggests that the percentage of "immunes" found by means of a serological survey may not give a good indication of the percentage of the population which has previously been exposed to EEV. For example, it is perhaps unsafe to assume that an antibody rate of only 7 percent in reptiles in the vicinity of the Okefenokee Swamp, as compared with an immunity rate of 60 to 80 percent in the crow population of the area, means that crows have a tenfold higher rate of exposure to EEV. A rather weak antibody response to an agent should contribute to its longer survival within the body of a reservoir host.

Little is known about the species of hematophagous diptera which may feed upon reptiles in the southeastern United States. Thomas and Eklund (1959,1960) found that *Culex tarsalis,* a recognized vector of western equine encephalitis virus, would feed upon garter snakes in the laboratory and succeeded in setting up a cycle of transmission with the virus in snakes and chicks, through the agency of *Culex tarsalis.*

The isolation of EEV from ticks, tentatively identified as *Amblyomma tuberculatum,* which were collected from experimentally infected tortoises, suggests a need to further examine these ectoparasites as possible vectors of the virus. In the present circumstances, however, the virus present in the ticks probably represents only ingested virus, since both of the tortoises involved had experienced high levels of viremia before the ticks were removed. It should be interesting to determine whether or not EEV can multiply within these ticks and to measure the ability of *A. tuberculatum* to act as a vector of the virus. In addition to the gopher tortoise, this tick has reportedly been collected from birds, dogs, rabbits, cattle, a pocket gopher and a lizard (Cooley and Kohls, 1944).

In view of the data presented, it seems possible to draw the following conclusions:

(1) Individuals of all major reptile groups (turtles, snakes, lizards, alligators) were found susceptile to moderate doses of EEV by subcutaneous inoculation.

(2) Antibodies to EEV were found in reptiles collected in nature. This may be taken as evidence of natural infection with EEV.

(3) An anamnestic-type response, observed in a snake and in a turtle upon first exposure to EEV in the laboratory, may be taken to suggest prior experience of these animals with the virus in nature.

(4) Reptiles may circulate EEV in greater quantity than previously reported in wild animals.

(5) The recognized role of arthropod vectors of EEV in transmission of the virus among birds and mammals suggests a need for host preference studies employing reptiles and potential arthropod vectors of EEV. Such studies should include reptile ectoparasites as well as hematophagous diptera.

(6) Establishment of the role of reptiles as reservoir hosts of EEV must await repeated isolations of the virus from reptiles infected in nature, as well as demonstration of a suitable mechanism of virus transmission from infected reptiles into an epizootic cycle involving birds and mammals.

SUMMARY

Blood samples obtained from reptiles collected in the vicinity of the Okefenokee Swamp in Georgia were examined for the presence of eastern encephalities virus (EEV) and virus neutralizing antibody. Seven of the 99 animals collected (five snakes, one turtle and one alligator) were found to posses significant titers of EEV-neutralizing antibody at the time of capture. Virus was not isolated. Fifty-six reptiles were experimentally exposed to EEV by subcutaneous inocu-

lation, employing doses of virus which might feasibly approximate amounts which could be encountered in nature. Individuals of all four reptile groups (snakes, lizards, alligators and turtles) responded to inoculation with the production of high titers of viremia, or of circulating antibody, or both. Titers of viremia as high as $10^{10.5}$ chick LD_{50} units of EEV per ml of blood were observed. The average duration of viremia was 12 days. Forty-two days was the longest viremia recorded, in which case the circulation of virus appeared to be intermittent. Two reptiles, without demonstrable antibody at the time of capture, evidenced what appeared to be an anamnestic-type response to inoculated EEV. Two other animals, carrying moderate levels of antibody when captured, appeared to experience a temporary depression of antibody titer after subcutaneous inoculation with EEV. It is concluded that a full appreciation of the role of reptiles as reservoir hosts for EEV must depend upon the possible future isolation of virus from reptiles infected in nature and the demonstration of an adequate mechanism for transmission of virus from infected reptiles to susceptible birds and mammals.

ACKNOWLEDGEMENTS

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DISCUSSION

QUESTON: What about amphibia? Has anything been done on this?

DOCTOR KARSTAD: Not to my knowledge. I did inoculate two or three leopard frogs with eastern encephalitis virus but I didn't recover it: The survival of our frogs was very poor. We were bothered by a plague which frogs get when kept in captivity. My answer is no. I know of no work being done along this line at present.

MR. GORDON CLARK [Fish and Wildlife Service]: Can you tell me the species of snakes that had positive antibodies?

DOCTOR KARSTAD: Yes. In the corn snake or red rat snake, one out of five taken appeared to carry antibodies. In black racers, one out of five; cottonmouth moccasins, three out of eighteen. We had only one cottonmouth in our series of experimentally infected animals. Unfortunately this animal didn't respond on any way to virus or antibody inoculation, but in some of our other experiments, snakes subjected to repeated doses of virus seemed to get into a state of unresponsiveness. Then after a period they would no longer react to inoculation of virus.

This snake was selected from an area where he certainly should have had every opportunity to be exposed to the virus. Perhaps he had been exposed so often that he didn't respond.

MR. SAMPSON [Illinois]: Do you have any information on how long the antibodies persisted in any individual—either experimentally or naturally, and the body levels?

DOCTOR KARSTAD: The antibody in snakes and other reptiles would grow very rapidly to a high level—between two and three logs—and then quite rapidly drop to an undetectable level in approximately ninety days. This was fairly typical. Various neutralizing antibodies are very durable and long-lived in most vertebrates. In mammals and birds the neutralizing antibodies to this viruse can exist for years or perhaps for life, after infection.

Here we have a situation where an animal loses its antibody fairly quickly, and in fact, in one case I was able to get a viremic phase occurring after the high level of the antibody had dropped off and reached an undeterminable level. Perhaps this is very important. Perhaps we can have recurrent infections if the antibodies can drop off during the winter time.

DOCTOR HERMAN [Fish and Wildlife Service]: Could you make a few comments in comparison with similar work in the bird species?

DOCTOR KARSTAD: Yes. In bird species, and many species of birds have not been studied with respect to this virus, the natural infections or experimentally induced infections in laboratories are usually short lived. Usually two, three or four days is the maximum length of the viremia, that may be of quite high level. After this period, the birds experience a prompt immune response and develop high levels of virus neutralizing antibodies. They carried them for the duration of our observation, and perhaps for life.

This situation is different in the reptiles I studied. I have tried to include all reptile groups native to this area under study. Therefore I have not been able to study any one species intensively. We found, in general, that viremia would reach a high level and persist for roughly two weeks, in most cases, and then a neutralizing antibody was usually observed following this, but not always. This neutralizing antibody would drop off very rapidly, perhaps allowing for repeated infections.

MR. GORDON CLARK [Fish and Wildlife Service]: I am interested in the bleeding of snakes. How much blood did you take from an average snake, and how do you do this?

DOCTOR KARSTAD: I was able to bleed some snakes as small as a lead pencil by heart puncture, ring-necks, for example, using a very small needle and glass syringe. From such a small snake I might draw one tenth of a milliliter of blood and work on a one to ten dilution.

From a larger snake, you can take up to two, three, or four cc's of blood; from the average size corn snake or rat snake I would draw routinely one ml.

DISCUSSION LEADER PRITCHARD: Did you examine these reptiles for other viruses, or other serums or antibodies to other viruses?

DOCTOR KARSTAD: Not specifically. However, in most of these studies, different viral agents would produce signs of illness or death in a chicken embryo or the newly-hatched chicks that were used for these studies. We should have been able to detect eastern encephalitis virus, western encephalitis virus, and several others. We did not make any virus isolations.

CHAIRMAN HAYES: Perhaps you have already stated this. Did the viremia occur before the antibody at any time? I noticed you said the antibody response dropped off frequently long after, or quite a bit before the viremia disappeared.

DOCTOR KARSTAD: That is not what I intended to say. We never did detect the virus and the antibody at the same time.

The usual pattern of events was that about four days to a week after inoculation of virus, a viremia would develop which might persist for about two weeks, after which time when the viremia was no longer detectable, virus neutralizing antibody would appear and rise from an undetectable level to two to three logs of virus antibody.

THE CURRENT STATUS OF BRUCELLOSIS IN WHITE-TAILED AND MULE DEER IN THE UNITED STATES

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Brucellosis is a contagious disease primarily of cattle, swine, and goats, and to lesser extent, other animals including man. It is regarded as one of the most widespread and contagious diseases of cattle in the United States. The U. S. Department of Agriculture makes a conservative estimate of about 100 million dollars as the annual loss to livestock people caused by brucellosis. Approximately 90 milion dollars of this is loss to the cattle industry through reduced milk production and loss of calves. The remaining 10-million-dollar loss is estimated for the swine industry. Brucellosis occurs also in goats in some of the southwest and Rocky Mountain states but no figure is given for loss to this relatively minor industry.

Human beings may contract brucellosis by consuming milk or milk products or handling meat from animals infected with the diseases. The disease may also be contracted by persons working with infected animals. Brucellosis in man, popularly known as undulant fever, frequently develops into a serious and long-lasting illness (Smith, *et al.*, 1949). Because of the economic loss and public health hazard that result from brucellosis, the United States Department of Agriculture, in cooperation with state departments of agriculture, is engaged in an active nationwide program to eradicate the disease in cattle. An essential part of the brucellosis eradication program involves periodic testing of herds and removal for slaughter of infected cattle until all animal reservoirs of the disease are eliminated, and the country becomes brucellosis-free (Manthei, *et al.*, 1956). This goal has been reached in New Hampshire and parts of several other states and is near in more than half of the United States (Fig. 1). Complete eradication of brucellosis depends largely on locating and eliminating all disseminators of the disease. This raises the question, "Are wild animals infected with brucellosis and capable of spreading it among cattle?" For example, in Michigan where brucellosis in cattle has been reduced until only 1 animal in 500 is infected (Mich. Dept. Agr., 1961), there occur occasional sporadic outbreaks in herds for which the source of infection is not apparent. These sporadic outbreaks lead disease workers and liverstock people to suspect that some animal reservoir of the disease other than cattle may exist. Deer, being conspicuos free-ranging ruminants frequenting livestock pasturing areas, are one of the prime suspects.

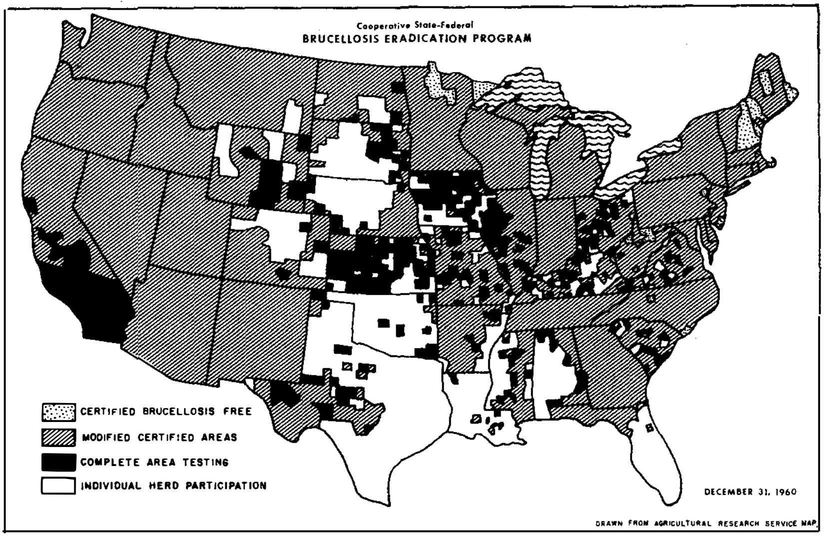

Figure 1. Progress of brucellosis eradication from Agricultural Research Service, U. S. D. A. Key: Certified brucellosis free—no known cases of brucelolsis in cattle. Modified certified areas—less than 1% of the cattle and 5% of the herds infected. Complete area testing—status not yet determined, or rate of infection exceeds 1% of the cattle and 5% of the herds. Individual herd participation—status not yet determined.

Brucellosis was reported by Rush (1932) in buffalo and elk of the western United States as early as 1931. Fenstermacher, *et al.* (1943) reported from Minnesota that brucellosis was absent in six white-tailed deer tested. Whitlock (1949) found no positive reactors for brucellosis among deer from different parts of Michigan. Bolin, *et al.* (1949, 1951) in North Dakota concluded that deer are not disseminators of brucellosis among livestock in that state. In spite of these early investigations, the status of brucellosis in deer was largely undetermined prior to the middle 1950's. Manthei, *et al.* (1956) state in the Yearbook of Agriculture, entitled *Animal Diseases,* "There is also serological evidence that deer have brucellosis." Severinghaus and Cheatum (1956) state in the book, *Deer of North America,* ". . . deer also are known to be suspectible. . . ." These statements are true, but without further amplification they put the deer in an unfavorable light. In the last few years, many states have been particularly active in testing deer for brucellosis. Some of the findings have appeared in print; it may be assumed that some have not. It is my intent in this paper to review the published information, together with as many unpublished records as I was able to obtain from the various states, and appraise the general significance of brucellosis in deer.

The response to my letters to the conservation departments of various states asking for information on deer was splendid. I wish to express here my appreciation for the fine and generous help given me.

THE NATURE OF THE DISEASE

Brucellosis is a bacterial disease caused by the genus *Brucella.* Three species of *Brucella* are recognized: (1) *Br. abortus* which most commonly affects cattle, (2) *Br. suis* which is most common in swine, and (3) *Br. melitensis* which is most common in goats. Brucellosis in cattle is known also as Bang's disease or contagious abortion.

Species of *Brucella* may occur in other than the normal host, as for example, *Br. suis* may occur in cattle, but the disease in these instances is less marked and appears to be self-limiting. *Br. abortus* of cattle is the disease of primary concern to wildlife people, and discussion in this paper will be limited to it except for appropriate remarks concerning the other species.

Infection with brucellosis is believed to take place mainly through the alimentary tract. Cattle expel myriads of virulent *Brucella* in aborted fetuses, placental membranes, placental fluids, and the vaginal discharges that persist for some time after calving. Cattle may contract brucellosis from licking these materials, or eating grass or drinking water contaminated with them (Manthei, *et al.,* 1956). Conceivably, deer could disseminate *Brucella* to cattle by contaminating pastures and water with aborted fetuses and infected placental fluids and membranes. I have received reports (none of them first-hand, incidentally) of aborted deer fetuses found in pasture fields. The implication in these instances was that aborting deer were endangering cattle with brucellosis.

TESTS FOR BRUCELLOSIS

A reliable and time-proven practical method for diagnosing brucellosis in farm animals is the plate seroagglutination test (Manthei, *et al.,* 1956). The test is made on serum extracted from a sample of blood taken from an animal. I will not discuss the mechanics and procedures involved in the test because they may be found in any laboratory procedure manual. I want merely to point out that it is reasonable to expect the standard test for brucellosis to be applicable and accurate for deer. Youatt and Fay (1959) demonstrated that white-tailed deer will develop a high antibody titer to brucellosis and react to the seroagglutination test in a manner that is typical of cattle. Consequently, I have full confidence in the reliability of the test that is standard for cattle as a test of deer blood.

Although in the brucellosis eradication program cattle are tested specifically for *Brucella abortus,* the same test will also detect *Br. suis* and *Br. melitensis* (Manthei, *et al.,* 1956). To the best of my knowledge all deer reported in this paper were tested for *Br. abortus;* however, it is reasonable to assume that the other *Brucella* species would have been revealed if they were present.

RESULTS OF SURVEY

Deer have been tested for brucellosis in at least 32 states. Figure 2 and Table 1 show the distribution of deer tested and the number of reactors in each state for which I obtained records. All the deer tested in North Dakota and states to the south and east, with the exception of those from Nebraska, were white-tailed deer (*Odocoileus virginianus*). In Nebraska and the states to the south and west, the deer were predominantly mule deer (*Odocoileus hemionus*). There is overlapping in this part of the country of the range of the whitetail and the mule deer. Where it was not posible to ascertain from records how many of each kind were tested, the deer were grouped as undesignated. Table 1 also shows the serologic titers. Specific serum dilutions are shown wherever the information was available. Some states reported only the number of reactors.

Of 12,706 white-tailed deer tested in 24 states, 20 or 0.16 per cent are considered reactors or, in a general sense, infected. Of 1,046 mule deer in four states, none were reactors. Of 2,989 undesignated deer (mule and white-tailed) in five states, none were reactors. The percentage of reactors among white-tailed deer in individual states ranged from none in 14 states to 0.3-0.6 per cent in Louisiana, Alabama, Florida, and Virginia. Obviously there are too few records from some of the states to support a conclusion concerning those individual states. I do believe, however, it is significant that brucellosis is non-existent or rare in all of them. The highest incidence of reactors among deer occur in states of the Southeast. It may be significant that these same states have lagged behind in the brucellosis eradication program (Figs. 1 and 2).

DISCUSSION

If we apply the same interpretation that is used for cattle in the brucellosis eradication program, a serum antibody titer of 1:25 is not proof of infection, a titer of 1:50 places the deer in a suspicious category, and a titer of 1:100 is accepted as proof that the deer has brucellosis and is therefore a potential carrier of the disease. This interpretation for deer is based largely on assumption rather than experimental evidence.

The work of Youatt and Fay (1959), in experimentally inducing brucellosis in 2 adult male white-tailed deer, showed that deer will

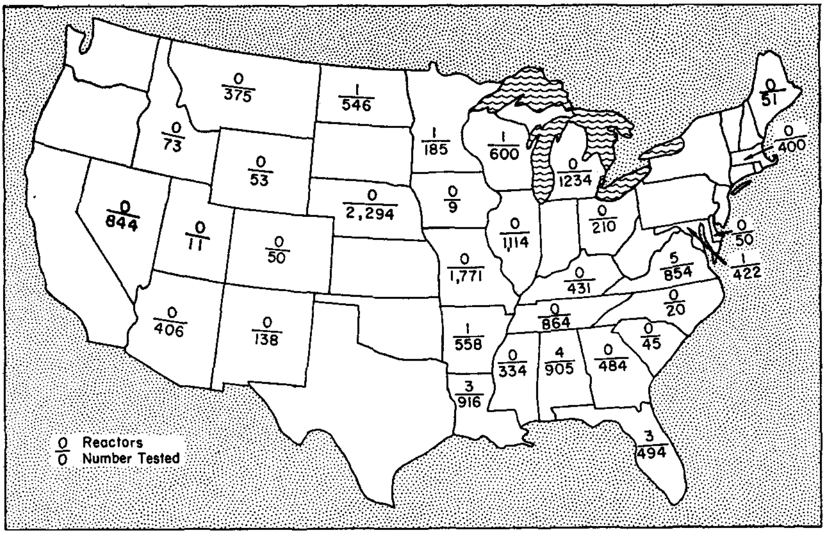

Figure 2. Results of the survey of brucellosis in deer of the United States.

develop and maintain an antibody titer well beyond the suspicious category. The level still remained high at the end of one year when the experiment was terminated. Baker, *et al.* (1961), who artificially infected two adult female white-tailed deer, observed that both deer developed a "reactor" condition soon after inoculation. One persisted as a reactor during nearly the entire 17½ months of the experiment. The titer of the other doe dropped to the suspicious category approximately 6 months after infection.

It is possible that the variation in titers observed by the two groups of workers is connected with a difference in the virulence or the numbers of viable organisms inoculated into the deer. Such variations in experimental findings can be resolved only through studies involving larger numbers of deer.

Serum antibody titers of 1:25 and even 1:50 are frequently due to interfering substances that react to the test similarly to brucellosis. Bailey (1961) reported that a deer blood sample showing a 1:25 titer for brucellosis was found to have a high antibody titer to tularemia when tested for this disease. I am not implying that all low titers are cross reactions with the tularemia organism, but this is an example of an interfering substance.

The apparent absence of brucellosis in the deer of the southwestern and Rocky Mountain states might be interpreted to mean that mule deer are more resistant to infection with the disease. A better ex-

TABLE I. RESULTS OF BLOOD TESTS FOR BRUCELLOSIS IN DEER IN THE UNITED STATES

	Number of Deer Tested				*Serologic Titers*						
State	*White-tailed*	*Mule*	*Undesig-nated*	*Total*	*1:25 (non-specific)*	*1:50 (suspects)*	*1:100 (reactors)*	*1:200 (reactors)*	*1:400 (reactors)*	*Reactors (titers not given*	*Reference*
Alabama	905			905	5	2	2	1	1		Hayes, *et al.*, 1960
Arizona	209		197	406		0	0	0	0		Woolsey, 1961
Arkansas	558			558	1	1	1	0	0		Hayes, *et al.*, 1960
Colorado			50	50						0	Davis, 1961
Delaware	50			50						0	Shotts, *et al.*, 1958
Florida	494			494	2	1	1	1	1		Hayes, *et al.*, 1960
Georgia	484			484	2	1	0	0	0		Hayes, *et al.*, 1960
Idaho			73	73						0	Shaw, 1961
Illinois	1,114			1,114	1	1	0	0	0		Ferris, 1961
Iowa	9			9						0	Haugen, 1961
Kentucky	431			431	0	0	0	0	0		Hayes, *et al.*, 1960
Louisiana	916			916	4	3	1	1	1	0	Hayes, *et al.*, 1960
Maine	51			51						0	Witter, 1961
Maryland	422			422	3	3	1	0	0		Hayes, *et al.*, 1960
Massa-chusetts	400			400						0	Reynolds and Smith, 1958
Michigan	1,234			1,234	0	0	0	0	0		Fay and Youatt, 1959
Minnesota	185			185			1	0	0		Fenstermacher, *et al.*, 1943 Wedman and Driver, 1957
Missis-sippi	334			334	1	0	0	0	0		Hayes, *et al.*, 1960
Missouri	1,771			1,771	2	0	0	0	0		Wildl. Dis. Assoc., 1959
Montana			375	375		0	0	0	0		Newby, 1961
Nebraska			2,294	2,294	0	2	0	0	0		Bailey and Cuming, 1960
Nevada		844		844						0	Greenley, 1961
New Mexico		138		138						0	Lee, 1961
North Carolina	20			20						0	Critcher, 1961
North Dakota	546			546						1	Bolin, *et al.*, 1949, 1951
Ohio	210			210						0	Steen, *et al.*, 1955
South Carolina	45			45	1	1	0	0	0	0	Hayes, *et al.*, 1960
Tennessee	864			864	1	1	0	0	0		Hayes, *et al.*, 1960
Utah		11		11						0	Low, 1961
Virginia	854			854	3	2	2	2	1		Hayes, *et al.*, 1960
Wisconsin	600			600	0	0	1	0	0		Trainer and Hanson, 1960
Wyoming		53		53							Hepworth, 1961
	12,706	1,046	2,989	16,741	26*	18*	10	5	4	1	

planation, I believe, lies in the greater dispersal of cattle on the open range with little or no opportunity for transmission among cattle, or between cattle and deer or vice versa.

The usual mode by which cattle contract brucellosis is by ingesting *Brucella* organisms from an infected cow that has recently aborted or calved. Transmission is favored by the close confinment of dairy herds. Deer are relatively solitary in their habits, especially at the time of fawning. That a doe is inclined to hide her fawn is well known. It seems likely that cattle would come across a fawn largely by chance. Futhermore, while deer are known to be susceptible to brucellosis, *very few* have been found infected with the disease.

SUMMARY

From the data presented in this paper, I believe we are justified in concluding that brucellosis is a comparatively rare disease in deer of the United States, and that it is an unimportant disease from the standpoint of the health of the deer or deer as a reservoir of infection to livestock.

Nearly 17,000 white-tailed and mule deer in the United States have been tested for brucellosis. Of these, only 20 white-tailed deer would be considered infected if the results of the tests are interpreted in the same manner as for cattle. The percentage of reactors among white-tailed deer in individual states ranged from none in 14 states to approximately 0.6 per cent in two states. The highest incidence of reactors occurs in states that have been less active in the brucellosis eradication program in cattle.

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DISCUSSION

CHAIRMAN HAYES: Doctor Fay, thank you. As I am sure many of you are aware, this is a very timely subject relative to deer management and the possible relationships that it might have with the livestock industry and the national eradication program.

MR. GRACE [Fish and Wildlife Service]: Is this program in connection with Doctor Huddleson's program? And is this strictly a serological survey or were any attempts made at culture?

DOCTOR FAY: This study is not connected with Doctor Huddleson's work. We have made some surveys in the state of Michigan. Most of this information, however, was obtained from progress reports and letters to various states asking for any information they had on the status of brucellosis in their state.

These are always based on serological examination, which is the accepted method of testing for brucellosis in cattle.

MR. TRAINER [Wisconsin]: I was wondering if you had any additional information of the sex of reactors among the deer—if they were all males, or females, or just how they fell.

DOCTOR FAY: I don't have a breakdown of that. Of those we tested in Michigan, some were females. I assume that in many cases the predominant number were males, since they are taken as trophies.

QUESTON: I have a question, Doctor Fay. This departs a little from the subject. However, it does concern brucellosis. I wonder whether or not you have the incidence of infection of swine in the country with that?

DOCTOR FAY: No, I have not. I have not worked with feral pigs, and I haven't run across anything with regard to it.

CHAIRMAN HAYES: Thank you, Doctor Fay.

Since we do have a minute or two here, I might contribute a little something to a question that was asked pertaining to culture studies.

Culture studies have been conducted by Doctor Morris Baker at the Alabama Wildlife Unit, in Auburn. Doctor Baker is engaged in studies in which doe deer are artificially infected with brucellosis.

At least in a part of this overall survey, with which I am familiar, most of the reactors in the Southeast were bucks, because in the majority of the areas, only bucks were collected during the hunts and only the bucks were brought in to checking stations where blood specimens could be procured.

As you can readily see and as Doctor Fay has pointed out, five years ago brucellosis was one of the major diseases which was suspected in wild animals—deer particularly. It was suspected that deer were a contributing source in nature for brucellosis to be transmitted to domestic cattle.

I think a lot of work has been done since then which in a sense gets the deer off the hook with that particular disease.

LEPTOSPIROSIS IN WILDLIFE AND DOMESTIC ANIMALS IN THE UNITED STATES

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The leptospiroses are a group of communicable diseases caused by antigenically distinct members of the genus *Leptospira.* They are called serotypes because their differences are determined serologically. About 60 serotypes are recognized. In the United States 11 serotypes exist and more are suspected.

Leptospires are extremely small, coiled, actively motile spirochetes. They are easily killed by disinfectants, heat and drying. They cannot live long under pH conditions below 6 and above 8. Special techniques are required to stain and cultivate them in the laboratory. These characteristics delayed an earlier recognition of leptospirosis in many species of animals.

Proper application of special techniques is necessary to study leptospirosis. Antibodies can best be detected with the microscopic agglutination test. Living leptospires of each desired serotype are used as antigen. This test is specific for some serotypes, but cross reactions between serotypes occur. Isolations are accomplished by the use of semisolid and solid mediums using rabbit serum as the usal enrichment. Experimental animals are sometimes used to isolate leptospires from contaminated tissues. Silver staining is used to demonstrate leptospires in tissues. The microscopic agglutination and the agglutination absorption tests are used to identify leptospires. Adequate training is necessary to conduct these procedures carefully.

At first leptospirosis was not considered economically important in animals. The first animals found infected were rats and small rodents. These infections were considered important only as a source of infection to man. Klarenbeek and Schuffner (1933) reported that *Leptospira canicola* caused disease in dogs. *Leptospira pomona,* origionally isolated from man, was found to cause disease in swine by Gsell (1944) and in cattle by Baker and Little (1948). These reports ied to recognition of leptospirosis as an important disease of dogs, swine, and cattle. We now know that leptospirosis is widespread among domestic animals in the world and is caused by different types of leptospires.

Leptospiral infections do not always produce morbid reactions in the host animals. The subjective complaints common in man, such as headaches, and muscular pains, escape detection in animals. Anemia, icterus, gastrointestinal disturbances, and nephritis are common symptoms in dogs. In cattle the principal symptons are fever, anorexia, anemia, icterus, loss of weight, agalactia, atypical mastitis, hemoglobinuria, and abortion. Abortion is the most common sign of disease in swine. Other signs such as icterus and hemoglobinuria occur less frequently. Leptospiral infections in horses are thought by some to be a cause of irridocylitis, but this concept is not proven. Many leptospiral infections in dogs, swine, cattle, and horses are inapparent and escape detection.

Inapparent and apparent leptospiral infections are epizootiologically important. Carrier animals result in either case and represent unexpected and expected sources of infection to man and animals. The leptospires remain in the kidney and are excreted in the urine. The degree and length of shedding depend upon the host-serotype relationship. Rats generally excrete *L. icterohaemorrhagiae* for the remainder of their life; and cattle excrete *L. pomona* for about 3 months. The degree and length of shedding are not known in many host-serotype relationships. This is particularly true for wildlife species.

Some leptospiral serotypes have a host of predilection which is called the primary or reservoir host. In this host the leptospire causes few or no morbid reactions, and leptospires are excreted in large numbers for a long period of time. From this primary host, infections to other animals and man usually orginate. These side chain infections are termed accidental or incidental. The infections vary from severe to inapparent in accidental hosts. Man is an accidental host for all types of leptospires and is the terminal point of existence for the organism. Infections from man to man and man to animals are uncommon events.

The incidence and types of leptospires can be determined only by proper application of diagnostic methods. Prevalence of leptospirosis, based on serological studies only, is subject to question because: (1) Serological data are not sufficient to predict the infecting serotype. (2) Infections may be present for serotype not known. (3) Leptospires may be present in the absence of serum antibodies. (4) Heterologous titers may equal homologous titers. Prevalence based on thorough bacteriological examination is preferred because: (1) The objections of serological studies are overcome; (2) The leptospire isolated can be identified. Inability to cultivate some leptospires is a limiting factor of bacteriological studies. Prevalence studies based on serological and bacteriological methods yield the most information. It is expensive to conduct a thorough large-scale investigation and therefore, methodology is often sacrificed for economy.

In this country, leptospirosis occurs in cattle, horses, swine, dogs, rats, mice, opossums, raccoons, skunks, bobcats, fox, woodchucks, nutria, beaver, and armadillos. The prevalence of leptospirosis in other countries was reviewed by Alston and Broom (1958) and Van der Hoeden (1958). A brief account of the current knowledge of leptospiral serotypes among animals in the United States will follow.

Leptospira pomona, *L. canicola*, and *L. hardjo* infect cattle. Baker and Little (1948) isolated *L. pomona* and showed that it caused disease in cattle. It is widespread and is recognized to be economically important. Losses are estimated at 100 million dollars annually. *Leptospira canicola* was found in cattle by Turner *et al.* (1959); and *L. hardjo* was isolated from cattle by Roth and Galton (1960). The importance of these serotypes in cattle is not known. *Leptospira hardjo* may be responsible for agglutinins in cattle serums detected with *L. sejroe* antigen (Yager, 1952; Galton, 1956; and Bryne and Chambers, 1959).

Equine leptospirosis due to *L. pomona* was first detected by Roberts, York, and Robinson (1952). They reported a septicemic condition accompanied by dullness, fever, icterus, and periodic ophthalmia.

Yager, Gochenour, and Wetomore (1950) investigated periodic opthalmia in 35 horses and found antibodies against *L. pomona* in 34. Bryans (1955) studied opthalmia in horses and arrived at the conclusion that leptospiral cause of opthalmia was not proved. This opinion is shared by Alston and Broom (1958).

Leptospira pomona and *L. canicola* occur in swine. Gochenour *et al.* (1952) recovered *L. pomona* from swine. Due to the presence of other pathogens, the role of *L. pomona* could not be determined. Bohl and Ferguson (1952) found that antibodies for *L. pomona* were common among hogs in Ohio. Later reports by Bohl, Powers and Ferguson (1954) and Bryan, Rhoades, and Willigan (1953) showed that *L. pomona* caused abortion in swine. While investigating an outbreak of *canicola* fever in man, Ward *et al.* (1956) isolated *L. canicola* from a normal sow. The prevalence and importance of this type is not known.

In the United States *L. canicola, L. ichterohaemorrhagiae,* and *L. pomona* occur in dogs. *Leptospira canicola* was first found in this country by Meyer *et al.* (1937) and is widespread as reported by Alexander *et al.* (1956). It caused clinical disease, but inapparent infections are common. Although the isolation of *L. icterohaemorrhagiae* has been reported only once (Randall and Cooper, 1944), serological studies suggest it occurs occasionally (Alexander *et al.,* 1956). Murphy *et al.* (1958) recovered *L. pomona* from a dog in Pennsylvania. The serum of this dog exhibited a paraspecific serotiter for *L. autumnalis.*

The house mouse (*Mus musculus*) is commonly infected with *L. ballum.* It was first isolated by Yager *et al.* (1953). Brown and Gorman (1960) reported a high incidence among mice in Georgia. They also isolated *L. ballum* from the cotton mouse (*Peromyscus polionotus*). We have found about 75 percent of the house mice examined in Louisiana infected with *L. ballum.*

Rats were the first animals found infected with leptospires in the United States. Noguchi (1917) isolated *L. icterohaemorrhagiae* from Norway rats (*Rattus norvegicus*). A survey of rats in Baltimore (Li and Davis, 1952) revealed a carrier rate of 45 percent. In Louisiana, we found *L. icterohaemorrhagiae* in 50 percent of 30 rats examined. Cotton rats (*Sigmodon hispidus*) are occasionally found infected with *L. ballum* (Brown and Gorman, 1958).

Opossums (*Didelphis marsupialis*) are known to harbor 7 leptospiral serotypes. *Leptospira ballum* occurs in Virginia (Yager *et al.,* 1954). In Georgia McKeever *et al.* (1958) and Galton *et al.* (1957, 1959a, 1960) reported the occurrence of *L. autumnalis, L. ballum, L. australis* A, *L. mini georgia, L. bakeri,* and LT 81 (a member of the *hyos* serogroup) among opossums. In these studies, 6.1 percent of 213 opossums were found bacteriologically positive. In Louisiana, we have found 20 percent of 300 opossums infected with leptospires. Among the 60 strains isolated are *L. pomona, L. autumnalis, L. ballum, L. mini georgia* and strains of the *hyos* serogroup.

Seven leptospiral serotypes occur among raccoons (*Procyon lotor*). McKeever *et al.* (1958) and Galton *et al.* (1958, 1959a, 1960) reported isolations of *L. ballum, L. pomona, L. australis* A, *L. grippotyphosa, L. autumnalis, L. mini georgia,* and LT 81 from raccoons in Georgia. In North Carolina, Galton *et al.* (1959b) isolated strains of *L. australis* A and *L. grippotyphosa.* We have isolated *L. autumnalis* from raccoons in Louisiana, but only 15 animals have been examined.

Skunks (*Mephitis mephitis*) are known to harbor 6 leptospiral serotypes. McKeever *et al.* (1958) and Galton *et al.* (1959, 1960) reported the isolation of *L. pomona, L. ballum, L. mini georgia,* and LT 81 from skunks in Georgia. In Louisiana, we have isolated *L. pomona, L. icterohameorrhagiae, L. mini georgia, L. canicola* and strains of the hyos group. McKeever *et al.* (1958) isolated 18 strains from 132 striped skunks, and we have isolated over 240 strains from 480 skunks. Besides rats and mice, the skunk has the highest rate of infection among wild animals examined by us. We find *Leptospira pomona* and *L. canicola* often enough to warrant considering the skunk significant in the epizootiological picture of these two important serotypes.

Leptospira pomona and *L. ballum* were isolated from bobcats (*Felis rufa = Lynx rufus*) in Georgia (McKeever *et al.,* 1958); and we isolated a strain of *L. pomona* from a bobcat in Louisiana. *Leptospira ballum* was isolated from the gray fox (*Urocyon cinereoargenteus*) in Georgia by McKeever *et al.* (1958); and Galton *et al.* (1959) reported isolations of *L. grippotyphosa* and *L. australis* A from gray fox in North Carolina. She also isolated *L. grippotyphosa* from the red fox (*Vulpes fulva*). An isolation of *L. pomona* from a woodchuck (*Marmota monax monax*) in Pennsylvania was reported by Clark *et al.* (1960). *Leptospira ballum* was isolated from a cottontail rabbit (*Silvilagus floridanus*) by Galton *et al.* (1959b).

We have isolated leptospires from nutria (*Myocastor coypus*), beaver (*Castor canadensis*), and armadillos (*Dasypus novemcintus*) in Louisiana. These leptospires have not been identified except for one strain of *L. autumnalis* that was isolated from an armadillo.

Our knowledge of leptospirosis among deer is for the most part restricted to serological studies. A serologic survey on 243 deer serum samples in Illinois by Ferris *et al.* (1958) revealed antibodies for *L. pomona* in 10.2 percent and for *L. grippotyphosa* in 9.8 percent. In Minnesota, Wedman and Driver (1957) found *L. pomona* antibodies in 16 percent of 187 deer serums. A serological survey of deer blood collected from 11 southeastern states revealed antibodies for *L. pomona* in only 1.73 percent of 403 samples (Shotts, Greer, and Hayes, 1958). Unpublished serologic data from our laboratory showed 20 percent reactors for *L. pomona* from 100 deer blood collected in northern Louisiana.

Although studies of leptospirosis among wildlife have been limited to several areas of the United States, the presence of at least 11 serotypes among a variety of animal species is known. Virtually nothing is known concerning the pathogenesis of these infections. Much time, effort, and support are required before the role of wild animals in the overall picture of the leptospiroses can be ascertained with a degree of accuracy. Certainly we can recognize their possible role in the transmission of leptospirosis to man and domestic animals. The high incidence of *L. pomona* found in skunks in Louisiana is of importance from a disease control standpoint. Obviously, quarantine measures would be of limited value; therefore, control of leptospirosis in cattle would of necessity have to be based on prevention by developing an immune population.

SUMMARY

Eleven leptospiral serotypes occur in various species of animals in the United States. These are as follows: (1) *Leptospira pomona* in cattle, swine, horses, dogs, skunks, opossums, raccoons, bobcats and woodchucks; (2) *L. canicola* in dogs, cattle, swine, and skunks; (3) *L. icterohaemorrhagiae* in rats, dogs, and skunks; (4) *L. hardjo* in cattle; (5) *L. ballum* in mice, cotton mice, opossums, skunks, bobcats, cotton rats, raccoons, cottontail rabbits, and gray fox; (6) *L. autumnalis* in opossums, raccoons, and armadillos; (7) *L. australis* A in opossums, raccoons, and gray fox; (8) *L. bakeri* in opossums; (9) *L. grippotyphosa* in raccoons and red fox; (10) *L. mini georgia* in opossums and raccoons; and (11) LT 81 (*hyos* serogroup) in opossums, raccoons, and skunks.

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DISCUSSION

MR. COWAN [Michigan]: Doctor Roth, I didn't detect the mention of deer Would you care to comment on that?

DOCTOR ROTH: My comments regarding deer was based only on serological evidence. This is of interest: it was zero per cent for *pomona* in Massachusetts to a twenty per cent in a small sampling of deer in Northern Louisiana, and there were percentages of sixteen per cent, I believe, in some states and seven, in others. Sampling has been rather small. In one group of samples by the southeastern states, which is done by Dr. Hayes' group, I believe indicated 1.77 per cent for *Leptospira pomona.*

QUESTION: I am from the Armed Forces Institute of Pathology. Which of these species can be transmitted to men?

DOCTOR ROTH: Sir, man is considered as an accidental host for any and all types of leptospires. Infections vary from a mild, seven-day fever—in Australia they call it Autumn Fever—to diseases in Japan among the rice workers, with varying severity. In this country human infections, or certain manifestations of them, are known to be caused by some of the serotypes—*icterohaemorrhagiae, canicola, pomona,* and there is serologic evidence of human infection of *mini georgia.* I may have missed some, but man is apparently an accidental host for any and all types.

QUESTION: Are these conditions amenable to antibiotics?

DOCTOR ROTH: We could take a specific instance to answer your question. Work by Kinsey and his group in the State of Washington indicate that the carrier state by cattle can be eliminated by the use of antibiotics and streptomycin. This requires several days of treatment; the same is true for swine. Treatment by streptomycin will do it. It is not economically important except for high-priced breeding animals which might be involved.

QUESTION: How about penicillin?

DOCTOR ROTH: In the animal studies it is not coming out very well.

QUESTION: Have you made post mortem laboratory studies?

DOCTOR ROTH: We have not done any histopathology studies.

DOCTOR BLOCK [Fish and Wildlife]: Have you examined muskrats?

DOCTOR ROTH: Yes; but their numbers are few and the animals are hard to come by. We have some plans to test some in the next year, or year and a half. And then too, we have a few mink in Louisiana, and consequently we intend to examine a few of these.

QUESTION: Several years ago, while I was in California, I tried for several years to get somebody to check on the muskrats in California without success. I hope you can send somebody on it.

MR. WITTEMEYER [Iowa]: Apparently a great number of species are involved. Are there means for artificial protection other than trying to eliminate wildlife, which obviously is out of the question because of the numbers involved?

DOCTOR ROTH: Yes. You are speaking of preventatives. There are vaccines—bacterins, I should correctly call them—available. It is commercially available, and there are 19 companies producing them in the United States. There is one product for *Leptospira pomona* designed for cattle, swine, and horses. And there is a product which combines *icterohaemorrhagiae* and *canicola* in dogs. These products give a fair degree of immunity.

CHAIRMAN HAYES: Doctor Roth, would you review your personal feelings relative to the serological evidence of Leptospirosis in various species of wild animals? How do you feel about the significance of the serological level?

DOCTOR ROTH: Serological evidence contributes to our knowledge in general. However, in our experience and our studies in Louisiana, particularly in the skunk, we isolate leptospires from the animal in the absence of serum antibodies, so that is why I took the liberty to point out that our knowledge based on bacteriological evidence would certainly lend more weight than serologic evidence. And then, too, the cross reaction that we see, for example, known as paradoxical reaction is a good example of this and occurs in the dog.

DR. PETERLE [Ohio]: We have a student working on a project wherein he is trying to relate artificial relations of *pomona,* and it bears out the relationship of lack of serological evidence in some of the animals that he has adversely infected. He is working with the opossum and the raccoon. This is certainly the case.

CHAIRMAN HAYES: This is one disease that we are going to hear more of in the immediate future and a great deal more work is in order.

TOXOPLASMOSIS IN WILDLIFE IN SWEDEN

KARL BORG

State Veterinary Medical Institute, Stockholm, Sweden

Early in this century, precisely in 1908, almost simultaneously a small protozoan was discovered in a North African rodent, the gondi (Nicolle and Manceaux, 1908), and in rabbits in South America (Splendore, 1909). Because of its crescent shape it was named *Toxoplasma* and, after the first-mentioned host animal was assigned the species name *gondii.* About 30 years later it was observed that the same protozoan could cause severe disease in human beings and after another 10 years the rather surprising discovery was made that subclinical human infections are very common. At about the same time it became obvious that the infective causal agent was very widely spread among animals, not least among wild ones.

PARASITOLOGY, ETC.

Toxoplasma gondii is considered to be a protozoan the classifying of which is not quite clear. It is not host-specific. It can appear as a single-celled organism in body tissues, intracellularly or in cyst-like structures called pseudocysts. Mature proliferative forms are oval, newly-liberated ones tend to be more crescent-shaped; the parasite is basophilic and Gram negative and because of lack of a specific staining technique can be very difficult to identify in injured tissues. The pseudocysts are most easy to identify. Morphologically, the parasite can be very similar to *Encephalitozoon, Leishmania, Sarcocystis,* Fungi, *Histoplasma,* and Torula and in making a diagnosis must be differentiated from such agents.

Toxoplasma occurs in different strains, which morphologically, serologically, and immunologically are identical but which differ considerably in biological aspects, mostly in their virulence for various animal species. Toxoplasmosis might de demonstrated by isolation of the parasite (usually by animal inoculation), intradermal allergy test or serologically by Sabin-Feldman dye test or by complement-fixing antibody test.

Free *Toxoplasma* parasites have a very low tenacity. Outside the host animal they die almost at once when dried-up or chilled. They will remain alive when heated to +50°C for at most 5 minutes and in hydrochloric acid at concentrations equivalent to those in gastric juice up to 15 minutes. It has been found that toxoplasms survive best at +4°C and at this temperature can keep their infectivity in heavily infected tissues up to four weeks although their vitality will diminish successively.

Toxoplasms can be found in the blood, urine, faeces, nasal discharge, and tissues of infected animals. The parasite has a world-wide distribution and its frequency seems to be dependent on climatic conditions.

The pathogenesis in toxoplasmosis seems to be of fundamentally uniform nature in various animal species, including man, and according to earlier reports (Frenkel, 1949, 1956; Lainson, 1955; Möller, 1958; Sabin and Feldman, 1948; Weinman and Klatchko, 1950) it might be summarized as follows.

In several animal species the pathomorphology indicates a primary enterogenous infection followed by a lympho-hematogenous generalization and a parasitemia during which the toxoplasms enter the host cells, usually reticulo-endothelial cells. There they multiply by longitudinal binary fission, or maybe even by budding, and the oranisms are then dispersed by rupture of the cell membranes, the liberated organisms parasitize fresh cells, etc.

Because of the antigenic properties of *Toxoplasma,* humoral antibodies are produced. In acute generalized infections, the animals are apparently not able to build up immunity but instead present an anaphylactic condition accompanied by a hyperergic inflammation that is caused when liberated toxoplasms and their antigens come in contact with humoral antibodies.

In chronic toxoplasmosis the infection is restricted to the cells of the reticulo-endothelial system which then proliferate, and a balance is established as a result of the development of immunity by the host. As humoral antibodies apparently do not influence intracellular toxoplasms, the possibility exists that the infection is transformed into a latent phase where the parasites are encapsulated in terminal colonies with localization preferably in the central nervous system. Here they are very difficult to combat because of the difficulties for humoral antibodies to penetrate the blood-brain barrier.

Resistance reducing factors may reactivate the disease in latent infected animals.

TOXOPLASMOSIS IN MAN

The discovery that *Toxoplasma* can cause lethal infections in human beings was made in the United States of America in 1937 (Wolf, Cowen and Paige, 1940). It referred to a newborn child with an encephalomyelitis. However, a review of literature and old preparations made it obvious that the disease had been observed before 1937. With the subsequent development of serologic methods it has been possible to recognize an extraordinarily wide distribution of the infection in human populations, and thus frequencies of 20-40-60, or even 80 per cent have been shown in clinically healthy adult people in different countries (Beverley, 1957; Feldman and Sabin, 1949; Gard, 1951; Roth and Fritz, 1950; Thalhammer, 1957). It has also been found that women are infected more often than men.

Clinically manifested cases of human toxoplasmosis are less common and may occur either before or after birth. In a pregnant woman with a subclinical type of the infection, the infective agent may pass transplacentally to her foetus and cause its death or severe ailment in the newborn child, *e.g.*, internal hydrocephalus, intracerebral calcifications, chorioiditis, and possibly other neurological manifestations. Sometimes a generalized infection may be present at birth or develop soon afterwards with manifestations of various types. Acquired toxoplasmosis in adult humans might occur under varying symptom pictures, usually with a good prognosis. At times, however, it might take an acute course with meningo-encephalitis, pneumonia, exanthema, adenopathy, etc., and eventually sudden deaths.

TOXOPLASMOSIS IN ANIMALS

Since its first discovery, *Toxoplasma* has been reported from quite a number of animal species, mammals as well as birds. As the parasite is not host-specific one might assume that the host animal record will increase considerably in the future, for instance, quite recently toxoplasmosis was reported in roe deer for the first time (Burgisser, 1960). As in man, the frequency of the infection has been found higher in females than in males in both dogs and rats (Fankhauser, 1952; Perrin, 1943a,b.). It has also been observed that in gondis and hares the incidence of the disease is higher during the winter months

(Christiansen and Siim, 1951; Hülphers, Lilleengen, and Rubarth, 1947; Nicolle and Manceaux, 1908).

Several authors have noted that *Toxoplasma* can cause sporadic fatal cases or local outbreaks of disease in domestic and wild animal populations (Borg, 1956; Bouvier, Burgisser and Schneider, 1954; McDiarmid, 1960; Vaccari, Ballarini, Pieresca, Bertoni and Semellini, 1960). However, the only evidence of widespread epizootics of clinical illness seems to have been among hares and capercaillie in Denmark and Sweden (Borg, 1953a and b; Christiansen, 1948a and b).

PERSONAL OBSERVATIONS

The State Veterinary Medical Institute in Stockholm is a laboratory with special departments for complete diagnostic work. Originally it was intended for diagnostic and research work on diseases in domestic animals but some 15 years ago research work on wildlife pathology was linked to this laboratory. Through propaganda the public is urged in different ways to send to the laboratory animals which have been found dead out in the field. Since the beginning we have received about 10,850 indigenous wild living animals in this way, representing about 40 species of mammals and 120 species of birds.

In this material toxoplasmosis has mainly been demonstrated in mountain hares and field hares (*Lepus timidus, L. europaeus*) and capercaillie (*Tetrao urogallus*), and some cases have been diagnosed in black grouse (*Lyrurus tetrix*) and pheasant (*Phasianus colchicus*) too, and in an osprey (*Pandion haliaëtus*).

In a survey of hares and capercaillie during the years 1948 to 1960 the specimens received for examination were predominantly females in the hares and overwhelmingly males in the capercaillie (Table 1).

TABLE 1. SEX DISTRIBUTION OF SPECIMENS EXAMINED, 1948-1960

	Number of animals examined	Sex distribution ♂	♀
Lepus timidus	1402	46.3 %	53.7 %
Lepus europaeus	1098	46.9 %	53.1 %
Tetrao urogallus	881	63.2 %	36.8 %

Of these animals, the mountain hare and the capercaillie are distributed over almost the whole of Sweden whereas the field hare occurs only in the southern half of the country.

The predominance of female hares in this material could not be explained. In the capercaillie, on the contrary, the considerable predominance of cocks can undoubtedly be attributed to the fact that the cocks are much easier to find in the field because they are bigger and more strikingly coloured than the hens.

In this material, the frequency of toxoplasmosis has been very high (see Table 2).

TABLE 2. FREQUENCY AND SEX DISTRIBUTION OF TOXOPLASMOSIS IN HARES AND CAPERCAILLIE, 1948-1960

	Cases of toxoplasmosis	Frequency		Sex distribution ♂	Sex distribution ♀
Lepus timidus	110	7.8%	(110/1402)	46.5 %	53.5 %
Lepus europaeus	133	12.1%	(133/1098)	47.5 %	52.5 %
Tetrao urogallus	263	29.9%	(263/881)	48.7 %	51.3 %

Toxoplasmosis has been the most common cause of death in our research material from capercaillie and one of the most common causes of death in the hares.

Toxoplasmosis was diagnosed in more females than males. Since for hares the total material includes more females than males there is no statistically significant over-representation of females in the toxoplasmosis material for these species. In the capercaillie, relations are reversed, and calculations show that the toxoplasmosis frequency is significantly greater in the females than in the males ($P<0.001$). As seen above, the toxoplasmosis frequency in the capercaillie totals 29.9 per cent but calculations on each sex separately give the figure 23.1 per cent (129/559) for the cocks and 41.6 per cent (134/322) for the hens, thus a considerably higher frequency in the hens.

This material therefore presents certain conformities regarding sex predisposition to earlier statements in human beings, dogs, and rats.

Geographically, most of the cases of toxoplasmosis originate from the southern part of Sweden, and this pertains absolutely as well as relatively although less of the total material derives from the north. Some years ago a similar condition was observed for human toxoplasmosis in Sweden but recent work has not been able to confirm this.

As in some other animal species, a certain seasonal tendency may be traced in this material, although this tendency is not very pronounced. The relative incidence of the toxoplasmosis cases in the mountain hares is thus far even over the whole year but in the capercaillie there is a dramatic increase in the autumn months. (Fig. 1.) In the common hares, the frequency has been least during the summer months.

The following might be an explanation to the pronounced frequency peak in the capercaillie during the autumn months. In Sweden the capercaillie chicks are born towards the end of May or in the beginning of June, i.e., a great number of susceptible individuals have been added to the capercaillie populations during the summer. The incubation period in avian toxoplasmosis is rather long, maybe several

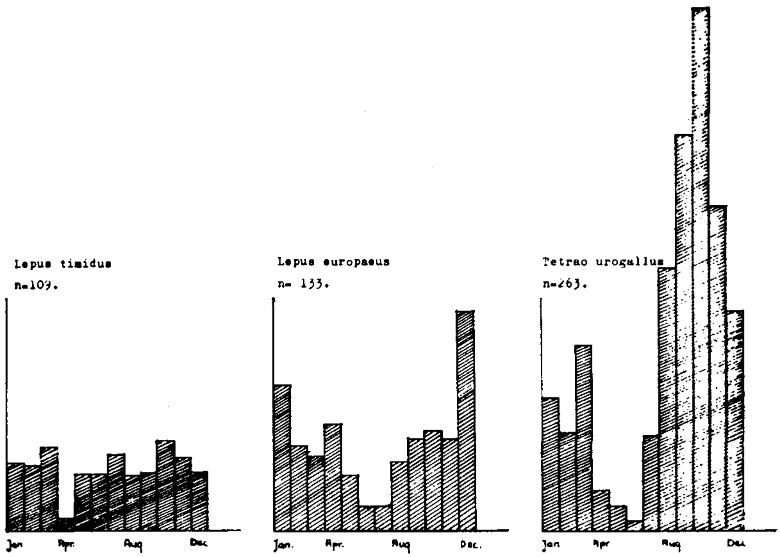

Figure 1. Toxoplasmosis, relative monthly incidence for the years 1948 to 1960, Sweden.

weeks (Geissler, 1952) and the autumn peak occurs when the year's chicks have reached this age or a little more.

Our Swedish material consists of spontaneous, fatal cases of toxoplasmosis and, to judge from the gross pathological changes, the infection has mostly run an acute course. In hares the appearance at autopsy was rather characteristic although not pathognomonic, but in the capercaillie it was less specific.

In the hares the most pronounced gross lesions occurred in the mesenteric lymph glands, liver, spleen, and lungs. The mesenteric lymph nodes were swollen, the cut section was hyperplastic with necrotic sectors of varying size. The liver was often a little or sometimes even extremely congested. In about 1/3 to 1/2 of the animals greyish white or yellowish foci have been visible. The size of these foci ranged up to about 3-4 mm in diameter and they were scattered in the liver parenchyma in various numbers, as sparsely, moderately, or sometimes very abundantly. The spleen was usually enlarged, often extremely enlarged, its edges rounded-off, and its cut surface dark red and bulging, and sometimes finely granular. Only relatively seldom were foci of about the same kind as in the liver parenchyma visible. The lungs were voluminous, oedematous, and congested, the mucous membrane of the trachea hyperemic and tracheal lumen filled with a white, foamy liquid. There were often considerable amounts of a sero-sanguineous fluid present in the pleural cavities and around the nostrils.

As mentioned previously, the autopsy findings in the capercaillie were not very characteristic. The liver showed at times no notable changes; at times it was somewhat enlarged. Foci of about the same kind as in the hares were only occasionally visible. The spleen was very often (in about 60 per cent of the cases) more or less enlarged, its cut surface somewhat dry and dull but very rarely foci of about the same kind as in the liver were demonstrable. The lungs were of about the same appearance as in the hares but the lesions were more moderate.

The histo-pathological lesions in the two animal species were of fundamentally uniform nature. A pronounced activity of the reticulo-endothelial cells —swelling of the nuclei and cell proliferation—occurred in the mesenteric lymph nodes (hare), liver, spleen, lungs, etc. The mesenteric lypmph nodes showed further the picture of an acute, nonspecific lymphadenitis and, moreover, here as in the liver and spleen there occurred widely spread, fresh degenerated or necrotic foci. Lymphocytic and histiocytic infiltrations were demonstrated periportally in the liver, perivascularly in the myocardic tissue, and interstitially in the lungs. The gross lesions in the brain consisted in the hares of moderate congestion or small hemorrhages, and frequent foci of glia cells. In the capercaillie there was always a diffuse or focal, more or less severe nonsuppurative, lymphohistiocytic encephalitis or meningo-encephalitis, with histiocytes around the vessels, and focal proliferation of glia cells.

In the hares, in about ⅔ of the cases pseudocysts in various numbers were demonstrated in the following organs in the order mentioned: spleen, mesenteric lymph nodes, and liver, in about ¼ of the cases in lungs and more sporadically in myocardic tissue and brain. In the capercaillie, in a little more than half of the cases, pseudocysts were demonstrated in brain and spleen, comparatively often in lungs and less frequently in liver and myocardic tissue.

Toxoplasma infections in the hares were very similar, pathologically, to those in several other infectious diseases, as *Pasteurella multocida* infections, pseudotuberculosis, tularemia, listeriosis, and brucellosis (*Brucella suis*). The severe oedema of the lungs is a good suggestive sign of toxoplasmosis.

The clinical picture in toxoplasmosis of the hare is known from experimental infections. It is rather unspecific with more or less pronounced signs of disturbances of the general condition, apathetic behavior, anorexia, etc. Experimental acute infections will usually cause death in about 7 to 9 days.

In capercaillie, the clinical picture is more specific and it has been observed in spontaneously diseased birds caught in nature or caged at breeding stations. Acute infections proceed with diminishing or disappearance of appetite, and about the same time the chin feathers stand up, followed shortly by a similar reaction of the neck feathers. Increasing sluggishness sets in, sometimes combined with balance disturbance and weakness in the legs. The birds often lie sideways on the breast and the head is leaned backwards over the back in peculiar movements. Later the head is so twisted that the underside is held more or less completely upwards. Thus there occurs a spiral twisting of the neck (Fig. 2). The neck is then held either backwards along one side of the body or it is stretched forwards. The twisting of the head and neck may be either to the right or left, but in the same bird it appears always to be in one direction only. Efforts to move are made in circles and in reclining position on the breast or one side of the body. The birds die rather soon after these symptoms are apparent. The whole course of the disease usually takes place in about 4 days. The twisting of the head and neck seems to be particularly characteristic, though it does not invariably occur.

At the breeding stations, whole hatches of capercaillie died out

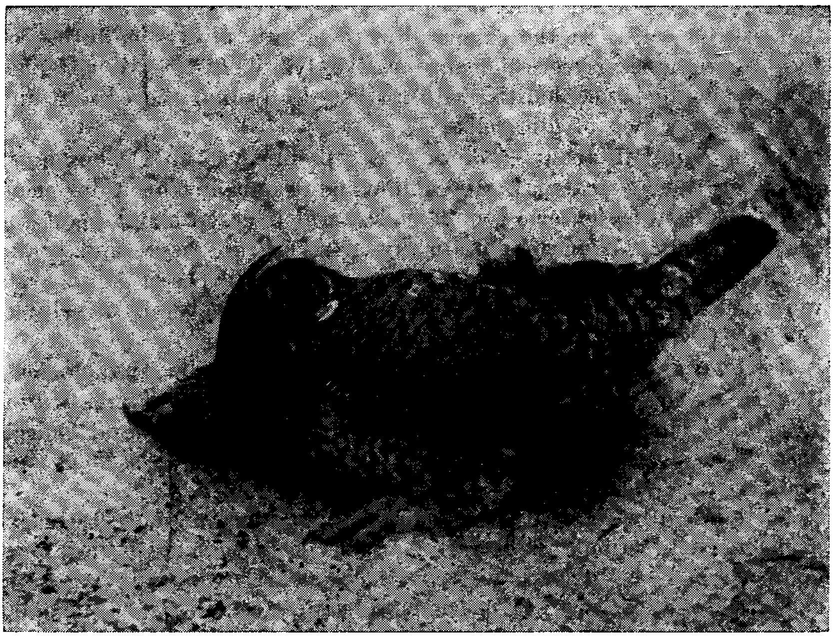

Figure 2. Acute toxoplasmosis in capercaillie.

gradually from this form of disease. These deaths did not occur at the same time, but the birds fell ill, one after the other, and in the course of 4 to 6 weeks all the chicks in the hatch succumbed.

A more chronic course of toxoplasmosis has also been observed in capercaillie, however. Increasing sluggishness and lowering of vision were the most pronounced features of this form, these being in some cases mistaken for fearlessness.

Except for a few sporadic cases, our observations on pheasant toxoplasmosis concern two outbreaks at which the local pheasant populations were totally exterminated. One enzootic occurred during the winter of 1949 on an estate, Boo, in the middle of Sweden. A heavy die-off was observed beginning at Christmas time and was in progress for about two months. The chief observations concerning diseased birds consisted of diminished ability to fly, and some caught birds died after about 14 days' illness. The other enzootic occurred on an estate, Christinelund, in the south of Sweden during July 1955. A very peculiar behavior was observed, the birds running in circles flapping one wing, spirally twisting their necks or crawling on the ground as if the legs would not carry them. The outbreak occurred shortly after parathion spraying certain crops for which reason the estate owner thought the pheasants might have been poisoned. In fact, it seems not unlikely that the poison caused a lowering of resistance in the birds resulting in exacerbation of the disease, particularly as the outbreak occurred at a time not quite normal for toxoplasmosis outbreaks in game.

DISCUSSION

Toxoplasmosis is very widely distributed in the southern part of Sweden, and in the animals in question it often runs an acute, fatal course. A rather extensive mortality of capercaillie has been observed in recent decades among chicks and young birds. Unfavorable climatic conditions might be responsible for the mortality in the chicks but the mortality in the young birds, mainly observed in the south of Sweden, coincides with the autumn peak of the toxoplasmosis in the birds examined. Whether the mortality due to toxoplasmosis has dynamic significance as regards populations is hardly possible to judge; the high incidence of the disease indicates, however, that it is not insignificant.

Except for the congenital form in humans, the modes and sources of infection are incompletely known. In many cases the pathologic-anatomical gross lesions indicate an alimentary route of entry and thus that infection might have occurred through foodstuffs contaminated by faecal or urinary excreta or by ingestion of infected meat.

Other possible modes of transmission are inhalation of infected aerial suspensions or the intermediary of blood-sucking insects. However, numerous experiments using various kinds of insect vectors have failed to transmit infection, and thus this mode of infection has been considered not very likely. Nevertheless, transmission by insect vectors still seems a most logical explanation in light of the manner of living and food habits of the game species in question and particularly the wide distribution of *Toxoplasma* infections in these animals, as well as the low tenacity of the toxoplasms outside the host animal.

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DISCUSSION

QUESTION: Doctor Borg, what method of diagnosis are you using?

DOCTOR BORG: We have used different methods of testing. We have worked with the dye test and experimentally until we are quite familiar with the clinical picture. Our material is not always suitable for serological tests and the test doesn't run a hundred per cent. The skin test is not good for dead animals, and there are some difficulties in it with wild living ones.

QUESTION: On your pathological sections, what is your choice of stain?

DOCTOR BORG: The best is haematoxylineosin, I think.

QUESTION: Are you getting any encephalitis?

DOCTOR BORG: We have a special type of encephalitis.

QUESTION: How about ocular lesions?

DOCTOR BORG: I am not sure that we have found any.

QUESTION: Are you finding lumps of lymphoid tissue in the lungs in the early stage?

MR. PACKARD [West Virginia]: Do you find any special exterior symptoms—you mentioned interior symptoms—that show in hares?

DOCTOR BORG: They are rather unspecific in the hare. There are no signs of a central nervous disturbance or anything like that. We have been able to observe diseased hares only from experimental hares.

DR. KARSTAD [Ontario]: Do you very frequently give inoculations to isolate, and if you do, what tissues do you find particularly good?

DOCTOR BORG: We have tried to isolate, but toxoplasms are very sensitive and die soon after the host animal is dead. We haven't had any real success in this. In Denmark they have succeeded in isolating toxoplasm from the hare.

DR. COWAN [Michigan]: Have you been able to associate any cases in humans with hunting activities?

DOCTOR BORG: We have had two outbreaks in pheasants; two real outbreaks. The pheasants were totally exterminated. There was a game manager and we tested him because he had handled these a long time. He was negative.

DR. COWAN: Have you had an opportunity to survey the wild populations to find out what the incidence might be?

DOCTOR BORG: As a matter of fact, no.

DOCTOR HERMAN [Fish and Wildlife Service]: I feel that some may be wondering in the back of their minds about the United States. Is this occurring here?

As Doctor Borg indicated, this disease has been studied and is being studied currently very extensively in the United States.

We know that it is fairly common in domestic pigeons. That seems to be the first animal that would carry it. It has also been found in crows, but the work that has been done in the eastern part of the States—we have had some tested from the Patuxent Center—has all shown negative results. We have no record of it in rabbits in this country; the rabbit we have, of course, is a different species from the ones that Doctor Borg is referring to.

HANDLING WILD MAMMALS WITH A NEW TRANQUILIZER[1]

VAGN FLYGER
Maryland Department of Research and Education, Annapolis

Wild mammals are fascinating to watch in the wild or in cages but handling these same creatures is frequently unpleasant or dangerous. Many types of restraining devices have been developed to minimize injuries to both the handler and the animal, but these devices are often cumbersome and place restrictions on manipulating the animal. Anesthesia can be used, but this involves an element of danger to the animal and places limitations on disposing of the animal. Biologists have frequently dreamed of a magic potion which could be administered to an animal which would thereupon become docile or tame. A recent development in the drug field may prove to make this dream a practicality and revolutionize the handling of animals.

The drug, Chlordiazepoxide (Librium, Hoffmann-LaRoche), when administered to wild mammals in the proper dosage makes them astonishingly easy to handle. In many cases, the animals become as docile as household pets and maintain themselves on food and water. For example, a gray fox when given an injection of this substance became so docile that he accompanied me on trips lying on the front seat of the car. He permitted anyone to fondle him, and even ate dog food from the dog's dish.

Chlordiazepoxide is administered either parenterally or orally in capsule form. If given in the latter form, only animals that do not chew their food well will take it. For example, small pieces of meat with the capsules tucked inside can be tossed to dogs and large cats which swallow them entire.

Experience has shown (Table 1) that Chlordiazepoxide when given at the rate of 30 to 40 mg per kilogram of body weight will usually make an animal docile enough to handle barehanded. Even 10 mg per kilo will noticeably pacify the animal. Doses exceeding 40 mg per kilogram of body weight are likely to produce ataxia which may gradually disappear. Animals usually remain docile for 24 to 36 hours but when large doses have been given effects have lasted four or five days.

Animals vary somewhat in their response to this tranquilizer but probably greater variability exists in the temperament of the animals. Mild-mannered animals produce less contrasting response than do more vicious or aggressive individuals.

[1]Contr. No. ...., Md. Dept. Research & Education.

TABLE 1. RESULTS OF INTRA-PERITONEAL INJECTIONS OF CHLORDIAZEPOXIDE INTO VARIOUS WILD MAMMALS

Sex	Weight grams	Amount mg	Dose mg per kg	Results
				Raccoon, *Procyon lotor*
M	3860	25	65	Noticeably quieter but would still bite.
M	1900	50	26	Docile.
F	3660	100	27	Handled with bare hands but would bite half-heartedly.
F	3720	100	27	Would struggle but docile.
F	2490	100	40	Docile for over 36 hours.
F	3350	200	60	Docile for over 36 hours, slight ataxia
				New York Weasel, *Mustela frenata*
F	200 approx.	8	40	Became unconscious but 12 hours later very active, no ataxia. Docile.
				Skunk, *Mephitis mephitis*
M	2640	25	9	Docile for 36 hours.
M	1840	33	18	More calm but could not be handled.
F	2780	50	18	Quieter, but could not be handled.
		+25	27	About the same.
		+25	36	Docile.
F	1275	25	20	Docile for over 36 hours.
M	1417	33	23	Quieter but not docile.
M	2060	50	24	Docile.
F	2000	50	25	Docile.
F	650	25	38	Docile for over 30 hours.
F	1000	50	50	Docile for over 48 hours.
F	910	50	55	Docile for 48 hours.
M	795	50	63	Docile for over 48 hours.
M	765	50	65	Docile for over 48 hours.
M	700	50	71	Docile.
				Gray Fox, *Urocyon cinereoargenteus*
M	3180	appr. 100	32	Immediately docile, ataxia for one day, docile for over 5 days, died on 6th for reasons apparently unrelated to drug treatment.
				Feral Domestic Cat, *Felis domestica*
F	3129	25	8	Calmed considerably but still vicious.
		+25	16	Still vicious.
				Woodchuck, *Marmota monax*
				A number of woodchucks were tried and became docile enough for the handler to place a finger between their incisors.
				Gray Squirrel, *Sciurus carolinensis*
M	482	8.0	17	Noticeably calm but would bite.
		+ 5.0	27	Docile for over 30 hours.
M	600	12.5	21	Calm but would bite.
		+12.5	42	Lethargic & sleepy, 15 hours later active, alert and docile.
M	550	12.5	23	Docile for over 5 days, ataxia lasted 3 days.
M	431	12.5	29	Docile but very active.
F	337	12.5	37	Docile, active, growled when handled.
F	350	12.5	36	Unconscious for 4 hours, then woke up and bit finger of handler.
M	548	75	136	Became limp but docile, ataxia for 5 days, ate and drank.
				White-footed Mouse, *Peromyscus leucopus*
M	20	appr. 0.5	25	Docile but active and no loss of equilibrium.
				Porcupine, *Erethizon dorsatum*
F	3180	75	24	Calmed somewhat but flipped tail when touched.
		25	32	Docile.
				Cottontail, *Sylvilagus floridanus*
	1110	50	45	Calmed considerably.
		25	68	Easily handled, some ataxia, effects not noticeable after 7 hours.
				Varying Hare, *Lepus americanus*
	1515	38	25	Noticeably calmed.
		25	42	Easily handled, slight ataxia, all effects gone after 7 hours.

The term docile is used to describe animals that can be handled without eliciting a defense reaction such as biting, lifting the tail in the case of skunks, or flipping the tail in the case of porcupines.

Some possible uses for chlordiazepoxide might be to:

(1) Laboratory technicians required to handle animals for disease studies.

(2) Demonstrate wild animals to children or TV audiences.

(3) Pacify wild animals that are in danger of injuring themselves against the bars of their cage.

(4) Transport wild animals to the laboratory or zoo over long distances.

The results of administering chlordiazepoxide are often spectacular and it promises to be a valuable tool for handling wild mammals. The combination of this drug and the automatic projectile syringe may further extend our ability to handle animals. It is not at all inconceivable that in the very near future we may be able to shoot a tiger or deer and then walk up to it and pat it on the head.

ACKNOWLEDGMENTS

I wish to express my appreciation to the following men for supplying animals: Sgt. Eugene Whitebread, Sgt. Troy Sheppard, Dr. William G. Sheldon, and Mr. Mason, and Mr. Arthur Jones.

The drug used in the experiments was graciously supplied by Dr. R. Roncalli of Hoffmann-La Roche, Inc.

DISCUSSION

MR. LORD [Illinois]: Did you try sparene?

DOCTOR FLYGER: I tried it once, but it was not too effective.

QUESTION: Have you tried this on rabbits?

ANSWER: Yes, but as with domesticated animals, you don't get too much to look for.

QUESTION: What I was interested in is the possibility for photographing animals in their natural habitat.

DOCTOR FLYGER: It works well on squirrels. I think this tranquilizer would be the most satisfactory one.

QUESTION: Is it expensive?

DOCTOR FLYGER: I don't know. It is not on the market yet, except in the oral form.

MR. MONTGOMERY: Has any tolerance been worked out for this?

DOCTOR FLYGER: I have a little data with 1 millogram per 60 kilograms of body weight. The animal is just a little bit more docile, and going down from that until you get 1 millogram for every ten. If you get to where you make it 100 millograms per kilo of body weight, the animal becomes unconscious. This has happened sometimes. The animal usually wakes up in 12 hours or longer. I tried it on a barn owl; it slept two and a half days.

You can overestimate the amount needed: if you under-estimate, you can have some unpleasant results—the odor with skunks, or being bitten by a raccoon.

QUESTION: Is this available commercially only as a liquid, or as water soluble crystal?

DOCTOR FLYGER: It is available in capsule form. You can give it to animals in granules by putting it in pieces of meat and then they will swallow it entire. It is only available in experimental form right now in the injectable state. It is dissolved in water or Polysorbate-80. It doesn't keep very long in liquid form.

MR. DAVIS [Colorado]: I couldn't tell if you were giving the substance intramuscularly, or IP.

DOCTOR FLYGER: It can be given intramuscularly, but it takes longer, and you can give it intravenously, if you can find the vein.

QUESTION: You stated that you could give the capsule in meats. What is the time element?

DOCTOR FLYGER: It would take over half an hour before it would take effect then.

MR. WOODWARD: Have you worked with antelope at all?

DOCTOR FLYGER: No; just small mammals the size of a raccoon and on down.

QUESTION: Would there be any information in the near future on large animals?

DOCTOR FLYGER: Yes. I'm going to try this within the next few weeks on white-tailed deer; and other people tried it on elk. We tried it on a deer without much success.

QUESTION: What if you give them an overdose? Is there anything you can do to bring them around?

DOCTOR FLYGER: Nothing that I know of.

MR. BISMARCK [Ontario]: Do you have any obvious variation in your results between animals that appear placid and those that appear to be quite nervous, in behavior? The background of this question is we have used chlorine chloride on timber wolves, and there is very much variation. It seems to be related to this nervous type of behavior or placid behavior.

DOCTOR FLYGER: I haven't noticed any such difference. I have not worked with any real placid animals because you can't really tell what has taken place.

QUESTION: In referring to placid animals or nervous animals, I am basing this on observations of animals we have in captivity. We have such variations that one animal would require three times the dose of another one.

DISCUSSION LEADER PRITCHARD: Have you conducted any study in which you have injected any animal continuously over a long period of time?

DOCTOR FLYGER: No. I haven't done that. It has been used in mental institutions on violent patients and they have been given it continuously and apparently the patient doesn't become tolerant of it. The dose that it takes to make the patient calm in the first instance would be the same as that used weeks afterwards.

QUESTION: Is this material such that it has the possibility of use to capture larger animals?

DOCTOR FLYGER: Yes. The company has just come out with a new type which they call Librium B which is in a much more concentrated form.

CHAIRMAN HAYES: I am sure that there will be many applications for this drug in the future, and there are many reasons to believe that its qualities will be improved upon and that the dosages will subsequently be lowered.

BIRD REPELLENTS FOR PINE SEEDS IN THE MID-SOUTHERN STATES[1]

WILLIS C. ROYALL, JR. AND JOHNSON A. NEFF

Bureau of Sport Fisheries and Wildlife, Nacogdoches, Texas, and Denver, Colorado

Seed-eating birds are present in great numbers in the mid-South (Louisiana and adjacent states) from autumn until early spring, which is also the period when pine seed is sown in nurseries and on forest lands. Several biologists of the Bureau of Sport Fisheries and Wildlife or its predecessor agencies (Burleigh, 1938; Fitch, 1948; Reid, 1952; Meanley, 1953; Meanley and Kalmbach, 1954) and foresters of the Southern Forest Experiment Station (Derr and Cossitt, 1955) have reported that blackbirds and meadowlarks (Icteridae), finches (Fringillidae), mourning doves (*Zenaidura macroura*), and other birds have been a major cause of failures of natural and artificial seeding of pines.

Bird repellent chemicals applied as powder coatings to pine seeds are gradually solving the problem. The use of repellents in direct seeding longleaf, loblolly, and slash pine has been particularly successful (Mann, Derr and Meanley, 1956; Mann, 1958), and promising results also have been obtained on shortleaf pine. Effective, practical seed treatments have resulted in initial seedling stands of five to ten thousand trees per acre. This progress has been possible through cooperative efforts of the Denver Wildlife Research Center and the Southern Forest Experiment Station over the past fourteen years.

Recorded trials of chemicals on crop and tree seed to repel birds date back at least 150 years, and known references have been summarized by Neff and Meanley (1956). The Denver Wildlife Research Center started its investigations in the bird repellent-deterrent field in 1941, when color was used to discourage birds from taking poisoned grains exposed for rodent control (Kalmbach, 1943; Kalmbach and Welch, 1946). This work showed green and yellow colors to be most deterrent to various bird species. Thus, in 1947, color (Monastral green pigment) was tested as a deterrent when the Denver Center began cooperation with the Southern Forest Experiment Station in studies of the bird-longleaf pine seed problem in Louisiana. In these and later field trials, however, unnatural colors applied to seeds did not provide adequate protection.

Anthraquinone dust was tested on ponderosa pine seed at two grams per pound of seed at the U. S. Forest Service Nursery, Halsey,

[1]Suppliers include E. I. duPont de Nemours and Co., Inc.; Naugatuck Chemical Co.; Stauffer Chemical Co.; and Winthrop Laboratories.

[1]Presented at the Twenty-Fifth North American Wildlife Conference, Dallas, Texas, March 7-9, 1960.

Nebraska, by Jack F. Welch in 1948; in 1951, in Louisiana, Vincent Reid experimented with longleaf pine seed immersed in water dilutions of Goodrite ZIP. Neither treatment was sufficiently effective. From 1951 through 1954 Neff and Meanley (1957 a, b) carried on extensive studies in Arkansas to test the repellency of candidate chemicals against blackbirds that were damaging rice seed and maturing rice. Cage and field tests disclosed that moderate to low concentrations of anthraquinone, Morkit (a German repellent), and certain other formulations were repellent to birds when applied to seeds. Continuation of these studies led to discovery of the greatly increased effectiveness of these materials when they were applied as seed coatings at heavier rates, *i.e.*, 10 to 20 percent of seed weight.

Samples of the most promising repellents used in the Arkansas rice study were rescreened by Meanley at Alexandria and later field tested by the Alexandria Research Center of the Southern Forest Experiment Station. U. S. Fish and Wildlife Service biologists continued working with the Alexandria foresters at longleaf planting time in 1952, 1953, and 1954 in field testing candidate repellents (Kalmbach and Meanley, 1953; Meanley, 1954). Good results were obtained with sublimed anthraquinone, Morkit, and quinizarine.

Field work from 1952 through 1957 was most intensive on cutover longleaf areas in southwestern Louisiana, and work was initiated with repellents on loblolly and slash pine seeds at other sites. Since 1955, this research has continued as a three-phase cooperative program in cooperation with the Southern Forest Experiment Station. In Phase I, the Denver Wildlife Research Center (and its southern field station) carries out the basic cage and field screening of all candidate materials. Since 1951, 310 chemical formulations have been screened in approximately 3,000 aviary and field exposures.

Phase II involves jointly-conducted direct seeding field tests of the more promising seed protectants derived from Phase I. Twelve joint field tests have been run in Arkansas, Louisiana, and Texas.

Phase III, pilot direct seeding, is primarily a Forest Service operation. Working largely with materials developed in Phases I and II, the Southern Forest Experiment Station has made substantial contributions in adapting repellents to field practices.

Screening studies by Meanley at Alexandria demonstrated the value of thiram compounds as bird repellents when applied to seed at 10 and 15 percent concentrations by weight of seed, and later joint field testing substantiated a forecast made by Welch (Welch and Graham, 1952) that thiram would show a degree of small mammal repellency when applied at high concentrations.

In 1957, several promising new formulations were sent to Alexandria for field testing; these were in large part reported upon by Derr (1959).

In the eastern Texas upland forests some three million acres have both an inadequate pine seed source and inadequate stocking (Anonymous, 1956). Here field testing has continued in cooperation with the Nacogdoches Research Center of the U. S. Forest Service; the senior author participated in these studies from 1958 through September 1960, with headquarters at Nacogdoches. Foresters have shown increasing interest in direct seeding on this western edge of the southern pine region.

A joint field test of three loblolly pine seed treatments (Arasan 75, Arasan 75 plus Endrin, and Winthrop Bird Repellent) was made on the Stephen F. Austin Experimental Forest during early 1959. Significant benefit was derived from two treatments (Royall and Ferguson, 1960a). On an adjacent tract, 144 one-hundredth-acre plots were staked out for preliminary screening of eleven other treatments along with an untreated check. These plots were sown in February 1959 with loblolly seed at the rate of two pounds per acre. Also, counted numbers of seed were placed on protected and exposed micro-plots for weekly observations of field germination and seed losses. The location of half of all sown plots and micro-plots within a one-acre small-mammal exclosure has permitted precise measurement of the nature and extent of seed losses to birds and small mammals.

Since bird populations were high, results of the exclosure tests proved significant. Flocks of sparrows (*Zonotrichia albicollis, Spizella pusilla*) and juncos (*Junco hyemalis*) were particularly evident from December 1952 through March 1959. Cardinals (*Richmondena cardinalis*) were ever-present at an average density of one bird per two acres, but small flocks often were seen within the test plots. This species is apparently more difficult to repel than other species which predominate in cutover longleaf sites. Weekly observations showed heavy seed losses on many micro-plots both inside and outside the exclosure wherever candidate repellents were not effective. Late spring counts of seedlings on hundredth-acre plots also left no doubt as to the worth of each coating. Stocking ranged from 0 to 4,167 seedlings per acre. Five treatments gave 2,000 or more seedlings per acre, whereas six others and the untreated check fell under 1,000 per acre.

Seedling production averaged 1,600 per acre inside the one-acre small-mammal exclosure and 550 outside, a difference attributed to harvest mice (*Reithrodontomys fulvescens*). Live-trapping transects and micro-plot examinations supported this conclusion. Inside the exclosure 80 percent of 3,600 seeds were hulled by birds while only 9 percent were missing. On the other hand, 58 percent of the seeds exposed outside the exclosure were hulled and 38 percent were missing, apparently carried away by mice.

During the winter of 1959-60, thirty-three different repellent coatings on longleaf or slash pine seed were exposed to bird attack within the exclosure. Only four to eight treatments were tested at any one time. For each candidate, twenty seeds were placed on each of six widely-spaced micro-plots. Seed losses were recorded five times over a one-month period. As during the preceding winter, bird feeding succeeded in separating good from poor seed treatments. Only eleven of the thirty-three candidates gave 60 percent or better protection.

Three of the most promising compounds from the first winter's exclosure study, Sublimed Anthraquinone, Spergon, and Thiram 50D, were included in an early 1960 joint field test on the Stephen F. Austin Forest (Royall and Ferguson, 1960b). Another joint study was carried out during the same period to compare a thiram treatment alone with thiram in combination with endrin in presence of a high rodent population. Results of the three Texas studies are to be covered in a future joint paper, but it may be here stated that the addition of endrin produced significantly better stocking.

Several effective bird repellents may soon be recommended for operational use on loblolly seedlings in eastern Texas. Similar studies are being made by the U. S. Forest Service's Research Centers at Crossett, Arkansas, and Alexandria, Louisiana, both of which are interested in direct-seeding of loblolly. Other tests have been completed on slash and short-leaf pine seeds at various points within the ranges of these species, and it is quite apparent that successful direct seeding of these pines may be accomplished in most instances with chemically-treated seed.

No matter how successful it has been elsewhere, a repellent material cannot be safely recommended for use in new regions without preliminary trials in those regions. For this reason, field testing in new areas should be extended, particularly in the case of shortleaf pine. Currently, anthraquinone, three thirams, and a number of other materials of almost equal merit are available on the market.[1] A few initially promising materials such as Morkit were removed from the market, and others have been proved impractical for various reasons after extended field trials.

Search for better bird repellents, not only for pine seed but also for agricultural crop seeds and maturing grains, must be continued. While research on bird repellent treatments for direct seeding of southern pines has resulted in effective operational techniques, the field of bird repellents has barely been scratched.

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TECHNICAL SESSIONS

Tuesday Morning—March 7

Chairman: FREDERIC H. WAGNER
Research Biologist, Wisconsin Conservation Department, Madison

Discussion Leader: ROGER M. LATHAM
Outdoor Editor, Pittsburg *Press,* Gibsonia, Pennsylvania

FIELD AND FARM RESOURCES

FOOD COMPETITION BETWEEN GAME AND NON-GAME BIRDS

VERNE E. DAVISON
U. S. Soil Conservation Service, Athens, Georgia

Can we plant and manage foods successfully for game birds? The answer is: "Yes! *if* we select plants that can be managed without heavy loss to competitive birds and mammals, and by natural deterioration." Conversely, the answer is: "No! if we ignore these destructive factors."

THE CHIEF PROBLEMS

1. Competition for food between game and non-game birds is a serious problem in the management of habitat for wildlife. Fifteen species of non-game birds (such as blackbirds, cowbirds, crows, grackles, and sparrows) gather in large flocks throughout the Southeast and feed heavily on the seeds of agricultural crops in the fall and winter. They also feed heavily on non-agricultural crops such as acorns, beechnuts, wild fruits, wild pecans, and the seeds of pines, sweetgum, ragweed, and barnyardgrass (one of the so-called "wild millets").

2. Many of the most attractive and nutritious game bird foods waste away quickly as they sprout, mold, or rot when left afield in the

climate of the Southeastern States. Fortunately a few species are highly resistant to deterioration (Neely 1956).

3. It is increasingly evident that food plantings will have to be made, and choice natural foods should be managed, to maintain suitable game populations on lands in the Southeastern States — both private- and public-owned. The increasing human population, with its growing urbanization of recently huntable lands, is one reason; more intensive use of croplands, meadows, pasture, range, and woodlands is another; and the increasing demands for a place to hunt (including financial arrangements between hunter and landowner) is a third influence in current and near-future situations.

The growing of wildlife foods usually involves agricultural practices of soil, water, and plant management. Encouraging results are demonstrated in many Soil Conservation Districts and on Federal and State Wildlife Refuges. The general proposition—of producing more wildlife food per acre agriculturally than nature alone will provide—needs no special discussion at this point. Nor is it my purpose to discuss the various techniques used in farming for wildlife. The current need is for more information about specific game-bird foods, particularly as to their susceptibility to natural deterioration and their attractiveness to competitive species of wildlife.

In the 1960 North American Wildlife Conference, an entire technical session (10 papers) was devoted to a "Depredations Control Symposium." The session was concerned mostly with agricultural crop damage and whether or not species such as redwinged blackbirds should be reduced in numbers by control programs. Carl W. Buchheister (1960) suggested that "certain agricultural practices tend to 'bait' the blackbirds and grackles," but he expressed the Audubon Society's opposition to wholesale killing of blackbirds to protect rice and other farm grains. A food planting for a covey of bobwhites, a flock of doves, or a flight of ducks may also "bait" the blackbirds. Therefore, we must select plants unattractive to them, or save the food by using protective practices such as flooding of duck foods. Let's look at the impact that flocks of non-game birds naturally have on specific game-bird foods. Then we can see how to follow Mr. Buchheister's suggested solution, "adjusting our agricultural practices and policies so as to avoid these conflicts."

THE FLOCKING NON-GAME BIRDS AND THEIR FOODS

The most competitive non-game birds are those that gather in sizable flocks. They compete most seriously during the fall and winter, feeding on our plantings of game bird foods. The 15 non-game species most destructive of game foods in the Southeast are redwinged and rusty blackbirds, bobolink, brown-headed cowbird, common crow, purple finch, boat-tailed and common grackles, eastern meadowlark, slate-colored junco, and 5 sparrows (chipping, field, fox, house, and white-throated). Three more—robins, starlings, and cedar waxwings—also gather in large flocks and feed heavily on fruits that may be eaten by game birds.

Though this discussion focuses attention on the most competitive species of non-game birds, we must be mindful also of added competition from mice, rats, and a few additional non-game birds. For example, cardinals, jays, and towhees take significant quantities of buckwheat, browntopmillet, and grain sorghums which are planted in small patches for game.

Table 1 lists 27 common cropland seeds and the species of birds that will eat them. The table specifies that the seed is a choice, fair, or unimportant food for the game species—bobwhite, mourning dove, ducks, geese, and wild turkeys, and for 9 groups of non-game flocks. It refers specifically to redwinged blackbirds (Brewer's, rusty, tri-

TABLE 1. CROPLAND SEEDS—FOODS OF GAME-BIRDS AND FLOCKING NON-GAME BIRDS. C = choice, F = fair, Blank = unimportant or unknown.

	Game Birds					Non-Game Birds								
Species of birds	bobwhite	doves	ducks	geese	turkey	blackbirds	bobolink	cowbird	crow	purple finch	grackles	junco	meadowlarks	sparrows
Plants														
barley		F	C	C	C	C	C		C			F		F
barnyardgrass		C	C	C		C	C	C				C	C	C
bristlegrass	C	C		F	F	C	C	C			F	C	C	C
browntopmillet	C	C	C	F	C	C		C		C		C	C	C
buckwheat	F	F	F		C				C	C				
corn	C	C	C	C	C	C		C	C	C	C	C	C	C
cowpeas	C	F			C									
croton, woolly	C	C				F		F						
Japanesemillet		C	C									C		C
junglerice		F	C			C	C	C						F
lespedeza	C	F			F									
millet, foxtail	C	C			C					C		C		C
oat	F	C		C	C	C	C	C	C	C	C	C	C	C
peanut	C	F		C	C	C			C	C		C	C	C
pearlmillet	C	C				C					C	C		C
proso	C	C								C		C		C
ragweed, common	C	F			F	C		F			F	C	F	
rice	C	F	C	C	C	C	C	C			C	F	C	C
rye	C	C	F		C	F								F
sesame	F	F				C						F		C
signalgrass	?	C	F			C	F							
sorghums	C	C	C	C	C	C		C	C		C	C	C	C
soybeans	C	F	F	F	C									
sudangrass	C	C	C							C		C		C
sunflower	C	F			F	C	F		F	C	C	C	F	
vetch	C				F									
wheat	C	C	C	C	C	C	C	C	C		C	C	C	C

TABLE 2. NON-CROPLAND FOODS THAT FEED GAME BIRDS AND FLOCKS OF NON-GAME BIRDS IN THE SOUTHEAST. C = choice, F = fair, blank = unimporant or unknown.

	Game Birds				Non-Game Bird Flocks				
Foods	bobwhite	dove	duck	turkey	robin	starling	cedar waxwing	grackles	black-birds
acorns	C		C	C				C	
beechnuts	C		C	C				C	F
blackgum	F			F	C	C			
bulrush, saltmarsh			C						
camphortree					C	C	C		
hackberry	F			C	C	C	C	F	
pine seeds	C	F		C					C
pokeberry	F	C		F	C	C	C		
privet	F				F	F	C		
redcedar					C	F	C		
rose, multiflora				F	F		C		
smartweeds		F	C						C

colored, and yellow-headed blackbirds have similar feeding habits); bobolink; brown-headed cowbird; common crow; purple finch; common grackle (boat-tailed grackles eat similar foods); slate-colored junco; eastern meadowlark (western meadowlark foods are similar); and chipping, field, fox, house, song, and white-throated sparrows (several other sparrows eat the same foods). These evaluations reflect published records (Stoddard 1931; Martin, Zim, and Nelson 1951; and others, and extensive observations and ''free-choice'' feeding experiments (Davison and Grizzell 1961). The methods of evaluations are those of Davison and Hamor (1960).

Table 2 lists non-cropland foods (acorns, beech, blackgum, bulrush, camphortree, hackberry, pine, pokeberry, privet, redcedar, smartweeds, and multiflora rose). These are of various importance to the four game birds (bobwhite, doves, ducks, and wild turkeys) and flocks of robins, starlings, and cedar waxwings.

I have not made sufficient studies yet, to include the foods of the other North American game-birds and non-game flocking species such as the snow buntings, sandhill cranes, crossbills, western doves, goldfinches, grosbeaks, sharp-tailed grouse, horned larks, longspurs, ring-necked pheasant, prairie chickens, western quails, ravens, and Bohemian waxwings. Those who are familiar with their food habits may discern likely problems of food competition between the game birds and non-game species in areas other than the Southeastern States.

The significance of this total competition for foods is: *The foods eaten by millions of non-game species are not available to game birds. Because of this competition, the cost of growing food for game birds may be largely wasted. However, the proposition of growing game-bird foods is not hopeless. Let's see what can be done by management and proper selection of foods.*

DISCUSSION AND CONCLUSIONS

By studying each plant in the tables, we are alerted to non-game flocks that compete with game birds. A study of each game bird's choice foods will indicate also the alternate opportunities to produce foods without serious competition. The following paragraphs discuss the practical usage of this information.

Bobwhite foods. Small food patches (1/8 to 1 acre) seldom feed bobwhites satisfactorily if browntopmillet, buckwheat, pearlmillet, proso, or grain sorghum (Durell 1957) are grown. One exception is: browntopmillet is a useful late summer and early fall food—before the non-game seed-eaters gather into destructive flocks—but browntop must be supplemented with a dependable late fall, winter, and spring food such as Florida beggarweed, lespedezas, soybeans, or tickclovers. A quick glance at the tables will show that one group—the agricultural lespedezas—are superior bobwhite foods because no flocking species are attracted to this legume. Add the knowledge that (1) deterioration by weather is low (about 50% over a period of a full 12-months), (2) even rats and mice do not use the seed importantly, and (3) only livestock and plowing destroy the availability of the food (Davison 1954). Fencing will protect the lespedezas against livestock, where domestic animals are a problem. Non-agricultural legumes such as milkpeas, partridgepeas, and perennial tickclovers are similarly unattractive to flocking species. Partridgepeas are less dependable, as they frequently fail to produce seed in food-patch management. Cowpeas and soybeans, though not eaten by non-game birds, are destroyed by deer and domestic livestock; they deteriorate seriously by weather by mid-winter, but are moderately useful to bobwhites until then. Woolly croton is a useful plant in pastures (Fessler 1960) since no kind of animal grazes it, only doves find it attractive, and non-game birds compete sparingly if at all.

Mourning dove foods. From the problem of flocking-bird competition, the evident choice of foods to grow would be woolly croton or pokeberry. The croton is safe from livestock, but pokeberry is not. Cardinal is the only bird that competes with doves for pokeberry seed, though several fruit-feeders eat the pokeberries heavily in summer. Pokeberry is also the most weather resistant of the dove foods.

However, browntopmillet, corn, oats, and wheat (in summer), and grain sorghum usually are suitable foods for doves during the fall, in hunting season, if you depend on the seeds that escape machinery-harvest in fields of 20 acres or larger. The oats, grain sorghum, and wheat, however, cannot be grown economically for doves in food patches, since all four deteriorate rapidly in humid weather. Sesame is difficult to grow because of "wilt" disease, and it is not the choice food we once thought it to be (feeding experiments to be published).

Duck foods. Only saltmarsh bulrush, smartweeds, and soybeans are safe from flocking birds in fields managed for choice duck foods; but soybeans are not practical to grow, as they rot too quickly. However, acorns, browntopmillet, corn, and Japanesemillet can be protected from flocking-bird competition, by flooding the field or woods in October or when the flocks appear. Widgeongrass is fully satisfactory in brackish-water ponds. Pearlmillet, rice, and grain sorghums are not practical to grow for ducks since the seeds remain available above water to the flocking competitors. Buckwheat yields little in the South, and it deteriorates more rapidly than better duck foods. A more thorough discussion of agricultural food management for ducks is available in USDA Farmers Bulletin No. 2144, "Managing Farm Fields, Wetlands, and Waters for Wild Ducks."

Wild turkey. Food patches of winter grazing crops such as clovers, ryegrass, and wheat are very useful and economical for wild turkeys. Chufas are difficult to grow repeatedly on the same sites due to raccoon damage.

General comments. Thus it is evident that any plant food which is equally choice to flocking-birds and game birds must be considered very carefully. Plants such as buckwheat, pearlmillet, rice, grain sorghum, and grain wheat are relatively inefficient in game-bird food patches in the Southeast. Proso, better adapted to northern climates, probably can be used there as we use browntopmillet in the South.

Peanuts have not been grown successfully for game birds, except as late summer food in patches for turkeys.

We have insufficient experience to discuss the problems and values of planting barley, barnyardgrass, bristlegrass, junglerice, foxtail millet, signalgrass, sudangrass, and sunflowers for game birds. Competition with flocking birds would be a problem to consider.

Robins, starlings and cedar waxwings may not be serious competitors for game-bird foods. They were included in these studies because they gather in large flocks in the South, and we needed to evaluate their choice foods in this light.

Another use of the information in Table 1 is for the two million people in the United States who feed cropland foods to bobwhites, doves, ducks, wild turkeys, and non-game birds such as cardinals, juncos, white-throated sparrows, and towhees. Grain mixtures are packaged and sold for birds in nearly every town and city. Table 1 includes most of the choice foods for this purpose. Fortunately, such grains do not deteriorate significantly by weather action over a period of 20 or 30 days, even when fed on the ground or on platforms without roofs. A group of "competitors," not previously mentioned but often tolerated enjoyably at such feeding stations, are the squirrels and chipmunks.

SUMMARY

Choice foods can be provided for game birds, but competition from non-game species that gather in large flocks is a serious problem in the Southeastern States in fall and winter. Fifteen species of flocking birds are significantly destructive of game-bird foods.

Forty-six game-bird foods are discussed with emphasis on their suitability for management. The problem of their deterioration by rot, mold, and sprouting is discussed as a second limiting factor.

The foods to favor for bobwhites, mourning doves, wild ducks, and turkeys are suggested.

The problem of feeding game bird species better, in spite of flocking non-game birds and weather deterioration, is not insurmountable, however. It simply needs careful attention.

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DISCUSSION

DISCUSSION LEADER LATHAM: Thank you, Mr. Davison. You have given all of us some valuable information that can save money and wasted time if followed.

In Pennsylvania where we have a wintering problem with wild turkeys, the competition resulting from huge flocks of migrating robins in the fall sometimes so badly strips old wild grape crops in the mountains that we enter the winter with much less of this crop for wild turkeys than we would have otherwise. I suspect that in many areas the available crop is cut to perhaps ten per cent, and during periods of deep snow, the wild grape that has dried and is hanging on the vine is the most valuable food for that period.

Perhaps robins are a real threat, you might say, for winter turkey survival. I think this illustrates the competition that can occur between game and nongame birds, even in the North.

MR. FREDERICK SCHMID: I was wondering, Mr. Davison, if in your studies of the use of bicolor by quail you found severe competition by Peromyscus where the bicolor borders wood lots and fields.

MR. DAVISON: Yes, Mr. Schmid, as you would know, we've worked too hard on bicolor not to have studied some of those things; however, not quite in the direction you have done it. Our studies have been conducted by determining how much food was left on the ground year after year so we knew we had considerable food left.

When we collected bobwhite crops and left them around where mice could get to them, they never ate them. The competition by other birds often excites us because doves often come into a bicolor field apparently just to be on the ground, but they cannot eat the seeds or will not eat them as long as the hull is on the seed.

MR. SCHMID: The way we're set up we can't go into every last thing, and I was wondering if you have come across any evidence.

MR. DAVISON: We see no evidence at all, and I want to tell you I have looked at millions and millions and millions of seed on the ground and I haven't seen mice eat them.

MR. SCHMID: Just from a casual observation, I may add that I have seen the Peromyscus climb bicolor and eat the seeds when they're in the unripe stage, when they are just filling out in late summer. The bicolor doesn't ripen well until well into September.

MR. DAVISON: We have a little competition by sparrows when the seed is in the dough, but at that time we don't have enough to make any difference.

MR. ROLAND C. CLEMENT [National Audubon Society]: That was a thoughtful paper and it suggests to me that this increasing awareness of competition between game and non-game forms and between wildlife in general and agriculture, is a result of general deterioration in the habitat, so that when the wildlife manager, for example, tries to recreate optimum conditions, he attracts everything in the whole region.

Perhaps what we need to emphasize particularly from now on is the necessity of trying to retain as much diversity in habitat as possible to avoid this concentration of all forms of life in the few remaining optimum sites.

MR. DAVISON: Yes, sir, I think we should go as far as we can in that direction, Clement, but in many ways we can not because we grow for human food and other animals, things that are more tasty than nature alone provides. Consequently the birds have sense enough, taste-wise I'm sure, to come to the food.

Another alternative that will suggest itself is to find one food that would feed only one kind of bird and that no other bird would eat. I laughingly say we sometimes are trying to do it. We almost have it in the bobwhite, we almost have it for ducks in smartweeds, but we can't do it completely. We can strain it down where our only competitors come in small numbers. We can afford to feed them and help them along with our gamebirds, but we don't need to do that for red-wing blackbirds and grackles and a few others.

DISCUSSION LEADER LATHAM: Another comment?

MR. WALT DYKSTRA [Bureau of Sport Fisheries and Wildlife, Washington]: I'd like to ask Mr. Davison for some negative information in that one of my current headaches is how to make airports unattractive for birds. The airport management people are asking for suggestions as to the types of trees and shrubs and grasses that could be planted which would not constitute an attraction for birds.

In your research have you compiled a list of plants that are not eaten by any forms of birds? Is such a list available?

MR. DAVISON: Yes, I have not published it yet. I keep saying I'm going to have the publication in 1960 or 1961, now I say in 1962. I could pull out of my files a great many plants that would be very useful around an airport that no kind of bird will eat, or that the only birds that would eat them would be one or two species.

THE FUTURE ROLE OF SHOOTING PRESERVES

CHARLEY DICKEY
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Shooting preserves have grown steadily in the past ten years and there are an estimated 1,800 private and commercial preserves now in operation. Forty-one states now allow preserves to operate. The past decade has shown conclusively that private enterprise can give an assist to state and Federal game agencies in meeting the demands of hunters. Furthermore, the assistance of private enterprise has worked no undue hardship on these agencies or their programs.

Shooting preserves have increaesd rapidly in the Southeast in the past five years because of enabling legislation and hunter response. Five years ago Georgia had one preserve operating in the state-wide season. Today, with a six-months season, Georgia has 30 licensed commercial preserves and nine private preserves. These preserves will handle roughly 175,000 quail during the 1960-61 season.

Some of the largest preserves in the nation handle as high as 15,000 quail each season. Other large preserves may stock more than 10,000 pheasants a year. The Dixie Lily Ranch, near Williston, Florida, has hosted as high as 4,000 hunters in a season.

There are now one or more shooting preserves within easy driving distance of nearly every major population center in the United States. Although many hunters do not patronize shooting preserves, they recognize them as one way of meeting the recreational demands of outdoorsmen. Preserves are no substitute for the many programs of state and Federal agencies; neither will they be able to replace the vital development of private lands in America. Shooting preserves are one approach among many to create hunting for our growing population.

What will be the role of shooting preserves in the next decade? There is no question that the number will increase. Also, the number of hunters handled and number of birds harvested will increase.

Private shooting preserves will increase faster than commercial preserves. Groups of city hunters, ranging from five to perhaps one hundred, will work with farmers for in-season stocking of game birds, especially ringnecked pheasants. Quite often this type of operation will not be on an extended season basis but will operate only during the state-wide season.

The following is an example of one type of small club which will increase in popularity during the 'Sixties. The Spit 'n Argue Pheasant Shooting Society of Greenwood, South Carolina, is going into its fourth season. There are ten members; nine members each pay $105.00

a year. The tenth member, the farmer owning the land, puts up no cash. He furnishes the land, has a holding pen which the others paid for, and plants feed and cover. The Society contracts for 400 almost-mature pheasants. They do not get into the problems of game bird rearing. The holding pens have automatic waterers and feeders so that the farmer is put to little trouble.

The pheasant are delivered to the farm two weeks before Thanksgiving. The hunting starts the first Saturday after Thanksgiving. It continues for eight straight Saturdays, weather permitting. Fifty pheasants are stocked on 275 acres of land each Saturday morning; the members hunt on Saturday afternoons.

As a full-fledged member, the farmer hunts with the others. The members can shoot only stocked game; they cannot shoot the native quail, squirrel and rabbit. The members can hunt only on Saturday afternoons; they have no rights on the land the remainder of the week. The farmer, along with his son and friends, can hunt the surplus pheasants the other six days of the week.

Of the fifty pheasants stocked each Saturday morning, from 30 to 35 are harvested by the members. This leaves 15 to 20 pheasants on the property for the farmer to hunt during the week. The members knew this in advance and like it that way. It is their contribution to the farmer in return for using his land and other favors. The club is unique in that the hunters contribute something to the farmer.

It costs the nine paying members about $13.00 per hunt; on the average they will take home at least three pheasants. The members did not attempt to tie up more land than they needed. The surrounding farmers are happy as they pick up roaming pheasants. The farmer is pleased with the situation as it provides plenty of hunting for him and his friends at little expense and trouble.

This kind of simple and uncomplicated club is certain to increase in the 'Sixties. It is inexpensive enough so that the average income bracket hunter can afford it. This type of operation is no problem to the state game commission. Most important of all, the members are providing their own hunting at their own expense and are benefiting a farmer.

Some of the private preserves in the nation now have 100 or more members. They have guest privileges. A given acreage of land may handle as high as 1,000-hunter days for an extended season. This type of operation is generally geared for the upper middle income bracket and higher. Everyone cannot afford it but at least it is that many hunters who are kept satisfied and it is that many hunters who are not out hunting on open land. The 'Sixties will see a gradual but continual growth in this type of operation.

Also under the heading of private shooting preserves, the 'Sixties will see an increase in the number of companies and corporations that establish their own operations for company brass and clients. This will not be confined to large industries. For instance, one poultry farmer in Georgia has found that his quail preserve helps with the sale of broilers and eggs. In New Jersey a dairy farmer has a preserve for his employes as part of an overall program to maintain good labor relations.

There is a trend in many sections of the country for old-line hunting clubs and lease arrangement clubs to stock just before the statewide season opens. They "sweeten" the areas throughout the hunting season. Many of the clubs have gotten away from spring stockings because the results have generally been unsatisfactory. By stocking one to four weeks ahead of the season with quail, or stocking during the shooting season, the private clubs get a better return on their birds. They are often happy to get a 40 to 60 percent recovery.

One of the greatest contributions of commercial preserves is that the operators, at their own trouble and expense, have worked out methods whereby pen-raised pheasants, chukar, and bobwhite quail can be stocked in season for sporty shooting. The techniques they have developed are being applied on private preserves and are helping to satisfy thousands of hunters.

Only five years ago there was some doubt that the bobwhite quail would be satisfactory for shooting preserves, either private or commerical. Game breeders have improved their techniques of raising birds in isolation, weather and flight conditioning quail, improved their feed and cover, and refined their actual stocking processes. Improvements in game bird nutrition and disease control have also aided.

There is a better liaison between preserve operators to exchange information on new techniques of game bird management. For instance, in April 1961 there will be short courses on game birds at Michigan State University, the University of Georgia and the University of Florida. Two trade journals, *Modern Game Breeding* and *Game Bird Breeders, Pheasant Fanciers and Aviculturists' Gazette,* now have regular monthly columns on shooting preserve management. About one-third of the states have associations of game breeders and preserve operators to exchange information and upgrade operations. The Sportsmen's Service Bureau recently published a 96-page booklet on "Shooting Preserve Management." Feed companies, state game commissions, extension services, arms and ammunition companies and private game breeders are all adding to the literature available to those who want to know more about preserves. The potential preserve operator of today, either private or commercial, has a much better chance of success than one entering the field five or even two years ago, if we are to assume that accumulated knowledge is a criteria for success.

All of the problems are far from being solved. The commercial preserve operator will always have his headaches in trying to mass produce game birds which are fully ready for a good field performance the day they are stocked. Also, he must learn to do this and still make a reasonable return on his investment.

What of the growth of commercial shooting preserves in the 'Sixties? One fundamental fact should be kept in mind: these preserves are economic ventures. The sportsmen ultimately control the number which will remain open. Only as many preserves as the hunter will pay to support can stay in operation. The hunter is also the final arbiter on the quality of sport on preserves. If he refuses to spend his money at substandard preserves, only the best will survive.

The number of commercial preserves in the nation will increase during the 'Sixties but there is no indication that there will be a sudden burst of them opening. From past experience we now know that it is difficult to make a living from a preserve. The increase will be gradual but steady, barring a national economic slump or war.

There is a trend in several states for shooting preserves and fee fishing lakes to become the nucleus of year-around outdoor recreational centers for the entire family. Such centers give the operators a longer period in which to take in their annual income. Besides hunting and fishing, a few operators have added swimming, hiking, horseback riding, zoos, clay target facilities, scenic tours, greenhouses, Christmas trees, rifle ranges, bird-watching areas and clubhouse games. While dad goes hunting, mama can look at flowers, the kids can fish, grandma can watch birds, and the entire family enjoys healthful outdoor recreation.

An outstanding example of this is the Ida Cason Callaway Gardens which started in 1949 near Pine Mountain, Georgia. They have 3,000 acres developed for scenic tours, horticulture, two greenhouses, a 175-acre fishing lake, a 50-acre swimming lake, bird watching areas, a golf course, motel and restaurant. This year they are adding an 1,000-acre shooting preserve. At modest prices, families can visit the gardens for an afternoon or a month. On Sundays the gardens has had as high as 10,000 visitors. This multi-million dollar operation started on foundation money but is now self-sustaining, all profits going into improvements and expansion. It is one of the outstanding examples in America of how private enterprise can help to not only provide hunting and fishing but outdoor recreation for the entire family.

Many shooting preserves in Illinois, Ohio, New York, Pennsylvania, Georgia and other states have added fishing lakes, and contrariwise. The preserve operators are learning that they need a year-around income and that they must diversify. This is all to the benefit of the American sportsman.

It is now possible for a sportsman traveling from either New England or Chicago to Florida to spend each night at a shooting preserve, the same as a motel. In the Southeast nearly every large motel has a swimming pool. A few motels now have fishing lakes which their overnight guests can enjoy. In the future, some of the large motels will not build on the city limits but will buy farms farther out. The motels will have swimming, fishing, target ranges, putting greens and a variety of outdoor attractions. Some will have shooting preserves. They will cater to the entire family rather than the hunter alone.

If we believe that both private and commercial shooting preserves will increase in the 'Sixties, then what are some of the factors which should be considered? What about regulations?

Generally, most state commissions have fairly liberal regulations with a minimum of red tape. If the operators want a six-months season, then they should be granted it. Time has shown that a season this long is acceptable and there is almost no opposition from sportsmen. Most states now allow a season of six months. The no-bag-limit is also generally accepted.

Most states have a maximum acreage which is allowed in a single preserve. This ranges from 500 to 1,000 acres, usually. There should definitely be some sort of restriction on total number of acres in a single preserve. Everyone in the game business knows the tendency of sportsmen to tie up more land than they actually need.

There should be a regulation requiring a minimum seasonal release of any species to be used during the six-months season. This puts the operator to enough expense and trouble so that it guarantees he is contributing something and is not opening to get an earlier and longer crack at native game which might already be on the preserve.

Most states have a special non-resident license for shooting preserves, applicable on any preserve in the state for the full season, and for released species only. The most general charge is $5.00. This has been found to be a happy medium. Out-of-state hunters do not balk at paying $5.00 and this charge gives the state commission some revenue. State commissions are put to administrative expense by both private and commercial preserves and should therefore receive some income from preserve operations.

For the actual licensing of the preserves, most states charge from $25.00 to $50.00 per year. This is a reasonable charge and the operators seldom complain. On the other hand, it would work a hardship on the small operator to go much higher.

Several states, as Illinois, Michigan, Pennsylvania and others, now have one man in each commission who works with the preserve operators. He meets with them, discusses regulations, helps them with food and cover planning, on hunter management problems and serves as a general advisor. This is desirable from the standpoint of the commission and also the operators. With the expected growth of preserves in the 'Sixties, other commissions will undoubtedly assign one man to work full time with preserves.

It is to the advantage of the commissions to encourage the game breeders and preserve operators to organize an association. It is easier for a commission to work on regulations with an association rather than scattered individuals. The association should be urged to have its members improve standards of game rearing and improve the quality of the shooting preserves.

In advising preserve operators on management, state technicians should keep in mind that the management techniques for stocked birds are different than those for native game, although there is some overlapping. The feed and cover development on shooting preserves is essentially for recovery; feed and cover development for native game is for year-around survival.

As a service to its license buyers, state game commissions should print an inexpensive directory each year of the shooting preserves open to the public. Some states, as Michigan, already do this. The directory should receive a good distribution and be used to answer letters from hunters on where they can hunt. The directory should also be used in appropriate commission publications. The person compiling the directory should be sure that he lists only the preserves open to the public and those which want to be listed. At present, some states send out a complete list and the hunter has no idea which of the preserves are commercial and which are private.

In a very few states, the license-buyer cannot write his state game commission, which he helps support, and obtain a list of commercial preserves where he might hunt. This is not fair to the operator, who is contributing some income to the commission, nor is it fair to the sportsmen who do most of the supporting.

The state commission problems in the administration of shooting preserves do not appear to be complicated and certainly not insurmountable during the 'Sixties. Most administrators have the attitude of giving the preserves a free rein, within bounds, and seeing what will develop.

With America's expanding population, it is fully apparent that state and Federal agencies can use a helping hand from private enterprise in meeting our future hunting and fishing needs.

DISCUSSION

DISCUSSION LEADER LATHAM: I would just like to make one comment on Charley Dickey's paper. In Pennsylvania this year the regulated shooting grounds operators had a six-weeks vacation because hunters, for some reason, didn't like to hunt when the snow was waist deep. This has created a situation.

When Charley mentioned that there are a number of private shooting preserves developing with 10 or 15 sportsmen banding together, I am a little disturbed and I think that there should be some educational work along this line to at least suggest that these people try to establish their private shooting preserves on lands which are now closed to public hunting, rather than taking up land which is presently open to public hunting. Certainly there is enough of posted land if they would look for it a little.

MR. O. E. FRYE [Florida]: We had quite a discussion last night relative to the possibility of the S.P.C.A., for example, beginning to have something to say about shooting preserves and about releasing these birds and shooting them. Have you had any trouble at all that you know of with that yet?

MR. DICKEY: I don't know what the intentions of the S.P.C.A. are but I know that they have essentially left these places alone. The only incident that I can remember is when an S.P.C.A. official visited a Pennsylvania shooting preserve about six years ago, when I was working in Pennsylvania. He looked it over but he had no comment and he did not object to it. Some commercial operators occasionally release pheasants in poor condition, which makes it difficult for the birds to survive, and I think that is one of the things that we should look into more in the future. But generally S.P.C.A. has taken an apparent hands-off attitude.

DR. E. L. CHEATUM [New York State Conservation Department]: In some of the eastern states, and particularly in New York, I think that much extension of private shooting preserve posting operations is going to run head-on into conflict with the rank-and-file sportsmen of the state who are very interested and very enthusiastic about New York's program, under the Fish and Wildlife Management Act, of opening more lands to general public hunting. This head-on conflict may result in limitations on total acreage in any county that may be licensed under a private shooting preserve.

I'm merely expressing an opinion. There's nothing pending with respect to legislation or anything of this nature, but I do want to point out this basic conflict between these two programs, and I'm sure other states have the same problem.

MR. DICKEY: Thank you, Dr. Cheatum. That is a very definite problem that I can see in New York where you have more shooting perserves than any other state in the nation. I think very definitely that it would be a wise thing to have these acreage restrictions in a single shooting preserve. It might be that some state would want to consider a maximum acreage for commercial preserves and a smaller maximum acreage for a private shooting preserve. We do know, all of us who work with sportsmen, that they tend, if you don't put some restriction on them, to tie up more land than they actually need. Some of the commercial shooting preserves will have 10,000 pheasants on 300 or 400 acres. Certainly a private group of 10 or 15 doesn't need to tie up half of the county.

THE HUNTER—WHO IS HE?

TONY J. PETERLE[1]
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W. Winston Mair (1960), in his critique of the 25th North American Wildlife Conference, had this to say: "I am disturbed too at the apparent complete lack of research into the social and cultural aspects of the wildlife conservation field. We are spending significant sums of money on wildlife now and plan to spend much more in the future, particularly with respect to the allied field of recreation. But there has been at this Conference no mention of research into the mores of our people, their motivation and their real needs." I hope this project will be, at least, a step towards a better understanding of the hunter, his needs, desires, motivations, and, as a result, his future.

Certainly I am not the first to question why. A most thoughtful and perceptive paper was written by Clarke (1958) inquiring into man's position as a hunter in "the basic process of organic nature." A further insight into the relationships between man's hunting and his environment was presented by Shepard (1959), who said, "Hunting provides the logical nucleus for the evolution of communal life with its celebrations of a biosocial participation mistique." Speaking of the hunter, he says the hunt and the kill "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." A number of other publications are available which primarily concern the dollars-and-cents value of hunting and fishing (Anon., 1956, 1957; Couture, 1954; Leedy and Dambach, 1948; White, 1955).

I would probably be remiss in my duty if I didn't also include the comments by Krutch (1957) and Anthony (1957) presented in an article entitled "The Sportsman or the Predator?" Krutch, who is in some measure a proponent of the reverence-for-life philosophy, had this to say: "When a man wantonly destroys one of the works of man we call him Vandal. When he wantonly destroys one of the works of God we call him Sportsman." In his rebuttal to Krutch's position, Anthony stated: "But man is a predator biologically and historically, and his mental processes are totally conditioned by this fact. . ." It is not the purpose of this paper to discuss the merits of each argument.

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[1]A contribution of the Ohio Cooperative Wildlife Research Unit. Professor H. A. Toops of The Ohio State University Psychology Department provided considerable assistance in the design and review of the questionnaire and edited a draft of this paper. The Olentangy Wildlife Experiment Station, Ohio Division of Wildlife, provided the mailing list and addressed all the correspondence.

Our questionnaire was designed to inquire into the ecology of this "predator" species, more particularly, that variety or cline who, by their own admission, identify themselves as hunters. Perhaps we are treading where others with more knowledge fear to go. Darling (1960), in speaking of the British people's innate quality of kindness to animals, says that questioning or disturbing this belief may be irrelevant or even irreverent. I feel that the more we know about our "consumer," the better chance we will have of selling our "product." The "consumer" is the general public, more specifically, the hunting-license buyer. In the future he may be the wildlife photographer, the bird watcher, or just a man enjoying the many recreational opportunities available in the open country. The "product" is considerably more difficult to identify and I will evade the issue by saying it is "conservation" and let each of you attach your own definition.

The Ohio Division of Wildlife has, for a number of years, compiled a randomly selected list of hunting license buyers from license stubs held by dealers. A 1-percent sample of the total number of licenses sold in each county comprises the statewide game kill survey mailing list. The Wildlife Division supplied us with a list of 6,810 names taken from the 1959 hunting license stubs. The sales for the 1959 license year totaled 674,082, giving us slightly over a 1-percent sample of all licensees.

We began to develop the questionnaire in the fall of 1959 and tested a rough draft on groups of college students in the winter of 1959-60. Using college students as the initial test group gave a rather biased estimate of the reaction by "average" hunters. The construction of one question in particular gave us an adequate response in the pre-test, but was almost a complete failure in the final questionnaire. A commercial art firm was contracted to assist in the design and preparation of the final questionnaire form. The result was a printed booklet 3⅝ inches by 8⅝ inches, containing 200 questions on 23 pages (Figure 1). We attempted to keep the replies in simple x or check form, with the actual writing at a minimum. In addition to boxes for checking the respondents' answers, we provided boxes and numbers for coding the results. The response boxes proved adequate, but the coding boxes should have been twice as large and the code numbers, rather than being consecutive, should have agreed with the columns on the punch card. In timed tests it took most people between 20 and 30 minutes to complete the questionnaire. Coding for machine punching takes about 5 minutes for each booklet, while the key-punch operators can completely punch the data on two cards in about 2

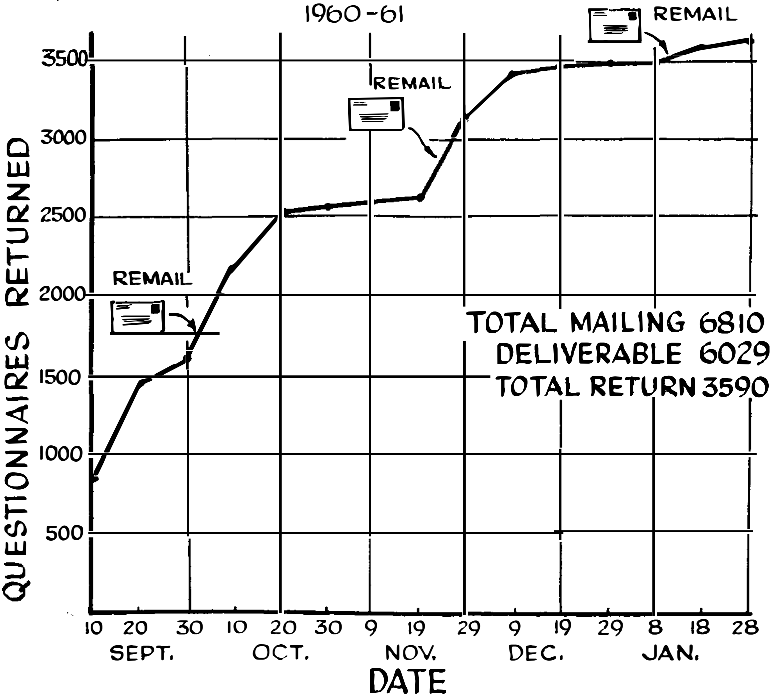
Figure 1. The Questionnaire, "For Hunters Only"

minutes. The information was condensed on the cards by using combinations of multiple and addend coding.

A cost accounting of the project is not complete since we are still in the process of receiving returns and tabulating data. A rough estimate based on an expected return of 4,000 questionnaires amounts to about $1.00 for each returned questionnaire. This estimate includes processing the data on punch cards, but does not consider any cost for machine analyses.

Initially, we mailed 6,810 questionnaires on September 1, 1960. This mailing consisted of a question booklet, an explanatory letter, and a postage paid return envelope. Official Ohio Division of Wildlife stationery was used for the initial and all subsequent letters, the letters being signed by the Chief of that Division. Subsequently, we mailed follow-up letters to non-respondents on October 3, November 21, January 3, 1961, and again on February 6, 1961. Only the November and February mailings included additional copies of the questionnaire with postage paid return envelopes. Figure 2 shows the rate of returns in relation to the remail dates. As of the first week of Feb-

Figure 2. RATE of RETURN "FOR HUNTERS ONLY"



ruary, we had a return of 3,616 questionnaires, about 60 percent of those deliverable. Postal authorities specified the following on those questionnaires considered non-deliverable: no such address, 295; moved, 275; unclaimed, 82; not here, 37; deceased, 23; insufficient address, 13; unspecified, 56; making a total of 781 non-deliverable addresses. Fifty-nine people have returned the questionnaire unanswered for personal reasons; *viz.*, questions not related to wildlife, too personal, not interested. The remainder of the returns have been quite complete and clearly filled out, most of the respondents signing their names where requested at the end of the booklet. A great many wrote additional comments in the space provided, comments ranging from highly critical to quite flattering. Most of the remarks concerned the operation of the Ohio Division of Wildlife, since the letterhead of the explanatory material was the official seal of that state agency. A review and discussion of these comments is quite interesting, but they cannot be adequately summarized.

As an interesting sidelight, the Ohio Division of Wildlife has had equal success in securing returns from a game kill survey sent out to the identical licensees, about a 60-percent return. This is in contrast to their normal yearly return of 35-40 percent. Apparently, our questionnaire had some influence in increasing the normal return rate of the game kill survey.

The following discussion is based on data from 1,100 questionnaires randomly selected from the total return. Since this constitutes a preliminary report involving less than one-third of the total returns, no statistical treatment of the data was attempted.

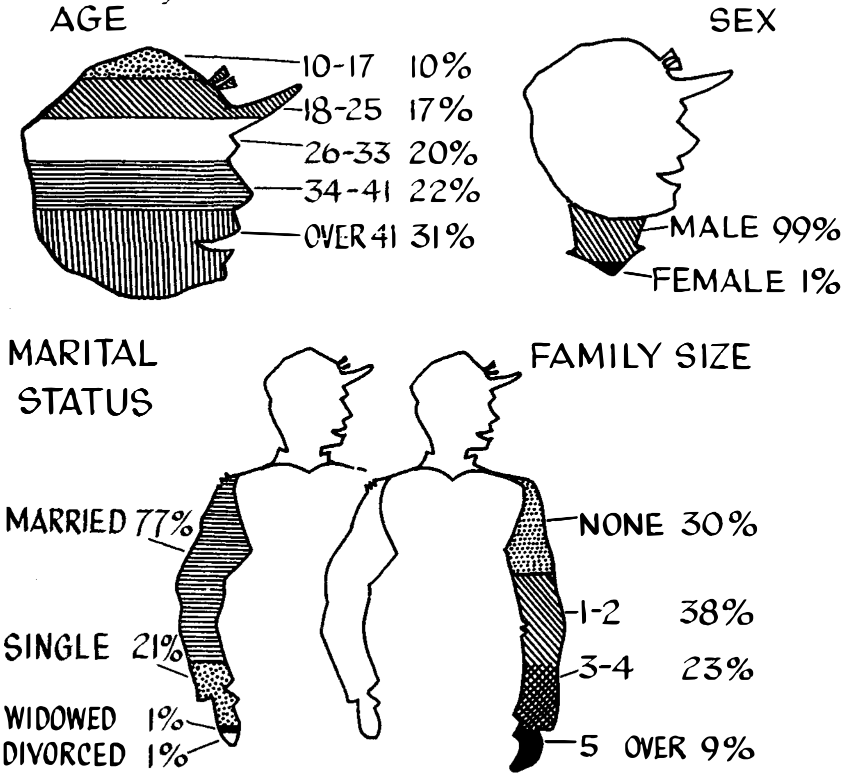
According to the 1960 census, Ohio has about 9.7 million people, an increase of 22 percent over the 1950 population. Some (Munson, 1960) predict that the population will reach 19 million by 1980. In 1950 nearly 10 percent of the state's total population purchased hunting licenses, but in 1959 only 7 percent became legal hunters. This decline in fishing and hunting license sales has been evident in several of the midwestern states. I wonder what proportion of the 1980 population will be interested enough in the sport to purchase a hunting license. A few percentage points of 19 million will make a big difference in the income available to the conservation agency. Perhaps a better understanding of just who buys a hunting license will enable us to predict the future trends in sales.

The first portion of our questionnaire was devised to identify the individual hunting license buyer and to determine whether he belonged to what the psychologists call an ulstrith group (Toops, 1948). Questions concerning his age, sex, race, marital status, size of family, place of birth, the origin of his parents, occupation, annual income, educational level, and whether he served in the armed forces helped to define his position in the socio-economic structure.

The succeeding figures (3, 4, and 5) graphically depict the composition of our cooperating Ohio hunting license buyer. He is about 35 years old, about 70 per cent of our sample reporting their ages as younger than 42 years. This is comparable to the average age of Massachusetts and Utah sportsmen (Anon., 1957; Couture, op. cit.). Only one out of every 100 license holders reporting was a huntress. Slightly over three-fourths of our hunters are married (77 percent), 21 percent are single, and the remainder are equally divided between divorcees and widowers. Sixty-one percent of the hunters have a family, 9 percent having 5 or more children.

Over one-third of the respondents considered themselves craftsmen or foremen, 15 percent laborers, 12 percent students, 9 percent service workers, 6 percent each for farmers, professional people, and operative workers, 4 percent each for managers and sales people, and 3 percent clerical employees. The Utah study cited earlier reported

Figure 3. THE HUNTER

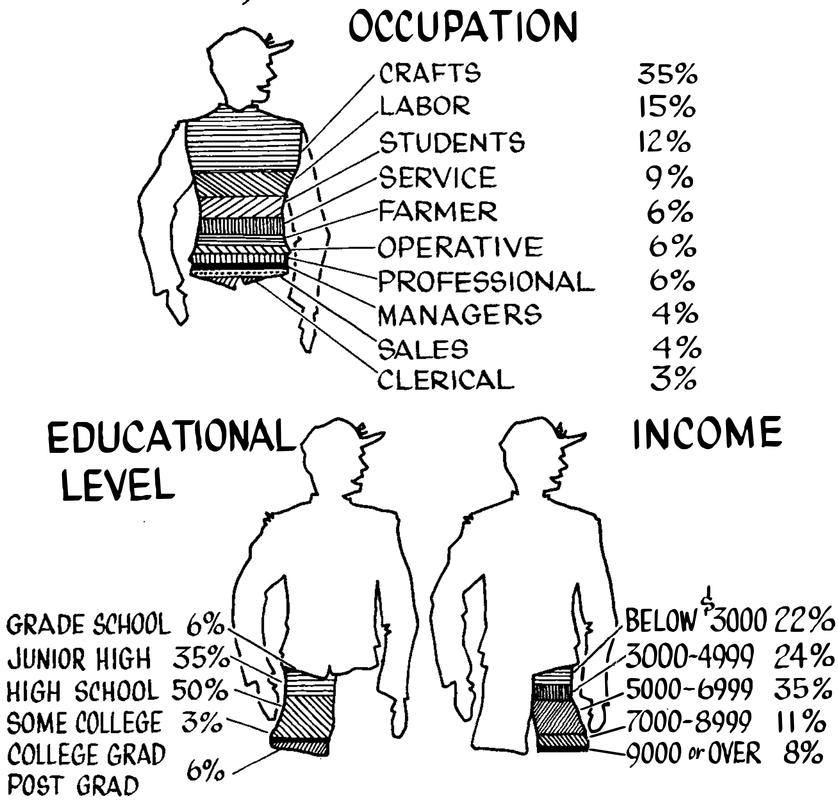


nearly twice the number of students (22.5 percent) but only one-third as many service workers from a survey of both hunters and fishermen.

Half of the hunting license buyers have had some high school experience, 6 percent going on to graduate from college. Earnings of 8 percent of the hunters amount to more than $9,000 per year, 22 percent earn less than $3,000. Eighty out of each 100 licensees are working, 17 are unemployed, and 3 are retired. The reported unemployed group is nearly double that reported for the entire state during the past six months.

Everyone knows that most all farm boys are hunters. Our survey shows that nearly 40 percent of those reporting said they were born on a farm, one-third of them living on a farm during their formative years from 7 to 20. One-fourth of them are small-city boys and the remaining are equally divided between those calling a metropolis their

Figure 4. THE HUNTER

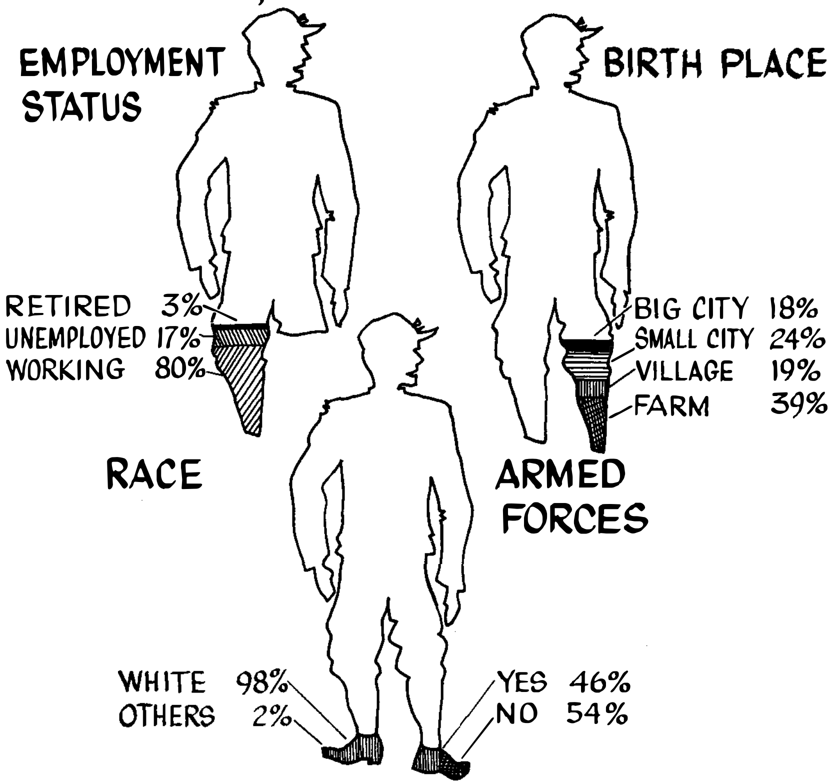


birthplace and those coming from villages. About 98 percent of the respondents are Caucasian and 46 out of every 100 have had some armed forces experience. These estimates will be more meaningful when compared with recent U. S. census data as it becomes available.

About 70 out of 100 hunters' families usually eat the game that is brought home, but an equal number sometimes give it away to friends. Six percent of the hunters admitted that they sometimes discard the game after reducing it to possession.

Hunting seems to have definite social relationships, since 92 percent of the licensees reported that some or most of their friends hunt, 56 percent said their neighbors hunt, and 85 percent of the respondents hunt with the same companions from year to year. These companions are usually family or relatives (83 percent) or friends (64 percent).

Figure 5. THE HUNTER



Only about 18 of every 100 homes surveyed by our questionnaire have some sort of game trophy either displayed, worn, or stored away in some closet. Many of the hunters do, however, like to read about trophies and trophy hunting. Seventy-two percent reported that they read one or more outdoor magazines, 40 percent saying they read three or more. Most of their wildlife knowledge comes from these popular types of outdoor literature since only about one-third of them said they had read a wildlife book written by a professional biologist. Less than one-fourth (24 percent) of those hunters going afield comply with the State law that requires written permission of the landowner before hunting.

Nearly half the hunters agreed that they could be satisfied with a hunt if they didn't kill any game; even a higher proportion (79 percent) said that part of the pleasure of hunting results from seeing sunsets, birds nests, trees, flowers, and other wonders of nature. More than 70 percent thought that we should set aside more wilderness areas.

Forty-two percent of the respondents felt that the game belongs to everyone, not to the landowner, but half of them agreed that the farmer had a right to charge a fee for the privilege of taking the game. The same group would be willing to pay a fee comparable to that paid to see a movie or a ball game, but only 14 percent said they paid a fee to hunt in the last year.

Common trees could be identified by about 90 percent of the hunters, but only 43 percent could tell what kind of a duck they shot. The federal regulation that only three shells be used in a shotgun while hunting waterfowl was agreeable to 80 percent of our license holders.

Seventy percent of the hunters thought that scientific studies should form the basis for a game management program and 66 percent would be willing to pay an increased license fee if the additional funds would be used for game research and management.

Only about 8 percent of the hunters indicated a strong desire to kill any of the common African or Asiatic big-game species such as the tiger, elephant, lion, water buffalo, and the rhinoceros. This is in contrast to 37 percent who said they would like to kill a deer, 17 percent a brown bear, 13 percent a grizzly bear, 12 percent a moose, and 10 percent an antelope; 13 percent indicated that a wild goose was high on their trophy list. No one was interested in shooting a walrus, but 6 percent would like to take a polar bear. Eight hunters said that shooting a wild burro would be desirable. If we could supply enough deer, moose, bear, and geese, 75 percent of the desires of our hunters might be satisfied, at least for the game species listed by our survey.

Ninety percent of our hunters began hunting before their 18th birthday. There was a two-third's chance that their father or brother took them out and about half of them brought a piece of game home from their first hunt. The gun they carried had been received as a gift (44 percent) or purchased (45 percent). A few had inherited the gun (8 percent) and some had traded for it (3 percent). If the gun was a gift it usually had come from their father (75 percent), uncle (9 percent), or brother (6 percent).

Music was the favorite type of entertainment for most of the sportsmen surveyed. One-fourth of them preferred popular music, 15 percent musical comedy, 9 percent rock and roll, 7 percent classical music, 3 percent jazz, and one in every 100 respondents indicated a preference for opera.

Apparently, few Ohio hunters have had any extensive wilderness experience. We attempted to measure their experience in remote areas by asking if they had observed a number of species in the wild. Fox and deer had a relative value of one, coyote four, otter five, polar bear nine, and if he had seen a wolf in the wild a value of ten was added to his score. The maximum possible score was 68 points. Sixty percent of the hunters had additive values of 10 or less; 22 percent, 11 to 20; and 12 percent had scores of over 20.

Slightly less than half (44 percent) of the hunters belonged to any adult organizations. Membership in sportsmen's organizations totaled 24 percent, a high participation compared to the national average of 5.5 percent for all fishermen and hunters (Anon., 1956). Six percent of our survey group belonged to the National Rifle Association, 9 percent to the Grange, and 5 percent to the Farm Bureau. One-third of the hunters belonged, at one time or another, to the Boy Scouts of America, 13 percent to 4-H clubs, and 7 percent to the Future Farmers of America. Less than half of those who do join organizations take an active part as officers or leaders.

The value of publicly owned lands to the Ohio hunter is quite evident. Fifty-four percent of the respondents spent time afield on state and federally owned lands. Slightly over three-fourths (78 percent) of them hunted on private land, 20 percent on railroad rights of way, 6 percent on private shooting preserves, and 12 out of each 100 hunters travelled outside the state to hunt.

A few brief comments concerning suggested differences between different kinds of hunters might be of interest. Rabbit and raccoon hunters are younger, and grouse hunters older, than pheasant, squirrel, duck, and deer hunters. Most students hunt rabbits, while the professional people prefer grouse and duck shooting. Managers prefer to hunt grouse and deer, but a mechanic, printer, painter, or plumber would rather bag a quail, Hungarian partridge, or a duck. Raccoon, fox, woodchuck, and deer hunters began their hunting experiences earlier than the other types of hunters. The adult grouse hunter was most successful on his first trip afield as a youngster, while the quail hunter was least successful. The fox, raccoon, and woodchuck hunters have the lowest income and the grouse hunter is the wealthiest sportsman in the group. This is expected since more grouse hunters have college training than any of the other groups. Most squirrel hunters prefer to be alone when hunting, while the pheasant and deer hunters like the companionship of several people.

A measure of the relative hunting success of those answering our questionnaire was obtained by assigning values of one to five to each of the game species. A one value was assigned to pheasants and rabbits; a two to squirrels, raccoon, and woodchuck; a three to quail, Hungarian partridge, and foxes; a four to grouse, ducks, woodcock, and geese; and if the hunter bagged a deer we added five points to his score. If a hunter bagged three rabbits, one pheasant, two quail, and a duck, his score was 14 points. According to our scoring system, raccoon, fox, and woodchuck hunters killed more game than any other group of hunters. Grouse, quail, and duck hunters had about equal scores and the pheasant hunters had the lowest scores of the group.

A few comments about those men who purchased a license but did not hunt: More of them appeared in the 10-17 and in the over-41-years-old class in comparison to the total sample. Fewer of the non-hunters started hunting before the age of 15, only 44 percent compared to 67 percent of our total sample. More students, farmers, managers, sales personnel, and service workers appear in the non-hunting group, but fewer craftsmen and foremen. Although our sample is quite small, more non-hunters are in the very lowest (grade school) and highest (college and post graduate) educational groups. Perhaps a future sample of non-hunting license buyers will more clearly identify these differences that are suggested here.

SUMMARY

A mailed survey was used to sample 6,810 Ohio hunting license buyers, slightly over 1 percent of all 1959 licensed hunters in the state. A return of 3,616 questionnaires was obtained by using four follow-up letters mailed to 6,029 deliverable addresses. Based on an anticipated return of 4,000, the cost per returned questionnaire amounts to $1.00. This preliminary tabulation of data from the 200 questions was based on a sample of 1,100 randomly selected returns, and, as a consequence, no statistical treatment of the data is presented. The composition of the Ohio hunting population was described giving age, sex, marital status, education, earnings, place of birth, occupation, race, armed forces experience, employment status, and size of family. Additional information was presented concerning the hunter's attitudes, social life, and hunting experience. A few possible distinctions between types of hunters are briefly stated. Based on a small sub-sample of the total, some differences between hunters and those who buy a license and do not hunt are suggested.

A statistical analysis of the data is planned following personal interviews of a selected sample of non-respondents and the publication of the U. S. Bureau of Census data for 1960.

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DISCUSSION

DISCUSSION LEADER LATHAM: Tony, that was a fine informative paper, and I was struck by one thought in particular, and that is that I suspect that the nine percent of the hunters who like rock and roll music best are the ones who cause most of the trouble between landowners and sportsmen.

DR. R. E. TRIPPENSEE [Amherst, Massachusetts]: I want to congratulate Tony on this presentation. Many times we have a lot of statistics that are presented in a chart that nobody can read, but he has presented a lot of this material in a way that you could really listen to and digest, and that is wonderful.

Commenting on the results, I'm sure many state people will be interested in perusing your paper and going on to some of your results. You forgot to mention that some of your hunters wore unmatched socks, but I think that is the only thing you missed.

Again I want to congratulate Tony on his paper. I think we're going to have to go into the sociological and psychological factors of hunting before we get through with it.

MR. DON W. HAYNE [Fish and Wildlife Service]: I think this was a well conducted study, and I had a couple of general comments, which I certainly hope that Tony doesn't take as critical of his study.

I want to point out, first, that what is being studied is what hunters choose to tell. This applies to any study where we ask them what they kill, that is through the common kill-survey type of study. I know that Tony knows this very well and it's well to keep this in mind.

A broader comment, and perhaps a more controversial one, would be that we must be very cautious in attempting to tailor our management thoughts and procedures by studies such as this, or similar studies. I should not really say "studies such as this" because this study seeks information. But if we conduct studies to determine by polls the wishes of sportsmen, then obviously this must be treated with the greatest of care before it is incorporated into a management program.

I might use two examples. First of all, we have seen in industry an example of this in the exorbitant growth of fins on large cars, where apparently very competent people were misled by studies of what consumers said they wanted.

What if you had polled deer hunters in states where we have optional any-deer season 20 years ago, determining whether such seasons should be undertaken? I'm not putting in anybody's mind the thought that these studies will be used in this manner, but I'm merely raising these points as a caution to the supposition that we can increase the sale of licenses by attempting to tailor the program to what the hunters tell us they want.

DISCUSSION LEADER LATHAM: I think that these are fine comments and I'm sure that states can get some information that is valuable they may want to follow up after they have seen Tony's figures, but I agree too that there is a danger in interpreting the figures for management purposes.

MR. FRYE [Florida]: I would like to comment about this business of using questionnaires. We have found that if we know pretty well how a questionnaire is going to come out, and we're trying to get a program across, that we can sometimes use it as moral support by getting the right answers. Maybe that isn't quite cricket, but it works fine if we're putting in a controversial program and we can show some fine statistics here saying that most people wanted it.

Incidentally we have run a questionnaire of that type on any-deer season in Florida, and we have gotten something like 70 per cent of respondents, who have said they would be ready for it; yet we're still afraid to put it in.

DISCUSSION LEADER LATHAM: We've been talking about the decrease in license sales. I think that philosophically wildlife people should think in terms of having people buy more licenses because we feel that they need the recreation, that this is of value to them rather than in terms of the need for more income to carry on our work. Of course they go together, but I think that we're obligated to think in terms of the individual rather than our department in the long run.

CHAIRMAN WAGNER: This is in partial reply to your remarks, Dr. Hayne. I have no disagreement whatsoever with what you said, but I do feel that it is a long step in the right direction because so often now we base our policies on the opinions of the people who come to us. I'm convinced, that so often we bend to a small minority of the public who, for one reason or another, are quite vocal. So whether or not a study like Tony's is an accurate cross-section of public opinion it certainly comes much closer to that than what we have right now I think.

SYMPOSIUM: PROSPECTS AND PROBLEMS IN STATEWIDE HABITAT MANAGEMENT OF SMALL GAME

REMARKS OF THE MODERATOR

FREDERIC H. WAGNER

In 1957 Jack H. Berryman wrote in the *Journal of Wildlife Management*: "It is the responsibility of the wildlife management agencies to produce harvestable surpluses of game, and for making these surpluses available to every segment of the American public . . . a major portion of the private lands must be utilized for production and remain open to public hunting." This surely is a view that has motivated many of us from the outset in our field. We have accepted this responsibility from the beginning. We have moved ahead to discharge it by adopting and then abandoning, as our research advised, a number of practices and policies. And we have arrived at the view that generally the most promising approach is to maintain and provide the proper environment which our game needs to express its own natural reproductive power. Durward Allen's book, *Our Wildlife Legacy* is a superb exposition of this history and transition of views.

But a hard look at our achievement to date does not disclose the general success we had hoped for. More often than not, where we have hunting over large areas it is either on species that can subsist in an environment used for other things, and largely by accident favorable for them, and/or we are harvesting from declining remnants of past abundance.

The view is becoming wide-spread in our field that in many cases we are not going to achieve our goal on the scope at which we are now operating or with the approaches we are now using, although the outlook varies with the species and the portion of the continent.

The $64 question is: In what direction do the chances for success lie? Where can the agencies discharge their responsibility with some hope of reaching the goal of preserving and increasing game and maintaining public hunting? Is it in redoubled efforts along our present line? Is it through integration with other conservation programs? Are there yet promising unexplored approaches? Or is it almost a certainty that in populous areas the goal is no longer attainable for some species, and that management will have to be done by affluent individuals who can afford the luxury of an area that exists for something besides bread alone?

In the hope of exploring these questions, and of hearing your views on them, and of exchanging these views, we have devoted the rest of our session to a symposium on this problem. We have asked four distinguished members of our field to present research findings and personal views on them. We earnestly invite you to present your views following the presentation of the papers.

RING-NECKED PHEASANT HABITAT MANAGEMENT IN THE UNITED STATES

R. A. MACMULLAN
Michigan Department of Conservation, Lansing

There is no doubt but that we can alter the landscape to make good pheasant habitat. Classic proof is the spectacular job of habitat improvement the settlers did when they cleared the original forest cover of the Middle West for farming. For example, considering my own state, I doubt that pristine Michigan could have supported one per cent of the pheasants it does today.

But despite this sure knowledge that we have done it, game managers have not been particularly successful at providing *still more* pheasants by habitat improvement.

Why this paradox? Why, when interest in pheasants is close to an all-time high, and when we spend much money and effort on habitat improvement, are we virtually stymied in our attempts to "make" more pheasants?

I would like to discuss what I think America's wildlife managers know about habitat improvement for pheasants in North America. It is difficult to speak for the continent's pheasant workers in generalities. I am sure I will be guilty of some degree of oversimplification. Nevertheless, I would like to attempt to report what I think is the consensus of the wildlife managers. Perhaps this could be considered an informal report from the technicians to the administrators on what we have learned about habitat improvement for pheasants.

My colleague Dr. Whitlock, who speaks later in this symposium, and I sent a questionnaire to the major pheasant states to bring us up to date and to doublecheck our ideas about the thinking in other states. Like most pollsters, we sneaked in some off-beat "crystal ball-type" questions, too.

None of the states we queried feels that the trend in pheasant numbers is rising appreciably. Several states feel that the Soil Bank program has helped pheasants in good pheasant range. New lands opened to agriculture by irrigation have provided new pheasant range in some states. But even these bright spots are tarnished by deterioration of other established pheasant range within the same states.

All but 2 of 13 states that offered an opinion felt that the long-term trend of pheasant population levels would continue to be static or declining, subject to the well-known fluctuations of pheasant numbers.

Obviously, prospects for even moderate increases in pheasants are not very bright.

This pessimistic forecast for the future of pheasants is universally based on the expectation that pheasant habitat will deteriorate, or at least not improve. Since pheasant habitat is almost synonymous with farm land, it is almost self-evident that changing agricultural practices in turn are to blame for the deterioration of pheasant habitat. It is just about that simple.

To go a step further, the agricultural practices that seem to be most responsibile for deterioration of habitat are those that result in destruction of cover—in the broadest sense—whether clearing woody winter cover or mowing hay fields.

Shortage of food, changes in crops, urbanization, new pesticides, and a score of other things can qualify as inhibitors of pheasants. But almost every state recognizes shortage of cover, of the proper type and in the right places, as a major limiting factor of pheasants in their established range. Cover inadequacies fall into two categories —winter and nesting. Probably the shortage of nesting cover is the more important of the two.

So the biologist charged with improving the habitat for pheasants has his work cut out for him: provide cover. The techniques to do this are well known, and are not difficult. A fertile farm field left to grow a crop of weeds makes pretty good nesting cover. A cattail marsh makes good winter cover. But before his plans are off the drawing board the wildlife manager is faced with the specter of cost. It takes land to grow corn, and it takes land to grow pheasants. The land the pheasant manager needs for growing pheasants will also grow corn. So the pheasants he grows must literally be purchased in terms of the amount of corn, or rice, or hay that the farmer would have to sacrifice.

Here the technician can conveniently dump this sticky problem in the lap of the administrator. If the sportsman wants to pay the price of agriculture, we can do a beautiful job of improving habitat for pheasants in much of the intensively farmed area of north central America.

But this price is mighty steep. Because it is so steep much of our effort at habitat improvement for pheasants has been spent on second-rate agricultural land, or on the odd corner of farm land that the farmer feels he can spare.

In Michigan, we found that our habitat improvement program for private farms was being applied only to the portions of the farms which were already idle, and then only to a small segment of that. Our average cooperator had 24 acres of idle land, and we were able to get him to improve only 2 acres (Zorb, 1960). So here, too, we have met with poor success. Although the price of the land we use is cheaper, we produce few pheasants, and the cost per bird still remains high.

Thus, we have developed what amounts to an axiom of pheasant management: *It takes good agricultural land, properly handled, to produce bumper crops of pheasants.* The continent has the agricultural land. Unfortunately for us, it is not and cannot always be handled properly *for pheasants.*

Man's great success at making pheasant habitat has been inadvertent—it has been incidental, an accident. Clearing forests from the land, plowing the prairie sod, and watering the desert radically changed the environment, and made it suitable for pheasants. But the clearing, and the plowing, and the irrigating were done so that farmers could grow crops and make a living. The cost of these changes was not charged to pheasants.

As an aside, I would like to say a word here about evaluation of habitat improvement. Several states have attempted to evaluate their programs. Judging the survival of plantings, for instance, is not difficult. But it is difficult to measure increases in pheasants. Occasionally we find instances where habitat improvement can produce pheasants in the bag for less than a dollar a bird. But these are rare. More likely, costs are $4.00 to $40.00 a bird; or perhaps explained in terms such as "$20.00 per acre of nesting cover provided." In Michigan's evaluation of the state's habitat improvement program for private farms, we were not able to detect any increase in pheasants. On the other hand, variability in the sampling was such that we could not expect to establish statistical significance of an improvement of less than 40 per cent.

Not much importance can be attached to specific costs. We have few examples where costs have been figured, it is difficult to know how to figure costs properly, and we are still so inept at measuring the increase in pheasants we might produce that the figures don't mean much yet. On the other hand, we have at least made a start, and we know more than we did eight years ago when Marshall (1953) stated ". . . the cost for each piece of game produced [by habitat improvement programs] when the end result of survival of the planting and its use by wildlife is estimated is entirely unknown." Nevertheless, despite the paucity of specific data on costs, and on the number of pheasants we produced, the habitat improvement programs have obviously not been spectacularly successful, or cheap. Rarely has there been any evidence of programs that are efficient and economical in producing pheasants. Of course, it must be remembered we are talking here of pheasants produced—not of rabbits or other game produced, or of other intangibles such as the good will the program may create.

We must face the cold hard fact that our production of pheasants in America, 95 per cent of it anyway, is incidental. Pheasant production is dependent on the largesse of the land and the shape it happens to be in as a result of man's use of it for agriculture—we are dependent upon the farmers' sufferance.

I am struck by the parallel of this problem with the white-tailed deer problem. The white man lumbered the "Big Woods"—relatively poor deer range—and made superb deer habitat. Now the habitat is deteriorating, as the forest regrows. Production of deer, too, is at the mercy of the economic interest in the land that serves as habitat for deer. Comparable histories can be reconstructed for the prairie chicken, ruffed grouse, quail and other game; and for that matter, many other forms of wildlife not given the attention that game species receive.

CONCLUSIONS

A habitat improvement program for pheasants should aim at correcting deficiencies in the habitat, which in most cases will mean providing adequate winter or nesting cover on good agricultural land. The program should be of good quality and intensity and not spread too thin. Consequently, such programs will often appear expensive. I would recommend that we inspect our efforts at habitat improvement for pheasants with these considerations in mind:

1. *Quality Development.* We should not let costs scare us completely out of a habitat improvement program. Careful inspection of a proposed program may show that the more expensive improvements are in the long run more efficient. We should not overlook chances to dovetail improvement measures in with agriculture— even on high-value lands. For example, purchase of a first-cutting hay crop might provide the needed nesting cover, without charging the entire use of that field for a year to pheasants.
2, *Advisory Services.* We should continue as we have for many years to provide advisory services: advice to the landowner as to what he can do to help pheasants—if he is willing to provide the land—and advice to agencies. Participation by the pheasant manager in the planning of such large-scale programs as

the Soil Bank or other land retirement plans has a formidable potential for helping pheasants.

3. *Research.* By all means we should expand our research on habitat improvement. Despite the work that has been done on pheasants, more research can be expected to pay good dividends. I would recommend three areas:
   a) *Habitat requirements*—in the broad sense. We deprecate second-class land, and point out that habitat improvement practices are usually inefficient there. But we don't know why. Research into the role soil plays in the distribution of pheasants has uncovered some intriguing leads. Perhaps we will someday know how to improve that land, too.
   b) *Techniques.* Trite and prosaic as it may sound, we still need to know more about the simple techniques for efficiently improving the habitat deficiencies we can now recognize—how best can we make habitat attractive to the nesting hen or the bird seeking winter cover?
   c) *Evaluation.* Our methods for evaluating the game produced by habitat improvement programs are still primitive. True effectiveness of a program can only be determined when we can reliably measure results.

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A REVIEW OF BOBWHITE QUAIL MANAGEMENT IN EASTERN NORTH AMERICA

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State game departments are faced with the unpleasant truth that the actual production of bobwhite quail by the use of any presently applicable technique in anything like the quantity desired by the hunter is beyond their present financial capacity, that the average quail hunter has been getting by primarily on birds that occur with no particular effort toward their management, and that quail hunting is likely to become to a greater degree than most other hunting more and more a sport available to a relatively small percentage of hunters. In Florida, for example, quail hunting already belongs to two distinct classes of people—the wealthy and the hardy. The man with money can afford to lease good natural quail areas, apply the normally expensive techniques necessary to produce good quail hunting, or visit a commercial shooting preserve. The dedicated quail hunter of moderate means can still find good shooting if he keeps one or two good dogs, makes an effort to cultivate the good will of small landowners and perhaps devotes some time to improving habitat on their property, and has sufficient know-how and interest to "beat the bushes" in the submarginal hunting areas to which he has access.

The basic problem is that even though bobwhite are fairly abundant throughout their range—probably underharvested in most areas—they are not sufficiently abundant in most areas available to the average hunter to furnish hunting that is satisfactory to him. This bad situation is compounded by the fact that the cost of increasing the quail population to a satisfactory level is beyond the scope of game departments operating at present license levels—or any license level that could conceivably be given favorable consideration by a state legislature. The various quail management activities of the states are generally recognized as being a drop in the bucket as contributions to the total harvest: at worst, public relations efforts to merely pacify the sportsman—at best, sound but inadequate efforts to demonstrate management techniques that can be applied by private individuals.

It is paradoxical that game departments at the time in history when they are best staffed, best informed, and are most nearly satisfying the hunters' demands for deer hunting, for example, particularly in the Southeast, find themselves in such a quandary regarding quail. The most obvious reasons for this situation are as follows: Deer were generally reduced far below the carrying capacity of the range, are being restored in many instances by the relatively simple and inexpensive techniques of restocking and protection, will probably continue to increase for some time to come in most bobwhite states, and in most states occur in huntable numbers in National Forests and other areas more accessible to the public. Quail, on the other hand, are generally decreasing in abundance because of unfavorable land use practices, are generally less available to the average hunter because of their occurrence on farm lands more subject to posting than are the forested areas that constitute the more important deer habitat, are generally more in demand by wealthy individuals, and can be increased only by more complicated and expensive techniques.

Even after the honeymoon is over insofar as the boom in deer hunting is concerned, the problem of furnishing quail hunting will remain greater headache to the game administrator unless there is a substantial change in the hunters' viewpoint. This is true for the simple reason that more land is required to produce a satisfactory bag of quail than a satisfactory bag of deer. To begin with, not every deer hunter must kill a deer in order to have a successful deer season—not so with the quail hunter—he must bag at least 50 or 100 birds (5 to 10 good days in the Southeast) if he is to be satisfied and justified in keeping dogs and calling himself a quail hunter. Perhaps a little elementary arithmetic with an illustration from my home state of Florida might best get across the point: In one highly satisfactory hunt (for the Southeast) on a management area of approximately 350,000 acres one deer was harvested for each two hundred acres with one hunter out of four bagging his deer. In this instance I think we are safe in saying that four hunters were satisfied by the deer production of two hundred acres. If we arbitrarily consider 50 quail per

TABLE 1. COSTS OF VARIOUS QUAIL MANAGEMENT ACTIVITIES IN SEVERAL STATES

	Restocking	Extension Work on Private Lands	Work on Managed Public Hunting Areas	Work on Lands Open to Public But Not in Management Areas
Florida	$	$ 15,000.00	$ 21,782.00	$
Georgia	600.00[1]	28,000.00		
South Carolina		22,000.00	4,000.00	
Alabama		3,200.00	10,600.00	
Mississippi		14,090.00	12,066.00	
Louisiana		250.00	2,650.00	4,050.00
Texas	45,700.00	1.000.00	2,400.00	
Oklahoma	60,000.00	85,000.00	66,000.00	
Arkansas			6,100.00	
Tennessee	1,950.00	13,400.00	1,180.00	
Kentucky	70,000.00	2,800.00	200.00	12,380.00
Missouri		80,000.00	6,200.00	
Kansas	42,570.00		14,800.00	
Illinois	77,000.00	118,000.00		
Ohio		15,200.00	25,500.00	
Virginia	1,800.00[1]	26,580.00	39,800.00	
	$299,620.00	$424,520.00	$213,278.00	$16,430.00

[1]No cost figure given so arbitrary figure of $1.00 per bird assigned.

year as the bag necessary to satisfy a quail hunter, that a bag of a bird per ten acres is about the best that can be expected on the average area of 100,000 or more acres, we arrive at a figure of 500 acres as the amount of land necessary to satisfy one hunter, or 2,000 acres as the amount of land necessarby to satisfy four quail hunters, or ten times the amount of land necessary to satisfy the four deer hunters.

In an effort to gather the information upon which this paper is based questionnaires were sent to the twenty-three states that comprise the major portion of the bobwhites' range. Answers were received from all states. Certain of the data were suitable for tabular presentation and are presented in Tables 1, 2, and 3; others, primarily general discussion questions, were not. The questions were prefaced by a statement that it was understood that the states would not have detailed factual data upon which to base their answers to certain of the questions, and that in such instances all that was expected was their considered opinion. Also, some states may have misinterpreted our questions and I may have misinterpreted their answers. For any of the latter, I humbly apologize. States were listed roughly from south to north rather than alphabetically to better permit regional comparisons.

All states questioned had open seasons on quail in 1960-61. The longest statewide season was 98 days in Georgia; the shortest statewide season was 8 staggered days in Kansas, which also had 19 staggered days for limited areas. Ohio, which was closed to quail hunting for years, has no statewide season, but has 25 days of hunting on most quail areas and 60 days on two experimental areas. All the states had some statewide open season except Ohio and Iowa, which had a 30-day season in only a portion of the state. As would be expected, seasons were longest in the deep south with the following seasons in effect: Florida—86 days; Georgia—98; South Carolina—93; Alabama—93; Mississippi—79; Louisiana—84.

In answer to a question as to game farms, the following production figures for quail were given: Georgia—900 mature birds; Alabama—a few birds for experimental purposes; Texas—47,600 mature birds; Oklahoma—60,000 mature birds; Tennessee—3,000 red color phase birds for restocking evaluation study; Kentucky—5,400 mature birds, 80,000 chicks for distribution; Kansas—38,700 mature birds; Illinois—110,000 mature birds; Indiana—9,300 mature birds, 167,000 chicks for distribution; Virginia — 1,800 mature birds; Maryland — 7,000 chicks purchased for distribution; New Jersey—20,000 mature birds, 14,000 chicks for distribution; Pennsylvania—15,500 mature birds, 6,800 chicks for distribution; Iowa—1,000 mature birds, 10,000 chicks for distribution. The remaining nine states did not report purchasing or producing pen-reared quail. Most states did not present complete data as to distribution of hatchery birds. Tabulation of those data presented indicates 104,800 birds released on lands open to public hunting but not in state management areas; 101,900 on private lands closed to public hunting; and 10,500 on state management areas. Those states replying indicated recovery of birds released for restocking as varying from one to seven percent—usually around three percent. Only one state charged for birds to be released on private lands—50¢ for a bird costing 96¢. None of the deep south states except one with a 900-bird release stock pen-reared quail, although most if not all of them have at one time operated large game farms. The question that charitably occurs is whether the more northern states which do stock quail are forced by public pressure through the entrenchment of the restocking idea or whether those states in more northern and sometimes submarginal quail habitat feel that the release of hatchery birds is a useful supplement to poor natural production.

Of general interest in this connection is the fact that some of the southeastern states which are relative newcomers in the conservation field have in many respects developed sounder conservation programs than some of their northern neighbors with originally more advanced programs; apparently because the panacea programs such as widespread quail restocking, bounty payments and the like, which were accepted as proper twenty years ago have not become so firmly entrenched in the more recently developed states.

TABLE 2. EVALUATION IN NUMERICAL ORDER OF IMPORTANCE BY STATE GAME AGANCIES OF QUAIL MANAGEMENT TECHNIQUES IN THEIR STATE

A. Techniques presently applied by game agency and private individuals.

B. Techniques that can be practically applied by game agency and private individuals in the future in conjunction with expected land use attitudes and practices.

	Food Planting		Automatic Feeders		Prescribed Burning		Restocking		Cover Planting		Manipulation of Farm Pattern	
	A	*B*	*A*	*B*	*A*	*B*	*A*	*B*	*A*	*B*	*A*	*B*
Florida	2	3	3	4	1	1	5	6	6	5	4	2
Georgia	3	3			1	1			2	2		
South Carolina	1	2	4	4	1	1	5	6	3	5	2	3
Alabama	4	4	5	5	1	2			3	3	2	1
Mississippi	1	2	6	6	3	4	7	7	5	5	2	1
Louisiana	1	2	4	5	2	1	5	6	6	4	3	3
Texas	2	2			3	3			1	1	4	4
Oklahoma	2	3	5	6		4	3	5	1	2	4	1
Arkansas	1	1	6	5	2	6	5	4	4	2	3	3
Tennessee	1	3	6	6	5	4	4	5	2	2	3	1
North Carolina	1	1							2	2	3	3
Kentucky	2	3					1	2			3	
Missoui	2	2				4			1	1	3	3
Kansas	2	2	5	5	6	6	1	4	3	1	4	3
Illinois	3	3	4				5		1	1	2	2
Indiana	3	4	4	5			1	3	2	2	5	1
Ohio	4		5				6		3	3	2	2
West Virginia	1	1							2	2		
Virginia	1	2	5	5	6	4	4	6	2	3	3	1
Maryland	1	1	4	4		6	5	5	2	2	3	3
New Jersey	1	1					4	4	2	2	3	3
Pennsylvania	1	1					2	2	1	1	3	3

All states replied that they attempted to improve quail hunting by habitat improvement programs. Relative expenditures of various states for restocking and habitat improvement are presented in Table 1. States that did not appear in this table did not present this information in a form that could be used comparatively. Expenditures for habitat improvement far outweighed those for restocking. Only three states reported spending more for pen reared quail than for habitat improvement.

States were queried relative to their evaluation of management techniques presently applied for bobwhite and management techniques as the states believed they can be practically applied in the future. These data are presented in tabular form in Table 2. Of interest is the fact that only five states, Kentucky, Kansas, Pennsylvania, Indiana and Oklahoma, rated restocking as the technique that was either first, second or third in importance as applied in their state at present. Only three states, Kentucky, Indiana and Pennsylvania, rated restocking among the three top categories of techniques that can be applied in the future. Most states either gave restocking no rating at all or had it listed way down the line. Food planting and cover planting were considered to be the most important management techniques presently in use with manipulation of farm pattern apparently replacing food planting as the technique believed to offer most promise for future management. As would be expected, food planting rated high in the Southeast; cover planting high in the West. Prescribed burning rated first in Florida, Georgia, South Carolina and Alabama, and was fairly high in all of the Southeast. In addition to the ratings presented in Table 2, Mississippi rated control of cover by discing, herbicides, etc., as fourth in technique presently in use and third as future technique; Kentucky rated preservation of natural food producing trees as most important technique to be applied in future; and Ohio rated regulation of harvest as first in both categories.

Four states—Georgia, Virginia, New Jersey and Pennsylvania—believed their quail habitat to be improving; five—Alabama, Texas, Oklahoma, West Virginia and Maryland—believed their quail habitat to be remaining about the same; one—Arkansas—believed that its quail habitat was deteriorating rapidly; five—Florida, Missouri, Kansas, Illinois and Iowa—believed it to be deteriorating moderately; and eight—South Carolina, Mississippi, Louisiana, Tennessee, North Carolina, Kentucky, Indiana and Ohio—believed it to be deteriorating slowly.

States were questioned as to the factors presently limiting their bobwhite population. Their evaluations of these factors are presented in Table 3. In addition to information in Table 3, Kentucky rated

TABLE 3

	EVALUATION IN NUMERICAL ORDER OF IMPORTANCE BY STATE GAME AGENCIES OF FACTORS PRESENTLY LIMITING QUAIL IN THEIR STATE						EVALUATION IN NUMERICAL ORDER OF IMPORTANCE BY STATE GAME AGENCIES OF ACTIVITIES LIKELY TO CONTRIBUTE MOST TO QUAIL HUNTING IN THE NEXT DECADE IN THEIR STATE			
	Intensive Timber Production	Intensive Pasture Improvement	Clean Farming	Hunting	Predation	Disease	Habitat Manipulation by Private Individuals With State Advice	Habitat Manipulation by State on Lands Open to Public Hunting	Put and Take Shooting on Private Hunting Preserves	Put and Take Shooting on Lands Open to Public Hunting
Florida	2	1	3	5	6	4	1	3	2	4
Georgia	3	1	2				1	2	3	
South Carolina	1	2	3	4	5	6	1	3	2	4
Alabama	1	2	3	6	5	4	1	3	2	
Mississippi	1	2	3				1	2	3	4
Louisiana	1	2	3				1	2	3	
Texas	3	2	1				1		2	
Oklahoma		1	2				1	2		
Arakansas	2	1	3				1	2	3	4
Tennessee		1	2				1	2	3	4
North Carolina	3	2	1				1		2	
Kentucky		1	2				3	2	1	
Missouri	3	2	1	5	6	7	1	2	3	
Kansas	3	2	1	6	4	5	1	2	3	4
Illinois		2	1	3	4	5	1	2	3	4
Indiana	4	5	1	2	3		1	4	3	2
Ohio	5	4	1	6	3	7	4	3	2	
West Virginia	1	2					1			
Virginia	7	2	3	4	5	6	1	2	3	4
Maryland	5	2	1	4	3	6	1	2	3	4
New Jersey	2	3	1				1	2	3	4
Pennsylvania		3	1				2	1	4	3
Iowa		1	2				1	2	3	

abandonment of cultivated fields as third in importance; Missouri rated increased numbers of livestock as fourth; Ohio rated weather as second; West Virginia rated geography as third; Virginia rated weather as first; and Pennsylvania rated weather as second. Since weather and geography are basic factors affecting game populations everywhere, they are not believed to be properly comparable to the other items listed and should probably not be considered in comparing evaluations. Clean farming was considered of most importance as the factor limiting quail. This was followed closely by pasture improvement and more distantly by intensive timber production—chiefly in the deep south where the control of fire necessary for the production of pine timber is creating extremely unfavorable conditions for quail in timber lands. Hunting, predation and disease were rated lower than three habitat factors in all states except Indiana, which rated hunting and predation ahead of pasture improvement and timber production, Ohio which rated predation ahead of pasture improvement and timber production, and Maryland which rated hunting and predation ahead of timber production. In these instances, however, I do not believe that this necessarily implies attributing any great importance to these factors.

In Table 3 is also presented each state's evaluation of activities likely to contribute most to its quail hunting in the next decade. All states except three believed that habitat manipulation by private individuals with technical advice from the state offered the most promise for improving quail hunting. Kentucky rated put-and-take shooting on private shooting preserves as first and habitat manipulation by state on public hunting areas as second. Ohio rated harvest management first; private shooting preserves second; and habitat manipulation on public hunting areas third. Pennsylvania rated habitat manipulation by the state on public hunting areas as first. Of interest in considering these answers is the fact that Ohio is the only one of the states listed which has had a long history of no hunting of quail.

The states were queried as to the approximate percentage of the total bobwhite harvest that results from various activities. Fourteen states believed that 90% or more of the total harvest results from birds that occur with no particular effort toward their management. Two credited the same factor with from 78 to 90 percent, and one credited this factor with only 20 percent. The remainder declined to answer. The next most important item was reported to be management by private individuals with or without technical advice from the state. Far behind were: management by the state, release of birds by private individuals (including put-and-take shooting), and release of birds by the state.

The next question was "What is your estimate of the cost per bird of achieving in two years a 100 percent increase in bobwhite from the application of any of the following techniques suitable to an area of up to 5,000 acres of presently unmanaged average habitat in your state: food planting, use of feeders, cover planting, manipulation of farm pattern, control burning, other?" Half of the states declined to answer this question. Estimates of cost per bird ranged from 25 cents by manipulation of farm habitat in Missouri to a high of $20.00 in Indiana based on a habitat improvement evaluation study. Prescribed burning was considered the most economical technique in areas where applicable with costs per bird ranging from 50 cents in Louisiana to $1.00 in Florida, North Carolina, and Virginia. Kansas and Missouri estimated the lowest costs—from 25 cents to $1.00 per bird in Missouri and from 40 cents to $1.50 in Kansas. Florida indicated a cost of $2.50 per bird by the use of feeders based on a study in grazed woodlands. Several states—Florida, Kentucky, Virginia, North Carolina, and Arkansas—believed the cost per bird to range from $2.00 to $5.00 for food planting, cover planting, and manipulation of farm pattern.

The final question—"What would be the most practical program to increase your statewide quail population by 50% during the next five years, and what is your estimate of the cost of this program? (This question is purposely phrased in general terms to obtain each state's ideas relative to the various ramifications of the question. Your answer should be limited to not more than 500 words.)"—was received with a great variety of reaction. Replies ranged from no answer and such comments as "impossible to accomplish" and "not answerable" to obviously thoughtful tangling with the problem. I would agree that the objective might be impractical, but it would certainly not be impossible if the various states had and could justify applying sufficient funds to employ enough men to pay enough landowners to make the necessary habitat improvements and alterations in land use practices.

Nine states—Florida, Georgia, South Carolina, Missouri, Louisiana, Texas, Kentucky, Kansas and Virginia—indicated that they believed that an extensive program designed to educate, influence, and in most instances compensate landowners in habitat improvement is the best approach. Most did not estimate the cost of such a program. Those that gave an estimate were: Florida — $2,000,000.00; Louisiana — $500,000.00; Kentucky—$500,000.00 plus; and Kansas—$250,000.00. Indiana and Missouri placed the cost of the necessary five-year program of habitat improvement at $10,000,000.00. It is doubtful that any states feel that the expenditure of the necessary funds to increase the statewide quail population 50 percent is justifiable or practical. To begin with such an increase could not be expected to result in a 50 percent increase in kill and more importantly would occur principally on private lands where the birds would be no more available to the hunter than at present. This question was designed solely to obtain some insight into the thinking of the various states relative to the problem.

For some time with the help of the many people who answered our questions we have dwelt upon most of the major aspects of bobwhite management, we have spread a wet blanket here and there, probed the vitals of some sacred cows, commented about subjects that are probably generally understood but may be more often left unsaid, and have finally reached the point where some conclusions appear to be in order. These are:

1. State game agencies do not at present or in the foreseeable future have sufficient financial resources to appreciably improve quail hunting.

2. State quail management programs presently contribute very little numerically to the total bobwhite harvest but are nevertheless essential and proper.

3. Quail hunting will become more and more a sport limited to those individuals willing to pay for it either in money or effort.

4. Compensation in some form or another to the landowner for habitat improvement is a proper and perhaps the only reasonable approach to increasing quail populations on a statewide basis.

5. The role of the state in quail management except for work on public hunting areas should be primarily one of furnishing technical advice and encouragement to private individuals who will for their own benefit apply the techniques necessary to improve quail hunting.

PROBLEMS FACING STATE AGENCIES IN FARM-GAME HABITAT MANAGEMENT

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State conservation agencies do have a responsibility in connection with statewide habitat improvement for small game. If we think otherwise, we had better reduce license fees and quit taking the hunters' money for something they think we are doing. There is little question about the value of most of the improvements directed toward the benefit of waterfowl. However, it is apparent there are a lot of questions and doubts now in the minds of game administrators and technicians as to what has been accomplished in the field of upland small game habitat improvement on a large scale. Actually, these doubts are not new. At the 1953 meeting of this organization, Marshall (1953) of Minnesota reported on a study of farm-game habitat improvement programs carried on in 15 states of the Northeast and South. In his opinion, the results were highly questionable, considering time and money expended. He suggested certain criteria which should be applied to an evaluation of these programs. Evans, Smith, and Grieb of Illinois (1954) suggested a somewhat similar program setting up well-defined objectives to use in judging the success of small game habitat improvement over a large area.

Some states started shortly after the Pittman-Robertson Act was passed in 1937. Since the close of World War II a large number have initiated and carried on extensive small-game habitat improvement programs. Many types have been tried and millions of dollars have been spent. The impetus for these campaigns has largely sprung from realization of the cost and futility of stocking pen-reared game birds.

Imported wild-trapped game animals such as cottontail rabbits also enter the picture. It was realized by most state conservation agencies that this type of game restoration and maintenance was basically inefficient, even though highly popular with sportsmen. Because of this approval by sportsmen, most states have found it very difficult to cut down or abandon game farms, in particular those producing pheasants. In most cases, the farm-game habitat improvement program has been pushed as a substitute for artificial stocking. The rather precipitous pheasant decline in the 1946-48 period had an effect in stepping up or initiating the farm-habitat improvement program in some states. This was an attempt to still the outcries from disappointed sportsmen and seemed more desirable than getting into an expanded game-farm program. The pitfalls of the latter were recognized. The possibility of failure in the statewide habitat improvement was seen by some, but it looked like a worthwhile chance.

There are a number of questions we should ask ourselves in regard to this admittedly complicated problem of farm-game habitat improvement. They are by no means entirely biological questions. Some may argue biology is the only field in which we wildlifers are competent to debate and that economics, psychology, sociology, etc., are beyond our ken and should be left to those who profess knowledge of these sciences. However, we are faced with vociferous hordes of wildlife experts on every hand, particularly during or just after unsuccessful hunting seasons. Perhaps we can be excused for wandering afield just a bit ourselves.

As the previous participants in this symposium have indicated, farm-game can be increased by rather intensive methods which of necessity are relatively costly. Nearly all state game agencies agree that it is beyond their financial capabilities to carry on habitat management that will be effective for large areas of land. Nearly all are agreed that dropping some lands out of agriculture, such as extension or variation of the Soil Bank program, would be of great help. Where undisturbed nesting cover and winter food availability are controlling factors, as many agencies believe they are in many situations, it is obvious that the relatively large acreages involved in federal land retirement programs dwarf the small acreages that state agencies can possibly affect. Taking a long-range look into the future which few or none of us here today may see, we must realize that the retired lands will inevitably be returned to agriculture as our population increases. It may be sooner than we wish.

There is a limit to land productivity despite all the wonders of agricultural chemistry and plant genetics. No beanstalks such as Jack's of our childhood days are yet on the horizon. One can also view with apprehension the future of state and federal game lands when the population pressures really begin to bear down. Perhaps this danger of a world-wide food shortage can be met in time, but there is little indication of a well-organized effort to meet the threat except in a very few countries. Some of our present-day Isaiahs view the increasing food problem as a bigger threat to civilization than the uncontrolled hydrogen atom. As game managers, we in our small way can view it as a peril, too.

To get an up-to-date slant on present-day thinking among state game agencies, questionnaires were sent to 19 states, particularly those in the pheasant range and including a considerable area of northern bobwhite quail range. There is practically unanimous agreement among the states contacted that any campaign to increase pheasant populations significantly on a state-wide scale is financially impossible. Estimates ranged from 5 to 100 million dollars on one basis. On another, from 600,000 to 5 million a year was quoted. Four states said it was an impossible goal and were not able to estimate the cost. It seems evident that there isn't much hope, at least among the pheasant-producing areas, of doing anything practical on a big scale.

Nearly all of the 19 states contacted are now spending sizable sums for small-game habitat improvement—several going over $100,000 a year, and two going as high as $300,000 per year. One admitted closing out its program. Answers to other questions indicated that many could see no bright future in continuing, but did not say they were quitting despite obvious discouragement.

The logical approach to the problem seems to me to be something like the New York and Pennsylvania plans. We should not delude ourselves with the idea that the landowner is going to be content with a plan or a few pounds of seed or some planting stock, and thereby making a notable contribution to the happiness of the hunter. If the landowner is willing to settle for those, then we can be pretty sure that he looks upon them as personal gain. He will accept them. Some wag whose name is lost in the unwritten annals of history (it sounds like Al Smith) observed that nobody shoots at Santa Claus. Something for nothing is a characteristic human reaction and as predictable as Pavlov's dogs. If we expect the landowner to continue to allow public hunting, we are going to have to offer him something more.

Zorb (1959), in a study made in Michigan, found that landowners who had received aid in improving their farms for wildlife were no more likely to allow public hunting than those who had not. The hope for improvement in hunter-farmer relations proved to be an illusion. Pennsylvania and New York found that farmers were most interested in protection from trespass and protection for their fences, buildings, livestock, and other property.

Michigan's so-called "Williamston Plan" begun back in 1929 has not been an unqualified success. Its weakness, which was recognized years ago, is the same that Pennsylvania and New York felt the need to consider in developing their plans—*i.e.*, the farmer is primarily interested in controlling trespass. The Williamston Plan's only deterrent to hunting trespass is official signs. The Conservation Department makes no special effort to patrol the area against unauthorized hunting.

The Williamston Plan clubs were fairly successful for a time, but in late years have slowly declined in number and area until now they make up such a small fraction of the total area of the state that their total effect is virtually nil.

To sum up: Research efforts to evaluate these extensive small-game habitat improvement programs have failed to come up with quantitative evidence to prove their value. Research has shown that intensive efforts on small areas where cover is markedly deficient will produce more game but at a fairly high cost per unit of game.

My interpretation of the available evidence leads me to the conclusion that statewide programs should be modified. The shotgun approach should be dropped in favor of pin-pointing efforts on smaller areas where deficiencies in cover and food are glaringly apparent. Evaluating habitat improvement programs on the basis of pounds of seeds distributed or number of shrubs and trees planted means little or nothing. Large-scale habitat management by state agencies for pheasants appears to be a losing proposition. Ruffed grouse and snowshoe hares are in about the same class as pheasants. Rabbits and quail offer more promise. Hungarian partridges and chukars probably fall somewhere between the pheasant and the quail.

In short, we have got to be more realistic about habitat improvement. No one denies that it is basic. By its influence, game birds or animals live or die. But in the holy name of habitat improvement some sins have been committed just as they have been in more sacred causes. We should take more long, searching looks at what we are doing in this field. We should not risk more millions on programs we can't justify on the basis of hard cold facts. It's possible that we are right, but then a fellow can fill an inside straight once in a while, but nobody has made a big success of it consistently without unusually nimble fingers.

I am not so optimistic, perhaps, as my fellow panel member, Jack Berryman, regarding the future course of wildlife management on private land. It does not seem probable to me that we can influence its direction so effectively as will other more powerful forces—*e.g.*, changing land uses, population increases, etc. We should try but I think the results are in doubt. A certain amount of cynicism should be pardoned in one who has seen favorite hunting spots of his boyhood days turn into subdivisions during the last few years. In many cases we are only fighting delaying actions, but fight them we should.

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THE RESPONSIBILITY OF STATE AGENCIES IN MANAGING HUNTING ON PRIVATE LANDS

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THE PROPOSITION

It is the responsibility of state fish and game departments to assume leadership in providing harvestable game supplies and public hunting opportunity on public and private lands; and for full development and management of wildlife resources for the benefit of all segments of society. The alternative is to abandon the American tradition of public hunting, and to abandon the management of a resource with tremendous, unrealized potential.

This, in debate parlance, is the proposition—one view on a symposium examining the philosophical question of state responsibility in providing public hunting. The proposition, thus stated is followed by a review of fundamental issues, development of a philosophy in support of the proposition, and finally, a seven-point approach to implement the philosophy.

ISSUES AND CONTENTIONS

We are concerned first with the basic question of whether a responsibility exists, not with the difficulties that complicate its successful administration. Several issues are pertinent to the quesion.

1. The Issue. Whether private lands can be used for public hunting.

The Contention. Roughly 76% of the United States, excluding Alaska and Hawaii, is privately owned. It follows, therefore, that private lands *must* furnish a major portion of public hunting, particularly for upland game. And, it is obviously necessary to secure the cooperation of the landowners.

State and Federal management areas and commercial shooting preserves will be of increasing importance, but main reliance must be on private land, under conditions harmonious with its primary use.

2. *The Issue.* Whether states are responsible for providing hunting for the average hunter, and for preventing conflicts of interest caused by wildlife resources.

The Contention. Constitutionally, game is owned by the state, held in trust for the people. Further, most game departments are charged with ". . . the responsibility for propagation, protection and management of wild game." This American legal framework embodies ownership, trust and management. It implies a responsibility for the welfare of game and its habitat, whether on public or private lands. It also implies a responsibility to the people—to the average sportsman, and all others involved in game production and harvest, and for preventing conflicts among these people.

The law does not spell out how this responsibility is to be discharged. Traditionally this has come to mean a direct responsibility: propagation of game-farm animals; acquisition and direct manipulation of habitat; and establishment of public shooting grounds. A broader view would assume an indirect responsibility: a responsibility for developing broad social, economic and legal programs that would result in favorable conditions for game and its habitat, provide public hunting, and prevent conflicts.

There are also very practical reasons for the states assuming responsibility for developing public hunting programs. The problems of working out individual hunting arrangements are too complicated for individual hunters and landowners. As the number of farmers who no longer live on their land increases, the problem of locating the owner and obtaining permission becomes more difficult. And, there are too many hunters and landowners to expect individual arrangements to meet with a wide degree of success. It is unrealistic to expect a state's one million hunters to conduct individual negotiations and to expect individual landowners to develop effective hunting arrangements. This can result only in a crazy quilt patchwork of arrangements and additional posting simply because it is too inconvenient and complicated for the landowner to manage public hunting. A further weakness of individual arrangements is that they fail to guarantee maintenance of adequate habitat. The total habitat transcends property lines.

In the United States there has been a traditional concern for the average hunter, the "one gallus hunter." Public hunting has been our heritage and remains the goal, however difficult, for most game departments. To abandon the goal is to abandon responsibility to the average hunter, the landowners and the resource.

3. *The Issue.* Whether fish and game departments can cater primarily to the fishing and hunting public and, at the same time, fully discharge their responsibilities.

The Contention. Sportsmen are not the only people interested in and affected by fishing and hunting. Yet, most game departments cater primarily to this group.

This is costly and fallacious and implies a selfish interest in only one phase of wildlife management—the pursuit of pleasure. It begs a basic question: are state agencies interested solely in fishing and hunting, or in the full development, use and enjoyment of wildlife resources and in the many people that are or can be affected by their management?

The contention is this: game departments are responsible for developing programs that benefit all segments of society—the farmer, the businessman and the sportsman.

4. *The Issue.* Whether fish and game departments can control the many activities that influence wildlife management.

The Contention. Obviously, fish and game departments have no direct control over many of the activities that affect wildlife resources such as highway construction, pollution, residential expansion, the use of pesticides, and farm practices.

Fish and game departments are, however, responsible for understanding these activities and for developing coordination, cooperation and positive programs that assure reasonable consideration for wildlife resources in total land use planning.

5. *The Issue.* Whether fish and game departments can, without assistance, discharge their responsibilities for managing wildlife.

The Contention. The complexities of completely managing wildlife require a myriad of talent: experts in land use planning, urban and rural development, economics, human population dynamics, and others, in addition to countless specialized scientists. Obviously fish and game departments do not have, and are not likely to have, all such talent. Assistance can and must be obtained through cooperative and contractual arrangements with public and private agencies.

6. *The Issue.* Whether present management philosophies and concepts are adequate to meet the future needs of wildlife management.

The Contention. Present philosophies and concepts are inadequate to meet mounting fishing and hunting pressures; for recognizing the coming role of wildlife resources in the national agricultural, industrial, economic, social, and cultural patterns; for resolving conflicting interests; for developing economic potential; and for providing public hunting. The increase in posted lands, the adverse resolutions from farm organizations, and the restrictive legislation, together with an ever-shrinking habitat, are evidences of the inadequacies of present concepts and philosophies.

Summation. In capsule form, it is contended that state agencies have a responsibility for providing public hunting but that present concepts and philosophies are inadequate to discharge this responsibility.

A POSITIVE PHILOSOPHY

There is clearly an urgent need for a new philosophy of wildlife resource use. Responsibility must be recognized and willingly accepted and programs developed that recognize the full potential of the wildlife resource.

Maintaining habitat, or hunting on private lands, cannot be isolated and solved as single problems. The same is true of pothole drainage, pollution and a score of others. There is a thread of similarity in almost every problem: the value of the resource is not realized. This indicates a basic weakness in the attitude towards wildlife resources. The problems will not be solved nor atttudes changed simply by improving existing techniques—by more of the same. What is needed is a philosophy that develops the positive value of the wildlife resource.

While recognition has been given to the aesthetic, social and economic values of wildlife, a positive program for full development of these values is lacking. The wildlife resource has tremendous, unrealized potential. Yet, wildlife management is characterized by protectionism and defensive policies. This must be reversed and defensive philosophies abandoned in favor of a positive philosophy.

If wildlife resources suddenly became something of tangible value to the farmer, to the community, to Main Street, in short to the public at large, would a defensive position be necessary? No. Instead, there would be strong support for the resource. Is it not then reasonable to adopt a philosophy that visualizes full development and management of wildlife resources for the benefit of the public at large and not just the fishermen and hunters? Wouldn't it then also be reasonable to expect continued fishing and hunting?

Such a philosophy is needed now to transform the resource into local, state and national assets. It must embody certain principles. It must recognize wildlife as a resource of the land, governed by the same principles that govern other land resources, and subject to similar limitations and similar opportunities. It must recognize the potential of the wildlife resource in its broadest perspective. It must recognize the need for reducing conflicts and for improved coordination. And finally, it must recognize the need for developing the full economic potential of the resource.

A PHILOSOPHY IN ACTION

Translation of philosophy and concept into action requires imagination, boldness, and sheer determination. It cannot be accomplished by policy decree, but only through the tedious pursuit of a positive program. A seven-point program is here proposed to activate a positive philosophy for discharging the responsibility of state agencies in managing wildlife resources.

1. *Intensifying Management.* Hunter pressure causes much conflict and ill will. Now, public hunting doesn't necessarily mean that all hunters must be out at the same time. Application of existing techniques for manipulating hunter pressure should be accelerated and emphasis increased on developing new techniques.

2. *Improving Relationships.* If private lands are to furnish public hunting, ways of working with landowners must be developed. This is fundamental, yet it remains a major stumbling block. It means more than public relations and good manners. It means developing mechanisms for maintaining effective working relationships at the local level—working cooperative organizations that actively involve the landowner, recognize his problems and respect his rights. The objective is to bring the landowner into the solutions of problems with which he is directly concerned. The same applies to other land users.

3. *Improving Coordination.* It is also true if private lands are to provide public hunting, working relationships must be developed with other land management agencies. The goal is simple: to provide public hunting. All too often this objective is lost in a series of useless disputes and controversies between agencies. This frequent lack of compromise must give way to the cooperative task of incorporating wildlife management into total land use planning. This will require liaison, coordination and cooperation with all agencies whose activities influence wildlife.

4. *Reaching a Broader Public.* Direct efforts are required to reach and work with a broader public, with agriculture, industry, and with professional people. If a game department caters to "the sportsmen" it is serving a public that is neither homogeneous nor identifiable, but composed of a cross section of the people, most with other primary interests. Successful wildlife management requires support from organized groups—from farmers, businessmen, ranchers and others. Wildlife must become important to these people and specific programs developed for them.

5. *Considering the Total Environment.* Wildlife management cannot be practiced successfully until state agencies actively and directly

concern themselves with the changing pattern of land use, human population statistics, agricultural economics, the impact of a modern and expanded transportation system, and so on. Wildlife managers have long recognized the biological environment. Unfortunately, little attention has been given to the political, legal, social, cultural and economic forces which create, to a large extent, the total environment and govern land use. These forces are just as important as soil fertility, climate, food and cover.

Only through careful study and understanding of these forces can they be considered in program planning and in developing long range wildlife management plans. Most state agencies have no formal means of doing this. Organization and staffing in this important area of program planning is equally important with waterfowl biology, big game biology and information and education.

6. Developing the Economic Potential of the Wildlife Resource. Wildlife economics, the development of the full economic potential of wildlife resource, is one of the most important, yet most neglected and least understood phases of wildlife management.

The wildlife resource has a tremendous, unrealized potential. Even without intentional development, expenditures for fishing and hunting have had an important impact on the local, state and national economies. If the potential is fully developed, wildlife resources would have a far more important economic role.

The climate for economic development has never been more favorable. Consider these facts: many farm operations are submarginal and uneconomic. Land retirement could reduce the agricultural surplus. There is an expanding labor force, most of which must be absorbed in providing services. There is both the market and the demand for outdoor recreation, the two necessary ingredients for economic potential. The economy is expanding, seeking new enterprises and markets. These situations all represent opportunities for economic development of wildlife resources.

To see the opportunity and to take advantage of it requires deliberate program planning, a field unexplored by state agencies.

There are at least three areas apparent where this economic potential can be developed.

(1) *The development of a system of compensation to individual landowners.* This has been discussed before (Berryman 1957, 1958) and the basic requirements of a compensation plan outlined. Suffice it to say that such a plan is practical and sound and the stigma attached to so-called "paid hunting" can be avoided. This, obviously, is one important step in providing habitat and hunting opportunity on private land.

Of this we may be sure: unless the states take the initiative in developing a system equitable to sportsmen and landowners, it will be done privately and not to the advantage of either the resource or the general public.

(2) *Community development.* Many businesses profit from fishing and hunting. There is, however, no organized effort to show communities how to realize returns from fishing and hunting. Many communities are completely unaware of the potential value of wildlife in stimulating local business. State agencies could do much for the rural and urban areas and for the wildlife resource by providing planning and development services. Here is an opportunity to help communities plan and promote business that would in turn support wildlife management.

Community development and planning is gaining acceptance and providing valuable service. It is a program that should become a tool of wildlife management.

(3) *Improving conditions through economic exploration.* It is frequently possible to improve habitat by developing an economic use for a product or a new, profitable land use. For example, the economic production and marketing of charcoal briquets is of benefit in thinning timber stands in the north woods. The production of fish sticks removes so-called trash fish. Consider the advantages of developing a market for salt cedar, juniper, carp, or cattails. This would be a profitable means of control.

Where certain land uses are detrimental, the development of alternate land use practices would be worthwhile. The same is true of certain agricultural practices.

There are many opportunities to be found in the area of production and marketing. They can be explored through cooperative and contract research.

The economic development of the wildlife resource is not "commercialization"; it is not "paid hunting." It is a sound means of managing a resource. The challenge is to develop economic potential, avoid the dangers of crass commercialism, and maintain the high quality of the sport.

7. *Reorienting Education.* An accelerated, expanded and reoriented program of public education is vital. We are not speaking here of the traditional "I & E" approach. The public must be educated to the ultimate role of wildlife resources in the total resource picture. A common fallacy is that there is but one public. There is a need to direct specific educational efforts at several specific publics. Industry, agriculture and labor must be made aware that wildlife is not a competitor, but a valuable resource. The license-buying public must be

made aware that the wildlife resource is important for more than providing fishing and hunting.

A new image of wildlife resources must be created in the public mind. The public must visualize the importance and potential of the resource. This image must be shared by policy makers, politicians, chambers of commerce, and so on.

In short, having demonstrated the value of wildlife resources, the burden of defending these resources can be shared with a larger segment of the public. This is a job for education.

CONCLUSION

In conclusion, state agencies have a responsibility for providing public hunting on private lands and also for the larger and more important task of developing the full potential of the wildlife resource for the use, enjoyment and benefit of all segments of society. To discharge this responsibility will require the development and implementation of a new and positive philosophy.

To accept less is to allow public hunting to go by default and to miss the opportunity for developing a uniquely American system of wildlife resource management.

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DISCUSSION

MR. BEN GLADING [California Department of Fish and Game]: First of all I wish that Earl Frye had sent me that question about how you're going to increase these birds 50 per cent. If he had asked me about pheasants or California quail I'd say it would be pretty easy. I would have got down and prayed for better weather in the next five years and we would have our jobs done. This wouldn't take very much money, but a little influence in the right place would probably do the job.

Seriously, I think that maybe we are looking at the wrong side of this thing when we continue to stress the economics. The first three papers in particular I think were rather heavy from the standpoint of economics, how we're going to pay for it. Recognizing the fact that economics are important and that somebody is going to have to pay for it is good, but in my thinking, if we think entirely in terms of economics in this, we're going to lose. The reason is pretty patent. I would like to refer to Peterle's paper when he mentioned population growth and the fact that the number of hunters was not keeping pace with population. This is certainly true where I come from.

At the present time, only about one out of 20, about five per cent of the population, buys a hunting license. According to predictions in 1980 the population of our state will be from 30 to 35 million, and I'm confident that instead of five per cent of the people being hunters in 1980, it will be in the neighborhood of two or three per cent. What the future, as far as the year 2000 brings, I hesitate to say, but it is going to be on the one per cent level if the trend continues.

Certainly if we are hinging our hopes on the economics of the lands of our state that now can be produced for one per cent of the people, we're going to lose, and we in the State Game Departments are going to lose. Therefore we had better start looking at something else. And the something else is simply the aesthetics of the situation. We know, and it has been brought out here in part in Berryman's paper, that we've got to look at the whole broad picture. In particular, I think, one of the things that the game departments have been lax in is in taking into their thinking groups other than hunters.

If we in game departments are expert in anything, it is in managing land for wildlife. The protectionist groups are a little lacking in ways and means of managing lands for all types of wildilfe. This is our field of expertese. We, I think, should exploit this, not only for the hunter but certainly for the person who likes to see wildlife and likes to see wild lands in the middle of our farm lands.

It has only been fairly recently that we've come to this realization in our state. The more we see it, we're certain this is the course we have to take. We have a little pilot experiment that we're running with one Soil Conservation District next to Sacramento, and we, in effect, are making farms better looking and we're getting the women in as allies. We have a couple of pretty bushes out there that are useful to wildlife and we find that by putting these in and encouraging the women by saying "Look what this does for you," she keeps the old man from plowing them up and she gets quite proud of them.

We're groping but I'm certain that in the long range we have to seek something else than just economics, because we're going to lose if this is the only thing we talk about. We have got to join with the other groups who are talking about esthetics.

MR. JOHN ANDERSON [Port Clinton, Ohio]: It seems to me that the profession of wildlife management as a whole is being hampered by a couple of basic misconceptions. One is the notion on the part of the hunter that hunting is a God-given right. I'm born an American and therefore I expect, since the game belongs to all the people, that the government is going to take care of it, and that the government should provide me a place to hunt and game to shoot at. The various states and federal government have tried to do this, but it appears to me that it can't be done, because obviously you do not own the land. The land is privately owned, and we've talked all around the point except what it boils down to, after listening to this symposium, is that if we expect a private landowner to produce a crop of game, then we're going to have to pay him for it, and pay him handsomely. Pay him enough so that he will make as much or more profit on his pheasants and rabbits as he does on his corn. He is not going to do anything about providing habitat which will create game until we do.

If this makes it tough on the one-gallus hunter that is too bad, but those are the economic facts of life. It seems to me we had better quit trying to repeal the law of supply and demand.

Another thing it seems to me is this business of free advice. I think this is hurting our profession. You gentlemen, many of you, have spent eight years getting an education, many of you have 15 and 20 years' experience, and you feel that you should go out and provide advice on game management free. A doctor of medicine wouldn't think of doing this and neither would a lawyer, and that is probably the reason the doctor of medicine is making $50,000 a year and a doctor of philosophy is making $5,000. This may be radical thinking, but it seems to me that we've gotten just about as far as we can get on the other concept.

DISCUSSION LEADER LATHAM: Thank you, Andy.

Would anyone else like to comment?

MR. VAL LEHMAN [King Ranch]: This goes back through about 30 years of intensive upland game management on approximately a million acres for 16 years at Kingsville. We had the world-record population of turkeys for many years, the highest populations of deer in that habitat type, and more quail than anyone else in South Texas for as long as we've had management. I think some radical thinking is needed on this, but at the same time some of our stuff goes back many many years.

We can do habitat management profitably. Our quail management on King Ranch costs about ten cents an acre a year, and the going price of shooting rights is a dollar per acre per year on adjoining ranches. You can do that if you have the basic essentials, the woody cover, herbaceous cover, and grass. If the man is overgrazing you're just flying against a hurricane if you attempt to put in little fenced plots or plant multiflora rose or anything else. If the basic land use is all right you can come in with game management at moderate cost and it will pay great dividends.

A second point is this: of course, having done this work for the state and the federal government for many years, I came into a practical cow ranch attempting to apply some of these same techniques and in the same manner that we had done them in government service, and the program fell flat on its face. You can't get a ranchman to do quail management unless you develop techniques that are not only beneficial to game but are helpful to the primary land crop, which in this instance was cattle. But it can be done; you can take fire gorges that you put in pastures for fire protection of the range and locate them in such a way that they serve as food strips for game. You can develop, as we did down there, cactus, formerly considered a useless plant, into a valuable quail-livestock food. I have had seven men planting nothing but cactus on King Ranch for the last eight years. We planted hundreds of miles of living fences, and we're trying to get ten per cent of the King Ranch in cactus for emergency stock feed. It took experimentation with a lot of species to get that; it took experimentation with fertilizers to double the protein content of cactus in 12 hours with spraying, but it can be done. It has been done and the landowners have been willing to do it.

The last point, and I think this is important, let's view game, and our work as government people in game, somewhat like the Livestock Sanitary Commission in Texas. They're absolutely incapable of doing all the branding, the rounding up and the working of all the cattle in Texas. They're an advisory agency. I think that the states and the federal government should recognize that it is utterly and completely impossible for them to properly and intensively manage game on all of our private lands. You have to get the land-owner to do it. You get him to do it by providing sound advice, not by giving him a few little plants to plant in a row, or some pretty bushes, but by staying ahead of land use, for example, and giving him things that really work, work for the advantage of his cattle, work for the advantage of his game.

Then from an economic standpoint possibly you can accomplish what has been accomplished there now for many years on one 120,000-acre study area; since 1948 we have produced 13.5 pounds of game per acre. That compares with an average productivity of 10 pounds of beef in the Rio Grande Plains as a whole. If we view game as another crop of the land, possibly one of the most undeveloped phases of agriculture, stay ahead of the agencies that are doing most to destroy game now which, in our country is the A.S.C. programs, then I think that the states will be providing a great service. It will make a lot of additional work for game management people professionally, and it will have some hope of really coping with this problem. But if we stay in our old straitjacket I think we're lost.

MR. GEORGE GRIFFITH [Michigan Conservation Commission]: We've been exploring a point in Michigan that would bear on what Mr. Berryman had to say. He pointed out that there are many other segments of society who have a stake in wildlife as well as the hunter and fisherman. The hunter harvests a percentage of the game, and that is a small percentage. The rest of it belongs to all the people and is used by them.

My point is, how can state agencies collect a fair fee from the people who watch warblers, photograph wildlife, pick flowers and other many things that are being done today, yet do not at the present time pay any fee for the use of that wildlife? The hunter carries the load, as far as that economic point is concerned.

MR. MERT GOLDEN [Pennsylvania Game Commission]: We, like many other states, are engaged in a rather intensive habitat improvement program on both private and state lands with a great variety of results. However, because of the continually growing demand for this type of recreation, our problem seems to be gaining access to the lands that naturally produce wildlife, proceeding on the theory that wildlife production must be incidental to some more important land use. The problem of gaining access and the harvest of these various species is becoming increasingly important to us.

I think most of you are reasonably familiar with our cooperative farm-game project program which provides about a million and a quarter acres of some of the better agricultural land in Pennsylvania, and gives the hunter access to this land. I think one of the peculiarities of one of our problems is that this terrific gun pressure has created a situation where the landowner appears to be quite willing to cooperate with the hunting public, accepting very little in return for the use of his land. Four years ago we launched into a program of providing safety zone signs to the farmers which they themselves erect around their buildings. They erect those signs in a radius of 250 yards of all occupied buildings. In this four-year period this program has developed to the point where last fall we had opened up more than one million acres, made available to the hunting public, to harvest the various wildlife populations produced on private land, by simply providing the farmer with a dozen safety zone signs. This in total provides approximately two and a quarter million acres of private land to the hunters of Pennsylvania, and I think this approach, in areas where you have concentrated hunting, heavy gun pressure, I think has wonderful possibilities.

DISCUSSION LEADER LATHAM: Thank you. I think this indicates that sometimes you can get effective results with very little expenditure if you study the problem closely and find out what single item sometimes is causing your difficulty.

MR. VERNE DAVISON [Soil Conservation Service]: Let's not put all of our eggs in one basket, gentlemen. I think certainly that one of our greatest problems is to provide habitat and hunting for the public. Let's not ignore, however, another way of producing hunting and habitat and more game for private hunting. If you do that, and you must do it, we are beginning to do it in most every state, then we must recognize that there are two sort of things we are trying to do.

One is to open up lands for public use, which costs a rather small amount. The other is, we still need to manage habitat so it produces more game than there is at the present time. You don't get that for nothing. We're going to have to have money, brains, machinery, and effort put forward to it. That is, I think, what we're talking about primarily is whether it's going to take more money and where it's coming from. In that regard we need better techniques so that what we spend is more predictably successful and less costly per bird. That will get us part of the way and not take away from the public aspect at all.

One other thing I think we've overlooked in this discussion. We have talked specifically, of course, about the responsibility of a state wildlife agency. Let's not overlook the fact that any agricultural agency must also assume a responsibility for management, protection, and encouragement of such habitat management that will increase our production per acre on those areas where people are willing to do it.

MR. CHARLES O. KELLY [Alabama Department of Conservation]: I'm wondering how we can possibly ignore the economics of a program of this type. I can't figure out in Alabama where we could ignore the economics of the program and continue to do very much. We speak of groups other than the hunters, and we find ourselves using the hunters' money to create populations of certain types and in various states. These other groups that we speak of often move in and say, "Let's stop hunting; let's not shoot any more of it." If you don't watch out, you spend money to create game, and then the group that you create it for will put pressure on you to kill any further revenue to support it.

I can speak of the quail in Ohio which they are finally beginning to shoot again. If you spend money to create quail in a state and use the hunters' money to do it, and these other groups come in and say, let's not shoot it any more, then you are cutting off the hand that is feeding you. In our state, and I think it's true in most states, that until these other groups wish to put some money into the program we're going to have to play up to the hunters, the men that are footing the bill. I think to do otherwise would put us all out of business in a relatively short time. I think, Earl, that would hold true in Florida, I think we have a similar situation in both states. We, in Alabama, are going to have to go along with the hunters, the ones who are footing the bill, because we operate entirely out of our hunting and fishing license money with no other source of revenue. If these other groups, as the gentleman from Michigan stated, want to come in and start contributing to the program, then certainly we would be willing to give them a pro-rata share of our treatment, but until they do we're going to go along with the hunters, and I think to do otherwise would put us out of business.

MR. BERRYMAN: I would like to comment briefly on the point that was just made and was also raised by Mr. Griffith from Michigan. I think ultimately there is no question but that other people are going to have to contribute besides the license buyers. On the other hand, just looking at the present, I think the end justifies the means. If we can gain support from the broad public to provide for producing continued hunting, then we are serving the sportsmen indirectly. I think we have a good example in Utah. The Fish and Game Department has worked directly with one Chamber of Commerce. There is at present a road-building program that would destroy a fishing stream, and this Chamber of Commerce feels that that stream is so important to the economics of the community that the Chamber has come out in support, not just the fishermen, but the downtown businesses and so on.

I think if a state assumed responsibilities for assisting communities to develop the economic values, and if the states assumed responsibility for developing programs that help these other segments of society, they in turn would provide support which would assure continued hunting. So it is just one way of getting at it and not depending exclusively on the sportsmen. Obviously many people are benefiting from fishing and hunting and that's good, but we're not attempting to seek their support before state legislatures and so on. When it becomes worthwhile to them—this was pointed out in the case of the King Ranch—we won't have to worry about the interests of the sportsmen.

DR. J. J. HICKEY [Wisconsin]: I think the audience wants to congratulate our panel and the planning that went back of this interesting discussion. It is wonderful that we're able to look at our programs realistically in terms of the bags that we're getting out of these programs, but I'm afraid that this emphasis on the bag is a false attitude and a betrayal of the basic philosophy of the wildlife profession. Some of our speakers have gotten up on Cloud 9 where we have to go from time to time. I think Berryman did this, but what is the role of wildlife in American culture? This has been touched on in a very interesting essay by Leopold, and modern hunting has been discussed in the *Journal of Wildlife Management* by Doug Clarke.

I'm personally disturbed by the rise of the commercial shooting preserve. I feel this is a sign of defeat which the state conservation departments are sustaining. I don't think that commercial shooting has a place in American culture. I do think that state conservation departments do, and we will have to get back on Cloud 9 and think through what our role in American culture is. Among these things, for instance, where we can justify our existence is the need to bring our urban people back to the land and to get them in touch with rural people.

The two dominant things that are happening in this country are this increasing population we have and an increasing degree of organization. We, in the conservation field, have a contribution to make but this contribution will not necessarily be in the amount of game in hunters' bags.

DR. E. L. CHEATUM [New York]: First of all I'd like to commend the Technical Session Chairman, Gene Dustman, representing the Wildlife Society for an extremely excellent and improved arrangement of the Technical Sessions to eliminate or at least greatly reduce the competition of attendance of important meetings during the Conference. Secondly I certainly want to commend Wagner and you, Roger, and the panelists, for this extremely stimulating panel discussion which has taken place.

There have been two mentions in the course of this morning of New York's Fish and Wildlife Management Act. I would like to outline briefly what that Act is. Essentially it is a very explicit legislative definition of the responsibility of the New York State Conservation Department for the management of the wildlife resources of the state, all going down from all of the vertebrates right on down to the invertebrates. Secondly, it establishes a legislative base for an extremely important social experiment in grass-roots planning for the management and the recreational use of fish and wildlife resources in the state. The grass-roots are represented by appointed farm representatives, by appointed sportsmen representatives, and by an appointed member of each county board of supervisors who represents all groups in his county, including the garden clubs and commercial interests, et cetera.

There are three representatives from each county, the state is divided into district boards. Then from each district board there are representatives elected to the state board, which is the final clearing-house with the Conservation Commissioner on policy and program.

We feel that this is rolling now, and we have over 200,000 acres of private lands under cooperative agreement, including close cooperation with federal lands, too, in the case of the Army for example, and U. S. Forest Service. We hope to have at least 400,000 acres under cooperative agreement by 1965 and a million by 1970 or 1975.

The main point is that for the first time there is a legislative mandate for this broad-based planning for all resources that relate to soil, water, and the wildlife and the fisheries which are dependent on those habitats. I might also add that, as an adviser to each of these boards and from each county, the S.C.D. chairman sits in to correlate with the Soil Conservation Programs developing on private lands, and also an adviser for the Forest Practice Act Board which is developing the programs for private woodlands management.

So they're all tied together and we feel there is a tremendous future whereby we can face up realistically to these problems and also expand the economics base from both private and public funds for moving forward.

MR. LEVI MOHLER [Idaho Fish and Game Department]: Where people are fewer and game is abundant, some of these problems can be faced more directly, and we are having some success with that in the State of Idaho. One of the problems which you have everywhere is the problem of the relationship between the landholder and the sportsman. In Idaho we have a landholder-sportsmen's council which is doing a lot to materialize this philosophy that the last two speakers have mentioned, and that is so important in preserving our heritage of hunting. This council stays completely out of the field of management but it seeks as its sole purpose to get the participants and land operators together to solve problems which are very real in pheasant hunting areas, and it is doing a lot of good. I think it has a lot of potentiality for use in many areas over the country.

TECHNICAL SESSIONS

Tuesday Morning—March 7

Chairman: CARL W. BUCHHEISTER
President, National Audubon Society, New York City

Discussion Leader: WILBERT M. CHAPMAN
Director of Research, The Resources Committee, San Diego, California

COASTAL AND MARINE RESOURCES

SEROLOGICAL TECHNIQUES IN FISHERY RESEARCH

CARL J. SINDERMANN
U. S. Bureau of Commercial Fisheries Biological Laboratory, Boothbay Harbor, Maine

Very early in the twentieth century, two events occurred that have only recently begun to affect the course of fishery research. Karl Landsteiner (1901) observed that the red blood cells of one human could be agglutinated or clumped by serum from another, and he proposed the ABO blood group system familiar to us today. In that same year G. H. F. Nutall (1901) published the first of a series of papers demonstrating that an antiserum reactive with serum proteins of one species of animal would also react with related species, thus instituting the science of systematic serology. Since these basic observations were made, and particularly since World War II, knowledge of human blood groups has advanced, so that now many human blood group systems have been proposed in addition to Landsteiner's ABO system (summarized by Mourant 1954, Race and Sanger 1954). We can now characterize an individual human being serologically with remarkable precision, and we can describe each human population serologically with similar precision.

Immunogenetic information has also been accumulated for cattle and chickens. Cattle blood group systems surpassing human systems in complexity have been developed as a tool in herd lineage studies. Work in the last decade has suggested that blood types of chickens may be associated with characteristics such as egg production. Sheep, buffalo, pigs, whales, pigeons and doves have also been examined serologically, but until recently many of the other animal groups had been virtually ignored. This was particularly true for the fishes, and is still generally true with but a few exceptions.

This paper is concerned with those exceptions—with the progress and status of research in fish serology. It has several objectives: (1) to point out the scope of serological methods available to fishery research; (2) to demonstrate that fish serology is approaching the stage of quantitative studies; (3) to suggest the potential utility of serological or blood grouping studies to every investigation of marine animals; and (4) to indicate how serology has provided information of value to our own investigations of sea herring and certain other fish species of the western North Atlantic.

Systematic serology is based on three assumptions, which are receiving increasing support with the passing years: (1) that animals have evolved biochemically as well as morphologically, so that biochemical characteristics can provide as valid criteria for fish systematic studies as morphological and morphometric characteristics; (2) that many of these biochemical characteristics are genetically determined, and are not affected by environmental influences; and (3) that subpopulations within a species may be distinguishable by the existence of constant quantitative differences in the frequency of occurrence of particular genes when any two groups are compared.

Immunogenetic studies of fishes have a remarkably brief history, mostly confined to the past 10 years. At present I know of only eight groups in the world with major continuous research activity in this field: the U. S. Bureau of Commercial Fisheries Biological Laboratory at La Jolla, California, concerned with sardines (Sprague and Vrooman, personal communication); the U. S. Bureau of Commercial Fisheries Biological Laboratory at Seattle, Washington, working with salmon racial separations based on blood types (Ridgway, Cushing and Durall 1958, Ridgway and Klontz 1960); the Nankai Regional Fisheries Research Laboratory in Japan concerned with tuna blood groups (Suzuki, Shimizu and Morio 1958); the Fisheries Research Institute at Ijmuiden, Holland, concerned with North Sea fish (deLigny, personal communication); Dr. Cushing at the University of California, Santa Barbara, one of the pioneers in fish serology, who has been interested in a number of species including tuna (Cushing 1952a, 1952b, 1956, Cushing and Sprague 1952, 1953); the U. S. Bureau of Commercial Fisheries Biological Laboratory in Honolulu, Hawaii, working with tuna and bait fish (Sprague, personal communication); Dr. O'Rourke of University College, Cork, Ireland, who is interested in several species of marine fish (O'Rourke 1959); and our laboratory, the U. S. Bureau of Commercial Fisheries Biological Laboratory at Boothbay Harbor, Maine, concerned with several commercial species from the western North Atlantic, particularly herring (Sindermann and Mairs 1959).

Most of the emphasis so far has been placed on development of techniques, so there is still little quantitative information available, but everyone working in this field is firmly convinced of and very enthusiastic about its potential value to fishery research, once exploratory work has been accomplished. In the published literature, blood group systems have been described for tuna and Atlantic herring. Quantitative studies have described subpopulations of Pacific salmon and Atlantic herring, and indications of antigenic differences that may be of potential value have been found in over 20 species of fish.

PROBLEMS AMENABLE TO SEROLOGICAL APPROACHES

It might be instructive to look at some of the specific fishery problems that we in the immunogenetics group at Boothbay Harbor have considered. These are illustrative of the kinds of problems that may be amenable to serological investigation, although there are undoubtedly many applications that have not even been visualized.

(1) Immature herring (*Clupea harengus*) are caught in the Gulf of Maine and canned as sardines. The origin of these small fish is unknown. We know there are major spawning areas on the Nova Scotia coast and on Georges Bank off Cape Cod, but we do not know if either or both contribute to the coastal sardine-herring stocks.

(2) Atlantic redfish (*Sebastes marinus*), caught on the major fishing banks of the western North Atlantic, are of great commercial importance. We do not know if these are fringes of a large pelagic oceanic population, or if they represent discrete subpopulations. Furthermore there are pronounced morphological differences suggestive of possible subspecies.

(3) In recent years there have been increasing reports of large sharks in inshore North Atlantic waters. More information is needed about subpopulations and migrations of many shark species, from dogfish on up to those that cause closing of beaches.

(4) Along the Atlantic coast are five major species of clupeoid fishes, and several minor species. The natural relationships of these species—indeed of many comparable groups of fish—are subjects of conjecture and argument. Further fundamental studies are needed.

These are some of the problems to which we have applied serological approaches, and for which we have in some instances partial answers. I propose to concentrate on our own work at Boothbay Harbor, but you must recognize that comparable problems are being examined serologically in the other laboratories already mentioned with equal or possibly greater success.

1. *Herring Subpopulations*

Insights into the nature of herring subpopulations have been gained with a blood group system described earlier as the C system (Sindermann and Mairs 1959). Cells from individual fish were tested against antisera prepared by injecting herring erythrocytes into rabbits. In appropriate dilutions of such antisera cells of some herring clumped or agglutinated very weakly if at all, while cells from other herring reacted and agglutinated strongly, even in higher dilutions of the antiserum. This suggested that some individuals possessed a factor (an antigen) on their red cells that other individuals lacked. We labelled this factor or antigen "Antigen C" and characterized fish as C-positive if they possessed the antigen, or C-negative if they lacked it. The antiserum was further refined as a reagent for detecting antigen C on herring blood cells by antibody absorption. Absorption is the critical technique in all cell antigen research, and is the key on which much of the future of this work depends. It is actually a fractionation method to get specific test reagents (Fig. 1).

With such a reagent we tested blood samples taken along the Maine coast for frequencies of antigen C. Tests of over 2000 individuals clearly demonstrated population heterogeneity, and disclosed the existence of 2 subgroups, eastern and western, probably drawn from different spawning populations (Fig. 2). The next step was to sample known major spawning populations (Georges Bank and Nova Scotia) for the frequency of this antigen, in an attempt to relate the immature sardine-size fish to spawning groups. This was done, and the tests indicated that the major known spawning groups could contribute to eastern sardine herring stocks (Fig. 2), but that we must look elsewhere for the source of at least part of the western stocks, since the frequencies of antigen C were lower in western stocks than in either major spawning group. We have since looked in the Gulf of Saint Lawrence and on the Rhode Island and New Jersey coasts for the spawning group with relatively low antigen frequency that we knew must exist. Recently we tested a small sample of inshore spawners from the southern Gulf of Maine that had such a low frequency. Although much more extensive sampling must be done in this area, this suggested an inshore source of western sardine herring stocks.

The possibility still existed that the eastern stocks could be drawn

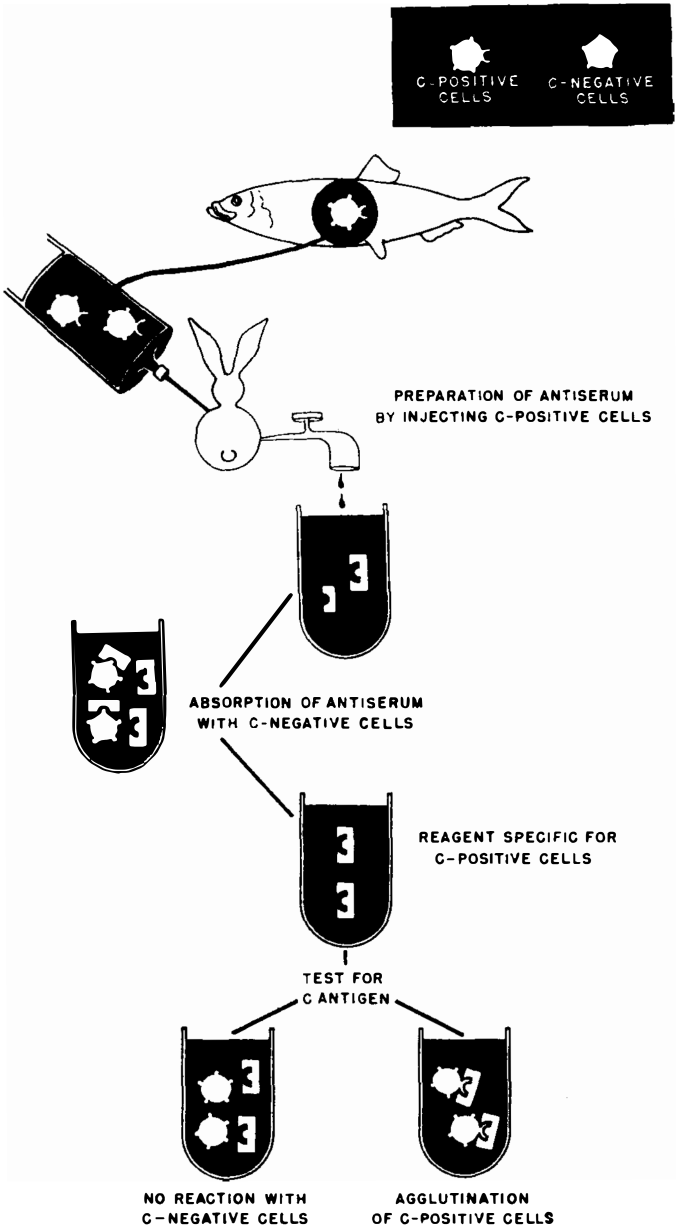

Figure 1. Absorption of herring C reagent.

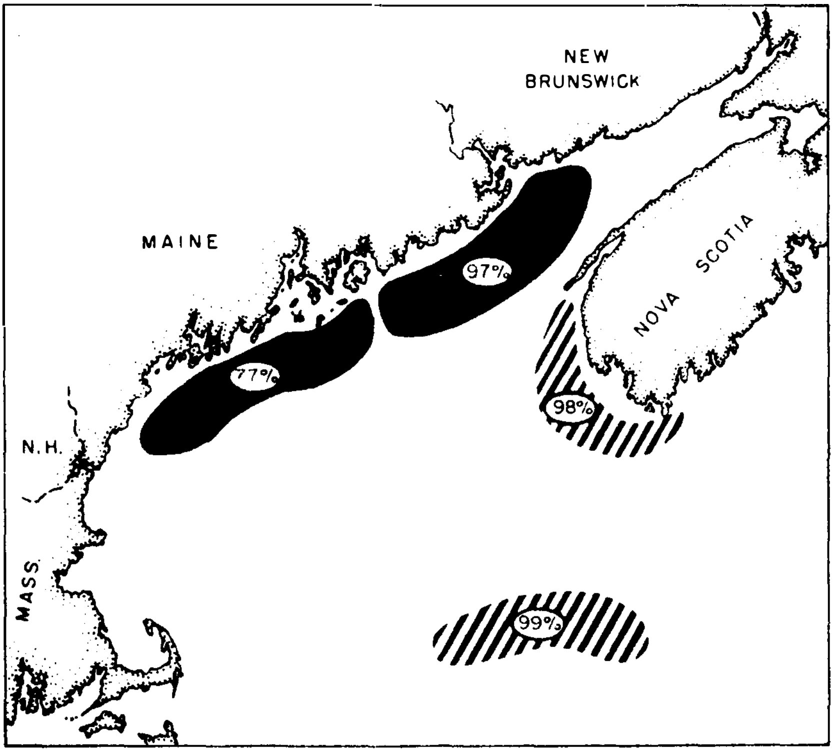

Figure 2. Antigen C frequencies in immature herring (black areas) and in major known spawning populations (diagonal bars).

from either or both of the major spawning populations—Georges Bank or Nova Scotia—and we needed another system that would differentiate between the two, since the frequencies of antigen C would not. By injecting rabbits with herring cells that were negative with the C reagent, antisera were produced that would differentiate, after absorption, another antigen with reactions independent of the C system. We have done preliminary tests of both major spawning populations for the frequency of this new antigen, called antigen "D," and have found it significantly higher in the Georges Bank population. We have recently begun sampling and testing the eastern sardine stocks for the frequency of the D antigen. Results of the first tests relate them definitely to Nova Scotia spawners. More data are needed, but we feel that we are approaching the solution to a problem that has remained unsolved for over half a century—the origin of east coast sardine herring stocks.

Tests with the herring blood group antigens have indicated that we should consider our sardine herring stocks as two separate entities in any future management plans and have suggested the spawning populations that we must scrutinize to understand reasons for the characteristic drastic fluctuations in abundance of immature herring from year to year. With these and other blood factors yet to be discovered, an interlocking characterization of each individual fish and each subpopulation can be achieved eventually, so that just as individual humans can now be completely characterized or typed, and human races and subgroups identified by frequencies of each blood type, so also individual herring may be described eventually as C^+, D^-, E_2, F_o etc., and herring subpopulations described by frequencies of each factor. At that point we will be able to give an excellent approximation of the discreteness or intermixing of subpopulations and their subsequent movements, on the basis of red cell reactions alone.

2. *Dogfish and Redfish Blood Group Systems*

We have had greatest serological commitment with herring, but have recently completed some work with sharks that has proved even more exciting and definitive. This grew out of interest in the increasing reports of larger shark species along the coast of the northeastern states—in 1960 particularly, when beaches were closed repeatedly by shark scares. We felt that immunogenetic methods could be applied to studies of shark subpopulations and migrations as well as to bony fish. We examined the east coast spiny dogfish, *Squalus acanthias,* to see if antigen differences could be detected that might be used in migration work, as a pilot study for the larger shark species (Sindermann and Mairs, in press). An isoagglutination system which we have labelled the S system was found to exist in this species, with two erythrocyte antigens, S_1 and S_2. Individuals may possess both, either or neither antigen, being of types S_1S_2, S_1, S_2, or S_o respectively. S_1 antigen can be detected by isoagglutinins in sera of dogfish which lack the antigen while either S_1 or S_2 can be detected with rabbit antisera absorbed with S_2 and S_1 cells respectively. A flow diagram illustrating this work is shown in Fig. 3. We have had the added advantage of being able to type unborn young from gravid females and to compare these with the parent female. This has provided genetic information that is so difficult to acquire for most marine fish. The dogfish S system is convincing evidence to us that there is order in what we work with, and now awaits quantitative studies of antigen frequencies in dogfish populations.

Blood groups in another commercial marine species, the Atlantic redfish, *Sebastes marinus,* have been examined (Sindermann in press). This species is widely distributed and abundant in the North Atlantic,

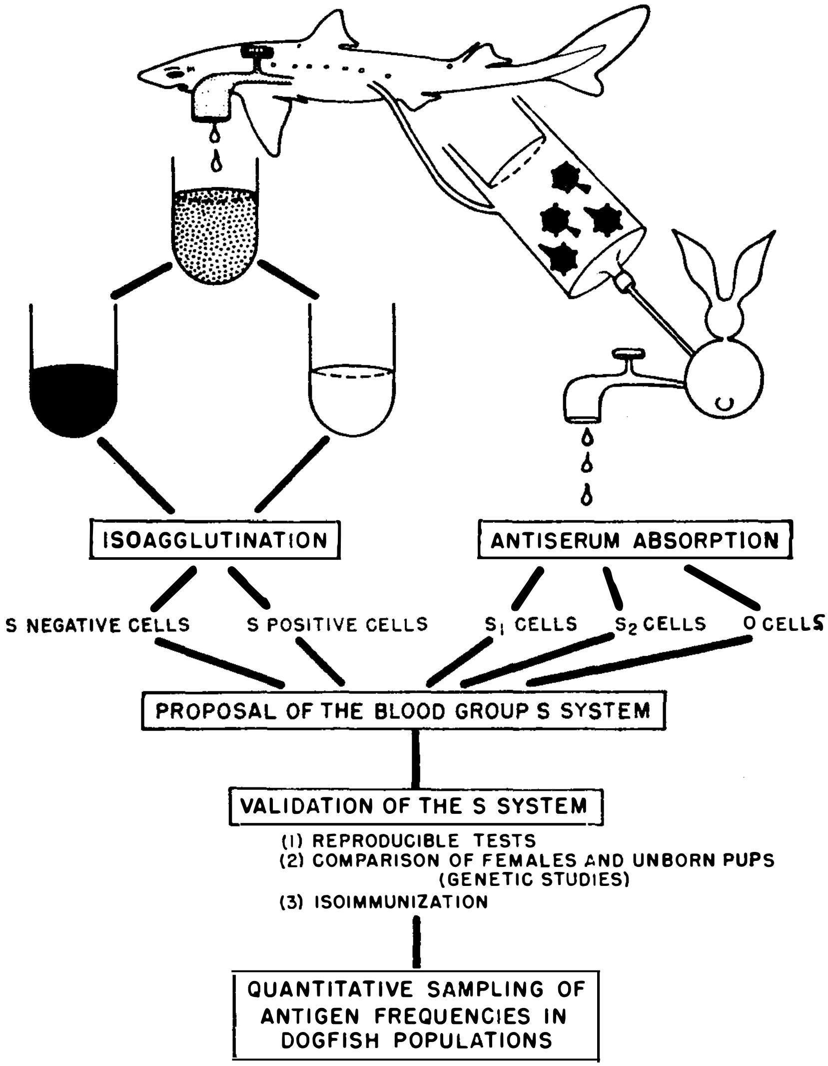

Figure 3. Flow diagram of dogfish studies. Isoagglutinins in dogfish sera and antibodies remaining in absorbed rabbit antisera are used simultaneously to determine the presence or absence of S antigens.

and is almost impossible to tag. A one-week symposium on its taxonomy in Copenhagen (1959) failed to reach agreement about intraspecies groups using traditional methods. We have proposed a first blood group system for redfish, the "A" system, comparable to the human ABO and the dogfish S systems in that it is composed of two antigens, A_1 and A_2. Individuals may possess both, either, or neither antigen. Specific reagents, produced by antiserum absorption, will detect either antigen. So far quantitative data are limited to one geographic area (Eastport, Maine) where A_1 occurs in over 75% of the fish. If comparable sampling of each major fishing ground is done, we should be able to determine discreteness of geographic groups.

3. *Serological Relationships of Five Species of Atlantic Clupeoid Fishes*

Subpopulations within a species have been considered thus far in this paper, but serology can have a major role in solving taxonomic problems above the level of species as well. We have examined the five dominant clupeoid species of the western North Atlantic: herring (*Clupea harengus*), alewife (*Alosa pseudoharengus*), blueback (*Alosa aestivalis*), shad (*Alosa sapidissima*), and menhaden (*Brevoortia tyrannus*). Their serological relationships—the relative serological distances that presently separate species—have been determined with a combination of several techniques, using both cells and serum. Methods used were precipitin tests visualized photoelectrically and by agar diffusion, erythrocyte agglutination with absorbed antisera, and electrophoresis. With this composite approach we have achieved a model representing the relative serological distances separating the five clupeoids (Fig. 4). Alewives and bluebacks were found to be serologically very similar, while herring were serologically remote from the others. Shad were closer to the alewife-blueback complex than were menhaden. This composite method provides another criterion that can be used in taxonomic studies, along with morphological characters such as gill rakers, teeth, scale counts, fin position, etc. It actually does much more than this. It supplies a method for separating closely related species, many of which may be difficult to separate morphologically, especially in young stages. Also, it provides a tool for recognition of species hybrids, since hybrid values fall between those of the two parent species. Most importantly, from our point of view, this work gives us background for comparable studies of subpopulations within a species. These would complement studies using blood group systems, and would provide greater serological depth. Actually, there is a whole spectrum of methods that could and should be explored in this composite approach to systematic problems, including such things as serological comparison of egg proteins or sperm antigens.

THE SEROLOGICAL FUTURE

It seems clear that serology, especially that part of it concerned with blood group antigens, will soon become a standard method in

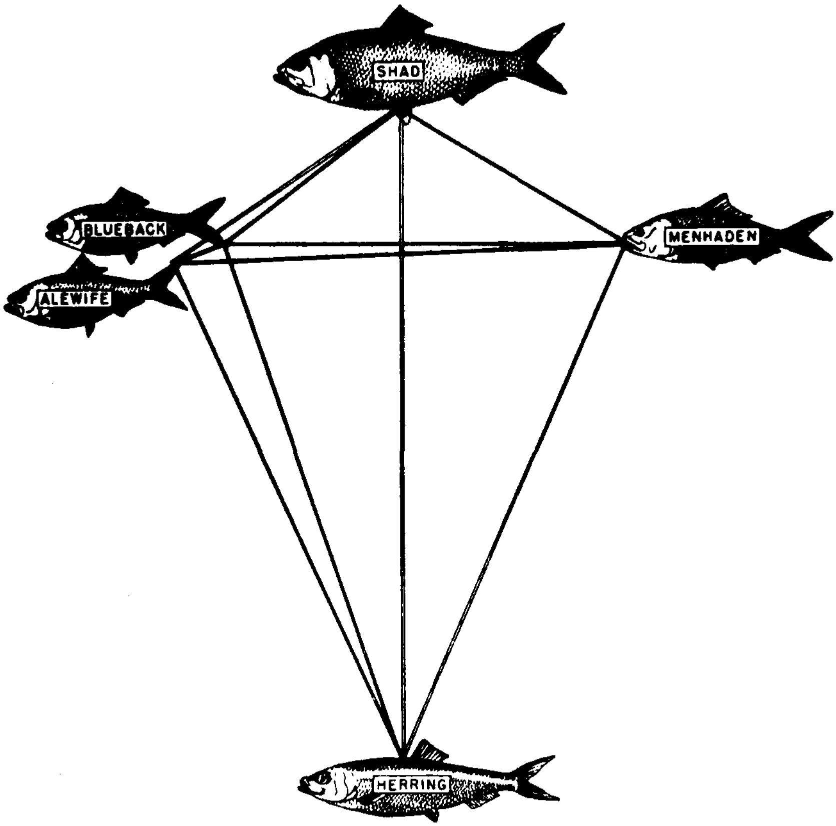

Figure 4. Serological relationships of five clupeoid species.

fishery biology. Systematic problems in any group of animals, at any taxonomic level, should be susceptible to investigation by one or several of the many serological approaches available. Population, racial, or subspecies problems are amenable to these techniques, and wherever you look in fishery research, whether in fresh-water or in the sea, there are problems, some of them of long standing, for which serological methods may provide definitive answers.

Comparable studies of marine invertebrates should be as rewarding as studies of fish. Antigenic differences have been detected among geographic races of Japanese oysters (Numachi, 1959) and it is possible that information about subpopulations and migrations of other species such as crabs, lobsters or shrimp could be derived from serological investigations.

With the increasing attention to and exploration of serological tools in several laboratories in the United States and other countries, the pace of research has accelerated. Once our period of groping and pilot studies is over, we should have another criterion, reasonably unaffected by environment, available for the study of subpopulations and migrations of fish—a criterion which should take its place beside more traditional methods, and may in fact prove ultimately of greater utility than such methods. The future seems limited only by the extent of our commitment.

SUMMARY

During the past decade there has been increasing interest in the use of serology for systematic studies of fishes. Of the varied techniques available to serology, investigation of red blood cell antigens, and subsequent description of blood group systems to contain them, offer greatest promise to the understanding of intraspecies groups. Quantitative study and comparison of antigen frequencies in fish from different geographic areas may provide information about the degree of intermixing and movement of subpopulations within a species. It is becoming apparent that discrete individual differences in red cell antigens characterize teleosts as well as higher vertebrates, and that geographic variations in antigen frequencies may be expected. Tuna, salmon, sardines and herring have been examined serologically, and quantitative information identifying geographic groups has been published. Blood group systems have been proposed for tuna, spiny dogfish, herring and redfish, and individual differences in erythrocyte antigens noted in many other species of fishes.

The practical aspects of serological work are exciting indeed. Since information derived is genetic, it will be possible to assess the discreteness of stocks or groups of fish for management purposes. Herring of the Gulf of Maine have been characterized in this way. Furthermore, it is possible to relate stocks of immature fish to specific spawning aggregations by these methods. This work is also in progress with Atlantic herring. As more marine laboratories begin blood group research, and as methods are refined, serology should become a standard method in fishery research, providing information about stocks and movements of commercial species, as well as supplying a tool for basic studies of subpopulations and the genetics of marine fishes.

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DISCUSSION

DISCUSSION LEADER CHAPMAN: This has been a fascinating paper. The new technique of serology as applied to fisheries racial problems is becoming one of the most useful tools that has been developed in our work in a long while. We have on our coast the problem of dealing with the yellowfin tuna, stretching over an area of about 4,000 miles from north to south, and it is an absolute necessity to get them separated into homogeneous populations for conservation regulation. None of the other normal techniques used in this work has had any effect, and serology is beginning to provide us with, we hope, a satisfactory tool to deal with that problem.

MR. SILLIMAN [Fish and Wildlife Service, Washington, D. C.]: You stated that you were using blood serum for sardine differentiation. Dr. Ridgway in Seattle, working on salmon, is also using this. He has recently been experimenting with plant proteins and I would like to ask your opinion of these serums.

DR. SINDERMANN: Plant extracts have been used and are being used with success by a number of people working in fish serology. We have tried plant extracts and started early with them. We found that the extracts were distinguishing the same C system that was distinguished by our rabbit anti-serum. I feel that there is a broad avenue of research in plant extract work, and I think that it will be pursued more vigorously. We have had initial success with rabbit anti-sera of fairly high specificity, so we have clung to this.

I might say though that we have recently tried using elasmobranch fishes as sources of anti-serum, and we find that the dogfish is an almost ideal experimental animal. It yields large quantities of blood and produces quite specific anti-serum. We plan to extend our studies, using both dogfish and skates during the coming season.

We have been using with the C system the same anti-serum that we developed three years ago and we still have good supplies of it. When you do absorptions selectively for some of the antibodies, you use up anti-serum fast. Normally the rabbit produces sufficient quantities for our work.

It might be true that if you were going to do a continuing population study as it should be done, you might run into difficulty. We feel safe, however, since we can turn to these plant extracts if we ever run short of our original C reagent.

BENTHIC FAUNA OF GEORGES BANK

ROLAND L. WIGLEY
U. S. Bureau of Commercial Fisheries Biological Laboratory, Woods Hole, Massachusetts

For over 300 years fishing has been a major industry in the coastal New England States. The bountiful supply of fishes available to the the Pilgrims and their contemporaries was a prime factor enabling them to successfully colonize this region. Later, the fishing industry played a fundamental role in colonial New England's commerce and was a key to its prosperity (Ackerman 1941). The backbone of this fishing industry at the present time is the bottom-dwelling group of fishes, called groundfish, which includes such species as cod, haddock, several hakes, and flounders. These fish spend most of their lives in the vicinity of the sea floor, feeding on invertebrate animals and the smaller fishes that abound in that stratum. The so-called benthic and epi-benthic organisms are the principal source of nourishment for these vast stocks of commercially valuable fishes.

The importance of an adequate food supply for fish has been recognized for centuries. This has resulted in numerous investigations of the food, feeding, and availability of foods for many species of fish (Dean 1923, FAO 1958-60). As the habitat for many stocks of fishes is continually being diminished and many stocks fished commercially and by sportsmen are dwindling in number, it is only by chance or guesswork that wise use can be made of our fishery resources unless the ecological aspects are clearly understood.

Our knowledge of New England marine life was greatly enhanced by such illustrious zoologists as Professors Louis Agassiz, Addison Verrill, and Sidney Smith. These and a number of other nineteenth century zoologists faced a vast unstudied fauna. The staggering taxonomic problems consumed a large share of their time. And, of course, proper classification is a necessary prerequisite for most ecological studies. However, in this particular region, the general sequence of interest took a peculiar turn. Interest switched from taxonomic inquiry to physiological studies, with relatively little effort devoted to ecological aspects. This turn of events is particularly true in respect to the benthic fauna studies.

In recent years the necessity for information about all aspects of marine life, including the benthos, has been rising rapidly. Not only is there academic interest in this sphere, but the need arising from increased demands for more efficient fisheries management, the possibility of using the oceanic environment for warfare, and the disposal of atomic wastes in our offshore waters have created a vital need to understand the life and waters of our seas. Not the least of these is the biological realm on the New England Continental Shelf.

GEORGES BANK

Georges Bank is a relatively shallow sill extending between Massachusetts and Nova Scotia at the mouth of the Gulf of Maine. Since this bank is roughly 12,000 square miles in area, it forms a significant portion of the New England Continental Shelf. As such, it is the largest fishing bank in this region, and is one of the most productive fishing grounds in the world. Waters overlying this bank are strongly influenced by the generally cold Gulf of Maine waters on the north and warm oceanic waters on the south (Bigelow 1927). Due to relatively strong tidal and non-tidal water movements there is considerable mixing of water masses on and adjacent to Georges Bank.

In addition to the different water masses with their particular physical and chemical properties, the water depths and sediment types in the Georges Bank region are quite varied. Thus, a rather wide variety of habitats for marine organisms is available. This biotopic diversity is matched by the multifarious benthic forms.

Until recent years very little was known about the Georges Bank benthos. Occasional references to the occurrence of certain species appeared in some of the early taxonomic literature and faunal synopses (Gould 1870; Verrill, Smith, and Harger 1873). These reports were frequently based on specimens obtained from fishermen, a source of some of the earliest information about the fauna. First directed efforts toward a study of the benthos were dredgings made from the vessel *Bache* by Smith and Harger (1874). They reported on the species composition of a modest number of catches mainly from the eastern and northern parts of Georges Bank. These catches consisted principally of the larger, epi-benthic forms. The *Blake* made a few collections from the eastern and southern sections of the bank (Agassiz 1888). During the years 1882-1886 the two U. S. Fish Commission research vessels ***Fish Hawk*** and ***Albatross*** occupied a number of stations on Georges Bank where benthic faunal samples and hydrographic data were collected. Since that time, however, little has been added to our knowledge of the Georges Bank benthos until the past few years.

The investigation on which the remainder of this report is based was essentially a qualitative and quantitative survey of the benthic fauna on Georges Bank and adjacent areas. Special attention was given to geographic, bathymetric, and substrate relationships with the fauna. It is anticipated that a more complete and detailed analysis of this study will be published at a later date.

QUANTITATIVE SURVEY

Quantitative samples were collected from the research vessel *Albatross III* at 161 localities on and adjacent to Georges Bank in August 1957. The samples, which included both the sediment and fauna, were collected by means of a Smith-McIntyre (Smith and McIntyre 1954) grab sampler. A portion of sediment from each sample was saved for particle size composition and organic content analyses that were undertaken in the laboratory ashore. The remaining portion of each sample was washed through a sieve having 1-mm. apertures. Animals retained on the sieve were preserved in formalin for further processing ashore. After sorting and identification, the number of specimens and wet weight of each species or higher taxon were determined.

Faunal Components

The bulk of the Georges Bank benthic fauna was composed of four major taxonomic groups: Crustacea, Mollusca, Echinodermata, and Annelida. Other taxonomic groups present, but only in small quantities, were: Coelenterata, Ascidiacea, Bryozoa, Nemertea, Spiunculoidea, Porifera, Pycnogonida, Nematoda, and Brachiopoda. For convenience in referring to these last named categories, they have been combined under the heading Miscellaneous. A summary of the number of specimens and weight of each major component is listed in Table 1. The main aspects of faunal composition can be judged from this data.

TABLE 1. SUMMARY OF THE AVERAGE COMPOSITION OF GEORGES BANK BENTHIC FAUNA

Taxonomic group	Specimens (per m^2) Number	Percentage	Wet weight gr/m^2	Percentage
Crustacea	1113	66	8.2	5
Mollusca	54	3	64.6	41
Echinodermata	47	3	48.4	31
Annelida	334	20	9.2	6
Miscellaneous	142	8	26.2	17
Total	1690	100	156.6	100

As compared with the other faunal components the Crustacea were exceptionally abundant. However, in terms of weight they accounted for a smaller share than any other major group. The Amphipoda, which were very abundant and small in size, were the dominant crustacean group. The large numbers of specimens and small weights for Crustacea were primarily due to amphipods. Mollusca were very few in number but provided the greatest weight. The pelecypods contributed the main portion of this weight. Annelida were moderately numerous (334/m^2), ranking second in number of specimens, but generally they were small-sized and formed a rather minor share in regard to weight. The Miscellaneous category contributed moderately small numbers of specimens, and added significantly to the weight. Coelenterata and Ascidiacea were the main components of the Miscellaneous category.

Geographic Distribution

As previously stated, an inventory of the benthic fauna was one of the main objectives of this study. Inasmuch as the organisms that make up the benthos vary tremendously in quantity as well as in species composition from one locality to another, consideration of the geographic distribution is especially important. Both the number and weight of organisms per unit area are used in this discussion, but for most purposes weight is considerably more useful than number of specimens. Thus, the wet weight, expressed in grams per square meter of bottom, is most commonly used in this report.

The quantitative geographic distribution, by weight, of all benthic organisms, *i.e.*, all groups combined, is illustrated in Figure 1. Distinct differences in quantity were associated with geographic location. There were three areas where a high density (>100 gr/m^2) of benthic animals occurred. These areas were located in the following sections

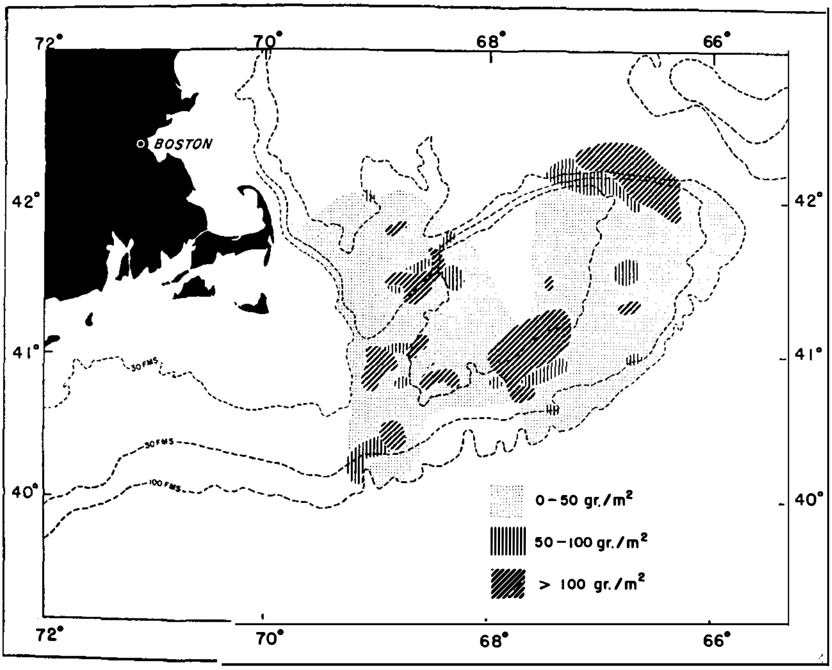

Figure 1. Geographic distribution of the benthos in terms of wet weight per m^2.

of Georges Bank: (1) northeast, (2) south-central, and (3) western. The first two of these areas each consist essentially of one large contiguous area, whereas the third is a cluster of six relatively small high-density patches that are considered as a single group for discussion purposes. Moderate densities (50-100 gr/m^2) of benthic animals were found adjacent to nearly all high-density areas. However, the total geographic area that supports a moderate density is distinctly more limited than that of either of the other two density categories. It is also apparent from Figure 1 that large portions of eastern and central Georges Bank, plus the deep-water basin to the northwest, support a rather small biomass (<50 gr/m^2).

Each major faunal component had a somewhat different and distinct geographic density pattern. Crustacea were most prevalent along the western and southeastern parts of the bank; moderate quantities occurred in the northeast and southern sections. Mollusca were most abundant on the northeast, south-central, and western portions of the study area. Echinodermata were especially dense in the central part of Georges Bank, with moderate quantities occurring on the bank's northeast, northwest, and south-central parts. Annelida were prevalent on the northeastern, south-central and western sections. They were the only group abundant in the deep-water basin northwest of Georges Bank.

Benthic Fauna and Bottom Sediments

Bottom sediments.—Bottom sediments on Georges Bank and adjacent areas are predominantly sands. Sediments in practically all sections of the study area contain sand, and it is the principal component in most sections. For comparison purposes, the sediments have been analyzed and classified according to standard procedures (Wigley 1961). The classification of sediment types used here is based on the system reported by Shepard (1953), using the four major size classes: gravel, sand, silt, and clay. Sediment categories, called textural classes, are named by one, two, or three size-class components depending upon the relative quantities in each sample. Most of these textural classes have binary names in which the predominant component plus the second ranking element are identified. A textural class name consisting of a single term is used when the sediment is composed of 75 percent or more of one size-class. Three terms are employed when each of three constituents make up 20 percent or more of the sediment.

The geographic distribution of textural classes in the study area is shown in Figure 2. Sand is the textural class that is overwhelmingly most widespread. It occurs over nearly all the central and southern

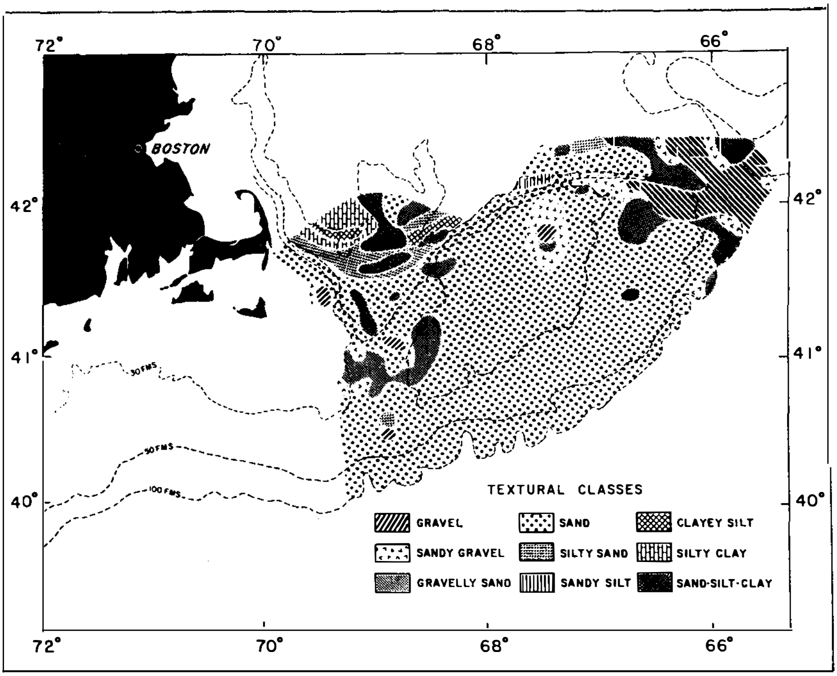

Figure 2. Geographic distribution of sediment textural classes in the Georges Bank region.

parts of the study area. Gravels, sandy gravel, and gravelly sand are found on the northeastern portion of Georges Bank. A few patches of these same classes also occur in the north-central and western sections. Fine-grained classes, mainly silty clay, sand-silt-clay, and silty sand, are found in the deep-water basin northwest of Georges Bank. A more comprehensive and detailed description of these sediments and methods of analysis are given by Wigley (1961).

Relationships between the fauna and sediment.—Striking correlations were observed between the type of bottom sediment and the quantity of benthic organisms. High abundance was associated with coarse sediments and low abundance was associated with fine sediments. In Figure 3 the mean number of specimens and mean wet weight of organisms are plotted for each textural class. The latter are arrayed in Figure 3 along the horizontal axis in decreasing particle size from left to right.

By far the greatest faunal weight was found in gravel and sandy gravel bottoms. The biomass in the sandy gravel sediment was exceptionally high (1300 gr/m^2), due largely to the occurrence of dense beds of *Modiolus modiolus,* the northern horse mussel. Moderate to

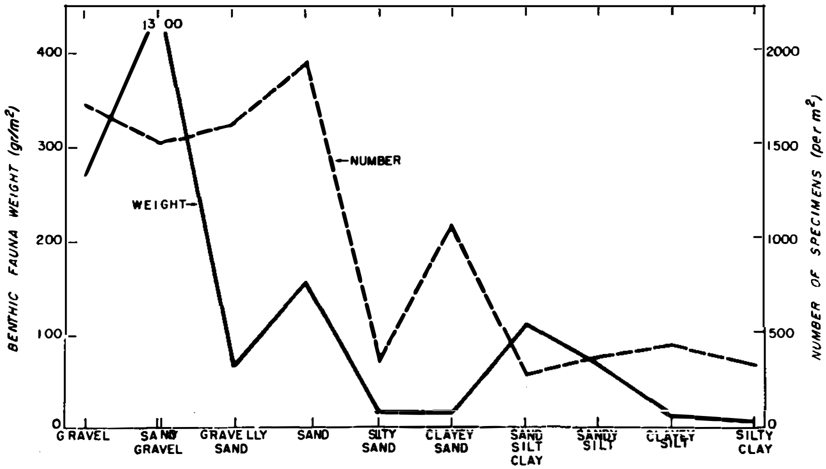

Figure 3. Mean number of specimens (per m²) and wet weight (gr/m²) in each textural class.

low quantities, 14 to 154 gr/m², occurred in sediments in which the sand fraction was dominant. Lowest weights were found in clayey silt and silty clay bottoms. These are the finest-grained sediments and the faunal weight occurring in these two textural classes was 11 and 7 gr/m², respectively.

The relation of numbers of specimens to sediment classes was quite similar to that for weight. Greatest numbers of specimens were found in gravels and sands; fewest specimens occurred in sediments containing large quantities of silt and clay. Organisms were most abundant (1934/m²) in the sand textural class. Gravel, sandy gravel, and gravelly sand also ranked high, with the number of specimens ranging from 1513 to 1718/m². Except for the clayey sand category, in which the number of specimens averaged 1074/m², the remaining textural classes (silty sand, sand-silt-clay, sandy silt, clayey silt, and silty clay) supported rather few specimens—255 to 436/m².

SUMMARY

In the New England coastal states fishing has been a major industry for over 300 years. A large segment of this industry is dependent upon the bottom-dwelling fishes, such as haddock, cod, hakes, and flounders. The principal source of nourishment for these species of fish is the benthic fauna.

The first quantitative inventory of the benthic fauna of a New England fishing bank was made in August 1957. The fauna was found to be composed (by weight) of the following groups: Mollusca

41%, Echinodermata 31%, Miscellaneous groups 17%, Annelida 6%, and Crustacea 5%. The over-all average weight of the benthic fauna was 156.6 gr/m^2; average number of specimens was 1690/m^2.

Pronounced differences in quantity and species composition of the benthic fauna were associated with geographic location. The fauna was most plentiful on the (1) northeast, (2) south-central, and (3) western sections of Georges Bank. The benthic fauna also showed marked differences in kind and quantity in relation to bottom sediments. The richest fauna (268 to 1300 gr/m^2) occurred in the coarse-grained sediments, such as gravels and sandy gravel. Fine-grained sediments (clayey silt and silty sand) yielded the smallest biomass, 7 to 11 gr/m^2.

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DISCUSSION

DISCUSSION LEADER CHAPMAN: The beginning of marine ecology is just now with us. I don't think there has been any quantity of work of this nature done outside of the North Sea, and I'm tremendously interested in the complex problems of 300 or 400 different species of organisms and their inter-relationships. I think you're going to be an elderly man before you get them worked out.

MR. JOHN SIMPSON [Omaha, Nebraska]: What is the comparative area of the Georgia Banks?

MR. WIGLEY: We usually take the 100-fathom depth contour as the outline of the Bank, and the total area encompassed is approximately 12,000 square miles. It is quite a large area.

MR. SIMPSON: Is it an irregular sized area? Approximately how many miles by how many miles?

MR. WIGLEY: It is 150 miles long and 75 miles wide.

WHAT IS HAPPENING TO OUR ESTUARIES?

SETON H. THOMPSON
U. S. Bureau of Commercial Fisheries, St. Petersburg Beach, Florida

Along our South Atlantic and Gulf coasts from Cape Hatteras to the Mexican border, there is an almost continuous fringe of bays, inlets, estuaries and marshes. Detailed charts of these areas today would bear almost no resemblance to those made 20 years ago. Why? Man-made changes!

Some of these changes are the result of large-scale engineering projects. These include harbor improvements and navigation channels, flood- and erosion-control structures, and contemplated now are hurricane barriers. They are essential to the growth and well being of our Nation. We must have them. But they do not account for the major changes in the coastline.

The major changes have been the cumulative result of a multitude of small dredging and filling projects, none of which individually seemed to be significant. These small projects have been primarily to make new land for residential use. They have been undertaken to satisfy the apparently almost insatiable demand for waterfront living.

These small projects take place in an insidious way—like baldness. You can see I speak with authority on that subject! A few falling hairs every day go unnoticed until suddenly there is a large bare spot. That is the way it is with these fills—individually they don't amount to much, but in the aggregate they are shrinking the water areas, rearranging the coastline, and altering water currents and water quality.

This is a chart of just one Florida Bay, showing the original shoreline, the additions that have been made to it by dredging and filling operations, and the projects either now in progress or on the drawing boards. It is certainly not the least spoiled inshore coastal area, but neither is it the worst. This is Boca Ciega Bay, a tributary of Tampa Bay, on the west coast of Florida. Similar developments are occurring from North Carolina to Texas. But this is one I have watched evolve through the past 10 years, and I have been looking down on it daily from my office window for the past three years. All of these changes have been made in that time and they are still going on.

These land-development projects are going on at an accelerated rate. Submerged grass flats are either being filled, or being dredged out to provide fill for adjacent areas. These are the targets of most of these projects because of the low purchase price and development cost. Mangrove islands, tidal flats and sand dunes are disappearing.

Now, why are these changes important? Obviously, they mar the natural beauty of the area, but they are important also to the organisms that live in the inshore waters. These include practically all of our valuable fish and shellfish, and the long chain of plant and animal life on which they live. I represent the Bureau of Commercial Fisheries and, therefore, the species that contribute to the catches of commercial fishermen, but in this area both the commercial fishermen and the sport fishermen, with few exceptions, seek the same species. So anything harmful to species of commercial importance and injurious to the commercial industry would also be harmful to the species that make our southern waters attractive to the angler.

Shrimp, menhaden, red fish, spotted trout, tarpon, snook, mullet, and many others, spend part of their lives in the estuarine zone. It is vital to their existence. Some of these species utilize the area as nurseries, some as spawning and feeding grounds, and others spend their entire lives there. They cannot live without it.

It is because of this almost continuous estuarine area that the Gulf and South Atlantic rank high in the United States' production of fish and fishery products. These are rich, producing areas, with commercial fisheries annually yielding about 1¼ billion pounds of fish and shellfish, worth upwards of $100 million. They provide employment for about 40,000 fishermen, and another 20,000 people find employment in the shore establishments handling fishery products. Follow this back, if you will, to the shipyards that build the boats, the manufacturers of nets and ice, and all of the other articles used, and the wealth producing value of the fishery resources is enormous.

It is not so easy to place a value on our sport fishery, but it is safe to say that this is one of the prime inducements for tourists to visit our southern coasts.

Just what are the effects of dredging and filling operations on our inshore waters? A number of things can happen. First and most obvious, of course, the water area available is reduced by the amount of land filled. An equal bottom area is denuded to get the fill material. Currents and tidal interchange very often are affected, and when that happens, almost inevitably there are changes in salinity and temperature of the water. Most dredging and filling operations at least temporarily result in the addition of sediment to the water, and siltation of adjacent shallows.

These physical and chemical changes affect fish and fishing in our coastal waters in several ways.

Let's be fair about this—there are some favorable or beneficial effects. Spoil sites along waterways are often used by commercial fishermen as a base of operations and as a place to erect drying racks for nets. They may also be used as launching ramps for sport fishermen. There can be no doubt that filling marshy areas is an effective control for the mosquito nuisance. In dredging operations, occasionally deep holes are created in which fish congregate during the colder months. This makes for good fishing, but only in those places where most of the natural area has been undisturbed by dredging. In other words, the grass flat areas are the productive areas, and if holes are to yield good catches they must be associated with undisturbed grass flats. After a period of extensive dredging in which most of the flats are eliminated, the holes fail to yield good catches.

Obviously, conservation interests have not gone about the job of protecting our estuaries in the right way. That is not a criticism; it is an observation. On the federally financed construction projects, like navigation channels and harbor improvements, funds to investigate the possible effect on fish and wildlife have not been available until construction funds were at hand. Frequently that meant that information was received too late to be useful. That is being changed now, and we are hopeful that investigation of specific projects can be undertaken as soon as the projects are conceived, so that protective measures for fish and wildlife can be built into the engineering designs. This is a distinct step forward. Progress also has been made in establishing a broad estuarine research program designed to provide a reservoir of knowledge on which to draw for various kinds of inshore water developments, including the numerous relatively minor dredge and fill projects.

We need to go further than this if the estuarine environment for fish and wildlife is to be preserved. The States concerned could take three important steps in this direction:

1. Declare a moratorium on the sale of submerged lands. Our troubles begin when these lands fall into private hands.
2. Take inventory to ascertain ownership of all the submerged coastal areas.
3. Establish a Board, similar to a city's zoning commission, to determine the best uses to be made of our coastal waters.

The function of this proposed Board would be to develop an overall plan for each segment of our coast, and avoid the piece-by-piece type of development we have been experiencing. Patently, the State conservation agencies should be represented on such a Board.

This recommended action will not reverse the damage already done, but there is still time to protect some of the remaining natural areas. Our valuable marine fishery resources warrant the effort and expense involved. There is no doubt that they are in far greater danger from man-made changes in our estuaries than from any amount of commercial or sport fishing.

DISCUSSION

DISCUSSION LEADER CHAPMAN: What sort of funds and establishment do you and other people have to deal with the research end of this problem?

MR. THOMPSON: Working on estuarian research in the Gulf States under an inter-state compact, we have the Gulf States Marine Fisheries Commission, which has established the Estuarian Technical Research Committee. This is still in its infancy, but it provides the tools and the agency to coordinate state and federal action.

To be specific, we have one man working entirely on a basic plan for estuarian research, with total funds of $45,000 to work with.

DISCUSSION LEADER CHAPMAN: While Seton was up in Alaska chasing salmon for many years I was chasing salmon up and down the Columbia River, where they have been building dams hand over fist, destroying tremendous areas of spawning grounds and disturbing the environment to the detriment of the fish. There, also, we talked as though we were doing a big job, but we were working with very small funds in those years and the engineers always had adequate funds with which to build their structures. They always resented biologists being around and, as a consequence, we haven't got many fish left in the Columbia River. I hate to see this dreary set of events recur in the enormous estuarian area of the Gulf.

I think the wildlife people, the sportsmen, and the commercial people simply must boost money out of the Department of the Interior and the Bureau of the Budget to get the research on this project going at a satisfactory level. This is only one of the problems all around the United States where man is changing the habitat so rapidly.

MR. SETH GORDON: How much of this kind of research work is going on or planned for? In the Pacific we have the same problem, as you know.

DISCUSSION LEADER CHAPMAN: I personally don't know the answer, Seth. Do you, Seton?

MR. THOMPSON: I don't know either. So far as I know, the federal agency is not doing any research in this field on the Pacific Coast.

MR. GORDON: You mean then that what is being done is being done by the State of California, and the Federal Government is not doing anything to help?

MR. THOMPSON: This may be so, I can't answer your question .

DISCUSSION LEADER CHAPMAN: I'm rather well acquainted with the State of California, and I don't think it is doing anything either.

MR. SILLIMAN: What you say is perfectly true, but if you're speaking in general about the effects of man-made development on estuaries, both the federal and state governments have rather extensive programs to develop means for passing salmon and trout over the dams which you mentioned.

MR. JOHN SIMS [Omaha]: Is there any connection at all between the commercial fisheries and the Fish and Wildlife Service, the Reclamation Bureau, and the engineers? I'm thinking specifically about this situation on the West Coast. The Columbia River in years gone by produced unlimited quantities of salmon. Certainly that isn't the case any more. I wonder if there is any correlation between those various agencies on that situation on the West Coast?

MR. THOMPSON: I am not as familiar with the West Coast area as others here are, and I shouldn't be trying to answer this question. I can say that with respect to all engineering projects involving federal funds or federal sponsorship, there is provision for study under the Coordination Act to minimize damage to fish and wildlife as a result of a project, or possibly even to benefit fish and wildlife. This is a very general answer to your question and I can't do any better, I'm sorry.

MR. SILLIMAN: In addition to that, isn't there some interested inter-agency committee which includes all agencies concerned with water development or water resources which coordinates the work in the Columbia River Basin?

DR. CHAPMAN: In the Columbia River Basin things are going much better now than they were when I was a young lad in that area working on the Grand Coulee problem. I remember so well going with my superior, the Director of the Washington State Department of Fisheries, to see the colonel in charge of building

Bonneville Dam in the early '30's, and he did not want to see us at all. Finally he came steaming out of his office and walked past and Mr. Brennan said that he was down here on business and wanted to talk with him. He said, "Mr. Brennan, I want you to know that my business is building this dam and we're going to build the dam, fish or not." We corrected that attitude somewhat, and there has been sufficient political influence used in the Columbia River that the research programs are now well coordinated. There are fine research programs and fine engineering programs going on to take care of the fish. In that area where Lewis and Clark came across the mountains, one of their most beautiful passages describes the enormous volumes of salmon spawning in the streams, saying that there was food for large settlements there in perpetuity. There hasn't been a salmon in that area of the Columbia River for better than 30 years.

We have a fine research organization but most of the salmon are gone. I think that is what is going to happen in the estuaries of the Gulf of Mexico; about 30 years from now we're going to have a marvelous research organization built up and no shrimp.

MR. LARRY JAHN [Wildlife Management Institute]: You mentioned a program of research in regard to habitat. Do you feel that there should be a program of habitat preservation, or is it merely a modification of the development which is necessary to maintain habitat for these organisms?

DISCUSSION LEADER CHAPMAN: I am going to answer that myself, Seton, and ask you to answer it too. You have to know the relationship of the organisms to their environment before you can make a sensible approach to a conservation program. With one man and $45,000 and 5,000 miles of coast, you can't find these things out.

MR. THOMPSON: The research findings, of course, are yet to be produced. We hope they will be before too long and they're going to have to be applied in many ways. I suggest that once we know the relationship and the responses of the various organisms to their environment, we actually carry large-scale experimental work—model type studies if you wish—to see more specifically how these various engineering projects will affect the fish and wildlife.

MR. JAHN: Dr. Thompson, my main point of the question was, do you feel at this time whether you should attempt to preserve some of the natural habitats which exist, or whether your future lies in attempting to modify this development which is taking place, realizing that the development is going to take place?

MR. THOMPSON: There are two kinds of developments, some that are going to take place regardless of effect on fish, and some that will take place unless action is taken to curb them. This particular type that I showed in Boca Ciega Bay is not the type that has to take place. I think that all of these bays can be examined to see how they can be developed to the best benefit of all citizens. This might result in filling in some areas to abate mosquito nuisance. It might result in the establishment of a marina in another place, because that's going to be an essential feature to the growth of the area.

A bridge presently is contemplated from Fort Myers to Sanibel Island. The people on Sanibel Island don't want that bridge at all. There is a question of whether it should go in. It's going to change the water circulation in the area; there is no doubt about that. It will probably change the inhabitants of the Pine Island Sound area, which is a rich grassy area and extremely important. I question seriously whether that bridge should go in in its present design.

Knowing that it is going to have an effect on water circulation in the area, we are recommending that instead of a causeway type of structure, it have several spans so that the water circulation be maintained as nearly in its natural state as possible. I think we have got to hold the line and preserve the natural environment just as far as we can until we know more about it.

QUESTION: In connection with St. Petersburg, and development of the area, do you know what provision is made for the discharge of human and industrial waste, by the city, as well as by the various developments?

MR. THOMPSON: There are treatment plants throughout that area at the present time. This wasn't true ten years ago.

MARINE PRESERVES FOR ECOLOGICAL RESEARCH

CARLETON RAY

New York Aquarium, New York Zoological Society, Brooklyn, New York, and Secretary, Bahamas National Trust, Nassau, Bahamas

In this discussion of marine preserves for ecological research, much will be said that also applies to land areas, and I would like to develop my theme on the theme of this conference—Planning for Population Pressures. Except in matters of relative development by man, it is a fact that the conservation of the sea's continental shelf areas and that of the land are not very different in principle. Furthermore, we may find that marine conservation will very soon be just as pressing a matter as land conservation, especially in this day of massive bulkheading, filling, and the mass migration of human bodies below the surface.

I would like to utilize some ideas from three sources. All express what I believe to be vitally important thoughts on the responsibilities of ecologists as scientists, namely to become involved either personally or through professional societies in the conservation and sanctuary movement and all that these imply in politics and practical management. The sources are all recent: Nicholson (1957), Elton (1958), and Darling (1960). The thoughts of these three Britons are particularly worth listening to because of the status of the first as the director of the Nature Conservancy and of the latter two as among the foremost of ecologists. Perhaps what they say and what I will say has been said before, but it needs saying again and again not just to sympathetic audiences such as this one, but also to those who might not agree with us.

It is sometimes surprising how few of the many biologists in the many organizations of the world are not particularly concerned with natural resources and sanctuary problems that confront us. This is not true of such organizations as the Wildlife Management Institute or the Ecological Society of America and a few others. But there still are a huge number of what we might call the "disinterested scientists" and there is a need to diminish this number. For the destructive forces among us are powerful, and we will be as powerful as they are only if we muster all of our moral and rational forces.

One way to diminish the number is to point out the study value of ecological preserves and their value as reservoirs for source material. This has, of course, been done in some cases, but too often this aspect has taken a back seat to the recreational and purely esthetic aspects, as important as these are. Just how important is it to create study areas? What do they mean? These are the questions that I would explore and which I will illustrate by the Exuma Cays Land-and-Sea Park under the management of the newly-created Bahamas National Trust for Places of Historic Interest or Natural Beauty. The Bahamas Islands cover about 100,000 square miles of territory. There are about 3000 islands there, among them Shroud Cay (Fig. 1) in the Exuma Park, rising from a limestone platform between Florida and the volcanic Antilles. The most extensive reefs in the Western Hemisphere are in these islands.

The Bahamas are now in progress of development in many directions, mostly for the tourist trade. But they are still relatively undeveloped. Until the Bahamas National Trust Act was passed in 1959, there was no formal organization for park development or management there. This act came into being as a result of the urging of Colonel Ilia Tolstoy and the encouragement of several Americans, Britons, and Bahamians and as the result of a survey sponsored by the New York Zoological Society in which were also involved: the Government of the Bahamas, the Bahamas Department of Agriculture and Marine Products, the National Audubon Society, the American Museum of Natural History, and the Marine Laboratory of the University of Miami. So at once the Trust had the broadest possible support of Government and a wide base of scientific and professional conservationist advice. Today the Executive Committee and Council of the Trust have a large proportion of scientists who are committed to give information and advice and who also give their support to the Trust's aims. On this broad basis rests the best chance for continuing and expanding the Trust in perpetuity, not only for the public, but also for scientific study.

At present, the Trust is most concerned with getting a good start in the management of its two major realms, and in surveying other areas of need. The two already established are: 1) the Exuma Cays Land-and-Sea Park and 2) the Flamingo Protection Division on Inagua where there is one of the last three major remaining flocks of the West Indian Flamingo, also the Bahamian national bird. The Trust is also collaborating with the Caribbean Conservation Corporation in reestablishing the Green Turtle to former abundance.

The Exuma Park is at present the largest marine sanctuary in the Western Hemisphere, specifically dedicated to the preservation of the integrity of these islands and their aquatic environments which are so mutually interdependent in the Bahamas. The word "marine" includes, in a sense, in the Bahamas, and other insular places, both above water and underwater fauna and flora. For these islands are truly products of the life of the sea and it would be false ecologically to attempt separation of the two realms—land and sea.

Fig. 1. Shroud Cay, a 3-mile long pseudoatoll in the Exuma Cays Land-and-Sea Park, operated by the Bahamas National Trust in the Bahama Islands. See text for description.

Shroud Cay (Fig. 1) is a pseudoatoll with mangrove and marl at its center and with an enclosing ring of oolitic aeolian hills. There are luxuriant reefs in the offshore eastern waters and in the cut between Shroud and Wax Cay to the north. It would be difficult to predict the research that would be done on Shroud, but it is a simple matter to outline the many unsolved problems, at least in part. Botanical problems present themselves in an area of salty, drying winds from the east principally. To the west of the protecting hills, the vegetation forms a forest with bromiliads and orchids. The insularity of the resident crabs, snails, lizards, and such birds as the woodstar humming-bird presents problems in systematics. The many cuts between the islands provide channels through which flow strong tidal currents.

Thus the oolite sand formed on the western banks is swept into bars and is entangled in the roots of mangroves, eventually to become part of the islands themselves in the land-building processes that are little studied in the Bahamas.

The cuts and tidal flow also provide for a multitude of reef environments of different kinds. Reefs near these small islands, as Shroud Cay, are luxuriant in some places and marginal in others, providing the reef physiologist with ideal study conditions. Work on reef physiology has barely begun, as has work on the behavior of a great majority of marine forms in the most complex environment known—that of the coral reef. Commercial forms are also found here in abundance—spiny lobster, grouper, conch—and the green turtle is now in process of being re-introduced.

A second Trust responsibility is Inagua in the southern Bahamas. This large island is ecologically between the limestone Bahamas and the volcanic Antilles. It is one of the very exciting and least known spots of our hemisphere. Chiefly known as the home of the West Indian flamingo, it also boasts a population of Bahamian parrot, a colony of spoonbill, white-phase reddish egret, wild donkeys, extensive limestone caves, a small breeding colony of the green turtle, large conch beds, and an interior stunted forest. It lies in the path of the Antilles Current, which nourishes its unknown reefs. Like many of the Bahamas, the interior waters are nourished by "ocean holes" through which the tide flows, to be seen bubbling up in spots in the very middle of the island. Yet, with all these riches, scientifically speaking, there have been few expeditions to the island. The activities of the Trust will increase the scientific work.

In these two insular marine areas of Bahamas Trust jurisdiction, it is not good enough to say that scientists may visit if they wish. Robert P. Allen of the National Audubon Society has made a thorough study of the flamingo on Inagua, pointing to measures for control and management, but we know so little of the other features that public control and general management may soon become a problem. And not only is study vital from the management viewpoint, but it is also of major scientific interest in many fields. For instance, Nicholson reviews three different sorts of nature preserves: 1) undisturbed habitats closed to the public, 2) semi-natural or deliberately managed habitats, 3) areas for grazing, recreation, or other public purposes. All three have their obvious underwater and marine counterparts. In all, research may go on, but there is little doubt that research is difficult without careful public control. As Nicholson points out, no preserve is really permanent in its outward aspect. All need study of present aspect and future trends and an interpretation of "what nature used to do with the area and would do with it in the absence of human interference."

Darling puts it this way: "The value of wilderness to science, put baldly—very baldly, and not at all sentimentally—is the provision of study areas of pristine conditions. . . . Any ecosystem represents a complex of conversion cycles, of energy flow. . . . If determination of their energy cycles is possible, we can assess what may be called the voltage and amperage of different habitat types and ecosystems. Thereafter, investigations of changed conditions caused by human interference or usage could be compared." I will add that today it is vitally necessary that these voltages and amperages be ascertained, and this certainly involves study areas, called sanctuaries, for all branches of biological science.

Let us consider scientific responsibility one step further. If we wish to have something left to study after a very few years, it behooves the scientists to become vastly more concerned with legislation and the taking of initiative in setting up sanctuary areas. There is inertia against this. Scientists have plenty of carcasses in the museums to study—plenty of remnant ecosystems dotted here and there. But the problem is larger than that. This is, of course, recognized for the land, but what of the so-called "limitless" sea, that is not limitless at all as our intensified pollution of it and squandering of its resources show beyond any question? Nevertheless, the opportunity for sanctuary at sea, on the littoral particularly, is good. If we only use what we have learned by land, there is still a great opportunity to rescue and study a good part of the sea because it is comparatively undeveloped. But the time is short. The scientist can no longer keep aloof from this. After all, he most often knows the value of an area better than anyone else, and this knowledge must be used.

Elton is concerned with the pressing problems of ecological invasions and the determined simplification and stabilization of environments by man. He examines the breakdown of Wallace's realms by modern man and points out that nature does not operate best in simplified, sterilized communities. He quotes Dr. Schweitzer in asking whether we are not too interested in man-to-man relationships and not enough with man-to-nature and philosophizes that it is dubious to put man's sole interests first even in the interest of man.

Elton makes a very strong case for the preservation of ecological variety and complexity in the interest of the creation of environments with a high degree of stability. He synonymizes a "wise principle of co-existence between man and nature" with conservation. There is no doubt that this sort of conservation, with solid research to back up our actions, is a key to our eventual pattern of survival. And in a day that sees that depauperization of the land and the inevitable turning to the sea—too often as an easy panacea—we must turn our efforts to the sea not only for food and minerals, but more important even, for knowledge in undisturbed areas.

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INTERNATIONAL ASPECTS OF OIL POLLUTION

THE HONORABLE JAMES CALLAGHAN

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It gives me great pleasure to address this Technical Session of the 26th North American Wildlife and Natural Resources Conference in Washington on some of the work done by the Co-Ordinating Advisory Committee on Oil Pollution of the Sea.

As you are aware, the headquarters of the Committee is in England but it has links with similar committees in all parts of the world.

The purpose of the Committee is to keep the seas, coastlines, harbors, piers and beaches free from oil and so to preserve wildlife and safeguard the amenities for holiday makers, naturalists and fishermen. The need for such a Committee became apparent ten years ago when detailed reports were received of heavy destruction of sea birds around the coasts of Britain and other European countries, notably Germany, Belgium, Norway and Sweden. The cause of their death was shown to be fouling of their plumage by fuel oil, resulting in their being unable to fly, or, sometimes, to swim. Mr. Lester A. Giles, Jr., Director of Education, the American Humane Education Society, and Mr. John Livingston, Executive Director of the Audubon Society of Canada, described the process of contamination as follows:

> "Once contaminated by oil, a bird has very little chance of recovery. Oil 'glues' the outer feathers together, exposes and mats the down underneath. Natural insulation destroyed, the bird has no further protection from water temperature. It dies from exposure. According to Tuck, a spot of oil no larger than a quarter dollar will kill a murre, if it is on the vulnerable underparts.
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> "When a diving bird surfaces in an oil slick, its back and wings are fouled. It usually dies from starvation. Some of these im-

mobilized birds are washed inshore alive, where they attempt to preen. In the process, some oil may be fatally ingested. Beach birds along the Newfoundland shore are often picked up by foxes."

At the same period there were growing complaints from holiday resorts in Europe and the Atlantic coast of Southern Florida that lumps of sticky oil as large as footballs were being washed up on the beaches, and that tarry smears were widespread on shingle, rocks and sand to the discomfort of holiday makers.

Accordingly, a small group of enthusiasts established the Co-Ordinating Advisory Committee on Oil Pollution of the Sea in March 1952 and bent their energies to rousing public opinion to bring pressure to bear on governments, shipowners, oil companies and others concerned, so as to end this growing nuisance. This Committee marked the revival of similar efforts that had been made before the Second World War to deal with the problem caused by oil pollution. Some 40 years ago, immediately after the First World War, a number of nations took steps, by means of national legislation, to regulate the discharge of oil in their territorial waters. This was followed early in 1926 by an international conference convened in Washington by the United States Government. The Conference disagreed about the compulsory fitting of separators to separate off contaminated oil from water before discharges through the bilges of ships. But the Conference decided to recommend a system of zones within which the discharge of oil should be prohibited. As a general rule it was agreed that the width of such zones should not exceed 50 nautical miles and a number of countries agreed to observe these new limits.

Despite this failure to obtain international agreement in 1926, British shipowners voluntarily adopted the zone of 50 miles recommended by the Washington Conference and this course was also adopted by shipowners in the U.S.A., the Netherlands, Sweden, Norway and Belgium. In 1936 the U.S.A. asked for the voluntary zone to be extended to 100 miles and U.K. shipowners agreed to do this.

Great Britain submitted the question again to the League of Nations in 1934 and a draft convention was prepared. But once more this move came to nothing owing to the failure of certain nations to participate.

In 1952, therefore, when the Co-Ordinating Advisory Committee was established, there was no more than the gentlemen's agreement mentioned above between some nations governing the conduct of their ships when within a reasonable distance of shore.

By this time, the situation had changed in two important respects. First, in 1914, only 3.4% of the world tonnage of ships burned oil;

the overwhelming proportion of tonnage was coal burning. Today, over 90% of the world tonnage is burning oil and the number of ships has substantially increased.

Second, large and increased volumes of oil are constantly being transported about the world and this movement has necessitated building and operating large fleets of tankers. Also a change in the siting of refineries at points distant from the oilfields has resulted in more crude oil being transported by sea. As an example of the growth in the movement of oil, imports of crude and fuel oil into Britain alone have increased by 240% during the last decade. The world tanker fleet has increased even more. In 1939 it was 16 million tons dead weight; by 1953 it had increased to 35 million tons dead weight; and by 1960 over 66 million tons dead weight. That represents an increase of over 400% in 21 years.

The principal countries in which tanker tonnage is registered are as follows:

	Dead Weight Tons
Liberia	11,652,868
Britain	10,953,573
Norway	9,936,517
U.S.A.	6,992,312
Panama	3,666,815
France	3,161,874
Italy	2,870,849
Sweden	2,600,516
Japan	2,401,222
Greece	2,097,361
Netherlands	1,984,413
Denmark	1,412,401
Germany	1,117,027
U.S.S.R.	1,107,800
The Rest	4,439,562

The Liberian fleet is not, of course, indigenous. Tankers registered in that country are mostly registered there under what is called "a flag of convenience" and their true ownership lies in the hands of nationals of other countries, especially the U.S.A. Experts estimate that the world's tanker fleets will continue to grow at a rapid rate. This is of great significance in overcoming the problem of pollution of the seas by oil for it is generally accepted that of the many ways in which pollution can take place, the world's tankers are mainly responsible.

The process is as follows: After discharging their cargo of oil in port, it is their practice to wash their tanks through with whirling jets of water and then to pump the resultant oily water mixture overboard. It is essential that their tanks should be washed and gasfreed before they take on fresh cargoes of different grade oil, or before they go into port for dry docking and repairs. According to Mr. Logan, Deputy Managing Director of Shell Tankers Ltd., washing the tanks in large crude carriers may involve the handling of 50-150 tons of oily sludge and 1,500-5,000 tons of washing water. It is now common practice to pump the mixture of oil and water washings into a separate slop tank aboard the tanker, where the great bulk of the water separates quickly from the oil and, after settling, is suitable for discharging overside without pollution of the sea. The contents of the slop tank are discharged into the port facilities where these are available.

Part of the problem—probably the major one—thus consists in the provision of facilities at tanker loading and repair ports to receive the contents of the slop tank. Progress has been made, particularly in the ports of Western European countries and the U.S.A. But in many oil loading ports in the Middle East, and elsewhere, a great deal remains to be done and we look to the oil companies who control the installations to press on with the provision of adequate facilities.

The operational problems on board tankers also need further study. Unfortunately there is a dirty water oily layer of variable consistency between the dry oil at the top of the slop tank and the clean water at the bottom, and it is in this layer that the problem resides, if the pumping goes on for too long. There is no doubt that many of our reputable tanker companies are doing their best to minimize the damage and are engaged in programs of research in a number of directions, so far without marked success.

Claims are made at regular intervals that chemicals introduced into the watery oil layers will assist in obtaining a clear-cut separation of water from oil. One large tanker company has assessed the possibilities of 10 different proprietary materials with disappointing results. Among the difficulties they have found are that different oils require different chemicals; that the mixing of the demulsifier must be done with care; that large amounts of demulsifier are necessary and storage is a problem aboard ship; and, finally, that the presence of chemicals in the recovered oil may be a bar to its further usefulness.

Other claims have been put forward by makers of proprietary materials that the introduction of their products into washing water forms a fine milky emulsion which is innocuous when pumped overboard. Tests show that under practical conditions, it is unlikely that the whole of the sludge can be broken up into a milky emulsion and washings, therefore, contain large coarse fragments of sludge floating free. So, when the milky emulsion is discharged into sea water, it tends to break down, resulting in free droplets of oil which quickly coalesce into surface oil slick.

I am sorry to say that the tests conducted so far by a large tanker company show that the makers' claims are groundless. In short, despite optimistic press reports, which appear at regular intervals, there is no sign of a wonder chemical that will solve our troubles.

A further difficulty about the use of chemicals is that there is still considerable uncertainty about the effect of the use of emulsifiers on fauna and flora, and some claim that they may do more damage than the oil itself.

Research work is now taking a non-chemical turn and more attention is also being paid to cleaning the tanks into one slop tank aboard the tanker, and to treating the isolated oil washings aboard ship during the subsequent cargo voyage. These arrangements will require considerable modification to the internal design of the tanker and, at present, investigation work is taking place under practical conditions at sea. The tanker company involved believe that this is a promising approach, and inform me that they are pressing on with this work on board ship with all speed.

Unfortunately there are other tanker owners who do not have this high sense of responsibility and pay little regard to civilized conduct in the matter of oil pollution. They continue to foul the seas indiscriminately.

The most recent international attempt to remedy the situation was the London Inter-Governmental Conference of 1954. Although it was hoped that the Conference would be able to reach agreement on the steps that would stop altogether the discharge of oil into the sea, whether from tankers or dry cargo ships, this did not prove possible. The Conference drew up a Convention which included the establishment of agreed prohibited zones for tankers and dry cargo ships extending generally 50 miles from land. The biggest changes from the earlier convention lay in the establishment of a North Sea zone extending for a distance of 100 miles from the coasts of the countries bordering the North Sea and, for tankers, a large Atlantic zone whose western boundary was roughly 900 miles out from the British coast drawn along the line of longitude 30° West. The Australian zone was also extended for a distance of 150 miles.

It was agreed to recommend all Governments to sign this Convention and that a further meeting should take place in three years' time (*i.e.*, in 1957) to review the position. The Conference recognized that the idea of drawing prohibited zones was only a palliative and they passed an important resolution to the effect that:

"The only entirely effective method known of preventing oil pollution is the complete avoidance of the discharge of persistent oils into the sea and, as stated above, measures are possible which would enable this to be substantially achieved."

A number of other resolutions was passed calling upon Governments to provide adequate reception facilities at ports for oily residues: to encourage the development of efficient oily water separators for installation in cargo ships: and urging Governments to arrange for the preparation, publication and distribution of explanatory manuals for the guidance of ships' officers, crew and shore personnel.

Finally the Conference asked that the United Nations should undertake the collection, analysis and dissemination of information about oil pollution and, in particular, technical information about port facilities for the reception of oily residues, and the results of research into the problem of oil pollution.

This Convention has had greater success than the ill-fated attempt of the League of Nations but, even so, the success is only partial. So far 12 nations have ratified the Convention. They are: Belgium, Canada, Denmark, Finland, France, the Federal Republic of Germany, Ireland, Mexico, Netherlands, Norway, Sweden and the United Kingdom. These nations cover less than 50% of the world's tanker tonnage.

The major nations remaining outside are:

	Dead Weight Tons
Liberia	11.6 million tons
U.S.A.	6.9 million tons
Panama	3.6 million tons
Italy	2.8 million tons
Japan	2.4 million tons
Greece	2.1 million tons
U.S.S.R.	1.1 million tons

It is understood that Italy has prepared legislation and hopes to ratify the Convention within the next few months. Poland has notified her intention to ratify the Convention and only the formal steps necessary to complete ratification are now awaited. As to the United States, the Committee on Foreign Relations last year recommended the Senate to advise and consent to the ratification of the Convention and I understand that the consent is expected in the near future. Australia has passed the Commonwealth legislation necessary for acceptance but the State legislation is still being prepared; they hope to accept the Convention during 1961. Brazil and Venezuela have both decided to recommend ratification to their respective national Congresses. India has the question under active consideration.

As part of the effort to secure further ratifications, the Co-Ordinating Advisory Committee on Oil Pollution of the Sea called a conference in Copenhagen in July 1959. Diplomatic representatives of 19 countries attended, and membership of the Conference was drawn from 9 countries, whose delegates took part in the proceedings. Two Resolutions were passed, whose main purpose was to step up pressure on those Governments who had not ratified the 1954 Convention, and to call for a new international conference, which was long overdue, as the proposed conference for 1957 had not taken place.

One practical result of the Copenhagen Conference is worth recording. Attention was drawn to oil pollution off Newfoundland and the Atlantic Coast of Canada by Mr. Leslie Tuck, Wildlife Biologist, Department of Northern Affairs and National Resources, Canada, and Mr. John Livingston, Executive Director of the Audubon Society of Canada. They drew attention to the serious mortality of sea birds due to oil pollution and asked that the 50 mile zone, which had been agreed by Canada in accordance with the International Convention should be extended for 300 miles east and southeast of Newfoundland. The Conference supported this proposal in a Resolution that was forwarded to the Canadian Government and, as a result, the Canadian Government proposed to the other nations signatory to the Convention that the width of the prohibited zone off the Atlantic Coast should be extended from 50 to 100 miles from the shore which is as far as the Convention provides may be done. The other signatories did not demur and this new extension, which will have beneficial results on wildlife off the Atlantic Coast of Canada, accordingly came into force on 25th February 1961. This was a valuable result of the publicity given to this matter at the Copenhagen Conference and our thanks are due to those who took the initiative in this regard.

I am sorry that we cannot record such successes in the case of other countries. Approaches have been made to the Governments of Liberia and Panama without success. They have ignored all our appeals. The U.S.S.R. have shown considerable interest in the matter, and I do not despair of their ratifying the 1954 Convention. It should be said of the United States that although they are only now about to ratify the Convention they have, nevertheless an excellent record in the field of propaganda and prevention. A National Committee was set up in the United States in 1956 on the initiative of the Secretary of State, consisting of a number of Government Departments and related interests. This regularly reviews the research program, considers the possibility of domestic legislation that may be necessary and advises generally on the problem. Also in the field of propaganda, the Oil Pollution Panel of the Merchant Marine Council of the U. S. Coast Guard has been second to none in the volume and attractiveness of the material they have distributed to ships' masters, engineers and to tanker crews.

It is understood that the ratification by the United States of the 1954 Convenion will be subject to certain reservations. It will urge the various authorities to provide adequate reception and disposal facilities. The United States Government does not undertake to construct, operate or maintain shore facilities, nor to assume financial obligations to assist in these activities. I understand the reason is related to United States domestic law. The United States will also recommend amendments to the Constitution to bring about international uniformity in fines, penalties and enforcement and a greater exchange of information.

Some of these seem to be realistic amendments and I hope they will be seriously considered by the responsible body charged with the prevention of oil pollution, that is the Inter-Governmental Maritime Consultative Organization (IMCO), a specialized agency of the United Nations.

IMCO have agreed to convene a further international conference on the prevention of pollution of the sea by oil in March/April 1962. Suggestions have been made recently to delay this conference but, in view of the fact that by that time it will be five years overdue, I am glad to say that these moves have been strongly resisted both by the American and British delegates to IMCO working together. There is little we cannot do jointly when we decide to combine.

This new conference must be made a success; its purpose will be to review the present situation, the working of the 1954 Convention and any necessary amendments, and the practicability of securing complete avoidance of the discharge of persistent oils into the sea. We must all wish every success to this conference. The problem of oil pollution is international and lasting remedies can only be brought about through international action. It is my hope that the conference will decide to fix a future date for the total prohibition of discharge of oil into the sea. This can be done, and it should be the aim of the conference.

The conference should set itself a Seven-Point Prevention Program.

1. A new international convention to achieve the total prohibition of the discharge of oil into the sea.
2. Adequate port facilities for receiving waste oils.
3. Co-operation by dry cargo ships and tankers in observance of the convention.
4. Legislation by all maritime states.
5. Agreed measures for national and international enforcement.

6. Research into the effects of pollution, cleansing methods and disposal.
7. Pooling of knowledge and propaganda.

It is as well to mention some of the difficulties that will have to be faced in drawing up a convention to achieve total prohibition. They were well outlined by the Managing Director of British Petroleum Tankers at the Copenhagen Conference. He said:

"There are two ways in which complete prohibition could be tackled. One is by ensuring that all tankers are cleaned before leaving the discharge port; the other by the provision of suitable facilities at all crude loading terminals to receive oily residues resulting from tank cleaning carried out on passage to the terminal. The first of these alternatives would have the advantage of providing a high degree of control because, if tankers had to be cleaned before leaving port, there could be no pollution. Although reception facilities are already provided at the U.K. refinery terminals and the principal dry docking and repair ports in the U.K., they do not exist at oil installations where products are handled and these, throughout the world, are much more numerous than crude oil loading and refining terminals. At many oil terminals throughout the world, it would be difficult or physically impossible to provide these facilities involving additional berths, tankage, pumping arrangements, separators or tank cleaning barges, etc., to the extent necessary to provide sufficient accommodation to allow tankers to clean after completion of discharge. Moreover, the delays in turn-round and congestion would mean that existing tanker fleets would have to be substantially increased to meet the oil companies' commitments. All these factors would inevitably add considerably to the price of oil, assuming the possibility of the necessary accommodation being available at the various oil ports. The second alternative, namely the provision of reception facilities at the oil loading terminals abroad, would present further difficulties of another kind no less formidable. Submarine loading lines are in use at many oil ports, particularly in the Middle East, and serious obstacles would have to be overcome in getting the oily sludge ashore through the under-sea pipeline. At loading terminals where the distances between ship and shore are considerable, special pumping equipment would be required.

"Although it might be possible to surmount these technical difficulties, a fundamental fact that must be faced is that at no Middle East crude oil loading terminal is any British oil company wholly in control. These terminals are owned by a consortium of partners of different nationalities, some from countries (including the U.S.A.) which have not yet ratified the 1954 Convention."

So far as dry cargo ships are concerned, the main problem concerns those ships in which bunker fuel tanks, from which the fuel has been consumed, have to be ballasted with sea water, which thus becomes contaminated with oil. To enable this contaminated water to be dealt with, the Convention provides that the oily residues must be separated from it for discharge into shore facilities, or outside the prohibited zones.

Under the Convention, port authorities are not required to provide reception facilities. But considerable experience has been gained in the United Kingdom in the provision of adequate facilities under Article 8 of the existing Convention which has been in force in the U.K. since July 1958. Reception facilities in ports for waste oils must be sufficiently adequate to cope with all ships using the port so that the use of the facilities does not involve delays in turn-round. There is also the problem of available land. Many ports are sited in built-up areas, and it is essential that the quantity of oily water they handle should be kept to the minimum. Under U.K. legislation, a Port Authority is not required to make available facilities for dealing with untreated ballast water, as the British Government takes the view that the use of oily-water separators for nontankers is the most effective method of separation. Legislation provides that all dry cargo ships that use their fuel tanks for water ballast shall install such separators. The separators must also be installed where oily bilge water has to be discharged into the sea. The Danish Government, on the other hand, does not require the fitting of oily water separators and interprets Article 8 to mean that port facilities must be made available for quantities of oily water as well as for separated residues. This involves much larger reception facilities since even although separation may be effective, the settling time involved makes it a much slower process, particularly in exposed waters. Normally all residue from a dry cargo ship is returned to bunker and used as fuel.

The fitting of oily water separators in dry cargo ships is also the subject of differences of opinion between the British and U.S. authorities. The American Maritime Council in the U.S. stated in October 1959:

> "Our experience with oily water separators has been totally unsuccessful, and it has been explained that the present day grades of Bunker C fuel oil cannot be successfully and efficiently separated."

The U.K. Government and U.K. shipowners take a different view, and they regard separators as a realistic answer, provided the equipment is sensibly used. They admit that there are some grades of oil which cannot be easily separated by gravity but they hold the view that as a practical matter, the existing separator equipment will cope with all the commonest forms of oil met with, even although it is not the perfect answer on rare occasions.

There is clearly need for further research and agreement in principle that can only be achieved thorugh an organization such as IMCO.

Assuming, as I profoundly hope, that the conference can agree on the practicability of total prohibition, then we shall be faced with the question of securing adherence to the convention. We ought to have least difficulty with those states which are already operating, or about to operate, the 1954 Convention. But we are likely to run into a dead wall of indifference from the "flags of convenience" countries such as Liberia and Panama. It will be interesting to learn whether the United States can exercise any influence to persuade its nationals who register their tankers in these countries to accept the convention. One way of doing so might be for the U.S. oil companies to make observance an item in the charter party.

Adherence to the convention must run concurrently with an intensified program of education and propaganda among tanker owners, masters, engineers and crews. Previous experience suggests that each country can best do the job amongst its own nationals. But IMCO could be the clearing house for pooling ideas and also for prodding the laggard countries into action.

There should also be greater pooling of the various unco-ordinated efforts at research that are now taking place. I have already outlined the work that is being done in this direction by a large tanker company. In addition, the Warren Spring Laboratory of the Department of Scientific and Industrial Research of the United Kingdom has embarked on a research program to devise methods which will give effective cleaning of different types of contamination on beaches. Their present research program is as follows:

(i) To examine the whole problem of the use of emulsifiers, to determine the most suitable agent, formulation and method of application, in terms of cost and to establish that the emulsified oil is not subsequently liberated in a form which could cause pollution of beaches;

(ii) To develop, if possible, a mechanical method for the removing of solid or semi-solid deposits that is more effective and less costly than hand-picking, since it appears improbable that emulsifiers would be used for this type of contamination;

(iii) To examine other methods such as burning off, possibly using oxidants such as cheap nitrates or chlorates to aid combustion and to examine the use of cement or other powders to render small oil deposits innocuous to beach users.

The research program of the Warren Spring Laboratory will also cover the chemical treatment of oil floating on the surface. D.S.I.R. have also produced a new type of separator using a pebble bed filter of a type easily cleaned.

Operational research and pooling of knowledge is also necessary to deal with the accidental discharge and spillage of oil arising from collisions or carelessness in harbor. Most of the appreciable spillages in the U.K. in 1960 were due to accidents. Much could be learned by the exchange of information among the various countries who are endeavoring to deal with this matter, and this is yet another field in which IMCO can be a valuable co-ordinating body.

Research should also be pursued into the effect of oil and also of cleaning materials on inter-tidal flora and fauna. The harmful effects of oil pollution are self-evident but Mr. E. M. Nicholson, Director General of the Nature Conservancy of the United Kingdom, has stated that in the few cases that have been investigated by biologists, occasional isolated instances of oil being washed up on shores do not appear to have caused appreciable harm to the inter-tidal flora and fauna. As a result of a recent careful study of two accidents in the U.K. in which large quantities of oil were lost overboard from tankers, it is his view that the use of emulsifiers may be more damaging to the flora and fauna than the oil itself.

The whole problem of enforcement must be considered by IMCO. In my view it is necessary to strengthen the powers of harbor authorities as regards docks, harbors, piers, etc., and also to improve drastically the facilities for dealing with accidental spillage by means of booms, etc. Inflatable oil booms have successfully been used to contain spilled oil while it is being mopped up.

At sea, everyone should be on the watch against the discharge of oil by their own vessels or by others, and a regular system of reporting should be enforced.

A useful venture has recently been started around the shores of Britain. Pilots of Service aircraft in the course of their normal duties are required to report to their bases by radio if they see any patches of oil floating on the water near the coasts of Britain. The report is passed to the nearest Coastguard Station, which plots the likely drift of the oil according to the tides, and informs the local authorities if and where it is likely to come ashore. It is hoped that this Early Warning System will enable preventive measures to be taken before the oil reaches the shore. Aircraft also make reports about ships that appear to be discharging oil or oily waste into the sea. Civilian aircraft have also been asked to take part in this scheme and recently information from a civil air crew about a tanker which was apparently discharging oil in the middle of the English Channel has been sent to the country in which the tanker is registered and I understand that a prosecution is pending.

But of course it will be impossible to police the seas thoroughly.

The complete avoidance of discharge of oil can only take place when all masters, chief engineers, crews and ship-owners of every flag are all convinced that it is improper to use the seas and oceans for the reception of their tank washings and oily residues. It will be necessary to embark upon a world-wide program of education and propaganda by means of manuals, leaflets, films and other methods.

We shall need joint action on the widest possible scale if we are to achieve the Seven-Point Prevention Program that I have outlined. We can and we must achieve it. No one has the right to foul the seas any longer and I conclude with words uttered by Lord Hurcomb on this subject in 1953:

> "Subsequent generations have been fond of abusing the nineteenth century and the mistakes of the industrial era in dealing with town and country. Why go on committing with far less excuse and our eyes wide open, similar mistakes? We have polluted and are polluting the air by preventable discharges of dirt and concentrations of sulphur acids. We have turned too many of our rivers into sewers in which fish cannot live or plants grow. Let us remedy without delay the state of our beaches and of the surface of the sea, which not long ago seemed immune from human damage, now that the way to do so has been so clearly shown. If man makes himself a nuisance to the rest of nature—of which after all he is part—and continues to befoul his natural surroundings, the conseqences will come back upon man, upon his health and his pleasures, and will increasingly impair the best and surest means whereby he is able to sustain and recreate his physical and spiritual energies and well-being."

DISCUSSION

DISCUSSION LEADER CHAPMAN: You discussed the international affairs and commented about the United States going to this Conference. I might also say, you speak of the ocean in loving terms, and I feel it, but you perhaps underestimate the ingenuity of us Americans. I have mentioned the great work we are doing in reducing ecological complexity of pesticides.

We have rather elaborate plans afoot for sterilizing the ocean with nuclear waste.

To begin the discussion, there is a shy and retiring friend of mine in the audience who I always like to haul out into the public eye whenever I can. To begin this discussion gently, Pink Gutermuth, we'd like to hear your excuses as to why this treaty has not been hustled through the Senate.

MR. GUTERMUTH: I must say, Mr. Chapman, that I have to be called on before I will participate in these conferences, but the answer to your question is very simple.

The reason that this treaty has not been ratified is public apathy. If you would make an issue of this thing, it would come up very promptly and would be acted on by the Congress, if you would just get behind us.

DISCUSSION LEADER CHAPMAN: I think that is very important. It falls under the jurisdiction of Russel Long, as Committee Chairman, and he is a very reasonable man to deal with. We do hope that somebody who has these duties will take it up and push it along.

MR. KENT LEAVITT: Has there been any research on this disposal problem, and would it not be possible to make it essential to have a certificate attached to the clearance of any vessel coming in or going out of port to prove that the oil sludge had been disposed of?

THE HONORABLE JAMES CALLAGHAN: The answer to the first question is yes. There has been research. In the case of dry-cargo ships, under the legislation of some countries, that carry separators which separate the oil from the water in the tanks, and the oil can be reused again.

There is a difference of opinion between the United States research workers and some of the other countries about how effective this is; Britain, for example, claims that these separators are useful for all except particular grades of oil which are not in common use—at any rate by British shippers. Therefore our domestic legislation insists on separators being installed aboard every dry-cargo ship.

I understand that in the United States this view is not shared and it is believed that these separators are not efficacious and that there is some evidence to that effect, but I don't know to what extent the oils to which they are not efficacious are in common use in the United States.

As to the recovery of tanker oil waste, the answer is that no means has yet been found for making the recovery worthwhile and profitable.

Your second question was: Wouldn't it be a good idea to certify that the tanks have been cleaned before they leave port?

You will be up against difficulties from the tanker owners who will claim that this will delay them in starting on the return journey to the oil fields to pick up fresh cargos. It might mean another 24 hours in port, cleaning tanks, and, therefore, what they would prefer, assuming we can get them as title prohibition of discharge—they would prefer to take off with their tanks dirty. In any case they have got to be freed of gas, and that means a 24-hour delay when you are sailing out of port. They prefer to clean the contents of all their tanks into a slop tank, and then to discharge its contents at the next loading port.

Probably from a practical point of view, if we can insure that there is cooperation by tanker owners and ships and crews, it would be more economically feasible.

QUESTION: I would like to ask about the statement of the failure of chemical methods—have you used carbonized sand? It has been tested here and has been tested with some success of settling oil on the bottom.

THE HONORABLE JAMES CALLAGHAN: I am glad to have that information.

MR. NICHOLS [London]: Back in January 1943 I was here representing the United Kingdom shipping. We had a really happy relationship here and at that time we were working together. We went to the Pentagon—an American shipping man and a British shipping man went together—and I do feel that we should get a completely integrated American and British position on this.

If we can work together, as during the war, everything will grow. We all know that this has got to be done; it is only how soon it will be done, and how much payment and so on, before it is done, and if we are determined to do it, technical difficulties can be beat.

We know we have the guts to lick this problem. I plead that we should try to follow this as someone who is always campaigning on behalf of the American effort. It is a great embarrassment to us, who are standing up for this country—so far as conservation is concerned. I think it is true that conservation is an example where we have to apologize in not having a fine connection.

I go on boasting about the United States conservation efforts and say how we ought to keep up with them. This is embarrassing and I am sure that if everyone here would try to pull together and tackle this marine problem, it could be solved.

MR. LLOYD: I am a member of the National Committe that is working on this and I would like to straighten out one or two things that have cropped up their ugly heads here.

In the first place, there is a requirement in this country in the case of dry cargo ships that the bulkhead be tight and that there be no oil seepage into them.

Secondly, in the last month or so contracts have been let for the purpose of conducting research to improve oil separators. Oil separators are effective in reducing the amount of oil to a large degree—between 95 and 100 per cent—but if the oil has the same specific gravity as sea water, they are not effective. Contracts have been let by the Department of Commerce to investigate further and conduct research experiments on them.

There also has been some work done on the use of recovered oils and there are instances, particularly in the case of fleet tankers of large oil companies, where they have the facilities to take large quantities of oil. The oil is used for burning to provide continued cleaning of the vessels or the product may be converted into things like macadam.

They don't pay their full way, but they do contribute to a certain degree to the extensive operation. There are being considered at the present time also, other means of recovery and the use of sand. The Corps of Engineers would not permit its use in a harbor or other places where it might accumulate. Yet we have to consider as conservationists the effect on aquatic organisms and other products of the sea and when you work on a project you have to conduct very careful research experiments to determine what effect any method is going to have on products that we get from the sea.

When you get into this thing you realize more and more that there is much that has to be learned. A lot of research has to be done and if we get the ratification of the convention, and national committee gets into this problem deeper, we will find some of the government departments at least, recommending a program that will help to answer some questions that we don't know the answer to now.

DISCUSSION LEADER CHAPMAN: Thank you. I have just one comment that we have been touching upon.

Isn't it time that we stopped thinking in terms of whether we can clean up the mess and make money out of it? Isn't it time to think in terms of utilizing the natural resources we are now wasting?

MR. CALLAGHAN: If I may say so, yes.

CHAIRMAN BUCHHEISTER: Ladies and Gentlemen, I know that I speak for everybody in thanking the distinguished Mr. James Callaghan for coming to this country and presenting such a splendid paper, which was packed not only with information but with a great deal of inspiration.

As Chairman I am calling time, but I am going to take one-half minute to remind you that the estimated kill of sea birds off Newfoundland in the winter of 1959-1960 was 250,000 birds, and I think that ought to give us a good deal of thought.

A REVIEW OF THE NATURE AND EXTENT OF DAMAGE CAUSED BY OIL POLLUTION AT SEA

ALFRED L. HAWKES
Audubon Society of Rhode Island, Providence

Oil pollution of the sea has been a recognized problem since 1754 when Jonas Hanway described oil leaking from wooden vessels at Holy Island in the Caspian Sea as covering the sea "for leagues together." Prior to the first World War the problem remained relatively small and only certain oil-producing areas were involved. With the advent of oil-burning ships, the automobile and airplane, asphalt roads and the thousands of other devices and processes which demand that oil be produced, transported, and disposed of, oil pollution of the sea has become an international problem which is reaching the proportions of a disaster in some of its aspects.

From the time oil is taken out of the ground until it is burned, broken down by bacterial action, or destroyed by some other process, it is a constant hazard to every living thing and every piece of property with which it comes in contact. Nowhere and at no time is oil more likely to get where it is not wanted than when it is being transported at sea, either as cargo on a tanker or as fuel on dry cargo or passenger vessels.

The U. S. Coast Guard's Proceedings of the Merchant Marine Council for April 1960 lists the principal sources of oil pollution of the oceans. Two of the commonest from shipping are spills during bunkering operations and discharges from bilge and ballast tanks. Nearly half of all the oil spills whose causes were determined by the U. S. Coast Guard from January 1, 1956, to September 22, 1959, originated while oil-burning ships were taking on fuel. Bilge pumping ranked third as a traceable cause of oil pollution.

There is little excuse for either of these sources to be a menace. Almost all spills occurring while loading fuel are attributable to carelessness or faulty equipment. Port facilities for receiving excess oily water are available in many U. S. harbors. Few ship handlers are ignorant of the law forbidding discharges of bilge and other oily waste water within territorial limits. Most violations of this law are completely avoidable. The same may be said of pollution due to ballast dumping and tank cleaning operations. Both are necessary but both can be done at times and places where they cause a minimum of concern.

Another common source of trouble from shipping is leaking hulls. This is more frequent on riveted vessels which are now being replaced by ships whose plates are welded. Hull leakage, however, accounted for 20 per cent of the traceable spills over the four-year period mentioned previously.

Casualities such as collisions, groundings, and fires cause the worst pollution problems since they frequently occur near shore and release thousands of barrels of oil at a time. A recent grounding in Narragansett Bay flooded the area around Newport, Rhode Island with an estimated 10,000 to 50,000 barrels of so-called "bunker C" oil. The resulting mess had to be seen to be believed, and the Rhode Island governor was forced to declare a state of emergency to deal with the situation. Many of the worst oil strandings on Cape Cod occur as a result of wrecks in those particularly hazardous waters. In spite of modern technology and the equipment and facilities now available, these casualities still remain a principal source of pollution as well as loss of life at sea. Many of them admittedly serve also as monuments to careless seamanship. Gradual rusting out of tanks on sunken vessels makes them major sources of oil pollution for years after the date of sinking.

Deliberate release of oil at sea is permitted only in cases of extreme emergency and is seldom a serious source of pollution except in groundings and other casualties. It is interesting that the most objectionable types of oil from the pollution standpoint are crudes and fuel oils and that the British Ministry of Transportation, to avoid endangering human lives, recommends throwing almost *any* other oil than these overboard to quell waves when men are in the water.

Still a minor, but rapidly increasing, cause of oil pollution is the more than 8,000,000 small craft now plying our bays, rivers and lakes. The average weekend captain probably gives little or no thought to where and when he pumps bilge or to the pint or so of oil that goes overboard with it. Thousands of him in one area at one time, however, may compound this into a problem of major proportions in the near future. Much of the oil involved from small craft is lighter than crude or fuel oil but correspondingly less care is used in handling it. Bodies of fresh water are likely to feel this before it becomes a severe threat on salt water.

All oil pollution of marine waters does not orginate with shipping, although it is the principal cause. Shore installations are frequent trouble spots. Diasters such as fires, explosions, and floods often spread oil in harbors and rivers. Obsolete or worn equipment accounts for many spills. Spillage during transportation to or from docking areas and leaky storage equipment account for more oil on our waters. Effluents from a wide variety of shoreside industries contain significant amounts of oil along with other pollutants and can be among the most difficult of sources to locate. About one third of the recorded oil spills on Narragansett Bay over the past four years originated at shore installations of one type or another. While the oils used are light, spraying of salt marshes with insecticides in an oil vehicle adds another mite to the total. In some areas oil drilling operations and the associated brines, drilling muds and leaks are sources of marine oil pollution. In Cuba and on the United States West Coast and Gulf Coast natural oil seepage causes still other troubles.

The total effects of the enormous amounts of oil released on the marine waters of the world can never be accurately assessed. We can assume, however, that what happens in one area of the world is also going on in similar areas elsewhere and that similar results are sequential. The principal uses of salt water the world over may be listed more or less as follows:

Propagation and harvesting of fin fish;
Propagation and harvesting of shellfish;
Propagation and maintenance of other vertebrate and invertebrate marine life including waterfowl;
Swimming, boating, sport fishing, and other forms of recreation and esthetic enjoyment;
Navigation and commercial transportation;
Dilution and dispersion of wastes;
Domestic water supply—in the near future;
Industrial water supply—in the near future;

Contamination of salt water with oil diminishes the usefulness of that water for nearly every one of the above purposes in direct proportion to the amount of oil thrown out.

Certainly the prime hazard from oil spillage is the danger to human life. The greatest and most immediate threat is that of fire. Oil and oil soaked debris on the waters of any harbor or coastline or washed up on shore offer almost unequalled opportunities for major fire disasters. The potential is so obvious that it needs no further elaboration here.

Oil washed directly onto beaches by winds, tides and currents creates a variety of problems. It would seem, according to a recent report by the American Petroleum Institute, that seasonal currents may be more responsible for the location of the landings of these spills than either tides or winds, when the spills occur on the open sea. Beach strandings of oil are annoying to bathers and expensive to those whose livelihood comes in whole or part from sales and services to seashore users. In the small resort community of Narragansett, Rhode Island, (population—3,444) the estimated loss to local businesses of one day's closing of their beaches in good weather runs between \$10,000-\$50,000.

Then there is the cost of cleaning up. At one state beach in Rhode Island the cost of cleaning the beach and adjacent buildings as a result of a severe oil spill last fall, will run into several thousand dollars and has yet to be completed. Cleaning oil from bathing beaches in many areas along the east coast of North America is a more or less continuous process all during the swimming season. In some instances it has been necessary to set up "detergent stations" at the entrances to public bathhouses and to compel bathers to clean the oil off themselves before entering. A report from Texas relative to the Gulf Coast indicates that "It is a common occurrence in recent years for beach enthusiasts to pick up waste oil and tars on their feet and subsequently leave oil deposits on expensive rugs and furnishings in their motel and hotel accommodations, causing considerable costs to owners of these accommodations for rehabilitation." That the extent of damages of this type is not made public by those affected is indicated in a communication from John W. Mann, Executive Secretary of the U. S. National Committee for Prevention of Pollution of the Seas by Oil. Mr. Mann stated that hotel and resort owners are often reluctant to call attention to beach pollution problems because they fear the adverse publicity will affect their patronage. The bather himself certainly has no desire to come in contact with oil or to swim where it is visible or can be smelled. The after-dark shore fishermen who has never reeled in a long cast only to discover that his entire line passed through floating oil has a memorable experience waiting for him.

The fouling of boats of all kinds is another costly result of oil pollution. The cost of repainting a boat, and this is frequently the only recourse, varies with the size and type of the craft. An oil spill which floats into an exclusive yacht club anchorage can be an expensive proposition. Certain oil companies in the Narragansett Bay area have from time to time undertaken to repaint boats so damaged when there was no question as to the source of the oil. This has given rise to a class of yachtsmen on that bay who now await the first reports of a traceable oil spill, immediately sail their boats into the middle of it, and then indignantly demand a free paint job from the oil company. Fraud is only one of the consequences of oil pollution. The problem of boat fouling takes on a more serious complexion when commercial fishing vessels are involved. Hauling oil-smeared lobster pots, crab pots, or seines into a small craft can create serious problems and the waste of time and money for cleaning may mean the difference between profit and loss for a small operator.

In entering the area concerning the effects of oil on various forms of animal life, we approach one of the most widespread and tragic results of oil pollution of the sea. The world's only major and relatively untapped source of food is the ocean, and the most productive portions of it, the surface and shallow waters, are those portions most acutely affected by oil pollution. If we could count on the dilution of every oil spill by the entire volume of water in all the oceans our problem would indeed be a small one for many years to come. This is not the case, however. It is safe to assume that due to the confluence of major world shipping lanes in the areas of continental coastlines and harbors and the development of refineries and industrial centers near marine oil transportation terminals, the major portion of oil pollution of the sea will continue to occur in these areas—the same areas from which the greatest potential harvest of marine life should come.

There is some difference of opinion as to the exact nature and variety of the effects of oil on different forms of marine life. In general, there are five principal ways in which oil may affect salt water animals. These are:

The tainting of the flesh of fin fish and shellfish thus rendering them inedible;
Poisoning of animal life by ingestion of oil or its soluble fractions;
Upsetting of food chains;
Mechanical fouling of animals;
Repellent effects.

The tainting of the flesh of marine animals which have come in contact with oil is largely self-evident. While the notion that oil and water do not mix is a common one, it is not entirely correct. Particles of clay or other fine sediment quickly absorb large amounts of the oil and it then sinks to the bottom where it may remain for long periods of time. Disturbing the bottom in any way can refloat much of it at a later date. Oils, particularly the residual products of modern refining methods, are frequently almost the same density as water, and under certain conditions, sink readily. In extremely cold weather oil may quickly sink only to reappear when warm weather returns. By these means oil reaches the bottoms of marine environments and tends to remain there in direct contact with bottom-dwelling organisms. Many forms of marine life are killed outright by such contact and the best evidence of this is the almost complete absence of living things from the bottoms of bays and harbors where oil spills occur regularly. Those animals which can survive direct contact take on highly objectionable tastes and odors.

This can be a serious economic problem in certain areas. The quahog or hardshelled clam (*Mercenaria mercenaria*) is the foundation of an industry in Rhode Island which grosses over $2,000,000 annually for commercial diggers. Quahogs seem to be practically immune to oil pollution. The Rhode Island Department of Health states that there are quahogs flourishing in Narragansett Bay in the area of Providence where the Bay bottom is literally paved with oil. They also assure me that each and every one of these quahogs has a taste and odor which would make the strongest stomach turn. If oil settled undetected on the bottom in a portion of Narragansett Bay where quahogs are normally harvested—and the Health Department attests that there are many such unreported spills—and these flavored shellfish reached the New York markets on about two different occasions, Rhode Island quahoging would be a thing of the past. Tainting of European mussel beds by oil has caused serious problems there in the past, and Walter Gresh, regional director, U. S. Fish and Wildlife Service, Atlanta, Georgia, states that, "Fishermen in the lower St. Mary's and Savannah Rivers in Georgia, have reported that the fish caught in these reaches are unfit for human consumption. Pumping of bilges is thought to be responsible for the taste in the lower Savannah River."

Many marine animals are susceptible to certain fractions of oil which are soluble in water and are highly toxic. Dr. Paul Galtsoff, biologist for the U. S. Fish and Wildlife Service established this in 1935 and again in 1949 working with oysters and other marine invertebrates. These toxic substances are released for long periods of time from oil in the water. While these substances are undoubtedly diluted below dangerous levels in small or infrequent spills, areas where oil tends to accumulate on the bottom may be slowly building up long-term problems. In spite of the common notion of tides washing nearly everything in bays and estuaries out to sea, it simply isn't always true. In most estuaries the total result of surface flow is eventually to the sea, but the total result of bottom flow is upstream. Oils deposited on the bottom of an estuary then are sending a constant stream of toxic materials into the estuary and if the bottom is disturbed frequently the oils themselves may gradually work farther and farther upstream. Since the rates of microbial decomposition and other factors destructive to oil will vary enormously from place to place even in the same body of water, the length of time this process of accumulation may go on is problematical. A report presented to this body in 1953 by Hunt and Ewing indicated that during annual dredging operations in the lower three miles of the Rouge River in Michigan more than 17,000 gallons of oils and greases are scooped out daily for a period of fifty days. This is presumably a one year accumulation. Some of our salt water environments have been badly polluted for many years.

An additional hazard to animals from these toxic fractions exists when other forms of pollution are present in addition to oil. An animal which might otherwise resist the effects of an oil spill may succumb instead if it has already been weakened by other pollutants. The converse can be equally true.

In experiments with *Nitzschia,* a diatom food of the oyster, Dr. Galtsoff found that these microscopic plants were seriously inhibited in their growth if oil remained for more than one week on the surface of the water in which they were living. Another effect of the presence of oil was to stimulate the growth of certain bacteria which in turn became so numerous that the *Nitzschia* died. Presumably, the effects of longlasting oil spills would be the same on many of the other minute organisms at the base of oceanic food chains.

Oil smeared on exposed intertidal flats quickly coats all life including commercially valuable softshelled clams (*Mya arenaria*) and razor clams (*Ensis directus*), and a variety of other more or less sessile dwellers of this zone on both muddy and rocky shorelines. The famous Dungeness crab of the West Coast is another casualty of this type of pollution. Even fur seals have been killed as a result of contact with oil.

A less direct effect of oil pollution on marine life is its repellent effect. Fish in particular are possibly affected this way when they are migrating. Fish such as flatfish of various kinds which breed in salt marshes, may well refues to enter a good breeding marsh if sufficient quantities of oil or other pollutants are flowing out of the area. The same causes might well effect selection of migration routes and in turn affect commercial fishing grounds and methods.

The most obvious and spectacular loss of animal life due to oil pollution of the sea, and one of the principal reasons this subject is being reviewed at this time, is the enormous annual toll taken of marine waterfowl as a result of contamination by floating oil. There is ample evidence from both Canada and England that serious reductions in the populations of certain species of oceanic birds have taken place as a result of oil dumped at sea. While it is admittedly extremely difficult to pin down the cause of these reductions directly to oil, every piece of circumstantial evidence points to this source. The most convincing evidence is that certain colonies of seabirds subject to continued oil pollution have declined over periods of time while other colonies composed of the same species and in nearby areas but not subject to pollution have not declined in the same periods.

Oil affects birds in several ways. The principal damage is simple mechanical fouling of the feathers. Fuel and crude oils are thick and sticky to the point of being impossible to remove without the aid of solvents. Once a bird has come into contact with the oil by landing in it, swimming into it from the surface or by coming up underneath it, he is almost invariably doomed. In cold weather a spot of oil the size of a coat button is sufficient to cause death, particularly if located over the vital organs. The oil mats the contour and down feathers into strings instead of the broad water-repellent and circulation-resistant surfaces normally sealing the insulating layer of air between feathers and body. Once this seal is opened icy water seeps in against the skin and body heat is lost faster than it can be renewed. The process of degeneration is speeded up if there is also oil on the wings since this inhibits movement and thus feeding. If the oil covering is extensive, the bird must swim for all it is worth just to stay afloat since the oil destroys natural buoyancy. This may be the main reason why so many oiled birds head for shore and are so reluctant to take to the water again once there. Certainly when oil spills affect birds any distance at sea, most of them will sink long before they reach land.

Even in warm weather, oiling is fatal to birds. Inability to fly or swim properly interferes with feeding. Preening in an effort to remove the oil transfers much of it to the beak and from there to the digestive tract. Following a recent severe spill in Narragansett Bay, a large number of ducks killed by the oil were examined internally and found to have the entire alimentary canal coated with a layer of oil. Those ducks which survived in captivity for a few days frequently showed oil in the droppings. There is evidence that oiled birds spend so much time preening that they neglect to feed properly and become much emaciated even when food is available. There is no reason for not assuming that all of these same conditions apply to other birds such as alcids caught in oil spills at sea. Even unoiled birds may feel the effects of oil if they feed on plants or bottom organisms which have become contaminated. The oil itself is toxic and undoubtedly can be fatal if sufficient amounts are consumed.

Attempts to save individual birds by various washing and cleaning processes have not been noticeably successful. If the birds survive the cleaning process many of them seem to perk up for a day or two but then suddenly expire. An occasional individual will survive for an extended period of time and apparently recover completely. It is very likely that these are birds which had not had time to preen and consume oil. Also, some birds apparently survive handling better than others. Even if this approach to recovering oiled birds were successful, it is impractical because of the sheer weight of numbers and the time necessary—several hours—to do a through cleaning job on one bird.

Reports from many sources indicate that the kill of birds by oil has been getting progressively worse over the past few years. Mr. L. M.

Tuck of the Canadian Wildlife Service in Newfoundland has estimated that one nesting colony of auks in his area has been decimated by nearly a quarter of a million birds within the last two years and that it cannot survive comparable losses for more than another two or three years. Mr. Lester Giles, director of the American Humane Education Society, has counted approximately 4,000 oiled birds on Nantucket Island in December and January of 1960 and 1961 and this is a time of year when currents are carrying oil away from this area. In Narragansett Bay approximately 4,000 ducks, nearly one fifth of the entire wintering flock, were killed by an oil spill in early February of this year. Mr. Oliver Beckley, supervisor of game management for the Connecticut Board of Fisheries and Game estimates a kill of 4,000 more ducks as the result of an oil spill in Long Island Sound in mid-December, 1960. While not an oil spill at sea, as many as 10,000 ducks may have died as a result of oil on the Detroit River in April, 1960. Going back only a few years to 1955, a report from Germany indicates a kill of over one quarter of a million birds in the North Sea, mostly as the result of one spill. These figures represent typical reports from many sources. A long list of reported kills of this sort can easily be compiled but only begins to indicate the real extent of the problem, since, without any doubt, the major portion of bird kills go unnoticed at sea. The most spectacular slaughter results from disasters to ships. The slow steady kill of sea birds as a result of bilge pumping and tank washing may, however, in the long run account for more losses than ship disasters. In any event, if the smaller and more frequent, and preventable spills were halted, the larger, and presumably unavoidable disasters, would be less devastating in their effects on populations of oceanic birds.

There are still other deleterious effects of oil on the sea. The facts that in 1936 the River and Harbor Act of 1899 was interpreted by the Appellate Court to include oil as a hazard to navigation and that this decision has been standing firm since that time is indication enough of the menace of oil to shipping itself. There is no longer much question in the minds of conservationists that the sea is soon to become a major source of domestic and industrial water supply. Even if we cannot bring down the cost of desalinization the demand will soon make present costs seem reasonable. The effects of marine oil pollution as it exists today on such a water supply will present a real problem for sanitary engineers. Finally, a rather paradoxical hazard exists, in that except for the fire dangers involved some of the methods involved in cleaning up or disposing of oils spills may be nearly as harmful as leaving the oil on the water. Carbonized sand used to sink floating oil is an "out of sight, out of mind" technique which simply puts oil on the bottom and in direct contact with many of the organisms we wish to protect. Contary to earlier beliefs, carbonized sand will not sink oil indefinitely but releases it slowly for return to the surface. Sinking the oil does not decrease the toxicity of the soluable fractions and in fact gets them closer to the organisms most affected by them. At the recent Governor's Emergency Conference on Oil Pollution in Rhode Island several commercial oil solvents were suggested as a means of getting rid of the oil in particularly critical areas. Marine biologists questioned this technique on the grounds that the solvents or emulsifiers or their effects on the oil might be equally or more harmful to marine life than the floating oil itself. Although representatives of several commercial manufacturers of these substances were present, no concrete evidence was offered to meet these objections.

The direct financial losses involved in oil pollution of the sea can probably never be accurately assessed on a dollar basis. Their magnitude can be implied, however, in a simple review of some of the factors involved. A few of the more important ones are as follows:

Loss of natural resources which could be harvested, held as reproductive stock, serve as links in oceanic food chains, or provide esthetic values;
Destruction of bottom areas to produce the above-mentioned natural resources;
Loss of revenue to resort areas;
Costs to local and state governments of cleaning up when spills cannot be traced;
Loss to those sources responsible for the pollution in fines, cleaning expenses, legal expenses, loss of valuable oil, and poor public relations;
Costs of investigation to determine sources and responsibility for pollution;
Costs of prosecution when pollution cases go to court .

One of the conclusions which can be drawn from this review is that in addition to the many problems created by it, there are three basic reasons for oil pollution of the sea. These are: economic expediency, carelessness and negligence, and inadequate regulation and enforcement. All of these causes can be reduced, if not eliminated, by concerted action on the part of all the interests involved in oil pollution. Oil handlers and producers must shoulder the major portion of the responsibilty since they alone are responsible for the problem. There is much evidence that they are becoming aware of this responsibility and are taking steps to live up to it. The extent to which they can control the problem within their own ranks and by their own methods will determine the extent to which they will be controlled by regulations imposed upon them by outside, and not entirely sympathetic, interests. They will need all the help and cooperation they can get from conservationists but this does not imply any cessation or letting up of criticism or pressure to get the job done.

In placing the onus of elimination of oil pollution directly on the oil industry, let us not overlook two closely related problems with which the oil industry has little to do. First—many of the saline waters we are demanding be rid of oil pollution are so badly contaminated by other pollutants that they would be valueless even if 100% free of oil. Second those most aware of and concerned about oil pollution have failed to present clear, well documented, and voluminous information relative to the real extent of this problem. There is no question that the problem exists and is of disasterous proportions in some areas but there is real need for sound information making this clear to all concerned. There-in lies one of the major contributions needed from the biologists and conservationists of the world.

SUMMARY

The principal source of oil pollution of the sea is shipping. Oil is spread from ships when taking on fuel, pumping bilges, and washing tanks. Much oil is also lost through leaking hulls. Ship casualties such as groundings cause the most damaging spills of oil. Oil drilling and natural seepage are two less significant causes of oil pollution of the sea.

Some of the potential hazards and consequences of oil pollution are fire, poisoning of animal life, upsetting of oceanic food chains, mechanical fouling of animals, pollution of beach and resort areas, fouling of boats, tainting of fin fish and shellfish, interference with navigation, damage from some removal techniques, degradation of oceanic waters as a source of industrial and domestic water supply, and repellent effects on marine fauna.

Financial losses as a consequence of marine oil pollution stem from loss of valuable natural resources, loss of revenue to resort areas, loss of time and revenue for cleaning operations on commercial fishing gear, loss to sources responsible for the pollution, costs to local and state governments for cleaning shorelines and property, costs of investigations, costs of prosecution. Intangible losses may be even greater than those mentioned.

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DISCUSSION

CONFEREE: We have the information fairly well pinpointed as to where the problem areas are, where the birds congregate and that type of thing, but there is one interesting thing that came out of this that does not appear any where in our comments. In contacting the central states with regard to the beach area the states complained about having to close the beaches. New Jersey, for example, called it a catastrophe. They closed the beaches so frequently that it seemed as though the states were taking unilateral action to clean the beaches mechanically, but they were doing very little so far as making complaint to the enforcement agencies or getting together to take any kind of coordinated action to try to stop this thing.

POPULATION DYNAMICS OF THE ALASKA FUR SEAL HERD[1]

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The Alaska fur seal herd, near extinction in 1911, recovered rapidly when a conservation program was inaugurated. The apparently stable ceiling that the herd size had reached in the period around 1950 has subsequently given way to larger fluctuations and generally decreasing survival in the youngest age groups. Some of the recent developments are briefly reviewed. A simple model is developed on the premise that reduced survival is due to pressure on the food supply around the islands which affects the survival of the seal pups in their first year. Two equations are estimated for the relationship between pup population and survival to age three. While the two equations are based on different models, the results are in close agreement. The consequences of this estimated relationship are examined.

ACKNOWLEDGMENT

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INTRODUCTION

The changes in the fur seal herd subsequent to the 1911 treaty signed by Great Britain, Japan, Russia and the United States of America and particularly the results of the intensive research program carried on by the U. S. Fish and Wildlife Service since World War II were reviewed in Kenyon, Scheffer and Chapman (1954)[3] In it may be found an outline of the history of the herd and a more detailed examination of the sources of data and methods of study. However, to keep this paper essentially self contained, we will review briefly both the basic structure of the fur seal herd and the basic data sources.

The Alaska fur seal breeds on two islands—St. Paul and St. George —which together are known as the Pribilofs. On the basis of presently counted elements, about four-fifths of the total herd breeds on St. Paul. While one could speak of the St. Paul population, there is partial mixing between the herds on the two islands. There is also some

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[3]This paper will hereafter be referred to as KSC.

mixing particularly at subadult ages of Pribilof seals with those that breed off the coast of Asia on Robben and Commander Islands. The paper is, however, concerned exclusively with the Alaska herds and even more particularly those on St. Paul Island, for which the most complete data are available. This brief study makes no attempt at a complete bibliography either on the fur seal population—for this reference is made to KSC—or on the subject of animal population dynamics. Extensive bibliographies on this, particularly from a fisheries point of view, may be found in Beverton and Holt (1957) or Ricker (1958).

BASIC STRUCTURE OF THE FUR SEAL HERD

The fur seal herd is conveniently divided into six components:

1. Harem bulls: the adult males which return to the Pribilof Islands in the early spring and hold harems through part or all of the breeding season, *i.e.,* from late June to early August.

2. Idle bulls: the adult males which are not holding harems. While some males will not hold harems at any time because of immaturity or senility, others will be "harem bulls" part of the season and "idle bulls" at other times. There is thus an indistinct line between these two categories.

3. Female seals 2 years old and older: there are isolated cases of females being bred at age 2 and a small fraction begin to breed at age 3, but age 4 may be regarded as the first age of normal breeding. Breeding takes place on the islands in midsummer; the fur seal exhibits delayed implantation with development of the embryo beginning only in late fall or early winter. The single pup is born the following summer. The breeding and pupping areas are known as rookeries.

4. Bachelors: subadult males age 2 to 5.
5. Yearlings of either sex.
6. Pups: the young of the year born between late June and early August. The pups are land-bound until four to six weeks old and then begin the process of learning to swim and getting acclimated to the ocean. However, they still continue to nurse through the early fall—this may only cease with the departure of the female seals for the winter feeding grounds along the North American and Asian coasts. Subsequently, the pup also makes the transition to a marine existence.

BASIC DATA SOURCES

The estimation of the components of the fur seal herd is based on data obtained on the islands and from pelagic samples. We list the information used in this study.

1. The count of the kill of fur seals. From 1918 to 1955 this was limited to bachelors from 40¼″ to 45¾″ in size (termed Group III here). Some male seals were taken outside this size range and a few females were accidentally killed. Beginning in 1956, larger numbers of females have been taken following recommendations made by the Treaty Conference between Canada, Japan, U.S.S.R. and U.S.A. The commercial sealing season begins in late June and prior to 1956 ended between July 27 and July 31. In 1956 and 1957 the season was extended into August for both males and females, subsequently for females alone. Estimates of the age composition of the commercial kill are available since 1950. Age readings are made from the annuli in the dentine layer of a canine tooth; a sample of teeth is taken for this purpose.

2. Tag recovery data. The consistent and standardized program of pup tagging that was begun in 1947 has been continued in every year subsequently except 1950 and 1951. These tags are recovered on the islands from the animals taken in the commercial harvest.

3. Dead pup counts. A complete count has been made of dead pups on the rookeries in mid or late August in every year since 1950 except 1952. These counts are shown in Table 2.

4. Estimates of the proportion of pregnant females are obtained from the pelagic samples that have been taken along the North American coast in 1952, 1958-59-60.

RECENT TRENDS IN THE NUMBER OF FUR SEAL PUPS

In KSC six different estimates of the Pribilof pup populations in the late 1940's were given. These varied from 440,000 (rapid field estimate with corrections from sample count) to 590,000 (extrapolation from the trend of the commercial harvest). Approximately intermediate between these was the tagging estimate (530,000).

Since that time, major reliance has been placed on tagging to yield pup population estimates. The tagging on St. Paul Island and subsequent recovery of tags in the commercial harvest gives an estimate of the number of pups on this island at the time tagging took place, usually in late August or September. To this estimate must be added the dead pup count to obtain the estimated number of pups born. Table 1 shows the tagging data and estimates. The estimate is that given by Chapman (1951), the modified Petersen estimate

$$N = \frac{(n+1)(t+1)}{(s+1)}$$

where

N = population estimate (of the number of pups on St. Paul

Island *at the time of tagging*),

n = number of seals from the specified age group in the commercial kill (estimated from tooth age analysis),

t = number of seal pups originally tagged in this year class on St. Paul Island,

s = number of tagged and tag-lost seals recovered from the commercial kill (of the specified year class).

A tag-lost seal is one that had been tagged but has lost its tag and is identified by a check mark. No such marks were applied in 1948 and 1949 though some tag-lost seals in these year classes were identified by the tag scar.

TABLE 1. TAGGING DATA AND ESTIMATES OF FALL PUP POPULATION. ST. PAUL ISLAND, 1947-1955

Year Class	Number of tags placed (t)	Number of seals recovered from this year class (n)	Number of tags recovered from this year class (s)	Estimated population size at time of tagging (N) 1000's
1947	19,183	51,404	2,316	425.8
1948	19,532	53,854	2,293	458.6
1949	19,963	45,301	1,925	469.6
1952	19,979	80,519	3,562	451.5
1953	10,388	59,453	1,025	602.0
1954	10,000	42,719	687	621.0
1955	49,870	55,505	4,162	665.0

Note: no tagging took place in 1950 and only a token tagging in 1951 on one rookery.

Table 2 shows the dead pup counts and the resulting estimate of the number of pups born in each of the year classes 1947 to 1955 excepting 1950 and 1951. Also included in this table are the pup counts from 1920 to 1922. Actually, total counts were made only in 1916 and 1922 with the 1920, 1921 values being based on partial counts. However, these values fit in well between the two total counts and are, therefore, accepted as reliable.

TABLE 2. NUMBER OF PUPS BORN ON ST. PAUL ISLAND IN 1920-22, 1947-52 (1950-51 EXCLUDED) AND 1953-55.

Year Class	Estimated or counted early fall population 1000's	Dead pup count 1000's	Estimated year class total 1000's
1920	139	4	143
1921	146	4	150
1922	156	3	159
Mean 1920-22			150
1947	426	55[1]	480
1948	459	55[1]	514
1949	470	55[1]	525
1952	452	62[2]	514
Mean 1947-49 and 1952			508
1953	602	83	685
1954	621	101	722
1955	665	79	744
Mean 1953-55			717

[1]1950 Dead pup count used in 1947-48-49.

[2]1952 Dead pup count estimated on the basis of the 1953 dead pup percentage.

From Table 2 it is seen that the pup populations were essentially stable from 1947 through 1952 but climbed quite rapidly from 1953 to 1955. Since no clearcut reason can be given for this change, there has been some question as to its reality. It may be asked if it could be due to biases or sampling errors in the estimates. These possibilities have been examined and discarded—a complete review of this analysis will be published elsewhere. However, to assert that bias exists in the 1953-1955 estimates requires an explanation of why this is so, when it was not present in estimates of the 1947-49 and 1952 year classes.

Several explanations can be offered for the increase in the number of pups born: perhaps survival of females may have been unusually good in the late 1940's. Also during the period 1950-1955 the total number of bulls was increasing. This could have resulted in some increase in the pregnancy rate, particularly among younger females and those returning to the islands late in the breeding season. It is presumed that such females are usually bred by bulls that may have been "idle," viz. not holding harems in midseason. Unfortunatly, none of these can be now said to be the definite answer; in fact, it is unlikely that there is a single answer, but rather the explanation lies in a combination of several factors.

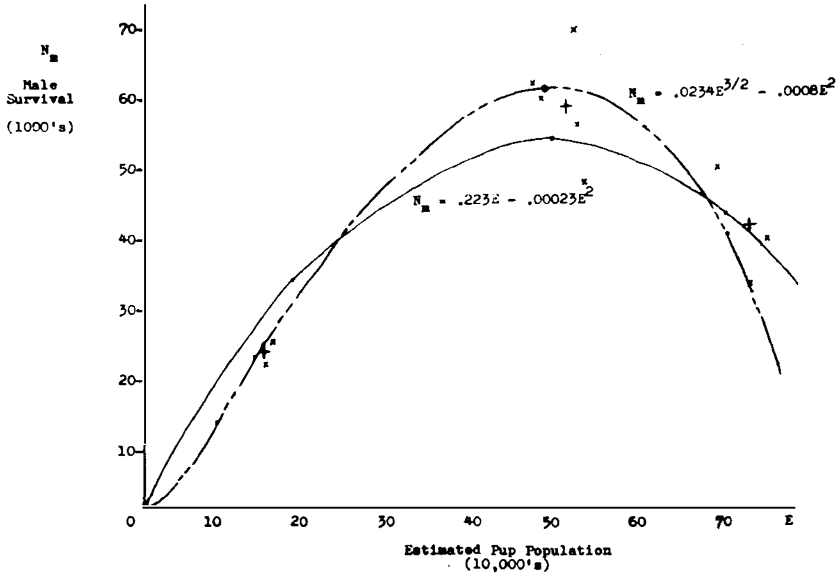
THE RELATIONSHIP BETWEEN PUP POPULATION NUMBERS AND SURVIVAL TO AGE THREE

The decline of the rate of growth of the commercial kill during the 1930's gave rise to speculation as to the factors responsible. While the first speculations centered on external factors, *e.g.* weather, ocean conditions, in more recent years the possibility of density dependent factors came to be more widely accepted. The recent even sharper decline in the returns of bachelors has given rise to attempts to formulat a mathematical relationship between the pup population size and the number of seals surviving three years later (Figure 1).

While there has been a spectacular increase in land mortality of the pups (compare KSC p. 29-33) this land mortality is only a small fraction of the total mortality that takes place in the first three years. While the hookworm parasite is one of the causes of this land mortality, there are several other causes, as well as many deaths for which the cause of death is not ascertainable. Nor is it known whether debilitation due to hookworm infection could result in increased mortality at sea. It should be noted that death due to hookworm and deaths on land due to natural causes taper off rapidly in August with relatively few recorded after August 15 while the seal pups do not leave the islands until October or later.

The population increase of the fur seal may also have resulted in

Pup Population - Male Survival Relationship
Year Classes 1920-22, 1947-52 (except 1950,51), 1953-55



the increase of a predator population and any such predator would clearly have the greatest impact upon the most vulnerable elements, the pups and yearlings. But essentially nothing is known about predation at sea upon the fur seal.

It is more obvious that as the fur seal population has increased there has been greater pressure on the food supply within the Bering Sea area immediately adjacent to the islands. This will have the greatest impact on the nursing pups, for if the female seals have to commute further to feed, the time between feedings may be increased. Also more of the food obtained by the female will be needed to supply energy for her food search and less will be available to be converted to milk for the pup. It is apparent that one of the critical periods in the life of a fur seal is the transition during its first fall from the islands to a life at sea and a successful transition may depend upon the reserve of fat the pup has acquired during its summer feedings. Various numbers of dead pups or yearlings, as they are called after January 1, in an emaciated condition are found each year on the beaches of Alaska, British Columbia and Washington.

These ideas have been incorporated into a simple model which is developed in Appendix 1. Equations relating male survival on St. Paul Island to the original pup population size will be estimated below. One of these is of form developed in Appendix 1 from these simple considerations on the limitations imposed by food on the nursing females and one is of the logistic form. Male survival only is considered since the data pertains only to males; for a similar reason the study is restricted to St. Paul Island. First some notation is necessary.

Let

E = estimated number of pups born on St. Paul Island,

N_m = estimated number of males surviving to age three.

The equation developed in Appendix 1 has the form

$$N_m = \alpha E^{3/2} - \beta E^2 \quad (1)$$

while the relationship analagous to the logistic has the form

$$N_m = AE - BE^2. \quad (2)$$

Here α, β, A, and B are all parameters.

As to the second of these equations, an argument can be constructed similar to that given by Schaefer (1954) viz. that the relationship between N and E must have the form

$$N_m = kEf(E)$$

where f(E) represents the density dependent factor that restricts growth. The simplest form that can be assumed for f(E), a linear function leads to (2) above. Data are available to estimate the parameters α, β, of (1) or A, B, of (2) not only from the recent studies summarized earlier in this paper but also from the early 1920's when population levels were much lower than at present. Table 3 shows the estimated number of males surviving to age 3 from each of the year classes 1920-22, 1947-52 (excluding 1950, 1951) and 1953-55.

TABLE 3. ESTIMATED NATURAL SURVIVAL OF MALES TO AGE 3 FOR ST. PAUL ISLAND

Year Class	Age Group 2	3	4	Breeding Reserve	Escapement[1] or native kill	Adjusted[2] Total
1920[3]	527	11,725	232	8,416	2,267	23,190
1921[3]	697	12,726	396	6,826	1,556	22,241
1922[3]	346	13,630	491	7,424	2,583	24,523
Mean 1920-22						23,318
1947	826[4]	31,746	19,658	—	6,139	60,949
1948	788	30,014	17,995	—	4,903	55,990
1949	133	29,697	12,502	—	3,904	47,876
1951	1,391	32,350	18,083	—	5,647	59,844
1952	1,735	30,733	31,448	—	2,122	69,395
Mean 1947-52						58,811
1953	839	38,290	8,855	—	881	49,839
1954	2,858	23,473	5,599	—	58	33,128
1955	1,015	27,912	10,438	—		40,409
Mean 1953-55						41,125

[1]Figures for the years 1920-22 are the reported kill of male seals (Canadian male kill estimated from sex ratio of U. S. native kill). The 1947-55 figures are estimated escapement.

[2]Age 4 plus escapement increased by 10 percent for mortality from age 3 to age 4.

[3]Age classification was estimated from lengths only in 1920-22; this data is taken from the annual report, "Alaska Fishery and Fur-Seal Industries," U. S. Fish and Wildlife Service (Bureau of Fisheries prior to 1940).

[4]Estimated fom the kill of 2 year old males in 1950 and 1952; 1951 was slightly exceptional as the sealing crew was instructed to take larger animals, the length limit being increased by 1."

In estimating the survival of the early 1920's, no attempt has been made to estimate escapement except for those animals which were deliberately spared and marked in some way for the breeding reserve. While the male age composition in the early 1920's was estimated from length rather than direct age determination, the method of analysis used mitigates this problem. Precisely, the analysis has been based on the average population size and survival for the year classes of three periods, 1920-22, 1947-52 (excluding 1950, 1951 because no population estimate is available) and 1953-55. These represent three distinct population levels; low, high and very high. Furthermore, year to year fluctuations and errors are minimized and the uncertainty of age estimates of the early 1920's need not concern us.

Aside from these points, the compilation of Table 3 is a straightforward addition of the kill at age 2, 3, and 4 together with the escapement. The escapement has been estimated by the methods that were outlined in KSC Appendix E. The age four kill and escapement must certainly have been alive at age three and are in fact, the survivors of a larger group that was exposed to a year's natural mortality. This factor has been taken into account in the compilation.

A straightforward least squares fit of the three means of Tables 2 and 3 yields the following estimates of the population-survival relationship

(1)* $$N_m = 0.0234E^{3/2} - .0008E^2$$
(2)* $$N_m = 0.223E - .00023E^2.$$

These two estimated relationships together with the basic data are shown on Figure 1. It is seen that both fit the data reasonably well, both have maxima for E just over 480,000. The actual estimated maximum return differs slightly more though even here the difference is not great. For (1)* maximum $N_m = 54{,}000$ and for (2)* maximum $N_m = 61{,}700$.

MAXIMUM SUSTAINABLE PRODUCTIVITY OF THE FUR SEAL HERD

The population survival relationship estimated in the last section gives a method of estimating in turn the population level that will yield the maximum kill of young seals on a sustained basis. There is no a priori reason that the commercial harvest should be restricted to males nor is there an a priori reason that female and male survival rates should be the same.

Letting N_f denote the female survival to age three, we assume

$$N_f = \lambda N_m.$$

This is a simplifying and hence restricting assumption—it is possible that the ratio of male to female survival may change with population density. Now let

p = average pregnancy rate among females 3 and older,
a = average annual mortality rate among females 3 and older.

It is immediate that E pups are produced by $\frac{E}{p}$ females and that the recruitment required to maintain this number of females is $\frac{aE}{p}$. Letting H denote the number of males required to maintain the male breeding stock, the balance equation for the sustainable kill, K may be written down.

$$K = N_m + N_f - H - \frac{aE}{p} \tag{3}$$

Since H is small, regard it as fixed. Now, if the relationship between the male survival and initial population size is of the form (1)

$$N_m = \alpha E^{3/2} - \beta E^2$$

then

$$K = \alpha(1+\lambda)E^{3/2} - \frac{aE}{P} - \beta(1+\lambda)E^2 - H.$$

For convenience write $\rho = \frac{a}{p(1+\lambda)}$. By elementary calculus it is found that K is maximized with respect to E if

$$E^* = \left[\frac{3\alpha + \sqrt{9\alpha^2 - 32\beta\rho}}{8\beta}\right]^2.$$

It should be noted that the function $N_m = \alpha E^{3/2} - \beta E^2$ is maximized for $E = \left(\frac{3\alpha}{4\beta}\right)^2$ and this is always greater than E*. In other words, the pup population level at which maximum sustainable productivity is obtained, will be lower when the commercial harvest includes both sexes rather than males alone.

A similar analysis can be carried out with equation (2) i.e. $N_m = AE - BE^2$. In this case, K is maximized when $E^{**} = \frac{A - \rho}{2B}$. Again it is easily seen that the maximum sustainable productivity occurs at a lower pup population level than in the case when the kill is restricted to males.

To complete the estimation of E*, E**, it is necessary to estimate ρ, *i.e.*, λ, p and a. To obtain estimates of p and a it is necessary to resort to the pelagic samples taken in 1958, 1959, and 1960. The age distribution and pregnancy rate of the females taken in these catches is shown in Table 4.

These samples are clearly unrepresentative with respect to the younger ages. If we assume they are representative in the older age groups and apply Heincke's method to estimate the annual mortality rates (cf. Chapman and Robson 1960), the estimated values are:

1958 ages 12 and older .25
1959 ages 8 and older .18
1960 ages 9 and older .20

TABLE 4. AGE DISTRIBUTION AND NUMBER OF PREGNANT FEMALE SEALS IN PELAGIC SAMPLES 1958-1959-1960[1]

Age	1958 Sample Sampled Number	1958 Sample Pregnant Number	1959 Sample Sampled Number	1959 Sample Pregnant Number	1960 Sample Sampled Number	1960 Sample Pregnant Number
1	30	0	15	0	14	0
2	4	0	34	0	4	0
3	39	1	43	0	18	0
4	42	1	93	6	36	1
5	70	32	114	64	55	27
6	99	80	118	91	45	36
7	103	92	143	109	66	52
8	102	91	164	142	105	90
9	81	78	108	96	144	133
10	97	85	96	82	129	118
11	113	104	98	88	136	124
12	134	110	76	67	106	96
13	110	91	56	50	120	105
14	92	75	70	59	107	86
15	71	56	87	77	67	56
16	56	44	69	52	53	38
17	36	20	36	29	46	31
18	22	13	27	23	23	19
19	14	4	16	13	19	11
20	3	1	5	2	6	1
21	1	1	7	6	6	3
22	1	0	5	6	0	0
23	—	—	1	0	1	0
24	—	—	1	0	1	0
25	—	—	0	0	—	—
26	—	—	1	0	—	—
	1320	979	1483	1058	1307	1027

[1]Taken from "Pelagic Fur Seal Investigations," by Karl Niggol, Clifford H. Fiscus, Jr., Thomas P. O'Brien, Ford Wilke. Unpublished report U. S. Fish and Wildlife Service, Bureau of Commercial Fisheries, Marine Mammal Biological Laboratory, Seattle, Washington.

The average of these is 0.21; it is convenient to use 0.20, giving slightly more weight to the estimates of 1959 and 1960 based on more age classes. A lower mortality seems indicated at younger ages; 0.05 was used in the 1952 population study but in view of the recent pelagic data this seems low. We have adopted a morality rate increasing from 0.08 at age 3 by steps of 0.02 to 0.20 for the 9 and over group. For the whole female herd, this yields an average value of a = 0.14.

Having an estimate of the mortality rate, it is straightforward to determine a weighted estimate of the pregnancy rate p. This is necessary since the youngest ages, which have the lowest pregnancy rates, are under-represented in the pelagic sample.

Weighted estimates of the pregnancy rate among female seals age 3 and older obtained from the 1958, 1959, and 1960 pelagic samples are .582, .585, and .578. A rounded estimate of p is 0.6.

Unfortunately, no direct information is available with regard to λ, the parameter which expresses the differential survival of female and male seals in the youngest ages. One indirect approach is possible for we have estimates of the male survival to age 3 from several year classes. There is also available an estimate of the total female herd from the number of pups born and the estimated pregnancy rate. The estimated pregnancy rate of 0.6 applied to the 1956 pup population estimate of about 770,000 suggests a female population (3 and over) in 1956 on St. Paul of 1,283,000. Now, we can, using the mortality rates estimated above and the male survival estimates to age 3 from Table 3, write down the following equation:

$$\lambda[49{,}839 + 69{,}395\ (.95) + 59{,}844\ (.879) + 63{,}344(.791) + 47{,}876\ (.692) + 55{,}990\ (.588) + 60{,}949\ (.485) + 60{,}000\ (1.94)] = 1{,}283{,}000.$$

The parentheses in the left hand side includes the 1953 year class survivors, the 1952 year class survivors reduced by one year's further mortality, the 1951 year class survivors by two year's further mortality, etc. The contributions from year classes prior to 1946 are not individually estimable but a rounded figure has been used from the average kill of 1939-1946 plus an estimated escapement of about 5,000. This yields a value of λ of 3.0 which seems unreasonably high.

If, on the other hand, we use a slightly higher value for the pregnancy rate which may have been the case in 1956, and the same mortality rates used in KSC (.05 below age 10 and .12 for the 10 and over group), an estimate of λ is obtained by exactly a similar computation to be 1.5.

These mortality rates are not in accord with the pelagic samples nor with the females taken in the hauling grounds samples. These indicate slightly greater mortality rates than those estimated from the pelagic samples: however, it is not clear what weight should be given these since the hauling grounds should not be representative of the whole herd. In the calculations that follow, three values of λ have been used, 1.5, 2.0, 2.5. Perhaps the intermediate value $\lambda = 2.0$ is the most reasonable value, but it is clear that additional information is extremely desirable on this point. These calculations are shown in Table 5 giving the level (in terms of the pup population) of the maximum sustainable kill and how that kill is divided between the two sexes. These are for the two models and the three values of λ. In these calculations the male escapement (H) for the breeding reserve has been set at 5,000 throughout.

TABLE 5. LEVELS OF MAXIMUM KILL OF FUR SEAL HERD FOR THE TWO MODELS CONSIDERED AND FOR THREE LEVELS OF DIFFERENTIAL MALE-FEMALE SURVIVAL

λ	Pup Population Level for Maximum Kill	Maximum Kill Male	Female	Total
	Non-Linear Model (Equation 1)			
1.5	353	48	3	51
2.0	376	52	29	80
2.5	393	54	60	114
	Logistic Model (Equation 2)			
1.5	282	40	1	41
2.0	315	41	23	64
2.5	340	44	44	88

In view of the kill sustained by the herd for a long period in the 1940's and the early 1950's under a regime of killing males only, the estimates given here for $\lambda = 1.5$ and for the logistic model (equation 2) seem low. The non-linear model (equation 1) suggests the optimum pup population level (in terms of sustainable kill) of subadults is just below 400,000. With a pregnancy rate of 0.6 this corresponds to a female population size of between 600 and 700 thousand. The most reasonable value of λ is 2.0 which suggests a kill of 52,000 males, 28,000 females. Clearly, this finding must be regarded as tentative—as additional information is obtained the model on which this is based will be affirmed, modified or denied. Also more information must be sought on all aspects of the female fur seal, mortality rates of subadult and adults, pregnancy rates and possible changes in these rates in response to population changes.

APPENDIX

A theoretical model relating survival of fur seal pups to population size

The ideas discussed earlier of the effect of food limitation around the islands on the nursing pups are here incorporated into a model relating survival of the young seals to initial population size. To develop this method it is necessary to specify some assumptions. Assume:

1. the adult female needs b units of food per unit time,
2. the adult female spends a fraction of time τ on land, and a fraction kr traveling to a distance r to feed,
3. the feeding rate of the adult female seal is f units of food per unit time.

From this it follows that the net gain in weight per unit of time for the pup is proportional to

$$(1-kr-\tau)f-b$$

the proportionality factor depending on the relationship between food intake of the female and milk production.

Now the total food needed for a population of $\lambda E (\lambda > 1)$ females and E pups is proportional to E. Assume the area grazed to provide such food is a circle of radius R about the islands. The argument is unchanged if the area grazed is a fixed sector of a circle expanding in radius with the increase of population. Then $\pi R^2 \propto E$ *i.e.* $R = \rho\sqrt{E}$ where ρ is a constant.

Net food for the pups is the average intake when feeding of the females ranges over this whole circle of radius R, *i.e.*

$$\int_0^{\rho\sqrt{E}} [(1-kr-\tau)f-b]\,dr = A\sqrt{E} - BE$$

where $\rho(f-f\tau-b) = A$ $\qquad \dfrac{kf\rho^2}{2} = B.$

Now, if it is further assumed that the probability of survival of the pups is proportional to food intake during the summer (nursing season) then the average number surviving (N) will take the form

$$N = \kappa(AE^{1/2} - BE)\ E$$

or

$$N = \alpha E^{3/2} - \beta E^2$$

where α and β are parameters depending on κ and A and B which in turn depend on f, τ b, κ, ρ. It is not possible to estimate these numerous parameters independently without much more information than is presently available on the physiology of the fur seal and the food situation of the ocean area adjacent to the islands. Hence we are forced to estimate the resultant parameters α and β from the available data, as has been done.

Further, with regard to the model itself, there are the random variations caused by the obviously uneven distribution of food around the islands. Also the food shortage will affect early and late pups differently. Nor will the foraging success of all female seals be the same. However, these factors are to some extent accounted for when we recall that we are calculating an *average* food intake for the whole group of pups.

A much more serious assumption is that the average survival is linearly related to the average food intake. This is very definitely a simplifying assumption and our main justification for it is that it is preferable to work the simplest possible model so long as it is not inconsistent with the facts. When the simplest model does not explain the observations, then it is necessary to set up more complex models.

It is not suggested that this is *the* model which explains the density dependent factors in the population dynamics of the fur seal. It is simply a model that seems to fit the data presently available and hence is worthwhile exploring. An alternative study based on part of this data has been given recently by Nagasaki (1960). Until both the theoretical knowledge of population dynamics and the statistical information on the fur seal populations is much more complete, it is going to be difficult or impossible to say any answer is final. All that can be done is to build possible models. Some will be later rejected as incorrect, others will form the basis for more complex and realistic models.

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DISCUSSION

DISCUSSION LEADER CHAPMAN: Thank you, Mr. Silliman for presenting that fine paper. There are many things in connection with this fur seal herd that are of interest. One is that this is the first of our conservation treaties, covering marine living resources on the high seas. It has worked successfully since 1911, excepting for a small interval during World War II. Secondly, we have worked well together on this commission with both the Czar of Russia and Communist Russia, and thirdly this is one example where, not only were the resources brought back to high content, but the population was brought back to too high a content and has to be reduced back down from maximum productive to stable productivity.

CHAIRMAN BUCHHEISTER: Before we close may I just say that we are very grateful indeed to Doctor Chapman who has been our discussion leader today, to all of the participants on this program this morning who took the time to prepare papers and come here to give them.

TECHNICAL SESSIONS

Wednesday Morning—March 8

Chairman: Wendell G. Swank
Assistant Director, Arizona Game and Fish Department, Phoenix

Moderator: Leonard E. Foote
Field Representative, Wildlife Management Institute, Marietta, Georgia

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MOURNING DOVE SYMPOSIUM

REMARKS OF THE CHAIRMAN

Wendell G. Swank

As we get more and more into the expansion of human populations and urban sprawl takes over our wildlife habitat, the number of species and the numbers of those species that we can have become fewer and fewer. The mourning dove is one of the bright hopes for future hunting in the United States. It is one bird that seems to thrive under urbanization, and as the population increases we have indications that doves do not decrease but even increase as people spread into the outer-lands.

In order to manage this species that we think holds some bright hope for the future, we need more information. We hope that this symposium will serve to bring together in one place the information that we now have on the mourning dove, and that it will be a point of departure for the future dove management program in the United States.

THE PAST STATUS AND MANAGEMENT OF THE MOURNING DOVE

HAROLD S. PETERS[1]
National Audubon Society, Atlanta, Georgia

The mourning dove is well known throughout the United States. It nests in 48 of the 50 states. It has the longest breeding season of any North American bird. It adapts easily to any terrain, temperature, and feeding condition. It nests around homes in towns as well as in rural areas. It shows peculiar adaptability to man-made habitat. In early days, the clearing of forests and westward spread of agriculture favored the dove. It increased in numbers rapidly and now is much more abundant than in colonial days. Diversified agriculture has provided increased feeding facilities. Man has been good for the mourning dove—and the dove has been good for man!

The dove is enjoyed in association with our daily life. Its mournful call arouses a protective instinct in many persons. They look upon it as a bird of peace, love, and gentleness. Some consider it a bird of ill-omen. Many people consider the birds nesting in their yard as personal property. Others know it to be a game bird without equal in sporty flight characteristics. It offers greater variety of shooting than any other game species. It is more readily available to sportsmen than any other bird, not requiring special habitat, conditions, nor equipment for its hunting.

The mourning dove is a game species in thirty states and one province. More birds are harvested than all species of ducks and geese combined. In fact, more mourning doves are harvested by American hunters than any other game species. The kill is increasing: in 1949 Dalrymple estimated 15 million were being killed annually, in 1955-56 I estimated nearly 19 million were taken, and some officials recently have figured nearly 30 million may comprise the annual bag. In spite of these astronomical figures the continental dove population apparently is maintaining itself at an all-time high and, so far as we know, is not endangered in any part of its range. While nearly all other game birds have declined in numbers, even with millions of dollars devoted to their study and care, the dove has held its own (with a few minor ups and downs) for decade after decade, even with increasing gun pressure. Perhaps we have been lucky; few facts have been available to assist in the management of the dove.

There have been fluctuations in dove populations, but in recent years these have seemed of minor importance. Severe freezes in win-

[1]In charge of Mourning Dove Investigations, U. S. Fish and Wildlife Service, until voluntary retirement January 31, 1958.

tering areas, cool rains in nesting seasons, and occasional outbreaks of disease (trichomoniasis and/or pox) seem to have depressed the dove populations only temporarily. The decline of 1950 seemed to have been overcome by 1953. The dove has great breeding potential, possibly by sheer force of enormous numbers.

Nests have been found in every month of the year in several southernmost states. But the main breeding season is from April to September, with some beginning in March and a rather surprising number continuing into October. The dove averages about three successful broods from five or six nesting attempts. Only two eggs comprise a clutch and each pair may produce four to six young. Nest and juvenal mortality is about fifty per cent. The young congregate into flocks that are familiar sights in rural areas. They feed upon waste grain and the seeds of weeds and other plants, being entirely vegetarian. Their soft bill and weak toes do not permit the scratching typical of most ground-feeding birds, and they are unable to pick kernels from ears of corn. Seldom do they cause loss to standing grain. Definitely they are beneficial to farmers and gardeners.

In the fall the young of the year constitute about 70 per cent of the dove population. Hunter bags frequently contain 70 to 90 or more per cent of juveniles. Many are killed in the state where hatched. Gradually the flocks of young migrate southward, feeding and moving in loose aggregations. Adults usually migrate after the bulk of the young have left the nesting grounds. There is a concentration of doves in the southern states from the central and northern states and southernmost Canada. Thus the birds produced in the South mingle with doves from other sections. The dove is more favored as a game species in the areas of greatest winter concentration. By late January or in February the wintering birds begin to spread northward and arrive gradually in nesting areas. We presume the young return to near the approximate area where they were raised to begin families of their own. The dove nests the year following hatching.

Doves have been taken for granted, and remarkably few investigations into the life history, production, and movements of mourning doves were made in early years. The first modern studies were by Nice in Oklahoma in the early 1920s. During the 1930s a large number of doves were banded at Key West by Demeritt. These provided some clues to the movements of doves from that area. Alabama pioneered in dove investigations through the Cooperative Wildlife Research Unit, beginning in late 1935 when I started the banding and life-history study, which was continued to 1941 by students, of whom George Moore was most outstanding. And he has continued active interest in the species until the present day! McClure made a very important study of the dove in Cass County, Iowa, in 1938-40. North Carolina conducted the first dove project under the Federal Aid Act, from 1939 to 1942.

The growing importance of the mourning dove finally induced the Southeastern Association of Game and Fish Commissioners to decide, in the spring of 1948, upon a region-wide study under the Federal Aid in Wildlife Restoration Program. This was promoted by the Wildlife Management Institute through their southeastern field representative Leonard E. Foote, who assisted in the original project outline and in all subsequent phases. And he has continued very actively in dove program analysis, interpretation, and encouragement until this day! By late 1949 the Southeastern Study was being conducted in ten states: Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, South Carolina, and Tennessee. The Federal Aid Branch of the Fish and Wildlife Service in the regional office, Atlanta, was designated the coordinating agency. The Branch of Wildlife Research of the Service in Atlanta was given responsibility for summarizing reports, providing technical assistance, and promoting supplementary work in states outside the Southeast. And that is where I came in, continuing in charge of the nation-wide dove program resulting from the Southeastern Study until my retirement from the Bureau in January 1958.

The Southeastern Study ended in mid-1952 but many phases of the program were continued in the original investigating states through 1956. Before the completion of the study most of the other states in the country were assisting in one or more parts of the dove study, so that it was truly a Cooperative Dove Study. Various types of censuses and road counts were employed during the first years of the investigation, and from all of these the call count technique was found most adaptable as an index to the breeding population. By 1953 this had become standardized and adopted as the annual census procedure. Dove banding was emphasized from the beginning of the study, so that 100,000 doves were banded from 1949 to 1955. This was a remarkable achievement since less than 50,000 doves had been banded in the previous 28 years of the bird-banding program. The many recoveries from this banding provided much needed information on movements and mortality.

The results of the Cooperative Dove Study, from 1948 to 1956, were published in 1957 as Technical Bulletin No. 1 by the Southeastern Association. In this Leonard Foote and I analyzed and summarized the most important results of all dove investigations to that date, and this bulletin is regarded as the foundation upon which to build a realistic Mourning Dove Program.

The Cooperative Dove Study was a huge program, the largest ever conducted on a single wildlife species. It required a half-million dollars in the original ten states and several hundreds of thousands of dollars in other states. Dozens of biologists and students and hundreds of enforcement officers and other employees of state game departments and government agencies participated. Some of the most helpful information resulted from about 26 theses submitted for masters' and doctors' degrees in educational institutions in 16 states. Support for these important graduate investigations came from state and federal sources as well as from many private conservation organizations and interested individuals, including the students and their supervisors.

Unfortunately, until recently, interest in the mourning dove seems to have waned in the past five years. Possibly this is because over-all populations have continued at such high levels, and have increased steadily since the close of the Southeastern Study. It should be unnecessary to point out the need for increased research and management investigations for a species so valuable as the mourning dove, but the following papers in this symposium will bring us up to date and point to the future. No longer should we take for granted a bountiful supply of doves which provides esthetic enjoyment to more people than are involved in their hunting. We should work togther to learn the factors of life history, production, movements, and methods of management to insure a satisfactory mourning dove population for the future. The dove is an important resource—let us work together on a realistic management program.

DISCUSSION

MODERATOR FOOTE: One of the old heads in this game has been George Moore. George was in charge of coordination of all of the southeastern projects. His activities in dove management extended far beyond that and they were based on dove work he did as a student at Auburn.

George, would you care to comment on some of the past history of this movement and give us some guides that we might look forward to in the future?

MR. GEORGE MOORE [Georgia]: Peters has done a good job of bringing up what has happened and how we have tried to manage, strictly on guesswork.

He has brought out the most significant part, that is the cooperative venture that we are undertaking in the southeastern states, and many other states that participate. I think the program could serve as a guide for any other state. This particular study got more information because we had a long way to go. You know, when you start from nothing a little can be a lot, but at least we have obtained more information in a relatively short time, than many other studies that have been conducted.

PRESENT STATUS AND MANAGEMENT OF THE MOURNING DOVE IN THE EASTERN MANAGEMENT UNIT

DAN M. RUSSELL

Kentucky Department of Fish and Wildlife Resources, Frankfort, Ky.

There is no game-bird species of nationwide importance that fits the theme of this conference as does the dove. It certainly merits primary consideration from all agencies concerned with game management in "Planning for Population Pressures."

It is doubtful that there is another game species of comparable importance, on which so much knowledge has been gained in so short a period on such a short ration of funds. The accomplishments are laudable. It will be noted, however, that throughout this paper where studies have been made the end results have pointed up the needs! The past year of work have brought dove management up to numerous heads: The wherewithal is available to set up and proceed toward a sound dove management program, but there is an apparent need to reappraise and refine the various factors and use them together in one direction.

THE EASTERN MANAGEMENT UNIT

This unit consists of the 27 states east of the Mississippi River and includes Louisiana (Peters, 1956). The unit was so designated on the basis of dove population movements as indicated by band recoveries. The unit encompasses all or part of the states in the Northeast, Midwest and Southeast regions. Currently there are 16 of the 27 states that have a dove-hunting season. One state, Indiana, has plans for a dove season in the future. No other change in hunting status is anticipated (Table 1).

POPULATION TRENDS

According to the latest tabulated data on population trends (Keil, 1960a), there has been a steady over-all increase in dove populations within the Unit since 1953. The population now stands at approximately 38 per cent above the 1953 level. It is interesting to note that according to the Call Count Survey, the hunting states in the Unit show a 45 per cent increase over 1953 while the non-hunting states show a 21 per cent increase for the same period. Of additional significance is the fact that band recovery rates are two to three times higher for doves banded in the hunting states, indicating that hunting pressure is more than double on doves that are produced in the hunt-

TABLE 1. EASTERN MANAGEMENT UNIT—DOVE MANAGEMENT QUESTIONNAIRE

State	Rank as Game Bird	Dove Season	Plans for Future Dove-Season	Management Studies	Type of Management Studies	Population Trends	Means to Indicate Population Trends
Maine	Non-Game	No	No	No	None	Slight Increase	Field Observations
New Hampshire	Non-Game	No	No	No	None	Increase	Field Observations
Vermont	Non-Game	No	No	No	None	Increase	Field Observations
Massachusetts	Non-Game	No	Maybe	No	None	Increase	Field Observations
Rhode Island	Game	Yes	....	No	None	Stable	Field Observations
Connecticut	Game	No	No	No	None	Increase	Field Observations
New York	Non-Game	No	No	No	None	Slight Increase	Field Observations
New Jersey	Non-Game	No	Maybe	No	None	Increase	Field Observations
Delaware	Game	Yes	....	No	None	Increase	Field Observations
Pennsylvania	Game	Yes	....	Yes	Banding-Kill Survey	....	....
West Virginia	Game	Yes	....	Yes	Banding-Road Counts	....	....
Ohio	Non-Game	No	No	Yes	Population Surveys	Increase	Field Observations Farm Game Surveys
Michigan	Non-Game	No	No	Yes	Banding-Road Counts	Increase	Field Observations Fall Road Counts
Wisconsin	Game	No	No	Yes	Banding Population Census	Slight Increase	Field Observations Surveys, Census
Illinois	Game	Yes	....	Yes	Nest Studies-Kill Survey	Stable	Field Observations
Indiana	Non-Game	No	Yes	Yes	Full-Time Dove Project	Unknown	Dove Study
Alabama	Game	Yes	....	Yes	Road Count-Banding Kill Survey	Increase	Kill Surveys Road Counts
Florida	Game	Yes	....	Yes	Banding-Kill Surveys	Increase	Kill Surveys Field Observations
Georgia	Game	Yes	....	Yes	Banding	Increase	Kill Surveys Field Observations
Kentucky	Game	Yes	....	Yes	Banding-Road Counts Kill Surveys	Increase	Road Counts, Kill Surveys, Field Observations
Louisiana	Game	Yes	....	Yes	Banding-Road Counts Kill Surveys	Increase	Road Counts, Kill Surveys, Field Observations
Maryland	Game	Yes	....	Yes	Banding	Increase	Field Observations
Mississippi	Game	Yes	....	Yes	Banding, Production Studies Kill Survey, Habitat Improvement	Increase	Field Observations Kill Survey
North Carolina	Game	Yes	....	Yes	Banding-Road Counts Kill Survey	Increase	Road Counts, Kill Surveys, Field Observations
South Carolina	Game	Yes	....	Yes	Banding, Managed Hunting	Increase	Kill Surveys Field Observations
Tennessee	Game	Yes	....	Yes	Banding-Road Counts Kill Surveys, Habitat Management	Increase	Road Counts, Kill Surveys, Field Observations
Virginia	Game	Yes	....	Yes	Banding	Increase	Field Observations

ing states. A tabulation of band recoveries in 1958 showed that 74 per cent were taken within the state of banding.

MORTALITY

Mortality factors were investigated during the Southeastern Cooperative Dove Study (Southeastern Association of Game & Fish Comm., 1957). Very little of record has been done since then. The data indicated an approximate 75 per cent annual replacement among juvenal doves and 55 per cent among adults. Major causes of dove mortality that have been observed and reported are Hunter Kill, Weather and Disease. Present views as to a major population decline seem to be centered on a disease outbreak and/or severe weather period.

Of the 16 hunting states in the Unit, four are in the Northeast, one is in the Midwest and all of the eleven in the Southeast (Questionnaire, 1960). The dove is considered second in importance as a game bird in the Southeast and ranges from there on to "no consideration" in some of the non-hunting states. Arms manufacturers have estimated that approximately seven per cent of the total sporting ammunition is expended by dove hunters. A nationwide total kill has been estimated at some 30 million annually. It is not known just what portion of this may be relegated to this Unit. The total kill of doves is estimated by various methods by the various states and ranges from about two hundred (Rhode Island) to about two million (Florida) (Peters, 1956). Most of the hunting states measure dove kill in terms of hunter success, *i.e.,* doves killed per hour of hunting, and do not make estimates of the total kill.

MANAGEMENT PRACTICES

All states in the Unit conduct the Dove Call Count-Breeding Bird Index in cooperation with the Bureau of Sport Fisheries and Wildlife. Aside from the Call Counts, two states (West Virginia and Pennsylvania) in the Northeast are conducting Road Count Surveys and Banding Operations. In the Midwest, all five states are conducting dove studies such as banding, kill statistics and road counts. Indiana is the only state in the Unit and perhaps the nation having a year-around dove study to which one man devotes his full time. Studies in Indiana are on production estimates, winter flock distribution, habitat management, disease, banding and road counts. In the Southeast, all states are continuing some of the Cooperative Dove Study projects and surveys such as banding, road counts and kill statistics. In addition to these, there are special studies and research being conducted cooperatively between the States, Southeastern Association of

Game and Fish Commissioners, Wildlife Management Institute, Bureau of Sport Fisheries and Wildlife and the Universities of Georgia and North Carolina. The Southeastern Section of the Wildlife Society has a currently active technical dove committee composed of members from all states and the agencies mentioned above. This committee was authorized by the Southeastern Association of Game and Fish Commissioners to meet in the spring of 1960 and submit recommendations for dove management and regulations for the Southeast as a unit. The success of this joint effort to formulate unified dove management recommendations was evidenced by its accomplishments and subsequent instructions to arrange for a similar session this year. It is hoped that this method of working toward a sound dove management program will be continued through the cooperation and guidance of the various states and agencies. It is suggested that other regions might investigate this procedure when attempting to further their dove programs.

STUDIES AND RESULTS

Effect of Regulations on Harvest: Until this past year there have been no known surveys or studies to ascertain the effects of regulations on the harvest. The importance of this should not be overlooked because dove management at this time is primarily the control of harvest through regulations. The minor change this past year as to what constituted a baited field is being evaluated by the Branch of Game Management and Enforcement, Southeastern Region, Bureau of Sport Fisheries and Wildlife (Smith and Gresh, 1960). Data forms were distributed to all agents and state enforcement personnel. Preliminary analysis of the data showed that about ten per cent of 13,240 doves killed and five per cent of the 4,609 hunters checked were found to be illegal. Further data involved 20,864 hunts and 108,329 doves. (See Table 2.) Results of this survey revealed the following type of information for the various categories of hunting fields: (a) volume of dove hunting, (b) hunting success, (c) difference in success over legal and illegal fields under present regulations, (d) effectiveness of law enforcement in retarding illegal hunts, (e) shooting success per gun-hour and day on a regional basis, (f) importance of certain kinds of fields as related to different parts of the region, (g) average hours hunted by each dove hunter. The writer was cautioned that in this initial attempt there were several things to be desired. However, on the basis of this first survey, plans for further surveys are being made, including the improvement in methods of gathering field data and standardization of analysis procedures. It is noted here that this is the first known fruitful attempt to bring about a mutual understand-

TABLE 2. SUMMARY OF SURVEY ON EFFECTS OF CHANGE IN REGULATIONS. TOTAL DATA FOR REGION 4

Field Category	No. of Shoots	No. of Hunts	Hrs. Hunted	Doves Bagged	% of Total Kill Examined	Kill Per Gun Hr.
Normal Planting	299	3,423	11,647	17,212	16%	1.48
Normal Harvest	1,289	12,461	37,388	67,472	62%	1.80
Hogged or Grazed Crops	229	1,840	5,337	10,396	10%	1.95
Manipulated Crops	29	293	1,004	1,619	1%	1.52
Feed Lots	25	184	599	638	tr.	1.07
Baited Fields ,	51	382	814	1,647	2%	2.02
Other	399	2,281	5,891	9,345	9%	1.59
Totals	2,321	20,864	62,680	108,329	100%	1.73

Average hunters per shoot—9.
Average hours hunted per hunter—3.
Average doves killed per hunter—5.2.

ing and solve the problems involved in the technical and enforcement aspects of dove management.

Kill Estimates: Pilot investigations toward providing a reliable method for estimating dove kill were conducted in Tennessee and Louisiana, in cooperation with the University of North Carolina, Institute of Statistics. This was based on a previous study by the Institute to evaluate methods. Results are being presented as a portion of this symposium.

Hunting Opportunity: Dove hunting draws largely on urban areas for participants. As dove hunting is generally a gang-type affair, this poses a trespass or permission problem. Studies are being conducted in Georgia, Tennessee and North Carolina regarding management of state-owned or other public lands for shooting areas. This is being investigated as to costs, hunting success, food plantings, etc. (Critcher, 1960).

Habitat Improvement: In Indiana, pine plantations on public lands are being experimentally pruned and thinned to provide openings suitable as dove nesting sites in areas now devoid of nesting doves. On small pines the leader is removed, causing the laterals to grow upward, giving a "basket" effect. On other trees an entire whorl is removed from the center of the tree to create an opening in the tree itself. On the larger and denser stands, up to 30 years of age, openings in the stand are being provided by clear cutting up to two-thirds of the stand. Control areas are being used while the study is in progress (Allen, 1960).

Banding: The emphasis on dove banding is still on nestlings. Where opportunity exists, adult and immature doves are trapped during the

May-August period. The flying doves banded at this time seem to follow the migrational patterns of nestlings banded in the same state (Foote, 1960). Emphasis is being placed on representatives of the sample by distributing the banding effort in proportion to the production rate in a given area. A banding quota was set up in 1956 to be completed in 1960. All but three states in the Unit have attained their quota. Results of this effort have not been analyzed due to a fire in the banding records office in Patuxent. Latest information received states that reconstruction of these records will be completed by July 1, this year.

Band Losses: A study of band losses in nestling doves was conducted on a Parchman, Mississippi, study site (Southeastern Association, 1957). Results showed that there were significantly more losses with size 3-A band than with size 3 bands. In the 4-6-day age group, 66.3 per cent of the size 3-A bands were lost as compared with 7.7 per cent loss of the size 3 bands. It was estimated that fifty per cent more nestlings could be banded with size 3 bands than with 3-A bands where return visits to band at the proper age are not feasible.

It was pointed out that it is important to know if the size 3-A bands are necessary for adult doves, since younger nestlings—therefore a greater number—could be banded without delay with the smaller size 3 bands. The importance of this may be fully realized when recoveries and returns are used to determine migration patterns, to isolate population segments, to compute kill data and the many other management problems that depend largely on banding for solution.

Population Segments: Management Units as currently established can and do ease administrative problems and also constitute a step in the right direction toward relating production areas to harvest areas. There is a definite need to further identify and isolate population segments within the broad boundaries of the Management Units. Only when it is known where the shootable birds of a given state or area originate can effective management be practiced.

Using habitat area, call counts, total doves banded, total recoveries and estimated total kill (most factors subject to further refinement), a formula was devised to determine the origin of the huntable dove populations in Florida. The harvest was shown to be made up of 30 per cent native doves, 59 per cent from 16 states in the Eastern Management Unit and 10 per cent from 4 states in the Central Management Unit. It was pointed out that the method tends to show the need for refinement of components (Foote, 1960).

Aging and Flock Composition: Studies were made at the University of Georgia (Jenkins, 1960) to devise a method by which doves of the year could be aged through the entire shooting season to January 15.

It was determined that this could be done though the techniques were somewhat cumbersome. Since the procedures did not lend themselves readily to field analyses, they might not be practicable on a large scale. It was stated, however, that a need exists for these data—at least for widely spaced portions of the management unit—to see how they fit in with migrational and production data. This is a potential companion indicator that may be brought into practical application if the further needs are met.

Disease: A study of the incidence of the disease trichomoniasis in doves was conducted in Mississippi in June 1959 and July 1960 (Locke and Reese). A low incidence of the disease was found. It was deemed more important then to determine the frequency of infection with pathologic strains of *Trichomonas gallinae* than merely to show that *T. gallinae* is present.

In Indiana (Allen, 1960) there was reported an incidence of a minimum of 24 per cent of virus pox in a flock of 700 doves, as determined by external examination. It was the opinion of the investigator that an incidence of this magnitude should be given some priority in disease studies.

A study on common poultry diseases among doves was conducted in the Veterinary School at the University of Georgia. The results have not been published.

Two methods for a dove disease surveillance system were explored during July, 1960 (Locke and Reese). One system was designed to sample production areas along call count routes. This could not be evaluated since no nests were found along the routes. The second system, a block survey, proved to be more useful in obtaining data on the incidence of trichomoniasis infection. However, it was decided that this technique was biased in an unknown manner, thus minimizing the importance of the results. It is hoped that this work will be continued as disease is one of the major possibilities for a population crash.

Road Counts: Analyses have been made of uncontrolled road count data in order to determine their use in obtaining a production index (Critcher and Overton, 1960). Data from Kentucky and North Carolina were evaluated by the University of North Carolina Institute of Statistics. The analyses revealed nothing definite due to insufficient data, but there were possibilities revealed. It was strongly recommended that the enormous amount of road count and call count data collected in the Southeast and other states over the past ten years be reviewed in the manner the North Carolina and Kentucky data were.

In an additional controlled road count study conducted this past year in North Carolina (Critcher and Overton, 1960) it was shown that the May road count index of an individual road was a better predictor of the September index of that road than was the May call count index. There was also an indication that the two indices may contribute independent information about the September index.

SUMMARY

There are 27 states in the Eastern Management Unit, including all states east of the Mississippi River and Louisiana.

Sixteen of these states currently have a dove hunting season.

The Unit dove population has exhibited a steady increase since 1953 and now stands at 38 per cent above the 1953 level.

Band recovery rates are higher for doves banded in the hunting states. The population, however, is increasing at a faster rate.

Chief mortality factors are hunter kill, weather and disease.

Estimated total kill by states ranges from about two hundred to about two million.

All states in the Unit conduct the cooperative Call Count Index and most states have some management surveys.

Several management studies have been initiated recently. The Game Management and Enforcement Branch of the Fish and Wildlife Service is conducting a survey on the effects of regulations on dove hunting and kill; Tennessee, North Carolina and Georgia are studying the possibiilties for dove shooting areas on public lands; Indiana is conducting habitat improvement studies; The states of Tennessee and Louisiana in cooperation with the North Carolina University Statistics Institute have begun pilot investigations toward devising a reliable method for estimating total dove kill; Banding is still being carried on and selected areas banding is emphasized.

A study of band losses in nestling doves was conducted in Louisiana in cooperation with the Fish and Wildlife Service, Branch of Wildlife Research.

Provisions are being made to identify and isolate population segments within the management units.

Studies have been made at the University of Georgia to provide a method of aging doves of the year through January 15.

The Branch of Wildlife Research (Fish and Wildlife Service) in cooperation with the states in the Unit has conducted studies on dove diseases and attempted to set up a disease surveillance system. Kentucky and North Carolina in cooperation with The Institute of Statistics have subjected road count data to analyses in effort to determine their use as a production index.

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DISCUSSION

MODERATOR FOOTE: Thank you, Dan, that was really boiling it down. There are several things that might stand some elaboration.

I would like to ask Dan to elaborate a little on the attempt that has been made to evaluate the hunting pressure that occurred on different types of fields with the change in the basic regulation which was made during the past year.

Second, I would like to ask John Findlay if he would comment on this type of study. The study originated with Mr. Parker Smith, of the Regional office in Atlanta. Much of the data were gathered by management personnel and much by state personnel, so it has been a cooperative program. To me this is the first time that we have tried to evaluate a regulation itself as it affected the hunter in the field. There are some biases in the sampling, but nevertheless it's a start.

MR. RUSSELL: All right. The Branch of Game Management and Enforcement (Southeastern Region, Bureau of Sport Fisheries and Wildlife) data forms were distributed to all agents and state enforcement personel. Preliminary analyses of the data showed that about ten per cent of 13,240 doves killed and five per cent of the 4,609 hunters checked were found to be illegal. That is a very small percentage of discrepancies in dove hunting. Further data involved 20,864 hunts and 108,329 doves.

Results of this survey revealed the following type of information for the various categories of hunting fields, such as the volume of dove hunting, the hunting success, the difference in success over legal anl illegal fields under present regulations, the effectiveness of law enforcement in retarding illegal hunts, shooting success per gun hour and day on a regional basis, importance of certain kinds of fields as related to different parts of the region, average hours hunted by each dove hunter. So you see they gathered quite a bit of information that they didn't even suspect they were going to get when they started.

The writer was cautioned that in this initial attempt there were several things to be desired. However, on the basis of this first survey, plans for further surveys are being made, as I mentioned a while ago.

MR. JOHN FINDLAY: I can't go too far as it is in preliminary stages. I'm not too sure just what they did obtain in the way of data. It was interesting and it was a worthwhile start. I hope we can really set up a planned program that will have some real meat in it for years to come, but I believe this particular study will form a very limited basis with the understanding that it was a pilot project.

I have been watching and working with doves since about 1937. I was in North Carolina when the first dove project was undertaken in the Southeast. I'm not willing to say that the management program of the Fish and Wildlife Service is quite as inefficient as indicated by Dan. It is true that regulations have formed a basic part of the dove management program, whether you like it or not. I'm not claiming that the regulations are entirely responsible for the increase in the dove population, but I don't think anybody else can say either that we haven't fairly well tailored the regulations to establish increases. I hope that there is a correlation between our management plans and this increase in doves. Nature had a lot to do with it, I am sure, but there has been a lot of thinking and work done in connection with the program.

MODERATOR FOOTE: Do you want to rebut?

MR. RUSSELL: I think he is entitled to defend himself.

MODERATOR FOOTE: One of the problems we have in the Southeastern United states, is getting more and more acute, and in a way it is related to regulations. It is a problem of getting space for hunting.

There are several states that have done some work on this; the most experienced is North Carolina. Perhaps Frank Barrick will make some comments on the attempts in North Carolina to satisfy some of this public hunting demand with state-leased managed areas.

FRANK BARRICK: In North Carolina last year we tried a pilot study, on ten areas across the state, primarily near centers of population in which we worked with farmers—mostly farmers who had anywhere from a hundred to several hundred acres of land under their supervision or ownership.

We set up criteria for selecting these areas, and on that basis we selected fields that we thought we could provide some public hunting on. We required that the farmer have ten acres that he could put into wildlife planting, primarily millet, and we specified how it should be planted and when it should be planted. We provided the planting material and fertilizer and paid him $15 per acre for the planting.

We required that the planting be not more than five acres in size and not less and would not be immediately adjacent to one another. They were separated sufficiently so that the birds would fly from one field to another. We worked with the Fish and Wildlife Service, and federal agents checked each area to be sure that there were no violations of the basic regulations and in the actual hunting.

We had various results. We found that in some of the areas, the plantings had not been made sufficiently early and the grain was not ripe when the dove season came in. In some we found that the doves had been there and had already left the general area when the season opened, so they were not effective.

On others we had very fine hunting. On one about 2,000 birds were killed in the first few days of hunting. Hunting, by the way, was open on Wednesdays and Saturdays—two days a week.

We paid the landowner $200 for the hunting rights on the farm, with the understanding that the hunting would be in and about those fields. We put up posters to warn against carelessness in the use of firearms, posted fields that had livestock, and put safety zone posters around farm buildings. We put up posters directing the hunters to shooting fields.

The hunters were invited to come, no charge being required. Generally speaking, the project was quite successful, even in those places where the hunting was not particularly good. The reaction from the hunters was good in that they felt that the commission was trying to do something for them to provide them with a place to shoot. Of course, where they had good hunting, they were highly enthusiastic. We hope to continue this project next year. Our biologists are, at the present time, screening farms for this type of project in the summer.

Incidentally, you will be interested to know that before and during the hunt season, we had a good many land owners contact us to find out how they could get in on this project, the idea of course being the financial return that was involved. Since then also, we have had quite a few people inquire as to whether they could participate in providing such a hunting place.

This summer we plan to use some of those areas we used last year, but in other cases we are going to use other areas and we expect to increase the number of places from 10 to 16.

We also are thinking of paying the compensation to the size of the individual farm—perhaps fifty cents or some rate per acre, with a maximum to any individual farmer. We found that we ought also to consider modifications in the way we did the planting.

We found that in some cases we had too much fertilizer, in others there was not sufficient cultivation between the rows, and we had too much crab grass coming in. These cultural things we will have pretty much worked out, so this summer we will have a much more effective planned program.

MR. MOORE: You said some farmers show an interest in monetary gain—I assume you meant fees. Have you considered or have they considered doing the same thing and charging a daily gun fee?

MR. BARRICK: Yes, they have, George. In the central part of the state we had several farmers who considered this thing very seriously and I believe there were one or two who actually did get into it. I can't report to you the degree of success which they experienced, but we did not try to discourage anybody from doing this on a private business-venture basis.

We were rather hopeful that there would be quite a few people who would go into it this way.

CONFEREE [Louisiana]: As I see the effect of the changes in the regulation, the difference in birds per hour is approximately 1.8 doves per hour; to 2.02 in a baited field. Realizing that this is a preliminary thing, I would like to pose a question—if subsequent research shows that this holds true, would this be a significant enough difference to warrant the attention of the program?

CHAIRMAN FOOTE: That is a very good question. I wish I had a good answer. In the first place I don't think that our population information on the species is sufficiently sound as yet to justify us going into this. This is just my personal opinion.

There apparently was not very much difference in the kill per gun hour over baited and normally harvested fields. Some of these normally harvested fields are just as attractive to doves as are the baited fields. This information on the type of hunting in relation to regulations is the very thing that we are after here, because alteration of this basic regulation pattern is one way to permit greater hunting opportunity or reduce greater hunting opportunity in relation to the size of the population we have available.

We can do it by days; it can be done by birds in the bag—these are all possibilities and I know that John Findlay and the people on the regulations committee had this in mind when this study was undertaken.

I would like to point out, though, that this study is biased because it was conducted by game management agents whose primary responsibility was the seeking out of violations. The percentages probably are not representative perhaps of dove hunting as a whole.

MR. CHARLES MARSHALL [Georgia]: We don't have any avian pathologist but we do have the cooperation of Dr. Malcolm Reed who is internationally known who will conduct these studies for us, and we feel that it is money well spent, at a very cheap rate for such an extensive study. We hope that we will be able to initiate it very soon and get specimens from the states in our southeastern organization, probably beginning next year.

DISCUSSION LEADER FOOTE: Thank you.

THE STATUS OF THE MOURNING DOVE IN THE CENTRAL MANAGEMENT UNIT

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The Central Management Unit encompasses fourteen states, extending from Minnesota to Arkansas on the east and from Montana to New Mexico on the west. This one and one-third million square miles of land amounts to 46% of the total area of the United States. Most of this area (93%) has been classed as dove range (Kiel, 1959).

There is an even division between hunting and non-hunting states. Four non-hunting states appear to be making serious efforts to gain hunting status, whereas only one state's hunting status appears to be challenged in the legislature at present.

Mourning dove populations have fared well in this area during the past several years. The dove appears to be benefiting from an agriculture that is making a large and easily obtained food supply available throughout most of the year. Nesting habitat does not appear to be in short supply.

No large-scale disease, parasite, or insecticide peril, beside that of the fire ant control program, appears at present to endanger the dove over most of its summer range. The principal winter range of much of this area's popuulation is in the states of Texas and New Mexico, and may to some degree be considered an insurance policy. Vast land areas are involved with low human density over much of the range. This is in contrast to the Eastern Management Unit where the further passage south is blocked by the South Atlantic and Gulf of Mexico.

Canadian prairies and towns can be considered as an additional extension to the summer range of the mourning dove.

Only in the southern third of the Central Management Area does dove hunting assume major importance. In states such as Missouri, Kansas and Colorado, the season in most years lasts much longer than the hunting opportunity. Migration in Missouri occurs rapidly in the first two weeks of the 5 week season, leaving little to harvest in the latter part of the season.

In Texas, however, the mourning dove assumes an importance probably equalled nowhere else. Although Texas reports no measurement of their total kill, it has been estimated as high as 4 million. Most states in the Central Management Unit report that the greatest percentage of outstate band recoveries occur in this great state lying at the toe of this management unit.

Mexico, although providing a huge over-wintering area, probably does not contribute a large kill, principally because of the low population density and low economic status of the people of this area.

POPULATION TRENDS

Recent trends in the Central Management Unit's dove population may be obtained from the results of the coo call census carried on since 1953. This census effort has indicated an increase in the breeding population index from 38 million to 65 million in the eight years measured (Kiel, 1960).

A similar record has been demonstrated in the state of Missouri, where an extensive census of breeding populations has been in effect since 1946 (Table 1, Wight 1960).

TABLE 1. MISSOURI BREEDING DOVE CENSUS DATA[1]—1946 TO 1960

Year	Doves/mile	Year	Doves/mile
1946	1.62	1953	2.30
1947	1.61	1954	2.70
1948	1.55	1955	3.66
1949	1.82	1956	3.51
1950	1.74	1957	3.53
1951	1.51	1958	3.03
1952	2.12	1959	3.76
		1960	3.50

[1]Based on roadside counts of doves on 107 permanent routes averaging 17 miles in length. These routes are covered from June 1-10 annually at sunrise to one hour following sunrise.

Following a low in 1951 of an average 1.51 doves seen per mile, the population built back to a plateau of about three and a half doves per mile by 1955. This population of breeders has remained fairly constant since that year at which we in Missouri consider a healthy breeding density.

Irrespective of the fact that at present little appears to threaten the immediate future of the sport of dove hunting in the Central Management Unit, several thoughts should be expressed regarding the exploitation and management of this resource.

PRESENT PROBLEMS

Many of the same problems that presented themselves in 1950-51 still remain only partially solved, and many have not even been touched. For example: The biological basis of the coo call census method has recently been subjected to critical review. One study completed at the University of Missouri Cooperative Wildlife Research Unit on the influence of pairing upon the cooing of penned males suggests that the *unmated males* are the doves that are heard on the early morning coo call counts (Frankel, 1961). The mated males in this study showed a remarkable disinclination to call! Thus, if only unmated males coo vigorously, what is the potential effect of changing sex ratios from year to year on the results of this census method? This brings up the question, would we expect sex ratios to change greatly between years? Another Missouri study by this same organization reported on at last year's North American Wildlife and Natural Resources Conference demonstrated that the adult segment of the dove population returns to the same breeding area year after year. (Tomlinson *et al.,* 1960). This study was based on trapped samples. Harris (1961), also studying migrational homing of nest trapped adults in Minnesota, supported these findings. One conclusion of both studies was that the adult male segment of the population demonstrated almost 100% fidelity to the breeding site. We then investigated the composition of the wintering flocks of mourning doves by collecting doves from the same banding area used by Tomlinson. Chambers (1961) found that of 23 adult doves that were banded in previous summers, 21 were adult males. This indicated the presence of a non-migratory segment of the breeding population on our study area which was almost exclusively adult males. Therefore, if some males do not migrate, but most females move south, it is logical to believe that different winter mortality is possible and could result in changing sex ratios.

Since Frankel's study of cooing habits was based on penned doves, some question remains as to whether wild doves will duplicate this silence while mated. Perhaps the announcement of territorial rights plays an active part in the males coing pattern irrespective of his matedness. Here again the problem has been developed and will be the object of a study beginning in a few weeks in central Missouri.

Although the coo call census may need additional refinement, the fact remains that the problem of censusing mourning doves has been doubly complicated by the demands of administrative procedure. These require that the population count be made of the breeders and *not* the production. This stretches the logic of the entire process. The fall dove population normally contains about 70% young of the year (Mourning Dove Investigations, 1957), and establishing the regulations before any measurement of the major segment of the population has been produced would appear to me to be highly questionable procedure.

MEASUREMENT OF KILL

One other area of change is needed to put the tools of wise management in our hands. At the present time there are all types of kill estimates in the various hunting states, ranging from no estimate of any kind to sampling procedures based on the best statistical planning. Some type of standard licensing is needed to provide a stable sampling frame from which to operate annual harvest sampling procedure. The principal suggestion has been the establishment of a federal dove stamp patterned after the duck stamp that is such a familiar face on our waterfowl scene.

It seems to me inconceivable that a resource as valuable and controversial as the mourning dove should be managed with almost no knowledge of the kill. We now make changes of seasons and bag limits with almost no attempt at measuring their effect on harvest. We have watched a dove population recover from a catastrophe, and during this time the harvest regulations were changed many times. Virtually nothing was recorded to document the effect of such regulations. There is a vital need for a method to standardize the measurement of harvest and it should be placed in action as soon as possible.

BANDING

Although much banding has been done in the states of the Central Management Unit, several problems remain. Foremost among these is the source of doves harvested in various states. For example, in spite of the major banding effort in the late 1950's, Missouri has yet to recover a dove banded in any state to the north of its boundaries. This suggests that Missouri does not receive sufficient numbers of doves from northern states to contribute to Missouri's harvest. Does this then mean that Missouri produces the doves it harvests?

Continued effort on specific problems such as this needs the attention of the profession. Still remaining to be utilized is the, by now, considerable amount of recovery data stored in the banding files at Patuxent. The calculation of mortality rates requires the elapse of at least five years from the last major banding effort in order that the calculated mortality rates may be based on sufficiently complete data. Certainly we can look forward to the computation of mortality rates for each Dove Management Unit in the near future.

BAITING

When intensive study of dove life history and management began in the late 1940's, doves were still managed on the basis of waterfowl flyways. Through the process of gathering additional banding data which demonstrated that doves did not fly the same path as ducks, the concept was changed. We now speak of three dove management units rather than four flyways inherited from the waterfowl workers. This change was necessary and good. Now let's consider another change that is necessary. Although we manage doves separately from waterfowl, we still protect both under the same baiting regulation.

A problem has arisen in Missouri out of a desire to develop an additional benefit from large areas of land purchased and managed for waterfowl. Although they serve the public that supports such lands during the waterfowl season, the question is raised, can they also support non-conflicting public use during other times of the year? If so, what can be done to manage those lands to attract huntable populations of doves? Obviously the baiting regulation as it now is interpreted allows little leeway for hunting management.

I feel the difficulty lies in trying to make *one* baiting regulation work for both doves and waterfowl. I believe it is almost impossible to write a regulation that will cover both groups of game birds. The only clear path is to consider the dove hunter and his methods separate and distinct from the fraternity of waterfowlers.

MAN-POWER—A BASIC PROBLEM

Time will not allow a full discussion of the problems remaining. But I would be remiss if I failed to discuss a most pressing need.

Dr. William Kiel in the 1960 *Mourning Dove Newsletter* provided data on each state's current contribution to dove research and management. It demonstrated that the most serious lack in the present status of the mourning dove in the Central Management Unit is the lack of effort. Of the seven non-hunting states, an average of 0.24 man-years of effort was devoted to the dove per state in 1960. This is 20% less than the national average for non-hunting states' contributions to dove projects. In the seven hunting states of the Central Area the average effort was 0.33 man-years per state. This is 45% less than the average for the 30 dove-hunting states. Even assuming that the nationwide averages are adequate effort to put into the management of the mourning dove, the average expenditure of effort in the central flyway on dove projects is shamefully lacking. Without doubt, some of this can be explained on the basis that non-hunting states have little to interest themselves in the dove, and have made contributions in the past. The lack of effort among hunting states in the Central Management Unit is difficult to understand. The philosophy that, since the dove is migratory, it is a federal problem is a possible explanation. However, the Technical Committee of the Mississippi Waterfowlf Flyway Council, which includes many of the Central Dove Management Unit states, has an active program of research and management going between the states and the Service. No lack of interest is evident here! Perhaps the lack of interest lies in the feeling that doves are not a pressing problem and effort should be expended on immediate problems. Whatever the cause, the program of research and management of the dove should not be allowed to falter.

The mourning dove is a familiar and beloved bird in the city, town, and countryside throughout its range. Economically it is a major contribution to the budget of some southern states and, although I abhor the idea of placing a dollar value on game, it is possible to estimate roughly the income to Pittman-Robertson funds that are apportioned back to all the states from the sport of dove hunting.

The total kill of mourning dove in the United States has been variously estimated at from 15 to 30 million annually. For the sake of the following calculation I shall use 20 million as the theoretical kill. Other factors I shall use are 4 shots per dove killed, and an average price of \$2.75 per box of shotgun shells.

20 million kill $\times$ 4 shots/dove killed = 80 million shots
80 million shells $\div$ 25 shells/box = 3,200,000 boxes shotgun shells
3,200,000 boxes shotgun shells @ \$2.75 = \$8,800,000.00
\$8,800,000.00 $\times$ 11% Pittman-Robertson excise tax = \$968,000.00

Therefore almost a million dollars could theoretically be returned to the states in the form of PR funds from the sale of shotgun shells alone used in the sport of dove hunting. In 1960 slightly over 15⅓ million were apportioned as PR funds.

By dividing through the apportionment of PR funds to each state, I was able to calculate each state's share from the theoretical PR return from shotgun shells used in dove hunting. Alaska led the states with a potential 50 thousand dollar return. Texas also would get almost 50 thousand. California would receive 45 thousand and New York 38 thousand. Pennsylvania 37 thousand. Michigan, Montana and Ohio would receive close to 30 thousand, and those states that receive a minimum apportionment would still receive 5 thousand from this source (Table 2).

The fact that doves have a dollar value is not a new idea. It should also be self-evident that the dove is one of the few examples of an upland target readily accepted by the hunter that is *not* suffering from the inroads of civilization and intensified agriculture.

A game bird with these characteristics becomes increasingly more valuable each year as we watch our other upland game species suffer the constant depletion of habitat. Farsightedness is required to evaluate the importance of the dove, and it should be apparent to all in the wildlife profession that our foundation of fact should be substantial for us in present and future management.

SUMMARY

The Central Management Unit encompasses a vast geographic area (46% of the U. S.) in which 90% has been classed as dove habitat. This area has the additional benefit of space for overflow in both Canada and Mexico.

TABLE 2. THEORETICAL DISTRIBUTION TO THE STATES OF PITTMAN-ROBERTSON FUNDS DERIVED FROM SALE OF SHOTGUN SHELLS USED TO HARVEST DOVES[1]

State	% PR Apportionment	Amount in Dollars	State	% PR Apportionment	Amount in Dollars
Alabama	1.82	17,617	Nebraska	1.79	17,327
Alaska	5.16	49,948	Nevada	1.93	18,682
Arizona	2.19	21,199	New Hampshire	0.52	5,033
Arkansas	1.60	15,488	New Jersey	0.65	6,292
California	4.67	45,205	New Mexico	2.29	22,167
Colorado	2.30	22,264	New York	3.97	38,429
Connecticut	0.52	5,033	North Carolina	2.04	19,747
Delaware	0.52	5,033	North Dakota	1.51	14,616
Florida	1.45	14,036	Ohio	2.90	28,072
Georgia	1.67	16,165	Oklahoma	1.74	16,843
Hawaii	0.52	5,033	Oregon	2.48	24,006
Idaho	1.94	18,779	Pennsylvania	3.86	37,364
Illinois	2.57	24,877	Rhode Island	0.52	5.033
Indiana	2.72	26,329	South Carolina	1.04	10,067
Iowa	2.03	19,650	South Dakota	1.77	17,133
Kansas	1.96	18,972	Tennessee	2.01	19,568
Kentucky	1.63	15,778	Texas	5.15	49,852
Louisiana	1.72	16,649	Utah	1.88	18,198
Maryland	0.69	6,679	Vermont	0.52	5,033
Maine	1.11	10,744	Virginia	1.97	17,069
Massachusetts	0.52	5,033	Washington	2.02	19,553
Michigan	3.18	30,782	West Virginia	1.27	12,293
Minnesota	2.40	23,232	Wisconsin	2.16	20,908
Mississippi	1.45	14,036	Wyoming	2.04	19,720
Missouri	2.30	22,264	Puerto Rico	0.08	774
Montana	3.09	29,911	Virgin Islands	0.08	774
			Guam	0.08	774
			Total		$967,993

[1]See text for basis of calculations.

The dove population has made vigorous recovery from the low recorded in 1951. Although little appears to imperil the population at this time, much remains to be done to determine the facts necessary for wise future management.

The biological basis of the coo call census has recently been tested in Missouri by observation of the cooing behavior of penned doves. Only unmated males cooed vigorously, which suggests that the coo call census may be effected by changing degree of matedness and/or sex ratios from year to year.

Other studies carried on in Missouri and Minnesota indicate a high degree of homing to the same breeding territory by adults, especially the males. Collections of doves during the winter from the same banding area in which banding has been carried on during previous summers has indicated a non-migratory segment of the breeding population comprised of adult males.

One of the remaining problems in the management of mourning doves is the administrative need for annual census data before a measurement of the production is possible. At the same time no uniform measurement of kill has been developed, which makes the evaluation of harvest regulations impossible.

The baiting regulation as applying to the harvest of doves has glaring weaknesses. These are occasioned by an effort to make one regulation fit both dove and waterfowl hunting. A separate and distinct baiting regulation to cover each is needed.

The greatest single problem in the Central Management Unit is the declining effort expended in dove research and on management problems. The disparity between the importance of the dove and the attention it receives is widening.

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DISCUSSION

MR. CONANT: I am wondering about the figure that Howard grabbed out of the air on the doves that we bagged in the Southeast. I believe that we worked out exactly four and a half shots per dove; so you were pretty close, Howard.

I would like to remark that dove and waterfowl regulations should be separate. This has already been discussed in considerable detail. I would go one step further and say that I believe it would be worth considering to separate the regulations by species of game and even by region.

My reasoning is that agriculture and other things definitely have a part in whether you harvest, or don't harvest doves, and one section of the country is quite different from the other. California certainly is different from the eastern United States,

DR. WEBER [California]: This is not particularly pertinent to this paper, but I have been disappointed that there has not been more discussion of the nesting habits of the mourning dove which admittedly is one of the unsolvable problems that face us all.

Now we all know that the migratory bird regulations were formulated to provide, among other things for the protection of the eggs and nests of the species of all migratory birds, and when they closed the season, limits were set up between March the tenth and September the first.

When Mexico, in 1937, joined into the migratory bird compact, one of the articles of the Migratory Bird Regulations, definitely stated that all open seasons must take into consideration the breeding habits of the species.

Now years later *The Mourning Dove* was published, and the statement was made that 33 per cent of all birds killed in September had eggs in nests and were lost. They recommended that the season in Alabama shouldn't be before November the 20th.

The next year, in Iowa, a pathological study was published and found that almost 22 per cent of all the nesting was after September the first.

Two years later, '45, Clayton,—this is still issued by the Fish and Wildlife Service as Circular Number 10—made the statement that late breeding is the main factor and it would be an obvious mistake to permit shooting during any period when many of the birds are killed and the young birds die and we lose public interest—

DISCUSSION LEADER FOOTE: Doctor Weber, please get to your point. What question would you like to ask? What question are you asking?

DOCTOR WEBER: I am asking a point here, that we are neglecting the very serious problem of morning dove—

DISCUSSION LEADER FOOTE: The point being—

DOCTOR WEBER: I have one more point that I would like to give, if I may. Albert Day, at that time made the statement that the Fish and Wildlife Service delay opening season until October 1st, or even later, which has not been done. It has been recommended in the Fish and Wildlife Service published Circular 10. I hope that with the new administration, with proper recommendation from you gentlemen —this very important matter will reveive proper consideration.

DISCUSSION LEADER FOOTE: I will hope—

DOCTOR WEBER: I can assure you that if this is not done in the usual administrative manner, then help must be sought elsewhere.

DISCUSSION LEADER FOOTE: Thank you, Doctor Weber. Doctor Weber misquoted when he said that 33 per cent of the total killed had young. Moore is right there, and he can correct me, if I'm wrong.

There were in excess of 60,000 birds examined which were shot in early September in the southeastern states. Less than about 6 per cent of these were adults still feeding young. So of the total kill of adults still breeding in September is relatively small in large samples that are taken. This undoubtedly is a problem in some areas and should not be neglected for future research.

Tom Baskett has some particular points in regard to the call count. Tom, I wonder if you would summarize those.

DR. BASKETT: I thought it might be of interest that in Frankel's Missouri studies of penned doves, removal of females regularly increased the cooing performance of their mates as much as tenfold. Cooing decreased to its former level when the females were returned to their mates. We hope now to test these results in the field. If the same results are obtained, they would certainly indicate that interpretation of call count data should take into account the possibility of differing sex ratios in different years.

THE CURRENT STATUS AND MANAGEMENT OF THE MOURNING DOVE IN THE WESTERN MANAGEMENT UNIT

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The western dove management unit is composed of the states of Arizona, California, Idaho, Nevada, Oregon, Utah and Washington. Smallest in total size, it is the only unit in which dove hunting is permitted in all member states. It is also the only one of the three which most nearly meets the standards of a dove management unit: one that produces the doves it harvests and does not produce doves harvested by other units (Kiel, 1959). Band recoveries show that 99 percent of its harvested production is taken either within the unit or in Mexico or Central America. Likewise only four percent of the total harvest originated outside the unit (Kiel, op. cit.).

Data and views contained herein, from states other than Arizona, were obtained by means of a questionnaire sent to each state. I want to thank the following individuals who answered the questionnaires and later read the manuscript: Donald McLean and Harold Harper, California Fish and Game; Joseph C. Greenley, Nevada Fish and Game; R. U. Mace, Oregon Game Commission; Clifton Greenhalgh, Utah Fish and Game; J. Burton Lauckhart, Washington Department of Game; Charles D. Haynes, Idaho Fish and Game. Thanks are also due Ronald Smith and John Stair of the Arizona Game and Fish Department for critically reading the manuscript and for helpful suggestions.

IMPORTANCE AS A GAME BIRD

The dove's importance to the hunters in this unit varies to some extent in proportion to its abundance during the hunting season. While the dove is an abundant breeding resident in all states, migration sharply reduces the population in some before the shooting season opens on September 1. Consequently the dove is considerably more important to those states in which dove numbers during the hunting season are near peak levels than in others where migration has severely reduced the population.

Size of the harvest is one measure of the dove's importance. Estimated kills are highest in the unit's two most southerly states where the onset of migration occurs later in the fall. They are also the states where hunter interest is highest. In California some 165,000 hunters shot doves in 1959, bagging nearly 1,800,000 doves; in Arizona 40,000 hunters harvested an estimated 900,000 in the same year.

Kills in other states (estimated from mail questionnaires) ranged from 86,000 in Nevada to 285,000 in Washington (Table 1).

TABLE 1. COMPARATIVE STATE DOVE HARVESTS WESTERN DOVE MANAGEMENT UNIT

State	1958*	1959	Increase or Decrease	% Change
Arizona	867,000	900,000	+33,000	+ 3.8
California	1,700,000	1,789,000	+89,000	+12.7
Idaho	144,000	163,000	+19,000	+13.2
Nevada	90,000	86,000	− 4,000	− 4.4
Oregon	158,000	195,000	+37,000	+23.4
Utah	86,000	111,000	+25,000	+29.0
Washington	251,000	285,000	+34,000	+13.6
	3,296,000	3,529,000	+233,000	+ 7.1

*1958 data from Kiel, 1960.

Hunter interest, as evidenced by percent of licensed hunters who shoot doves, varies from 6 percent in Oregon to 40 percent in Arizona (Table 2). Doubtless hunter interest in the dove, or lack of it, is due as much to the availability of other game birds as it is to the relative abundance of doves. In Arizona, for example, where hunter interest is exceptionally high, the only other upland game birds of any importance are the whitewinged dove and the Gambel quail, and the whitewing provides only localized shooting for the first few days in September. In states farther north in the unit, pheasants, various species of grouse, chukars, quail and bandtail pigeons compete with the mourning dove for hunter interest.

Other species notwithstanding, the mourning dove in 1959 ranked first in numbers bagged in California, Arizona and Nevada. In Utah and Idaho the dove was in second place. For the western unit as a whole the dove kill far surpasses the bag of any single species of upland game bird and probably exceeds the kill of any two.

TABLE 2. HUNTER INTEREST IN THE DOVE IN THE WESTERN MANAGEMENT UNIT—1959

State	No. of Dove Hunters	% of Licensed Hunters
Arizona	42,000	40
California	165,000	33
Idaho	13,000	7
Nevada	5,000	14
Oregon	17,000	6
Utah	19,000	11
Washington	23,000	8
	319,000	

DOVE POPULATION LEVEL

Spring call counts of recent years have indicated moderate fluctuations in breeding populations but no definite trend is evident. The 1960 counts were 5 percent below the 1953 level (Figure 1). Fluctuations within individuals states have been more erratic with most states showing no apparent trend. California is one exception. Since 1955 call count data have indicated a marked upward trend in California's breeding population. Arizona's data suggest a downward trend since 1956.

Some states have indicated dissatisfaction with the call count as an index to the dove population, and feel that while the technique has possibilities, considerable improvement is necessary before state trends can be reliably charted. Arizona, for example, shows a downward trend in calling doves since 1956, yet no one familiar with the dove situation in this state believes dove numbers have been declining. The diversity of habitat types, poor road network, the residential development of some call count areas and, most important, the presence of large numbers of whitewings in the best nesting habitat, makes this technique of limited value in this state. (Calling whitewings "drown out" the sound of cooing mourning doves and call counts are impossible in such areas). It is difficult to reconcile the highest hunter success in the unit (Table 3) with the lowest calling index, especially since band returns show that Arizona's kill is composed largely of locally raised birds (Kiel, 1959).

Utah, a state in which the call index suggests a fluctuating breeding population in recent years, reported that in their opinion dove numbers had been relatively stable. Another state indicated that a better sample of the various nesting habitats was needed to give reliable state trends.

All states but one registered an increase in total kill in 1959 over 1958 (Table 1) but whether this reflects a comparable increase in population level over the same period is debatable. It is noteworthy, however, that all states in the unit show an increase in the population index over the same period (Figure 1).

HUNT SUCCESS

Dove hunter success varies markedly between states in the unit. The two states registering the highest total kill also experienced the best success (Table 3). Arizona's kill per gun hour is substantially higher than other states, with California second.

TABLE 3. COMPARATIVE DOVE HUNTER SUCCESS WESTERN MANAGEMENT UNIT

	Average Bag* Per Hunter Day	Average Bag Per Hour
Arizona	5.8	3.4
Caifornia	5.5	1.9
Idaho	**	1.0
Nevada	4.9	**
Oregon	5.7	1.6
Utah	**	**
Washington	5.0	**

*Average value for 1956-1959 seasons evcept California which is for 1955-1958.
**No data available

Estimating mourning dove hunter success in Arizona is complicated by the fact that both mourning and whitewing doves are hunted to-

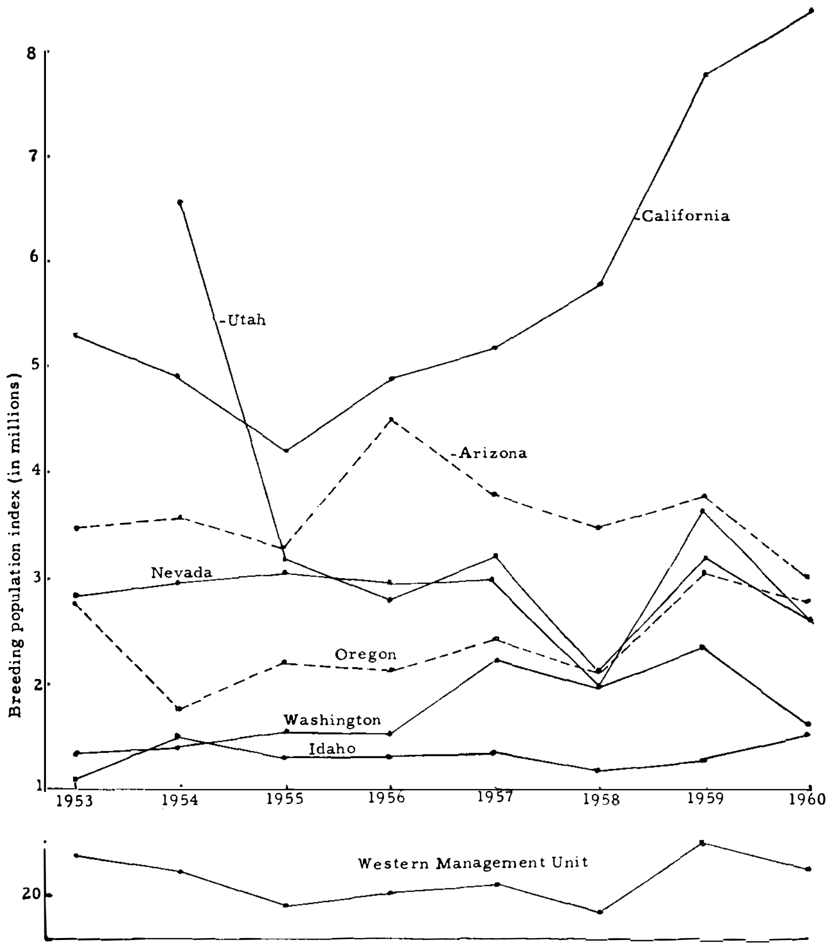

Figure 1. Trends in breeding population indexes in the western management unit, 1953-60 (From data in Kiel, 1960). Individual states in upper graph, unit total at bottom. Population indexes were calculated by multiplying the call index (average number of calling doves per 20 mile route by the estimated square miles of dove habitat in each state.

gether. Separating success per unit effort is next to impossible. Arizona data in Table 3 are averages for bag check data from the second half of September when virtually no whitewings remain in the state. Since the great volume of data secured early in the season when success is highest are not considered, the success figures shown must be considered conservative and below the true mean success ratio. Kill per hour in Arizona, even disregarding data from early in the season, is still appreciably higher than other states in the unit.

WINTER POPULATIONS

The mourning dove is an important breeding resident in all seven states, but wintering populations are significant only in Arizona and California. Other states reported that wintering doves generally constituted a small fraction of peak summer populations. While relatively large numbers winter in the southern portions of Arizona and California, the mid-winter population in neither state is thought to be more than 20 percent of peak late summer numbers. How much of the difference between winter and summer populations is due to migration and how much to an actual reduction in number of local doves from natural mortality is unknown. Certainly both factors must be contributing influences but the relative importance of each is difficult to assess.

FACTORS REGULATING POPULATION LEVELS

There is apparently a general feeling among the western states that mortality factors which are frequently a source of concern in other sections of the country and/or for other species are of little importance insofar as the dove in the western management unit is concerned.

Hunt Mortality: Only one state suggested that hunting might contribute significantly to total dove mortality. This state reasoned that it was the most important factor affecting population levels because the state kill was approximately 200,000. Band recoveries, however, suggest that the state's kill level is probably below the average for the western unit.

Other states reported that hunting was thought to have little or no effect on annual dove population levels. With the highest annual kill for the unit California reports the species is extending its range as new habitat is created by land clearing. Call counts since 1955 indicate a steady upward trend in breeding populations in this state.

Band recovery data suggest that the kill level for the western unit is intermediate between that of Eastern and Central Management Units (Kiel, 1959). What percent of hunter killed banded doves are reported continues to be one of the big unknowns complicating the problem of dove management. By comparing dove bands checked at a checking station with the number reported to the federal banding office, Arizona found that some 65 percent of banded doves shot were not reported (Stair, 1957), The experiment indicated a kill for that year of about 6 percent of the dove population in one of the most heavily shot areas in Arizona. The statewide kill was certainly much less than this.

Insecticides: No state felt that insecticides constituted a threat to the mourning dove. However, this view was apparently due more to an absence of information indicating that insecticides were a problem than to objective data proving the same. Oregon reported that while the influence of insecticides on population levels was not known, nesting in some orchards had declined markedly in recent years and that "this may or may not be due to more toxic insecticides now in use." California indicated it may be a problem in citrus areas. In Arizona, citrus is sprayed at blossoming time in late February and early March with DDT and Malathion for the control of thrips. Since this occurs long before the peak production months of June, July and August, (Stair, 1959), it is unlikely that such spraying would have any material effect on dove numbers.

Disease: Even less understood than the influence of insecticides is the role that disease plays in dove population dynamics. Only one state indicated disease might be an an important source of mortality. Outbreaks of trichomoniasis have occurred in recent years in metropolitan areas of southern California where concentrations of doves at feeding stations have aggravated the problem.

Land Use Practices: Land use practices of recent years have seldom been beneficial to wildlife. The mourning dove seems to be an exception. Several states, including California with its large and rapidly burgeoning human population, indicated current land use practices are more beneficial than detrimental. The growing of grain crops, land clearing, fruit and nut orchards, stream margin tree plantings, and soil bank grasslands were mentioned by different states as factors contributing to high and in some cases increasing dove population levels. Stock water developments were considered an important factor in the spread of the dove into otherwise uninhabitable areas. Washington stated "Irrigation has tremendously increased doves." This is certainly true as well for Arizona and other states where there could be little agriculture of any type (and consequently less food and water for doves) without a dependable supply of irrigation water.

In Arizona, however, a flood-control program in the offing may cancel much of the good of other land use practices. The plan, to be implemented by the Army Corps of Engineers, envisions a cleared floodway for much of the Gila River. It would necessitate the removal of many thousands of acres of tamarisk and mesquite which currently provide some of the best nesting cover for both mourning and whitewinged doves. The Arizona Game and Fish Department is attempting to have the plan altered so as to reduce the damage to this habitat type to a minimum.

DISCUSSION

While recent studies throughout the U. S. have turned up a wealth of data of importance in the management of dove, much of the information secured is more suggestive than conclusive. Knowledge of many facets of dove population dynamics important to sound management is still vague and uncertain. Without more precise information real management, aimed at maximum utilization of the resource, is impossible.

A detailed list of research and management needs with recommendations for procedures to attain the desired objectives and a plan for implementation of the program has been drawn up by the Dove Technical Committee of the International Association's Dove Committee (Kiel, 1961). I do not intend to elaborate further on this program except to discuss briefly one item of particular interest to all game departments.

Despite years of bag checks, mortality studies, and the banding of many thousands of doves, we still do not know for certain whether the annual take by hunters is 5 per cent or 50 per cent of the population. Most authorities agree that available data indicate a comparatively light hunter take of probably no more than 5 per cent. The evidence, however, is neither sufficiently conclusive to satisfy the protectionist element in our society nor is it convincing enough for the Bureau of Sport Fisheries and Wildlife to permit the degree of relaxation of hunt regulations which would be justified if the kill level were positively known to be this low. A concerted effort on either a management unit or continental basis is certainly needed to establish conclusively what percent of annual dove mortality is due to hunting.

Whether the annual kill is more or less than 5 per cent of the dove population is, to a great degree, more of academic than practical importance. Even in California with her relatively heavy hunting pressure and comparably high kill, all the evidence indicates that hunt mortality is not a controlling influence on dove numbers. In most other states both hunt pressure and kill are extremely light. A considerable easing of regulations aimed at an increased kill could doubtless be permitted in these states without any danger to the resource.

Since states in the northern half of the unit have indicated that migration is either under way or commences shortly after the annual September 1 opening date, liberalizing of hunt regulations would have to be by other means than an extension of season length. Even in Arizona where there is a large September dove population and high hunter interest, a significant increase in kill would not be realized by an extended season. With 40 day continuous seasons about 90 per cent of Arizona's kill was found to occur in the first two weeks of the season (Gallizioli, 1955).

Two states suggested that a season opening in the latter half of August would permit a more realistic harvest of their dove populations. In these states migration now drastically reduces dove numbers by September 1. Under the terms of the Migratory Bird Treaty Act an August season is presently impossible. Treaties can be amended, however. If an earlier season is the only means available for improving the harvest in the northern states of this lightly cropped species, then perhaps it is time the treaty was overhauled to bring it in line with current concepts of game management. The problem of late nesting doves would have to be investigated, of course. If the major part of the dove population has migrated by September 1, there is probably less nesting in the latter half of August in northern states than in more southerly states.

Other states asserted that a larger bag limit would stimulate more interest in the dove. In view of all the evidence indicating that hunting is not a limiting factor, there is no valid reason why the bag limit should not be substantially increased throughout this unit. An increase in bag limit to 15 birds per day, as was done in the central management unit in 1960, would doubtless increase the dove harvest in many states without any danger to the resource.

If with a 10-bird limit hunt mortality has no significant influence on the dove population as most observers agree, an increase to 15 birds is unlikely to produce an excessive kill. Effects of the larger bag on the total kill could be measured by comparing band returns from previous years and by observing the effect on average bag per hunter day. Possible, though highly unlikely, heavy kills would thus be detected and their effects on the breeding population index noted. No lasting harm would be possible under such conditions.

SUMMARY

In the western management unit the mourning dove is a more important game species in Arizona and California than in other states. The 1959 kill in California was 1,800,000; Arizona, 900,000. Kill in other states varied from 86,000 to 285,000. In California, Arizona and Nevada the mourning dove ranked first among game birds in numbers bagged and was second in Utah and Idaho. For the unit as a whole the dove kill surpassed that of any single upland game species.

Hunter interest, as evidenced by percent of licenced hunters who shoot doves, is highest in Arizona and California with 40 per cent and 33 per cent respectively and lowest in Oregon with 6 per cent.

Spring call counts since 1953 show no definite trend for the unit;

the 1960 counts were 5 per cent below the 1953 level. Individual states exhibit more fluctuations but only California shows a definite upward trend. Arizona's data indicate a downward trend since 1956. Some states doubt that call count data depict true state trends.

Hunter success in recent years has been highest in Arizona and California with 3.4 and 1.9 doves per hour. Hunt success data was not available from all states, however.

Winter populations of doves are present in significant numbers only in California and Arizona.

Available data indicate hunting in the western unit is not a controlling influence on the dove population.

Insecticides are apparently not a problem with mourning doves in the West although real data are scarce. Disease is not a problem except possibly in California where an outbreak of trichomoniasis has been aggravated by dove concentrations at backyard feeders.

Recent land use practices are thought to be more beneficial than harmful to the dove. An exception is the proposed floodway clearing along the Gila River in Arizona, which would wipe out many thousands of acres of choice nesting habitat.

Arguments in favor of more liberal hunting regulations are presented.

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DISCUSSION

MR. JACK ALLEN [Indiana]: Between September 12 and October 25, we trapped 326 immature doves, 76 of which had evidence of pox. It is possible that quite a large number of others have also had disease.

We have been discussing it with Bill Kiel and Doctor Lock and are making arrangements with the University of Illinois which already had a pox study going. with three veterinaries, in connection with poultry diseases. I think it is possible that we can get some more information on the dove disease.

MR. JACK ALLEN: One thing that was mentioned intrigued me. In Old Mexico, I think Howard said, there was an insignficant harvest of doves. Bill—why don't you comment on that?

MR. KIEL: Well, in trying to assess the importance of mourning dove kill in Mexico, we are faced with the problem of trying to determine what the rate of reporting bands would be from Mexico. A good many of the people wouldn't be familiar with English and the legend on the bird's band is much abbreviated, particularly on a dove band, so possibly the reporting rate of bands of doves shot in Mexico would be much lower than in the U. S.

We know that Dr. George Saunders of the Fish and Wildlife Service has done considerable work in Mexico and just this past year he found that doves are still taken in fairly large quantities near some of the large cities. Some of them are trapped; some of them are netted. Our recent analysis of dove banding, based on band recoveries, through the cooperative banding program has indicated that a sizable portion of the total dove kill is occurring in Mexico.

If I recall correctly, the percentage is about 11 per cent of all doves shot in North America were shot in Mexico, and if we assume that their rate on reported bands is lower than the average rate in the U. S., the kill might be higher than that. I know from work in Texas on the Rio Grande, that more and more U. S. citizens are going into Mexico to hunt. Perhaps dove hunting is becoming more important there.

MR. GENE WALKER [Texas]: I believe Bill has fairly well covered the situation on hunting in Mexico and there seems to be an acceleration in the traffic in birds in Mexico.

The hunting of mourning doves I don't believe is quite as important as that of white wings. It is most probable that there will be an increase in Mexico.

While I am here I would like to comment briefly on two points that have been discussed thus far. Maybe east Texas stands alone in this situation, but it has been developed here this morning that there are a number of questions in connection with the use of the coo count as a population index. We had some rather unsavory experience this past season caused by the relaxation in the regulations which were based on this coo count index.

For the past several years Texas has had large numbers of doves during the open season. During the count last spring it was indicated that we had a large population of breeding doves. Subsequently relaxation in the central management unit took place and everybody in Texas was all set to collect a record number of doves this past September.

The fact of the matter was that we had the sorriest shooting that we have had in many a year. The birds were not there at the time of harvest. That brings us to the point of trying to predict regulations or formulate regulations on the population.

I think it most important that we dig into this thing and see if there is not some way that we can span this gap between the productivity period so that we can more adequately formulate regulations that would take care of the actual population and insure a good stock.

MR. WALTER CRISSEY [Fish and Wildlife Service]: I should like to comment on this business of production, and I am curious as to what existed this past season in Texas—In other words, management on the basis of breeding population index versus some measure of production I believe must be justified on the basis of production being reasonably consistent from year to year.

If production is consistent, then the population measurement is feasible. If the major reasons for changes in population from year to year are less mortality, either by reason of shooting or weather, then a measure of population is necessary; if however, over broad areas it varies from year to year, which I think can be determined by age, a first step would be to resolve some means of attempting to determine this. I would ask for a suggestion on that.

The estimate that was given was that perhaps five per cent of the population was shot during the fall.

Along that line, five per cent, you could calculate what the total population would be for the United States as a whole, to start the season with. Only when you do this, you automatically arrive at computations considerably beyond what anyone can see. The kill I think must be more than five per cent, but I agree with the statement that we don't know if it is fifty per cent.

I don't think anyone actually knows the kill on mourning doves.

BEN GLADING, California: We have a great deal of faith in the department's approach to government research and management, and I certainly want to compliment Steve on a paper well-given, so far as the question is concerned.

While I am on my feet I would like to comment on the disease phase that was mentioned earlier. We have trichomoniasis in California. It is interesting to note that it had very little effect on doves, locally. You notice that there has been quite a build-up of our local populations, in Los Angeles in particular.

There are a number of people who have established feeding stations that attract birds and this is a real worthwhile endeavor, but in the case of doves, they have succeeded locally in causing infectious sores and disease and the Department of Fish and Game has put out a folder advising not to feed doves and to show the horrible consequences of doing the same.

MR. CHARLES KOSSACK [Illinois]: Up to this time we seem to be basking in the light of an abundance of doves, based chiefly on the summary of their call counts. I think we should use a lot of discretion and caution in the manipulation of any of our regulations which may present additional problems in law enforcement.

A PRELIMINARY EVALUATION OF TELEPHONE AND FIELD SAMPLING FRAMES[1]

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The authors of this study believe that harvest data are important in wildlife management and research. Therefore, it is presumed that a statistically reliable technique for obtaining these data should be established in order that biologists may place confidence in estimates of hunting pressure and harvest, and in order that valid research findings are possible.

Development of a frame suitable for estimating dove harvest data over several or many states was the objective of a study conducted by Chapman, Overton, and Finkner (1959). They recommended a complex frame consisting of a primary frame of telephone subscribers and a secondary, time-area, field frame designed to contact hunters in the field while dove hunting. The purpose of the secondary frame is to provide a ratio of kill (or other data) by persons not in the telephone frame to kill (or other data) by persons in the telephone frame. By this ratio, the estimates from the primary frame can be expanded to represent the entire universe of dove hunters.

The present study is a field test of this complex frame. The results of the telephone sampling phase were very encouraging. Survey methodology, response rates, and quality of response were all satis-

[1]A contribution from the Tennessee Game and Fish Commission, the Louisana Wild Life and Fisheries Commission, through Federal Aid to Fish and Wildlife Restoration Project FW-2R, and from the Southeastern Cooperative Wildlife Statistics Project, the Institute of Statistics, North Carolina State College.

factory, or more than satisfactory. The results of the field sampling phase were less encouraging. The required ratios can be obtained from the methods used, but the attempt to obtain a higher rate of hunter contacts, while maintaining a probability sample, was only moderately successful. Improvement in this phase is necessary in order that this be a practical field technique.

BACKGROUND

The report, Mourning Dove Investigations, (Southeastern Association of Game and Fish Commissioners, 1957), designed reliable estimates of harvest as one of the foremost needs in the over-all management of the mourning dove. As a result of this recommendation, the Wildlife Management Institute, Bureau of Sport Fisheries and Wildlife, Welder Wildlife Federation, and North Carolina State College, Institute of Statistics collaborated on a study by Chapman, et al., which very carefully outlined the problems biologists and statisticians face in accurately measuring hunting pressure and harvest. Although the emphasis was on doves, the subject matter applies equally to all game species. The objectives were to recommend: (1) a design which would permit the collection of comparable data among states, (2) low cost operations when only doves were involved, and (3) the feasibility of securing information for more than one species at relatively low costs to the states.

Chapman, *et al.*, considered the characteristics of the following simple frames to accomplish these objectives:

I. Complete Frames
   A. Area household frame
   B. Area-time field sampling frame
   C. Miscellaneous lists of households, total population
II. Nearly Complete Frames
   A. Dove permit holders
   B. Prerequisite hunting license holders
III. Incomplete Frames: Definable with respect to the Universe
   A. Hunting license holders
   B. Waterfowl stamp holders
IV. Incomplete Frames: Indefinable with respect to the Universe
   A. Telephone listing
   B. Automobile registration lists
   C. Miscellaneous partial lists of households, farms, and other segments of the population

A thorough discussion followed outlining the advantages and disadvantages of these frames. It was pointed out by Chapman, *et al.*, that ''all systems of obtaining hunter harvest information have in common, to varying degree, several sources of error, even when the frame adequately represents the universe. These errors may be broadly classified into sampling errors, response errors and non-response errors. Telephone frames are not widely used because it is difficult to evaluate the assumption that the attribute being measured is independent of the possession of a telephone.

"The personal interview is defined as the face to face questioning of a sample respondent by an interviewer, who records the answer. This method is characterized, ideally, by the virtual elimination of incompleteness, by the minimization of misinterpretation and non-response, and by little direct influence of participation and success on the likelihood of response. The telephone interview is defined as a personal interview conducted over the telephone. One expects the telephone interview to have much the same characteristics as the personal interview, with some lessening of the influence of the personal contact.

"As previously indicated, there are many unknowns in all aspects of such surveys. It would be undesirable to set up any sampling plan without concurrently conducting research on the many sources of error. For this reason, it is here suggested that certain tests be incorporated into the initial design, and that plans be made for other tests, depending on the outcome of the initial results. It should be kept in mind that the easy availability of telephone books, the ease of drawing a sample from these books, the much more complete enumeration of the sample that is possible, and the accuracy of identification of the respondent, make the telephone survey very desirable, and careful thought should be given to the possibility of using this as the primary frame over the entire region of interest. The telephone frame should be tested during the early stages of the study."

The writers further specified that such a primary frame, being an incomplete representation of the universe of dove hunters, must be supplemented by a secondary frame which would provide an estimate of the ratio of dove hunters not in the telephone frame to dove hunters in the telephone frame, a ratio of kill by hunters not in the telephone frame to kill by hunters in the telephone frame, etc. The time-area field frame was suggested as a likely possibility for this purpose, although it was recognized that sampling problems existed whose solution would require considerable ingenuity and investigation. The area-household frame was also recognized as a potential secondary frame, with major limitation being expense.

Following the Institute's report, a temporary National Technical Sub-Committee, charged with designing a Mourning Dove research and operational program, met in Dallas, Texas, in March, 1960. The fourteen members agreed that a high priority need was to determine the quantitative effect of over-all gun mortality and of specific regulations on the harvest and population. This was incorporated in the National Mourning Dove Research and Management Program approved by the Bureau of Sport Fisheries and Wildlife and the International Association of Game, Fish and Conservation Commissioners, in September, 1960.

More specific recommendations on the mourning dove involving the southeastern states were made by the Dove Committee of the Southeastern Section, The Wildlife Society at their meeting in April, 1960. One of the recommendations was for Louisiana and Tennessee, with the Institute cooperating, to field test on a county basis the complex frame recommended by the Institute Study (Chapman, *et al.*, 1959). Of principal concern to the Institute was an investigation of means of assembling telephone sampling materials, investigations of response rates, participation rates, and other response characteristics of the telephone sample, and development of general methodology for conducting the telephone sample. With regard to the field sampling phase, primary concern was in developing means of spending less time checking unproductive areas, with a subsequent increase in the amount of data collected for a given amount of field effort. It was specified that a probability sample be maintained. Under this restriction, the objective is reduced to the development of a means of sampling units of time and area with probability proportional to hunting pressure on those units.

THE TELEPHONE SAMPLING FRAME

Procedures: The procedures for testing the telephone sampling frame were outlined by Stern and Legler (1960). Basically, it involves the random selection of residential telephones in Wilson County,, Tennessee, and Rayne and Eunice exchanges of Acadia Parish, Louisiana, and the subsequent screening of subscribers and interviewing of dove hunters.

The first step in preparation of the materials was to contact the representatives of the telephone system in the two areas to be sampled with regard to availability of names and addresses of telephone subscribers. Discussions with the managers of the Southern Bell Telephone offices, located in the study areas, revealed that the company did not contract for any type of telephone survey, nor could they in any manner select a sample from their records. They were courteous and showed a tremendous interest in the study; however, copies of the telephone directories and maps of exchange boundaries were about the extent of their service. Records were available as to the total listings and a breakdown between business and residential telephones. All the telephones listed in the Wilson County directory were located within the county boundaries. This was surprising as some overlap was expected and did occur in the Louisiana study area.

As a result of these preliminary investigations, it was clear that it would be necessary (in these two instances) to sample directly from telephone directories. Operational procedures then were:

1. List the number of residential subscribers by column and page within each exchange included in the test.
2. Order these completely at random, so that the first selection (n) in the randomly ordered list represented a simple random sample of the entire universe of subscribers, the second n another simple random sample, etc. The sum of several such samples also represents a simple random sample of the universe. This step was accomplished very economically with punch card machinery and the samples having been drawn in this manner allowed a very flexible sample size in the following steps.
3. Basic sample sizes were set at 100 for Acadia Parish and 200 for Wilson County. As hunting pressure in Wilson County is concentrated in the early season, and in Acadia Parish in the late season, allocation of the sample was somewhat different in the two areas. Ten basic samples of 100 were selected for the interview period immediately following the early season in Acadia Parish, with 15 samples taken after the late season. In Wilson County, 7 basic samples of 200 were taken following the early season and 5 after the late season.
4. Selected samples were converted to names and addresses, and these typed on forms used by interviewers.
5. In Wilson County, the sample to be conducted following the early season was pre-contacted by mail, advising of the telephone survey to follow, and of the questions to be asked.
6. Immediately after the close of each half of the dove season, the screening process was begun. This involved asking all persons in the appropriate sample if:
   (a) they had ever hunted doves.
   (b) they hunted doves in the portion of the season just past.
   (c) number of days hunted and doves killed.
   (d) number of other persons in the household hunting doves during the portion of the season just past.
   (e) number of days hunted and doves killed by those persons.
7. After the second half of the season, the persons answering "yes" to the first question after the first season, were again contacted with regard to their activities during the second season.

8. Persons first contacted after the second half of the season were also questioned regarding their activities during the first half.

We believe that one of the most important aspects of the study is to employ local qualified persons as interviewers. It was feared that the rates per hour of $1.15 in Tennessee and $1.25 in Louisiana would handicap the employment of capable people. The manager of the Southern Bell Office in Wilson County suggested a retired telephone company employee. She in turn suggested a retired school teacher. Both of these persons were prominent and active citizens in Wilson County and proved most capable of handling the job. Part time employees are difficult to locate at the time when needed; therefore, it appears that this category of retired people would be most dependable.

The interviewers were thoroughly oriented on the background for the study. Literature on doves and dove hunting was given to the Wilson County interviewers with requests to read and become familiar with some of the problems in dove management. Instructions for interviewing were as follows:

1. Read the question exactly as written.
2. Do not enter into any additional conversation which would prolong the interview.
3. Do not influence the hunter's estimate of trips and kill.
4. Make notes of interesting comments or of requests for literature or for Game and Fish Commission services.
5. Determine as quickly as possible the best hours of the day to contact subscribers.
6. Keep an accurate record of the hours worked.
7. Terminate the survey after three unsuccessful attempts to interview the few remaining subscribers.

Response: Frequent checks were made with the interviewers during the course of the telephone survey to answer any questions which might have arisen. It was apparent from the first few days of the screening that the job was progressing much faster than was anticipated. After a few days it was established that most contacts could be made during the following periods:

Monday—Friday

7:00 A.M.—8:00 A.M.
11:00 A.M.—1:00 P.M.
5:00 P.M.—8:00 P.M.

Saturday

7:00 A.M.—8:00 P.M.

Sunday

No screening in Tennessee except in special cases. Louisiana reported good results on Sunday.

The response to the telephone contacts was most gratifying. Subscribers were courteous and dove hunters appeared to have little difficulty in estimating trips and harvest. Immediate contacts after each half of the season closed probably eliminated much of the memory bias indicated in other harvest studies. The rate of response for both seasons was 86.4 per cent in Wilson County and 89.1 per cent in Acadia Parish, remarkably similar for entirely independent surveys.

Non-Response: Non-response rates of 13.6 per cent in Tennessee and 10.9 per cent in Louisiana were somewhat greater than anticipated. Principal causes were as follows:

	Wilson County	Acadia Parish
Telephone discontinued	173	168
Subscriber deceased	80	36
Subscriber moved	51	39
No answer	20	19
Refused to cooperate	1	9
Total	325	271

The Wilson County sample was drawn from a directory published in January, 1960 which probably accounts for the high rate of discontinued telephones. Samples drawn from recently published directories should have smaller non-response rates, as the first three categories, above, are clearly a function of time.

Cost: One of the most encouraging aspects of the telephone frame is the cost of the actual interviews. The entire sample of 2400 Wilson County subscribers was screened and dove hunters interviewed for $200.10. In Acadia Parish the cost was $253.75 This was an average cost of approximately $0.10 per completed interview. Contract prices by "Telephone Answering Services" were not thoroughly investigated; however, preliminary contacts in Louisiana indicate that the cost would be prohibitive.

The cost of interviewing is a fraction of the total cost of the telephone survey. Processing the sample prior to interviewing was very time consuming. A conservative estimate of the processing cost in Tennessee would be approximately 1½ months of a secretary's time, or about $400.00 Total cost per completed interview in Tennessee, exclusive of project leader's time, and also exclusive of consulting services and other Institute time, is approximately $0.30. It might be well to point out that this study has been carried out in both Tennessee and Louisiana without benefit of a formal budget. Time and money for the investigations were squeezed from previously committed budgets.

Inspection of Data: No attempt will be made in this paper to present a statistical analysis of the data collected. This will be completed by the North Carolina Institute of Statistics at an early date. A cursory inspection of the Wilson County, Tennessee, data indicates that 8.2 per cent of the sample interviewed with regard to the first part of the split season (September 1—October 22) hunted doves. They averaged 2.6 trips for the 52-day season with an average kill of 11.9 doves per hunter. A total of 1.7 per cent of the sample hunted during the last part of the season, (December 15—January 1). They averaged 1.7 trips and 5.6 doves per hunter for the 18-day season.

A similar inspection of Acadia Parish, Louisiana, data revealed that 10.2 per cent of the sample interviewed regarding the first half season (September 3—20) hunted doves. They averaged 2.6 trips for the 18-day season with an average kill of 11.5 doves per hunter. A total of 16.2 per cent of the sample hunted during the second half (November 12—January 2). They averaged 5.4 trips and 26.4 doves per hunter for the 52-day season.

THE FIELD SAMPLING FRAME

Procedures: The procedures for testing the field sampling frame were outlined by Stern and Legler (1960). Basically, it involves hunter bag checks for a defined time period utilizing randomly selected areas and hours of the day for each sampling day.

Field bag check systems used in collecting hunter-kill statistics usually follow a pattern of judgment sampling. That is, the field worker contacts where and when he can. According to Schultz (1958), "it appears that the use of judgment sampling results in biased hunter bag check data. It is not implied that it is impossible to obtain usable data by sampling procedure; rather, the need for the collection of data under stringent controls with studies of variation and differences on a county or sub-county level prior to instigating studies on a regional basis is emphasized."

It is well known that ratio estimates are in general biased, the magnitude of the bias varying with several characteristics of the items being measured. In the present case, it is likely that biases are important only if the ratios being estimated are themselves functions of hunting pressure. If it can be assumed that the ratio are the same over good to poor dove hunting areas, that they remain the same over the length of the season, that they are no different in big shoots or small shoots, or accesible shoots or inaccessible shoots, then judgement sampling is probably just as good, bias wise, as carefully planned probability sampling. In fact, it may in this case be generally better, as more data will result from the judgement sample than from the usual probability sample.

While the above mentioned assumptions may hold, there is at present no way of evaluating them, and the judgement sample was ruled out. It is relatively a simple matter to define sampling units of area and time over a particular county (or other unit of area) and hunting season, such that a census clerk can contact all hunters in that unit within the prescribed time. This may be time consuming, but the mechanics are simple. However, a moment's reflection will make clear the impracticability of such a sampling system, as the great majority of effort will be expended in areas with very little chance of hunting, and a large expenditure of effort is required to obtain a small volume of data. Clearly, some means of obtaining a higher rate of hunter contact is needed. To this end, an attempt was made to establish a system of weights by which areas of potentially heavy hunting were sampled with greater probability of selection than were areas of potentially light hunting.

Ideally, a weighting system for sampling hunters in the field should consist of a three-phase set of weights, one to take into account the trends in pressure through the season and differences in day of the week, one to account for general quality of hunting in units of area selected for checking in one day (these are primary sampling units) and a third to allow concentration of effort in the more productive areas within the primary sampling unit. The first can be only roughly approximated without historical data with regard to hunting pressure in time. The second can be fairly well approximated by a field biologist or officer who knows the areas. The third presents the real problems of sampling, as this cannot be done in advance, and it is left to the census clerk to assign probabilities and select sub-samples for the time periods within a particular day.

In the present application, no attempt was made to include the generalized unequal probability system in time, as a limited field force was available, and it was impossible to really concentrate field effort. Schedules of sampling unit assignments were set up at the Institute. In Tennessee, sampling was done on the first five days, and on Saturdays and one random weekday per week for the reminder of the early season. In Louisiana, sampling was done on all 18 days of the first season. During the late season a pattern of judgement sampling was followed in Tennessee and Louisiana for days and areas checked. Further effort will be made to formalize the field work so that probability estimates can be obtained from a practical field sampling scheme.

The County and Parish under study were subdivided into primary sampling units, the size of which was determined by the ability of a clerk to drive from any part of the unit to any other part of the unit in 30 minutes. The Wilson County units were classified as excellent, good or fair dove territory, with attendant weights of 10, 5, and 1. Then primary sampling units were selected for the sample days with probability proportional to the weights. Acadia Parish was uniformly classified, reducing this step to equal probability sampling.

Definition and selection of the sub-units of area was the job of greatest importance, and the one whose solution was least satisfactory. It is clear that the task of classifying all workable sub-units within a primary unit prior to the season is not only prohibitive, labor-wise, but such pre-season classification would be largely invalid when time came to conduct the sample. The only workable solution here is to devise a system by which the census clerk evaluates the area just prior to sampling, assigns weights, and then selects the sub-units with probabilities proportional to these weights. This is essentially what the "judgment sampling" clerk has been doing all the time, with a few refinements added. A discussion of potential approaches and problems associated with this phase would be much more lengthy than can be handled in this paper. Neither biologist conducting the field work was willing to undertake a problem of this scope, so sub-units were selected with equal probability.

Inspection of Data: A total of 113 hunters was contacted in Wilson County on September 1. There were some fair to excellent dove hunts over the study area from September 2—5 and a few isolated shoots for the remainder of the 52-day season, but except for two hunters checked on September 2, no other hunts occurred in the units being sampled.

A somewhat better distribution of hunting was experienced on the Louisiana study area. A total of 25 hunters was checked on September 3rd, 13 on the 4th, 5 on the 5th, 3 on the 11th, and 6 on the 18th.

This limited amount of data from the early season revealed that 113 out of 115 or 98.3 per cent of the hunters checked in Tennessee lived in a house with a telephone and 81 or 70.4 per cent were listed telephone subscribers. A total of 45 out of 52 or 86.5 per cent of the hunters in Louisiana were from households with a telephone, and 28 or 53.8 per cent were listed subscribers.

A total of 16 hunters was checked in Tennessee during the last half and all were listed telephone subscribers. In Louisiana 157 hunters were contacted and 139 or 88.5 per cent had telephones in the household and 100 or 63.7 per cent were listed subscribers.

It seems clear that rate of inclusion in the telephone frame is high, and that most of the non-included hunting is by "other" persons in a household possessing a telephone.

RECOMMENDATIONS

We recommend that Tennessee and Louisiana continue testing the telephone sampling frame during the 1961 season. The project should be designed to estimate the hunting pressure and harvest by periods. Additional investigations will be necessary through some form of field or household sampling in order to establish a reliable ratio of hunters with or without a telephone in their household.

The results of the 1961 study should be compiled immediately after the season closes and made available for discussion at the 1962 North American Conference. If these results are practical, inexpensive and acceptable to biologist and statisticians, we believe that the Dove Committee of the Southeastern Section, The Wildlife Society should recommend this technique on a region-wide basis.

SUMMARY

A study to evaluate dove hunting regulations received high priority ratings from recent studies by the Southeastern Association of Game and Fish Commissioners, (1957), and Chapman, *et al.*, (1959). Further support for this study came from the National Mourning Dove Research and Management Program. The Southeastern Dove Committee further recommended that representatives from Tennessee, Louisiana, and North Carolina State College, Institute of Statistics cooperate on a study to investigate telephone and random field sampling frames as a combined technique for estimating dove hunting pressure and harvest. Wilson County, Tennessee, and Acadia Parish, Louisiana, were selected as the study areas.

The telephone sampling frame involves the random selection of residential telephones and the subsequent screening of subscribers and interviewing of dove hunters. Preliminary investigations indicate that a response rate of approximately 88 per cent can be expected. Interviewers received excellent cooperation from telephone subscribers and found that hunters had little difficulty in estimating trips and kill. The telephone frame appears to be practical, inexpensive, and has a distinct advantage over conventional frames in that the survey may be conducted immediately after the season.

The random field sampling frame involves hunter bag checks for a defined time period utilizing randomly selected areas and hours of the day for each sampling day. This system was abandoned on each study area at the close of the first half of the split season because the methods used did not provide sufficiently good insurance against "blank" sampling units. A pattern of judgment sampling was followed during the second half. A total of 98.5 per cent of the Tennessee hunters and 88.0 per cent of the Louisiana hunters had a telephone

in their household, and 74.0 and 61.2 per cent respectively, were listed subscribers. In order for the field sampling system to be acceptable to the State personnel, it will be necessary to further refine the method of sampling. Alternate means of obtaining the required ratios should also be investigated.

Recommendations are made to continue testing the telephone and field sampling frames during the 1961 dove hunting season.

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DISCUSSION

MR. FOOTE: It seems to me that ths problem of estimation of hunter harvest shows two real needs that we have in this dove program. One is to project estimates of the total kill in relation to regulations over large land masses and total kills in relation to our population indices.

The second thing that I see is a need for specific studies to evaluate hunting regulations. We must measure kill and this particular technique has high potential value if it can be worked out.

MR. HAYNE: Well I think these two states have to be congratulated on trying new ideas and putting enough into it to give it a good trial. This is interesting work and nobody is really going to know how these things work until they are tried.

As I listened to the speaker, I felt he was a little apologetic about the number of contacts *in the field*. Perhaps this is the weak point. The total estimate has not yet been brought out. I don't think that we can judge yet exactly whether to double the sample or multiply by ten. In many mail surveys, a hundred or two hundred contacts is a small number, but this sample has a good deal of weight because they have eliminated many of the problems inherent in other sampling schemes from work with field census.

We found exactly the same psychological problem. The census clerk finds it a very unrewarding activity to spend a day trying to find fisherman in an area which he was directed to search and perhaps has found one, or none at all. That is part of this type of study and does not necessarily indicate that no information has been obtained.

From what I understand we will rather expect that most of the hunters are in the field during the first few days and not later in the season, so it is not surprising that the clerk has trouble finding them. In fact, very much added effort is somewhat balanced with that of telephone calls.

This idea of using the telephone frame for sampling is very attractive and I expect that it will be exploited by others in the near future.

Although I am not talking of specific instances, we have had some disastrous failures of this on the national scale of some years ago, in prediciting Presidential elections. Much of the difficulty traced back to the fact that in those days at least, it took a special class of people who owned the telephones or were telephone subscribers. It is worth repeating here that this plan in general includes a notion for correcting for this bias, whatever its nature may be.

The field sampling approach is only one possible solution. Another is an area sample with an interviewer in the field to sample people in a particular small area. This type of sampling is now being carried on by some sampling organizations and if one is willing to spend money, this can be done through these organizations. An alternative is to train interviewers and have them do this, and it seems possible that this field check might be the answer.

Another aspect of this is whether information from the telephone frame alone selected as you can, is still biased and may not be useful on a year-to-year basis for determining such things as ratios of kill per effort and this point I think should also be considered.

MR. BESSLER: I am interested in this question and one thought occurred to me. Has there ever been any attempt made to ascertain the difference between instantaneous recollection and delayed recollection insofar as the accuracy is concerned?

MR. HAYNE: Well there have been attempts made and I don't think we need to go into the details of this memory bias. It is a fairly well demonstrated fact, and this does not have to be a very long period. This occurs in all fields of investigation. Extending this thought a little further, there has been some thought raised towards running a continuing survey—week by week, or bi-weekly, or something of this sort on a similar sample basis in order to cut down the possible bias.

Along this line there are two possibilities. One is the use of a panel—in other words a select group of hunters whom you will pay, and I must simply warn that in this case there is a very great danger that you will change the activities of these hunters, by seeing them repeatedly and perhaps telling them that the results of their hunting are important to you. This may very easily change the frequency in which they hunt, so you would have to draw a fresh sample each time.

That is the reason that the field sampling frame and this study were tied to the field sampler who could actually see what was in the bag and could see whether this was different from the results of the telephone survey.

MR. CRISSEY: I should like to ask if any effort was made to find the terms of cost and probable total cost for all the hunting area.

MR. LEGLER: No.

THE MOURNING DOVE PROGRAM FOR THE FUTURE

WILLIAM H. KIEL, JR.

U. S. Bureau of Sport Fisheries and Wildlife, Patuxent Wildlife Research Center, Laurel, Maryland

We have the opportunity now, while the mourning dove is abundant and the population is increasing, to conduct the research that will provide facts for sound management of doves in the future. There undoubtedly will be increased demand from the public for recreational use of this resource as human populations continue to grow. Recreational use means providing enjoyment for nonhunters and hunters. Doves will be managed for the benefit of the whole public. Migratory bird treaties with Canada and Mexico vest in the Bureau of Sport Fisheries and Wildlife of the U. S. Fish and Wildlife Service the responsibility for conservation and management of mourning dove populations in the United States. Part of this responsibility is to determine how much hunting may be allowed.

In 1960, a national research and management program for mourning doves was outlined by the Mourning Dove Technical Committee, which was appointed by the Dove Committee of the International Association of Game, Fish and Conservation Commissioners. This program has been approved by the International Association and by the Bureau of Sport Fisheries and Wildlife.

It has frequently been true in wildlife management that decisive action is taken only when crises arise. Many programs based on sound biological principles do not receive public support and cannot be effectively administered until some crisis brings the problem clearly into focus for the public (Allen, 1954). It is also true that wildlife biologists often cannot recommend a solution for a critical problem in game management, even when called upon to do so. They do not have the facts they need largely because there was not adequate support for research before the crisis arose. We are now at a point in the history of mourning dove populations where there is no crisis immediately at hand. We are also at a point where dove research is much less than adequate.

No crystal ball is required to forecast an increase in the hunting pressure on doves as the human population continues its rapid growth in this country. Thirty States and one Canadian Province now permit dove hunting and 10 additional States are considering open hunting seasons (Kiel, 1960a). At the same time, various nonhunting groups are campaigning actively to close hunting seasons in some States. Some groups of nonhunters, however, believe that a hunted species receives more attention from State and Federal conservation agencies, and that hunting is insurance for wise use and management (Grant, 1958). Sometimes, certain bird-protectionist groups and certain sportsmen's clubs are radical in their demands for privileges. But demands for special privileges can be expected to subside when well-grounded facts regarding the management of doves are known and understood.

PROGRAM DEVELOPMENT AND GOALS

The goal of the mourning dove program is to maintain a dove population that will provide traditional opportunities for enjoyment by nonhunters and that will sustain an annual harvest by hunting. To quote Leonard E. Foote (1960), "The objective of the entire program is to provide reasonable recreational use with maximum security for the species, to ensure its protection yet reap its benefits to both bird watcher and hunter."

The program has been developed cooperatively by research biologists and administrators from the States and from the Bureau. The first action was taken when President A. D. Aldrich of the International Association of Game, Fish and Conservation Commissioners appointed a temporary Dove Committee in August, 1959. In September, 1959, President C. P. Patton made the temporary committee a permanent Dove Committee (Appendix). James W. Webb, chairman of the Dove Committee, then directed the appointment of a Mourning Dove Technical Committee, of which Leonard E. Foote became chairman. The Technical Committee outlined a program of research and management and presented it to the Dove Committee at the 25th North American Wildlife and Natural Resources Conference in 1960. After review and some minor revisions, the program was approved by the International Association of Game, Fish and Conservation Commissioners and by the Bureau of Sport Fisheries and Wildlife in September, 1960. (This program is reproduced in the Appendix.)

The Dove Committee recently was combined with other committees to form the Migratory Birds Committee of the International Association. Thomas R. Evans is chairman.

RESEARCH PLANS

The National Mourning Dove Research and Management Program (Appendix) summarizes research needs of highest priority as follows: (1) To improve techniques for measuring the density and distribution of mourning doves; (2) To determine the relationship of production and harvest areas, and increase knowledge of the migratory movements and mortality of mourning doves; (3) To evaluate the effect of hunting mortality on the size of the population and the effect of hunting regulations on the kill.

Recognition of these research needs, now formalized in the National Dove Program, grew from the experience of many workers. Many important facts and suggestions were presented during and after the Southeastern Cooperative Mourning Dove Study, 1948-56 (Foote, 1953, 1957; Southeastern Association, 1957; Peters, *et al,* 1957; Kiel, 1959a).

Research currently in progress or recently completed has important bearing on the mourning dove program for the future. Leonard E. Foote of the Wildlife Management Institute, under research contract with the Bureau, is engaged in an analysis of dove call-count data, with the purpose of reorganizing the system of call-count routes on a statistically-sound basis. The Canadian Wildlife Service and the Bureau will cooperate to extend the dove call-count survey into Canada in 1961. Participants in the survey will include the Provinces of Ontario, Manitoba, Saskatchewan, Alberta, and British Columbia, plus Ducks Unlimited and several natural history societies. Prospects are encouraging that several Cooperative Wildlife Research Units will undertake studies designed to evaluate the call-count technique.

Methods of measuring hunting kill of doves were studied by the Institute of Statistics, North Carolina State College under a research contract with the Wildlife Management Institute, the Welder Wildlife Foundation, and the Bureau of Sport Fisheries and Wildlife (Chapman, Overton, and Finkner, 1959). The Institute of Statistics recognized that a dove hunting stamp or master hunting license would provide an efficient sampling frame for contacting dove hunters to determine kill. Lacking these, the Institute recommended a system employing a telephone sampling frame and field checks of hunters. Stern and Legler (1960) reported progress in testing this latter system during the 1960-61 hunting seasons in Louisiana and Tennessee.

A cooperative program of banding nestling doves provided data that were the basis for relating production and harvest areas in an analysis of bandings for the 1953-57 period (Kiel, 1959a). As a result, three mourning dove management units were outlined, and hunting regulations were established for these units in 1960. Investigations of the importance of band loss by nestlings were reported by Kaczynski and Kiel (1960). Migrational-homing studies in Missouri (Tomlinson, Wight, and Baskett, 1960) and Minnesota (Harris, 1961) showed a strong tendency for adult doves to return to the same nesting area in subsequent years.

MANAGEMENT PLANS

Management needs are law enforcement, population and harvest surveys, banding, and establishment of managed public-hunting areas.

The National Dove Program calls for regional coordination by the Bureau of Sport Fisheries and Wildlife. Excluding law enforcement, much of the current effort in management goes into the call-count survey and banding. The importance of these cooperative activities is shown by the fact that the call-count survey is the only index available for detecting population trends in doves, and the banding program led to the establishment of dove management units (Kiel, 1959b, 1960b). Need for public-hunting areas and habitat improvement will increase as the human population increases.

Implementation and Budget

Responsibilities for implementing the National Dove Program are listed in the Appendix. Close cooperation will be required of Federal, State, institutional, and private agencies. It has been estimated that $1.7 million will be needed each year for an adequate dove research and management program.

In conjunction with the annual Dove Regulations meeting in Washington, D. C., there will be an opportunity to discuss progress, planning, and execution of the National Dove Program. Representatives of the States, the Bureau, and private conservation organizations attend this meeting.

Conclusion

Through cooperative effort of the International Association of Game, Fish and Conservation Commissioners and the Bureau of Sport Fisheries and Wildlife, we now have a plan for a national research and management program for mourning doves. It is a cooperative venture so necessary in studying migratory birds. Our goals are to conserve the resource through wise use and to provide the traditional recreational benefits to nonhunters and hunters. The National Dove Program is already receiving widespread support and has been presented on the program of two regional wildlife conferences—the Southeast by Leonard E. Foote (1960) and the Midwest by Frederic H. Wagner (1960). Opportunity for building a sound dove management program lies ahead. Let us make the most of it.

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APPENDIX

A NATIONAL MOURNING DOVE RESEARCH AND MANAGEMENT PROGRAM

A Cooperative Program of
The International Association of Game, Fish and
Conservation Commissioners
and
The Bureau of Sport Fisheries and Wildlife
U. S. Department of Interior

I. Introduction

A. Background

The Dove Committee of the International Association of Game, Fish and Conservation Commissioners was appointed on a temporary basis by President A. D. Aldrich in August 1959. The members were J. W. Webb, South Carolina; M. O. Steen, Nebraska; R. D. Smith, Arizona; and W. C. Younger, Alabama. At the International Association meeting in Clearwater, Florida, in September 1959, the temporary Dove Committee presented a report which emphasized the importance of the mourning dove as a game bird and recommended an expanded research and management program on a national scale. The International Association accepted this report, and President C. P. Patton appointed the members of the temporary committee as a permanent Dove Committee.

Chairman Webb then directed the appointment of a temporary Dove Technical Committee with the purpose of outlining research and management needs for a national program of dove management. This Technical Committee was directed to present its outline of dove research and management needs to the Dove Committee at the 25th North American Wildlife and Natural Resources Conference, Dallas, Texas, March 9, 1960.

Members of the Technical Committee were L. E. Foote, Wildlife Management Institute, chairman; F. C. Zwickel, Washington; J. R. Longwell, Maryland; D. M. Russell, Kentucky; J. D. Newsom, Louisiana; Steve Gallizioli, Arizona; H. M. Wight, Missouri; D. D. McLean, California; H. S. Peters, National Audubon Society; J. M. Allen, Indiana; F. H. Wagner, Wisconsin; and C. D. Haynes, Idaho. W. H. Kiel, Jr., Bureau of Sport Fisheries and Wildlife, was invited to serve in a nonvoting advisory capacity.

J. W. Webb, chairman of the International Association's Dove Committee, asked the Bureau to review the recommended program of research and management and to submit its suggestions and additions prior to the September 1960 meeting of the International Association. The outline presented here incorporates the revisions and additions suggested by the Bureau and those of the International Association's Dove Committee. This is the program adopted by the International Association at Denver, Colorado, September 18, 1960.

B. Justification

Management of the mourning dove is a responsibility vested in the Bureau of Sport Fisheries and Wildlife under migratory bird treaties with Canada and Mexico. The primary responsibility of the Bureau is to safeguard the resource. In addition, the goal of mourning dove management is to maintain a population that will sustain an annual harvest by hunting and that will provide traditional opportunities for enjoyment of the resource by nonhunters.

The mourning dove is an outstanding member of our avifauna; it is the only game bird that breeds in every State of the Union, except Alaska and Hawaii. Because of its wide distribution, habits, and compatibility with civilization, it is familiar to and a favorite of untold millions of bird watchers. The species also ranks among the most important game birds in terms of popularity and in numbers harvested annually. In an era when many species are being restricted by land-use practices that destroy their habitat, mourning doves are extending their range and apparently are flourishing.

The dove is becoming increasingly popular both with the bird watcher and the hunter. Thirty States now hunt mourning doves, and several additional States are giving consideration to a hunting season. We now have the opportunity to lay a sound foundation for dove management while the species is in a state of abundance. We should not wait until a crisis develops before undertaking the research necessary to provide the information needed in a sound management program.

II. Summary of Research Needs of Highest Priority

A. Improve population inventory techniques for determining the density and distribution of mourning doves on the continent, so that the basic status of the population may be appraised periodically.

B. Through analysis of migration patterns, determine the relationship of production and harvest areas and extend our knowledge of the migratory movements and mortality of mourning doves on the continent.

C. Evaluate the effect of hunting mortality on the population level and the effect of various hunting regulations on the kill.

III. Research Needs

A. Population Appraisal

Objective 1

Improve techniques of population appraisal to permit the determination of the density and distribution of mourning doves on the continent, so that the basic status of the population may be appraised periodically in relation to harvest and other uses.

Procedures

a. Reallocate call-count routes on a statistically appropriate basis for an appraisal of populations.

b. Improve the basic call-count technique and exert quality control in the census procedure.

c. Evaluate calling doves in relation to breeding pairs and production in various habitat types of the dove range.

Objective 2

Develop techniques for obtaining annual production indexes.

Procedures

a. Develop and evaluate a breeding season production index

b. Sample sex and age ratios in bagged and trapped doves to serve as a fall or hunting season index to production.

Objective 3

Investigate the distribution and ecology of fall and winter flocks in hunting and nonhunting regions.

Procedures

Develop a method of fall and winter inventory to be used (1) to measure the effect of hunting regulations on the kill in the hunting States and (2) to assess the population that winters in nonhunting States.

B. Harvest and Mortality

Objective 1

Evaluate the effect of hunting on dove populations. In so doing, determine the proportion of total annual mortality due to hunting and the maximum hunting mortality allowable without causing a decline in population.

Procedures

a. Correct biases in band-reporting rates through uniform publicity to encourage band reporting.
b. Conduct pre- and posthunting-season banding to determine the proportion of annual mortality occurring during the hunting season.

Objective 2

Evaluate the effects of various types of hunting regulations on the dove kill.

Procedures

a. Select areas in which hunting regulations will be controlled experimentally.
b. Devise statistically sound estimates of the dove kill in the test areas.
c. Obtain reliable indexes to the dove population in the test area before and during the hunting season.

Objective 3

Develop a national survey of the hunting kill of doves.

Procedure

A State master hunting license or a dove hunting stamp appears to offer the best possibilities for a uniform sampling frame.

C. Banding and Migration

Objective 1

Relate areas of production and harvest so that management units can be better defined.

Procedure

Continue the analysis of banding data to reappraise the management unit concept.

Objective 2

Through analysis of banding data, study mortality rates and migration patterns of population units.

Procedure

Continue the national dove-banding program and the analysis of banding data.

Objective 3

Evaluate weighting factors and other procedures underlying banding analyses.

Procedures

a. Improve the breeding-population census and determine productivity rates.

b. Emphasize banding that is representative of the population being studied.
c. Study the uniformity and rate of reporting bands.

Objective 4

Improve techniques of trapping and banding doves.

Procedures

a. Study trapping techniques such as cannon nets, bait traps, nest traps, and mist nets.
b. Determine the proper size and type of band for doves through studies of band loss by nestlings and the wearing qualities of bands on adults.

D. Life History and Habitat Management

Objective 1

Establish sex and age characters to allow analysis of population structure at different seasons.

Procedures

a. Describe external aging characters for postmolting juveniles.
b. Study primary-feather molt rate in a far western population.

Objective 2

Extend and refine knowledge of habitat needs.

Nesting habitat

Procedures

a. Compare densities shown by call-count transect or other extensive survey such as mail-carrier counts with characteristics of habitat shown by amount and kinds of cropland (ag. statistics), soils, topography, natural vegetation, broad ecologic zones, etc.
b. Determine actual nesting densities in different localized habitat types.
c. Evaluate influence of agricultural and civil works land-use practices such as soil bank, cover plantings for other species, etc.
d. Study relationship of breeding densities to distribution of water in intermountain and plains areas. Evaluate influence of drainage and water development.

Fall and winter habitat

Procedures

a. Study characteristics of flocking areas including types and distribution of food, water, roosts, soil and land-use types, relationship to production areas.

b. Study value of late-winter food plots in carrying birds over the winter.
c. Consider desirability of purchase or lease and management of public hunting areas for future use.

Objective 3

Extend knowledge of population behavior to allow better understanding and interpretation of population censuses and density-habitat relationships.

Procedures

a. Measure sex composition of populations in spring and fall through trapping, collection, bag checks.
b. Study permanence of breeding pairs by marking pairs and observing through current and subsequent nesting seasons.
c. Study extent of breeding by young-of-the-year through pen studies, development of ovulated follicle technique.
d. Study productivity of populations in different habitat types, and in different parts of the continent. Determine contributions of different periods of the breeding season to fall populations.
e. Study composition and extent of nonmigratory population segments.

Objective 4

Establish the importance of disease as a mortality factor.

Procedures

a. Through surveys, determine the incidence of trichomoniasis, pox, and other diseases in the population.
b. Determine factors responsible for development of fatal infections.
c. Trace modes of transmission of the diseases and study control methods.

IV. Management Needs

A. Law Enforcement

Protection of the mourning dove resource is of paramount importance in management. This is recognized in the present State and Bureau enforcement program, but additional emphasis should be placed on this phase of management. To meet the rapid growth in the number of dove hunters and the resulting pressure on the resource, some additional manpower is needed as well as increased funds for operating expenses of present enforcement agents. We anticipate that the State agencies will also improve enforcement procedures, and that increases in Bureau enforcement activity will complement State programs.

B. Population Appraisal

In establishing annual hunting regulations, the status of the breeding population is annually determined from the call-count census. Supplemental information on production is being gathered, but there presently is no single production appraisal technique being used in a coordinated manner. This is a management need of high priority. We envision development of an annual production index survey, with State and Bureau operation, coordinated by the Branch of Management and Enforcement Assistant Regional Supervisor (technical).

C. Harvest Appraisal

Although regulation of the kill is an important management activity, and present regulations are directed at preservation of a basic breeding population, no quantitative evaluation of any dove regulation, in terms of harvest and effect on breeding population, has ever been made. Techniques currently being developed and field tested may result in an operational harvest survey, which can be conducted by State and Bureau personnel, with coordination by the Branch of Management and Enforcement Assistant Regional Supervisor. This is a management need of high priority.

D. Relation of Production and Harvest Areas

To design hunting regulations for optimum recreational hunting use and maximum safeguarding of the resource, relations of areas of production to areas of harvest must be understood in a quantitative manner. This will enable the regulatory agency properly to weight production indexes in various geographical areas to the harvest rate expected under alternative regulations in the harvest areas supplied. A continuing appraisal of quantitative banding and migration data is a management need of high priority. We envision contributions to the banding and band-recovery operations by both State and Bureau personnel, with coordination by the Branch of Management and Enforcement Assistant Regional Supervisor.

E. Habitat Improvement

As need is demonstrated and as techniques become available through research, habitat improvements for mourning doves will be undertaken on national wildlife refuges to the extent that funds will permit. Also, habitat management will be encouraged on other federal lands and on State and private lands through the publication and dissemination of research findings.

F. Provision of Hunting Opportunity Areas

Provision of areas on which mourning doves legally may be hunted is a management need of growing importance. A number of States already are testing methods suitable to maintain opportunities for public use of this resource, at low cost, especially near the larger metropolitan areas. It is likely that within the next half century, this will be the management need of highest priority. As methods to maintain public harvest areas are developed, both State and Bureau personnel can be expected to promote their use, with coordination by the Branch of Management and Enforcement Assistant Regional Supervisor.

V. Implementation of the Program

Areas of Responsibility

In order to implement a mourning dove program, cooperation from Federal, State, institutional, and private agencies will be required. The recommended delineation of responsibilities is set forth below. Much of what is suggested is now being done by the agencies listed, but there is a need for an intensification of effort in these areas of responsibility and a closer working relationship on the part of all agencies concerned.

A. The Bureau of Sport Fisheries and Wildlife should be responsible for:

1. Program development, coordination, leadership.
2. Organization and administration of operational surveys
3. Some of the basic research separately or in cooperation with States and institutions.
4. Summarization of information, including analysis of operational data and of cooperative research data, using appropriate scientific and statistical methods.
5. Arrangements for publication and distribution of information.
6. Habitat improvement on national wildlife refuges

as need is indicated and as techniques and funds become available.

B. The State Fish and Game Departments should be responsible for:

1. Some of the basic research separately or in cooperation with the Bureau and institutions.
2. Assistance in technical program development and coordination.
3. Assistance on operational surveys.
4. Habitat improvements on lands under control of State Fish and Game Departments.

C. Institutions such as Cooperative Wildlife Research Units should be responsible for:

1. Some of the basic research separately or in cooperation with States and the Bureau.
2. Minor assistance on operational surveys.

D. Private agencies should be responsible for:

1. Some financial aid, especially to institutional research projects.
2. Minor assistance on operational surveys.
3. Minor assistance in program coordination.
4. Assistance in program justification for funds.

LONG-RANGE MOURNING DOVE PROGRAM
Annual Budget Needs
State and Federal

I. Research	
A. Population Appraisal	$170,000
B. Harvest and Mortality	60,000
C. Migration Studies	100,000
D. Life History and Habitat Management	80,000
	$410,000
II. Management	
Operational Population Survey	$175,000
Enforcement	1,100,000
Operational Banding	30,000
	$1,305,000
Total Annual Program Needs	$1,715,000

Estimated Annual Bureau Share

I. Research	
Present Program	
Two biologists (Population Studies and Disease Investigations)	$30,000
Proposed Program	
A. Population Appraisal	$95,000
B. Harvest and Mortality	40,000
C. Migration Studies	45,000
D. Life History and Habitat Management	45,000
	$225,000
II. Management	
Present Program	
Operational Population Surveys	$20,000
Enforcement	280,000
Operational Banding	20,000
	$320,000
Proposed Program	
Operational Population Surveys	$95,000
Management Enforcement, Harvest Appraisal, Habitat Improvement and Hunting Opportunity Appraisal, and Coordination	480,000
Operational Banding	30,000
	$605,000
Estimated Total Annual Bureau Share	$830,000
Additional Bureau Funds Necessary	$480,000

REPORT OF THE DOVE COMMITTEE
to the
INTERNATIONAL ASSOCIATION OF GAME, FISH AND CONSERVATION COMMISSIONERS
Denver, Colorado
September 15, 1960

Since the Clearwater meeting, your Committee, in conjunction with representatives of the Bureau of Sport Fisheries and Wildlife and other agencies, has prepared a National Program for management of the mourning dove. Research and operational needs have been outlined and agreement reached as to priorities for orderly development of the program. Copies of the program and of the Dallas Dove Committee meeting were sent to representatives of the Associations at the Dove Regulations meeting, June 27.

The program we recommend is a partnership program, with areas of responsibility assigned to the Bureau, the States, education and research institutions, and private conservation agencies. Items of highest priority in management needs are improvement in population appraisal, determination of over-all gun mortality and effects of regulations on the kill, and improvements in population segment detection and measurement to relate production and harvest areas.

In point of numbers harvested, the mourning dove ranks first among all game birds on this continent and is presently hunted in thirty States and one Province. In many areas the mourning dove is traditionally a bird of peace and conflicts between hunting and non-hunting ideologies during recent years have led to proposals to prohibit or legalize dove hunting in some fifteen States·

At present, management of the mourning dove is based upon an annual survey of calling birds, a small sample of band recoveries to relate production and harvest areas, and other supplemental information. Much of this information is gathered annually by the States, with coordination by the Bureau's Branch of Management and Enforcement. The Bureau employs two dove research biologists and receives no specifically appropriated funds for its coordination of the population appraisal survey.

The program your committee recommends will strengthen the bureau so that it can fulfill its research and management responsibilities. The research program will be stepped up to permit rapid analysis of banding data and improvement in population mortality appraisal. The management program and the essential coordination functions of the Bureau will be augmented by assignment of regional personnel solely to dove management, whose functions will be prosecution of population surveys, banding, habitat improvement, provision of hunting opportunities and promotion of needed research.

Regional Bureau contact with the States is essential because the program will still depend to a large degree on State contribution to research and management phases through both Federal Aid and State funds.

Your committee concurs with Bureau estimates that an increased annual appropriation of $480,000.00 is a realistic estimate of costs for a revitalized Bureau and State partnership program for this species. Continued State assistance to the National Mourning Dove Program can be justified because the species is a heavy contributor to Federal Aid revenue.

This program is designed to furnish adequate information on the annual status of the continental dove population and the hunting harvest, so that the Bureau and States can devise regulations insuring the safety and the sustained management of the resource.

Copies of the completed program will be sent to all members of this association. We recommend that the Association's Legislative Committee initiate appropriate action to insure augmentation of the Bureau of Sport Fisheries and Wildlife budget for the Mourning Dove Program, and explore other means of financing the program.

To insure cooperative program planning and execution, we recommend continuation of the established representation of Bureau, State, and private agency personnel at an annual Dove Regulations meeting in Washington. We suggest that discussion of current execution of the National Dove Program be incorporated annually in the agenda of the Regulations meeting.

Respectfully submitted:

James W. Webb, Chairman
M. O. Steen
R. J. Smith
Wm. C. Younger

The following recommendations were proposed and passed at the Dove Committee meeting at Denver on September 15, 1960.

"Approved report of proposed program of Dove Committee, with the following change. In reference to management, it be changed to include operational surveys, banding and coordination.

Further approved that qualifications of personnel assigned to this work be raised with emphasis on additional technical knowledge.

The committee voted to urge the International Association of Game, Fish and Conservation Commissioners to support adequate appropriations to support this program, such appropriations based on figures contained in the attached report. Committee recommended further that the Association be encouraged to explore other means of financing the program·"

DISCUSSION

MODERATOR FOOTE: There are copies of this paper for anyone who would care to have it. I might comment that we are making some progress in implementing this program.

We have a grant to Tom Baskett, of the Missouri Wildlife Research Unit, from the Wildlife Management Institute to test this calling procedure on wild birds.

Investigation to determine the relation between calling birds and production will be the objective of some research being financed by the Welder Wildlife Foundation starting this October with the Colorado Wildlife Research Unit.

A resolution was passed by the National Wildlife Federation at their meeting here very recently in support of this national dove program. The International Association, the Audubon Society, and the Wildlife Management Institute are planning to support appropriations in the Interior Appropriations Bill now in the Congress, to give added support to this program this year.

I think Bill Kiel has presented a very fine summary of what we are trying to do here. I am sure also, that all of you who have had the fortitude to sit through this meeting realize that there are problems here.

I suspect that we have strong biases in the call count as well as a lot of unknowns in respect to it. We are just beginning to begin to estimate harvests. The banding data on which we are trying to determine movements of segments within units are very inadequate. In some states the recoveries are so small that you have nothing to work with.

I am certain that, as human populations grow, more and more dependence is going to be placed on this species as a major resource, so I have long been concerned that the management program that we have all been working at has really been too small on this species.

We fight among ourselves sometimes; we argue about regulations. We should remember that our first concern here is to safeguard the species, because without that safeguard we can neither hunt nor watch it.

BEN GLADING [California]: I would like to compliment Mr. Foote and Mr. Kiel on the approach you are taking, the conservation approach. I think it is very true that the way out is as expressed here by earlier speakers.

We in the United States have had experience in cooperating with societies. An attempt was made before the California legislature to prohibit dove hunting. It was through the Audubon Society's efforts that the bill was killed. I doubt very much that we could have done that by ourselves.

We in California have a program of work with the Audubon Society. They actually conduct some of the counts. I think in some of the other states the Federal agencies take the same bright aspect of recognizing that unless you have a habitat for the bird, you're going to lose the battle here.

You can talk all you want to about the economics of it; let's figure these dollars, but let's not use the dollars solely for more shooting. Let's use it for conservation.

CHAIRMAN SWANK: This has been a very interesting meeting, particularly to us people who have been engaged in the mourning dove problem for some ten years when the southeastern study got under way, and some of us even longer than that.

I would like to thank the panelists for their diligence and for the hard work in gathering all of the data, for contacting all the states in their management units and for trying to put together, really before it was ready, the report by Mr. Legler. I want to thank Bill Kiel for looking into the crystal ball and I think we all should push this program that is now before Congress to increase the appropriations so that we can get the management information that is sorely needed to protect this resource.

TECHNICAL SESSIONS

Wednesday Morning—March 8

Chairman: Gilbert N. Hunter
State Game Manager, Colorado Department of Game and Fish, Denver

Discussion Leader: David M. Gaufin
Assistant Director, Division of Wildlife Management, U. S. Forest Service, Washington, D. C.

FOREST AND RANGE RESOURCES

HABITAT OF THE JACKSON HOLE ELK AS A PART OF MULTIPLE RESOURCE PLANNING, MANAGEMENT AND USE

Robert L. Casebeer
Teton National Forest, Jackson, Wyoming

Millions of people from throughout this nation have been in, or know of, Jackson Hole located in northwest Wyoming. A portion of its popularity may be rightfully attributed to the famous elk herd residing there. Through the past 60 years the Jackson Hole elk herd has been the subject of much writing and discussion of a technical, popular or political nature. Preservation and management of these elk and their habitat has been of particular interest since the early settlement and has had an influence in the development of this portion of the West. The diversified land administration pattern which has developed has, in turn, had an unusual influence on the management of this particular group of animals.

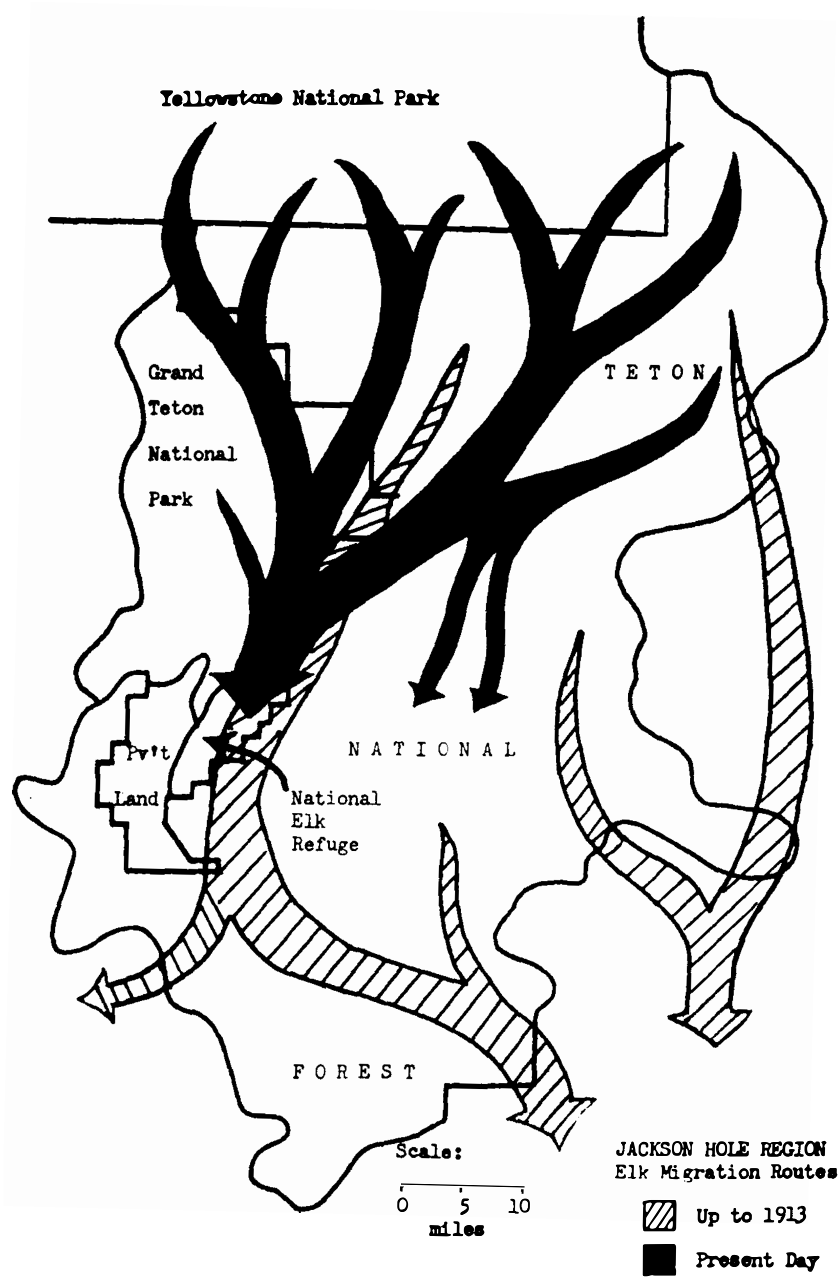
The United States Forest Service administers the habitat which constitutes much of the summer range and most of the natural winter range for these elk. They range over practically all the 1,700,000 acres in the Teton National Forest and spread out onto edges of three adjacent forests. Summer ranges extend into adjacent portions of Grand

Teton and Yellowstone National Parks administered by the National Park Service. (This herd is sometimes referred to as the Southern Yellowstone elk herd but is not to be confused with an entirely different herd in the northern portion of Yellowstone Park.) Private lands play a very minor role because less than three percent of Teton County (less of the entire Jackson Hole) is in private ownership. The people of Wyoming through the Wyoming Game and Fish Commission are responsible for the protection and management of the game.

Elk are native to the Jackson Hole region, having been mentioned in the *Journal* of Wilson Price Hunt for 1811. Explorers and trappers into this region between that time and the turn of the century left various ideas as to the presence or absence of elk and other wildlife. Historians say elk and other big-game species increased in Yellowstone Park and Jackson Hole between 1870 and 1885, coinciding with the big kill of animals, especially buffalo, on the plains just east of the Rockies.

Originally, elk migrated out of Jackson Hole to winter, principally to the south towards the Green River and Red Desert country, a migration of 100 to 200 miles. The entire herd did not always make this long migration, numbers and distances depending largely on the severity of the winters. Severe winters occurred often, at least they were severe enough to cause acute losses of elk, the first on record being in 1882. There were reoccurrences a number of times on through 1920. Resulting spectacular losses indicate that a balance of winter forage and elk numbers did not exist in those days and forces of nature were at work bringing about correction. Hard winters of the 1880's began to mark a reduction in the long migration out to the Green River. Homesteads established along migration routes, uncontrolled hunting, and elk starvation continued to block and reduce the numbers making this extensive annual trek until the last migration occurred out of the valley in December 1913, and those animals never returned. Those remaining in Jackson Hole became the sedentary herd which was the stock for the herd of today. An extensive migration has continued for a large portion of the Jackson Hole herd. Those summering in the high country of southern Yellowstone Park or northern Grand Teton Park and the Teton Forest move south 30 to 50 miles in the late fall. However, the southern limits of this movement now terminate in the south end of Jackson Hole or along the Gros Ventre River to the east.

No counts could be or were made in the early days. Estimates varied from 15,000 in the 1880's to 35,000 on the Teton National Forest in 1909. Such numbers carry some meaning, especially by inference to a probable impact on restricted and unnatural winter ranges which had


Yellowstone National Park
Grand
Teton
National
Park
T E T O N
Pv't
Land
National
Elk
Refuge
N A T I O N A L
F O R E S T
Scale:
0 5 10
miles
JACKSON HOLE REGION
Elk Migration Routes
Up to 1913
Present Day

developed. Numbers were also significant in the role of public appeal and public sentiment in those days of great losses such as in 1919-20. That year the loss was estimated to have been half the herd. Only 9,346 animals were counted the following winter, thus indicating a spectacular die-off.

Efforts to save the elk led to the first attempt at supplemental feeding in 1907. Private contributions of monies and appropriations by both the Wyoming Legislature and the United States Congress assisted in feeding programs during the severe winter of 1909, 1910, and 1911. This led to the original appropriations by Congress in 1912 to purchase land as a refuge for raising hay to feed a portion of this elk herd. Additions by purchases, contribution, and setting aside of other federal lands at various times up to 1945 has established the National Elk Refuge of 23,791 acres under the jurisdiction of the Bureau of Sport Fisheries and Wildlife. From one third to one half the wintering population of elk are fed either stored hay or standing native forage on the refuge. Supplementary feeding thus was started and a number of additional feed grounds have since been added by the state as the solution to an unnatural and restricted winter range situation.

Elk, under even the simplest conditions of administrative jurisdiction, seem to propound challenges to the modern game manager. But here are four different agencies responsible for the management of these elk or their habitat. Also, here are elk supported by supplemental winter rations, a program sincerely initiated to have secured their very existence.

Because the natural winter range and much of the summer range as well as most of the harvest of animals from this herd occurs on national forest lands, the Forest Service is sincerely interested in the role of game habitat and how it fits into the local land resource management. The Teton National Forest is particularly interested inasmuch as almost every acre is game habitat and many of these acres must provide other resources.

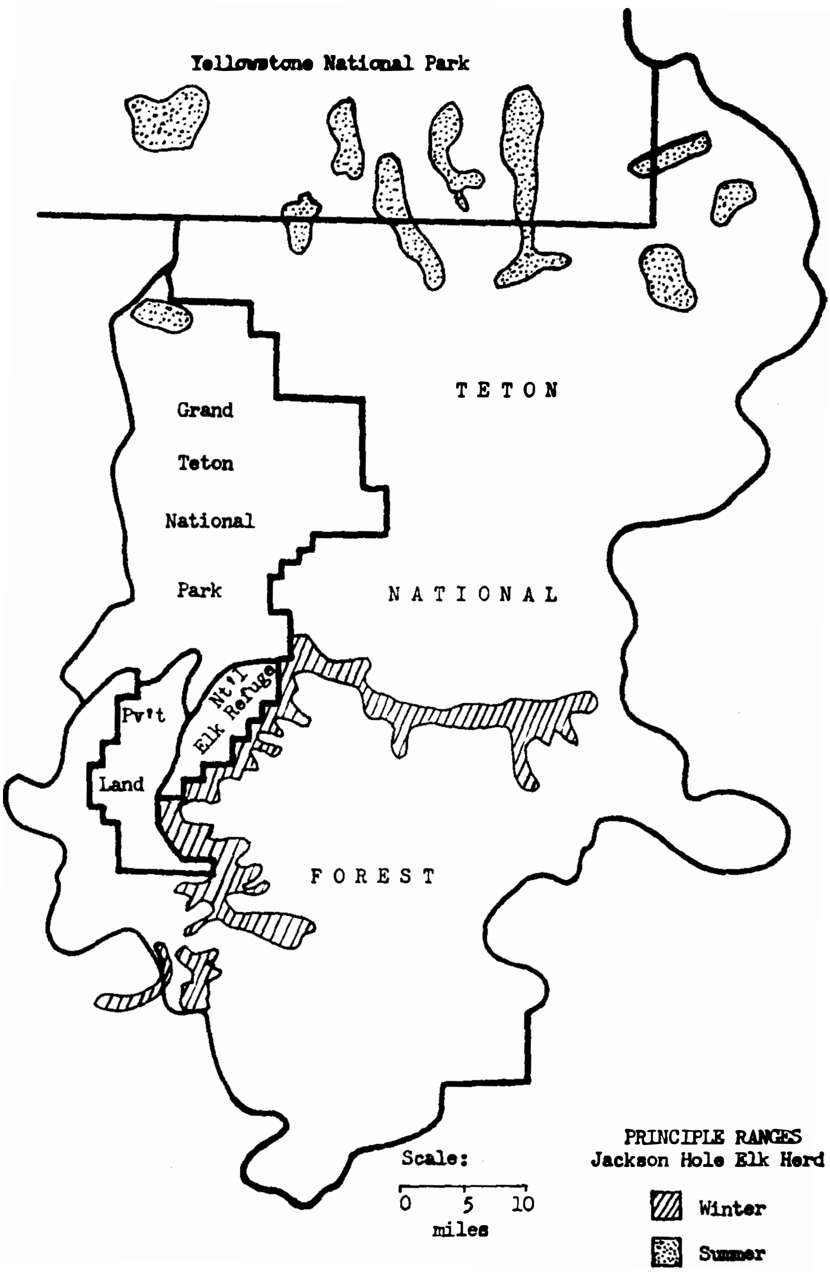
This forest is characterized by a mountainous terrain extending from about 6,000 feet elevation at the valley floor to nearly 11,000 feet. The geology and resulting soils and vegetation pattern are quite complex. Timber, principally lodgepole pine and spruce, dominates the vegetative cover, but there are many meadows of sagebrush or grasses and forbs. Higher ridges are often open, vegetated with subalpine grasses, sedges or forbs, with occasional clumps or edges of limber pine.

Included in the north portion of the forest is the Teton Wilderness Area, composed of 563,460 acres situated just south of some of the most remote portions of Yellowstone National Park and adjacent to two additional wilderness areas to the east in the Shoshone National Forest. Altogether these form an immense expanse of wilderness where several species of big game occur and hunters come to enjoy some of the most primitive hunting environment left in the United States. Big game hunting is big business on the forest, as is other types of recreation. Last year 68 commercial outfitters packed over 1,000 hunters to the remote portions of the forest. Between 2,500 and 4,000 elk and 350 to 400 moose are harvested annually as well as mule deer, mountain sheep, black bear and a few grizzly bear. About 1,800 acres of lakes and over 1,000 miles of fishing streams occur on the forest and it is estimated that about 37,000 visits are made here to fish. Folks expect good fishing as well as relaxation. Not only hunters and fishermen enjoy these esthetics of wild lands, but others come for riding, photographing, and just enjoying the great outdoors. Many individuals or families come on their own as tourists or campers, while thousands come as guests to the 45 dude ranches and lodges in Jackson Hole. This in itself is important to the economy of the community and to the state. But the attractions for these visitors are important only as long as they are maintained in close harmony with the points in nature which have formed the grandeurs of the past and which are prized highly as a resource for the future.

Headwaters of two prominent river systems arise on the Teton Forest, the Yellowstone, which flows into the Missouri, and the Snake, which flows into the Columbia. Over 2½ million acre feet of water from this forest are contributed annually to these systems, water which is important on down river for recreational, agricultural, industrial and domestic purposes. Whatever the use, it depends on stable flows of good water. For this reason forest watersheds must be protected to produce the highest possible quantity and quality of this extremely important resource.

Many other resources are available on this forest. Livestock has made use of the forage since early in the century. Last year there were about 13,500 cattle and almost 11,000 sheep on Teton Forest allotments. There were also about 3,300 horses permitted, mostly as pack and saddle stock used for recreation purposes. Timber is cut for local needs and by small commercial operators who contribute to the economy of western Wyoming communities. Other types of special uses, such as mining, oil and gas leasing, pastures and summer homes occur as minor activities of the forest. Each of these uses, regardless of how big or small, is important to the particular individual clientele of users.

Since its beginning then, this National Forest, like 153 others, has


Yellowstone National Park
TETON
NATIONAL
FOREST
Grand
Teton
National
Park
Nt'l Elk Refuge
Pv't
Land
Scale:
0 5 10
miles
PRINCIPLE RANGES
Jackson Hole Elk Herd
Winter
Summer

been developing uses of its many resources. Multiple-use principles have had to be applied in both the planning and management phases. Multiple-use was allowed under the original Organic Act of 1897 setting up the Forest Service, an act wisely interpreted at that time to be "for the greatest good of the greatest number in the long run." Now under Public Law 85-517, approved June 12, 1960, the Forest Service is directed by Congress to manage for multiple-use. This law is referred to as the "Multiple-use—Sustained Yield Act" and it does three basic things:

1. It declares as a Congressional policy that the national forests are established and shall be administered for outdoor recreation, range, timber, watershed, and wildlife and fish purposes.
2. It authorizes and directs the Secretary of Agriculture to develop and administer the renewable surface resources of the national forests for multple use and sustained yield.
3. It authorizes the Secretary to cooperate with states, local government agencies, and others in the development and management of the national forests.

Multiple-use is not a panacea. It has its limitations, but it also has its advantages. We in the Forest Service are convinced of the advantages and are endeavoring to practice multiple-use principles on national forests in the best interests of the total public. Under this new direction from Congress each of us down to the forest and ranger district level must re-evaluate management goals and resource plans within our jurisdiction to make certain they are for the long-range good of the American people.

On the Teton Forest the availability of the fish and game resources and the recreational uses which these provide will depend on how skillfully they can be managed in proper perspective and coordination with the other resources present. As mentioned before, watersheds must be protected on this forest. With good watershed management other renewable resources can be sustained. Abuse or misuse of the other resources not only waste themselves away but also degrade the watersheds. Good management of each is to the mutual advantage of all.

Previous discussion of the history of this elk herd emphasized periodic losses of animals during severe winters from starvation and lack of winter range, even before migrations to historical winter ranges had terminated. Then, as now, winter range was a limiting factor, the same as it is for most other big game herds in northwest United States. In recognition of the need for range to maintain the Jackson Hole elk, approximately 100,000 acres were set aside in 1919 on the Gros Ventre, Hoback and Lower Snake River for use as game winter range allowing only a limited amount of cattle use in trailing through portions to and from summer allotments. In addition about 570,000 acres are devoted to recreation or watershed protection, permitting no livestock grazing or timber cutting. In other words, game has exclusive use of the forage over a large portion of the forest.

With those early-day game die-offs there was no doubt severe pressure on the forage resource upon which the animals had to depend for winter subsistence. Even with the advent of a supplemental winter feeding program, these wild animals depended on natural forage for a portion of their winter diet. Pressure on natural range has continued and is evidenced by only remnants remaining of choice browse species such as chokecherry, serviceberry, and aspen. Severe hedging characterizes most plants still remaining. There have also been serious impacts on the soil by trampling. Heavy use by elk in late winter or early spring when the frost is first out of the ground and the soil is supersaturated with moisture has stimulated erosion on the steeper south and west exposures. Soils are churned over, and both seedling and mature plants pushed out or smothered by soil movement down over them.

The pattern of continuous heavy winter range use has been indelibly, and almost permanently inscribed on the watersheds. In 1949 and 1950 winter ranges for about 90 percent of the Jackson Hole elk were mapped and classified according to condition of vegetation and soil. None of the 228,000 acres showed better than fair condition. Only 27 percent rated fair, 52 percent in poor or depleted condition, and accelerated soil loss was noted on 21 percent. Exclosures have been in place for 12 to 15 years on some wintering areas. Where vegetative cover was sparse, as low as 5 to 20 percent of the time the exclosures were constructed, recovery under complete protection is hardly measurable, even today. Plots on severe sites inside exclosures and similar sites outside show little or no difference.

Because of continued impacts on natural winter ranges there has been a spiral decline in the carrying capacity of these ranges. This decline is not only reflected in the size of the elk herd but also by the impact on other big game species competing for portions of the same winter range. Mule deer numbers fluctuate quite erratically depending on the severity of winters and how closely they must compete with elk for forage. Remnant bands of bighorn mountain sheep have suffered sharp declines in recent years in areas where competition with elk for winter range is quite marked.

Since 1950 another situation has been gaining prominent attention on this forest—a summer range problem—in an area where domestic livestock has never been permitted. During the spring and summer many elk migrate over and concentrate along the higher open ridges in the north portions of the forest and southern portions of Yellowstone Park. Elk prefer using these ridge-tops in early summer. At that time snowbanks are still receding, the ground is saturated with moisture, and the vegetation is young and succulent. Growing seasons are short and average soil temperatures are low, making such sites quite fragile to adverse pressures.

On some ridges the combination of the geologic base with the resulting soil and vegetation in this climatic setting has been able to withstand the impacts of whatever game use occurs. Soil cover in these situations is still satisfactory and there is little cause for concern now about watershed conditions or game forage production. However, vigilance is necessary for keeping such areas under close observation to determine their future trend. Other ridges or portions of ridges are in varying stages of plant and soil development or deterioration. These sites are being studied to determine their true status and to be able to predict what the future might be for each.

Of dramatic concern is the status of one ridge in the heart of these summering ranges—one known as Big Game Ridge. Its drainage forms the very headwaters of the Snake River. Observations along the Snake River and immediate tributaries give cause for concern about watershed conditions. Mud and rock flows of recent origin occur down many of the draws from off the ridge and there are signs of further scouring out sides and bottoms of the main streams further down. Examination of the ridge top shows ample reason for rapid and severe water run-offs which cause these conditions. The open top of Big Game Ridge is from 1 to 3 miles wide and extends for about 13 miles, making up a total of 12 to 13 thousand acres. Many portions support less than 50 pounds of vegetation per acre and less than 5 percent ground cover. Soil losses are indicated by pedestals supporting clumps of grasses or sedges, and root systems of tree are exposed where there is evidence that soil covered them less than 80 years ago. There is real concern as to whether or not further deterioration can be arrested and if similar conditions will spread to other important summer concentration areas. It is possible that summer range may now become a limiting factor to the support of this herd.

Throughout these winter and summer ranges a number of studies have been established to determine the condition and trend of the habitat and its role in watershed conditions. Browse utilization transects and utilization cages are used to determine annual impacts of game on forage. Fenced exclosure plots are installed on both winter and summer ranges. Various types of permanent transects have been established, both with exclosures and on open ranges to measure trend in condition of both the soil and vegetation. Photographs are also used extensively to pictorialize range conditions.

Suffice it to summarize these studies by saying that on some sites, under proper management, soil potentials are adequate to permit the recovery of vegetative vigor and soil protection for satisfactory watershed conditions and even increased game forage production. However, on many sites soil conditions are such that complete protection would not provide natural recovery of the minimum watershed protection requirements within a period of time deemed at all desirable.

Studies have been extended to determine what might be done on the more severe sites to artificially restore watershed protection. Within a 280-acre elk-proof exclosure on winter range trials of grass and browse reseeding and fertilizing have been started. On sites where these treatments would not likely be successful, more drastic measures are being tried. Contour trenches were constructed on slopes of 40 to 70 percent to retard or hold water and soil run-off. These trenches are about 8 feet wide and average 2.5 feet deep. Costs have run about $170.00 per acre for this type of rehabilitation. It is hoped this treatment, even though quite expensive, may help to stabilize conditions so either natural or artificial seeding can become established.

It is accepted that there are complex problems involved in coordinating fish and game habitat management with watershed management. The knowledge of watershed behavior and the inference that soil and plant management have on water flow characteristics are far from complete. This type of knowledge requires much more than casual observations and off-the-cuff conclusions. It requires orderly study and evaluation. No single study will tell us what is happening, nor is there any single management application which will resolve the coordination of these important resources. Lacking complete information, however, much can be done on the basis of present knowledge to increase soil productivity while maintaining wildlife habitat and an optimum supply of usable water. This is a challenging order in Jackson Hole, an area where land administration is complex but clearly defined, and where game, especially this migratory herd of elk, is not bound by administrative boundaries or jurisdiction.

Here is another problem of the inter-relationships of man, wild animals, and the land. There is also a problem of dealing with personal attitudes and habit responses conditioned over many years, both within and from without each individual agency. By recognizing these problems it is felt that a big step has been taken towards possible solutions.

In 1958 the four agencies named previously, those having legal responsibilities for managing this elk herd or its habitat, formed, by formal agreement, the Jackson Hole Cooperative Elk Studies committees. The Advisory Council is composed of the administrators for these agencies and the Technical Committee is made up of technicians actually involved in field studies. Individuals from other agencies engaged in studies relative to this herd may also be invited to be on the Technical Committee.

The principal purpose of this agreement and the committees is to coordinate plans, programs and findings of studies and to provide an exchange of ideas, information and even personnel in studying this elk herd and its habitat. Ultimately, this approach should lead to ways and means of overcoming problems and providing for better game ranges and game herds for years to come. Those participating feel that marked accomplishments are being made. There is a better understanding and appreciation of individual agency responsibilities and policies in the field of wildlife or habitat management. Definite steps have been and are sure yet to be taken toward progressive and modern management of the elk, its habitat, and maybe even the people, as a result of these cooperative efforts. Cooperative efforts are necessary for maintaining wildlife as one of the renewable resources of these wild lands.

Speaking only of Forest Service lands, there is little doubt that high quality game habitat can be maintained in complete harmony with, in fact as a natural by-product of, good watershed management. Game habitat and watersheds are only two from a mosaic of resources available on the forest lands. The responsibility to the people of the nation is to plan and manage each resource so as to provide a coordinated balance in the sustained use of all resources.

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DISCUSSION

CHAIRMAN HUNTER: That was an excellent paper and I think many of us in the West realize the problem that exists in the Jackson Hole area. However, I think all the agencies are to be commended on their cooperative study there and I am sure in the end we are going to get somewhere.

DISCUSSION LEADER GAUFIN: Bob, speaking as a former Jackson Holer, you have succeeded in making a desk-bound bureaucrat very homesick. I would trade the problems of answering pink-jacket letters with wrestling with the Jackson Hole elk with you any time you wish.

MR. DICK PILLMORE [Denver Wildlife Research Center, Fish and Wildlife Service]: Concentrations of elk on the Jackson Hole feeding grounds present certain disease problems. Has the council taken any action and studies in this direction?

MR. CASEBEER: I would answer this only as a member of the technical committee of the Jackson Hole Elk Studies. The problem has been brought before the technical committee and the Wyoming Game and Fish Department research laboratory and they are concerned with some of the probabilities of disease. However, in recent years there has been nothing that has been of serious concern in the maintenance of this elk herd so far as disease is concerned.

MR. PILLMORE: Don't you have a very high incidence of ticks in the spring in those areas?

MR. CASEBEER: I can't answer as to what the incidence might be, but it has been of no concern so far as the management problem itself.

MR. GORDON FREDINE [National Park Service, Park Planner]: Bob, that was a fine presentation and I want you and the other people to know that the National Park Service is proud to be a party to the study that is going on, proud to be working with the Wyoming Game and Fish Commission, the U. S. Forest Service, and the U. S. Fish and Wildlife Service.

I understand that the purpose of this work is to recognize eventually what needed control and management measures must be put into effect in this area. Can you tell us how you think we are progressing in that direction and when you think the committees concerned will be ready to present a realistic management program for this great herd?

MR. CASEBEER: That is a very difficult thing to project. Of course, we would very much like to be able to. However, this committee was not set up to make management recommendations at the present time. The purpose was to coordinate studies which have been in progress for a good number of years, to initiate new studies if they are needed, to devise ways and means and new techniques of progressing on the studies, and to assist even with manpower between the agencies in the conduct of any study that they might be carrying on.

The recommendations for management do not come from this committee. It is for study purposes. However, usually it involves almost the same personnel when they go to inter-agency and other meetings to make management recommendations. However, we hope to set up as near as possible the exact conditions through our studies to point forward to management goals. We believe that already some steps have been taken which represent very progressive game management. We are working towards possible solutions, not only of the management of the game herd itself, but management of the habitat, which needs some artificial treatment for recovery in the time that we would like to see it done.

MR. LEVI MOHLER [Idaho Fish and Game Department]: Bob, I have seen some of this range, and I realize your committee has only been working a period of years. Could you give us some indication on those critical summer ranges? How do present conditions compare to what may have been on the same area 10, 20, 30 or 40 years ago?

MR. CASEBEER: That is very difficult to answer. We wish that we had some historical information on that particular point, Levi. However, the information that we do have indicates that on most of those areas, and in partcular on one area at Big Game Ridge, previous to 1880 there was sufficient timber and grasses to have carried a very severe fire through the area, which would be absolutely impossible now because of the scarcity of vegetation.

Tree roots which have been exposed since that time indicate a deteriorating condition on that particular area. The other summer-range areas we feel are in various stages of condition and change and we are watching them closely, but we do not have historical records to answer your particular question.

DEER ON THE BAD RIVER INDIAN RESERVATION

ROBERT S. COOK AND JAMES B. HALE

University of Wisconsin, and Wisconsin Conservation Department, Madison

The problem of an increasing white-tailed deer (*Odocoileus virginianus*) herd and decreasing winter browse has been present in Wisconsin since the early 1930's. Range management has been largely futile in the presence of a deer herd large enough to prevent browse recovery. Only partial solutions to the overpopulation problem have been reached through periodic liberal hunting seasons, mainly because of public resistance to intensive hunting of deer of both sexes on small areas.

Hunting offers the most economical way to herd reduction, but a herd-control program will be sold to the Wisconsin hunting public only on the basis of demonstrable facts. To provide such a demonstration, a study was conducted at the Bad River Indian Reservation in northern Wisconsin where all game is subjected to unrestricted hunting by Indians. We found that year-around deer hunting by Indians had no adverse effect on the hunting success of non-Indians (hereafter called ''whites'') subject to state hunting regulations on the same area, on deer herd composition and productivity, or on range conditions. The combined deer kill of Indians and whites was keeping the Reservation deer herd near the carrying capacity of its range, although the portion of the herd harvested annually was small.

This paper is a joint contribution from the Wisconsin Conservation Department and the Department of Forestry and Wildlife Management, University of Wisconsin. The study was financed with Federal Aid to Wildlife Restoration Funds from Pittman-Robertson Project Number W-79-R. We gratefully acknowledge the assistance and counsel of the following persons: Robert McCabe, Joseph Hickey, and Harland Mossman of the University of Wisconsin; and Cyril Kabat, Donald Thompson, Carroll Besadny, Robert Dorney, Frederic Wagner, Eugene Woehler, Burton Dahlberg, George Curran, David Cash, Daniel Bernhardt, Russell Mattison, Raymond Vallem, Robert Markle, Leonard Tomczyk, and Kyle Smith, all of the Wisconsin Conservation Department. The assistance of personnel of the Great Lakes Indian Agency and Bad River Tribal Council, as well as all Indian hunters, especially James Wilmer, is deeply appreciated.

Field studies began July 1, 1955, and ended May 30, 1957.

STUDY AREAS

The Bad River Indian Reservation occupies approximately 194 square miles on the south shore of Lake Superior in northern Wisconsin. About 8.5 square miles are in Iron County; the remainder is in Ashland County. There is marginal agriculture in the northern and southwest sections, but most of the Reservation is wooded, primarily with second-growth aspen, pine, and northern hardwoods. Logging and general land-use history parallels the remainder of northern Wisconsin. The terrain is flat to moderately hilly and is in a red-clay soil type. The road system is not extensive, but is suitable for travel at all seasons.

The Reservation was established in 1854 by treaty between the United States and the Chippewa Indians of the Lake Superior region (Kappler, 1904). The treaty, in addition to setting boundaries, provides unrestricted hunting and fishing privileges for the Indians.

The Indians sold part of their lands within the Reservation to whites as the years passed. Thus, since Indians did not own all land within the Reservation boundary, they have never discouraged hunting on the Reservation by whites during regular state hunting seasons.

Odanah, the only village on the Reservation, is located on U. S. Highway 2 in the northern part of the Reservation. The village had 531 residents in a census taken by the Great Lakes Indian Agency during January, 1957 (E. J. Riley, personal communication). Adult males who were potential deer hunters numbered 112. All but a very small number of the Indians hunting on the Reservation live at Odanah.

A control area with characteristics roughly similar to the Reservation, except for hunting by Indians, was established in the Glidden Deer Management Unit. This unit was delineated by the Wisconsin Conservation Department and occupies about 249 square miles in southwest Ashland County. The northern boundary of the Glidden Unit lies about 7 miles from the south boundary of the Reservation. The unit is almost completely within the boundaries of the Chequamegon National Forest. Measurements of deer populations, hunting, and range characteristics were made on both the Reservation and the Glidden Unit during the course of this study.

DEER POPULATIONS

Testimony of resident Indians and whites familiar with the Reservation area indicates that deer numbers on the Reservation have followed trends common to all of northern Wisconsin. Deer numbers reached a high point in the early 1940's. A slight reduction occurred following an any-deer hunt in 1943, increased again to a peak in the late 1940's, and then were substantially reduced by liberal hunting regulations in 1949 through 1951. Increases again have been noted since 1953.

Deer population levels for the Reservation and Glidden Unit were determined in the spring of 1956 and 1957 using the pellet-group-count method adapted for northern Wisconsin (Thompson, 1955, 1957). Five hundred 1/50-acre plots were sampled each spring on both areas. Biases in the pellet-group method reported by Eberhardt and Van Etten (1956) were minimized as much as possible by training observers, obliterating counted groups, and rechecking each plot for missed groups.

To increase accuracy, plots were stratified by heavier sampling in areas of greater deer use. Winter yarding ranges were mapped and classified as "yards"; a ½-mile-wide perimeter around each yard was classified as "intermediate" range; and the remainder of the range was called "open." Heaviest sampling rates were in yards and lightest in open classifications.

Personnel of the Wisconsin Conservation Department and the U. S. Forest Service conducted the pellet-group counts on the Glidden Unit, using the same methods as on the Reservation.

On the Reservation, the average number of deer-days of use per square mile was found to be 19 ± 3.2 in the winter of 1955-56, and 21 ± 5.5 in the winter of 1956-57. Similar estimates for the Glidden Unit were 31 ± 9.4 in 1955-56 and 30 ± 6.9 in 1956-57. Variances are at the 95 per cent level of confidence.

The differences in deer densities between the two areas were significant at the 99 per cent level in 1955-56 and at the 95 per cent level in 1956-57. Differences between years in either area were not significant. Deer densities on the Reservation were thus about one-third less than on the Glidden Unit in both years.

Data on productivity, breeding and fawning dates, sex and age ratios, and antler development were taken for Reservation deer. Cooperation of successful Indian hunters was necessary in this regard to obtain study material; an incentive was successfully established by offering Indians a reward of 50 cents for each buck deer head, and one dollar for each doe head and female reproductive tract.

During the 2 years of this study, information on Reservation deer was obtained from 64 does on incidence of pregnancy, from 216 antlered bucks on age-class distribution (doe ages contained an uncorrectable bias due to the Indian habit of not shooting adult does in the early season), from 166 live deer sighted in the field on sex and age composition, from 150 fawns taken in fall and early winter on sex ratios, from 127 fawns on breeding and fawning dates by back-dating fawn ages, and from 119 antlered bucks on beam diameters. In none of these categories were significant biological differences found between the Reservation deer and deer in the remainder of northern

Wisconsin, including the Glidden Unit. The population structure and productivity of Reservation deer apparently do not differ from deer on the Glidden Unit.

INDIAN HUNTING METHODS AND SUCCESS

Much preliminary work was necessary before the deer kill by Indians could be determined. Approval was first obtained from administrators of the Great Lakes Indian Agency. Members of the Indian Tribal Council were then approached individually and the project was explained to them. This was followed by a request for and granting of formal approval of the project by the Council. Next, a list of Indian hunters was prepared with the assistance of James Wilmer, an Indian hunter on the Reservation. A letter describing the project and information needed was mailed to each hunter. Soon after these letters were delivered, each Indian hunter was contacted personally to answer any questions he might have.

During this 2-year study, 71 (63 per cent) of the approximately 112 adult male Indians hunted deer. Forty-nine (69 per cent) of the 71 hunters cooperated by reporting deer killed. Most of the Indians not reporting were members of hunting parties which included one of the 49 cooperators; thus, most deer killed by non-cooperators became part of the record. Indian opinions indicated that the total recorded kill in both years was close to their personal estimates of the actual kill.

Every report of an Indian-killed deer was verified by going to the home of the Indian hunter concerned. Objective information on Indian hunting pressure could not be obtained due to the vagueness of Indian reports on hunting hours.

The Indians employ three hunting methods. During the summer months and up to the time of leaf-fall in October they hunt by watching at natural or man-made licks. The licks are usually close to roads, so that hunting effort is confined to very small areas. Relatively few Indians hunt during this period, due to the demands of their summer jobs.

From leaf-fall to snow-fall in autumn, hunting is almost exclusively carried on at night. Their method, which they call "fire-hunting" or "shining," calls for driving slowly along a road, spotting the eyes of a deer with a light, and attempting a kill. This type of hunting is popular with the Indians, and as summer jobs end, hunting pressure increases.

After there is snow on the ground, "shining" is no longer effective, and hunting methods are changed to stalking, or driving to standers. Interest in deer hunting dwindles after the regular state hunting sea-

TABLE 1. DEER KILLED BY INDIANS

	Sex and Age of Deer									% of
	Adult Males		Adult Females		Juveniles*		Unknown	Total Number		2-Yr.
Month	'55-56	'56-57	'55-56	'56-57	'55-56	'56-57	'55-56	'55-56	'56-57	Total
June	0	5	0	1	0	0	0	0	6	2
July	6	15	1	12	0	1	0	7	28	9
August	5	2	4	12	2	1	0	11	15	6
September	3	1	5	1	4	4	0	12	6	5
October	10	7	17	5	11	17	2	40	29	18
November	20	18	12	34	18	58	2	52	110	41
December	4	7	3	5	8	8	0	15	20	9
January	6	0	3	6	14	2	0	23	8	8
February	0	2	0	0	2	4	0	2	6	2
Total	54	57	45	76	59	95	4	162	228	

*Deer less than one year old.

son in November, but is continued by a few Indians until the "taste of winter browse" occurs in the deer meat, usually during February.

Results of the Indian hunting efforts are shown in Table 1. Assuming 71 active hunters, the 1955-56 kill was 2.3 deer per hunter; the 1956-57 kill was 3.2 deer per hunter. The kill by months reflects hunting effort. Prior to leaf-fall (early October), 22 per cent of the total kill occurred. A substantial increase in the kill took place in October and November, when 59 per cent of the deer were killed. Only 19 per cent of the kill was made in December, January and February.

The variability of the monthly kills between years was due in part to Indians moving in and out of the Reservation at irregular intervals. A few Indians move from reservation to reservation, living with friends and relatives. If these transients were hunters, the deer kill on the Bad River Reservation increased during their stay. Although the increase in the kill between 1955-56 and 1956-57 may reflect a herd increase, a slight increase in the total number of Indian hunters was noted in 1956-57.

Most of the Indians said they pass up killing does in favor of bucks during the summer months when fawns would be suckling. However, the 1956-57 monthly kill record does not substantiate this, although the majority of the does killed during this period were taken by two or three Indians.

HUNTING BY WHITES

General deer hunting regulations for Ashland County apply to both the Reservation and the Glidden Unit. Information on the hunting effort and success of whites on both study areas was obtained for the deer seasons of 1953 through 1956. Many of the data were obtained through the cooperation of the Game Management Division of the Wisconsin Conservation Department. From 1953 through 1955, only antlered deer with at least a 1-inch fork were legal targets. The seasons ran for 7 days in 1953 and 1954, and for 9 days in 1955. The 1956 season was changed to include all antlered deer with a 3-inch spike or

TABLE 2. ASHLAND COUNTY LEGAL DEER KILL

Year	Total County Kill**	Unit Deer Kill*				
		Unit	No. Killed	% of Co. Kill	Kill/Sq. Mi. White	Kill/Sq. Mi. W&I***
1953	461	Reservation	86	19	0.5	....
		Glidden	121	26	0.5	....
1954	456	Reservation	78	17	0.4	....
		Glidden	122	27	0.5	....
1955	669	Reservation	141	21	0.8	1.6
		Glidden	171	26	0.7	....
1956	755	Reservation	119	16	0.6	1.9
		Glidden	205	27	0.8	....

* By whites only, except where indicated.
** Data from Bersing (1954, 1955), and Bersing and Hale (1956, 1957).
*** Total white and Indian kill.

more, for 9 days. Seasons in all years were in the third week of November.

Legal hunting totals are shown in Table 2 for known white and Indian deer kills. County totals for all years and unit kills for 1955 and 1956 are from deer-registration records of the Wisconsin Conservation Department. Unit kills for 1953 and 1954 are based on a 70-per cent return of questionnaires sent to successful deer hunters in Ashland County which asked for location of their kills in the county in those years. Details on location of kill were not recorded in registering deer during 1953 and 1954.

The percentage of the total Ashland County kill on each unit remained approximately the same in all 4 years. Likewise, an increasing trend in kill per unit area also occurred in this period. On both areas, however, the legal kills per square mile are less than 10 per cent of the winter populations indicated by pellet-group counts. Thus hunting by whites, or by whites and Indians combined, was not a serious drain on the population.

Estimates of additional deer losses due to crippling, illegal killing, starvation, and miscellaneous causes based on dead deer found on pellet-group counts were made in the springs of 1956 and 1957 on the Reservation, and on the Glidden Unit in 1957 only. These estimates indicated that such losses were not large and did not significantly increase the herd losses due to legal hunting.

The effect of the additional Indian harvest on the success of white hunters on the Reservation was evaluated by comparing white hunting effort and success on the Reservation with the Glidden Unit. With the assistance of Wisconsin Conservation Department personnel, information was obtained during the 1955 and 1956 seasons from hunters in the field. Both personal interviews and hunting diaries distributed to hunting camps for return after the season were used.

Hunting success percentages in Table 3 include Reservation data from the 1953 and 1954 seasons obtained from questions in camp-

TABLE 3. DEER HUNTING SUCCESS RECORDS

Year	Area	No Hunters Checked	No. Deer Killed	% of Hunters Successful
1953	Reservation	128	35	27
	State-wide*	234,032	19,823	9
1954	Reservation	119	34	29
	State-wide*	247,310	24,698	10
1955	Reservation	131	47	36
	State-wide*	267,612	35,060	13
1956	Reservation	128	40	31
	Glidden Unit	112	24	21
	State-wide*	284,645	35,562	13

* From Wisconsin Conservation Department (1959).

TABLE 4. NOVEMBER DEER HUNTING-PRESSURE INDICES IN CARS PER MILE

Day of Hunting	Reservation 1955	Reservation 1956	Glidden Unit 1955	Glidden Unit 1956
1st	2.64	1.94	2.03	2.26
2nd	2.74	1.63	1.92	1.45
3rd	1.58	1.37	1.44	1.70
4th	1.53	1.17	1.41	1.56
5th	1.36	1.02	0.81	0.58
6th	1.27	1.02	0.83	0.87
7th	1.79	1.31	0.83	0.43
8th	1.54	1.57	0.84	0.77
9th	1.12	1.03	0.28	0.26
Mean	1.72	1.33	1.15	1.05

hunter diaries distributed in 1955. No comparable data for the Glidden Unit are available. The success of whites hunting the Reservation in all 4 years, as well as on the Glidden Unit in 1956, was much better than the state-wide average.

Comparisons of hunting pressure data were made using counts of hunters' cars along roads in the two study areas (Table 4). Cars were counted daily in mid-morning on established routes. This daily hunting-pressure index for the Reservation was greater than for the Glidden Unit in both years, and held at a higher level than the Glidden Unit as the season progressed. On the other hand, the changes from 1955 to 1956 were greater on the Reservation. Although car-counts are satisfactory indices of gross hunter numbers for comparing days or years on the same areas, the technique does not allow for differences in the land area per mile of road. Two areas of equal size may have the same car counts, but if the road :area ratios are different, true

TABLE 5. DEER SEEN BY HUNTERS

	Reservation				Glidden Unit			
	1955		1956		1955		1956	
Day of Hunting	Hunter-Hours	Deer Seen /10 Hrs.	Hunter-Hours	Deer Seen /10 Hrs.	Hunter-Hours	Deer Seen /10 Hrs.	Hunter-Hours	Deer Seen /10 Hrs.
1st	1091	1.7	903	2.2	644	1.4	951	1.5
2nd	942	1.9	930	2.1	435	2.8	1110	1.1
3rd	794	1.6	713	1.5	158	2.3	899	1.2
4th	717	2.2	765	1.4	306	2.4	694	0.9
5th	534	2.1	739	1.5	211	1.2	345	1.0
6th	477	2.0	559	3.4	93	2.2	432	1.9
7th	628	1.9	598	2.4	315	1.7	352	1.3
8th	453	2.3	442	3.3	233	1.7	264	1.3
9th	136	1.5	319	1.6	78	1.1	35	1.1
Total	5772	1.9	5968	2.1	2473	1.8	5082	1.3

hunting pressure would vary as does the ratio between areas. This effect on the present study will be discussed later.

Testimony also was taken from hunters on the number of hours they spent hunting and the number of deer they saw each day (Table 5). Again, these can be considered indices only, since they are influenced by cover density, hunter density, and weather. Deer were sighted at a higher rate by hunters on the Reservation than on the Glidden Unit in both years. This was expected because the Reservation has cover that is somewhat less dense, and travel is easier for hunters.

DISCUSSION OF HUNTING AND HARVESTS

Considering hunting by whites only, the Reservation in the years studied exceeded the Glidden Unit by having higher individual hunting success (Table 3), a higher daily hunting-pressure index (Table 4), and a higher sighting rate of deer by hunters in the woods (Table 5). However, these data do not indicate the true relationship between numbers of hunters and numbers of deer on the two areas. Although the hunting-pressure index was greater on the Reservation, there are approximately 2.76 square miles of land area in the Reservation per mile of road, while in the Glidden Unit there are only 1.43 square miles of land area per mile of road. Therefore, if the indices are reliable, and using 1955 as an example, the Reservation pressure index exceeded the Glidden-Unit pressure index by 49 per cent, while the Reservation road :area index exceeded the Glidden Unit road :area index by 93 per cent. Thus hunter densities per unit area on the Glidden Unit were greater than on the Reservation. The same relationships also existed in 1956.

Hunting-success data offer further insight on this situation. The percentage of successful hunters on the Reservation was higher than on the Glidden Unit (Table 3). However, the kill per square mile was the same or larger on the Glidden Unit than on the Reservation (Table 2). Therefore the number of hunters per unit area must have been greater on the Glidden Unit to achieve this greater kill.

The addition of the Indian deer kill on the Reservation brings the combined kill by whites and Indians to more than twice as many deer per unit area as the Glidden Unit (Table 2). Even at this harvest level, removals by legal hunting from the Reservation herd were only 8 per cent in 1955 and 1956. Hunting by whites on the Glidden Unit removed 2 and 3 per cent in the same years. These percentages are much lower than known removal rates of 25 per cent for Massachusetts (Shaw and McLaughlin, 1951) and 33 per cent for Michigan (O'Roke and Hamerstrom, 1948) which were sustained without reducing populations. Trippensee (1948) stated that an average deer herd on good range can sustain an annual kill of about 20 per cent without harm. Even with unrestricted deer hunting by Indians, the annual harvest of Reservation deer is much lower than the level required for herd reduction. The same conclusion is even more apparent for the Glidden Unit.

DEER RANGE

The density, composition and degree of utilization of deer browse species on the Reservation were determined by the quadrant method (Cottam, Curtis and Hale, 1953). The degree of utilization was recorded as ''heavy'' if more than ⅔ of the available twigs were browsed by deer; as ''light'' if less than ⅔ but at least 1 twig were browsed; and ''none'' if there was no browsing at all. All stems containing current growth between 2 feet and 7 feet above the ground were considered browse stems, except alder (*Alnus rugosa*), brambles (*Rubus* spp.), grey dogwood (*Cornus racemosa*), and epicormic branches on trees with main branches originating above 7 feet. The presence or absence of browsing by snowshoe hares (*Lepus americanus*) was also recorded.

Browse composition and density are shown in Table 6. Sample sizes for plots on which Table 6 are based include 797 stems in yard plots, 1,673 stems in intermediate-range plots, and 1,520 stems in open-range plots. Hazel, willow, aspen and sugar maple comprise more than 60 per cent of deer browse plants present on all 3 range types, with hazel being the most abundant. These species are all rated as third choice in a preference scale of four categories (Dahlberg and Guettinger, 1956). Considering all species in the composition list, 13 per cent of the species found in yards were preferred (first choice), 20 per cent were second choice, 67 per cent were third choice, and less than 1 per cent were fourth choice. On intermediate range, 10 per cent of the species present were first choice, 17 per cent second choice, and 73 per cent third choice. Despite the fact that range deterioration is indicated by a high frequency of low-choice browse, there is no reason to believe that browse is in short supply for the existing deer population. Dahlberg and Guettinger (1956) showed that low-choice browse could adequately sustain deer during yarding periods if available in quantity and in several species.

Browse-stem densities (Table 6) varied little from 1956 to 1957 except in yards. This was due in part to a higher proportion of yarding areas than other range being logged in the last 10 years, and the consequent greater stimulation of browse production following cut-

TABLE 6. RESERVATION BROWSE COMPOSITION AND DENSITY

Species Composition in Percent**	Browse Preference Rating*	Range Type		
		Yards	Intermediate	Open
Hazel (*Corylus* spp.)	3	33	29	30
Willow (*Salix* spp.)	3	12	11	16
Aspen (*Populus* spp.)	3	6	14	11
Sugar maple (*Acer saccharum*)	3	10	7	6
Red maple (*Acer rubrum*)	1	..	9	10
Red-osier dogwood (*Cornus stolonifera*)	2	..	6	7
Black ash (*Fraxinus nigra*)	3	7	..	..
Browse-Stem Density Per Acre				
1956		735	1,186	1,332
1957		950	1,144	1,379

* From Dahlberg and Guettinger (1956).
** Nomenclature from Fernald (1950). More than 5% of composition only. Number of species comprising less than 5% each: Yards—18; Intermediate—20; Open—19.

ting in yards. Subjective observations on the Reservation placed the best browse densities in recently logged stands.

Fewer stems were browsed during the winter of 1956-57 than in 1955-56 (Table 7), despite no significant change in the number of deer on the Reservation. However, browsing by snowshoe hares increased. When deer-browsed and hare-browsed stems were grouped, the apparent changes in percentages between years were not significant.

In subjective terms, winter deer range on the Glidden Unit was in poorer condition than on the Reservation. A total of 14 deer yards in the Glidden Unit and 10 yards on the Reservation were examined in the winters of 1955-56 and 1956-57. Browse availability and utilization observations indicated 13 of the Glidden Unit yards in poor condition and 1 in fair condition; on the Reservation, 2 yards were classed as poor, 7 as fair, and 1 as good.

CONCLUSIONS

The combined kill by whites and Indians per unit area on the Reservation was 2 times the kill on the Glidden Unit. During this study whites were limited to shooting antlered deer only. Although the deer population level was ⅓ lower on the Reservation than on the Glidden Unit, the Reservation herd was still large enough to provide satisfactory hunting for both Indians and whites. This indicates that the deer kill on the Glidden Unit (and other management units like

TABLE 7. DEGREE OF BROWSING BY PERCENTAGE ON RESERVATION

Range Type	Year	None	Browsing by Deer		Browsing by Hares	No. of Stems Sampled
			Light	Heavy		
Yards	1956	47	24	30	2	398
	1957	56	21	24	9	399
Intermediate	1956	63	19	18	3	837
	1957	71	14	15	6	836
Open	1956	75	14	13	5	760
	1957	83	11	6	12	760

it) could be at least doubled, including a harvest of antlerless deer, without causing a serious herd reduction.

The level of kill on the Reservation has not caused any significant changes in deer reproductive rates or sex and age composition of the population. Thus deer population data for all similar ranges in Wisconsin would apply to evaluations of the effects of hunting seasons on those ranges.

Deer browsing on the Reservation was not excessive during the course of this study, nor were important changes in browse species composition taking place. Although many highly palatable species were not present, a possible increase in browse densities in Reservation yards was indicated. However, a long-term trend cannot be safely predicted. Range conditions on the Reservation appeared adequate to maintain about 20 deer per square mile when 10 per cent of the herd is removed annually by legal hunting, plus other removals by illegal hunting, accidents, predation, and natural causes. The higher kill on the Reservation seems to be keeping the deer herd near the carrying capacity of its range, but range conditions on the Glidden Unit exhibited much poorer condition in the face of lower harvest rates.

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DISCUSSION

DISCUSSION LEADER GAUFIN: I might start, Jim, by asking if you have done any work on the relationship of range condition as correlated to timber management practices. You said that 20 deer per square mile was good from the herd-range standpoint, but how about in relation to timber management?

MR. HALE: This is something that we need to know more about. There was nothing of this nature involved in this particular study but we have been attempting for the last couple of years in cooperation with one of the Forest Service research centers in Wisconsin to get at this thing.

We have been going at it in two ways. We have tried to develop a quantitative method of assessing the susceptibility of northern-hardwood and swamp-hardwood forest types to browse damage by deer. The preliminary results indicate that there actually is not too large a percentage of these forest types that are susceptible to damage by deer simply because the larger trees on so much of the area have eliminated by crown closure anything approaching large-scale reproduction underneath them.

We have been working with the Forest Service on evaluating various timber-cutting methods to try and determine which methods and timing of cutting, particularly in hardwoods, are going to provide the best combination of wood products and deer browse as well as food and cover for other forest species.

DR. BUSS [Washington State University]: What kind of deer season was held in the Glidden area? Was it only a buck season? On the reservation, am I correct, you shot both bucks and antlerless deer as well?

MR. HALE: The hunting by Indians is unrestricted. It's both sexes and any age. Hunting by whites on both areas was antlered deer only.

MR. BRADKEY [Forest Service, Michigan]: Did you indicate that there was a significant difference in the range between the reservation and the Glidden district?

You apparently brought out the point that there appeared to be very little differences in the physiology of the herd between the Glidden unit and the reservation. Doesn't this contradict a number of other studies?

MR. HALE: We didn't have any way of quantitatively measuring this. All we can provide is a comparison of browse availability and utilization. This is hard to put on a statistical comparison.

MR. BRADKEY: Michigan, for instance, has studies which show that the range directly tied with the deer weights and so forth, and you seemed to indicate that your weights of the deer were equal on both ranges. These ranges are both relatively poor. Their comparison is one of bad against poor, not bad against good.

MR. HALE: As near as we could tell, there were no biologically significant differences between the deer using either area.

MR. BOB COONEY [Fish and Game, Montana]: We have some difficulty in white hunting. Is your hunting by permit on the reservations? So many of our reservations are restricted.

MR. HALE: No. This is strictly free public hunting the same as you would find on a National Forest. If the Indians wanted to get arguable about it, they could probably make it difficult for the white hunter, but they have never done this.

THE BROWN BEAR HARVEST IN RELATION TO MANAGEMENT ON THE KODIAK ISLANDS[1]

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The brown bear (*Ursus middendorffi*) is indigenous to the Kodiak Islands in Alaska. The islands provide 4,500 square miles of brown bear habitat, but the largest portion of the bear population is within the 2,780-square-mile Kodiak National Wildlife Refuge located on Kodiak and Uganik Island. The refuge seeks to preserve an ecological unit of natural brown bear habitat. Management objectives provide for a population in balance with the environment, permitting the development of large trophy sized bears. Surplus bears may be removed through hunting as a phase of this management.

Prior to World War II a very limited number of bears were taken for trophies on the islands. Following the war the brown bear gained rapid popularity as a trophy and by 1949 the annual harvest exceeded 100 animals. Since 1950, accurate harvest records have been maintained. As the brown bear and its habitat resist adequate population enumeration, indices obtained from the kill records are used as a basis in regulating the harvest. It is the purpose of this paper to evaluate these indices for the period of 1950-1960 and describe their use in brown bear management.

SOURCES OF INFORMATION

During the years of 1950-1959 Alaska game regulations required export permits before transporting brown bear hides from Alaska. Permits were only obtainable from designated representatives of the Bureau of Sport Fisheries and Wildlife. At the time of permit issuance, kill data was obtained from the hunter. This procedure provided information for nearly all the bears taken for trophies as most of the hides were shipped to taxidermists outside of Alaska. The data for 1960 was obtained by contacting guides and hunters in the field and may be less complete than in preceding years.

Information on the bears taken by natives for food was obtained by contacting the leaders of each village. Reports of violations served as a basis in estimating the size of the illegal kill.

HUNTING REGULATIONS AND SEASONS

Commercial hunting for brown bears was prevalent before the 1925 enactment of the Alaska Game Law prohibiting the sale of hides.

[1]The islands inhabited by brown bear include Kodiak, Afognak, Raspberry, Shuyak and Uganik.

From 1925 through 1927 the bag limit was three bears with no restrictions on the season. The bag limit was reduced to two in 1928 and a seasonal limit from September 1 through June 20 was imposed in 1931. In 1942 the bag limit was reduced to one bear per hunter. In 1954 the season was shortened to September 16 through May 31 on Kodiak Island. In 1957 this curtailment became effective for the entire island group, and the taking of females accompanied by cubs was also prohibited. The year following, cubs were also declared illegal. In 1960, the season was further restricted to October 1 through May 31 on most of the island areas.

Except for the years 1957 through 1959, regulations also required non-resident hunters to be accompanied by licensed guides. This regulation is believed to curtail the kill, because of the expenses involved in employing guides, although the take for the years without the regulation indicate its effect to have been slight.

HUNTING METHODS

The brown bears of Kodiak are usually in hibernation from November 15 until emergence in early April. This divides hunting into spring and fall seasons. After emergence from hibernation they frequent fringe areas of brush and grassy meadows at higher elevations. The brush provides cover and the meadows furnish succulent plants for their spring diet. Fall distribution of the bears is largely diverted to lakeshores, salmon streams and berry patches where bears feed upon salmon and ripened berries. Because the brown bear occupies dense vegetation, characteristic of lower elevations, fall hunting success is lower than that of the spring. The larger spring kill also arises from the fact that other big game seasons are closed at this time of the year, thus diverting more sportsmen to spring bear hunting. Most hunters also prefer the long-furred spring hide over the shorter-furred fall pelt.

Hunting is by two methods. Boats are used in cruising around salt water bays and large inland lakes, searching the adjacent hillsides for suitable trophies. Once located the bear is stalked on foot. Some hunts are conducted entirely on foot by walking in valley bottoms and viewing higher slopes for a prospective kill. Most of the bear killed are taken by guided hunters. Experienced guides have a high hunting success because they are familiar with the most productive hunting areas and methods. In 1959, the success of hunters who hired guides during the spring and fall hunts was 84 and 76 per cent respectively and for non-guided hunters the success was 35 and 20 per cent respectively.

ANNUAL KILL—1950-1960

The brown bear kill of the Kodiak Island group constitutes about 30 per cent of the total Alaska brown bear harvest. During the eleven-year period from 1950 through 1960, the calculated annual kill on Kodiak has fluctuated between 157 and 225 bears (Table 1). Between 75 and 80 per cent of the annual kills are taken for trophies. The estimated illegal kill, those taken in defense of life and property and for food, comprise 20 to 25 per cent of the total kill.

When the upward trend of the harvest reached 225 bears in 1953, records indicated that the percentage of large trophies in the harvest was decreasing; therefore the season was reduced 35 days the following year on Kodiak Island and on the remainder of the islands in 1957. Each reduction resulted in a lowered harvest; however, the popularity of the brown bear as a trophy continues to increase. As more hunters are attracted to the islands, additional restrictions will be required to retain a high proportion of the larger trophy bear within the population and to maintain a balance between increment and harvest. Thus a further two-week restriction of the fall season in 1960 again temporarily reduced the kill.

TABLE 1. THE ANNUAL BROWN BEAR KILL ON THE KODIAK ISLANDS, ALASKA, 1950-1960

Year	Spring Kill	Fall Kill	Total Annual Kill
1950	85	86	171
1951	104	57	161
1952	106	72	178
1953	137	88	225
1954	167	45	212
1955	135	58	193
1956	112	89	201
1957	114	43	157
1958	114	61	175
1959	127	69	196
1960	118	48	166

About two-thirds of the trophy kill occurs during the spring season (Table 1). The spring kill is the lowest in early April and gradually increases until it reaches a peak during the latter part of May. This progressive increase in the kill is directly related to the gradual emergence of bears from hibernation and to the increase of hunters in the field (Figure 1). In the fall the earliest portion of the season is the most productive and becomes gradually reduced as bears enter hibernation.

HIDE MEASUREMENTS AND SEX RATIOS

Hide Measurements

Most sportsmen hunting brown bears prefer, and thus selectively hunt for the larger trophy animals. This is especially true of the guided hunters, for a guide's reputation depends to some extent on

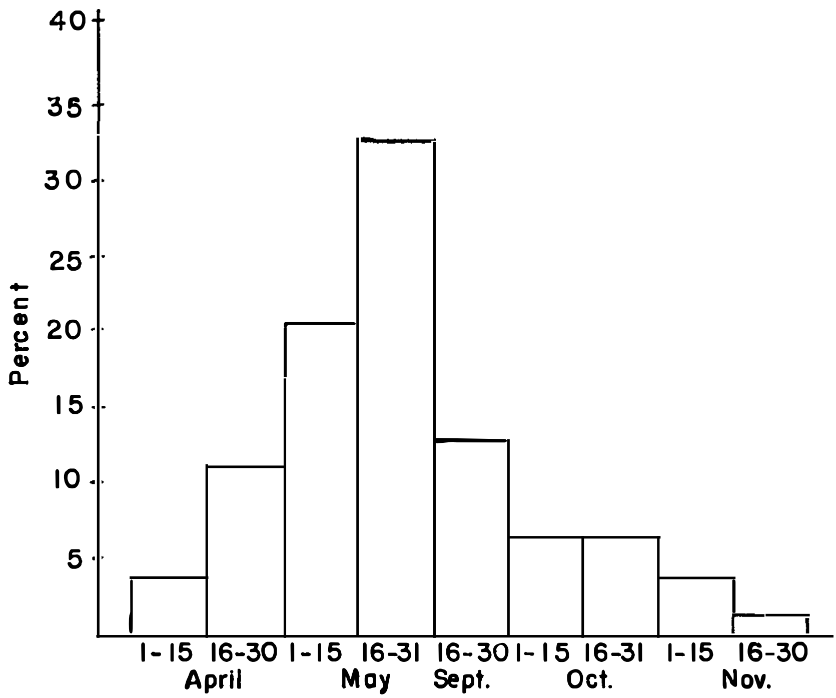

Figure 1. A typical seasonal kill chronology for brown bears taken on Kodiak Island, Alaska.

his ability to produce large bears. Although Boone and Crockett Club trophy standards are based on skull measurements, hunters characteristically appraise their kill by the squared hide size. Squared hide measurements are taken by stretching the open-skinned hide to its full length and width and measuring the distance from the nose to the end of the tail, and the width between the tip of the middle claws on opposite forelegs. The two distances are then added and divided by two, which yields the squared hide size. A ten-foot hide is considered a top trophy, and an eleven-foot bear is very rare. Measurements are subject to error but they can be used to reflect size trends.

A downward trend in hide size indicates overcropping of the larger and older bear, but it does not necessarily reduce the population. Good productivity and survival in the younger age classes could keep the population at a high level even though the age expectancy is reduced. The mean yearly hide size has varied between 8′ 7″ and 9′ 2″ but overall, the squared hide size has remained relatively uniform. The per cent of bears squaring nine feet and over has been fairly

TABLE 2. THE MEAN SQUARED HIDE SIZES FOR BROWN BEARS TAKEN ON THE KODIAK ISLANDS, ALASKA, BY GUIDED HUNTERS, 1950-1960

Year	Number of Kills	Average Size	Per Cent 9′ Plus	Per Cent 10′ Plus
1950	31	9′ 1″	58.0	39.0
1951	38	8′ 10″	40.0	29.0
1952	62	8′ 9″	45.0	27.0
1953	82	8′ 9″	48.0	21.0
1954	85	8′ 8″	47.0	24.0
1955	64	8′ 9″	44.0	25.0
1956	89	8′ 7″	43.0	15.0
1957	82	8′ 9″	38.0	21.0
1958	69	9′ 2″	59.0	19.0
1959	104	8′ 11″	47.0	18.0
1960	54	9′	57.0	15.0

consistent; however, the per cent of ten-foot bears has slightly diminished (Table 2).

Since 1950, spring hides of male bears have averaged about six inches more than fall hides (Table 3). An exception occurred in 1954 when the size of the fall hides exceeded the measurements of those taken in the spring. In recent years the average size of the fall bear has increased, which is attributed to the reduction of the early portion of the fall season. This seasonal size differential is only significant in the male kill as the mean hide size of the females remains relatively uniform. The percentage of nine and ten-foot bears in the kill is also much greater in the spring than the fall.

Sex Ratios

Figure 2 indicates the ratio of males to females as having remained essentially constant throughout the eleven-year period. The male take of this analysis constitutes 65 per cent of the harvest, resulting in a kill ratio of 188 males per 100 females. The distortion is attributed to the selective hunting for large bears. Females seldom square over 8¾ feet and those with cubs are now protected and were in the past largely passed up, thus adding to the distortion.

TABLE 3. COMPARATIVE SPRING AND FALL HIDE SIZES OF MALE BROWN BEARS TAKEN ON THE KODIAK ISLANDS, ALASKA, BY GUIDED HUNTERS, 1950-1960

	Spring Hides				Fall Hides			
Year	No. of Kills	Ave. Size	Per Cent 9′ Plus	Per Cent 10′ Plus	No. of Kills	Ave. Size	Per Cent 9′ Plus	Per Cent 10′ Plus
1950	19	9′ 7″	79.0	52.0	4	8′ 2″	25.0	0.0
1951	33	9′ 3″	61.0	42.0	9	8′ 10″	33.0	33.0
1952	29	9′ 6″	76.0	51.0	13	8′ 6″	23.0	15.0
1953	30	9′ 5″	80.0	36.0	22	8′ 9″	59.0	22.0
1954	55	9′ 0″	63.0	31.0	9	9′ 1″	44.0	22.0
1955	28	9′ 1″	75.0	46.0	19	8′ 8″	31.0	15.0
1956	31	9′ 5″	84.0	32.0	22	8′ 10″	45.0	13.0
1957	31	9′ 4″	68.0	48.0	17	8′ 8″	35.0	12.0
1958	35	9′ 4″	71.0	34.0	17	9′ 2″	70.0	23.0
1959	50	9′ 3″	64.0	34.0	22	9′ 1″	63.0	9.0
1960	30	9′ 4″	80.0	17.0	10	9′ 1″	60.0	30.0

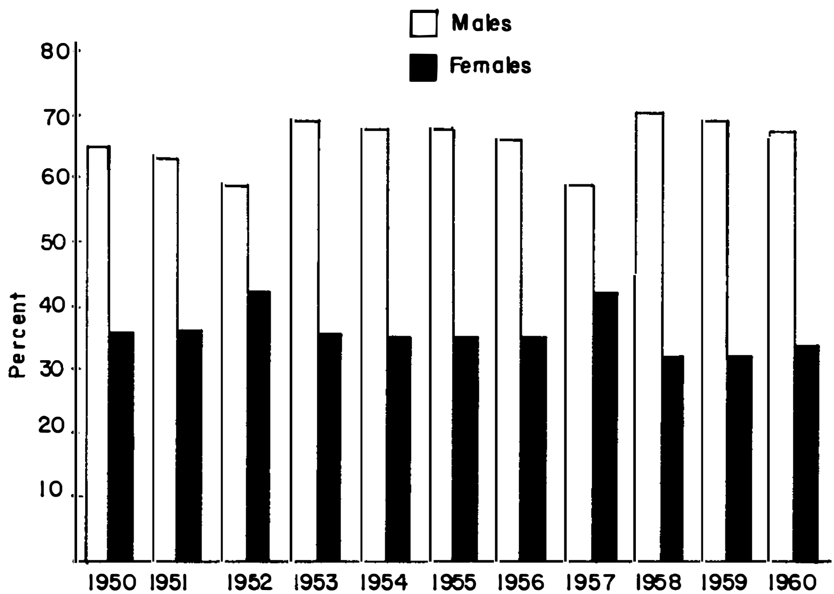

Figure 2. Sex composition of the annual Kodiak Island brown bear kill, 1950-1960.

Males predominate more greatly in the spring than in the fall harvest and constituted 68 per cent of 878 spring kills and 59 per cent of 389 fall kills during the 1950 to 1960 period. When only kills by the more selective guided hunters are considered, the difference is even more pronounced. For these hunters, males comprised 74 per cent of the spring kill and 60 per cent of the fall kill. From April to the end of May the per cent of males in the harvest decreases and from September through November, the male percentage in the harvest increases (Figure 3).

DISCUSSION

The preponderance of larger bears and more males in the spring kill can be attributed to several factors. The breeding season is underway in the spring and the adult males' movements are believed to be more pronounced than in the fall. Although quantitative data are lacking, males appear to emerge from hibernation earlier and enter later than females. This would account for gradual change in the kill sex ratio during the seasons. The ease of spring hunting also permits more selectivity for large trophies.

The statistics collected suggest that the overall population is in a satisfactory state, although heavy hunting pressure of the older age

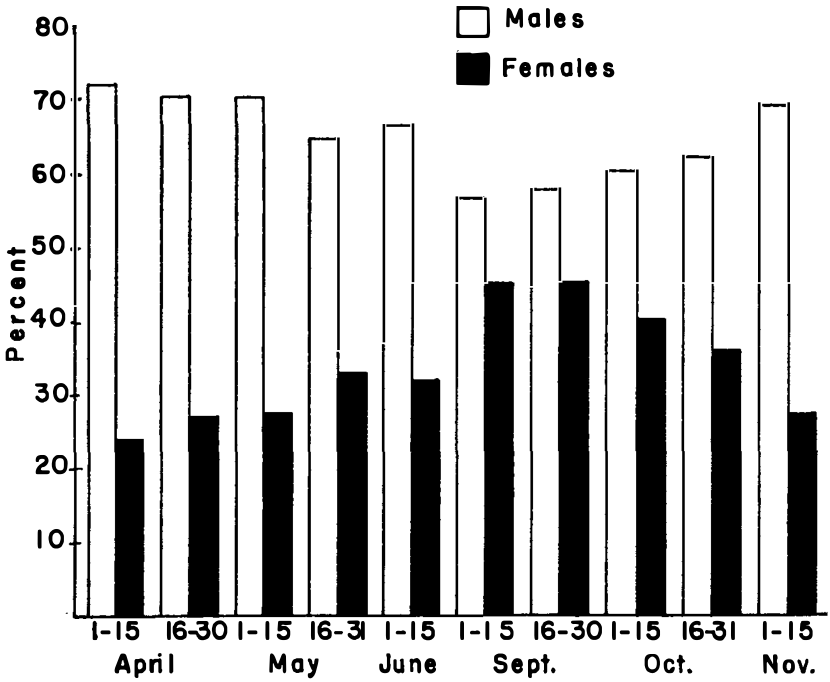

Figure 3. Sex composition of 1,267 brown bear kills by period, taken on the Kodiak Islands, 1950-1960.

classes has resulted in a slight reduction in ten-foot size bears. Since the fall hunting take is heavy to females as compared with the spring take and fall trophies are smaller, further seasonal restrictions would have the best results by limiting the fall season, especially the opening portion. These factors were the reason for elimination of the September season on the Kodiak Islands in 1960.

It should be emphasized that Kodiak Island continues to produce the world's largest brown bear. According to the latest Boone and Crockett Club records, all but one of the first fourteen brown bears listed were taken on Kodiak Island. Several of these were taken within recent years and at least one brown bear taken in the past year will place in the upper six records.

SUMMARY AND CONCLUSIONS

The brown bear is indigenous to the Kodiak Islands, where it has been subject to increasingly heavy hunting pressures since World War II. A large portion of the bear population is within the Kodiak National Wildlife Refuge which is managed for their aesthetic value and maximum production of trophy-sized bears. Hunting is permitted during spring and fall seasons. The collection of harvest data from 1950 through 1960 reveals that the kill has fluctuated from 157 to 225 bears annually. A seasonal chronology of the bear kill shows about two-thirds of the bears are taken in the spring.

Trophy hide measurements indicate spring hides of male bears average six inches greater than fall hides. No seasonal differential in the female kill was noted. The overall mean hide size has remained relatively uniform, although the number of ten-foot bears in the kill has slightly decreased. The sex ratio has remained fairly constant over the eleven year period in this analysis and males constituted 65 per cent of the harvest. The proportion of males in the spring harvest is 68 per cent compared with 59 per cent in the fall.

Regulations are based on the fluctuation of the trophy-sized bears, total take, chronology of the kill, and on the sex differential in the harvest. Based on these indices several seasonal restrictions have been imposed. It is anticipated that further restrictions will yet be necessary in the future; these should be imposed during the fall season, especially during the opening portion of the season. This serves to reduce the kill of the productive segment of the population.

DISCUSSION

DISCUSSION LEADER GAUFIN: Will, what is the correlation between the age of the bear and the squared hide size? How old is a 10-foot square bear, in other words?

MR. TROYER: I wish I could answer that question for sure. At present, we are in quite a study of tagging and marking bear hoping to come up with a technique for aging bear. At present, we don't have that information and there are a lot of differences of opinion on how old a 10-foot bear is and I think it varies quite a bit.

We are finding out that the age probably is much younger than we had previously thought and I am almost certain that some of these bears attain that size in six to eight years.

MR. DICK HARLOW [Florida]: Would you tell me how you get the estimated annual kill?

MR. TROYER: From 1950 to 1959, the regulations required an export permit for every hide shipped out of Alaska. This was not in effect in 1960. When the hunters shipped hides out we obtained kill information. The kill by natives was obtained from teachers and other sources in the villages, and the illegal kill was estimated from the actual known kill. The latter is probably our largest error. Practically all trophies were shipped out of Alaska, and on Kodiak we have no taxidermists, so we get a good count on the trophy kill taken on the islands.

CHAIRMAN HUNTER: Do the islands surrounding the refuge have the same season? In other words, since Alaska is now a state, is the state season run concurrently with the federal season?

MR. TROYER: Yes. The state regulations run concurrently with those on Kodiak Island. We do have some variations on the islands. For instance, for a few years the regulation was a little lower on Afognak Island than it was on the others.

At present, the seasons are the same except for an area right around the town of Kodiak where the season is a little longer because it isn't advisable to have a large population of bears right around the village. We also have quite a few cattle in the area and the bear cause a few headaches to the cattlemen.

MR. JIM BROOKS [Alaska Fish and Game]: Mr. Troyer mentioned that most of his harvest data was acquired through the export permit scheme that was in effect until 1959 and has been since abandoned.

I would like to comment that while that was a very excellent way of acquiring information on the harvest of bears from Kodiak Island, we felt that it had other serious shortcomings in that there were so many trophies being taken out of Alaska by servicemen and tourists it was almost impossible to police effectively that kind of regulation.

Many cars going out over the highway would have caribou horns, moose horns, and so on and it required practically a roadblock on the Alcan Highway on a year-round basis to enforce it. In lieu of the export permit program, we have instituted what we feel will be a far superior method of ascertaining the harvest of bears, and this year we will introduce a bear tagging program. That is, every brown, grizzly and polar bear taken in Alaska must be tagged within 30 days of taking.

This will provide us for the first time with information on how many bears of each species are taken, where they are taken, their sex and their size. I wanted to make this point clear because it appeared that, having dropped the export permit, we might be sacrificing procedures that were vital to bear management. I think we have replaced it with something superior.

AN EVALUATION OF ELK VALIDATIONS IN COLORADO

RICHARD N. DENNEY

Colorado Department of Game and Fish, Carbondale

Ever since 1952 Colorado has attempted to manage its elk herds on the validation of a specified number of regular elk licenses for the taking of elk of the hunter's choice in designated areas. This system has offered a more realistic approach to sound elk management than the usual "antlered only" or "hunter's choice" type of season used prior to 1952.

MECHANICS

Colorado is divided into 93 game management units, based on herd or major drainage areas, of which 86 were open to elk hunting in 1960. Fifty-six units having validations in all or portions of them were grouped into 35 areas, consisting of one to three units each, for validation purposes.

The procedure to obtain a validation is relatively simple, and there is no additional charge other than the original license. Any person desiring to hunt antlered elk in the areas open to general elk hunting may do so by obtaining an elk license at $10.00 for residents and $50.00 for non-residents—there is no limit or quota on the total number of these which may be sold. Then if he wishes to hunt an antlerless elk, he must make an application, available at license agencies and Department offices, to the Denver office showing the area and an alternate area that he wants, his elk license number, and name and address. This application then is placed in a drawing and if it is drawn he is sent a validation permit which must be kept with the original license, and a portion on the game when obtained. He is allowed to shoot an animal of his choice in that specified area, or a bull anywhere open to hunting in regular elk season. Fifteen per cent of the quota for each area is earmarked for non-residents—the per cent that they comprise in general license sales.

For several years the International Business Machines were used to shuffle and pick the successful applicants, but popular demand converted the drawing to the cracker barrel again, with the press, sportsmen and legislative representatives present.

As closely as can be determined, it costs the Department approximately twenty cents per validation for the total cost of applications, postage, printing the validation permit, drawing, labor for writing in the area and license number and addressing them.

BACKGROUND

During the period from 1940 through 1944 antlerless elk licenses were sold, ranging from 1,130 in 1940 to a high of 3,209 in 1943. Success ratios in those days averaged 53 per cent on antlerless licenses and the kill averaged 4,069 total elk per season. The numbers of antlerless permits were arbitrarily set and they were limited to specific county areas. In essence, then, these years may have been the beginnings of our validation system, but they were not based on the same foundation of factual information now used.

For many years prior to 1952 Colorado's elk seasons were of the "boom or bust" type, that is, the average season for a given area would be "bulls only" for one to three years, and then a "boom" season of "either sex" for one or more years in which a tremendous harvest would be made, and then more years of "bust" or bull seasons would be necessary to allow the herds to recuperate. There seemed to be an unwritten policy prior to the changeover that we would have two years of bull seasons and one year of either sex in certain management units and National Forests.

Biologists and game managers soon realized that this haphazard season setting wasn't really managing the herds to the fullest of their potential.

Some manner in which a specified number of animals could be harvested with a definite goal by sexes was needed. On the basis of our knowledge of the herds in certain management units, such as the aerial trend counts, sex ratios, kill composition, range trend and utilization, hunter pressure and success ratios, we felt that we had sufficient data on which to base an estimated or anticipated harvest, and then subsequent analysis would substantiate or repudiate the system. This more controllable kill and its effect on the herd could be more realistically evaluated, and then the number of validations could be raised, lowered or held the same, as the facts indicated in view of the herd objectives.

OBJECTIVES

Therefore, we actually embarked on our initial planned validation method in 1952 within two areas, each with an entirely different objective. One was an area composed of two management units (22 and 32) which were not good elk habitat generally, and where we felt elk should be decreased or eliminated if possible, as these units already had heavy winter deer populations and game-livestock competition problems. This area was increased to three units (added Unit 11) in 1953 and has had five consecutive seasons of 100 validations since the 300 in 1952, as well as one closed season and two "antlered only" seasons most recently. This number of validations is assumed by people well acquainted with the area to be more than the elk population of the three units combined. As noted previously, the objective here was to eliminate elk if possible by having many more validations than the population, and also to get validations started.

The second area was within one game management unit (85) where an access problem due to a private land grant prevented proper harvest with a regular season, and where a consequent range problem developed on both public and private lands. Obviously, the objective here was to bring the herd in balance with the range resources.

But generally the objecticve of this type of management, since its serious and intensive application in 1953, is to permit the hunting public to realize the largest possible harvest from a given elk herd or management unit that will still allow us to most nearly attain our predetermined management goal for this area.

EFFECTS OF VALIDATIONS IN SPECIFIC AREAS

The Elk River area, Unit 14 primarily, in the vicinity of Steamboat Springs has enjoyed a 37 per cent increase in average bull kill for the six years since validations have been used over the previous six years, and the overall kill in the area has been up 13 per cent. The average aerial trend count during the same period has been 53 per cent higher than it was prior to validations. The average yearling kill has been eight per cent higher since validations.

The Williams Fork area (Units 12 and 13) is an example of an area which has continuously been under-permitted. This isn't as obvious as it is in some areas, but is substantiated by the bull kill being 17 per cent above the pre-validation level, while the total kill has been 14 per cent lower, because of an average of only 100 validations. This has tended to keep the hunter pressure in the fairly constant level while it has generally increased elsewhere. Post-validation yearling percentages in the harvest average four per cent higher than those before, and the 1960 aerial trend count was 50 per cent higher than the previous count. The lowest kills in this area's immediate history occurred after the either sex seasons of 1948 and 1951. Range is apparently not a problem in this area, although annual damage is sustained on haystacks.

The Middle Park elk area (Units 18, 28 and 37) began with 200 validations in 1953 and neither the hunter pressure nor the number of validations changed appreciably until 1959 and 1960, when the number was raised to 300 based on the fact that the average post-validation aerial trend count is up over 100 per cent over the pre-validation period. The seven years of validations have averaged 35 per cent more bulls, but 14 per cent lower total kill. In one unit of the three in the validation area the yearling kill has dropped, but in the other two it is slightly higher.

In the Frying Pan-Gypsum area, Units 43, 44 and 47, the bull kill increased 19 per cent since validations started, the total kill decreased seven per cent, and the aerial trend counts increased 80 per cent, while the yearling percentage remained constant. The lowest kill experienced was the season after the 1951 hunter's choice season, when it was antlered only.

In the famous White River area, five units were combined for validation purposes originally in 1953, but since 1958 have been separated into two areas. The whole area will be discussed here as one for convenience. The lowest bull kills in the area were made after the area-wide hunter's choice season in 1948. The average bull kill has increased 15 per cent, the average total kill has dropped 14 per cent, the yearling kill has increased seven per cent, and the aerial trend counts have increased approximately 41 per cent compared to the pre-validation data.

The Grand Mesa area (Units 41, 42 and 52) has been one which has mirrored the same general trend as the areas discussed previously. It shows an average of seven per cent increase on annual bull kill, a decrease of 16 per cent on total kill, and an 82 per cent increase in aerial trend count compared to the days before validations. These figures include three game management units, one of which has very few elk, but the area was split up in 1960, and the primary unit, 42, shows a higher level on all phases mentioned than its average prior to validations.

DISCUSSION

In the beginning, there was apparently an inherent fear among our fieldmen at the Wildlife Conservation Officer level and in the general public at the word "validation." In a local game management meeting a recommendation of 600 validations from a game manager, for instance, conjured up a vision in the W.C.O.'s mind of 600 dead cows and calves besides the fairly constant bull kill in a particular validation area. This, of course, created a resistance to the system which has been slowly overcome by the true nature of validations proving itself through time, gradual acceptance, and with the aid of proper interpretation. The psychological explanation of this initial hesitation by the fieldmen and hunting public may be that when an either-sex season was declared, as in 1951, no mind's-image was pictured of the kill, no true realization, but when a specified number was mentioned, as in validations, a figure was presented for the mind to grasp, and it was reluctant to accept, or it recoiled from, that high a figure. This was true even though the hunter's choice season produced a much higher kill generally. During our eight years of experience with validations, however, even the most naive are beginning to realize that validation numbers are never actually attained in the harvest.

During the early years, it is admitted that some areas may have been set too highly in permits, but most areas were approached very conservatively. The lower numbers permitted since 1957 reflect the settling down to more practical figures as experience allowed us to temper the harvest based on more known factors.

The areas mentioned previously in the results in specific instances are among some of the finest elk hunting country in the state, and of course there are many more, but they show characteristics which are felt to indicate good herd health generally, such as an increasing bull kill, an increasing percentage of yearlings in the kill, and increasing aerial trend-count averages. There are factors influencing all the data presented here, of course, which in some cases are quite variable, like the weather, accessibility of herds and hunting areas; and some factors which have been steadily increasing, like license sales and hunting pressure.

When the bull kill increases over a period of years, other factors being somewhat equal, and the trend counts continue to go up, this increased bull kill is accepted as a desirable indication. The same is true of the yearling kill generally, a high or increasing percentage of yearlings in the herd harvest over a period of years is evidence of good herd health.

Table 1 presents the pertinent elk season results of the eight years

TABLE 1 SUMMARY OF COLORADO ELK SEASONS, LICENSE SALES, ELK HARVEST AND SUCCESS RATIOS, 1944 THROUGH 1960

Year	Type of Season A.O.—Antlered Only H.C.—Hunter's Choice	Elk License Sales	Elk Harvest, State-Wide Bulls	Cows	Calves	Total	Validation Area Total Kill Number	% Total*	Success Ratios in Per Cent Bull	Total	Cow-Calf	Val. Total
1944	A.O. with 2,450 Antlerless Licenses	51,279 Comb.	2,827	991	113	3,931					45	45
1945	100% H.C.	7,500 Limited	1,439	1,479	437	3,355			19	45		
1946	80% H.C., 20% A.O.	29,245	4,114	3,185	1,129	8,428			14	29		
1947	15% H.C., 85% A.O.	18,498	3,849	700	244	4,793			21	26		
1948	100% H.C.	23,961	3,831	5,154	1,643	10,628			16	44		
1949	70% H.C., 30% A.O.	25,170	3,641	3,481	1,126	8,248			15	33		
1950	90% H.C., 10% A.O.	25,266	4,061	2,519	866	7,446			16	30		
1951	90% H.C., 10% A.O.	29,350	4,581	4,240	1,509	10,330			16	35		
8-year Average		22,712**	3,543	2,719	883	7,145			17	36		
1952	A.O., 400 Val. Year of Transition	20,040	2,977	26	3	3,006	81	3	15	15	7	20
1953	A.O., 2,525 Val.	19,351	4,158	934	207	5,299	4,740	89	21	27	45	52
1954	A.O., 3,434 Val.	22,179	4,512	1,361	283	6,156	5,659	92	20	28	48	54
1955	A.O., 5,315 Val.	24,001	4,640	2,052	345	7,037	6,909	98	19	29	45	49
1956	A.O., 6,835 Val.	27,082	5,137	2,725	510	8,372	8,188	98	19	31	47	51
1957	A.O., 9,130 Val.	29,553	4,869	2,748	538	8,155	7,895	97	16	28	34	38
1958	A.O., 8,330 Val.	31,253	5,290	2,776	532	8,598	8,351	97	17	27	39	43
1959	A.O., 8,885 Val.	37,223	6,825	3,306	691	10,820	10,385	96	18	29	45	47
1960***	A.O., 8,820 Val.	39,574	6,787	3,348	674	10,809	(figures not available)					
8-Year Average	6,659	28,777	5,277	2,406	472	8,156	7,447	96	18	29	43	48

7-year average

* Approximately five per cent of the validation holders take bulls (Hunter, 1959).
** Excluding 1944, when deer and elk licenses were not separated.
*** Based on estimated license sales as of March 1, 1961.

prior to the transition year of 1952, and the eight years of validations since 1952 in summary form by year. This is very general, of course, and represents the overall state picture for all the areas open to elk hunting.

Approximately 70 per cent, or about 30,000 square miles, of the area of the state open to elk hunting is open to limited hunter's choice by means of validations, and 97 per cent of all the elk taken are from validation areas. From the time that validations were inaugurated in 1953 through 1959, the elk license sales have ranged from an average of 22,712 for the seven years prior to validations, to an average of 27,235 for the seven years during validations, or have increased 20 per cent. The average bull elk kill has increased 43 per cent state-wide, the cow and calf harvests have dropped 16 and 50 per cent respectively during validation management, and the total state-wide kill has averaged nine per cent higher. There has been a state-wide success ratio on bulls of 19 per cent, or an increase of two per cent; and the success ratio on total elk has dropped eight per cent. Hunter's choice permit success is very high—48 per cent.

Realizing that a state-wide summary by season wouldn't compare the effects of validations on specific units or herds, the history of each unit ever having validations was analyzed and the averages of the data prior to the use of the validations system were compared against the same categories when validations were in effect (Table 2). This was felt to be much more comparable than the data shown in the state-wide summary.

If the results itemized at the bottom of Table 2 are appraised, they show that the six-year period (average) after the adoption of validations yielded an average of 13 per cent fewer cows and 53 per cent fewer calves than the six years prior when antlered only and hunter's choice seasons were in effect, which is to be expected when unlimited antlerless animal hunting is allowed in comparison. On the other hand, the bull kill averages 28 per cent higher during validation periods, and the yearling percentage in the kill is four per cent higher. Both of these latter factors are indicative of good herd status.

It is apparent, then, that many of the herd health factors that we feel are desirable are on the upward trend under the validation plan of management. Whether this is a result of this type of management, or is purely coincidental, is debatable. We are reasonably certain that validations have had a tremendous effect on these results, but they may not be wholly responsible.

The matter of increased bull kill, for instance, could be interpreted as an indication of herd population status alone, or it may be attributed to the hunter psychology which results in heavier hunting pressure in units or areas where a sizable number of validations are offered—the hunters assuming that there must be a high population to justify the large number of permits. This logic is not necessarily true, as the bull kill has increased in many areas where validations are not set up. Hunter pressure and success ratios receive weighty consideration, coordinated with population and harvest data, in determining the number of permits that will be issued for a particular herd unit.

Aerial trend counts in our 26 established areas have been generally indicating an increase in the elk herds. These trend areas are not always limited to the populations in validation areas alone, but we feel that they reflect conditions quite well. While the great elk herds of 300-500 head as formerly seen are seldom or never observed nowadays, the observations of elk in areas where never before seen would support the assumption that we have more elk spread out over a wider range than ever before in recent history. This, of course, tends to reduce the effects of elk on the range, compared to the impact of a large herd on a critical winter or a controversial spring range as encountered 10 to 15 years ago. This invasion of new areas has come about most logically as a result of the heavy harvesting and breaking-up effect of the increasing hunter pressure and the kills sustained in the late forties and early fifties by hunter's choice seasons.

The point of increased aerial trend counts has been a matter of consternation among the non-believers, who hasten to offer such explanations as the observers are improving that much, or that now we're comparing helicopter counts with old fixed-wing counts. Generally, the counting conditions are as nearly comparable as possible each time, the trends are conducted within the same herd wintering areas each time, and specific qualifications are expressed whenever helicopter counts are used. The sex and age composition of the kill, coupled with sex ratio counts in some areas further support the contention that the herds are enjoying a healthy or increasing status.

Graphs of kill data for specific validation areas show a fairly uniform harvest since the inception of validations, and generally with an upward trend, compared to the erratic pattern of harvest during the boom and bust days of yore. The average total kill, pre- and post-validation-wise, in Table 2, while only slightly higher under validations, is significant in that it proves that we're providing as much or more under a sustained-yield plan than with the old methods, and still allowing an increase in the herds. This, then, refutes the old adage that you can't have your cake and eat it too.

Some units are very much under-validated, which can be readily corrected when it is felt that the optimum population has been attained in relation to any limiting factor—such as winter range. Many

TABLE 2. COMPARISON OF THE ANTLERED ONLY AND HUNTER'S CHOICE SEASON TYPE OF ELK MANAGEMENT WITH THE VALIDATION SYSTEM IN COLORADO, 1948 THROUGH 1959, BY GAME MANAGEMENT UNIT AND CUMULATIVE AVERAGES

	Antlered Only—Hunter's Choice System							Number	Validation System					
	No. Years*		Average Kill					Years	No.	Average Kill				
Unit	A.O.	H.C.	Bull	Cow	Calf	Total	% Yrlg.	Closed	Years	Bull	Cow	Calf	Total	% Yrlg.
2**								5	7	25	19	1	45	32
5	4	4	12	6	2	20	30	..	4	14	7	3	24	8
6	4	4	7	4	2	13	5	3	1	15	8	4	27	25
8	4	1	10	1	0	11	23	4	3	20	9	1	30	22
11	2	2	17	19	5	41	35	2	6	19	6	1	26	43
12	4	2	144	79	22	245	39	..	6	138	33	4	175	40
13	3	3	85	47	15	147	26	..	6	129	29	3	161	29
14	2	4	135	119	61	295	35	..	6	187	120	31	338	43
15	4	4	25	11	3	39	24	..	4	57	16	6	79	29
16	3	5	13	11	5	29	36	2	2	21	14	3	38	34
17	3	4	12	17	5	34	8	..	5	11	6	1	18	14
18	1	4	47	46	9	102	24	..	7	49	12	2	63	24
20	1	4	52	49	15	116	36	..	7	75	35	4	114	35
22	2	2	15	10	3	28	46	2	6	18	10	2	30	29
23	4	1	137	29	4	170	44	..	7	214	97	15	326	44
24	2	3	244	302	99	645	35	..	7	251	89	13	353	43
25	4	1	40	24	7	71	30	..	7	54	20	2	76	40
26	4	1	21	7	1	29	22	..	7	47	14	4	65	25
27	4	2	16	3	2	22	25	..	6	19	12	1	32	33
28	2	3	40	42	16	98	31	..	7	53	26	6	85	32
32	4	..	9	..	..	9	45	2	6	12	8	1	21	44
33	4	1	116	75	22	213	39	..	7	131	66	9	206	45
34	4	1	97	55	16	168	44	..	7	76	45	5	126	53
36	4	2	18	14	3	35	26	..	6	20	15	3	38	30
37	3	2	11	4	3	18	41	..	7	30	8	1	39	18
39	1	4	46	62	20	128	34	..	7	34	30	8	72	51
40	2	..	28	..	..	28	33	7	3	15	..	..	15	36
41	4	2	9	2	1	12	24	1	5	6	1	0	7	45
42	3	2	148	122	35	305	29	..	7	201	91	16	308	32
43	4	2	121	84	29	234	37	..	6	79	37	5	121	40
44	4	2	125	95	27	247	44	..	6	170	79	14	263	43
45	9	2	12	2	1	15	33	..	1	8	6	3	17	33
46	2	4	25	26	8	59	32	..	6	16	4	1	21	28
47	4	2	56	29	11	96	39	..	6	73	29	6	108	35
48	3	3	31	20	5	56	18	1	5	23	11	2	36	28
49	3	4	12	7	2	21	24	..	5	13	2	1	16	51
50	2	4	9	3	3	15	28	4	2	13	22	2	37	43
52	3	2	143	99	37	279	32	..	7	109	57	8	174	37
53	4	2	98	46	12	156	29	1	5	112	58	10	180	30
54	2	4	124	127	43	294	29	..	6	127	78	16	221	31
55	2	4	89	70	23	182	29	..	6	126	82	20	228	30
56	3	1	14	3	0	17	22	3	5	14	3	1	18	22

			Average Kill							Average Kill				
	A.O.	H.C.	Bull	Cow	Calf	Total	% Yrlg.	Years Closed	Val. Years	Bull	Cow	Calf	Total	% Yrlg.
57	2	..	4	..	..	4	0	5	5	3	0	0	3	20
58	2	2	2	0	0	2	17	7	1	7	4	0	11	0
59	2	4	12	2	1	15	6	2	4	10	9	2	21	39
63	2	4	28	29	10	67	30	1	5	25	12	2	39	37
65	2	3	63	38	12	114	29	..	7	139	70	18	227	32
66	1	4	56	46	18	120	32	..	7	106	39	9	154	23
67	1	4	52	54	16	122	28	..	7	95	57	14	166	27
68	1	4	70	79	24	173	23	..	7	108	82	15	205	33
70	4	2	93	39	10	142	25	1	5	110	41	6	157	37
71	2	3	92	62	28	182	31	..	7	187	75	12	274	42
73	2	3	122	110	40	272	32	..	7	111	47	8	166	41
74	2	3	155	96	40	291	33	..	7	209	160	37	406	39
75	1	4	102	72	29	203	31	..	7	153	93	21	267	35
76	1	4	141	96	41	278	21	..	7	205	83	17	305	33
77	1	4	108	61	23	192	31	..	7	166	76	17	259	32
78	1	4	103	70	21	194	26	..	7	204	91	21	316	30
79	1	4	81	67	25	173	26	..	7	89	47	11	147	36
80	1	4	117	113	42	272	22	..	7	206	94	20	320	31
81	2	2	42	18	8	68	22	1	7	75	37	8	120	27
85	1	6	22	8	2	32	12	1	4	23	7	2	32	12
Av.	2.9	2.8	64	45	17	126	29	0.8	5.7	82	39	8	129	33

* The number of years that each unit season was Antlered Only or Hunter's Choice.
** This unit has only been hunted by means of Validations or specified permits.

TABLE 3. THE STATE-WIDE PER CENT OF YEARLING ELK IN THE KILL DURING VALIDATION SEASONS AS COMPARED TO PRE-VALIDATION SEASONS, COLORADO, 1944-59

Validation Period		Pre-Validation Period	
Season	Per Cent Yearlings	Season	Per Cent Yearlings
1952	34	1944	31
1953	32	1945	32
1954	39	1946	34
1955	39	1947	39
1956	36	1948	33
1957	34	1949	28
1958	31	1950	30
1959	33	1951	34
Average	35		33

units have continued under our quota system with the permitted number high enough to yield the harvest equivalent to a hunter's choice season. This has been done in areas where the herds must be brought or kept in balance with the range.

The proper use of validations can distribute hunter pressure to units where normally they couldn't or wouldn't go to hunt due to terrain, cover, difficulty of access and many other factors. There exists a point, however, different in each instance, where an increase in validations begins to bring in diminishing results in the form of decreased success ratios, but with a possibly greater total harvest.

The average per cent of yearling elk in the state-wide harvest doesn't increase appreciably under the validation program (Table 3), but is much more significant in specific herd units (Table 2). The mere fact that it is higher, though, indicates that the general status is very healthy.

CONCLUSIONS

The soundness of this approach to management of big game is evidenced by the fact that several states are using this method, with some variations, in areas where the supply of a species won't meet the demand, or where they can attract hunters to areas where they need additional pressure and kill. Oregon (1960) has done this with elk, and deer in some cases; and Wisconsin's (1961) party permit and variable quota approach embody some of the same principles.

Perhaps it will not occur within the next 20 years, but with the increased leisure time for recreation and its companion-effect of increased hunting pressure, and the ever-shrinking big-game-animal ranges, the ultimate goal in the management of species such as elk will be to specify not only how many antlerless animals to harvest, but also how many bulls may be removed.

SUMMARY

Colorado has practiced the validation system of elk management for eight years whereby a specified number of regular elk licenses are validated for taking an elk of the hunter's choice in designated areas.

An average of 6,659 validations per year have been issued over this period.

In comparing the average data during the validation period from 1953 through 1959 to the 1944-51 pre-validation period, the following is true:

1. Elk license sales have increased 20 per cent.
2. The average bull kill has increased 43 per cent generally, and 28 per cent in validation areas alone.
3. The average cow and calf harvest state-wide has dropped 16 and 50 per cent respectively, and dropped 13 and 53 per cent within validation units.
4. The total state-wide harvest has averaged nine per cent higher, and two per cent higher within the validation areas.
5. The yearling composition in the harvest has risen four per cent.
6. An average of 97 per cent of the total elk taken over a seven-year period have come from validation areas.
7. The overall success ratio on bulls has increased two per cent, on total elk has dropped eight per cent, and on hunter's choice permits has held very high—48 per cent.
8. Aerial trend counts have generally increased significantly, some as much as 100 per cent.

As the number of validations are increased in an area, the success ratios increase to a point; then the success ratios drop off, even though the total kill may increase. It appears, therefore, that all the herd health factors indicate that the validation system of elk management allows you to "have your cake and eat it too" with a constantly increasing sustained-gain.

ACKNOWLEDGMENT

The advice and assistance, as well as encouragement, given me by Gilbert N. Hunter, State Game Manager, is gratefully acknowledged.

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DISCUSSION

DISCUSSION LEADER GAUFIN: Dick, am I right in assuming that the validation is not an extra permit? If their license is validated, they can just get the one elk; is that correct?

MR. DENNEY: Although we started harvesting two deer on one license in 1948, we haven't reached that point in the sustained management of elk. At the present time, a hunter may hunt an antlered elk anywhere in the state open to elk hunting by purchasing an elk license and, if he wishes to hunt an elk of his choice in specified areas, he must then make this application for validation, which is for one elk. The bag limit is still one elk.

MR. GRAHAM [Washington]: What do you do about parties? In other words, you said that they have an opportunity to make a choice and so if I and my partner both want validation permits one may get it and the other doesn't.

MR. DENNEY: We do not have a party system as far as keeping the number of applications from one party in a group, nor do we confine the number that may go to one party as Wisconsin does in its party-permit and variable-quota system on deer.

I understand that Oregon also has a party provision whereby all desiring to hunt in a party may have their applications clipped together and be treated as a party. We have some members of parties who have validations and, of course, those who are unsuccesful in drawing one. Sometimes the party may have none and at other times perhaps all the members have validations.

MR. BOB COONEY [Montana]: I was interested in your use of the yearling class in your health index. We have commonly used the calf as that class moves into the winter herd and I was interested in your use of the yearling. Do you have any comment on the desirability of using the yearling in your health index rather than the calf?

MR. DENNEY: Bob, as you know there are many things about elk and, of course, other big-game animals that we don't know. We feel that the percentage of yearlings at harvest is more indicative of the annual increment and carry-over in a herd population than the calf crop.

We have some cow-calf counts that we make in specified areas using helicopters and there are apparently differential mortalities between sexes in calves and, of course, depending on winter severity, hunting seasons, and other factors there are differences in the number of calves that come through.

In many areas we don't have this cow-calf information and we do have yearling information on most of our hunting unit areas, but we feel that it is more accurate than our knowledge of cow-calf ratios.

MR. ED HILLIARD [Colorado]: In issuing any preferential permit, such as a cow validation, has any thought been given to putting the successful drawer of one year on lower priority the following year?

In other words, you hear the complaint that "So-and-so has drawn one every year for five years and I never get one." Is there any thought being given to requiring the successful one to be in a secondary category to give the unsuccessful previous ones a better crack at it?

MR. DENNEY: It seems to me that I have heard this complaint that you have just voiced at check stations for about as long as we have had validations.

We have thought about it; yes, Ed. I am in an enviable position in that I have my immediate boss here and the Director and the Chairman of our Commission probably are also present. So I would like to pass the buck because Gil Hunter has a much better understanding of the administration problem.

CHAIRMAN HUNTER: Ed, to answer your question, I doubt under law whether we can do that. That would be discrimination. It would be the same as giving a landowner a preference over the average hunter.

However, in the last few years we have issued every validation. The validation is free after you buy your license. It merely gives you a choice of three animals if you are fortunate enough to draw one.

In other words, you always have the right to take an antlered or an antlerless elk. Now I have watched this as Dick has for years and I admit there are some fellows who draw every year. How they do it—but Ed is there and helps make the drawing himself, so I don't know.

We generally have sportsmen, press and a stockman make the drawings but I don't believe that we could bar previous successful drawers under our Colorado law.

MR. SKIBBY [Montana]: I am a Fish and Game Commissioner answering another Commissioner from Colorado. Montana has a 10-year penalty or limitation on moose, goat and sheep, so I think it would be perfectly lawful. If a hunter gets any one of these animals, he cannot get a permit for another 10 years.

CHARACTERISTICS AND STATUS OF FLORIDA BLACK BEAR

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This report is an attempt to bring together available information on the Florida black bear, *Ursus americanus floridanus* Merriam, as listed by Hall and Kelson (1959). Data presented include cranial measurements, legal and illegal kill from 1 January 1959 through 10 January 1960, average weights of Florida bear compared with black bear from other states, litter size, food habits, and economic status.

A sufficient amount of information on the life history and economic status of Florida bear has been collected over a year's period so that management recommendations of a preliminary nature are included.

TAXONOMY

The skull of the type specimen of the Florida black bear which was taken from Key Biscayne, Florida (No. 3484, male, old, U. S. National Museum) is described by Merriam (1896) as "very long, high, and narrow; frontal region remarkably elevated, highest immediately behind post-orbital processes; brain case very long and narrow; interpterygoid fossa very long; basisphenoid and palate deeply excavated, the latter strongly arched both antero-posteriorly and transversely." This description fits a good many of the adult male skulls examined in this study. A great variation, however, exists in the shape of the skulls examined, with some lacking the elevated frontal region.

Hunters who are successful in killing a bear quite often save the skull as a souvenir. This practice has made available a large number for examination and measurement. During the first year of study 60 bear skulls were located. Reliable information was obtained on sex and location of kill of 27 adult male and 15 adult female bear specimens.

Some of the skull measurements used are those suggested by Thomas (1905) while others are original. The methods used in aging the Florida bear skulls are the same as those reported by Stickley (1957). They are based on the amount of wear on the teeth, the degree of closure of skull sutures, and the degree of ridge development on masseteric fossa.

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[1]A contribution from Pittman-Robertson Project 41-R (Florida).

The majority of bear skull specimens came from the University of Florida Mammal Collection at Gainesville and the E. Ross Allen and Wilfred T. Neill Museum, Reptile Institute, Silver Springs, Florida. Special thanks are due Mr. E. B. Chamberlain, Jr., Federal Aid Coordinator, Florida Game and Fresh Water Fish Commission, Tallahassee, Fla., Dr. H. B. Sherman, Deland, Florida, Dr. James N. Layne, Biology Department, University of Florida, Gainesville, Florida, for editorial assistance, and to all Florida wildlife biologists and wildlife officers who contributed material for this report.

Following is a list of selected cranial measurements with diagrams illustrating the measurements taken:

SELECTED CRANIAL MEASUREMENTS OF THE FLORIDA BLACK BEAR

1. Condylo-basal length — from the posterior end of the occipital condyl to the anterior end of the premaxillary.
2. Posterior end of molars to anterior end of premaxillary.
3. Mastoid breadth.
4. Greatest zygomatic breadth.
5. Greatest width of rostrum.
6. Least interorbital constriction.
7. Width of skull over post-orbital processes.
8. Width of canine where it leaves the premaxillary.
9. Bottom of fossa socket to the most posterior point of the occipital condyl.
10. Greatest length of cranium—from the most posterior point of the keel to the anterior end of the premaxillary.
11. Palatilar length.
12. Basilar length.
13. Width of frontal just anterior to post orbital processes.
14. Height of skull directly posterior to molar ridge (ventral) to over the post orbital processes (dorsal).
15. Height of the cranium from the bottom of the fossa socket (ventral) to the point where the sutures meet on the dorsal part of the cranium which divides the frontal and parietal plates.
16. Cranial width (brain case).
17. Breadth of molar teeth measured across M_3.

Tables 1 and 2 show the differences between the sexes in measurements 1 through 17.

TABLE 1. AVERAGE OF 17 MEASUREMENTS OF 27 MALE FLORIDA BEAR SKULLS (mm)

Measurement	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Average	288	123	136	177	63	67	100	20	107	308	144	269	73	91	124	89	74
Number	18	26	25	24	27	26	26	26	18	25	23	20	26	24	25	23	26

TABLE 2. AVERAGE OF 17 MEASUREMENTS OF 15 FEMALE FLORIDA BEAR SKULLS (mm)

Measurement	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Average	252	112	116	153	55	65	86	17	90	265	129	235	64	77	101	86	69
Number	12	15	13	13	15	13	15	15	12	14	14	12	15	15	14	14	14

Analyses of the significance of the differences between male and

*Statistical analysis by Robert K. Hyde, Wildlife Biologist, Florida Game and Fresh Water Fish Commission.

female skulls were run on measurements 3, 4, 10, 12, and 15.* These particular measurements appear to show a greater difference between the sexes than 1, 2, 5, 6, 7, 8, 9, 11, 13, 14, 16, and 17. Table 3 summarizes the significant cranial measurements.

TABLE 3. SIGNIFICANT CRANIAL MEASUREMENTS (mm) OF FLORIDA BLACK BEAR

No. Obs.	Mea. No. 3 Significant 95% Level	No. Obs.	Mea. No. 4 Significant 99% Level	Obs.	Mea. No. 10 Significant 99% Level	Obs.	Mea. No. 12 Significant 90% Level	Obs.	Mea. No.15 Significant 99% Level
Male									
25	136 ± .39 (123-156)	24	177 ± .46 (157-196)	25	308 ± .66 (282-349)	20	269 ± .63 (249-299)	25	124 ± .43 (105-152)
Female									
13	116 ± .52 (97-124)	13	153 ± .64 (128-168)	14	265 ± .81 (235-285)	12	235 ± .82 (211-246)	14	101 ± .33 (85-107)

Based on cranial measurements 3, 4, 10, 12, and 15, a sufficient sample exists in males and females to show that a significant difference appears between the two sexes. However, except for measurement 15 and possibly 12, bears cannot be sexed by the other skull measurements because of the overlap between minimum and maximum measurements. Due to the lack of variance in measurement 15 in the female skulls more samples are needed to prove that the mean (101) is the true variance. The most significant difference between male and female skulls is found in measurement 15, which is the height of the cranium from the bottom of the fossa socket (ventral) to the point where the sutures which divide the frontal and parietal plates meet on the dorsal point of the cranium. Note Figure 3, lateral view of bear skull. The only measurement with no overlap between males and females was number 12, basilar length (see Figure 2). However, number 12 was significant at only the 90% level.

Merriam (*op. cit.*) reports that the Florida bear type specimen skull, number 3484, has a zygomatic breadth to basilar length ratio of 68.5, and for three old male skulls from Mer Range, Louisiana, gives an average length-width ratio of 64.6. The average ratio of zygomatic breadth to basilar length of 20 adult (as defined by Stickley) male Florida skulls is 65.8; closer to the Louisiana ratio than to the Florida type specimen skull.

Stickley (pers. comm.)* reports on 150 Virginia black bear skulls in the Virginia Polytechnic Institute Mammal Collection. Table 4 compares the largest bear skulls from Virginia and Florida in total length and zygomatic width.

*Information on Virginia bear skulls obtained from Allan R. Stickley Jr., Game Research Biologist, Va. Com. of Game and Inland Fisheries, Personal Correspondence, 1960.

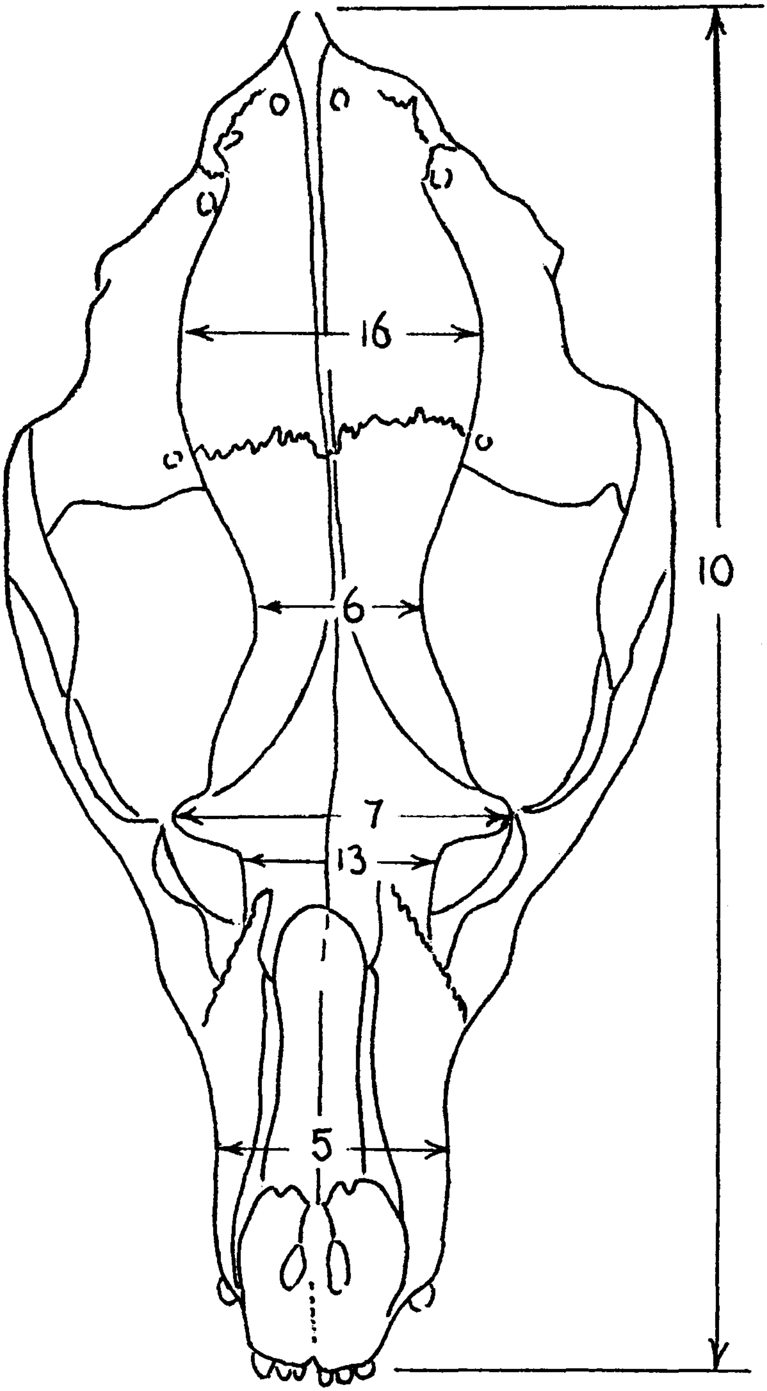

Figure 1. Selected Cranial Measurements of the Florida Black Bear (Dorsal View)

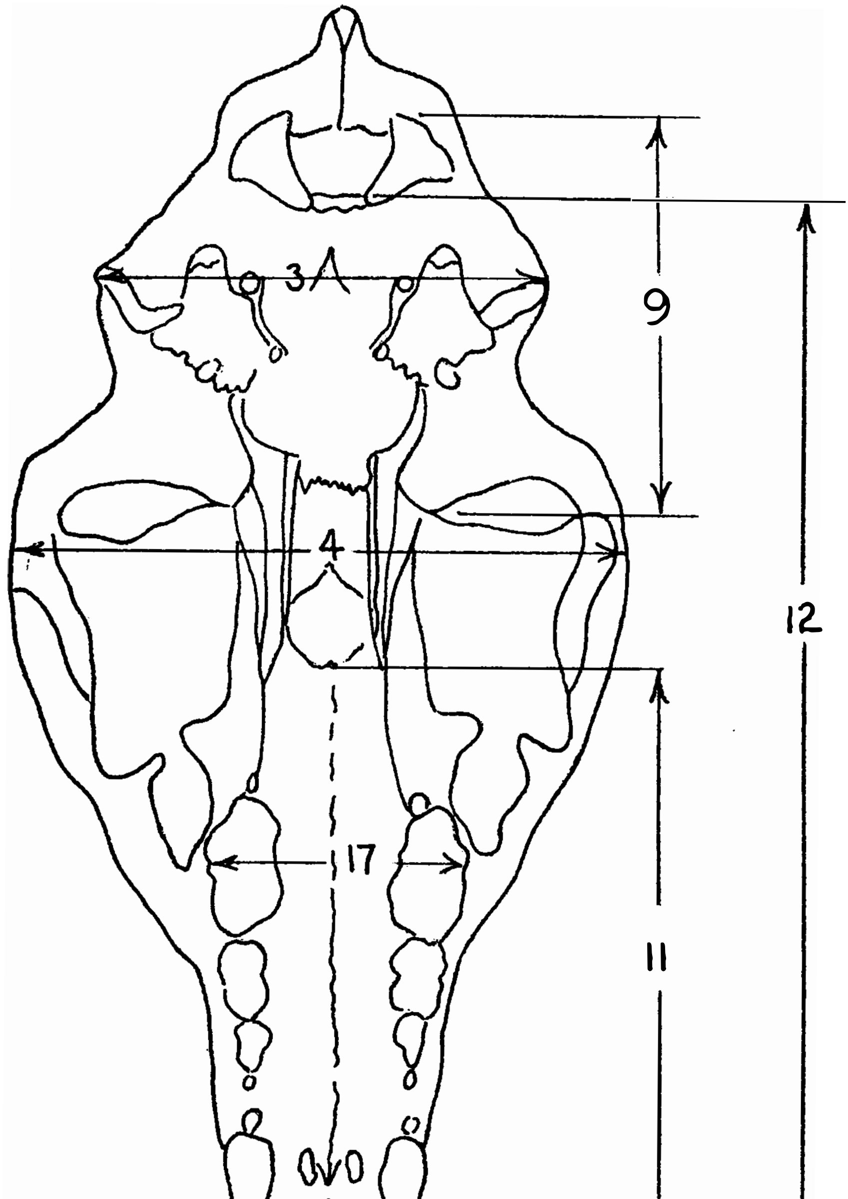

Figure 2. Selected Cranial Measurements of the Florida Black Bear (Ventral View)

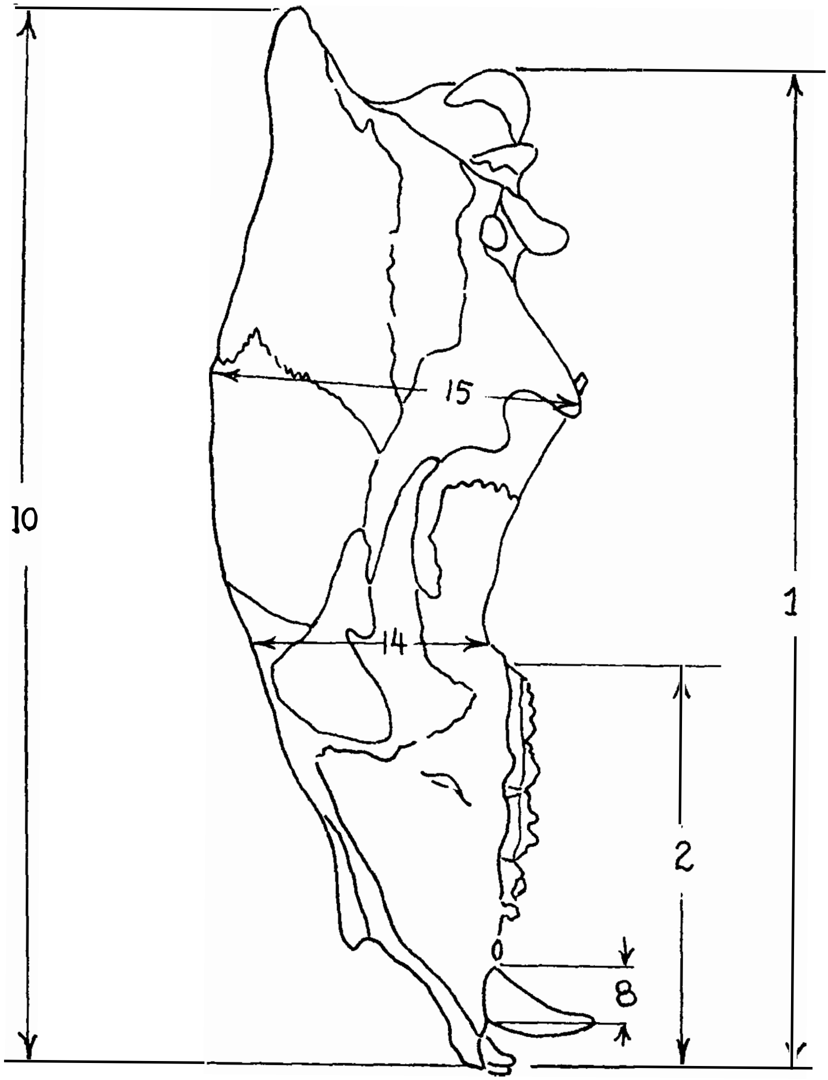

Figure 3. Selected Cranial Measurements of the Florida Black Bear (Lateral View)

TABLE 4. LENGTH AND WIDTH COMPARISON OF VIRGINIA AND FLORIDA BEAR SKULLS

Skull Length (mm)		*Zygomatic Width (mm)*	
Florida	*Virginia*	*Florida*	*Virginia*
330	297	185	189
336	293	196	172
349	341	......	207
323	283	190	162
311	317	186	177
302	293	170	169
307	306	162	169
317	309	182	188
310	342	189	196
305		194	
306	Average: 309	190	Average: 181
322		186	
307		186	
306		180	
Average: 316		Average: 184	

Ratio of zygomatic width to skull length, Florida .587
Virginia .586

Little difference exists between Florida and Virginia black bear skulls in length and width. Florida skulls average only slightly larger and the ratio of length to width is the same.

A critical review of the skull measurements compared has failed, so far, to show any outstanding differences between the Louisiana, Virginia, and Florida bear skulls.

The University of Florida Mammal Collection at Gainesville may possibly lay claim to having the largest black bear skull on record. This male skull, U.F. 5808, trapped from Duval County in northeast Florida, has an overall length of 13.75 inches and a width of 8.20 inches. The animal, after not having eaten for seven days before being weighed, tipped the scales at 580 pounds. The second largest black bear skull on record, Jackson (1939), is that of a specimen from Idaho which measured 13.25 inches in length and 8 inches in width.

WEIGHTS

In general there is a tendency for most hunters to overestimate the weight of a wild bear. This has resulted, where the majority of bear weights are estimates, in misleading information as to a sound average weight analysis of these animals. Research by Black (1958) on New York bear, in a trapping and tagging program, has shown that a wild bear may gain as much as 90 pounds in three weeks. With these variables in mind, the following data on Florida bear weights are presented with full knowledge they may have to be revised as more information is accumulated.

The average weight of adult males (3½ years and older) is 304.7 pounds and of adult females (3½ years and over) is 189.2 pounds. Table 6 compares weights of Florida bear with those of New York and New Hampshire.

With the exception of the average figure for New Hampshire males,

TABLE 5. WEIGHTS OF FLORIDA BEARS BY AGE AND SEX (DEAD WEIGHTS)

County	Males	Females	Age	Year	Remarks
Lake	......	155	Adult	1960	Weighed
Marion	406	......	Adult	1955	Weighed
Duval	580	......	13+	1954	Weighed
Union	225	......	Adult	1959	Estimated
Union	200	......	Adult	1959	Estimated
Union	175	......	Adult	1959	Estimated
Flagler	......	83	13+	1959	Weighed
Marion	160	......	Adult	1959	Weighed
Marion	......	146	Adult	1959	Weighed
Marion	......	170	Adult	1959	Weighed
Volusia	......	200	Adult	1956	Weighed
Lake	138	......	Adult	1959	Weighed
Marion	......	300	Adult	1957	Weighed
Marion	......	165	Adult	1957	Weighed
Marion	225	......	Adult	1957	Weighed
Highlands	295	......	Adult	1958	Estimated
Volusia	......	240	Adult	1959	Estimated
Putnam	522	......	5½	1946	Weighed
Highlands	470	......	4½	1959	Weighed
Highlands	......	312	5½-13	1958	Weighed
Highlands	512	......	5½-13	1958	Weighed
Highlands	425	......	3½	1950	Estimated
Columbia	......	150	13+	1959	Weighed
Columbia	235	......	5½-13	1959	Weighed
St. Johns	....	125	....	1959	Estimated
Flagler	......	225	5½-13	1959	Estimated
Collier	150	......	?	1959	Estimated
Lake	158	......	?	1960	Weighed

average weights of bears from Florida, New York, and New Hampshire are surprisingly similar. The largest New York male black bear weighed 599 pounds, Black (*op. cit.*), the largest Florida bear 580 pounds. In his study on Maine bear, Spencer (pers. comm.)* reports the weights of three of the biggest bears checked. They include a 403-pound male, a 375-pound male, and a 310-pound female (dressed weights). The 310-pound female exceeds the weight of any of the Florida female bear listed in Table 5.

REPRODUCTION

Spencer (1955) reports the average litter size of Maine bear, based on 38 observations by wardens and biologists, at 2.40. Based on 10 observations of live cubs with the mother the average litter size of Florida bears is 2.20 and ranges from 1 to 4. The figure 2.20 which is the number of cubs that survive after birth may possibly be less than those born. The limited number of Florida observations may possibly indicate a lower reproductive capacity than actually exists. It is also

TABLE 6 AVERAGE WEIGHTS OF MALE AND FEMALE BLACK BEARS FROM FLORIDA, NEW YORK, AND NEW HAMPSHIRE (DEAD WEIGHTS)

			Weights			
		Estimated	Males		Females	
State	Time of Year Weights Taken	Age Class	No.	Ave.	No.	Ave.
Florida	Fall and Winter	3½ and over	16	304.7	12	189.2
New York	Summer and Early Fall	3½ and over	49	323.9	19	200.0
New Hampshire	Summer and Early Winter	Adults	19	262.9	11	183.1

possible that the reproductive capacity of Florida bears may be less than that of Maine bears. In Michigan, Matson (1951) reported three litters of 5 cubs each, and Rowan (1947) a case of a female killed with 6 cubs.

KILL DATA AND POPULATION ESTIMATION

Intensive inquiries conducted between 1 January 1959 and 10 January 1960 by wildlife officers and biologists in Florida revealed an illegal bear kill of 33 and a legal harvest of 53.

TABLE 7. FLORIDA BEAR KILL—1 JANUARY 1959 TO 10 JANUARY 1960

	Legal				Illegal				
Regions	Male	Female	Unknown	No.	Male	Female	Unknown	No.	Totals
Northwest	3	6	2	11	....	....	....	0	11
Northeast	10	5	2	17	17	12	1	30	47
Central	5	5	13	23	2	....	1	3	26
Southern	1	....	....	1	....	....	....	0	1
Everglades	1	....	....	1	....	....	....	0	1
Totals	20	16	17	53	19	12	2	33	86

If the total illegal kill were accurately known it would probably exceed the legal. The Northeast Region reported the largest illegal kill. The Northwest and Central Regions probably had illegal kills as large as the Northeast Region, but the data were evidently more difficult to obtain. The Southern and Everglades Regions reported harvesting only one bear each. Central Florida listed a greater number of counties harvesting bear than the other four regions. The majority of illegal kills were committed by bee keepers and livestock owners. Two bears were killed by cars. Based on the results of the 1959 Random Survey Mail Questionnaire six Florida bear were legally harvested.

A rough population estimate of the number of bear in Florida, using the factor suggested by Seton (1929), that of multiplying the annual kill by 10, is 530 if the legal kill figure is used and 860 if the total kill figure (legal and illegal) is used. Frye (1950) estimated the Florida bear population in 1949 at about 500.

FOOD HABITS AND RANGE

Thirteen bear stomachs were collected from September through December 1952-59 and analyzed. Stomach contents were preserved, until analysis, by placing them in an 8 percent solution of formalin. Prior to analysis the samples were washed by placing the contents in a container supporting three different sized sieves. A strong stream of water was directed onto the material through the screens to wash out dirt and particles too small for identification. The food items remaining on the screens were then separated by species and ocular esti-

[1]Letter dated April 4, 1960.

mates made of the percentages present. Messrs. G. A. Dekle and H. A. Denmark of the State Plant Board, Gainesville, Florida, identified some of the insects and Dr. Albert M. Laessle, Biology Department, University of Florida, a number of the fruits.

The average weight of the stomach contents from seven bear was 2.3 pounds and the average quantity of stomach material present, based on liquid measure, 1⅞ quarts.

Table 8 illustrates the quantities of food items consumed.

TABLE 8. ANALYSIS OF 13 FLORIDA BLACK BEAR STOMACHS COLLECTED DURING THE MONTHS OF SEPTEMBER TO DECEMBER 1952-59.

Food Item	Common Name	Part Eaten	No. Times Occurred	Percent Occurrence	Percent Volume
Animal					
Dasypus novemcinctum	Armadillo	Flesh	1	7.6	1.40
Insects					
Diapheromera femorata	Walking Stick	Entire	2	15.4	3.90
Camponotus abdominalis					
Camponotus floridanus	Fla. Carpenter Ant	Adult	2	15.4	.38
Camponotus floridanus	Fla. Carpenter Ant	Larvae	1	7.6	.07
Curculionidae	Acorn Weevils	Larvae	4	30.7	.15
Papilius disjunctus	Horned Passalus	Elytra	2	15.4	Trace*
Belostomatidae	Giant Water Bug	Entire	1	7.6	Trace*
Total Animal					5.90
Vegetable					
Quercus spp.**	Oaks	Acorns	8	61.5	49.70
Ilex glabra	Gallberry	Fruits	2	15.4	12.00
Sabel palmetto	Cabbage Palm	Fruits	1	7.6	7.60
Nyssa biflora	Black Gum	Fruits	3	23.0	7.20
Ceratiola ericoides	Scrub Rosemary	Fruits	1	7.6	1.80
Sabel Etonia	Scrub Palmetto	Fruits	1	7.6	.38
Serenoa repens	Saw Palmetto	Fruits	2	15.4	.20
Carya sp.	Hickory	Fruits	1	7.6	.15
Vitis sp.	Wild Grape	Seeds	1	7.6	.15
Ilex opaca	American Holly	Seeds	1	7.6	Trace
Herbaceous Material	Stems, leaves	Seeds	6	46.1	3.00
Taxodium ascendens	Pond Cypress	Leaves	1	7.6	.07
Osmunda regalis	Royal Fern	Fronds	1	7.6	Trace
Gramineae	Grasses	Blades	2	15.4	Trace
Sabal palmetto	Cabbage Palmetto	Stalk	2	15.4	10.80
Ilex glabra	Gallberry	Leaves	2	15.4	.38
Pinus clausa	Sand pine	Needles	1	7.6	.07
Total Vegetable					93.50
Other					
Pinus sp., *Rubus* sp., *Smilax* sp.	Pine, Blackberry Greenbriar	Twig Ends	3	23.0	.30
Miscellaneous	Wood Chips, Decayed Wood, Bark	....	5	38.4	.30
Total Other					.60
Combined Total					100.00

* Trace—Item less than .01 in percent volume.
** Includes Water, Laurel, Myrtle, Turkey, and Live Oak Acorns.

Tabulations of the food habits data show that the fall-winter diet consists principally of vegetable matter (93.5%). Nearly 50% of all foods consumed was acorns. Animal matter (insects and armadillo) totaled 5.9% of the foods eaten.

Acorns are the most important fall-winter food of the Florida bear.

The importance of acorns to the diet of Virginia bear was recognized by Davenport (1951) when an analysis of bear kill records showed an increase in kill when a greater abundance of acorn mast occurred in the Virginia forests over that of West Virginia. The upswing in kill may have been due to the movement of bears from West Virginia into Virginia.

A mixture of flatwoods, swamps, scrub oak ridges, bayheads, and hammock habitats, thoroughly interspersed, makes the best Florida bear range. Bear range consisting of these vegetation types possesses the most varied food conditions in greatest abundance. With the exception of wet swamplands the above listed habitats are readily accessible and are either being rapidly sold for housing developments, cleared for improved pasture, stocked with cattle and/or hogs, or are being destroyed by the development of superhighways. It is evident that the largest bear populations are found in the Central and Northeast Regions of Florida.

ECONOMIC CONSIDERATIONS

Results of an opinion question asked on the annual Florida Random Mail Survey: "Do you consider bear an important game animal?" indicated that 35.9 percent of all hunters do not think bear an important game animal, 16.5 percent are indifferent, and 47.6 percent believe bears are important game animals.

TABLE 9. RESULTS OF OPINION QUESTION ASKED ON THE RANDOM MAIL SURVEY: "DO YOU CONSIDER BEAR AN IMPORTANT GAME ANIMAL?"

Region	Southern	Northeast	Northwest	Everglades	Central	Total
BEAR HUNTERS						
% Yes	81.3	78.6	66.7	73.3	85.7	80.3
% No	18.7	14.3	33.3	20.0	14.3	17.1
% Indifferent	0.0	7.1	0.0	6.7	0.0	2.6
NON-BEAR HUNTERS						
% Yes	49.5	42.7	44.2	48.5	49.7	46.9
% No	34.6	40.7	40.2	32.4	33.8	36.3
% Indifferent	15.9	16.7	15.6	19.1	16.6	16.8
TOTAL HUNTERS						
% Yes	50.1	43.3	44.3	48.9	51.0	47.6
% No	34.3	40.2	40.2	32.2	33.1	35.9
% Indifferent	15.6	16.5	15.9	18.9	15.9	16.5

When compared on a regional basis, the Central Region had the greatest number of hunters favoring the bear as an important game animal (51.1), followed closely by the Southern Region (50.1 percent), the Everglades Region (48.9 percent), the Northwest Region (44.3 percent), and the Northeast Region (43.3 percent). Results of this survey indicate that hunters in central and south Florida have a higher regard for the black bear as an important game animal than do those in north Florida. Statewide, 52.4 percent of all hunters are either indifferent or do not consider the black bear an important game animal.

Where bee-yards are located near bear country, in Florida, bee-keepers are periodically troubled by the marauding bears which damage their bee colonies. Consequently, bee-keepers have a low opinion of bruin. Unfortunately for the bears good bee-yard territory is also quite often good bear country. Hog owners who have suffered any losses from bear are inclined to side with the bee-keeper when bruin's reputation is being discussed.

Based on a mail survey of bear hunter expenditures during the 1960-61 hunting season, an average of $232.24 was spent per hunter. This figure was obtained only from those respondents who hunted bear. Expenses incurred included clothing, guns, ammunition, transportation, meals, lodging, refreshments, licenses, and care of dogs.

In an effort to determine the status of black bear in the other southeastern states, compared to Florida, the following five questions were asked recently:

1) Estimated present number of black bear in your state.
2) Estimated average annual harvest over the past ten years.
3) Estimated average annual expenditures for bear hunting in your state.
4) Do you feel that the black bear population in your state is increasing, decreasing, or unchanged?
5) Does the majority opinion in your state consider the black bear an important game animal?

Florida ranks third in bear population, bear kill, and bear hunting expenditures of the eleven southeastern states compared. North Carolina ranks first, Virginia second, Georgia fourth, Tennessee fifth, and South Carolina sixth. The remaining five states have little or no reported bear population.

There are an estimated 14,000 bear in the eleven southeastern states reporting. North Carolina reports the greatest number with 10,000 and Virginia second with 1,800. Annually an average of 1,400 bear are legally harvested. Approximately $565,000 are spent, on the average, by bear hunters in the six states which have an open season on bear. The amount spent in the state of Florida by bear hunters totals an estimated $53,400.00. In five states the bear population is increasing, in one state decreasing, and in the remaining five the bear population is holding its own. Seven southeastern states do not consider the black bear an important game animal and four do.

RECOMMENDATIONS FOR MANAGEMENT

The recommendations presented, based on such a short-term study, are subject to change should further investigations show the need. Preliminary recommendations include:

1) Reduce the illegal bear kill. This would involve encouraging bee-keepers to erect bear-bee platforms where yards are located in bear country. The Commission is presently supplying instructions on how to build platforms to interested apiarists, and has built a few demonstration platforms on national forest lands. This program should be continued and if possible expanded. If it involves private lands and the bee-keeper will not build a platform, every effort should be made to supervise the trapping and removal of the bear. In cases where bears are killing hogs, the same method of supervision in the removal of the bears should be employed.

2) Allocate special areas for bear hunting. Where a diversity of habitat exists and a growing bear population is known to be present an attempt should be made to set that portion of the forest aside as a special bear hunting area.

3) Where an oak eradication program is in progress in bear country an attempt should be made to persuade the land owners to leave some oaks.

4) Protect the female bear. In areas where a noted drop in the bear population occurs, females with cubs should be protected. If two or more cubs are observed with the mother and they exceed the 60-pound limit, only one should be taken. This regulation could probably best be adopted on special bear hunting areas. When the population again increases to former numbers, harvesting regulations may then become more lenient.

5) Investigate adequate methods of obtaining the annual bear kill. It may be possible to obtain a list of bear hunters in each region and annually mail them a questionnaire asking for bear kill and number of cubs sighted. A partial list is already available from the Random Mail Survey.

6) Publicize the esthetic value of bear and promote better relations between bee-keepers, livestock owners, and Game Commission personnel.

7) Continue research investigations particularly concerning population trends, acquiring accurate information on harvest, reproductive potential, and statewide abundance.

SUMMARY

Seventeen cranial measurements were taken on 27 male and 15 female black bear skulls from Florida. Based on these cranial measure-

ments, significant differences were found to exist between the sexes in the skulls of adult bears.

Little difference exists between Florida and Virginia black bear skulls in length and width. Florida skulls average only slightly larger and the ratio of length to width is the same. These include only the largest skulls.

Thirteen black bear stomachs collected during hunting season months (September through December) were analyzed. Vegetable matter composed primarily of acorns with lesser quantities of palmetto berries, water tupelo fruits, gallberries, and scrub rosemary fruits totaled 93.5 per cent by volume; animal matter, including armadillo and many insects, totaled 5.9 per cent, while twig ends, bark, and decayed wood totaled 0.60 per cent.

Mean weights of male and female adult (3½ years and older) bears were 304.7 pounds and 189.2 pounds, respectively. These values compared closely with weights of bears from New York and New Hampshire.

Records of ten litters of bears in Florida range from 1 to 4 young, with an average of 2.2.

The results of the 1959 Random Mail Survey indicate that 80 hunters spent 317 hunt days to kill a total of six bears. Questionnaires sent to wildlife officers and regional managers indicated that the legal bear kill from January 1, 1959, to January 10, 1960 totaled 53 and the illegal kill, 33. Discrepancies in the Random Mail Survey data on the number of bear killed indicates the inadequacy of the Random Mail Survey when an attempt is made to obtain kill information on a game species which has a low population and kill.

Results of an opinion question asked on the Random Mail Survey: "Do you consider bear an important game animal?" indicate that 35.9 percent of all hunters think not, 16.5 per cent are indifferent and 47.6 percent believe black bears are important game animals. Based on a mail survey of bear hunter expenditures during the 1960-61 hunting season, an average of $232.24 was spent per hunter. Florida ranks third in bear population, bear kill, and bear hunting expenditures of the eleven southeastern states compared.

Recommendations for management include decreasing the illegal kill, providing special bear hunt areas, encouraging the saving of oaks, protecting female bear, obtaining more accurate annual kill figures, publicizing the esthetic value of bruin, and continuing research investigations concerning population trends and reproductive potential.

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DISCUSSION

MR. FREID [New York State Conservation Department]: Could you describe briefly the method you used for determining the total population of bears in Florida?

MR. HARLOW: I just multiplied the legal and assumed illegal kill by 10. It is a very rough population estimation.

CHAIRMAN HUNTER: Do you have a special bear season or do you allow them to take bears while hunting deer?

MR. HARLOW: We do have special bear hunts that come previous to the regular hunting season. They are held in September. Bear can be hunted during the rest of the hunting season. In other words, the special bear hunts come just before the regular season on deer and other game species. After the special bear hunts are over and the regular hunting season comes in, bears are allowed to be hunted, both on the special bear hunt areas and over the whole state.

HUNTER-CHECKING STATIONS FOR COLLECTING DATA ON THE COLLARED PECCARY (PECARI TAJACU)[1]

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The purpose of this paper is to describe methods of gathering population data on the collared peccary. Limited interpretations of data collected over a four-year period at checking stations and taxidermy shops will be discussed.

The hunter-checking station has become one of game management's most important tools for the gathering of biological data. Sex and age ratios, age structures of populations, indicators of reproductive success and information on general population vigor have all come from data collected at these organized stations.

Beginning in 1957 the Arizona Cooperative Wildlife Research Unit, assisted by members of the Arizona Game and Fish Department and local sportsmen's clubs, experimented with techniques for gathering biological data on the collared peccary or javelina by the use of hunter-checking stations. This study was a companion venture along with several other co-ordinated research projects on the peccary that are being conducted by the unit and for which biological data were needed. The most closely related studies were: a study of tooth replacement and wear, a study of growth and development, a food-habits study and a study of reproduction.

When compared with the more common big-game animals, the gathering and interpretation of biological data on the peccary offer new problems. The principal one is that here we are studying an animal with a year-round breeding season. The resulting year-round parturition dates mean that animals do not fit as easily into yearly age classes or population cohorts as do deer, antelope, elk and other big-game animals. Bias in hunter selection because of size also exists.

In Arizona the annual hunting season is in February and lasts about two weeks. During the four years of checking station operations reported here, the number of hunters in the field varied from 14,340 to 18,979. The hunter success varied from 13.4 percent in 1957 to 23.0 percent in 1959, with a total harvest varying from 2,236 in 1957 to 3,098 in 1960. (Data Supporting the 1960 Hunt Recommendations, Arizona Game and Fish Dept. Report, 1960.)

Checking stations are usually established at roads leading into important hunting areas, and data are collected as hunters leave these areas after their hunt. The kill of peccaries in Arizona is scattered

[1]Contribution of the Arizona Cooperative Wildlife Research Unit; University of Arizona; Arizona Game and Fish Department; Wildlife Management Institute; and U. S. Fish and Wildlife Service, Bureau of Sport Fisheries and Wildlife, cooperating.

over many isolated mountain and foothill areas. Hence the kill is not great enough in any one place to make such established stations near the hunting grounds feasible.

To solve the problem of location, we set up our main checking station in the city of Tucson, and through an intensive campaign the location and purpose of the station was publicized. As an added inducement, the Tucson Sportsmen's Club offered prizes to participants who brought animals through the station. These prizes were given on a drawing basis after the season ended. This checking station was operated in 1957, 1958, 1959 and 1960. In addition to this, a checking station was run by Army personnel at the Ft. Huachuca Army Electronic Proving Ground during the same period. A week-end checking station was run by game department personnel in 1958 at Globe, and in 1959 at Apache Junction. The combined total of animals checked at all stations during the four-year period was 636.

In addition to the checking station operation, skulls of 506 animals were examined at two taxidermy shops. These skulls provided data on ages of animals killed by hunters and sex of some animals, but no other data except the kill location.

Reference data for aging animals by the tooth eruption pattern have been gathered on immature captive animals during the same period of time. The data on aging by the tooth replacement pattern have been described by Kirkpatrick and Sowls (Unpublished manuscript). An abbreviated description of the tooth eruption pattern is given here in Table 1. Although finer assignments of ages are sometimes possible, the categories given in Table 1 are convenient for use of field personnel and they give a suitable index to aging for general checking station use.

Studies on the rate of tooth wear of wild-trapped animals as an index to age are still being carried out and are not yet complete.

In the absence of wear-pattern information for assigning ages of mature animals we set up wear categories as follows: (1) *Slight wear but no particular teeth showing more wear than the others.* All young adult animals which have a complete set of teeth first show a uniform wear over the premolars and molars. Although there is more wear on some than others because of the long intervals before eruptions of teeth, no teeth show the dark spots on the cusps that will begin to appear after the enamel has worn off and the dentine is exposed. (2) *Wear conspicuous on the first and second molars.* Dark areas begin to show on these teeth as a result of the wearing away of enamel and the exposure of the dentine. This will make a good character for aging when more field data on tagged animals are available. (3) *All teeth show wear.* In this category all molars and premolars

TABLE 1. AGES AT WHICH VARIOUS TEETH ARE PRESENT

Age		Teeth present
2 - 6	months	All temporary teeth.
7 - 10	months	All temporary teeth plus 1st permanent molars.
11 - 12	months	All temporary teeth plus 1st permanent molars and canines.
13 - 18	months	All temporary teeth in plus 1st and 2nd permanent molars and canines.
19 - 21½	months	As above except third permanent molars just appearing.
Over 21½	months	All permanent teeth.

show dark areas of dentine. All teeth are nearly still full height. (4) *Very heavy wear but all teeth present.* This category is used when the molars and premolars are noticeably shorter than their original height. (5) *Very heavy wear with some teeth or nearly all teeth missing.* This category contains the "ancients." Considerable variation may exist in this category. Because tooth wear varies with the conformation of the mouth and with other factors, this group will probably be the most difficult group to age accurately, even after more data on tagged animals are obtained.

RESULTS

Sex ratio.—The 636 animals brought through the checking stations showed an almost even sex ratio. Of this number 49 percent were males and 51 percent were females.

In the sample of animals where sex was listed in the taxidermists' records, 63 percent were males and 37 percent were females. In some instances individual female animals that had been examined at the checking station were listed as males on the taxidermist's records. It soon became clear that the hunter's determination of the sex of an animal was not always reliable and that among taxidermists' samples a distortion would be expected. Hunters seem reluctant to list their kill as a sow.

Age ratio.—The numbers and percentages of animals by age and tooth-wear classes are given in Table 2.

The animals are divided according to the age assignments in Table 1 and according to tooth wear classifications previously described. Animals which were examined at checking stations are listed separately from those examined at taxidermy shops.

DISCUSSION AND CONCLUSIONS

From the data in Table 2 many questions are readily apparent: How much bias occurs because of the tendency of hunters to select a large animal? Obviously if hunters selected only the larger animals the percentage of immatures in the sample would not reflect a true picture of the younger cohorts of the population. There could be an even greater error in the sample of animals examined at taxidermy shops.

TABLE 2. AGES AND TOOTH-WEAR CLASSIFICATION FOR 1,142 PECCARIES EXAMINED AT CHECKING STATIONS AND TAXIDERMISTS' SHOPS.

	1957		1958		1959		1960			
Class or age	Check. Sta.	Tax. Shops	Check. Sta.	Tax. Shops	Check. Sta.	Tax. Shops	Check. Sta.	Tax. Shops	Total	Percent
2- 6 months	1	....	5	2	1	4	2	....	15	1
7-10 months	5	....	13	1	3	5	3	....	30	3
11-12 months	6	....	11	....	12	1	3	....	33	3
13-18 months	13	1	6	1	22	7	8	5	63	6
19-21½ months	18	14	5	8	10	19	3	5	82	7
Tooth-wear Pattern:										
1. Slight wear	4	18	15	26	17	46	21	5	152	13
2. Wear conspicuous on 1st & 2nd molars	32	28	44	27	25	40	29	9	234	20
3. All teeth show wear	43	68	53	44	26	38	33	10	315	28
*4. Very heavy wear	7	10	33	44	11	54	19	6	138	12
5. Very heavy wear some teeth missing	....	....	....	....	11	3	13	7	80	7
Total 2-10 months	6		21		13		5		45	
Percent of total	2		6		4		3		4	
Total 10-21½ months	52		31		71		24		178	
Percent of total	19		9		20		13		16	
Total over 21½ months	210		286		271		152		919	
Percent of total	79		85		76		84		80	
TOTAL ALL ANIMALS	268		338		355		181		1,142	

*Class 5 not used until 1959; unknown number in class 4 belong in class 5 previous to 1959.

Bias in size selection.—From Table 2 it can be seen that even though many hunters do avoid shooting immature animals, a considerable number of animals under 11 months of age are taken. With a hunter success varying from 13.4 to 23.0 percent during the years of the study, we know that many hunters are forced to take the smaller animals. Many trophy hunters deliberately seek a large animal, but most hunters seem to take whatever they can get except for the very small, young animals.

These intangible biases in size selection definitely affect the percentage of very young animals that appear at the checking stations. These biases may vary and we do not know at this time how to accurately measure this bias.

When we look at the segment of the sample between the ages of 11 and 21½ months of age a different situation exists. From studies of captive animals and data gathered from live-trapping operations we have found that on fair diets full body size is reached at about ten months. This means that after the age of ten months a large part of the size selection bias would disappear. For this reason the animals examined in the 11-21½ month age class would better represent a year's production and survival. When the hunting season is in February, the animals in this class would have been born between April 1 of the previous calendar year and April 15 of the calendar year before that. Because few animals are born in April as compared to other months, this age class can be regarded as the production and survival of one year.

Because many hunters decide whether to have the head mounted after they obtain the animal, samples from taxidermy shops would have far more bias than the checking station samples. Although this is true, a considerable number of young animals appear at the taxidermists.

Possible productivity rates.—One of the least known phases of the life history of the collared peccary is its annual rate of increase. The answer to this question and what influences this annual rate is vital to the future management of this species. In the absence of quantitative data on population dynamics, there seems to be a popular belief that the peccary reproduces at a slow rate.

Recent evidence indicates that the collared peccary has a high reproductive potential when food conditions are good. Knipe (1957) suggests that some sows may produce two litters per year. Among our captive animals used for reproduction studies one female bore three litters of two young per litter during a period of 14.3 months, while another bore three litters of two young per litter in 15.4 months. One captive female mated at the age of 38 weeks and bore young at the age of 59 weeks. At breeding time she weighed only 38 pounds, 14 pounds under her normal adult weight, which she attained by the time of her first parturition. In two instances captive females became pregnant while still lactating. Although these rates of increase among well-fed captive animals do not mean that wild animals will consistently reproduce at this rate, it indicates what might be possible when food conditions are good. Unlike the deer and other seasonally polyestrous animals the peccary is not delayed for long periods between breeding seasons if breeding failure or early death to the young occurs. The gestation period of 142-148 days (Sowls, in press) is shorter than for deer.

Of what value are the data collected during the hunting season in estimating productivity rate for the peccary and how does the peccary compare with other big-game animals in its rate of increase?

Probably the best animal for comparison is the mule deer of our western states. The reason for this choice is that a vast amount of information on this species has been gathered; its management problems in relationship to its productivity and survival are well understood and the effects of harvest are well known for a variety of habitats.

The mule deer is now regarded as an animal with a high rate of annual increase. Longhurst, Leopold and Dasmann (1952) sum-

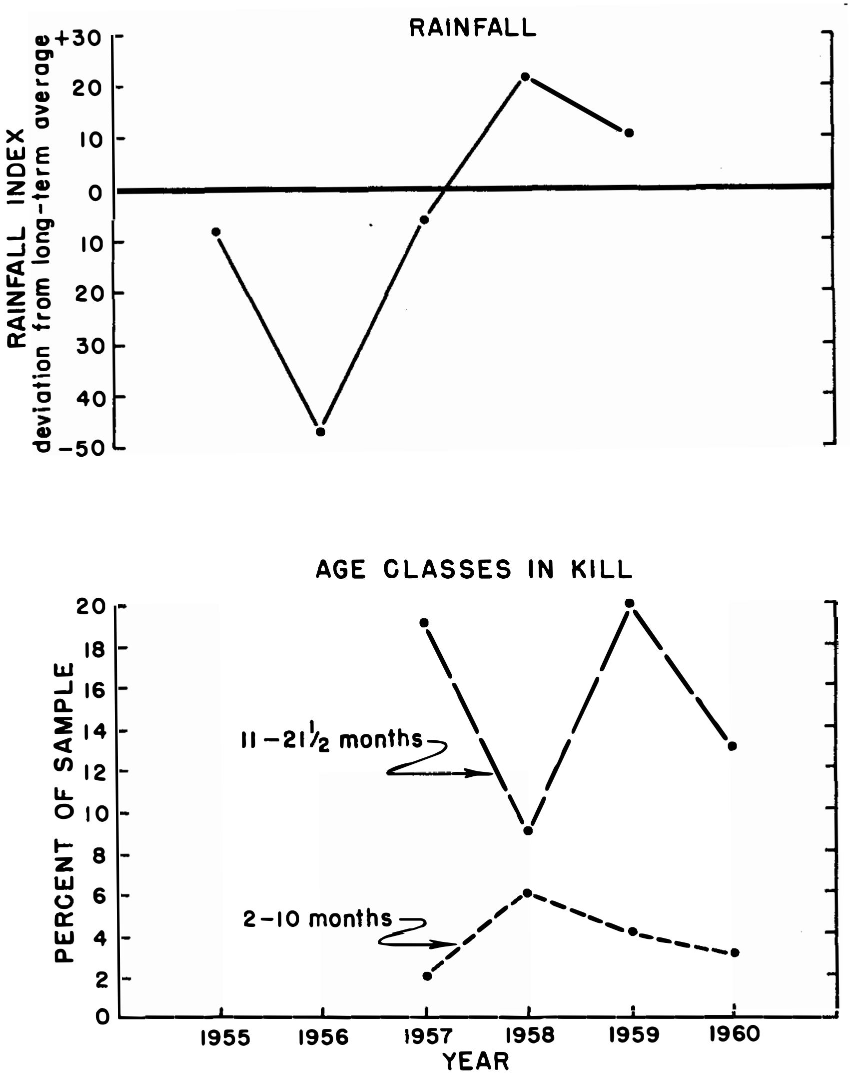

Figure 1. Relationship between rainfall and percentage of young animals in sample.

marized data on the annual rate of population gain in the western states and found it to be between 20 and 32 percent. Swank (1958) found a 19 to 30 per cent annual reproductive gain among mule deer in parts of Arizona.

These productivity figures for deer are usually based on the cohort of animals between 12 and 18 months of age with a most common age being about 16 months. Though this age bracket for deer includes only a 6 month period it does represent a full year's production because of the more restricted breeding season. In both deer and peccary about one year to nearly 2 years have elapsed between birth and the time of sampling.

Yearly percentages of the peccaries in our sample in the 11-21½ month age group varied from 9 to 20. This suggests that in good years production and survival to the second year of life would be at least 20 percent or equal to that of some western mule deer herds.

One important consideration that might alter the meaning of these percentage comparisons is the life span of the peccary. Data on their life span is still meager but our findings indicate that it is probably shorter than for deer.

Relationship of rainfall to production and survival.—Of what value are these data in revealing the influences of environmental changes on the production and survival of populations? In southern Arizona there are two dry seasons each year. Normally there are intermittent winter rains from November through March followed by a dry period in April, May and June. Heavy thunderstorms occur in July and August, followed by a dry period again in September and October. About 43 percent (Smith, 1956) of the moisture falls during the months of July and August. Great variations in the amount of precipitation occur with changes in altitude.

The diversity of the terrain from which our samples came, along with the biases already mentioned, makes relationships between environmental factors and production hard to detect. In spite of this there are strong indications of the detrimental effects of severe drought and a close tie between rainfall and production. Figure 1 shows the possible relationship between the annual rainfall and the production and survival of young peccaries during the four-year period of this study.

The rainfall index plotted in Figure 1 is the deviation from the long-term-average of the combined annual rainfall of nine stations scattered over the principal range of the peccary where the animals were killed. The percentages of animals in the 2 to 10 month age class are plotted and also the percentage of animals in the sample that were between 11 and 21½ months of age.

Following the dry year of 1956 a low percentage of animals in the 2-10 month age class were present in the 1957 sample. The possible influence of the dry year of 1956 was again reflected in the 11-21½ month age class in 1958. Hunter success in 1957 was the lowest of the four-year period that the checking stations were in operation.

Similar correlations between rainfall and production and survival seem to be present in the corresponding length of time after the far-better rainfall conditions of 1957. The fact that no clear relationship between rainfall and the percentage of young animals appeared in the later years may mean that other factors than rainfall are important and that only in extremely dry years as 1956 does the amount of precipitation overshadow these other effects.

SUMMARY

Between 1957 and 1960 the Arizona Cooperative Wildlife Research Unit assisted by members of the Arizona Game and Fish Department gathered age data on 1142 collared peccaries shot by hunters. At organized checking stations 636 animals were examined and age data from skulls was obtained on 506 animals at taxidermists' shops. The problem of measuring age cohorts of the population is complicated because of the year-round breeding season of this species and the resulting year-round parturition dates.

The sex of the animals examined at checking stations was almost even but taxidermists' records showed a high percentage of males.

Ages of animals were based on the tooth eruption pattern to 21½ months. Animals were grouped into five age classes through this age. Animals older than 21½ months were grouped into five tooth-wear categories. The assignment of ages to these categories is not yet possible because the rate of tooth wear in wild animals it not yet known.

Although size and age bias exists in samples from the kill, a large number of young animals are shot. In the age class between 11 and 21½ months it seems unlikely that bias from this size selection is important because by 10 months most animals have reached adult size.

Based on figures from the 11 to 21½ month age categories it is apparent that in good years as high as 20 percent of the sample can come from one year's production. This indicates a yearly rate of increase approaching or perhaps exceeding the western mule deer.

There appears to be a definite relationship between the percentages of animals under 21½ months of age and years of severe drought. Following the severe drought of 1956 only 2 percent of the sample was in the 2-10 month age group as compared to 6 percent the following year when rainfall was near normal. The effects of the drought were reflected in the 11-21½ month age class the next year when only 9 percent of the animals were in this later age group as compared to 20 percent the following year.

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DISCUSSION

DR. BEUCHNER [Washington State]: Lyle, do you have information on the length of time between parturition and subsequent oestrus?

DR. SOWLS: We are getting some information on that. It didn't fit into this paper, of course. We had one young female from whom we took the young when they were about a day old and she came into heat about 20 days later. We are now running a series of experiments to find out the natural period in the absence of conception. We have a lot of data on that now. It runs around 18 or 19 days but for some reason we find some peculiar things happening.

The female will be receptive usually for about three days in a row but then, sometimes, it will stretch out for seven or eight. Also, you may build up a pretty consistent record of a certain female going around 18 or 20 days and then suddenly it comes down to around seven or eight. I don't know what the answer is, but we are trying to run this over a full year's period. After that we plan to study the effect of various nutritional levels.

CHAIRMAN HUNTER: You spoke of a hunting success ratio ranging from 13 to 23 percent. Is that a common success ratio? It seems to me quite low.

DR. SOWLS: The javelina is not a difficult animal to kill but it is an extremely difficult animal to find. I think you can see why. You go deer hunting around a mountainside and down through a few saddles and you see four or five deer. You can look all day and the next day and the next day and you won't find the javelina although they are there.

It is a herd animal and unless you find all of them, you don't find any at all. That is one reason and sometimes the opening day interest is pretty high but after walking the hills and getting a few blisters, hunters lose interest about the second or third day.

WILD TURKEYS IN MISSOURI, 1940-1960

JOHN B. LEWIS
Missouri Conservation Commission, Columbia, Missouri

In April 1960, Missouri had its first wild turkey season in 23 years. Although the harvest was modest (94 gobblers), the percentage of successful hunters (12 percent) was high, especially when we consider that many of the hunters were novices at turkey shooting. In general, the season was a good one and a fine climax to a 20-year program of turkey research and management. We still have a long way to go, but we have made real progress.

Several years ago Missouri's would-be turkey hunters shared the pessimism that prevailed about wild turkeys in much of their range. In 1949 Mosby summarized the status and gloomy outlook for the eastern and Florida wild turkeys. He reported that these races then occupied only about 12 percent of their ancestral range. Turkey populations were thought to be increasing in only 3 of 17 eastern states, were static or decreasing in most, and were reported as dangerously low in 5.

Missouri's turkey hunters can now share in a wave of optimism surrounding the species. In 1959 Mosby was able to report a ten-year increase, estimated at 126 percent, in eastern wild turkeys throughout their range. The reported annual kill in the eastern states had risen nearly 100 percent in the same 10 years.

To see how the encouraging state of affairs was reached in Missouri we must look back to the inception of Missouri's research and management program for turkeys in 1940.

Prior to 1940 little was done in Missouri except to release game-farm turkeys. No thorough evaluation of the releases was made, but results were obviously poor. As Bennitt and Nagel (1937) noted, many of the released birds simply accumulated around farmsteads. In late 1939 investigations were started to determine why stocking of game-farm turkeys gave poor results and how native wild birds could be increased. Obtaining ownership of a tract of land where experiments in various phases of wild turkey management could be conducted was essential to the new program. Accordingly, the Conservation Commission purchased the 5,530 acre Caney Mountain Refuge in Ozark County, southwestern Missouri, in 1940. This specific tract was selected because: (1) It had not been badly burned or grazed for a period of about 5 years; (2) there was a small flock of native turkeys which had not been contaminated by game-farm releases; (3) the people living in the surrounding community were in sympathy with the project.

Steps were taken to exclude livestock and fires completely. Food plots and ponds were built to supplement the natural food and water supply and some predator control was exercised.

Ten turkeys were on the refuge at the time of purchase. By March 1943, the population had increased to 88 birds. This dramatic increase demonstrated that wild turkeys would respond to good management (Leopold, 1943). Unfortunately, the turkey management program on Caney Mountain Refuge was discontinued after 1943 because of personnel problems created by World War II. However, the work there provided information concerning management techniques which have been the foundation of our present restoration program.

In 1942 a statewide survey of wild turkeys was conducted (Dalke and Leopold, 1943). When results were compared with those of a 1934 survey (Bennitt and Nagel, 1937) it was once more apparent that liberation of game farm birds had failed to increase wild turkey populations. The stocking program was discontinued in 1943; 14,000 birds had been released in an 18-year period.

Personnel of the Missouri Conservation Commission have continued statewide turkey censuses at 5-year intervals, 1942-57. Results of these censuses have been presented elsewhere (Lewis, 1957) but are summarized here to round out the picture (Table 1).

TABLE 1. TRENDS IN TURKEY POPULATIONS BY GEOGRAPHIC REGIONS

Regions[1]	1942 No. Birds	1942 Percent Change[2]	1947 No. Birds	1947 Percent Change[2]	1952 No. Birds	1952 Percent Change[2]	1957 No. Birds	1957 Percent Change
Western Ozark	2,116	+107	1,796	−15	1,027	−43	1,016	− .87
Eastern Ozark	1,169	+ 5	456	−60	536	+17	1,210	+126
Mississippi Lowlands	42	− 75	58	+58	10	−83	....	−100
Central Plateau	786	− 16	841	+ 7	710	−16	763	+ 7.46
N.W. Oz. Border	227	− 33	129	−43	96	−26	98	+ 2
Totals	4,340	+218	3,289	−24	2,379	−28	3,087	+ 29.76

[1]Counties included in each region are as follows:
Western Ozark: Barry, Stone, Taney, Christian, Ozark, Douglas,
Eastern Ozark: Oregon, Ripley, Butler, Wayne, Carter, Shannon, Reynolds, Iron, Madison, Perry Bollinger St. Francois Jefferson, Ste. Genevieve.
Mississippi Lowland: Mississippi, New Madrid, Pemiscot, Dunklin.
Central Plateau: Texas, Pulaski, Phelps, Dent, Crawford, Washington.
N. W. Ozark Border: Wright, Laclede, Hickory, Camden, Maries, Motngomery, Warren.
[2]Percent changes from previous inventory.

Interesting regional changes in turkey populations have been observed since 1942. In that year the western Ozark region had the highest turkey population in the state. This was still true in 1947 (Anon., 1947), but during the next 5-year interval there was a 15 percent loss in this region. During the same period the turkey population of the eastern Ozarks declined about 60 percent. The 1952 (Sadler, 1952) survey showed that turkey populations had continued to decline in the western Ozarks, but had recovered slightly in the eastern portion. In 1957 the downward trend in the western Ozarks had halted and turkeys were 126 percent more numerous in the eastern Ozarks than they had been in 1952.

The actual changes in density of turkeys have been much more apparent than the reasons for them. Dalke, Leopold, and Spencer (1946) thought that major factors affecting distribution and density of turkeys in Missouri were soil type and fertility. However, any basic relationship between soil fertility and numbers of turkeys seems to have been over-ridden in more recent years by a number of sociological and land-use factors. Turkey range in the western Ozarks has probably deteriorated with the progressive changeover of the grassy glades and "bald knobs" into cedar thickets. On the other hand, reduction of open-range grazing, fire protection, dwindling human populations and changed public attitudes may have benefited turkeys in various other parts of the Missouri range in different degrees. Certainly good timber management has improved turkey range, especially in the eastern Ozarks. Tallies by Hornkohl (1947) and Sadler (1952) showed upward trends and larger flocks on National Forest lands where there was considerable cutting and timber stand improvement. The 1957 census (Lewis, 1957) indicated that almost half (55 percent) of the turkey population was found on 2/5 of the occupied range which was within the gross boundaries of National Forest lands.

After the program at Caney Mountain was terminated in 1943, little was done deliberately about turkey management in Missouri for a decade. However, the 5-year surveys were continued and turkey range was developing favorably in a few areas of the state.

THE MANAGEMENT PROGRAM SINCE 1954

In 1954 the Conservation Commission's program of turkey management was revitalized with the immediate objective of restoring turkeys to vacant range. At that time, only about one-third of the 22,000 square miles regarded as Missouri's potential turkey range by Dalke *et al.* (1946) was occupied. The most promising areas for restoration were the northern and eastern Ozark border and northern riverbreaks.

The first major problem was to establish a source of native wild turkeys for restocking unoccupied range. The second problem was to develop a more efficient method of capturing turkeys. And last, but certainly very important, was the selection of high-quality release areas.

To develop a source of birds to trap, work was started on 5 refuges that had been used to supply deer for a deer restoration program. One additional area was purchased and developed for turkeys. Small numbers of turkeys remained on all of these refuges. Initial plans called for building one pond and clearing one acre in each 80 acres of turkey refuge. These plans were carried out on most of the 45,000 acres of refuge land.

Response to this intensified management program was varied. One area in particular has produced over 100 turkey for restocking since 1955.

While we were getting our program of transplanting native turkeys in gear we tried releases of game-farm wild turkeys once more. Whereas the game-farm birds released earlier had been of mixed or dubious ancestry, these new birds were of high-quality Pennsylvania game-farm stock. Birds of the same stock have been successfully established elsewhere (Wilson and Lewis, 1959). Two hundred and thirty-seven of these birds were released on two promising areas in 1954 and 1955. The releases were observed closely for three years, but once again they failed.

Before any widespread restoration program using native turkeys could be initiated a more effective method of trapping turkeys had to be developed. Some turkeys had been taken during an earlier deer trapping program, but numbers were too few, and the birds were often injured. Several types of modified deer traps, pole traps and wire traps were used. Trapping difficulties like ours have often been encountered elsewhere. In fact, Mosby (1949) wrote that although live trapping wild turkeys looked promising, it was a very costly and difficult operation, and that restocking with either game farm birds or live trapped turkey would not solve the problems of a generally declining population.

In 1954 we tried the cannon net trap on native turkeys and results were encouraging (Sadler, 1954). Since 1954 approximately 250 turkeys have been caught in Missouri with cannon net traps. The success of this technique has been so important to the restoration of native wild turkeys in Missouri that it can be termed a break-through.

Since the recent restoration program was initiated in 1954 eleven areas have been stocked with turkeys. Seven of these can be classed as successful and one doubtful. It is still too early to appraise two more releases made last year and one started this winter.

Various stocking combinations have been used to determine numbers of turkeys needed to re-establish a population. Presently, it appears that 12 turkeys (4 adult gobblers and 8 hens), are a satisfactory number for a release in the unoccupied Missouri range (Table 2).

TABLE 2. TURKEY RELEASES

Release Area	No. of Birds Stocked	Initiation of Stocking	Completion of Stocking	Population Established	Estimated Population
Moccasin Bend	3 gobblers 3 hens	7-11-53	Spring, 1954	Doubtful	?
Ste. Genevieve	7 gobblers 15 hens	1-27-55	1-16-55	Yes	350+
Perry Co.	5 gobblers 7 hens	2-13-56	2-14-57	Yes	100+
Gasconade	6 gobblers 8 hens	10-13-57	3-12-58	Yes	80
Hickory	4 gobblers 8 hens	11-26-57	3-12-58	Yes	75
Warren Co. (Daniel Boone)	7 gobblers 9 hens	2-18-58	2-18-59	Yes	50
(Lost Creek)	13 gobblers 9 hens	2-18-58	1-24-59	Yes	50
Caney Mtn.	9-11 gobblers 14 hens	1-15-59	1- 7-60	Yes	30
Montgomery	16 gobblers 15 hens	10-20-59	12-28-59 (just comp.)	Too soon to know	?
Morgan	13 gobblers 12 hens	12- 3-59	(just comp.)	Too soon to know	?
Gasconade	6 gobblers 7 hens	this winter	(incomplete)	Too soon to know	
	91 gobblers 107 hens				
Total	198				735

Use of the cannon net trap often enables us to release together several birds trapped from the same flock. These birds quickly reassemble after liberation and seem less likely to start wandering than birds released singly. Dispersal from the release site is thus reduced. We suspect that this is a key to successful release.

One of the first questions asked after an area has been stocked is how long will it be before we can have an open season. This question could not be answered during the early stages of our restoration program. But it was evident from the beginning that if we were to keep the public interested in the turkey program some thought would have to be given to having an open season on turkeys very soon.

The possible advantages of having an open season were several. First, it would serve as an incentive for better management and protection of turkeys on occupied range. Second, the prospect of open seasons in areas recently restocked, or to be restocked, would help to stimulate interest for the establishment of new release sites.

Were there enough turkeys in the state to permit hunting? The 1957 census indicated that the population was increasing, but still below the 1942 figure. A fall season under these circumstances might be risky, but a spring season might be conducted without endangering the population.

Biologically a spring season can be justified. Turkeys are polygamous and one gobbler can mate with several hens. Yearling males normally do not breed and are not so likely to be called up to the hunters as are breeding adults. So, theoretically, if all of the adult gobblers in any one area were killed there would still be some yearlings left for breeding the following spring.

The season was established so it would fall after the peak in mating had occurred. This would be added insurance against the possible loss of breeding stock in any given area. Determination of the dates for the season was based on the back dating of brood reports received during the summer months over the past 8 years.

Frye (1957) indicated the relative invulnerability of mature gobblers to most natural causes of mortality. Sex and age ratios of 682 turkeys trapped over several years on areas where no hunting was permitted showed a ratio of seven young hens to three adult hens, and a ratio of three young gobblers to seven adults. Sex and age statistics from 636 turkeys killed during a fall hunting season showed the same ratio for the hens (seven young to three adults), but the ratio in gobblers was quite different from that of an unshot population.

The danger of hens being killed by the amateur turkey hunter who is not able to distinguish sexes is one of the major objections to a spring season. The truth is that most amateur turkey hunters rarely have the opportunity to make that choice.

Fourteen counties were opened to wild turkey hunting in Missouri (gobblers only) on April 27-29, 1960. Hunting was permitted from

5:00 a.m. until noon on each of the three days and only shotguns and long bows were legal weapons.

A checking station was established in each of the 14 counties and manned by a biologist during the season. All hunters were required to check their turkeys. Seven hundred and seventy-nine participated in Missouri's first turkey season since 1937, and ninety-four of them were successful. As pointed out above, the percentage of successful hunters (12 percent) was higher than expected, particularly considering the fact that many of them had never hunted turkeys before. Several factors may account for this: hunting pressure was lighter than anticipated; several turkeys were killed by local people who knew where the birds were; and there was a good population of turkeys in some areas.

It was possible to open hunting in one county, Ste. Genevieve, in which restoration of native turkeys had been started only four years earlier. Twenty-two wild turkeys had been released in 1955-56. The 1960 population was estimated to be about 300, most of which were within a 15-mile radius of the release site. There was local opposition before the season, but 11 birds were killed in the county, and the prospects for an increasing turkey population here seem good.

The success of the Ste. Genevieve County releases is important as pilot information. We can hold out hope for gobbler seasons, at least, to the residents of other areas with good potential range within a few years after releases are made. The effect of these early gobbler seasons may be compared to a "buck only" season, in that a limited harvest can be taken, but without endangering the potential increase in the population.

But in a larger view, we are now hopeful of significant increases in Missouri's wild turkey population and in restoration of turkeys to a large proportion of the potential range. We lay our hopes on the presence of trappable numbers of birds in several Ozark areas, on the presence of suitable but uninhabited range, on renewed public interest, and on the success of the cannon net trap in capturing wild turkeys for transplanting.

SUMMARY

Missouri's first wild turkey season for 23 years was held during April 1960. This open season, for gobblers only, climaxed a 20-year program of research and management. Although two attempts to establish game-farm birds failed, it appears that turkeys can be restored to much of their former range in Missouri by trapping, transporting, and releasing native birds. Intensive management on refuge areas has produced adequate numbers of wild birds to permit trapping. This fact, plus renewed public interest, plus use of the highly

successful cannon net for trapping, are all responsible for the indicated success of the program. In one county it was possible to open the hunting season only four years after the initial releases were made.

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DISCUSSION

DISCUSSION LEADER GAUFIN: Thank you, John, for a very interesting paper on the turkey. I might add that we in the Forest Service feel encouraged and optimistic about the possibilities for integrating the management of turkeys with timber management and other forest uses.

We have, in the last two years, requested our field men to submit estimates of the turkey harvest from the National Forests and the estimate for last year was around 10,000 turkeys.

DR. SHELDON [Massachusetts]: I wonder if Mr. Lewis would comment on the inventory methods used in Missouri?

MR. LEWIS: In all these surveys we used the inventory method as devised by Dr. Mosby in Virginia and was further developed or used similarly in Missouri by Leopold and Dalke in 1942; that is, we would go out in the winter where established flocks were known and try as best we could to get a cross section or a cross check from at least three different individuals.

I think this is a conservative way of getting at turkey numbers but it is one of the only methods we have been able to use in Missouri with any degree of success From trapping experience, we know that we have been observing what we thought was one flock using a bait site, but after we have spent time in a blind watching them, we found that there might be three flocks. Two others that we didn't even know existed in the area may be using the same bait site.

DR. SHELDON: You have never used helicopters or planes?

MR. LEWIS: It would be highly unsatisfactory. With the exception of last spring when we had about 16 inches of snow for about a one month period, the snow doesn't stay on long enough to give us a chance to do that.

Birds can be counted by plane and by helicopter, but not on a 10,000-square-mile basis.

MR. BAILEY [West Virginia]: You mentioned in your transplants that you used 8 to 12 hens. I thought it important to point out that in West Virginia as well as in a few other states, we have had almost remarkable success with the use of much fewer hens. In fact, we have never had a failure where as many as four hens were released.

I think that in a great majority of cases, a good chance would be had to establish a population with even fewer than four. Of course, one would be getting on the risky side there.

MR. LEWIS: Thank you, Wayne. I think in our original thinking on this we were trying to release enough birds for a rather sudden or a quick buildup and that was why we went to larger numbers.

I think, after talking to you, that fewer numbers of hens could be released and make a very satisfactory release.

MR. FREID: Could you tell me the price of the hunting permit and how soon after the twelve o'clock closure does the hunter have to report to the check station?

MR. LEWIS: We charged $5 for the turkey-hunting permit, which is the same as our state deer-hunting permit.

The turkeys had to be brought to the check station not later than six o'clock and, in all cases, most of the birds were in the check station not later than two o'clock. So this year, we are going to let our people off a little easier and require that the birds be brought to the check station by four o'clock.

Most of your birds are killed within the first three hours in the morning. I think very few of them were killed after ten o'clock.

MR. MATHIESON [Nebraska Game Commissioner]: I was wondering if you could detect any differences in the behavior of the birds compared prior to the first opening season and after the shooting started?

MR. LEWIS: Only from our field records on succeeding days. On a short season, I don't think this tells you anything. We killed as many birds on the last day of the season as we did on the first day, and conditions were even poorer on the last day, as far as hunting went, than they were on the first day.

I don't think that we had enough hunters to disturb the birds in any one given area very much. There were many areas of high turkey populations in which we had no hunters at all. I think we will have more hunters this year.

SUMMARY AND CRITIQUE OF THE PROGRAM OF THE 26TH NORTH AMERICAN WILDLIFE AND NATURAL RESOURCES CONFERENCE[1]

CLARENCE COTTAM
Director, Welder Wildlife Foundation, Sinton, Texas

Our challenge today is "Planning for Population Pressures." To serve as the official summarizer of a large conservation and resource conference such as this, and especially with such a consuming and timely theme, is indeed a challenge and an opportunity. One of the personal satisfactions I must admit, however, is that when one survives this ordeal he never again will be called upon for a similar assignment.

When one looks at the program and discovers the breadth and complexity of subjects treated, the numerous specialties involved and the eminence of many of the speakers, he begins to realize, if he was unaware of it before, that an adequate summary or appraisal on such short notice is considerably beyond the capacity and reach of any one reviewer; certainly it is beyond the capacity of this reviewer. This is a good way to learn humility.

The size of the task is made more apparent when it is realized that this reviewer saw fewer than half of the brief abstracts and only 4 out of 49 of the papers themselves until after reaching the Conference headquarters. For any of you who are justifiably critical because of the admitted inadequacies of this review and appraisal, may I respectfully suggest that you consider yourself in my shoes reviewing a technical and philosophic book of possibly 500 to 800 pages dealing not with one subject but with some 49 topics. Add to the above a review of many important side and evening discussions of about two dozen unrelated subjects. From this, try to give a coherent and unified critique of the total subject matter of these three days and nights of discussions, of papers, and of conferences. Truly, I am glad I am among friends who believe in the great Christian dictum that "Charity suffereth long and is kind." Frankly, when I left my home in South Texas with so little information available about the Conference, I began to wonder if I would find myself before this audience with nothing more than the virtues of Texas to talk about!

Conservationists have a penchant for punishment. You have been here at this Wildlife and Natural Resources Conference for three days and nights. Many of you also attended the stimulating convention of the National Wildlife Federation which preceded this event. Also,

[1]Contribution #61, Welder Wildlife Foundation.

most of you have participated in one to a half dozen or more related meetings conducted concurrently with this major Conference.

Because of the great size of this Conference, the tremendous breadth and complexity of subjects treated, and the obvious limitations imposed by time and space, it would be quite impossible to attempt a summary of most papers, even though many of them were well presented and are of great value. I urge you to read and digest the published record. Instead of any detailed reviews of papers I shall attempt an over-all appraisal. Obviously this can be nothing more than my personal view at the moment. I shall attempt a review of major trends and movements that either are in progress or trends that should be stimulated. I believe a conference of this sort should suggest something of where we are and the direction we are headed.

GENERAL SESSIONS

This large international Conference provided two general sessions of eight specific and exceedingly important discussions on related topics dealing with pressing issues entitled "People Pose the Problem" and "At the Edge of Space." The first topic might more accurately have been described as "Too Many People Pose the Problem."

In my opinion, it is not impossible that in years to come history will either look down upon this current period as the beginning of a new era in North American conservation history, or it will refer to this era as the time when great opportunities were thrown away. In my view, we are at the crossroads and at a time when momentous decisions must be made—when a course of action must be plotted. We must plan better and more wisely for the future than we have in the past.

I believe we can refer to three memorable periods in the development of conservation concepts in the United States. One was the era of Theodore Roosevelt and Gifford Pinchot. Before the first Governors' Conference was called in 1908 by President Roosevelt, he said: "Facts which I cannot gainsay force me to believe that the conservation of our natural resources is the most weighty question now before the people of the United States. If this is so, the proposed conference, which is the first of its kind, will be among the most important gatherings in our history in its effect upon the welfare of our people." This was an era of great accomplishments because we had great dyanimc leadership with vision, resourcefulness and courage. The major handicap was that the people were unaware of the importance of conservation and there was no effective organization of followers who were prepared to capitalize on the opportunity at hand. Still, this era gave birth to our great forestry, national parks and refuge programs.

The second era of major importance, it seems to me, was ushered in with Franklin D. Roosevelt's administration. With the aid and support of a much larger army of stalwarts to help, notably Jay N. Darling, Hugh Bennett, Aldo Leopold, Senators Norbeck, Walcott, Hawes and Pittman, Congressmen Robertson and Andreson and such stalwarts as Carl D. Shoemaker, Ira N. Gabrielson, and Seth Gordon, and Hoyes Lloyd on the Canadian side, and a great many others, there was inaugurated the important soil conservation program, the development of the national wildlife refuges, Federal aid to wildlife restoration, and a new impetus to research.

The third era, which perhaps has the greatest opportunity, and possibly is our last chance, even though many of our resources already are in short supply, is the present or contemporary period of this new administration. This Administration must yet prove its worth, but if its performance equals the recent pronouncements of our President, the Secretary of Interior and a number of congressional leaders, conservation should come of age to the betterment, security and progress of this great Nation of which we are proud to be a part. What a challenge we have before us!

Just last Friday, in dedicating the National Wildlife Federation's new home, President Kennedy said, "Throughout our history, our soil and water, our forests and minerals, have provided the resources upon which this country grew and our power ascended. Today, this great gift of material wealth provides the foundation upon which the defense of freedom rests here and around the world, and our future greatness and our strength depend upon the continued and abundant use of our natural resources. Thus, it is our task in our time and in our generation to hand down undiminished to those who come after us what was handed down to us by those who went before, the natural wealth and beauty which is ours." The President added that we must keep America a "place where wildlife and natural beauty cannot be despoiled" and where our people can "find the materials and spiritual strength upon which our greatness as a country depends."

The two general sessions of this Conference emphasized many of these same points and a number of the papers given in the technical sessions were based on the premise of which our President spoke. Dr. Gabrielson's important paper succinctly analyzed the President's special message on "Natural Resources" of February 23, 1961, to the Congress, House Document No. 94. I trust all of you will obtain a copy of this great document which we must assume is the Administration's statement of policy. It can, of course, be obtained from any member of your congressional delegation.

Dr. Gabrielson pointed out that it was almost unheard of for a President to send such a compelling and comprehensive statement on natural resources problems and opportunities to the Congress. Obviously, the Administration realizes that the appalling and serious contradiction and conflict in the federal effort has in large measure been brought about because of a lack of centralized review of agency policies and programs for water, forest, parks, public land, wildlife and recreation. The President's message promises that an Advisory Committee on Natural Resources will be formed within his Council of Economic Advisors.

As evidence that conservation forces now have an unexcelled opportunity, the President asserted that "from the beginning of civilization every nation's basic wealth and progress have stemmed in large measure from its natural resources." Consequently, we must use these resources wisely and without waste. The President expressed the hope that "consistent and coordinated Federal leadership can expand our fish and wildlife opportunities without the present conflicts of agencies and interests: one department paying to have wet lands drained for agricultural purposes while another is purchasing such lands for wildlife or waterfowl refuges — one agency encouraging chemical pesticides that may harm the songbirds and game birds whose preservation is encouraged by another agency—conflicts between private land owners and sportsmen, uncertain responsibilities for the watershed and antipollution programs that are vital to our fish and wildlife opportunities." It is long overdue that the Administration should take effective steps to put a stop to the foolish and extravagant conflict of interest that has so long existed.

That conservation leaders are greatly concerned over the conflicting pesticide issues, I can report that two well attended and lively, and I believe importantly constructive, sessions of related meetings have been held during the past few days. There is a general feeling of alarm over the dangerous and extravagant waste that results from some of the irresponsible and uncoordinated eradication and control programs encouraged and directed by the control arm of the Department of Agriculture. In my opinion, it is imperative that we have a declaration of national policy by the Congress on this matter. Such a bill by the Honorable John Dingell already is introduced. Unless there is an improvement and a change from present policies, there is, I believe, grave danger that we may witness more serious and deadly pollution of our surface and underground water, our air and our soil —and this will adversely affect more than robins and field mice! Basic and applied research must be stepped up and huge costly operational programs of eradication held in abeyance until we know what we are doing. Advanced, objective planning and research are essential and with unified conservation support this can become a reality.

We take great satisfaction and encouragement in the forthright assertions and plans of Secretary Udall of the Department of Interior. His address was brilliant and showed a keen understanding of basic needs and problems of conservation. In referring to the President's recent congressional message he said, "never before has a President of the United States given such a broad and comprehensive mandate to conservation policymakers" and "never before has the need for imaginative and truly national leadership been as great as it is today." He added that "the overriding mandate to the conservationists today is to preserve the natural habitat of man—to preserve it against the onslaught of bulldozers, cement mixers and sub-dividers." He concluded that man is biologically and temperamentally rooted in the soil. Therefore, to be cut off from our relationship with the earth—our mountains, lakes, forests, open spaces and wildlife—might well cause a fundamental and unwanted change in our national character. It, therefore, seems to be the policy to vigorously initiate a public program for the wise development of our resources, including the acquisition of unspoiled land and water in every section of the country. The Secretary wants vigorous support of the wetlands program and he promises a hard new look at existing programs and policies long overdue of the Bureau of Land Management, National Park Service, Fish and Wildlife Service, Indian Bureau, and Reclamation. He accepts the imperative need and urgency of a wilderness protection bill and urged conservation groups to unify its forces, "to think and plan big and aim high."

If performances measure up to public promises, and if conservation forces have the wisdom to unify their ranks and consider the forest instead of individual trees, and support such a dynamic program of high vision and purpose, a new era and epoch in the wise administration and use of our natural resources for public betterment should be dawning.

At the conclusion of the Secretary's stimulating and widely applauded address, our efficient and beloved friend, Pink Gutermuth, called attention to the National Forest Wildlife, Operation Outdoors Part 2, that was just released by the Department of Agriculture. It would be hard to overrate the importance and value of this proposed program of wildlife development and management in our 185 million acres of national forest, range, and watershed lands that are found in 41 of our 50 states. These widely distributed lands contain about ⅓ of the nation's standing sawtimber; they give rise to innumerable streams and watercourses; they provide home and habitat for ⅛ of the nation's big game and offer one of the largest accessible areas of generally unspoiled and unposted hunting, fishing, and recreation opportunities in the United States. These lands are dedicated to the multiple-use and sustained-yield concepts. It seems, therefore, self-evident that the nation cannot afford *not* to provide the necessary development and sound management of this great heritage. I urge each of you to obtain a copy of this important and well prepared forestry booklet giving the wildlife and recreational plans for our national forests—and then give this support.

William Vogt, director of the Planned Parenthood Federation of America, a noted writer, with a rich background of ecology and wildlife, feels that it is indeed a paradox for society and wildlife people generally to worry about a big-game supply and large bag limits in hunting and fishing for *Homo sapiens,* yet be unconcerned about the management of human populations.

As evidence that we must regulate the population increase, in a mere 40 years hence we shall be a nation of some 360 millions in comparison with today's 182 millions. Half of the world's population today is underfed. Hunger today afflicts more people than the total world population at the beginning of this century. At the present rate of growth our population will double in 40 years and quadruple within the lifetime of many people now living. He feels that without control of human populations our standards of living are bound to decrease. Social stability, under pressure of unsatisfied desires, is shaken, resulting in rebellion and communism as experienced in China, Cuba, El Salvador, Africa and Laos. Our resources are rapidly decreasing; consequently, population controls are necessary. It would seem the point of wisdom for society, when necessary, to de-sex the confirmed criminal element, sex perverts, the insane and the mentally incompetents.

RELATED MEETINGS

Superb motion pictures and Kodachromes, roundtables, workshops and discussions given at some of the related meetings may be equally as significant and important as are a good percent of the formal papers given in regular sessions.

To illustrate this point: A Wildlife Society committee on techniques met and brought to light two intriguing developments that later likely will have profound effect on wildlife research and management.

(1) They revealed the existence of several models of field-tested units of radio tracking equipment with effective ranges up to ½ mile and suitable for use on rabbits and other small mammals and quail.

(2) The existence of several prototypes for use on such large mam-

mals as deer, bears, coyotes, wolves and turkeys which range up to 10 miles. This technique, presently restricted to satellites in orbit, promises, within a short time, to give us detailed information on the movements and behavior of wildlife species.

As already indicated at two separate meetings, the controversial fire ant and pesticide programs were discussed in some detail. At 5 other separate meetings waterfowl management and flyways were considered with the aim of improving cooperation and better administration of this great resource. An important sizable session was held to consider wildlife disease problems. Wildlife extension specialists and outdoor writers also met to better organize their programs and to learn from each other better techniques of "selling their wares." Other specialized groups and societies, such as the American Fisheries Society, Wildlife Society, International Association of Game, Fish and Conservation Commissioners, National Rifle Association, Boy Scouts of America, Natural Resources Council of America, and others, met for needed planning, organization and more effective management. As is customary at these Conferences, the Cooperative Wildlife Research Unit leaders met to consider techniques and advances in research in various sections of the country.

A great benefit at these international gatherings is the stimulation that participants gain through personal contacts, discussions and interviews with others of similar interests and training.

TECHNICAL SESSIONS

There were six technical sessions again this year, three sets of two sessions each, running concurrently, treating 41 specific topics, some of which were somewhat unrelated. These topics, while appropriate and generally well handled, were complex and varied and covered a range of subjects as broad as the hemisphere and its oceans. Two unusually fine papers of genuine application to North America were from overseas. One, of general interest, was given by the Honorable James Callaghan, M.P., of London, England, and Chairman, Coordinating Advisory Committee on Oil Pollution of the Sea. His paper "International Aspects of Oil Pollution" is a succinct and clear summary showing the seriousness and history of the destructive worldwide oil pollution problem.

Another splendid summary on oil pollution in America was given by Alfred L. Hawkes of the Rhode Island Audubon Society. With such information the public can be expected to insist that better precautions be taken to prevent this cruel loss of bird life.

Another splendid overseas paper, "Some Wildlife Diseases of Sweden," by Dr. Carl Borg, State Veterinary Medicine Institute, Stockholm, shows clearly the worldwide aspects of disease problems and the need of broad contacts in this field.

One technical session was devoted to disease, nutrition and controls. The session was of extraordinary importance not only because of the information and new contribution on specific wildlife disease, carriers, and hosts, but also because it revealed new techniques and new approaches in the study, handling and management of wild animals. Vagn F. Flyger of Maryland gave information on value of application of a new tranquilizer that permits safer and more humane handling of wild creatures. Dr. David E. Davis of the University of Pennsylvania reported on the use of chemicals that ultimately may be of great practical value as a gametocide to curtail or possibly prevent reproduction in some species, such as house mice, rats and over-populous redwing blackbird colonies. This new approach ultimately may have great practical value. The studies of radioactivity in wildlife by Paul B. Dunaway and Stephen F. Kaye of Oak Ridge National Laboratory are of great value because of their many implications and should be continued.

Another crowded session dealt with wetlands and inland water resources in which pertinent and essential discussions were held pertaining to waterfowl research and the complexities and problems of management. Seven splendid papers were given dealing with waterfowl and food production, availability, control and the effects of carp on waterfowl food plants. It was gratifying to note that nearly half of the papers given were by young men in graduate schools or by recent graduates reporting on recent or continuing studies. Such papers of high quality by our younger members give encouragement that the future is in good hands.

The problem of waterfowl depredations to crops is of long standing and will likely continue in certain sections. Merrill Hammond's well prepared and splendidly illustrated paper gives helpful suggestions for meeting this issue when depredations are serious in the major grain producing section of the northern prairie states. Robert McCabe's history of the Delta Waterfowl pipe was an interesting discussion of an Old World technique used in trapping waterfowl for banding.

I was glad to see a symposium dealing with techniques of research, harvest, and management of the much-neglected mourning dove. This popular and major game species, so much esteemed by the sentimentalist and non-hunter, has long deserved more study and consideration than it has received by both the Federal Service and by many states where it is so abundant. The frequent conflicts, reflecting a paucity of knowledge, between the non-hunting and sportsmen fraternities and between management groups, too frequently have made the dove of peace almost a symbol of war. We need more precise knowledge on population dynamics, movements, migration, management, and techniques of sampling populations. This symposium by some of our best authorities in this specialized field brought together much up-to-date knowledge on present status and management in sections of the country where the bird is most abundant. Perhaps more importantly, the session pointed the way for future research and management.

It was gratifying that one full session could be devoted to papers dealing with a few of the many problems and challenges of coastal and marine resources. A number of eminent workers gave important and interesting contributions to this specialized field that too frequently has been ignored. It is hoped that subsequent conferences will also emphasize this phase of our resource base. Wildlife people who may be authorities on various terrestrial vertebrates are usually poorly informed on problems pertaining to our coastal and marine resources.

Chapman's authoritative "Population Dynamics of the Fur Seal" is worthy of study for its application to terrestrial big game. Seton Thompson's rich background of experience should cause all of us to study his paper on the estuaries. The inshore zone of coastal waters is of vital importance to commercial and sport species of fish and shellfish and to waterfowl and migrant non-game birds. Studies in areas of coastal drainage years ago convinced me that land management practices along our coast have profound effect upon our coastal waters. Thompson appropriately recommended that submerged lands should be retained in public control until a zoning or planning board, including competent conservation officials, could determine the best possible public use and management of these lands.

Specialists in other groups could undoubtedly get stimulating suggestions from Carl J. Sinderman's splendid paper on "Serological Techniques in Fisheries Research." In my view, each paper of this important session was indeed a genuine contribution.

Through demand, most wildlife conferences of the past have provided sessions and important papers on field and stream, and forest and range resources. This should be expected because these areas supply most of the habitat for our wildlife and game. The two sessions of this Conference provided much important information on new findings of research, life history, and habits of various and sometimes little-known species, management practices and techniques. Much new and well documented information was given on research and management of the peccary in the Southwest, the Kodiak brown bear in Alaska, the black bear in Florida, the elk of Jackson Hole, Colorado deer on an Indian Reservation, wild turkeys in Missouri, pheasants in the Northcentral States and quail in the Southeast.

Besides this pertinent and much appreciated technical information on specific species, there were reports on food habits and competition between species. All of these studies furnish information essential to sound management.

As evidence that our science of wildlife management is growing and maturing, and that its members are conscious of public responsibilities in this field, I was glad to note a more philosophical approach and a little deeper digging on public responsibilities and relationships in a considerable number of the papers. May I commend the two papers by Jack Berryman and S. C. Whitlock which treat specifically this problem. Time and space limitations will not permit an analysis or summary of their thinking, but I recommend that all of you read these presentations. They will stimulate your thinking.

RECOMMENDATIONS AND CONCLUSIONS

In the future I believe we should invite more young men to participate, providing they have good original research findings or conclusions to present and provided also that they are well prepared to give a quality performance.

While I believe more and better illustrative and educational material have been presented at this Conference than any in the past, I feel that future conferences will be still further improved by using more and better materials of this nature.

The program committee, the session chairmen and the speakers should make greater effort to insure that the conference summarizer has a majority of the papers well in advance of the conference. When I left home for this conference I had received but four of the 49 wildlife conference papers and less than half of the brief abstracts. In fact, I was never able to obtain 27% of the formal papers nor their abstracts, and many that I did get were not secured until after the papers were verbally given. With concurrent sessions no reviewer can possibly hear all papers.

These great Conferences have been a mighty force in popularizing conservation in America and in helping to make wildlife management a respected science. The Wildlife Management Institute, its financial sponsors, and the staff and particularly Dr. Gabrielson and his very able and efficient assistant, C. R. Gutermuth, deserve our deepest gratitude and support.

In my opinion, this Conference now concluding has been one of perhaps two of the most memorable wildlife conferences ever held.

Possibly, only the first, or 1936 Conference[1], in years to come, may be be rated as important and far-reaching in its effects as this:
1. in the presentation of objective facts and philosophies and in making better use of illustrative and educational materials, and
2. (and more importantly) in providing the stimulus for dynamic action to properly develop and wisely use our renewable natural resources. I am convinced that we have never had such a golden opportunity. Consequently, this period will later be recognized either as the time of lost opportunities or an era of great progress in the public interest.

God help us to have the wisdom, foresight and courage to push forward.

CLOSING STATEMENT

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

Friends, it is believed that you agree that this 26th Conference has been about the most successful of all of these yearly meetings. After listening to that excellent critique and program summarization by Dr. Cottam, I am sure that you know why we were pleased that Clarence accepted this important assignment. Appraising the program of this three-day international conference is a real task, especially when too few participants do as we ask and give us advance copies of their papers. You did a splendid job, Clarence, and I wish that better words would come to me to express our thanks more adequately.

In behalf of the Wildlife Management Institute, which sponsors these yearly conferences, I wish to thank not only Doctor Cottam, but all of the many organizations, agencies, and individuals that contribute to the success of these meetings. Sincere thanks to the members of The Wildlife Society, and to Dr. Eugene H. Dustman in particular. The members of the General Program Committee, which includes the heads of most of the national organizations and large federal land-management agencies, already know how much we appre-

[1]The First North American Wildlife Conference, called by President Franklin D. Roosevelt, was held in Washington, D. C., on February 3-7, 1936. Proceedings have followed each subsequent year. These conferences have served as a national clearing house and forum for the discussion of current problems, new techniques and management of North American natural resources. It will be recalled that these conferences were preceded by the American Game Conferences and still earlier by the Game Breeders Conferences. On March 1 and 2, 1915, the first American Game Protective and Propagation Association Conference (later known as the American Game Association) was held in New York City. The proceedings were published in the magazine, AMERICAN GAME, until 1928, when the Proceedings of the Fifteenth Conference were first published in a volume. In 1929, the conference name was changed and became known as the Sixteenth North American Game Conference, which continued until 1936, when the name was changed again.

ciated their help, and Dr. Dustman is singled out for special commendation because he handled the many preliminary details with such thoroughness and dispatch. The programs of the technical sessions certainly reflect his efficiency.

Speaking for all of the conservationists throughout North America, thanks to the press. While I seldom get to see a newspaper during these conferences, the coverage in the Washington papers, so I understand, has been quite good. It is hoped that the wire services and other periodicals did even better. Dan Poole worked hard to provide the press with abstracts of papers, with copies of complete papers, and with prepared releases highlighting the many talks of national significance.

In your behalf, as well as that of the Institute, thanks to the Statler Hilton Hotel and the Washington Convention and Visitors Bureau. There have been no complaints, and we are indebted to the Bureau for the efficient handling of the conference registration.

It seemed as though all of you enjoyed last night's banquet. This is a large ballroom, and both the Presidential and Congressional rooms were filled to capacity. Judging by the way in which it was received, the musical and variety show produced by Jack Morton Productions was up to standard. This was my 17th show, and I must say that it becomes more difficult each year to be able to use the words "variety" and "quality."

The members of the Institute staff always are relieved when these annual conferences come to a close. After all these years, you would think that we should have learned how to simplify things. Instead, the tasks seem to become more arduous.

Now, we come to the time when I have the privilege of expressing my feelings to those enduring ladies that keep Dr. Gabrielson and me going throughout the year and during these large conferences. Permit me that real privilege once again, friends, to ask Mrs. Gabrielson and my good wife, Bess, to stand for the ovation they deserve.

I am pleased to say that the registration was all that we expected. There were 1,123 enrolled at my last check, and when it is known that we never can get more than about 85 per cent of the people to register, this means that we have over 1,300 people in attendance. We had 759 at the annual banquet last evening, including 53 Senators and Congressmen and many of the new heads of the federal agencies at the head table. In addition to that long head table, which ran the full length of two sides of the room, we had about 60 Senators and Congressmen at tables throughout the room. Again I wish to say that neither the registration nor the attendance record is our measure of success of these yearly conferences. The things that count most are the overall program, the participation in the floor discussion, the good that comes from the related meetings, and the personal contacts that are made. These count much more than the number of people.

Now then, we have made definite arrangements for next year's conference. I am pleased to say that we are going to Denver in 1962. The headquarters hotel will be the new Denver Hilton, and the dates will be March 12, 13, and 14. It is hoped that you will be there. Thanks, and a safe trip home. Happy landings!

REGISTERED ATTENDANCE AT THE CONFERENCE

ALABAMA

George W. Allen, Maurice F. Baker, I. B. Byrd, Pete Farrar, Rep. George M. Grant & Mrs., W. L. Holland, Charles D. Kelley, Earl F. Kennamer, Raymond D. Moody, Ion S. Walker, William E. Younger.

ALASKA

A. W. "Budd" Boddy, Jim Brooks, Frederick C. Dean, Dale R. Evans, Sen. Ernest Gruening & Mrs., J. M Honeywell, Sig Olson, John E. Schwartz, Robert F. Scott, Will Troyer, Robert B. Weeden.

ARIZONA

Steve Gallizioli, Rep. John J. Rhodes, Clif Sorrells, Lyle K. Sowls, Wendell G. Swank.

ARKANSAS

William J. Allen, Nelson Cox, H. S. Crawford, David M. Donaldson, D. LeRoy Gray, Andrew H. Hulsey.

CALIFORNIA

Rep. John F. Baldwin, David R. Brower, Wilbert McLeod Chapman, Rep. Jeffery Cohelan, Maynard W. Cummings, William Dasmann, George D. Difani, Everett R. Doman, Ben Glading, Seth Gordon, Everett E. Horn, Rep. Harold Johnson & Mrs., J. M. Kolisch, W. M. Longhurst, Rep. Gordon L. McDonough, Rep. Clement W. Miller, Rep. George P. Miller, Ray J. Nebit, Cecil A. Phipps & Mrs.., Paul M. Scheffer, W. T. Shannon, Rep. John F. Shelley, Jamie Smith, Walter P. Taylor & Mrs., Ardis M. Walker, Henry M. Weber, E. J. Woolfolk, Rep. J. Arthur Younger.

COLORADO

Rep. Wayne N. Aspinall, Clarence W. Baker, A. E. Borell, M. F. Brandborg, Arthur H. Carhart & Mrs., Rep. J. Edgar Chenoweth & Mrs., Basil K. Crane, Robert W. Davis, Richard N. Denney, Ralph R. Hill, Ed Hilliard, Gilbert N. Hunter & Mrs., E. R. Kalmbach, Rep. Gordon L. McDonough & Mrs., Richard E. Pillmore, Ronald A. Ryder & Mrs., Cecil S. Williams, Harry R. Woodward, Lee E. Yeager.

CONNECTICUT

Philip Barske, Ezra D. Bowen, Roland C. Clement, John Dear, Bruce Demoranville, Rudy Frank, Rep. Robert N. Giaimo, Fleur Grandjouan, Franklin McCamey, Dur Morton, John S. Purtill, Ann Sayre, Michael J. Stula, Lyle M. Thorpe.

DELAWARE

William Baxter, Jr., Robert Beck, Caleb Boggs, Mrs. Elizabeth T. Caulk, Donald P. de Sylva, T. E. Doremus & Mrs., Pat Florio, Mrs. Richard A. Herbert, Clayton M. Hoff, Lt. Gov. Eugene Lammot, Harris McDowell, William F. Moore, Mrs. John H. Prest, Wilbert Rawley, Austin D. Smith, Norman Wilder.

DISTRICT OF COLUMBIA

Rep. Dale Alford, L. J. Andolsek, Earl Atwood, Rep. Wm. H. Avery, Robert C. Ayers, Carl J. Baird, Kyle R. Barbehenn, Rep. Walter S. Baring, James E. Beach, Walter S. Boardman, Matthew J. Brennan, Mrs. Agnes C. Bridges, R. A. Bridges, Betty B. Briggs, Frank P. Briggs & Mrs., Shirley A. Briggs, George W. Cain, Paul B. Cardinal, James K. Carr, John A. Carver & Mrs., James R. Cheek, Henry Clepper, Ed Cliff, Bruce B. Collette, C. C. Compton, Robert C. Cook, Walter F. Crissey, Betty L. Davis, Leslie V. Dix, E. J. Douglass, Bruce Dowling, Philip A. DuMont, Carl R. Eklund, John H. Fauntleroy, John D. Findlay, Adrian C. Fox, James G. Fulton, John A. F. Garrick, D. R. Gascoyne, Luther C. Goldman, Edward A. Greene, C. R. Gutermuth & Mrs., Paul M. Hammer, Eleanor E. Hanlon, James R. Harlan, Francis C. Harwood, F. S. Henika, David M. Hickok, Roy D. Hockensmith, Russ Holt, Fred E. Hornaday, Michael Hudoba & Mrs., Harlean James, Daniel Janzen, Caddie Jenkins, Robert M. Jenkins, Carl J. Johnson, Wanda L. Johnson, Samuel E. Jorgensen & Mrs., Willis Kind, Mrs. Rosalie M. Koch, Karl S. Landstron & Mrs., Betty Lantz, Frank W. Lara, W. H. Larrimer, Hugh L. Latham, Charles H. Lawrence, Ralph E. Lawrence, Mrs. Fred C. Lincoln, B. H. Lord, Jr., Gordon E. McCallum & Mrs., Richard E. McArdle & Mrs., James T. McBroom & Mrs., J. C. McClellan, Robert M. McClung, J. L. McHugh, Donald L. McKernan, Mrs. Richard Madsen, Juanita Mahaffey, John W. Mann, J. A. Martinek, Wm. L. Mathews, O. Lloyd Meehean, Arthur B. Meyer, Lansing A. Parker, Robert M. Paul, K. B. Pomeroy, Ethel M. Quee, Harry E. Radcliffe, John L. Retzer, George

C. Ruhle, R. M. Rutherford, Howard Simons, H. F. Smetana, Bruce Stollberg, Philip J. Stone, Donald B. Stough, Richard Stroud, Karl F. Stutzman, Lowell Sumner, John I. Taylor, Wm. Ralph Taylor, Dr. Luther L. Terry & Mrs., Abe Tunison, Gen. & Mrs. Nathan Twining, Stewart Udall, O. L. Wallis, Frank J Welch, Robert A Wells, Mr. and Mrs. Donald A. Williams, RobertE. Wolf, Mal Xavier, Comdr. Charles Zirow.

FLORIDA

A. D. Aldrich, Herb Alley, Stephen L. Beckwith, Rep. Charles E. Bennett, Philip A. Butler, James P. Cating, Noah Corbin, Earle Frye, David B. Gray, Jr., Richard F. Harlow, W. R. Pritchard, Hubert W. Robertson, Wm. B. Robertson, Rep. Robert L. F. Sikes & Mrs., Sandy Sprunt, Seton H. Thompson, Charles F. Waterman.

GEORGIA

Jack Crockford, Verne E. Davison & Mrs., Fred J. Dickson, Robert D. Dixon, Robert Downing, Frank W. Fitch, Jr., Leonard E. Foote, Francis C. Gillett & Mrs., Walter A. Gresh, Frank A. Hayes, J. H. Jenkins, George M. Kyle, Fulton Lovell, Charles M. Marshall, Howard A. Miller, George C. Moore, Harold S. Peters, Ernest E. Provost, J. K. Vessey.

HAWAII

Eugene K. Burke, Sen. Oren E. Long, Richard Woodworth.

IDAHO

Paul D. Dalke, Sen. Henry Dworshak, Kenneth E. Hungerford, Levi L. Mohler, Rep. Gracie Pfost.

ILLINOIS

George W. Bennett, Muriel Beuschlein, Georeg C. Decker, Thomas R. Evans, George B. Fell & Mrs., Edward Fitzgerald, Robert Gaylord, Jack S. Golden, H. C. Hanson, Wm. J. Harth, Wm. Bill Hewitt, W .D. Klimstra, Charles W. Kossack, Edward Kozicky, Fred B. Lifton, Wm. T. Lodge & Mrs., Frost Loomis, A. C. Lopinot, Rex Lord, Mac McGraw, John B. Madson, Rep. Barratt O'Hara, Paul Oppermann, Sam A. Parr & Mrs., Rep. Melvin Price, Glen C. Sanderson, J. Henry Sather, Thos. G. Scott, John H. Slachter, W. C. Starrett, Raymond L. Will.

INDIANA

Durward L. Allen, John M. Allen, Wm. B. Barnes, Clayton Bushong, Charles M. Kirkpatrick.

IOWA

Kenneth D. Carlander & Mrs., Paul L. Errington, Alden J. Erskine, Arnold O. Haugen, D. M. Hill, Earl T. Rose, E. B. Speaker. Glen W. Yates.

KANSAS

Rep. Wm. H. Avery, Rep. J. Floyd Breeding & Mrs., George C. Halazon, Blair Joselyn, Sen. Andrew F. Schoeppel, Fred Warders.

KENTUCKY

Ed. Adams, Minor Clark, Arnold L. Mitchell, Frank Phipps, Dan M. Russell, J. C. Salato, Rep. John C. Watts.

LOUISIANA

W. V. Adams, Jr., K. E. Biglane, Charles W. Bosch, Jr.. Robert L. Croft, John P. Davis, Sen. Allen Ellender, Leslie L. Glasgow, Grita Gresham, John D. Newsom, Earl E. Roth, Herbert Stern, Jr., Richard K. Yancey, L. D. Young, Jr.

MAINE

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