Wildlife Research

Problems Programs Progress

1963

UNITED STATES DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
BUREAU OF SPORT FISHERIES AND WILDLIFE

Circular 188

The Department of the Interior, created in 1849, is a Department of Conservation, concerned with management, conservation, and development of the Nation's water, wildlife, fish, mineral, forest, and park and recreational resources. It has major responsibilities also for Indian and Territorial affairs.

As America's principal conservation agency, the Department works to assure that nonrenewable resources are developed and used wisely, that park and recreational resources are conserved for the future, and that renewable resources make their full contribution to the progress, prosperity, and security of the United States, now and in the future.

Front cover photo by

Luther C. Goldman

Whooping Cranes, Aransas National Wildlife Refuge
Texas, February 1964

Vignettes by

Alfred J. Godin

Back cover photos by

Lee E. Yeager

WILDLIFE RESEARCH
PROBLEMS PROGRAMS PROGRESS
1963

Activities of the Division of Wildlife Research
in the Bureau of Sport Fisheries and Wildlife
for the Calendar Year 1963

"My people are destroyed for lack of knowledge . . ."

Hosea 4: 6

Circular 188

UNITED STATES DEPARTMENT OF THE INTERIOR

Stewart L. Udall, *Secretary*

Frank P. Briggs, *Assistant Secretary for Fish and Wildlife*

FISH AND WILDLIFE SERVICE

Clarence F. Pautzke, *Commissioner*

BUREAU OF SPORT FISHERIES AND WILDLIFE

Daniel H. Janzen, *Director*

Washington, D.C. • May 1964

CONTENTS

The emperor goose is one of the most striking of the many species of geese. It nests along the coastal estuaries and tundra of western Alaska, and winters southward mainly among the Aleutian Islands and the coastal areas of southern Alaska and British Columbia. (Photo by Karl W. Kenyon)

FOREWORD

Today's paramount wildlife problem stems from our material success as a Nation. Each day there are 8,000 more Americans; industrial development is on a fantastic scale; and suburbia is surrounding every city and town. Our national growth is consuming the very environment that is essential to wildlife—land, water, and space.

Continued national growth will require still more land and water. A population nearing 200 million individuals requires more land and water than one of only half or three-fourths that number, as we had in 1920 and 1950. This all adds up to the inescapable fact that the problem of preserving adequate living space for wildlife will become increasingly difficult to solve.

Research, the accumulation of more knowledge, and the translation of that knowledge into more effective management, offers hope. When we know more—much more in many instances—about the environmental requirements of wild birds and mammals, about how best to control noxious species, and about the socioeconomic relations of wildlife as a renewable resource, we will be in a better position to manage for maximum wildlife production on specific areas, or optimum wildlife populations in a watershed or region, or perhaps—as has been done with field crops—more wildlife on less land. And certainly increased knowledge will enable responsible Government agencies to meet more effectively other problems involving wildlife resources—pesticides, pollution, protection, harvest, and disease.

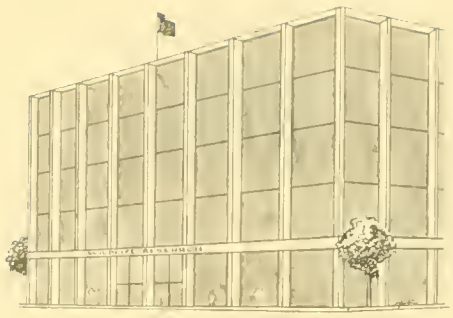
Wildlife ups and downs and major changes in kinds and quality are due to two main things: Changes in environment, and application of knowledge in management. Migratory birds, big game, upland game, fur animals, song birds, and fish can be retained as great natural assets if we can learn enough, and in time, about their needs.

The function of the Division of Wildlife Research of the Bureau of Sport Fisheries and Wildlife is to obtain information on wildlife resources, and the purpose of this report is to relay for administrative and management use some of the information obtained in 1963.

DANIEL H. JANZEN,
Director.

Outstanding among events in the Bureau's wildlife research programs in 1963 was the dedication of the new Biochemistry and Wildlife Pathology Laboratory at Patuxent Wildlife Research Center, Laurel, Md., on April 25 by Stewart L. Udall, Secretary of the Interior. (Photo by Rex G. Schmidt)

THE DIVISION OF WILDLIFE RESEARCH



The calendar year 1963 was one of expansion and personnel change in the Division of Wildlife Research.[1] Personnel changes, other than new staffing, were mainly in key positions.

There was no change in purpose and function of the Division. Through the year, as previously, it served as the wildlife factfinding arm of the Bureau, responsible for research on all wildlife—game and nongame, resident and migratory, harmful and beneficial. Results of the Division's investigations are used by the Bureau and by cooperating Federal and State agencies in wildlife management aimed at the production of more recreational enjoyment for the people, and more effective control of forms injurious to agricultural, industrial, and urban interests.

The research program.—Division research currently involves waterfowl and other migratory birds, upland wildlife with particular emphasis on problems occurring on public lands, pesticide-wildlife relations, diseases and parasites, control methods, and classification, distribution, and life history studies of wild birds and animals. Marine mammal research is presently concentrated on the sea otter.

Continuing an expansion that began in 1958 were research programs in animal-control methods and pesticide-wildlife relations. Disease and parasite research in the field of resident wildlife was expanded during the year through a contract with the University of Georgia. Smaller but still significant growth characterized research on waterfowl and on other migratory birds.

In meeting its wildlife-research responsibilities, the Division cooperates with agencies of the Department of the Interior, the Department of Agriculture, the Department of Health, Education, and Welfare, and the Department of Defense. In its game-bird introduction program, it cooperates with the Wildlife Management Institute, the International Association of Game, Fish, and Conservation Commissioners, more than 40 State conservation departments, and, of course, with the foreign countries concerned; and much of this research is in the native ranges of game birds considered potentially adaptable for release in selected game-deficient areas in the United States.

One of the oldest and best known of the Division's cooperative programs is that of the Cooperative Wildlife Research Units. These cooperatives are supported and administered under terms of a memorandum of understanding signed by officials of the Bureau, the Wildlife Management Institute, and the land grant colleges and game and fish departments of the 18 participating States. In addition to the research endeavor, the Units facilitate training of qualified graduate students in the wildlife field and promote conservation education through publication, demonstration, lecture, and consultation.

The Division is concerned with numerous other instances of cooperative research, made possible by the interest of various conservation agencies, scientific institutions, and individuals. These programs include the bird-banding record center at the Migratory Bird Populations Station at Laurel, Md., where banding data on nearly 12,000,000 birds of all kinds and recovery records on more than 1,000,000 migratory birds are filed, and where

[1] In action taken late in 1963, the Branch of Wildlife Research, as well as other Branches constituting the Bureau of Sport Fisheries and Wildlife, were given Division status, effective early in 1964.

734-563 O—64——2

more than 3,000,000 cards on the migration and distribution of North American birds are housed. In another cooperative program, bats have been banded, and the records are filed and kept current in the Bird and Mammal Laboratories housed in the U.S. National Museum.

The world's largest collections of North American birds and mammals are maintained at the U.S. National Museum, in cooperation with the Smithsonian Institution. These records, together with the professional taxonomic services provided by Division employees, are available to investigators both in and out of the Bureau. The assistance of thousands of banders, observers, and collectors who have cooperated in obtaining these specimens, or in providing data on them, makes this comprehensive service possible.

Organization.—The Division is organized on a line-and-staff basis. The directors of the 5 research centers, the leaders of the 18 Cooperative Wildlife Research Units, the leader of the foreign game introduction project, and the editor all report directly to the Division's central office in Washington; program planning, coordination, and administration for all Division research are functions of the Washington office; routine fiscal, personnel, and property management of field research stations are handled through the 5 regional offices of the Bureau. An editor, stationed at the Washington office, and a biometrician for the Denver Center, were 2 specialized positions filled in 1963.

In fiscal year 1964 the Division had 190 professional and 160 clerical or other employees, and a budget of about $4,599,000. Details of organization, administrative and supervisory channels, location of research stations, and financing are given in appendixes A, B, C, and D of this report. The 250 publications authored by Division personnel and close coworkers are listed in appendix E.

Chemical assay in progress at the new Pesticide Laboratory at the Patuxent Research Center, Laurel, Md. (Photo by F. C. Schmid)

SPECIAL ACTIVITIES AND EVENTS

BUREAU SERVICES THROUGH THE DIVISION

Research centers serve the public

The several wildlife research centers, stations, and laboratories of the Bureau of Sport Fisheries and Wildlife, because of their central locations, have great opportunity to serve the interests of the people in wildlife matters.

In 1963 the Bureau's staff of mammalogists and ornithologists housed in the Natural History Museum, Washington, D.C., were called upon many hundreds of times for information concerning their specialities. Members of the Congress, more than 20 Federal bureaus and agencies, various American and foreign universities, a dozen nationally circulated magazines, nearly a score of national scientific organizations, museums throughout the world, professors and graduate students from many educational institutions, and hundreds of individuals who queried by letter or telephone, sought information on birds and mammals.

Visitors to the Bureau's wildlife laboratories included 169 parties from 25 States, the District of Columbia, and 15 foreign countries, among whom were 107 nationally and internationally known scientists and wildlife officials. In addition, 20 scientists or officials concerned with marine mammals, and scores of individuals, visited the Seattle Laboratory on the West Coast.

The Patuxent Wildlife Research Center, Laurel, Md., readily accessible to the Washington metropolitan area and its 3 million people, has become widely known as an outdoor-indoor laboratory and scientific headquarters. More than 100 visiting parties, including institutional and agency scientists, Federal and State personnel, scientists from foreign lands, and conservation groups, youth and adult—all concerned with or interested in wildlife resources—sought information or instruction here in 1963. With the availability of meeting rooms, the Patuxent Center was used for several regional, interdivisional, and special wildlife workshops and conferences during the year. Such use promises to increase.

In the West, the Denver Wildlife Research Center is a meeting place for professional wildlife personnel associated with various Federal land-management agencies and concerned with wildlife problems or plans. State wildlife personnel, especially of Colorado but also of many other States, are frequent visitors. Wildlife and natural-resource students from several Colorado and other State colleges and universities favor the Center for field trips and instruction. And like the Patuxent Center, the Denver installation is frequently a meeting place for conferences and workshops on wildlife affairs.

The 18 Cooperative Wildlife Research Units and the 22 substations of the Division are local meeting centers for Federal, State, and layman groups having wildlife or other conservation interests.

Assistance to Government agencies

Bureau research specialists are being called upon increasingly by Federal and State agencies, municipal governments, industry, and private land-users for help in finding solutions to their wildlife and nuisance-animal problems.

Ornithologists use the taxonomist's skill to identify positively, from only a feather or two, birds involved in plane strikes and, occasionally crashes. Mammalogists, using infrared or other "black" light, identify rodents previously misclassified, or devise a more accurate identification technique. Chemists with special training and

equipment detect minute quantities of pesticides in soil, water, and animal tissue. Control-methods experts prescribe for mouse-infested orchards or woodlands, seek repellents that prevent forest damage, or screen chemosterilants that may, when perfected, prevent rodent and predator outbreaks. The specialist in animal diseases is called upon when rabies in skunks or foxes reaches epidemic proportions, or when birds are the suspected vector in bacterial contamination discovered in food processed for human use.

There are specialists in other disciplines used in wildlife research. Available in Bureau programs, or in cooperation with other agencies, are biologists and biometricians skilled in measuring population dynamics in game birds and mammals; ecologists who devise methods of converting land marginal for agricultural or industrial use into productive and economically profitable wildlife habitat; and aviculturists whose knowledge of animal behavior appears to offer hope of preventing extinction of the whooping crane and other threatened species.

There are Bureau research specialists in other wildlife fields. Their main and general assignment, in both direct and cooperative investigations, is the conservation of the Continent's migratory bird resources, perpetuation of hunting and fishing now inventoried at $8 billion annually, and preservation and enhancement of outdoor recreational opportunities of still greater value.

RESEARCH OF SPECIAL NOTE

Contamination by pesticides

During the year, research biologists and analytical chemists of the Bureau collected and analyzed hundreds of specimens of fishes, birds, mammals, and food organisms. The findings revealed the presence of pesticide residues in the eggs, tissues, and vital organs of numerous species collected from practically all parts of the country, including several Canadian Provinces. For example, DDT residues were present in 36 of 37 clutches of eggs of wild black ducks taken in 8 States from Maine to Maryland. In a number of cases the pesticidal levels in game species exceeded the tolerances permitted in domestic meats shipped in interstate commerce. The significance of almost universal contamination of fish and wildlife by these chemicals is yet to be determined. Since it is known that minute amounts of some pesticides in the daily diets of species such as quail and pheasants have pronounced effects upon their survival and reproduction, man's widespread use of these chemicals is regarded as one of the most serious threats faced by agencies charged with conservation of living natural resources.

New animal control methods

Considerable progress was made during the year toward the discovery and development of new and improved methods for controlling damage caused by certain species of birds and mammals. Foremost among these was the successful field testing of a chemosterilant to limit reproduction of coyotes over a 720-square-mile area in New Mexico. Approximately 80 percent fewer coyote pups were produced on the treated area than on a comparable check area. Advances were made also in the discovery and development of selective lethal chemicals with high toxicity to target species of birds and mammals and comparatively low toxicity to other kinds of wildlife.

Bird banding

With the installation of more versatile data-processing equipment, methods of processing banding data changed markedly in 1963. During the year somewhat more than 800,000 birds were banded, including 300,000 ducks, geese, and coots, of which mallards totaled 102,841. Species of major economic importance, mainly blackbirds and starlings, accounted for about 200,000 records, and gulls and terns for about 100,000. The good banding year is further reflected by the 30-percent increase in the number of waterfowl banded, and by the 21-percent increase in band recoveries. A total of 2,329,931 bands were issued in 1963, and the attachment of preopened bands on plastic tubing was begun.

Visitors to the banding station came from throughout the United States and Canada, and from Europe and South America.

Bat banding

The importance of learning more about the distribution, migration, and life history of bats has been underscored during the past year by the apparent increase in bat rabies. Growth of the bat-banding program during the year was spectacular, as indicated by the following: Bands issued 254,925; records received, 19,500; recoveries reported, 1,209; total letters written (by the Bird Mammal Laboratories), 635; and number of bats banded, 195,000 (approximately).

Pelicans feed on fish which feed on invertebrate aquatic fauna which may pick up pesticide residues from a contaminated water environment. Often, the magnification of poison concentrations through the food chain results in the death of the fish and/or birds. The Bureau is studying food-chain relations in aquatic birds at several locations in the United States. (Photo by V. B. Scheffer)

Since the inception of the bat-banding work, over 1,161,889 bands have been issued for use on bats. The recovery rate over the years has averaged about 1 for every 100 bats banded. Several major papers have incorporated results obtained by tracing movements of banded bats, and much has been learned about the distribution, abundance, and life history of these mammals through the program. There are currently about 50 active banders, all scientists attached to universities or museums, engaged in studies of bat biology which require the use of banded animals.

All data on banded bats and recoveries are housed in the files of the Bird and Mammal Laboratories where they are available for study by qualified individuals.

Studies of Midway Albatrosses continued

Dr. Chandler S. Robbins and Game Management Agent John Waters continued studies of albatrosses, long a hazard to military aircraft on Midway Atoll.

In accordance with recommendations previously made by the Bureau, the Navy paved a strip at least 400 feet wide along taxiways that were formerly used by the birds as a nesting area. As a result, fewer than 3 percent of the Laysan albatrosses nested within 400 feet of their former breeding grounds, and displaced black-footed albatrosses moved even farther away from the taxiways during the nesting season of 1962–63.

Three of the original 99 Laysans banded as nesting adults 24 years earlier were recaptured. These birds presumably are now at least 31 years old.

During the fall of 1963, before the nesting season, the Navy made preparations for leveling and hard-surfacing the shoulders of the two runways to a distance of 750 feet from the center lines in order to give still further safety to departing and landing planes. Also, trails were bulldozed

Chemosterilants screened by Bureau chemists promise a humane method of animal control without the use of poisons or traps, and with savings in time and cost. (Photo by E. P. Haddon)

through the dense growth of *Scaevola* to provide access to birds scheduled to be removed during the nesting season of 1963–64. The 750-foot boundaries were clearly marked so that none of the birds nesting outside the construction area would be sacrificed in the limited control action planned.

Wintering waterfowl in Mexico

Tabulation of waterfowl band recoveries at the Patuxent Center has shown clearly that the heaviest hunting pressure in Mexico is from Baja California south to Nayarit. This reflects the influx of American hunters into these nearby areas more than it does the location of wintering waterfowl concentrations in the region. The January aerial surveys made since 1948 show that Mexican waterfowl are distributed as follows in the winter: Pacific coast, 44 percent, East coast, 36 percent, and interior Mexico, 20 percent.

Studies on diseases common to man and animals

Collaborative programs on diseases common to man and wild animals are being conducted at the Patuxent Center. The National Institute of Neurological Diseases and Blindness, of the National Institutes of Health, is collaborating in this field in relation to slow-acting viruses of animals and man; the Armed Forces Institute of Pathology, Division of Geographic Pathology, in relation to trypanosome infection in raccoons and various filariid worms of other animals; and the Johns Hopkins University School of Hygiene and Public Health, Department of Pathobiology, in relation to infections of the respiratory systems of various wild animals.

Rare geese from Buldir Island

The Aleutian Canada goose, *Branta canadensis leucopareia*, formerly occurred widely along the

Banding offers the most effective means of determining the flight patterns of migratory birds, knowledge of which is essential in formulating regulations and other management activities required for the protection and harvest of these resources. The use of various colors in multiple bands permits identification of individual birds in intensive field studies. (Photo by F. C. Schmid)

Aleutian chain, nesting on many of the islands. Widespread introduction of foxes on the islands, mostly after 1880, led to losses of geese so severe that the race was at one time regarded as extinct. Buldir Island, extremely remote and forbidding, was spared the attention of the fox ranchers, and here a population of the geese persisted. An expedition in July sought to obtain goslings for propagation in captivity.

Personnel of the party included five Bureau employees and a graduate student of the University of British Columbia. Support and hearty cooperation were provided by personnel of the U.S. Navy, Coast Guard, Federal Aviation Agency, Bureau of Commercial Fisheries, and three commercial airlines.

The weather during time on the island was windy, with heavy fog and rain. The party saw 120 adult and 31 young geese; it was estimated that a total of 200 to 300 might occur there. Obtained were 18 goslings, which were transported by air to Denver for eventual transfer to the Monte Vista Refuge in Colorado. During the expedition, observations were also made of 35 species of birds and 6 of marine mammals.

Cooperative Wildlife Research Units conduct 250 projects

In 1963, the 18 Cooperative Wildlife Research Units worked on about 250 formal projects, of which about 80 were completed. This research, all at the graduate level, resulted in the graduation of 50 men with masters' degrees and 21 with doctoral degrees. The 18 Unit schools also graduated 162 men with bachelors' degrees.

NEW RESEARCH FACILITIES

Northern Prairie Wildlife Research Center

In response to the need for a center to handle more effectively research concerned with wetland habitat preservation and management, a new facility, authorized by the Congress in 1962, came into being in 1963. Called the Northern Prairie Wildlife Research Center, it consists of 2 land tracts in North Dakota: a 500-acre headquarters near Jamestown, and a 1,440-acre research area near Woodworth. The Woodworth field station has a laboratory as its central structure, complemented by a residence and service buildings. This station is in the critical pothole wetland type, typically interspersed with crop and grazing lands. Waterfowl productivity of these lands and compatibility of such use with agricultural interests will be featured in research planned at the station.

The main laboratory will be on the Jamestown tract. On this area will be residences, a service building, a greenhouse, a series of experimental ponds, propagation facilities, and other installations required for the extensive research program now getting under way.

The research program of the Center will follow two main approaches: (1) Fundamental studies of restricted scope on plant and animal requirements under controlled conditions in the laboratory, the greenhouse, and the Center's ponds and fields; and (2) practical field studies on Federal refuges and other public land, and on private property where wildlife problems occur.

The relations between land use and wildlife production, correlated with habitat quality, will be given particular attention in the research planned.

New quarters for Bird and Mammal Sections

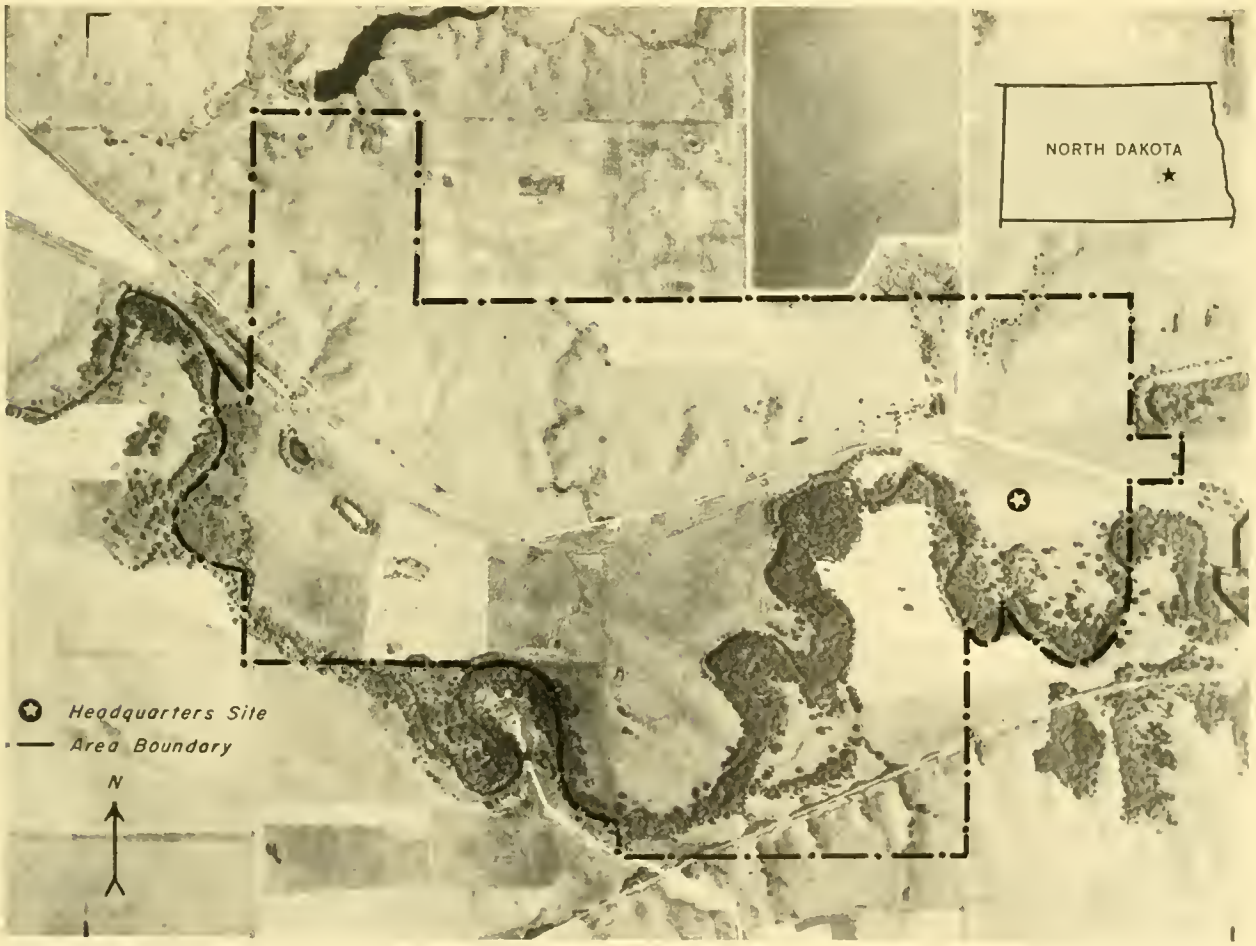
Early in the year the Bird Section of the Bird and Mammal Laboratories moved to the new east wing of the Natural History Museum. Now stored there is the combined U.S. National Museum–Biological Survey Collection of birds, and there the staffs of the two units operate in proximity and harmony and with increased efficiency.

Late in 1963 construction began on a new matching west wing of the Museum. The work, immediately adjacent to the Mammal Section in the old building, will provide new quarters on the top floor of the old building where the combined mammal collection and staffs will be housed as soon as the space is ready.

Machine Data Processing Unit

Most of the work done at the Migratory Bird Populations Station is dependent on its Machine Data Processing Unit. The Unit plays a vital role in mail-questionnaire and wing-collection surveys, processing of banding data, preparation of reports to band reporters and banders, and preparation of tabulations of data for use in analyzing results of mail-questionnaire and wing-collection surveys and banding data. In performing these jobs during the year, 750,000 cards were punched and verified, and over 50 million cards were passed through the sorting machines. Nearly 3 million cards were tabulated and summarized.

Headquarters of the Woodworth Station of the Northern Prairie Wildlife Research Center near Jamestown, N. Dak. The laboratory is on the right, and the pumphouse and garage-service building are to the left. (Photo by Harvey K. Nelson)



Aerial photograph of the 500-acre headquarters site of the Northern Prairie Wildlife Research Center near Jamestown, N. Dak. The Center will serve the "pothole" country of the Dakotas and Minnesota—a part of the northern prairie characterized by the presence of many natural marshes and ponds. Much of this land, important to breeding waterfowl, is being converted to agricultural use. (Photo by U.S. Geological Survey)

In 1963, important improvements were made in the equipment used by the Processing Unit. An 082 card sorter was exchanged for an 083 sorter, substantially increasing the rate of operation. The station also exchanged the 508 interpreter, limited to only 60 cards per minute with 2 lines of print, for a 557 interpreter handling 100 cards per minute on any one of 25 lines.

Also, the tabulating and printing capacity of the Unit was greatly increased by the exchange of the 408 accounting machine for a 1004. This exchange increased the printing output from 150 to 360 lines per minute, and the summary punching operation from 25 to 200 cards per minute, cutting down operating time on routine jobs by as much as 80 percent. Lastly, the 1004 has the ability to make computations which should greatly expedite the work of research biologists.

New laboratory at Denver Center

The Denver Center has long had need for a major laboratory building designed specifically to meet the Bureau's needs for research in the Western States. In fiscal year 1964 the Congress alloted $50,000 to develop plans for such a facility at a contemplated cost of $600,000. It is to be constructed at the Denver Federal Center on a location that will provide for a greater consolidation of activities than is now possible. When completed, the Chemical-Wildlife Evaluation Laboratory, as it will be called, will provide space for much of the Center's control-methods research and similar facilities for pesticide-wildlife work. It is planned also to house the administrative offices of the Center in the new building.

Control methods research facility

On July 18 the unit concerned with bird-control research moved into new quarters at the Denver Center. The new facilities consist of a 33- by 70-foot office and laboratory building, the upper floor of which is devoted to chemical laboratories and offices, and the lower floor to an electronic laboratory and office. A 30- by 50-foot aviary adjoins the main building, and has a top floor designed for holding experimental birds and a basement for storage and workshop. This new facility will greatly enhance the development of techniques for alleviating bird damage.

New pesticide laboratory equipment

Procurement at the Denver Center of a gas chromatograph, equipped with an electron capture detector, will allow detection of extremely small quantities of chlorinated hydrocarbon pesticides.

Bear River Station improvements

A 16- by 20-foot addition to the animal quarters at the Bear River Research Station was completed and equipped during the summer of 1963. The addition is divided into two rooms of equal size, one of which is used as an insectary for the study and propagation of invertebrates suspected of being involved in naturally occurring avian botulism. The other room is used for the cleaning and sterilization of laboratory animal cages.

Two 12- by 16-foot screened, flyproof enclosures, each containing a 9- by 12-foot concrete basin, were constructed during the summer. They will be used for culturing aquatic invertebrates and studying experimentally induced botulism outbreaks.

Among the major pieces of equipment acquired by the Bear River Station were a freeze-dry unit for preserving bacteria and viruses, a large steam sterilizer for animal cages, and an electrically operated steam generator for the sterilizer.

NOTABLE PUBLICATIONS

One of the distinctive wildlife publications of 1963 was the "grouse issue" of the *Journal of Wildlife Management* (vol. 27, No. 4). In this 370-page number, Bureau employees are authors of 4 of the 30-odd main articles. They are:

John W. Aldrich, "Geographic Orientation of American Tetraonidae," p. 529–545.

Gardiner Bump, "History and Analysis of Tetraonid Introductions into North America," p. 855–867.

Paul D. Dalke (and 4 coauthors). "Ecology, Productivity, and Management of Sage Grouse in Idaho," p. 811–841.

Carlton M. Herman, "Disease and Infection in the Tetraonidae," p. 850–855.

Two books by Bureau employees were published in 1963:

John J. Craighead (and two coauthors), *A Field Guide to Rocky Mountain Flowers*, Houghton-Mifflin Company, Boston, 227 p.

Arnold O. Haugen (and one coauthor), *Field Archery and Bowhunting*. Ronald Press, New York, 213 p.

Another book, scheduled for publication in 1964, is *Marsh Wealth: A Study in the Ecology of the Fresh and Salt Marshes of the United States*, by

Neil Hotchkiss of the Patuxent Center. The 224-page volume will be published by Devin-Adair Publishing Company, New York.

Dr. Lester L. Short, Jr., was author of a prominent paper: "Hybridization in the Wood Warblers *Vermivora pinus* and *V. chrysoptera*," Proceedings of the 13th International Ornithological Congress, vol. 1, p. 147–160.

The Migratory Bird Populations Station continued publication of the Administrative Reports series through 1963 by issuing numbers 16 through 39, a total of 23 papers on various aspects of migratory bird management, research techniques, harvest, population dynamics, and related subjects.

Among the 50-odd theses produced by Unit graduate students in 1963, a particularly outstanding one was: Charles M. Loveless, "Ecological Characteristics of a Selected Mule Deer Winter Range," Colorado State University, doctoral thesis, 318 p. (typewritten).

HONORS

Iowa Wildlife Unit leader

Dr. Arnold O. Haugen was continued in his appointment as a member of Operation Archery Project of the American Association of Health, Physical Education, and Recreation, a section of the National Education Association. He served as regional membership chairman, and as a member of the nominating committee of the Wildlife Disease Association. He was a member of the North Central Dove Committee and of the Midwest Pheasant Council, discussion leader for the panel "Evaluation and Research" at the National Conference on Leadership and Leisure, elected President of the North Central Section of the Wildlife Society for 1964, and appointed vice chairman of the Governor's Advisory Committee on Conservation of Outdoor Resources by Harold E. Hughes, Governor of the State of Iowa.

Scientific equipment in wide variety and almost fantastic capability is used in modern wildlife research. This Atomic Scanogram II Chromatogram Scanner is used at the Denver Wildlife Research Center to measure radioisotope-tagged pesticide materials on paper chromatograms. (Photo by James E. Peterson)

National award

Dr. Aelred D. Geis and Mr. Samuel M. Carney of the Migratory Bird Populations Station received one of the $500 awards made annually by the American Motors Corporation, New York City, for outstanding contributions to conservation. The award was for development of the wing technique for identifying, aging, and sexing ducks killed by hunters. Only one wing of a duck need be contributed by a hunter, using a self-mailing envelope. The method provides information essential to an understanding of the population dynamics of the various important species, and makes possible the use of a larger and better-distributed sample. It is also saving in time and manpower and, therefore, in costs.

The sea lions on Walrus Island in the Bering Sea, pictured here, and the sea otters of the northern coast, are among the marine mammals under study by Bureau biologists. (Photo by Karl W. Kenyon)

RESEARCH HIGHLIGHTS OF THE YEAR

WATERFOWL MANAGEMENT RESEARCH

A primary responsibility of the Bureau of Sport Fisheries and Wildlife is the preservation and management of migratory birds, among which waterfowl are of paramount importance. In meeting this responsibility, continuing research is necessary, to improve habitat management, to develop new habitat, to define guidelines for habitat acquisition, to evaluate the effects of regulations and other management measures, and to improve inventory methods and operations. In these research activities the Bureau wishes to acknowledge the cooperation of the Provinces and States, both through the Flyway Councils and through their own research programs.

Mallard population dynamics studied.—Because of the Mallard's dominant position, analyses of data on this species have been emphasized at the Migratory Bird Populations Station. From the size of the kill in 1962 as measured by the mail questionnaire survey of hunters, the age composition of the kill indicated in the mail wing-collection survey, and the band recovery rates computed in the preseason banding program, it was possible to estimate the size of the 1963 breeding population.

These analyses verified the results of the Bureau's aerial surveys in May, since this indirect method of estimating the population yielded essentially the same estimates as the May aerial surveys adjusted for visibility rates. This study also explained that because of low production in 1962 (only 0.8 immature bird per adult) the breeding population did not increase substantially in 1963, despite the reduced hunting kill in 1962. The data also indicated that if the kill in 1962 had not been substantially reduced through restrictive regulations, the continental mallard population, already at a low level, would have continued a downward trend instead of attaining some recovery in numbers.

Wood duck research.—The wood duck is an extremely important species in the Atlantic and Mississippi Flyways, ranking second in the hunting kill in 1962 in both. Because of its unique range and the wooded habitat it utilizes, the status of the species cannot be determined either by breeding-ground survey or winter inventory. In order to provide information needed for management, research personnel have measured its status by indirect methods, mainly through band-recovery rates and kill statistics from the questionnaire survey of hunters, and the wing-collection survey. This approach has established that there are over 2,000,000 wood ducks associated with the Atlantic and Mississippi Flyways and that, despite the large number shot, the rate of kill does not appear to be excessive.

Since banding data play a vital role in understanding population dynamics of the wood duck, the Populations Station has also worked on techniques for increasing the efficiency with which the birds can be captured for banding. One development is drive-trapping roosting wood ducks at night. In one drive, 870 were taken in a trap erected by 4 men in half a day. No other technique has approximated this potential for capturing the birds.

Mail surveys of waterfowl hunters.—During 1963 several mail questionnaire surveys, as well as duck-wing, goose-tail, and swan head-feather surveys, were carried out to measure the size, species,

Blessed event at the Canvasback factory. The pose of the mother duck is characteristic, and she guards the ducklings with devotion and courage when intruders appear. This nest was on the Redvers study area in Manitoba. (Photo by Jerome Stoudt)

age, and sex composition of the waterfowl kill and determine certain characteristics of hunters.

The results of the 1962–63 questionnaire survey indicated a reduction in the duck kill of nearly 50 percent below that of 1961–62 in the Central and Mississippi Flyways, while in the Atlantic Flyway there was no real change (+3 percent). In the Pacific Flyway, there was approximately a 12-percent reduction in the duck kill. The reduced kill in the Central and Mississippi Flyways was undoubtedly the result of very restrictive waterfowl regulations in 1962, which permitted only a two-bird limit (but only one mallard) and a 25-day season. The results of the wing-collection survey in 1963 suggest a marked increase in the kill—approximately double that of 1962 in each of the two middle flyways, 36 percent greater in the Pacific Flyway, and unchanged in the Atlantic Flyway. Final figures await completion of data analyses for the several surveys employed.

The species composition of the kill in 1962 was indicated by the wing-collection survey, and it indicated a decrease, proportionally, in the mallard kill in both the Mississippi and Central Fly-

ways. In the Mississippi, the wood duck kill increased greatly in 1962, amounting to 15 percent of the total and ranking second only to the mallard with 40 percent. In contrast, the wood duck kill represented 15.3 percent of the kill in 1963, but only 6.1 percent in 1961. The increase in the proportion of wood ducks in 1963 was probably the combined results of the liberalized wood duck bag limit and the restrictive limit on mallards. Despite a "bonus scaup" regulation, the kill of lesser scaup generally declined in all flyways; the kill of greater scaup increased substantially in all but the Central Flyway where this species is not common.

The sex composition of the mallard kill in the 1962–63 season was of special interest in view of the restrictive regulations in effect. In the Central Flyway, the sex composition of the kill in adult mallards changed from 2.5 males per female in 1961–62 to 2.8 in 1962–63. In the southern half of the Mississippi Flyway, the sex composition of the kill increased from 2.3 to 2.7 males per female. These data suggest that, with the one-mallard limit, hunters showed slightly greater tendency to shoot drakes. For mallards in entire United States, the adult sex composition of the kill was two males per female, while that of immature birds was 1.2 males per female.

Whistling swan hunting survey.—The whistling swan hunting season in Utah in 1962 was evaluated through a mail head-feather collection survey, as well as three mail questionnaire surveys. The head-feather collection provided information on age composition, since gray feathers from immature birds can readily be differentiated from white feathers of older birds. It also showed that

A "wing-bee"—identifying ducks from wings mailed to the Bureau by successful hunters. Sex and age can be determined from examination of these wings. Distribution of hunters and kill likewise are obtained from the wing survey—information of great value to management. In 1963, "wing-bees" were held at one location in each of the 4 waterfowl flyways, and a total of about 100,000 wings were processed. (Photo by Arnold O. Haugen)

well over 50 percent of the birds taken were immature. A total of 313 swans were shot by the 1,000 hunters with permits. Hunters reported knocking down an additional 82 birds that were not retrieved.

Ninety-six percent of the hunters expressed an interest in applying again for a permit, while 58 percent of a random sample of Utah waterfowl hunters favored a controlled swan-hunting season. Twenty-five percent of all Utah waterfowl hunters were opposed to the season.

Hunters' reaction to waterfowl regulations.—To determine how waterfowl hunters react to restrictive regulations, a questionnaire was sent to individuals who had purchased a duck stamp for 1960. They were asked their reaction to various regulations. In the Atlantic and Pacific Flyways a majority of hunters indicated a preference for the seasons in effect in 1962 rather than closed seasons. In the Mississippi and Central Flyways only 38 and 35 percent preferred the restrictive open season to a closed season.

The most important finding from this survey resulted from a comparison of hunting success in 1960 of hunters who purchased and those who did not purchase duck stamps in 1961 and 1962. It was found that hunters who continued to purchase stamps each year had been approximately three times as successful in 1960 as hunters who did not continue duck-stamp purchase, indicating that the decrease in kill is not necessarily proportional to decrease in number of hunters.

Kill on private versus public land.—A mail questionnaire survey was conducted in 1963 to estimate for each State and Flyway the relative amounts of hunting and kill on various types of public and private land. The survey indicated that the total number of hunter-days was about equal on public and private areas in all but the Central Flyway, where about 65 percent of the hunting was on private land. Slightly over 50 percent of all ducks were reportedly bagged on public areas in the two eastern Flyways, slightly over 50 percent on private areas in the two western Flyways. Private areas provided more than half the goose bag in all Flyways, whereas public areas contributed the larger share of the coot bag. Hunting success for ducks appeared slightly higher on private than on public areas in the Pacific Flyway, but was nearly equal in all other Flyways. Hunting success in all Flyways was higher for geese on private land, and higher for coots on public land.

Species management studies.—Blue-winged teal, lesser scaup, and ring-necked duck banding data have been examined to evaluate the effectiveness of regulations designed to increase their harvest.

For lesser scaup and immature blue-winged teal it was found that there was little relation between band recovery rates (which reflect the rate of hunting kill) and the annual mortality. For scaup, the rate of kill seems to fluctuate greatly from year to year, but this is not due to regulations. Apparently such factors as timing of migration, variations in weather, and distribution in relation to hunter concentration are responsible for fluctuations in the kill of scaup.

For blue-winged teal, there is a high mortality in immature birds not explained by differences in kill. There is relatively low shooting pressure on both lesser scaup and blue-winged teal, but for teal, at least, the kill rate is influenced by the date on which the season opens. Band recovery rates were much higher in years with early opening dates, which more nearly coincided with the migration period.

Data for the ring-necked duck, considered because of its great similarity to the lesser scaup, prompted proposals that this species be included with scaup as "bonus birds." It was found that the ringneck generally received about twice as much shooting pressure as lesser scaup. Also, both harvest rates and annual mortality for ringnecks are influenced by hunting and changes in hunting regulations. This indicates that, although the lesser scaup is a prime candidate for special regulations which increase its kill, this is not the case for the ring-necked duck.

Habitat evaluation of Back Bay and Currituck Sound.—A 5-year investigation of Back Bay–Currituck Sound as waterfowl habitat was terminated by the Patuxent Center in September 1963, about 18 months after the severe storm of March 1962 had raised the salinity to 13 percent of sea strength, and provided a unique opportunity for evaluating the effects of this change on food productivity.

During the summer of 1962, water salinity remained above 10 percent of sea strength, and aquatic plant production exceeded that of all previous years since the beginning of the study in 1958. The water was clearer, seed and tuber production increased, and multitudes of brackish-

The canoe paddle marks a nest site used for 4 consecutive years by a ring-necked duck. This diving duck characteristically nests in dense emergent vegetation, especially vulnerable to severe drought. Drought brings extensive destruction of the nesting grounds of the diving-duck group, which includes also the canvasback, the redhead, and the scaups. (Photo by Howard L. Mendall)

water clams, which later served as waterfowl food, were observed for the first time in the investigation. Waterfowl utilization totaled 27 million waterfowl days from September 19, 1962, to April 9, 1963. This is the highest observed during the 5 years and more than twice the utilization in 1958.

In the summer of 1963, Back Bay freshened to about 4 percent of sea strength—a near record—and aquatic plant production was the worst on record. Currituck Sound, on the other hand, maintained salinities in excess of 7 percent and aquatic plant production continued to be good.

Goose production.—Fall and winter family counts are used to determine productivity of snow geese, blue geese, and white-fronted geese, all of which nest in the far north where observation is impractical. In 1962, about 38 percent of the continental population of white-fronted geese were immature birds, and preliminary data for 1963

Nest of a black duck on an upland site. This species, the most important game duck in the East, has been studied extensively since 1937 by the Maine Unit. (Photo by Howard L. Mendall)

734-563 O—64——4

Ross' goose, showing the characteristic dusky patches on the head and shoulders of young of the year. From this characteristic, productivity for the year can be determined after the birds reach their wintering ground. (Photo by John J. Lynch)

indicate better than 38 percent production. In 1962, about 29 percent of the lesser snow geese were immature, and 1963 data indicate a productivity between 29 percent and 40 percent. Blue geese immatures constituted 32 percent of the population in 1962, but preliminary data for 1963 indicate only 16 percent to 27 percent immature birds in the population.

Wood duck nesting structures.—Studies on 20 impoundments at the Patuxent Center revealed that predation of wood duck boxes by raccoons, minks, and snakes was eliminated in 1963 by the installation of aluminum predator guards 9 inches wide and 38 inches long. These guards enclose the post of the nest structure longitudinally in "sandwich" fashion.

Tests of methods to discourage starlings from using wood duck houses yielded valuable results. In 1963, starlings used 37 percent of the conventional vertical houses but only about 4 percent of

the horizontal furnace-pipe boxes and none of the horizontal roofing-paper boxes. Wood ducks used 28 percent of 43 available vertical boxes, 25 percent of the 52 furnace-pipe boxes, and 15 percent of 39 roofing-paper boxes.

Management of aquatic plants. — Eurasian watermilfoil has spread rapidly over many of the more protected parts of Chesapeake Bay and now occupies more than 100,000 acres. It has also been found in Alabama, California, Indiana, New Jersey, New York, North Carolina, Ohio, Pennsylvania, Tennessee, and Wisconsin. This exotic milfoil grows in medium to hard water and in saline situations up to about 28 percent of sea strength, and it can exist in salinities as high as 43 percent of sea strength.

In the Chesapeake Bay area, the effectiveness of 2,4-D treatment at 20 and 30 pounds acid equivalent per acre was best when the water temperature was above 18° C., the vegetation thick enough to contain the treatment, and before the period of flowering. Preliminary studies with new compounds reveal that diquat, a mixture of endothal, and the potassium salt of silvex, showed promise in tidal situations. The sodium salt of fenac was not effective in tidal areas in controlling Eurasian watermilfoil.

Alligatorweed is another exotic plant that detracts from waterfowl habitat in southeastern United States by crowding out food plants and blocking waterways. In cooperation with U.S. Army Engineers, biologists from Patuxent tested several methods of control. They found that the iso-octyl ester of silvex is effective for a longer period of time than the potassium salt of silvex. Both formulations are effective in controlling rooted alligatorweed at rates of 20-pound acid equivalent per acre. Effective methods of controlling floating mats have not yet been found.

Improvement in North Dakota waterfowl habitat.— Most potholes in three study areas in North Dakota were in good condition in the spring of 1963, owing to an excellent winter carryover of water from the previous fall and fairly good spring snow melt. During mid-April, water levels in potholes of the more permanent type were much higher than during the corresponding periods in 1961 and 1962. Water levels of temporary or seasonal types also were considerably improved, with the exception of a few potholes on higher elevations. Late spring and summer rainfall in 1963 was not sufficient to maintain levels and potholes dried increasingly as the season progressed. On October 15, at the end of the growing season, only 19 out of 137 ponds still contained water. Comparable figures for 1961 and 1962 were 0 and 109.

Transient waterfowl concentrated on the study areas in much larger numbers last April and May than in 1961 and 1962. Diving ducks, including redheads, canvasbacks, and lesser scaup, were especially abundant. Unusually large populations of waterfowl were resident during late spring and

A typical 2-acre pond on the Yellowknife area, Mackenzie District, Northwest Territories. Lesser scaup commonly nest in the sedges bordering such ponds. In the Far North, water tables are still relatively stable. (Photo by H. W. Murdy)

Many potholes in Stutsman County, N. Dak., even large ones like this, became completely dry during the summer of 1961. In years of average precipitation, this is one of the better duck-nesting areas in the prairie pothole country. Waterfowl reproduction is seriously affected as drought becomes severe. (Photo by R. E. Stewart)

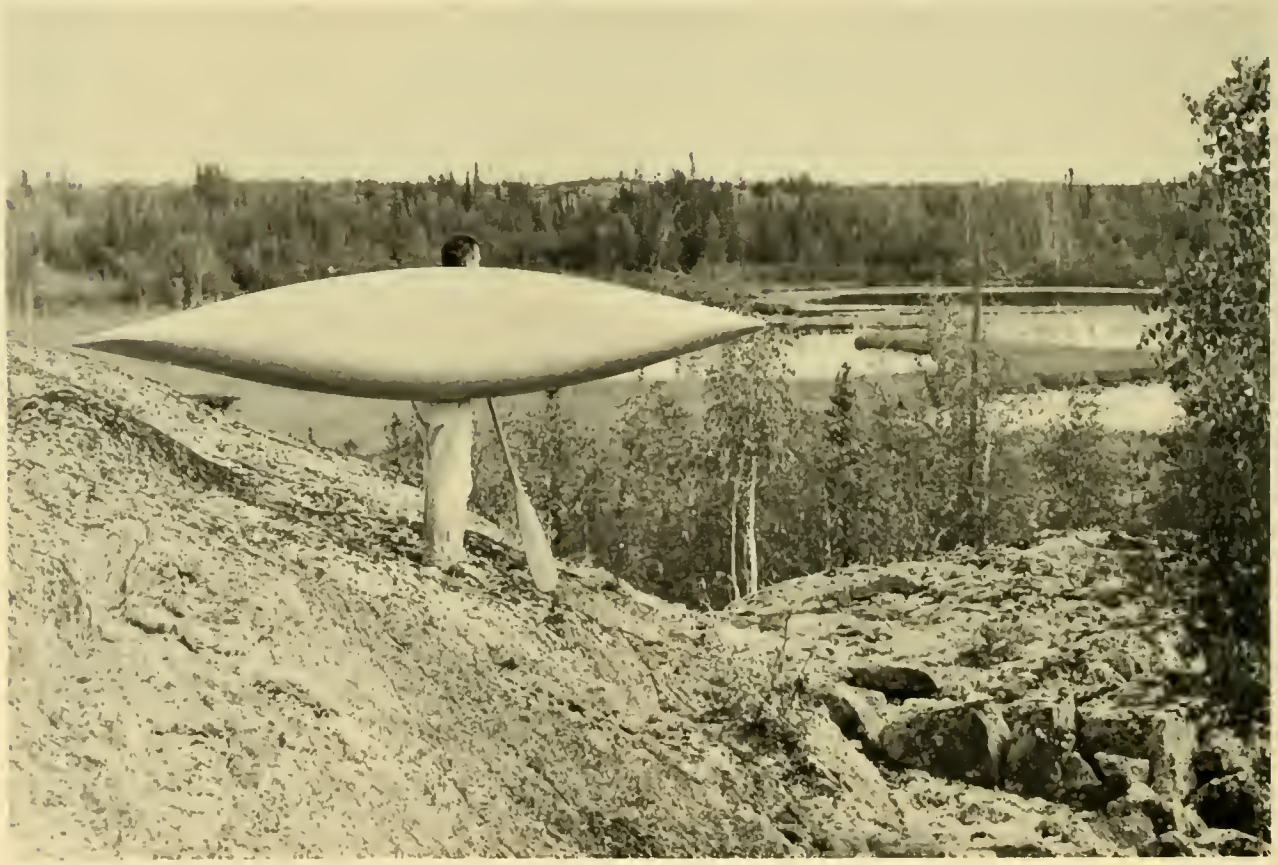
summer. Coots showed a phenomenal increase in breeding pairs, as compared with 1961 and 1962, and the 11 species of ducks that became established were also represented by substantially greater numbers.

The total waterfowl breeding population in 1963 consisted of 592 pairs of ducks and 369 pairs of coots and may be compared with the 136 and 278 pairs of ducks and 29 and 94 pairs of coots in 1961 and 1962. Nesting success on the 3 areas in 1963, based on 53 duck nests active (containing eggs) when found, was 32 percent (17 nests), while 68 percent (36 nests) were destroyed by predators or were deserted. Raccoons appeared to be responsible for most of the nest losses. A total of 183 duck broods were recorded on Stutsman County areas in 1963, a marked increase over the 116 broods in 1962 and the 40 broods in 1961.

Waterfowl production improves on Far North area.—The 5-year Yellowknife study was initiated in 1961 and became fully operational in 1962. Located in the Mackenzie District of the Northwest Territories in a superior habitat type, the area consists of a 30-mile segment of the Mackenzie Highway and contains 15 square miles with 236 natural water areas ranging in size up to 92 acres.

Field work in 1963 was carried out on the tract between May 15 and August 24. A notable feature of the investigation was the opportunity to compare productivity during an extremely early season with productivity during the moderately late season of 1962.

The breeding population was estimated at 776 pairs, averaging 51.7 per square mile or 13 percent more than in 1962. Lesser scaup, ringnecks, and baldpates were substantially more abundant; green-winged teals were decidedly less numerous; and there were fewer mallards. As compared with 1962, nesting began 12 days earlier for the mallard and pintail, and 3 and 4 days earlier for the bufflehead and scaup. Hatching, beginning about June 7, was also more advanced than in 1962, and was about as early as can be expected in the Yellowknife region. Production was recorded at 1,353 class I ducklings, or 32 percent more than in 1962.



Waterfowl brood counts on Far North study areas sometimes requires portaging of canoes over rugged terrain, like that shown here on the Yellowknife area, Mackenzie District, Northwest Territories. (Photo by H. W. Murdy)

In an Iowa Unit project, ducks were counted on specified areas as they flew to and from roosts at dawn and at dusk. (Photo by Arnold O. Haugen)

Rapid growth of ducklings in Arctic.—It has long been assumed that the rapid growth of ducklings in arctic and subarctic regions accounted for the high rearing success observed under conditions induced by the short far-north summer. Actual measurements of growth differences between temperate and northern breeding areas has not previously been accomplished. In an Alaska Cooperative Wildlife Research Unit study, color-dyed canvasback ducklings were found to attain flight at 47 to 50 days, or 1 to 2 weeks earlier than in southern Manitoba; arctic-born buffleheads were flying at 40 days; lesser scaup showed growth rates comparable to those noted in South Dakota.

Wood duck roost counts.—In evaluating the usefulness of roosting flights for determining wood duck populations, an Iowa Unit fellow concentrated on pool 10 of the Upper Mississippi River Wildlife and Fish Refuge, where he had access to 530 pairs of nesting birds. About 35 percent nested in the 50 square miles of bottomlands and 65 percent nested off the refuge along 5 miles of tributaries or on adjacent bluffs. This pattern represented no significant change from 1962, either

in size of the nesting population or its distribution among major habitat types. Migration and chronology of nesting were 1 week earlier than in 1962. An index to annual fluctuations in the nesting population on the refuge was based in roosting-flight counts at the mouths of tributaries.

Factors affecting waterfowl foods in rice fields.—Ecological factors that influence the loss of waterfowl foods associated with rice culture were studied during the winter of 1962–63 by the Louisiana Unit. Emphasis was on the rate and magnitude of seed loss, the causes of loss, and the effect on viability and nutritive content of seeds exposed on the ground and under water. Underwater storage resulted in less loss in all species except domestic rice, which showed an almost total loss shortly after flooding. Red rice, signal grass, jungle rice, barnyard grass, and browntop millet showed little deterioration during 120 days of submergence; signal grass, browntop millet, and smartweed showed low viability after 120 days of inundation, and birds and small mammals caused major losses of foods when the seeds were exposed on the ground.

For the rice grower interested in waterfowl management, the following recommendations can be made: (1) Delay flooding of rice stubble until after the first frost to prevent rice seed deterioration and germination, and (2) flood fallow fields from October 1 through March 31 to provide resting and feeding areas for waterfowl.

Fulvous tree duck in Louisiana.—In the 1963 breeding season, fulvous tree ducks returned to the fresh marshes of north-central Cameron Parish in Louisiana in late March and early April. Nesting had begun by late May, and the last broods were flying by November 1. Early in November practically the entire tree duck population in the State concentrated on Lacassine National Wildlife Refuge and shortly thereafter departed for the wintering grounds. Aerial censuses of tree ducks on spring and fall concentration areas showed a decline in the State population.

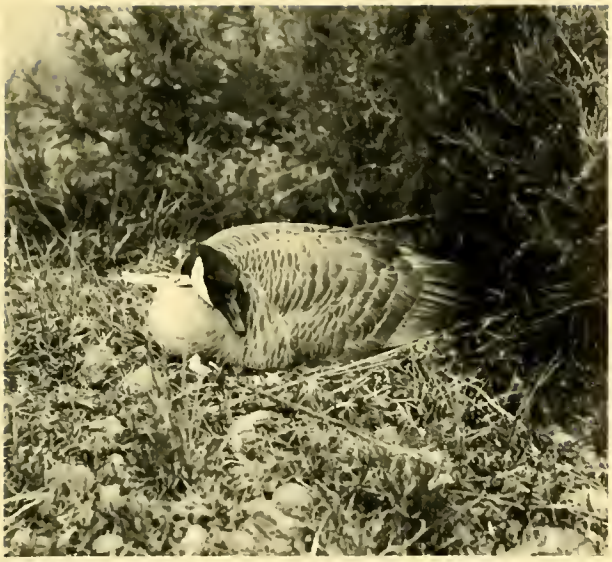
Tree duck crop depredations were serious in 1963 in only a few fields, and were limited to water-planted rice seed. Primary losses of breeding water fowl are apparently largely confined to deliberate actions of farmers to protect their crops.

The investigation suggested the following recommendations: (1) make an annual appraisal of the tree duck population; (2) inform rice farmers of nonlethal control methods; (3) feed ducks on Lacassine National Wildlife Refuge in an effort to hold them on the refuge during periods when serious crop depredations occur; (4) clarify and publicize the legal status of tree ducks in an effort to reduce killing in summer; and (5) obtain further data necessary to the proper management of the species.

Waterfowl renesting and homing.—A long-term waterfowl renesting and homing study by the Maine Unit was completed at the end of its eighth year. Results in 1963 continued to indicate that half or more of the breeding populations on the study areas consist of females that had previously nested here, the majority of surviving hens returning to the same small islands in succeeding years. Many important relations with respect to cover used, laying dates, and clutch sizes have been indicated in the data gathered, and hold important implications for waterfowl management in the Northeast. The report is now being readied for publication.

Canada goose sex ratios.—In a project recently completed by the Missouri Unit, under the direction of Dr. William H. Elder of the University of Missouri, it was found that accurate age ratios of Canada geese could not be deduced by comparing the number of old with the number of young geese trapped at baited banding stations without taking into account the length of time the bait was available to the birds. The proportion of adults in the catches increased with the time the bait was exposed. There were no significant differences in the ease of trapping male and female birds. This means that sampling birds captured in banding traps at random sites is not a satisfactory means of determining the success of the previous nesting season.

Wood ducks prefer metal boxes.—In a 2-year study of wood duck nesting in southeastern Missouri, wood and metal boxes were dispersed and available in almost equal numbers. Metal boxes apparently were preferred throughout the nesting period. Despite the ducks' preference for metal boxes, losses to predators were slightly higher in them. Metal boxes also were often hotter than wooden boxes. Daytime temperatures in the wooden boxes closely paralleled the ambient temperature, but daytime temperatures in metal boxes usually exceeded ambient temperatures by a few degrees.



The Montana Unit, working with the nesting population of Canada geese in the Flathead Valley, determined the reproductive rate and population turnover for the flock over a 10-year period, and devised various methods for field study such as the neck band of colored plastic tape (left) and the weighing device (right). (Photos by John J. Craighead)

Canada geese in the Flathead Valley.—Study of banded and color-marked Canada geese in the Flathead Valley by the Montana Unit revealed that goslings exhibit a strong tendency to return to the area where hatched. None of these geese nested the first year of life, but they did pair, and some pairs defended an area. Only two-thirds of the 2-year-old geese nested, and they, too, showed a strong homing instinct. Geese 3, 4, and 5 years of age and older tended to return to the previous year's nest site, or near vicinity, to nest. It would appear that the goose population in the Flathead Valley of Montana is largely maintained by members of the population unit returning each year to nest.

Production and utilization of sago pondweed.—Sago pondweed is one of the major waterfowl food plants in the United States. It grows abundantly in the marshes of the Bear River National Wildlife Refuge. In 1962 and 1963, the Utah Unit, cooperating with the Refuge Division, sought to determine just how much sago pondweed is being produced on the Refuge, and how important it is as a waterfowl food.

During the two growing seasons, numerous samples were taken to determine the amount by weight, of vegetation and seed, and the number of tubers produced. In addition, soil and water salinities have been measured, water temperatures and depths recorded, and soil types observed to ascertain whether correlation exists between plant production and any or all of these factors.

An excellent brood-production area on the Montezuma National Wildlife Refuge for mallards, black ducks, blue-winged teals, and wood ducks developed by flooding a low-grade stand of young hardwoods. An evaluation of the type as waterfowl habitat is being made by the New York Unit in cooperation with the Division of Wildlife Refuges of the Bureau. (Photo by Daniel Q. Thompson)

In addition to productivity studies, a number of waterfowl were placed in enclosures of predetermined size in order to approximate summer utilization. Results showed that, in summer, ducks take a high percentage of the seeds produced, but their consumption of vegetative parts and of tubers was not extensive.

Ecology of wetland timber impoundments.—The New York Unit's research on plant succession, waterfowl use, and waterfowl productivity on Montezuma National Wildlife Refuge has been greatly facilitated by the development of an automatic sequence camera, giving photographic surveillance of randomly selected plots for the entire daylight period. Three such cameras were in operation during the late summer and early fall of 1963 and obtained a total of 60 observation-days in this initial attempt. Minor technical problems have been encountered in the operation of the cameras; however, a completely transistorized circuit was developed during the winter quarter, and promises to make the camera even more useful.

OTHER MIGRATORY BIRDS

Migratory birds other than waterfowl of special concern to the Bureau include mourning doves, woodcock, wild pigeons, various shore birds, and sandhill and whooping cranes. The whooping crane is threatened by extinction; the other groups are of particular recreational importance.

National mourning dove breeding survey.—The breeding population of the mourning dove in the United States is censused in a national cooperative effort in late May and early June each year by Bureau and State personnel. The data obtained are used to compute indexes to breeding populations in the three mourning dove management units.

One of 60 "photographic plots" established by the New York Unit on the Montezuma National Wildlife Refuge. Automatic-sequence cameras are mounted at sampling locations to obtain a measure of duck use at different periods of the breeding and rearing seasons. The camera, in the waterproofed open-end box on the pole, is set to begin photographic surveillance of the plot at daylight the next morning, taking 1 picture every 15 minutes. (Photo by Daniel Q. Thompson)

This census is based on the number of doves heard cooing at 20 stops of 3 minutes each and 1 mile apart along permanent routes in each State. Analysis and interpretation of data is done by the Migratory Bird Populations Station.

Since the census is made before production of young has been completed, much effort has been given to the development of techniques that will yield data on age composition of the dove population in the fall. Attention has been focused on wing collections, which have worked successfully for other migratory game birds. Studies to date indicate that September-shot doves, when representing a sufficiently high portion of the total hunting season collection, can be used to measure the age composition of the kill.

As a means of assessing the importance of hunting in mourning-dove mortality, the Bureau has initiated a program of preseason and postseason dove banding. Emphasis will be on a comparison of recovery rates from birds banded before and after the hunting season, thus estimating hunting-season loss. The program is expected to run for 3 years.

Analysis of dove-banding data has permitted refinements in relating production areas to harvest areas. Statistical tests indicate that recovery patterns of doves banded as adults are different from those of birds banded as immatures; data for young and adults are now treated separately. Similar tests indicate that direct recovery patterns of all age groups differ from indirect recovery patterns, except for adult males; therefore, except for adult males, only direct recoveries are used.

Mourning dove studied in Arizona.—The mourning dove is one of Arizona's most important game birds; the State is important as both a nesting and a wintering area. During the last 2 years the Arizona Unit has attempted to develop better methods of determining the annual production, and has also studied the percentage of doves killed in Arizona but hatched outside the State. During the 2-year period 2,221 mourning doves were trapped and banded. The coo count or call count has been used to measure the number of breeding pairs in specific areas. Emphasis in the study was on refinement and improvement of this technique.

Dove production in north-central Colorado.—In the four primary habitat types used by mourning doves in north-central Colorado, a quantitative measure of productivity was determined in 1962–63 by the Colorado Unit. The four types, each

The extensive mourning dove banding program of the Bureau and many State cooperators will result in clearer definition of migration routes, longevity, and population dynamics, knowledge of which is necessary to sound management. The banding of nestlings has proved to be relatively rapid and economical. (Photo by Oklahoma Wildlife Conservation Department)

represented by a typical sample of 150 acres, were (1) urban (Fort Collins, Colo.), (2) foothills brushland, (3) irrigated farmland, and (4) shortgrass high prairie.

The urban type showed by far the highest productivity during the 2 years of study. Comparative production figures per 150 acres are given in the following tabulation.

AVERAGE ANNUAL DOVE PRODUCTION IN MAJOR HABITAT TYPES OF NORTH-CENTRAL COLORADO

Habitat type	Number of nests	Successful clutches	Young fledged	Young per 100 acres	Nesting pairs
Urban	245	138	236	157	115
Foothills brushland	32	16	27	18	12
Irrigated farmland	11	6	11	7	5
Shortgrass high prairie	2	2	2	2	2

The urban type, during the 2-year period of 1962–63, was about 8.7 times more productive than the foothills type, 22 times more so than the farmland type, and 28 times more so than the shortgrass prairie type. The far larger area contained in the nonurban types gives these three habitats greater significance than indicated in the tabulation.

Mourning dove color sensitive.—Research at the Missouri Unit on the effects of head-marking penned mourning doves provided elaborations of previously published information on this subject. Removal of the female and eggs or squabs from the pen always broke the pair bond, and caused the males' rate of perch cooing to increase as much as fifteenfold.

One of the most distinctive of American game birds is the woodcock. They nest in the Northeast, including southeastern Canada, the Lake States, and elsewhere. The species' wintering grounds are in the more southern States, especially Louisiana, where unfrozen ground permits the birds to probe for the staple of their diet, angleworms. (Photo by Howard L. Mendall)

Green, white, or red head marks on the female did not prevent reestablishment of the pair bond upon the return of the female to her mate, at which time the rate of perch cooing decreased rapidly. Yellow head marks on the female did prevent reestablishment of pair bonds, and the rate of perch cooing in previous mates remained high. Pair bonds were quickly re-formed when yellow head marks were removed.

Significance of these findings to field studies employing color-marked birds is not yet known. Preliminary results indicate that colored back straps do not have the effects on behavior that head marking does.

Mourning dove food habits in New York.—Study of the mourning dove by the New York Unit has centered on its food habits in Tompkins County. A total of 181 mourning doves were collected, including 103 adults and 78 juveniles. By considering the phenology of weed-seed availability and crop harvesting patterns in relation to utilization of these foods by doves, the research has established significant relations in dove food habits in the Northeast. Wheat occurred in the highest frequency (44 percent), followed by foxtail grass (36 percent), corn (27 percent), buckwheat (20 percent), and lesser ragweed (21 percent).

Earlier woodcock season.—As reported a year ago, the woodcock season was advanced 10 days in the fall of 1962, to October 10, because research by the Massachusetts Unit indicated that many birds migrated through the State before the season that opened on October 20. Presumably because of this action, the woodcock harvest in Massachusetts, as shown by hunter questionnaires, almost doubled in 1962 and in 1963.

Woodcock production.—As a means of measuring the annual woodcock production, a sample of hunters in the United States and Canada is asked each year to send woodcock wings to the Migratory Bird Populations Station. Hunters provided 15,315 wings in 1962. Examination of the wings has revealed both the ratio of adult to current-year birds and the sex composition of the kill. A comparison of the ratio of young per adult female indicated no change in productivity from 1961 to 1962, a conclusion supported by spring counts of breeding-population size in 1962 and 1963.

The reliability of singing-ground counts is being tested in Michigan, where 126 randomly selected routes were censused in 1963. These routes, together with regular nonrandom routes, will be covered again in 1964. With 2 years of data it will be possible to compare both numbers

and change in numbers of birds recorded on the two types of routes. Results obtained in 1963 suggest that random routes provide a more accurate picture of woodcock abundance.

A great need in woodcock management is knowledge of mortality rates and the extent to which one age or sex is more likely to be shot than another. An effective banding program would supply this information. Using improved trapping methods, personnel at Moosehorn National Wildlife Refuge in Maine banded over 500 woodcocks in the summer of 1963.

Sandhill cranes in Mexico.—A sandhill crane survey initiated by the Denver Center in Mexico in 1962 was continued in January 1963. The 1962 survey was conducted in the States of Chihuahua, Durango, Sinaloa, and Sonora, and expanded in 1963 to include the States of Coahuila, Guanajuato, Puebla, and Tamaulipas.

The Bustillos and Babicora valleys in the State of Chihuahua are by far the most important sandhill crane wintering grounds in Mexico. In 1963 a total of 31,850 cranes were recorded here, as compared with 20,125 in 1962. In addition to small, scattered flocks found in other regions of Chihuahua and Durango, the only other cranes observed were in the Carmen Marshes of Puebla. These wetlands are potentially an excellent wintering area for the birds but at the time of the survey showed signs of a prolonged drought.

Search for missing whooping cranes.—The disappearance of four whooping cranes from the Aransas Refuge and adjacent barrier islands during the winter of 1962–63 prompted an intensive aerial search that extended from Galveston to Mexico. Nearly 100 hours of flying time were devoted to the search over a 4-week period in February and March, 1963, and all possible habitat, both coastal and inland, was covered on four occasions without success. Repeated flights over the usual wintering grounds failed to provide any clues regarding the fate of the missing whoopers.

In addition to the four birds that disappeared from the wintering grounds, six failed to return from the breeding grounds in the fall of 1962. This, coupled with the fact that no young were produced, made the year 1962 one of the most disastrous on record for the wild population of whooping cranes.

The Bureau is committed to protection of rare and threatened species of mammals, birds, and other American wildlife. Special efforts are being given to preservation of the whooping crane. (Photo by Luther C. Goldman)

Wildlife habitats—tidewater to timberline, bottomland hardwood in Maryland (above) to cold-stunted Engelmann spruce in Colorado (below), 100 to 11,000 feet—are studied by Bureau ecologists in both direct and cooperative programs. (Photo by F. C. Schmid, top; Lee E. Yeager, bottom)

UPLAND WILDLIFE ECOLOGY

Much of the resident game of the United States, both birds and mammals, is produced on privately owned land, where wildlife management responsibilities are primarily those of State game and fish departments. The Bureau has clear responsibility for research on public lands leading to improved management of upland wildlife. Another segment of the Bureau's responsibility in the upland area deals with wildlife affecting forest regeneration and range condition. The primary approach in this country-wide Bureau program is close cooperation with Forest and Range Experiment Station personnel of the U.S. Forest Service. Bureau research on farm game species is carried on principally through the Cooperative Wildlife Research Units working directly with the States.

Reindeer.—A study of the reindeer herd on St. Matthew Island, in the Bering Sea, is being conducted by the Alaska Unit. The reindeer increased from 29 animals introduced in 1944 to 1,350 animals in 1957 and now number approximately 6,000, an average annual increase of over 30 percent. There are now many indications of excessive stocking of the range. Yearlings decreased from 21 percent of the population in 1957 to 14 percent in 1963. Fawn weights averaged 36 percent less than in 1957, and adults were correspondingly lighter. Subcutaneous fat was absent in most animals examined. Lichens have been nearly eliminated from the winter range, and willows have died in some areas. Grasses and sedges showed an increase in density on winter-range study plots, at the expense of the lichens, the main winter reindeer food. A drastic reduction of the population is imperative if the herd and range are to be saved.

Hunter access and deer kill distribution.—The Bureau, in cooperation with the U.S. Forest Service and the North Carolina Natural Resources Commission, has completed a detailed analysis of the relation between access roads and the white-tailed deer kill in North Carolina. Assigned biologists worked on the Uwharrie Wildlife Management Area in the Piedmont region and on 13 game-management areas in mountainous country.

Of 3,633 kills on the Uwharrie over a 3-year period, and 4,132 kills in the mountain areas over a 4-year period, the following distance-to-road data were obtained: On the Uwharrie, 40 percent of the kills were within 300 feet from the nearest road or trail; 81 percent were within 600 feet, and 99 percent were within 1,200 feet. None of the deer were killed beyond 1,800 feet from a road or trail. Of the total area 99 percent lies within 2,400 feet of driveways of some sort.

In the 13 mountain areas, hunters shot 25 percent of the deer within 300 feet of a road, 54 percent within 600 feet, 83 percent within 1,200 feet, 93 percent within 1,800 feet, and 98 percent within half a mile of a road or trail. Of the total area, 98 percent lies within 2,400 feet of a roadway or trail.

The Uwharrie was hunted by urban sportsmen, who were not prone to enter remote areas. In the mountains, most of the hunters were local residents, more likely to work back-country range.

Ecological characteristics of a mule deer winter range.—The ecological characteristics of a selected mule deer range in north-central Colorado was studied by the Colorado Unit during a 2-year period from 1960 to 1962. The investigation was conducted in cooperation with the Colorado Department of Game, Fish, and Parks, the Atomic Energy Commission, and the Bureau of Sport Fisheries and Wildlife.

The uncorrected map acreage of the Sevenmile area is about 600 acres but when topographic configuration is accounted for the actual surface area is 960 acres. Shrubs and coniferous trees cover about 90 percent of the tract, and are about equally divided between the two types. About 75 percent of the surface lies between gradients of 41 and 60 percent; 45 percent of the slopes are south facing, and 45 percent are north facing.

In the winter, the mean radiation index for south-facing exposures was 37, and for north-facing exposures was 19. South-facing slopes received approximately nine times as much direct sunlight in the winter as other aspects, and were generally warmer, had less ground-surface snow, more total annual precipitation, lower relative humidity, and much more wind. North-facing coniferous timber types, contrastingly, had significantly lower minimum and mean air temperatures,

The Romanzof Mountains of the Arctic Wildlife Range where the Alaska Unit undertook a back-pack reconnaissance of its wildlife resources in 1962. (Photo by David R. Klein)

greater frequencies and longer durations of subzero and subfreezing temperatures, deeper ground-surface snow for longer periods, higher relative humidity, more effective precipitation, and less wind than the other exposures.

Of the 600-odd deer observed during the study 73 percent were in shrub types, 13 percent in open-timber types, 11 percent in drainage areas, and 3 percent in heavy timber areas. Of the total number seen, 70 percent were observed on the upper half of the exposures involved.

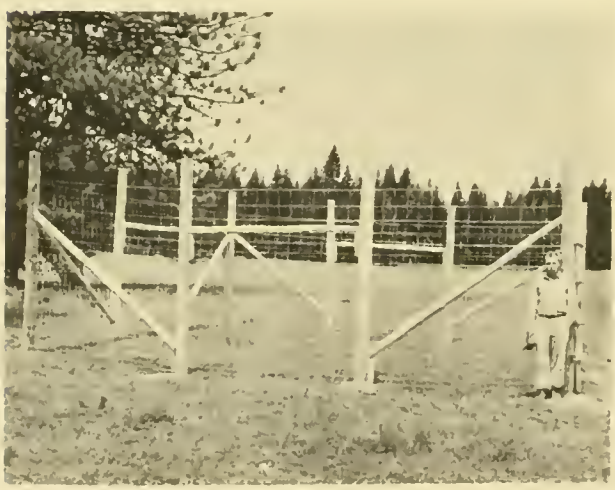
Results of this and associated research conducted concurrently by the Colorado Game, Fish, and Parks Department have provided new and relatively precise information for more effective management of mule deer winter range, the key problem in maintaining herds of the most important big-game species in the West.

Ecology of the Middle Fork mule deer winter range.—The Idaho Unit's investigation of this critical winter range on the Salmon River revealed an area of unstable soil on relatively steep slopes. Downward soil movement is caused by runoff, gravity, and big-game concentration on the area during the winter months, abetted by relatively thin density of the principal shrubs: bitterbrush, 27.7 percent; gray rabbitbrush, 23.3 percent; big sagebrush, 19.3 percent; and slender eriogonum, 14.8 percent. Bitterbrush provided only 9 percent of the live perennial vegetative cover; big sagebrush, 5.4 percent; gray rabbitbrush, 4.3 percent; and slender eriogonum, 4.3 percent. There are approximately 444 shrubs per acre, of which 69 are bitterbrush plants. Utilization of bitterbrush during the mild winter of 1961–62 was 56 percent of the annual growth.

The inaccessibility of the critical Middle Fork range makes adequate harvests of mule deer difficult. During the early part of the hunting season (September 15–November 15), deer remain high and scattered in precipitous terrain and descend to lower elevations in numbers only during the third month of the season. Productivity studies for both the herd and the range have provided the Fish and Game Department and the U.S. Forest Service with basic management information.

The expanding reindeer herd on St. Matthew Island in the Bering Sea provides the basis for a range-use study by the Alaska Unit. The herd has increased from 29 animals at the time of release in 1944 to 6,000 in 1963. (Photo by David R. Klein)

Environmental analysis shows the way to more effective management of critical wildlife areas. The Colorado Unit, under AEC contract and in a cooperative project with the Colorado Game, Fish, and Parks Department, concluded a comprehensive study of a selected mule deer winter range that involved the measurement of weather, vegetational, topographic, and soil factors, correlated with deer use and behavior on the area. (Photos by Lee E. Yeager)



In range studies on the Public Lands, the Bureau cooperates with the U.S. Forest Service or the Bureau of Land Management and usually with the States involved. Here, forage production and utilization are under measurement on heavily used elk range in Idaho (left), and on a critical deer winter range in Utah. (Photos by Paul D. Dalke, left; W. L. Robinette, right)

Winter food is a major factor in sustaining deer herds. The Denver Center, in cooperation with the Rocky Mountain Forest and Range Experiment Station, is experimenting with chemical repellents in efforts to protect newly established deer browse, in this case aspen regeneration. (Photo by Donald R. Dietz)

Nutrient requirements of white-tailed deer.—Studies of calcium and phosphorus utilization in male deer, using specially designed metabolism stalls, were continued through the year by the Pennsylvania Unit. Deer were subjected to restricted diets and sacrificed. Bone marrow conditions paralleled the well-known New York studies. The sequence in utilization of various body-fat deposits appeared highly definitive as to stage of malnutrition. Microflora in the rumen apparently retained ability to digest carbohydrates much longer than proteins when deer were subjected to starvation diets for extended periods. Maintenance of male deer on 16-hour days through the use of artificial light, initiated June 22, 1963, has thus far resulted in a general retardation in antler velvet rubout and molting of the summer pelage.

Venison quality and palatability studies.—Factors influencing quality and palatability of venison were studied by the Utah Unit. Washing the carcass after field dressing and field cooling, or not washing it, or not transporting the carcass while it retained body heat, had no appreciable effect on the quality and palatability of the deer tested. Aging was found to be beneficial in developing better flavor and greater tenderness in venison, as well as making the carcass easier to handle, cut, and wrap for storage. One week of aging gave optimum results in flavor. Meat from animals 2 years old or less was preferred to that of the older

animals. Meat taken during the earlier months was preferred to late-season kills. The five packaging materials recommended for locker use, although showing variation in effectiveness, preserved a good color and prevented freezer burn and weight loss. Flavor, palatability, and tenderness of ground meat were increased by the addition of fat. Fat also contributed to a moister (juicier) product. Use of the antibiotic Aureomycin on the meat increased significantly the flavor and acceptability scores.

Population study of bighorn sheep.—The objectives of this investigation were to determine the population dynamics of Rocky Mountain bighorn sheep on Wildhorse Island (in Flathead Lake) during the years 1959 to 1962, and to bring together information on this population for a 22-year period. The work was conducted by the Montana Unit.

The number of bighorn sheep on Wildhorse Island increased from 2 yearlings in 1939 to 6 sheep (2 rams, 3 ewes, and 1 lamb) in May of 1947, when an additional 7 (3 rams, 3 ewes, and 1 lamb) were released. The herd increased to approximately 100 animals by the summer of 1954. Counts for the 4 years 1959 to 1962 were 114, 112, 100, and 97. It is considered probable that almost all of the 2-year-old ewes produced lambs from initial introduction until the peak population was reached. Under the present condition of a stable or declining population, just over 50 percent of the 2-year ewes reproduce. A minimum loss of 114 bighorns can be accounted for since 1952. The heaviest mortality of adult bighorns, found dead with horn sheaths intact, was estimated to have occurred during the sixth year of life in females and during the eighth year in males. The maximum life span of 17 rams (1 year old or older) found dead or dying was estimated to be 10 years.

Horn growth and aging in bighorn sheep.—A study of 62 bighorn sheep by the Montana Unit showed that horn growth in rams is affected by physiological and environmental conditions, evident from cessation and resumption of growth that formed distinct rings, and the retardation of growth that formed secondary or false annuli. Examination of external and internal characteristics revealed that horn growth occurred over the entire surface of the bony core and not just at its base.

Differential growth rates control conformity of the horn. Linear growth was greatest during the second year and became increasingly less subsequently. Definite differences were noted in the formation of distinct annual rings and secondary or false rings. Within limitations of individual variation, the distinct annual rings (true annuli), formed at the end of growth periods, may be used as an indication of age in rams.

Grizzly bear population study in Yellowstone Park.—In 1963, a total of 55 bears were handled (24 initial captures and 31 recaptures), by Montana Unit personnel, raising the total number for the 5-year study to 282. Thirty-three bears were captured during 28 of 68 trap-nights, for a success of 41 percent, an increase of 9 percent over 1962. The remaining 22 animals were shot with drug-filled syringe darts while free-ranging. Twenty-four bears were marked for a 5-year total of 165 different grizzlies. Eighty-seven marked bears were theoretically in the population in 1963 and 74 were observed 1 or more times.

The radio-tracking system and a bioelectronic laboratory were in full operation during 1963. Seven bears were instrumented during 1963 for a total of 13 to date. The last grizzly to receive its transmitter (No. 164) was tracked to its "hibernating" den on November 5. The distinctive signal was first received at a distance of about 10 miles. Using directional receivers, the source of the signal was located deep in wilderness country during a severe snow storm and the instrumented bear was actually observed entering the den.

Peccary.—For the sixth consecutive year the Arizona Unit and the Arizona Game and Fish Department worked together in manning the 1963 javelina hunter checking stations. A total of 156 animals were handled, and data on weights, general condition, and age were collected. Aging was determined from the teeth. In addition, attention was given to the possibility of using eyelens for aging, and eyeballs were collected from dead javelinas for the second consecutive year.

Further data on javelina reproduction, rate of increase, and food and water requirements were collected from captive animals kept by the Unit. To assist in solving the difficult problem of interpreting corpora lutea data, females are being sacrificed at known stages of the reproductive cycle.

Social behavior in swamp rabbits.—A study of social behavior of confined swamp rabbits by the Missouri Unit showed that males have strong social hierarchies. The penned rabbits formed

breeding groups, each of which had its own dominant male and its females. Some males were excluded from any breeding groups. Within the groups, dominant males evidently sired most or all of the young. Males of the breeding groups showed some territorial tendencies and defended areas depending upon location of the females. Wild swamp rabbits may form breeding groups of this type, and the interrupted habitat type often used by the species would be conducive to formation of such groups. This is apparently the first specific delineation of a habitat preference in relation to breeding habits of the swamp rabbit.

Ecology of the striped skunk determined by telemetry.—Five skunks were trapped and radio-equipped by the Ohio Unit in July and August of 1963. A high incidence of rabies in this species prompted an attempt to develop tracking equipment to study movements and behavior patterns. Radio tracking showed that skunks prefer waterway shorelines as travel lanes, but frequently use fencerows. They feed in hayfields, meadows, or pastures with short vegetation, and usually travel 0.5 to 1 mile from the densite. Movements from dens began at about 7 p.m. and the animals returned between 3 and 5 a.m. Four to six hours were spent in the feeding area once it was reached by casual, unhurried travel. After feeding, the instrumented skunks moved directly back to the den.

Arctic fox.—In an arctic fox study by the Alaska Unit it has been found that eskimo trappers along the Arctic coast blame the low price of furs ($12.50 average), availability of other forms of employment, and occasional poor health, for the reduced trapping in recent years. At the village of Barrow an average of 73 traps per trapline is maintained. Traplines vary from 5 to 175 miles in length and average 63 miles; motorized over-snow

Radio-tracking of wild animals has become common, and offers a means of studying movements, range, and behavior provided by no other technique. Montana Unit members "instrument" a grizzly bear by installing a radio transmitter attached to a neck collar (top); South Dakota Unit personnel demonstrate a radio tracking device (middle); a striped skunk, "instrumented" by the Ohio Unit, travels through a soybean field toward feeding ground (bottom)—this animal was tracked continuously for several days. (Photos by Montana Cooperative Wildlife Research Unit, top; Paul F. Springer, middle; and Tony J. Peterle, bottom)

Trapping wildlife, alive and unharmed, for in-hand study is commonplace in Bureau programs, both direct and cooperative. A snowshoe hare just removed from livetrap by Alaska Unit graduate student (top), and a trap being set for pine squirrel by Bureau biologist. (Photos by David R. Klein, top; Denver Wildlife Research Center, bottom)

vehicles are used more frequently than dog teams to maintain traplines. Pelt studies indicate that young foxes reach primeness later than adults; a large early season catch of juveniles can therefore have a pronounced effect on the value of the annual harvest.

Effect of slope on browse production.—In a timberstand improvement study on the Pisgah National Forest in North Carolina, in cooperation with the U.S. Forest Service, clearings on lower slopes produced 10 times more available deer browse than those on upper slopes. Cleared areas on lower slopes produced 801 pounds of browse per acre, as compared with 5 pounds on uncut areas. The most important browse species were red oak, black gum, smilax, dogwood, red maple, black locust, sourwood, *Vaccinium* sp., sassafras, and white oak. Track-count plots indicated that clearings were used more than check areas during the first growing season and during critical periods.

Productivity of bobwhite quail in Alabama.—This 10-year study, designed to evaluate the annual production of quail as related to weather or other factors, was completed in 1963. Wings were solicited from hunter cooperators, who contributed 81,749 during the period. The percentage of juvenile quail in the bag, and the fraction of the total hatch before July 1 of each year, were ascertained from these materials. It was clearly demonstrated that the peak hatch for each year was correlated with the wettest part of the season. Dry periods early in the season resulted in the hatching of an above average number of young after July 1, and years of above-average rainfall resulted in an above-average percentage of young quail in the kill, the Alabama Unit reported.

Fertilization improves quail habitat.—Fertilization experiments in conjunction with burning were continued on both the burned and unburned tracts studied by the Alabama Unit. Intercepts measured in September indicated the following coverage, in percent, by quail food plants: burned and fertilized area, 23.82; burned area, 13.38; fertilized area, 2.64; check area, 1.42. These results are considered significant and of definite management interest.

Habitat components of the bobwhite quail.—This project, completed in 1963 by the Oklahoma Unit, showed that from late May until autumn the principal foods of quail were grass seeds. Of particular importance were Johnsongrass, fringeleaf paspalum, panic grasses, and wheat; insects

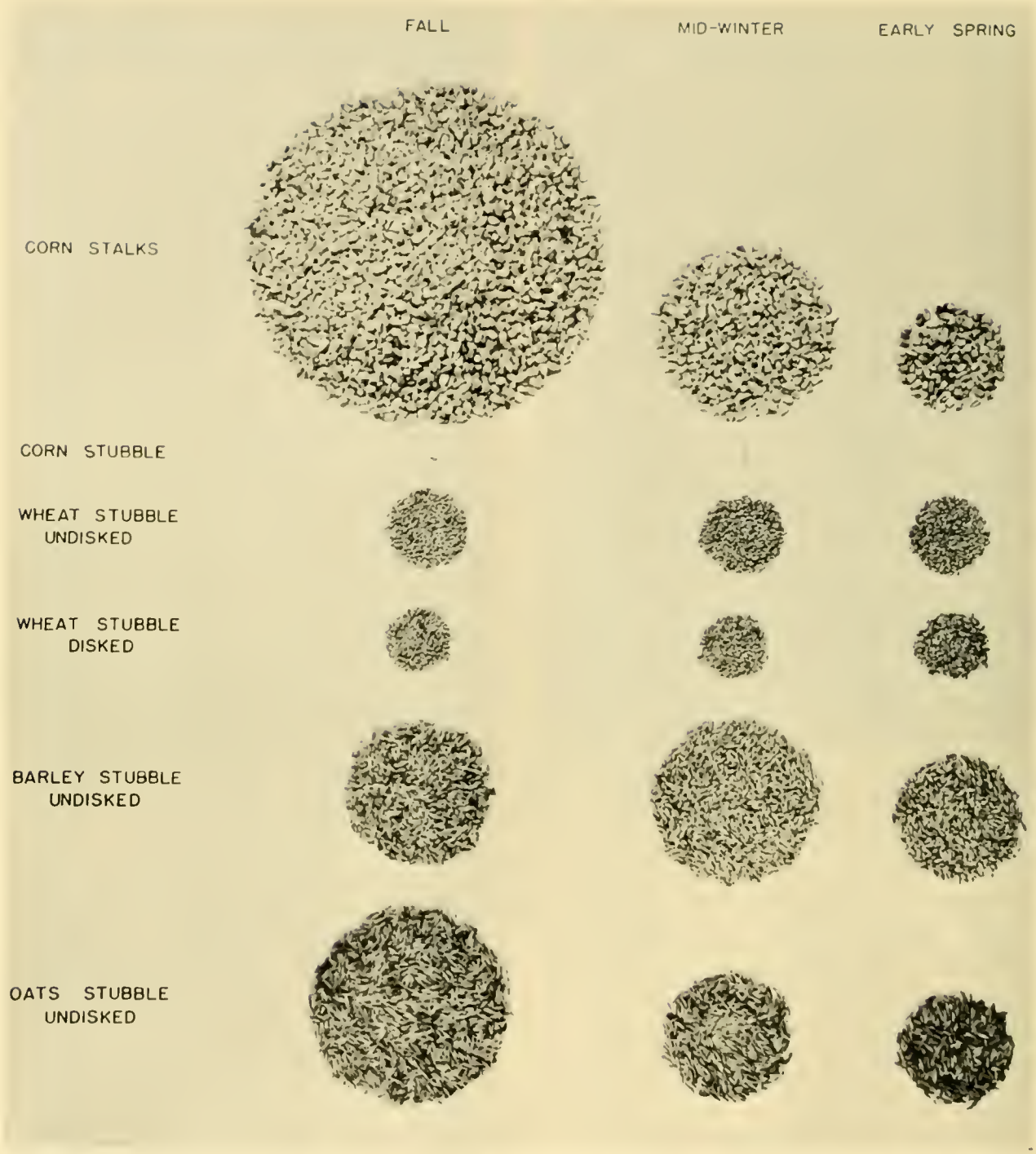
Habitat of bobwhite quail is being studied by the Alabama, Oklahoma, and Virginia Units, and pesticide investigations are under way at the Patuxent Center and at two research stations in Alabama. Nest in typical cover in Oklahoma (left) and a quail family in old field type in Virginia (right). (Photos by Oklahoma Cooperative Wildlife Research Unit, left; and L. G. Kesteloo, right)

also were prominent in the summer diet. In winter, seeds remained a dietary staple, but the insect material was largely replaced by leafy foods. Of more than passing interest was the fact that when the ground is covered with snow, sumac seeds become important in the quail's diet.

Cover used for various purposes possessed distinctive characteristics. Roosting spots were typically surrounded by taller herbaceous plants, usually bunchgrasses. These were of low to moderate density and provided little overhead canopy or obstruction. Resting places on the other hand were generally under low trees or shrubs, which did provide overhead canopy, lateral concealment, and low stem density. Cover used for escape was at least 3 feet in height and dense enough to provide some concealment. Foraging and dusting were carried out in places where stem density was low.

Mearns' quail.—The Arizona Unit conducted research on Mearns' quail during the year, working in grassy areas of the live-oak woodland in the southeastern part of the State. In recent years very short hunting seasons on Mearns' quail have been permitted by the Arizona Game and Fish Department. The study has clearly shown that the quail population is not damaged in these hunts, since the bird has a high reproductive potential. Age ratios in the fall population are comparable to those in Gambel's and scaled quails.

Juncos important consumers of conifer seed.—In the Northwest, the seeds of Douglas-fir and other important forest trees are staple foods for many birds and mammals. In some years forest regeneration is threatened by the loss. The juncos, small birds common to the region, are perhaps the most abundant of the seed eaters. Analyses of the gizzard contents of juncos collected seasonally



Determination of the kind and quality of winter food available to wildlife is highly important to management. The Colorado Unit found that there is extreme variation in quantity of grain left in fields at this season, determined largely by cultural practice, as shown in the direct comparison above. (Photo by Wayne W. Sandfort and Harold W. Steinhoff)

Typical cover along dry drainage courses in the desert type of southwestern Utah. Gambel's quail find fairly suitable habitat in such cactus-yucca-greasewood stands. (Photo by Utah Cooperative Wildlife Research Unit)

on the Andrews Experimental Forest of western Oregon have revealed that Douglas-fir and hemlock seeds are most freely taken, amounting to more than 20 percent of the total diet in a 90-bird sample. The juncos displayed a strong preference for Douglas-fir seed over the seeds of hemlock and red cedar, the Denver Center reported.

Problems with multiflora rose.—Multiflora roses have been widely planted in hedgerows for wildlife food and cover and as a "living fence." About 3 miles of experimental multiflora hedgerow was established on the Patuxent Center, beginning in 1947. During ensuing years it became a nuisance in many places on the Center, owing to vigorous growth and wide dissemination of seeds by birds. Elsewhere many landowners had become bitterly disillusioned with multiflora, and State response had ranged from warnings to attempts at legislation to prohibit its further use.

In an attempt to reevaluate the rose for wildlife purposes on agricultural land, Patuxent personnel determined that, from the original plantings, the rose had spread over much of the developed area of the Center itself. In favorable locations, it had formed impassable thickets, and it was very common along fencerows, forest edges, roadsides, ditches, an orchard, and the banks of a farm pond.

In cooperation with the Agricultural Research Service, the Center has undertaken control tests with seven leading herbicides. Most of the chemicals killed the canes quickly, but some of the treated plants had started to sprout again before the onset of winter. Final results cannot be evaluated until after another growing season.

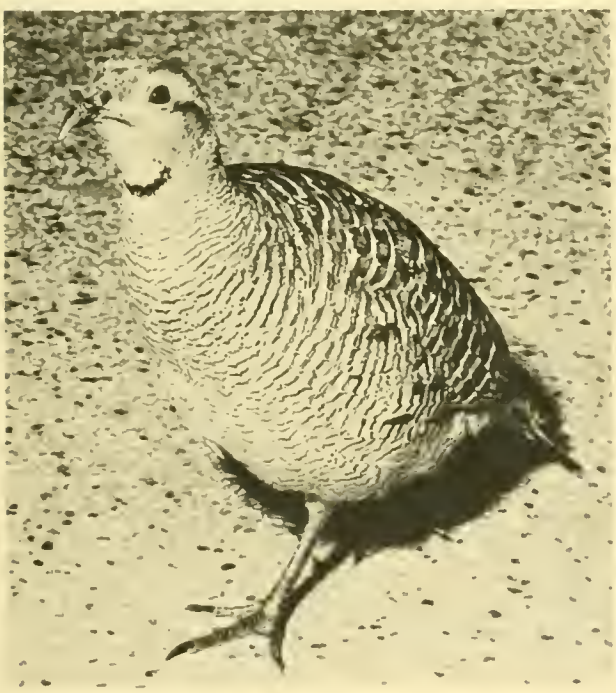
Multiflora rose, good wildlife cover and effective as a hedgerow and "living-fense," is an aggressive spreader under some conditions. Its ecology and methods of control are being studied intensively at the Patuxent Center. (Photo by F. C. Schmid)

Recreational use of forest land.—The Virginia Unit studied area use in George Washington National Forest, interviewing 1,532 parties leaving the study area. Resultant data yielded a total-use estimate for commercial, residential, and miscellaneous categories amounting to 833,314 man-hours with a probable error of ±15 percent. Approximately 83 percent (691,837 man-hours) of this total was recreation use. Component recreation uses were 233,711 man-hours in private camps, 182,389 man-hours on developed sites, and 275,688 man-hours on undeveloped areas, with probable errors of ±26, ±28, and ±21 percent. Hunting, sightseeing, fishing, and primitive camping were the major uses on undeveloped areas. Hunting was estimated at 140,517 man-hours, sightseeing at 54,395, fishing at 34,119, and camping at 24,285, with errors ranging from ±26 to ±47 percent. On developed sites, campgrounds received 79 percent of the 182,839 man-hours of use.

The most important result of the study was the development, in the absence of prior knowledge of optimum sample size or allocation of effort, of a stratified random sampling design for obtaining acceptable estimates of total and component recreation use on large units of forest land.

Foreign game introduction program.—Trial liberations of 16 species or subspecies of foreign game birds, including 5 pheasant crosses new to the United States, are currently under way in 23

The Foreign Game Introduction Program has required extensive travel in foreign lands, and close working relations with native peoples, in the search for birds adaptable to game-vacant regions in the United States. Francolin grouse trappers in India with tools of the trade—nets, rope for dragging net, and carrying basket (top); gray francolin, a game bird adaptable to cultured lands in semiarid regions (bottom left); and black francolin, a species apparently suitable to forests and farmlands of the humid South, in holding pen (bottom right). All species of foreign game are carefully evaluated as potential pests, and held 2 months in quarantine for assurance against disease introduction before release. (Photos by Gardiner Bump)

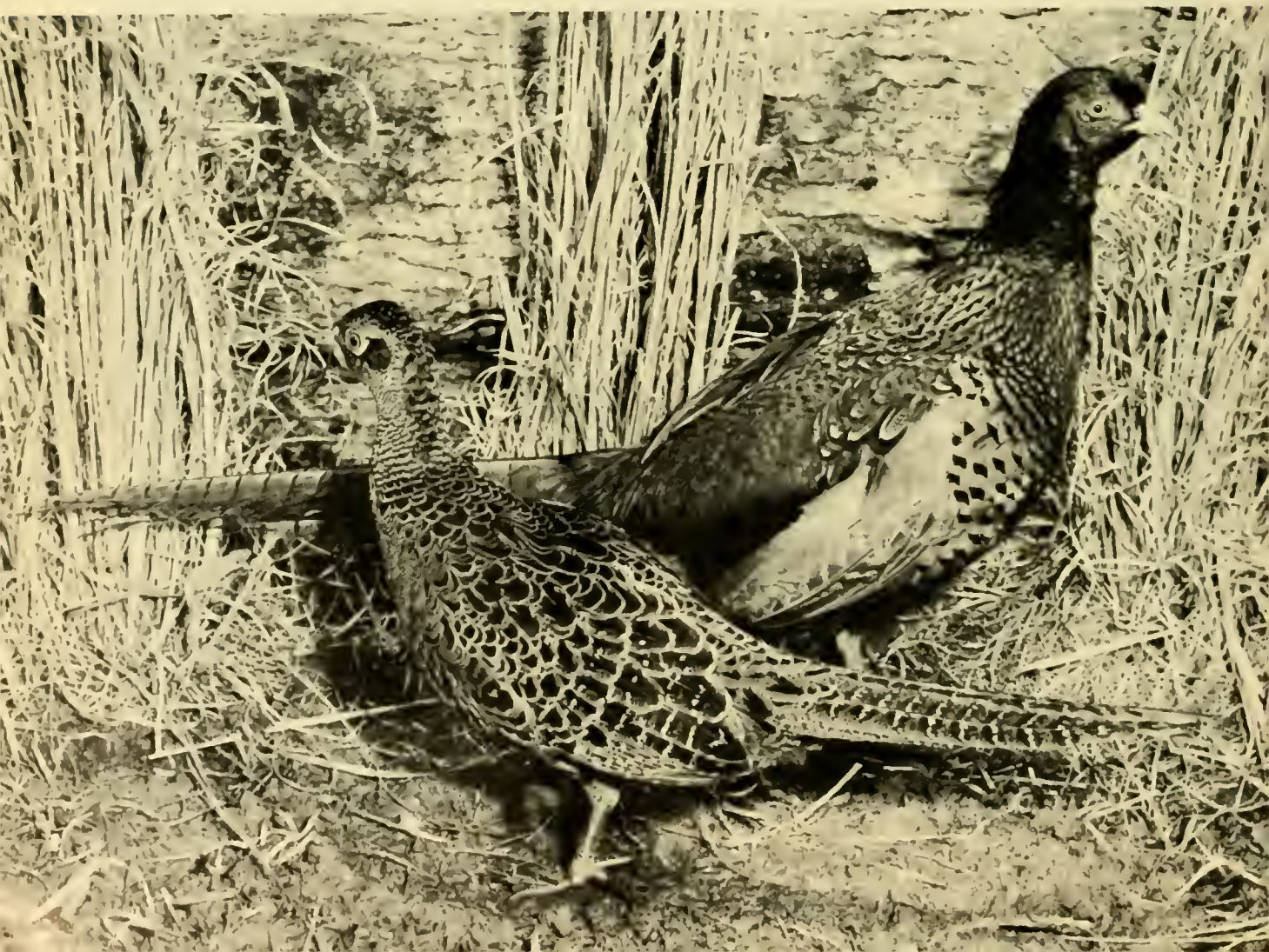


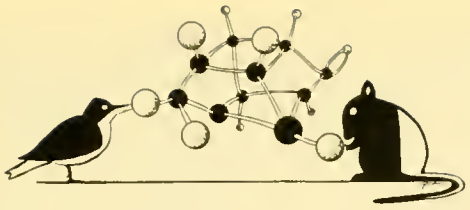
States and Guam. Twelve species or subspecies, 10 of which are pheasants, occupy farm and adjacent brushland habitats. Six are potentially adaptable to rangelands and dry farmlands; and three are woodland species. Areas in which the releases are being made lie mainly in the east-central, southern, southwestern, and far-western States.

No new game birds were obtained or recommended for trial in 1963. Program personnel continued to assist cooperating States in the selection of release sites and evaluation of previous liberations. Much of their time was spent in providing technical suggestions relative to production, on State game farms, of quality stock well conditioned for survival upon release in the wild. During the year, 25 States reared and liberated 23,958 birds of 19 species or subspecies, mostly to supplement previous releases.

Although it is still too early to evaluate results for most species under trial, some trends are evident. Iranian pheasants, black francolin, and gray francolin have definitely demonstrated the ability to survive, reproduce, and increase substantially in a number of release locations. Conversely, Indian sandgrouse have disappeared, and Reeves pheasants are barely hanging on. Six other species are maintaining themselves in numbers great enough to justify guarded optimism, and two others have probably failed.

The Iranian black-necked pheasant, brought to the United States through the Foreign Game Introduction Program, now occurs in more than 40 counties of Virginia and in smaller numbers in several other southern and southeastern States. This pheasant appears adaptable to semihumid forest-farmland habitats where ring-necked pheasants have failed to survive. (Photo by Virginia Commission of Game and Inland Fisheries)





PESTICIDE-WILDLIFE RELATIONS

In the controversial pesticide question, the Bureau has wide responsibility for obtaining facts on the immediate and long-range effects of pesticides on wildlife resources. The objective of extensive investigations is to assist in the development of methods and materials which will insure effective pest control with the greatest possible safety to man and wildlife. In the Bureau's concept, safe use requires a multiple approach in research: more selective chemicals; more accurate dosage; substitution, where possible, of biological or ecological methods for chemicals; use of less persistent but still effective chemicals; rigid adherence to prescribed directions; and, above all, thorough testing prior to release for general application.

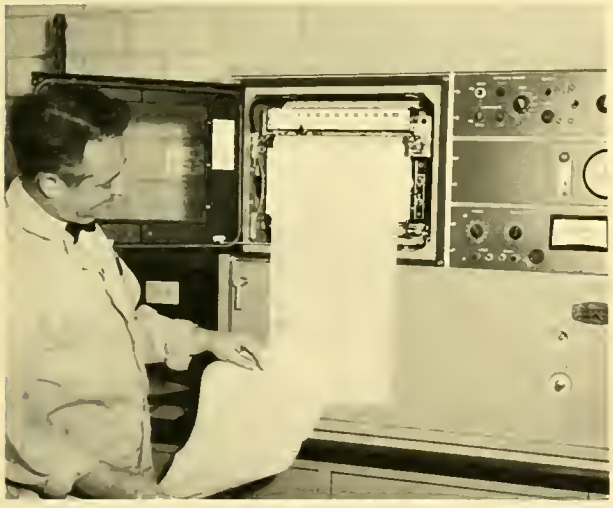
Improved methods and equipment.—In chemistry, the Bureau's research centers have given special emphasis to the simplification of analytical methods in order to reduce the time required for determining pesticide residues in biological specimens.

The adaptation of the gas chromatograph, employing an electronic-capture detector, to routine analyses for chlorinated hydrocarbon residues shows promise of reducing cost as well as increasing sensitivity of pesticide detection without excessive "cleanup."

New facilities have been added to the laboratory at the Denver Center to aid in the development of methods and to allow the detection of lower levels of certain materials. Such equipment includes an Atomic Scanogram II Chromatogram Scanner and a liquid scintillation counter to permit detection and measurement of extremely minute quantities of radioisotope-tagged pesticide materials used in translocation and metabolism studies.

Limited field observation on the effects of experimental applications of Phosphamidon on wildlife was possible through cooperation with the U.S. Forest Service in tests to determine its suitability for the control of spruce budworm and hemlock looper. Additional joint investigations are anticipated in order to attain a mutual goal of replacement of chlorinated hydrocarbon insecticides with less persistent pesticides for forest insect control.

Persistent pesticides from remote areas.—Pesticide residues have been isolated and identified from aquatic plants and snails collected in northern Canadian waterfowl nesting habitat, as well as in the atmosphere in these areas. In an attempt to understand better the presence of pesticides in remote and untreated areas, the Denver Center developed an air-sampling device consisting of a 2-inch glass tube containing a loosely packed glass-wool filter coated with mineral oil, fastened outside the airplane.



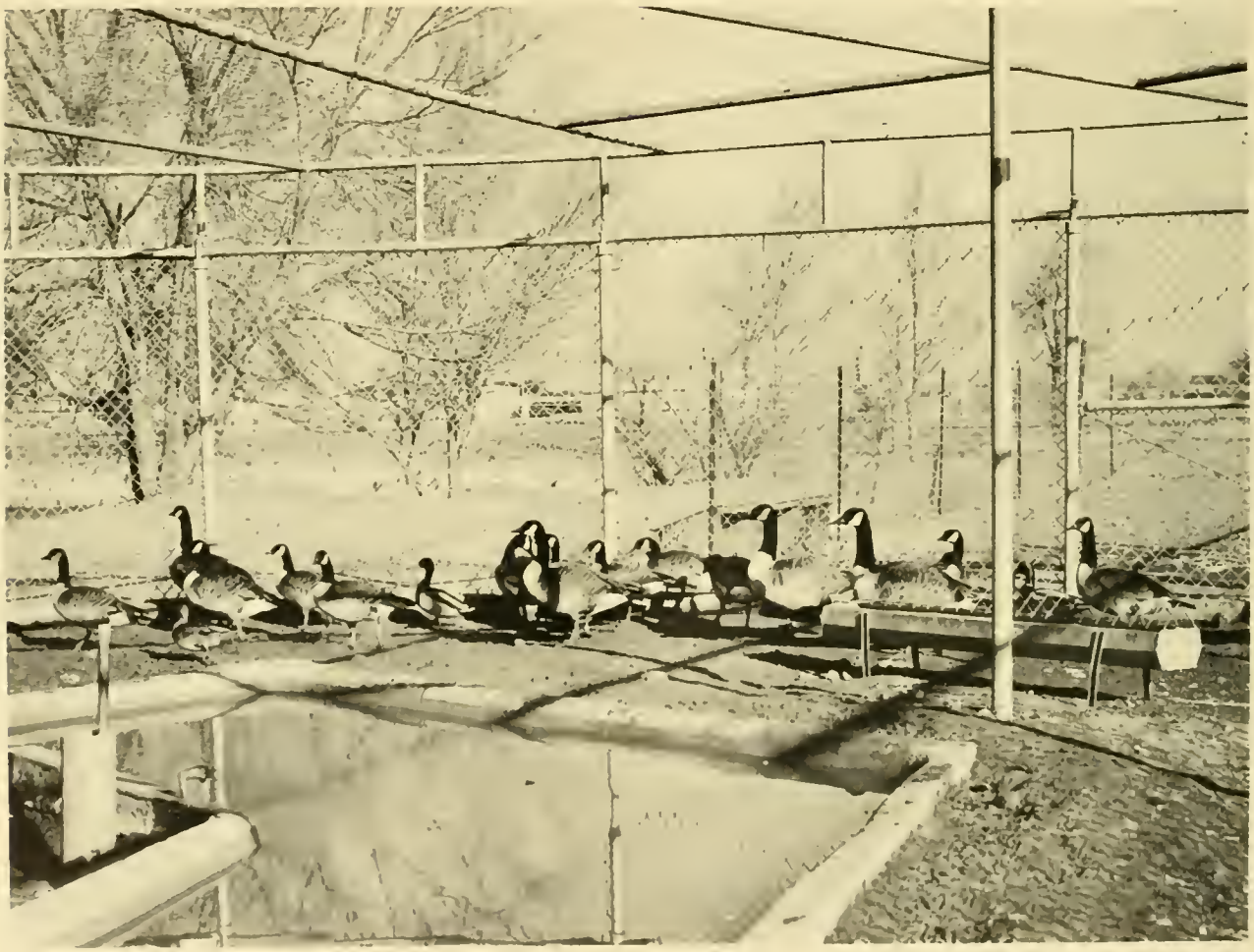
Modern and highly specialized laboratory equipment permits measurement of minutely small quantities of pesticides in animal tissues. A chemist (left) using gas chromatograph for separation and analysis of pesticide residues, and (right) a chemist preparing thin-layer chromatography plates for pesticide analysis. (Photos by Rex G. Schmidt)

Canada geese in 2,4-D feeding test.—The feeding habits of Canada geese make them vulnerable to herbicide ingestion. To investigate the impact of one such material on the internal organs of geese, an ad-lib feeding test using 1,000 p.p.m. of 2,4-D sodium salt was initiated at the Denver Center. Upon examination, tissue damage in the form of progressive kidney enlargement and a general "jaundiced" appearance of the viscera was evident. Microscopic examination of tissues indicated more specific damage consisting in general "disorganization" of the kidney and liver cellular structures through a fatty degeneration, round-cell and connective-tissue invasion, lesions and dissolution of renal tubules, arteriole wall enlargement, and glomeruli enlargement.

Histologic examination of geese removed from extended treatment and placed on a "clean" control diet indicated that tissue damage may be repaired.

Sevin appears low in toxicity to wildlife.—At Lostwood National Wildlife Refuge in North Dakota, Sevin, an insecticide of the carbamate group, is being field tested by the Denver Center for acute and chronic effects on wildlife. In the laboratory, this compound appears to be of low toxicity to birds and mammals and is not stable in composition, thereby reducing chronic hazard in the field. It appears promising for use on upland areas where pests such as grasshoppers must be controlled with minimal danger to wildlife. Spraying of water areas should be avoided because of its high toxicity to some forms of aquatic life.

Pesticides and prairie grouse.—Tests with penned prairie grouse have indicated that dieldrin is highly toxic to them. The largest oral dose survived by sharptails has been 1.5 mg/kg, and by prairie chickens, 10 mg/kg. Sevin, a carbamate insecticide of potential use on grouse range, has



Holding pen with water and feeder used in conducting pesticide studies with wild ducks and geese, Denver Wildlife Research Center. (Photo by M. G. Sheldon)

The effects of pesticides on game and aquatic birds are being determined under controlled conditions at Bureau research centers. Pheasants, quails, ducks, geese, sharptail grouse, gulls, and pelicans are some of the birds studied in 1963. (Photos by L. G. Kesteloo, left; James E. Peterson, right)

been found low in direct toxicity. Sharptails have survived acute doses of Sevin up to 1,500 mg/kg, and prairie chickens have survived up to 1,800 mg/kg.

DDT residues in mule deer.—The accumulation and elimination rate of DDT residues or metabolites was determined at the Denver Center in a 2-year mule deer buck by analyzing subcutaneous fat from the rump before, during, and after exposure to DDT placed in the feed at a rate of 10 mg/kg/day for 10 consecutive days. Feeding of DDT began on September 27 and ended on November 8, 1963. Fat samples ranging in amount from 2.8 to 5.4 grams were obtained at each biopsy.

Analysis of fat samples taken 3 days before the beginning of the test showed less than 0.5 p.p.m. for the aggregate of insecticide residues. Seven days after ingestion, residue levels were 27 p.p.m. for DDT and 1.6 p.p.m. for TDE. Sixteen days after conclusion of the 10-day test, residue values had increased to 58 p.p.m. and 7.3 p.p.m. respectively, and by November 8, about 1 month after the last DDT ingestion, they were 9.6 p.p.m. and 2.4 p.p.m., respectively, in the fat samples. On the same date, various organs showed traces of DDE, up to 12 p.p.m. of DDT, up to 1.6 p.p.m. of TDE, and up to 0.84 p.p.m of DDMU.

Toxicity of organophosphate insecticides to mallards.—In 1963, the Denver Center, in cooperation with the University of California and the Kern Mosquito Abatement District, began research on the effects on mallards of Guthion, Baytex, parathion, SD–7438, and Sumithion, at 25 p.p.m. of the diet.

Eight ducks in each of six pens were offered food contaminated with one of the five insecticides. One pen served as a control. From the first week, birds on Baytex and parathion diets ate much less than those on Guthion, Sumithion, and SD–7438. The average consumption in grams per bird per day was: Control, 74; Guthion, 77; parathion, 50; Baytex, 38; SD–7438, 78; and Sumithion, 72.

Birds on Baytex and parathion diets ate an average of 140 grams of clean food per bird per day during the first week, indicating that they were influenced more by the repellent quality of the insecticides than by intoxication. Later, control birds consumed 46 grams of clean food per bird per day and 15 grams per bird per day of the Baytex diet, indicating that mallards are repelled by even small amounts of this insecticide. Individual birds continuously on Baytex diets died after 28, 32, and 35 days, and those on parathion diets died after 28, 29, and 41 days.

Effects of DDT on bald eagles.—Studies on the effects of pesticides on eagles were continued in 1963, both by experimental studies and by determination of DDT residues in eagles found dead in various places in North America.

The 1961–62 feeding experiments in Alaska demonstrated that eagles can be killed by DDT, and indicated that a median lethal dose within 100 days is about 160 p.p.m. in the diet. Residue analyses of those birds show that they are variable in their accumulation of pesticides.

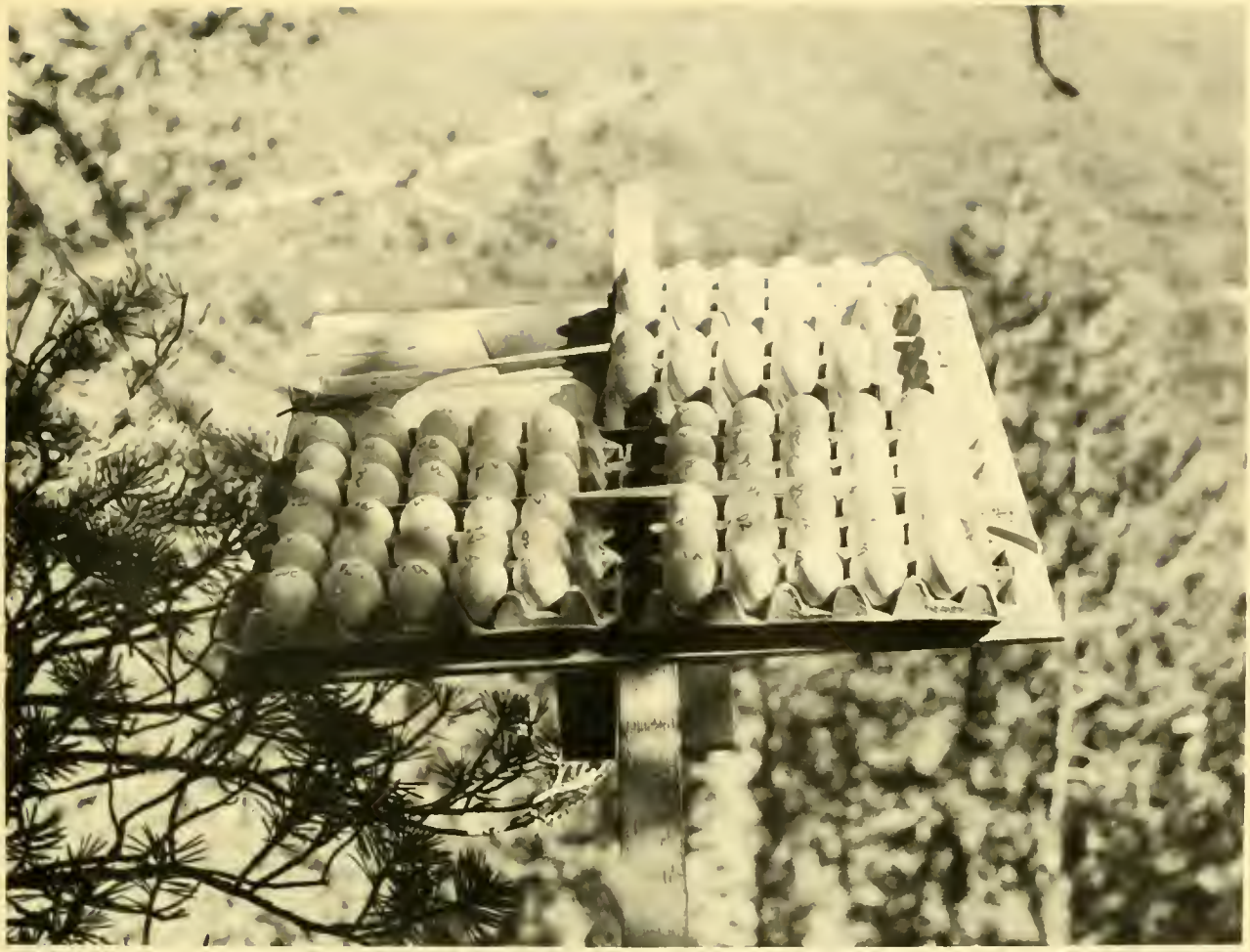
In 1962–63, 16 eagles were captured along the Chilkat River, Alaska, where large numbers congregate to feed on spawning salmon. The birds were kept at the Experimental Fur Station, Petersburg, Alaska, and had continuous access to water and to the ground.

The feeding experiments were designed to show residue gain and loss rates in wild birds. Results indicated that eagles accumulated residues when fed pesticide-contaminated food and eliminated them when fed clean food.

The Patuxent Center has received 58 bald eagles found dead or incapacitated in 20 States and 2 Provinces. Autopsies showed that at least 16 (and possibly 24) had been shot; 3 were sick; the others died of unknown causes. Residue analyses have been made of at least some organs of 56 of the eagles. All but one, a bird from Alaska, contained detectable DDT residues. In addition, five bald eagle eggs from three unsuccessful nests in New Jersey and Missouri contained 24.3, 11.4, 36.9, 1.1, and 5.6 p.p.m. of DDT.

These findings show that eagles in the wild have access to, and ingest, substantial quantities of DDT. This strongly suggests that a high proportion of bald eagles carry DDT and its metabolites in their tissues. The existence of residues, however, does not foretell what effects, if any, they may have, either on adults or on eggs.

An immature bald eagle being examined for evidence of disease and parasites. Tissue specimens will be subjected to pesticide analysis. The bird, found weak and sick on the Chippewa National Forest, Minnesota, was sent to the Patuxent Center for examination. (Photo by F. C. Schmid)



Chicken eggs at various stages of incubation are exposed to aerial application of malathion. Embryologists at the University of California critically evaluated the effects of the insecticide on egg development and hatchability. (Photo by James O. Keith)

Effects of heptachlor on wildlife.—In studies on three similar areas of 14,000 to 20,000 acres in Georgia and Alabama, from February 1958 to March 1962, Patuxent Center determined the effects of heptachlor on bobwhite quail and other animals. On two areas in Decatur County, Ga., the Plant Pest Control Division of the U.S. Department of Agriculture applied heptachlor by airplane, to eradicate the imported fire ant. An untreated area in Escambia County., Ala., was a control.

Whistling cocks and coveys were counted along transects on the study areas. On the Georgia sample, whistling bobwhite cocks averaged 28 per 1,000 acres the year before treatment and coveys averaged 20; on the untreated Alabama area, cocks and coveys averaged 25 per 1,000 acres through the study period.

Three years after treatment, cocks and coveys were at a lower level on parts of the sample treated with 2 pounds of heptachlor per acre than had been recorded before treatment. Whistling cocks and coveys also declined on adjoining land which remained untreated (data significant for cocks, and approached significance for coveys). This decline was attributed to movement of quail from untreated land to repopulate treated land.

Pesticide residues in black duck eggs.—Black duck populations of the Atlantic Coastal Region, studied at the Patuxent centers, reached a peak during the 1954–55 fall-winter period, according to the cumulative winter survey data. Populations then declined to a low in January 1958 and have increased only slightly since, despite restrictive hunting regulations and fewer duck hunters.

Pesticides are applied chiefly by plane in large-scale operations, and the effects of such applications on fish and wildlife are of great interest to conservationists and wildlife management agencies. At top, biologist and pilot are reviewing flight plan to be followed in experimental spraying; and at bottom, left and right, biologists are banding or otherwise marking birds and mammals for appraising effects of the pesticide. (Photos by Ohio Cooperative Wildlife Research Unit, top; James O. Keith, left bottom; and Van T. Harris, right bottom)

Wing surveys of the last 3 years have shown declining age ratios. In 1960 the immature-to-adult ratio was 2 : 1, in 1961 it was 1 : 7, and in 1962 it was 1 : 5. Mortality studies indicate that a 2 : 1 ratio is barely adequate to rebuild a population if it is hunted heavily. So far as determined, the breeding-ground habitat has not changed drastically during this period, and climatic changes have not been sufficient to explain the reduced breeding success.

The possible effect of pesticides on black duck populations was considered worthy of exploration. Since black ducks feed on animal life as well as plant material, they may be more susceptible to exposure to pesticides than many other species of waterfowl. During the winter, for example, they often feed avidly on worms, small clams, mussels, snails, small crabs, other crustaceans, and small fish.

In an exploratory survey, three black duck eggs were collected from each of three to five nest samples in a series of representative breeding areas. Sample clutches were received from Nova Scotia, New Brunswick, Maine, Vermont, Massachusetts, Connecticut, New York, New Jersey, Delaware, Maryland, and Michigan. Eggs were opened and examined for freshness and stage of embryonic development, then prepared for chemical analysis of residues. The three eggs from a single nest were pooled for a sample unless they differed in developmental stage or freshness.

Analyses completed to date by the thin-layer chromatographic technique showed DDT residues in 36 of 37 clutches taken in 8 States from Maine to Maryland, indicating a high incidence of egg contamination.

Effects of pesticides on osprey productivity.— Ospreys studied by Patuxent have decreased in Atlantic-coast areas for several years, and conservationists are wondering if pesticides are involved in the decline. Since ospreys subsist on shoal-water fish, they could be exposed regularly to toxicants through the food chain.

The presence of pesticides in osprey eggs and young was shown in 1962 by Mr. Peter Ames of the Yale Peabody Museum, who reported DDT or its metabolites in six eggs, one nestling, and one embryo. Three fish samples taken from osprey nests at Old Lyme also contained pesticide residues. The colony is declining, and reproductive success is low.

A biologist checks on osprey's nest. The never-abundant osprey, a fish-eating hawk, is vulnerable to pesticides of the chlorinated hydrocarbon group which may accumulate in the water where it feeds. (Photo by F. C. Schmid)

Parallel studies were accordingly initiated in two areas, Old Lyme and the lower Potomac in Maryland, where an osprey colony apparently was thriving. Single eggs were taken from a series of nests in each locality, and the success of the remaining eggs was followed. Embryo development in the eggs collected was determined in the laboratory. Pesticide determinations for the eggs have not yet been completed. Food samples and a series of fecal samples from the nest sites were collected for analysis if pesticide residues in the eggs indicate that this is desirable.

A comparison of nest histories from which eggs were taken showed that the lower Potomac nestings were more successful. Here, eggs from 17 of 26 nests hatched 27 nestlings and fledged 24 young. Eleven eggs disappeared from nests, and 3 failing

to hatch were later collected. In Connecticut, eggs from 2 of 15 nests hatched 4 nestlings and all fledged; 16 eggs disappeared, and 9 eggs failed to hatch and were collected. Correlations between productivity and pesticide residues in eggs and food items remain to be determined.

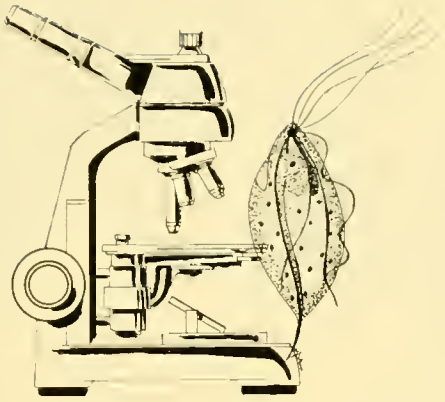
Nonchemical methods in mosquito control.—Mosquito control districts along sections of the Atlantic coast of Florida are convinced that permanent impoundment of marshes is an effective means of controlling saltmarsh mosquitoes.

Through contract with the Patuxent Wildlife Research Center, the Florida State Board of Health supervised an evaluation of the effect of these impoundments on wildlife. Monthly inventories were made of birds using impounded and unimpounded saltmarsh study areas in Volusia, Brevard, Indian River, St. Lucie, and Martin Counties. These counts have shown consistently about 10 times more bird use on impounded than on unimpounded marshes, and the impoundments provide more accessible open water and submerged aquatic plants and fish that serve water birds as a food supply. The necessity of mosquito control through the use of insecticides has declined markedly in the vicinity of the marsh impoundments.

DDT in relation to towhees.—Pesticide research on the rufous-sided towhee was brought from the field into the laboratory in 1963. Studies involved the kinetics of DDT fed to captive birds at different seasons. Initial findings demonstrated that this migratory species is significantly more vulnerable to dosages of DDT just before and during the breeding season than during the fall. All data are being analyzed at the Massachusetts Unit preparatory to a final report.

Malathion S–35 distribution in a small forested watershed.—A 2-pound-per-acre Malathion S–35 treatment of a 20-acre forested watershed near Dover, Ohio, resulted in a significant change in small-mammal populations. Although bird behavior was altered for a few days, several species continued to nest on the tract and successfully reared young. No effects were noted on the soil microfauna or on earthworms. Movement of the insecticide into runoff flow was slight. Residue studies carried out in 1963 showed no differences between animals from the treated and control watersheds. Sulfur-35 assay of mammals showed significantly higher quantities in females of all animal groups except birds. Among mammal species tested, shrews held the highest residues; in the avian fauna, a Baltimore oriole contained maximum values in cmp/mg. Some of the insect families containing high residue values included caddis flies, stone flies, soldier flies, and pseudo click beetles. The research was by the Ohio Cooperative Wildlife Research Unit.

Effects of endrin on vole reproduction in bluegrass meadows.—Endrin was applied by the Ohio Unit to four bluegrass meadows in 1961 and 1962 at rates of 0.6, 0.9, 1.3, and 2.0 pounds per acre. Populations of voles (*Microtus pennsylvanicus*) were censused in April, before the May application. Trapping was again conducted 2 and 4 months after the insecticide treatment. Specimens were collected for bioassay of residual endrin and for analysis of productivity. Endrin applied at 0.6 pounds per acre had no apparent effect on the populations that could be trapped, but the higher rates reduced populations 71 to 95 percent. The sex ratio in the sampled population was not affected by the 0.6-pound-per-acre application, but at 2.0 pounds per acre there was a significantly higher decrease among females. Ovulation rates, as indicated by the number of corpora lutea and corpora albicantia, showed no differences as a result of the spray treatment. Treated animals did show a lower percentage of pregnant and nursing females, and consequently a decrease in the number of litters produced. No endrin was detected in voles taken from the area treated with 0.6 pound per acre, while specimens from the 2.0 pounds per acre plot contained up to 0.73 p.p.m.



WILDLIFE DISEASES AND PARASITES

Wild birds and mammals are subject to a wide variety of diseases and parasites, many of which show variations on hosts in different environments. Study of wildlife diseases, particularly diseases of migratory birds, is an important Bureau responsibility. In 1963, the Disease Laboratory at the Patuxent Center conducted research on birds and mammals; the Denver Center's disease research concentrated on diseases and parasites of waterfowl and was carried on mainly at the Bear River Substation in Utah.

Widespread botulism losses reported.—It is difficult to estimate the mortality to waterfowl annually attributable to botulism, because unobserved, undiagnosed, and unreported outbreaks undoubtedly occur each year. An apparent change in mortality from year to year may actually be only a reflection of the effort devoted to field observations, laboratory diagnosis, and reporting. However, on the State and Federal refuges in northern Utah, where regular observations have been made, estimated losses were higher in 1963 than in any of the 10 previous years.

A die-off of diving ducks on Torrey Lake (South Dakota) in April was shown by toxicity tests in mice to have been caused by botulism. At almost the same time, an outbreak on Big Grass Marsh (Manitoba) was reported by the Canadian Wildlife Service. During the summer and early fall, the Lower Souris and Tule Lake National Wildlife Refuges each suffered losses in the neighborhood of 5,000 birds. On the Bear River Refuge, an estimated 30,000 aquatic birds perished from the disease. Less severe outbreaks were recorded on Saginaw Bay, Mich., on a Richfield Oil Co. marsh near Los Angeles, and on the Fish Springs Refuge in Utah. At least 7,000 birds were believed to have been lost on Utah State refuges.

Avian botulism-invertebrate relation investigated.—For the ninth consecutive summer, aquatic invertebrate studies were carried on by the Bear River Research Station to explore further the hypothesis that dead and decomposing carcasses of small, water-living, bottom-inhabiting creatures are used as media for growth and toxin production by *Clostridium botulinum* type C. The average number of the 2 predominant bottom-fauna types, collected weekly at 80 stations in the 0.9-square-mile study plot, are shown in the tabulation, along with the number of sick and dead ducks picked up each week in the same area.

Organism	Weeks—June 17 to Sept. 13, 1963												
	1	2	3	4	5	6	7	8	9	10	11	12	13
Midge larvae	130	83	101	74	64	56	31	16	13	14	12	28	40
Oligochaetes	97	72	94	117	108	121	108	88	105	119	110	128	149
Sick and dead ducks	2	1	1	3	6	3	2	15	29	176	30	90	179

On the basis of previously accumulated evidence showing that certain invertebrate carcasses support toxin production, and that living vertebrates can concentrate toxin by feeding on toxic bacterial cells, a reasonable explanation of the tabulation can be offered. Assuming that the decline in the numbers of midge larvae in the first 11 weeks represents a gradual die-off, it may be postulated that a simultaneous gradual buildup of toxin occurred. Because the oral lethal dose for a duck is 100,000 or more times the intraperitoneal lethal dose for a mouse, it would be expected that low-level toxin production could occur for a considerable time before an appreciable number of birds would acquire a lethal dose in feeding. The relatively stable oligochaete population, as well as some of the free-swimming invertebrate species (not tabulated here), may have served to concentrate and store the toxin produced in the midge carcasses.

Waterfowl helminth manuscript near completion.—The bibliography of references to waterfowl helminths was brought to current status and will be ready for publication as soon as the typing of the manuscript is completed. During the year, 450 references were added, bringing the total to about 2,400. About 300 books and papers were abstracted in the course of surveying the literature.

The checklist of helminths of waterfowl, now totaling 844, was brought up to date. Descriptions of 27 species, 21 of which were translated from the Russian, were added to the list, and keys for the identification of nematodes, acanthocephala, and cestodes of waterfowl were revised as descriptions of forms were obtained. There still remain 26 species for which descriptions are not available.

Fowl cholera low in 1963.—Although no major losses from fowl cholera in waterfowl are known to have occurred in the western United States during the year, several isolated cases were encountered in the course of routine diagnostic examinations. Two whistling swans, a Canada goose, and a cackling goose from western national wildlife refuges were shown by bacteriological examination to have died from the disease. Because of the constant danger of fowl cholera in waterfowl, about 85 Canada geese of a captive flock on the Monte Vista Refuge were immunized with a commercially prepared bacterin in November.

Trumpeter swan cygnets show lower mortality.—Studies of the causes of mortality in trumpeter swan cygnets on the Red Rock Lakes Refuge were continued from the previous year. Of 24 cygnets in 6 broods regularly observed on Lower Lake, 8 died or were unaccounted for, a mortality of 33.3 percent. Of 19 cygnets in 7 broods observed in 1962 on Lower Lake, 13 were lost, a mortality of 68.4 percent.

These figures seem representative of the Red Rock Lakes Refuge as a whole since the 1963 national aerial trumpeter swan survey for 1963 revealed 127 cygnets on the refuge, as compared with 53 in 1962. This is the largest number reported since the first census was taken in 1932.

Malaria infections in waterfowl.—Studies at the Seney National Wildlife Refuge in 1963 indicated the presence of at least 6 species of blackflies (*Simulium*) breeding in the area. At least 1 serves as a vector for *Leucocytozoon*, a malaria-like organism which occurs in the Canada geese. Breeding habits of this fly are being studied in the hope of developing control methods that can be incorporated into the management schedule for waterfowl impoundments. Gulls, found to be highly susceptible to a *Plasmodium* (mosquito-borne malaria) recently isolated from Canada geese, were used, along with young ducks and geese, in surveying the prevalence of this blood parasite in the Seney goose population. Evidence of infection was determined in over 50 percent of the geese sampled. The specific mosquito vector of the infection is not yet known.

Throat disease in mourning doves.—Surveillance of trichomoniasis, a throat disease of mourning doves, was continued during 1963 by the collaboration of many State game personnel. Infection rates appeared higher in many areas than in previous years, but no alarming losses were reported. A definite and rapid reduction of incidence was noted in July.

Nematodes in relation to merganser losses.—Diagnostic services of the laboratory at the Patuxent Center led to evidence that a nematode worm parasite (*Eustrongylides* sp.), for which fish serve as an intermediate host, was a contributing factor to losses of mergansers in the Back Bay, Va., area.

Type E botulism in birds.—At year's end a large die-off of loons and gulls on Lake Michigan indicated a relation to the type E botulism recently evident in processed fish. This implication has initiated research activity on type E botulism in birds and collaboration with other agencies, particularly the Bureau of Commercial Fisheries and the Michigan Conservation Department.

Tissue damage from pesticides.—In an effort to clarify the mechanism of certain neurological signs in experimental ducks treated with Kepone, histological sections of various tissues of the central nervous system were studied without uncovering any attributable lesions or changes. Active sperm formation was found in the testes of male mallards and pheasants exposed to various dosages of Kepone, thus contradicting our earlier findings in which degenerative changes in the testes of male pheasants were reported.

Ring-necked pheasant.—Blood samples from 1,467 pheasants from 44 Iowa game farms have been collected by the Iowa Unit. Rapid plate

Wildlife disease specialist examining slide smears for squirrel coccidea, Patuxent Center. (Photo by F. C. Schmid)

tests on 835 of these samples have shown that Iowa game-farm pheasants are remarkably free of pullorum. Reactors were found in only one flock, and infection in that flock has since been eliminated.

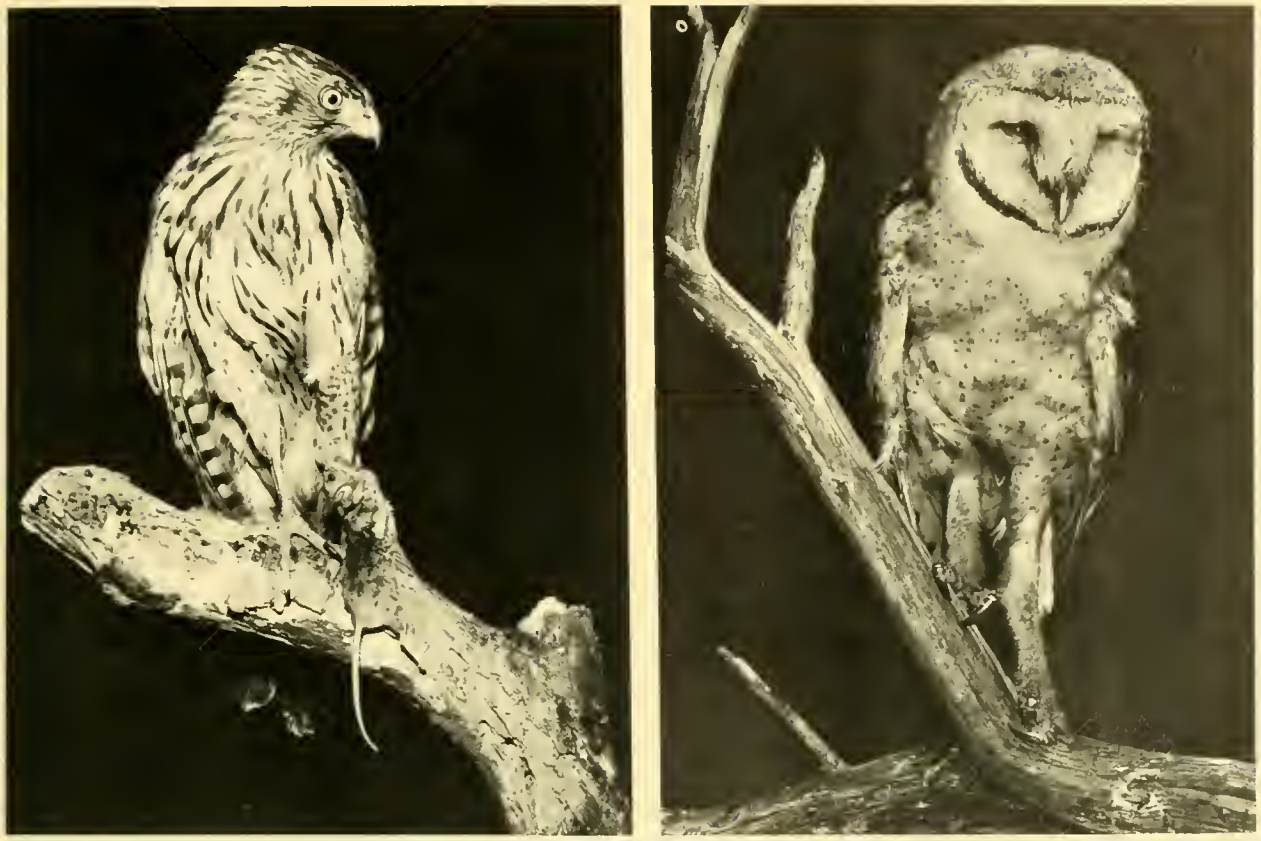
Wildlife disease surveys.—The Iowa Cooperative Wildlife Research Unit worked with State officials in wildlife disease surveys in 1963. In routine checks for rabies in wild mammals brought to the Iowa State University Veterinary Diagnostic Laboratory, 80 of 121 skunks, 1 of 2 badgers, 2 of 22 bats (*Myotis* or *Eptesicus*), 3 of 8 civet cats, 3 of 16 foxes (red or grey), and 2 of 62 raccoons were found rabies positive.

Of 211 Iowa deer checked for brucellosis to date, all were negative for the disease. Of 231 whitetails checked for leptospirosis at the National Animal Disease Laboratory, 199 were negative for antibodies of the disease. Fourteen percent (32) showed some reaction, but only 3.5 percent involved *Leptospira pomona*. The 91 deer checked were free of Johne's disease.

Gizzard worms in wintering goose population.—The Virginia Unit examined a total of 84 Canada geese killed on the Mattamuskeet National Wildlife Refuge and environs for gizzard worms (*Amidostomum anseris*), and 73 were found infected. The mean number of worms per infected bird was 11.8±2.3, with a range of 1 to 148.

Lesions of the cuticular lining and hemorrhagic areas on the mucosa were apparent in birds harboring 15 or more worms. In an adult female parasitized by 148 gizzard worms, the gizzard lining was extremely loose and hemorrhagic areas between the cuticular lining and mucosa were apparent, but no effect on the external appearance could be observed.

This white-footed mouse is typical of the rodents that become so abundant every few years that they endanger crops, forage, and forest regeneration, justifying in such instances effective and, so far as possible, selective control. (Photo by L. G. Kesteloo)



"Flying mousetraps"—by day and night (left, red-shouldered hawk; right, barn owl). Several Cooperative Wildlife Research Unit and other Bureau research projects have dealt with predator-prey relations. Mice are a mainstay in the food of most hawks and owls. (Photos by L. G. Kesteloo)

ANIMAL CONTROL METHODS

The problems of animal damage become more acute as competition between man and wild animals increases, thus compounding the need for more selective and effective control measures for birds and mammals injurious to forests, crops, or rangelands, to stored goods, or otherwise inimical to human welfare or health. Many approaches to the control of such animals are being explored, including manipulation of habitat, cultural practices, chemical repellents and scaring devices, drugs and lethal substances, traps, sonic and electronic installations, radiation, reproductive inhibitors, and bacteriological agents.

Physiology in bird control.—Physiological studies undertaken at the Denver Center will facilitate the development of safe and effective methods for controlling damage by starlings and blackbirds. An important phase of this work involved telemetering and recording of physiological characteristics such as circulation, heart rate, brain waves, body temperature, and respiration rate via sensors and transducers surgically implanted in birds. Such systems permit continuous recording of physiological data from birds being restrained only by cages. Information obtained in this manner will be valuable in determining the physiological basis of chemical repellency and toxicity, and for evaluating the effectiveness of mechanical and chemical control measures.

New avicide for starlings and blackbirds.—The new candidate avicide, DRC–1339, has survived a series of laboratory and field tests with excellent results and has shown much promise as a slow-acting oral toxicant. The material is 300 to 500 times as toxic to starlings as to rats, suggesting a wide margin of safety for mammals. The chemical is readily accepted by starlings with fatalities occurring 6 hours to 5 days later. In initial field trials more than 100 starlings have been killed per pound of bait exposed. Research is near completion on this compound, and efforts will be directed toward registration, release, and availability for use during 1964.

Curtain spray for control of roosting birds.— A "curtain" spray unit that collects and reuses the toxicant has been constructed by biologists of the Denver Center and was tested last spring in a marsh roost near Ione, Colo. The unit consists of a 37-foot tower, twin 60-foot booms and catch basins, and a sump tank and pump for circulating liquid avicides. Blackbirds and starlings herded slowly at night beneath the booms of the unit must pass through the toxic spray.

Early laboratory trials showed that starlings were killed by flying through a 6-percent emulsion of DRC–632, one of the promising contact poisons notable for its high dermal toxicity for birds and low hazard for mammals.

Fourth year of blackbird study completed.— The field phase of the 4th year of a 5-year study of the blackbird-corn damage problem in the vicinity of Sand Lake National Wildlife Refuge was completed in September. As in previous years, the program was a cooperative undertaking of the Bureau and the South Dakota Department of Game, Fish, and Parks.

The program in 1963 included (1) tests of fright-producing and soporific chemicals to protect cornfields from foraging blackbirds, (2) tests of amplified bird distress calls broadcast from ground equipment and low-flying aircraft, (3) banding and color-marking blackbirds to determine breeding and wintering areas, migration routes, and extent of local movement, (4) appraisal of corn losses in a 94-section area adjoining Sand Lake Refuge, (5) evaluation of grain sorghums as possible blackbird-resistant crops, (6) precise estimates of blackbird populations using Sand Lake Refuge during the damage period, (7) food habits,

Hoards of blackbirds or starlings feeding on grain or in feed lots cause heavy losses to owners. A flock of 10,000 blackbirds can consume 2 tons of grain per week, worth $60 to $150. In such instances, selective control of overabundant wild birds is justified. (Photo by Brooke Meanley)

Damage in the cornfield: blackbird (left), nutria (right). (Photos by F. C. Schmid, left; Van T. Harris, right)

April through September, to determine the total impact of feeding at Sand Lake, and (8) study of redwing production in the vicinity of the Refuge.

Breeding redwing populations in Arkansas.—The breeding male red-winged blackbird population of the Arkansas Grand Prairie was censused in 1963. For this purpose, the area was divided into two geographical strata, an inner block where rice culture is intensive, and an outer section where rice growing is less common. Sampling units were selected at random within each stratum: roadside units 150 yards wide and 5 miles long (272.5 acres), and field units in the form of 10-acre circular plots.

Counts of males were obtained by the modified roadside technique developed by Dr. O. H. Hewitt of Cornell University, under contract with the Bureau. Results for the entire 900-square-mile Grand Prairie were extrapolated from counts made on the stratified random samples. The breeding male population was estimated at 44,000 birds in 1963. Average densities were 25 territorial males per 100 acres for roadsides and 6 per 100 acres for fields. High roadside densities were attributable mainly to the cover types found in the commonly occurring irrigation ditches along the roads. Roadside acreage was only about one-seventh that of the fields, but contained 37 percent of the birds, 63 percent of the birds being away from the roadsides. These densities suggest that efforts to control redwings of the Grand Prairie should be concentrated in the wetland habitat associated with ditches and reservoirs.

Scare devices.—Crop growers have spent an estimated $1 million to $2 million a year on scare devices without obtaining clear information on their value or effectiveness in protecting fields from bird loss. In tests in northern Ohio, an automatic exploder and a recorded alarm cry reduced damage substantially for a radius of 600 feet in each case. The tests further showed that neither of the devices decreased in their effectiveness during the test period.

Preparation of equipment to transmit the amplified distress calls of blackbirds. This method often is effective in protecting crops from flocks of depredating birds. (Photo by Paul F. Springer)

Decoy trap for blackbirds and starlings.—Research personnel are using decoy traps extensively and successfully to take blackbirds and starlings for banding, for disease and physiology studies, and for testing chemosterilant and lethal agents. The traps are also being evaluated as a means of reducing local populations of depredating blackbirds and starlings.

In 40 decoy traps of 2 designs used by Bureau personnel in the Arkansas rice area, over 53,500 birds were taken. Most (98 percent) were cowbirds. Good trapping success in some areas prompted many growers to build and operate similar traps. One farmer reported taking 10,000 birds in 1 trap in less than 2 months; another caught 6,000 in 3 traps in 3 weeks. Many other examples of trapping success can be cited.

Bird behavior studies implemented by banding.—During 1963, over 71,000 blackbirds and starlings were banded in selected areas by biologists and cooperators of the Bureau's Patuxent Center, 82 percent more than were banded in 1962. The increase was due mainly to more extensive use of light traps and decoy traps, both devices newly developed for capturing large numbers of blackbirds. Over 50 percent of the 71,000 bandings were cowbirds, 20 percent were red-winged blackbirds, 20 percent were common grackles, and about 10 percent were starlings.

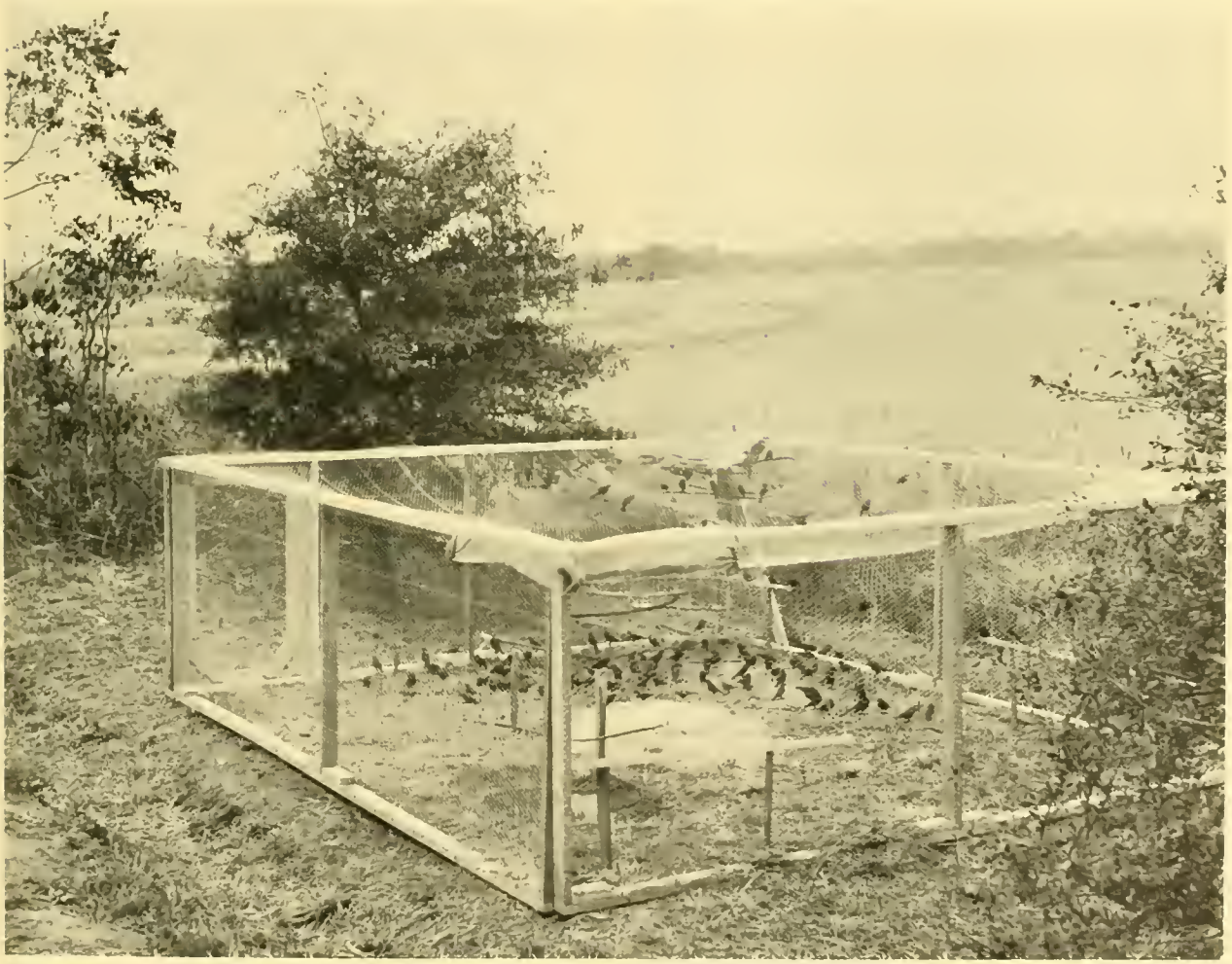
About 2,800 redwing nestlings were banded by 175 cooperators in 40 States and 7 Provinces in 1963. Nestlings banded since 1958 now number 12,000 birds of known age and place of origin. Most of the banding was in the Middle Atlantic States (5,500), or the States adjoining Lake Michigan (2,500). The interest and efforts of cooperating banders in many States are contributing substantially to the blackbird banding effort.

Sudan dye for tagging birds.—A physiological tagging technique for identifying birds that feed on candidate chemosterilants has been developed by the Massachusetts Wildlife Unit. Sudan Black B dye, when ingested by adult birds just before or during the egg-laying period, is deposited in the yolk in discreet layers. The position and color intensity of the layer in the yolk indicates the quantity consumed and the date of ingestion. The most important application of the tagging technique is its use as an experimental control in field testing candidate chemosterilants with large numbers of birds without capture and with a minimum of disturbance in the breeding colonies.

Gull populations in southeastern New England.—A recent winter gull census by the Massachusetts Audubon Society, under contract with the Bureau, showed that feeding sites around metropolitan Boston and New York City harbored about 80,000 of approximately 110,000 gulls between Grand Manan, New Brunswick, and central New Jersey. About 20,000 of the remaining 30,000 birds were at dumps near smaller towns. Only about 10,000 gulls were found along the shore in what might be considered the "natural" habitat for herring gulls.

A comprehensive report on this contract showed that in 1900 the breeding population of herring gulls in New England numbered about 8,150 pairs, all nesting on islands east of Penobscot Bay, Maine. In 1961, the population was estimated at 58,000 pairs, more than half of which nested in Massachusetts. Continued increase in numbers has been associated with the founding of new colonies.

Observations of gull concentrations at feeding areas such as dumps and fish piers indicated the



Decoy traps liberally baited with waste grain and set adjacent to cornfields may take large numbers of depredating blackbirds. This farmer-built model, costing a few dollars, proved effective in Arkansas. (Photo by Brooke Meanley

birds respond rapidly to changes in available food. The closure of dumps and improvement of sanitation at fish-handling facilities resulted in markedly lower gull numbers. Quite clearly, effective biological control of herring gulls must depend on reduction in the amount of food available at metropolitan dumps, piggeries, sewage outlets, and open-air fish processing sites.

Seagull problem at naval air station relieved.—The distress call of an immature herring gull was used by Denver Center personnel to frighten gulls from runways at Moffett Naval Air Station, Mountain View, Calif. The call was broadcast from a loudspeaker mounted on top of a truck driven, with sound on, toward each group of gulls resting on runways. At the call the gulls quickly arose, circled the truck, and flew away. Some 2,000 to 3,000 birds were driven away during a 45-minute period each morning during the test period of November 16 to 21, clearly demonstrating the effectiveness of the method.

Bird hazard survey at Washington National Airport.—Ornithologists of the Audubon Naturalist Society of the Central Atlantic States, under contract with the Bureau to study the bird-hazard problem at Washington National Airport, observed bird species, numbers, and movements on or near the airport between dawn and dusk about once a week since October 1962.

At least 143 species of birds were observed on, over, or near the airport. The greatest number was seen during spring and fall migrations. Considered potentially hazardous to aircraft were 23 species in the fall, 35 in the spring, and 8 species from May through July. Herring, ring-billed, and laughing gulls were the most abundant and constituted the greatest hazard to aircraft landing and taking off. Of lesser importance were shorebirds, swallows, swifts, crows, starlings, blackbirds, pigeons, mourning doves, and horned larks. Evidence was obtained of at least nine bird-plane strikes in 1963. Five of the strikes occurred in April and 1 each in May, June, September, and October.

System developed for rating chemicals.—There has long been a need for a better method of rating the hundreds of chemicals that are screened annually by Bureau laboratories for animal damage control. Both lethal agents and repellents are being sought, but these terms are not well defined and some compounds may qualify in both categories.

Denver Center biologists recently developed a rating system that more accurately defines the toxic and repellent qualities of chemicals under study. The system incorporates three functions: (1) The lethal dose of the compound; (2) acceptance in relation to lethal dose; and (3) mortality in the test species. A rating of 5, 10, and 100, respectively, for the 3 functions—written 5–10–100—would indicate a highly toxic compound (5 mg/kg) that is well accepted (10 times a lethal dose) and extremely effective (100 percent mortality). At the other extreme, a compound with a rating of 1,000–0.05–0 would be one that is practically nontoxic (1,000 mg/kg), poorly accepted (0.05 times a lethal dose), and has no lethal effect on test animals (0 mortality). Such a compound would be an excellent repellent.

Antifertility agents have promise in predator control.—The first field trial of an antifertility agent in coyote control has been carried out by the Denver Center. In March, 5,000 drop baits containing a synthetic estrogen, DRC–629, were used in a 20-township area in southeastern New Mexico. The baits were placed when coyote sign was evident, and were spaced over the area so as to reach as many of the animals as possible.

An appraisal of the study was determined by collecting female coyotes in April and May. Examination of 27 animals from the treated area and 21 from the untreated area indicated that only 21 percent of the females on the former would have whelped, and that 100 percent of those on the latter would have reproduced. It can be concluded at least tentatively that in the first comprehensive field test the antifertility agent reduced the coyote crop on the treated area by 80 percent.

Compound S–6999 shows specificity for commensal rats.—Based on toxicological investigations by McNeil Laboratories, Fort Washington, Pa., compound S–6999 appears to have specific toxicity for commensal rats. Its high toxicity to Norway rats (LD 50 percent 7.4 mg/kg (4.76–11.69) is in contrast to its toxicity for laboratory mice, which is in the range of 2,000 to 3,000 mg/kg.

Because of the highly specific nature of compound S–6999, the Denver Center supervised a total of 134 separate field trials during 1963 to determine the optimum practical concentration, suitable bait ingredients, and pattern of action when exposed for rat control. Trials involved both Norway and roof rats.

The chemical acts rapidly and death can occur within 1 hour after ingestion; animals apparently run for cover at the onset of symptoms, and few reappear. Compound S–6999 appears to be practically nonhazardous to animals other than rats when exposed in a bait at a concentration of 1 percent or less. No accidental poisoning of any wild or domestic animal occurred in any of the 134 field trials, although in a few instances baits were known to have been consumed by dogs, cats, hogs, and chickens.

Registration of DRC–714 as a pocket gopher control.—A highlight of the year was further development of the promising pocket gopher toxicant and rodenticide DRC–714. Personnel of the Denver Center, cooperating with the Chemagro Corporation, have decided to develop the chemical as a rodenticide and will undertake steps necessary for registration. The Denver Center will expand its testing program on field rodents and will gather data on the effect of the chemical on nontarget species of wildlife. These efforts should soon clarify the potential of DRC–714 in mammal control, and lead to its eventual availability to the public.

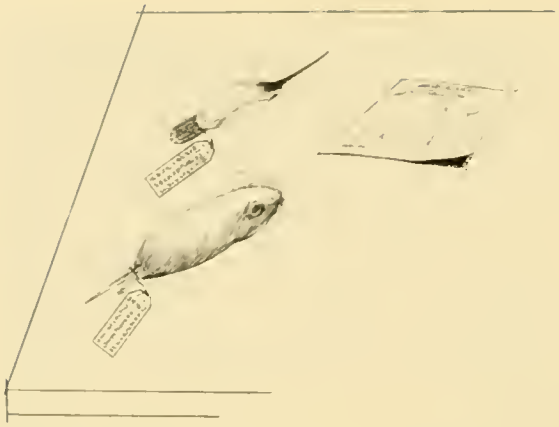
Nutria studies progressing.—Laboratory tests in evaluation of zinc phosphide as a candidate toxicant for use in nutria control have been completed. Favorable results were obtained at the 20-mg/kg level. Followup field tests to evaluate zinc phosphide treated baits on nutria in or near sugarcane fields are being made.

Nutria population studies are in progress near Houma, La., and Beaumont, Tex. A method of nape-tagging nutria with a ¾- by 2½-inch Saflag tag and safety pin is being used. Data from observations and trapping are beginning to yield valuable information on nutria populations and movements, necessary to the development of baiting techniques.

Pocket gophers injurious to Christmas trees.—The Mississippi Valley pocket gopher is responsible for serious mortality in Christmas tree plantings over much of Minnesota and western Wisconsin. Losses to gophers are most prevalent in the central pine region and the Twin City area. Since Minnesota is one of the top Christmas tree States in the Nation, the loss is regarded as serious. For example, in 1962 more than 5.5 million trees, valued at more than $6 million, were harvested.

Case-history studies of red pine and Scotch pine plantations, in cooperation with the Minnesota School of Forestry, have demonstrated losses ranging from 13 to 16 percent by the time plantations are 10 years old. The greatest damage usually occurs in plantings between the first and sixth year. The "burrow builder," a Bureau-developed tool, has been effective in controlling gophers, but while the loss has been materially reduced, it is still in excess of $200,000 annually.

New method of testing seed protectants.—Bureau biologists, in cooperation with the University of Florida Agricultural Experiment Station, evaluated a newly developed method for field-testing candidate blackbird repellents in 1963. The tests were designed both for distinguishing bird damage from other types of damage to germinating seeds, and for isolating side effects of candidate bird-repellent chemicals on germination. This was accomplished by comparing the total damage in identical companion rows of sprouts in which alternate rows were protected. To insure bird pressure, some test plots were grown inside a large enclosure containing captive birds. Consistent differences between candidate materials, and agreement between measurements of sprouting success and observed damage, indicate that this technique may have the sensitivity and reliability long needed in field-testing repellents on planted seed.



CLASSIFICATION, DISTRIBUTION, AND LIFE HISTORY STUDIES

The Bird and Mammal Laboratories of the Bureau, located at the U.S. National Museum, perform research on the geographical variations of birds and mammals and provide a wide scope of services to the general public concerning the fauna of the Continent. Other major responsibilities involve preparing and maintaining the extensive study collections, identification services to cooperators and scientists throughout the country and in foreign lands, and much in the way of extension education to many of the large number of people who visit the Museum and the Smithsonian Institution.

North American Mammal Collections.—In November 1963, an account of the status of mammal collections in North America appeared in the *Journal of Mammalogy*. This represents the results of a survey made by a committee in 1962, and follows similar surveys made in 1923 and 1945. Tabulated are 265 public and 45 private collections, totalling 1,586,000 specimens. Most collections are in the United States; Canada has 25, Costa Rica one, and Mexico one. There are 29 collections that have more than 5,000 specimens. Of these the largest is the combined U.S. National Museum–Biological Survey Collection of mammals (305,000); runners-up are the American Museum of Natural History, New York (200,000), the Museum of Vertebrate Zoology at the University of California, Berkeley (130,000), and the Museum of Zoology at the University of Michigan, Ann Arbor (107,000).

Bird and mammal specimens handled.—Curatorial work at the Bird and Mammal Laboratories during 1963 is summarized as follows: specimens received, 1,006 birds, 3,502 mammals; specimens installed in collections, 389 birds, 782 mammals; specimens loaned for study, 347 birds, 751 mammals; study skins or skeletons prepared, 265 birds, 26 mammals; identifications for outside submissions, 283 birds, 82 mammals. Specimens carded totaled 19,920 birds, and birds merged into collections numbered 11,550.

Sea otter studies.—Preparation of the monograph on sea otters continued, with completion of sections on food habits and feeding behavior, tagging studies, field studies during 1954–63, list of identification characteristics, and bibliography. Progress was made on a comprehensive study of the female reproductive tract, done with the University of Missouri. Field work was limited to observations on Buldir Island. Sea otter studies will be continued in 1964.

Wild turkey monograph.—The monograph on the wild turkey sponsored by the Wildlife Society will contain two chapters by one of the Bureau's specialists in ornithology. The first, chapter 1, "Historical background," was completed, approved, and sent to the editor of Wildlife Monographs. Chapter 2, "Taxonomy, distribution, and present status," was completed in draft except for statistical verification of size and proportion differences in the various races of turkeys, which is under way.

Preparation of bat banding manual.—The increased interest in bats because of their involvement with disease stimulated bat banding during the year. Since 1953 the number of bands issued has increased about 2,000 percent, and has become so great that a procedural guide has become a necessity. Approximately 50 letters have been sent to zoologists, primarily those actively engaged in or supervising bat studies, announcing the proposed manual and requesting suggestions which would make the publication as accurate and informative as possible.

Geographic variation in Canada geese.—The wintering flock of Canada geese at Rochester, Minn., numbering about 5,000 birds, was studied in the field, and specimens were preserved from large numbers caught in cannon nets for banding. Many others were handled and colors were compared with a color chart. The birds appeared to represent populations of the giant Canada goose and Todd's Canada goose, as well as intermediates between these and western and lesser Canada geese. This mixture of racial types would be expected in this locality.

Precise identification of wild birds and mammals requires exacting measurements and comparisons, and detailed knowledge of structure, dentation, plumage, and other physical characteristics of the animals involved. (Photos by Rex G. Schmidt)

Breeding specimens of Canada geese from Saskatchewan and Alberta were received for the collection from the Canadian Wildlife Service, which aided materially in clarifying the manner of intergradation between the western and giant subspecies across the northern Great Plains. Breeding specimens were also received from Thelon River, Northwest Territories, which will be valuable in filling a gap in the present knowledge of variation in that important area.

Methods of determining sex of cranes.—In cooperation with the National Zoological Park, six lesser sandhill cranes were shipped from the Bitter Lake National Wildlife Refuge for use in developing an instrument to aid in sexing cranes. With the instrument devised, the following cranes were sexed: 18 live birds at Philadelphia Zoo; 13 live birds at the National Zoo; 39 hunter-killed and 2 live lesser sandhills at Roswell, N. Mex.; 10 live lesser sandhills and 25 greaters held in captivity at Monte Vista, Colo.; 5 live greaters at Santa Fe, N. Mex.; 6 live cranes at the San Antonio Zoo (one of these was a whooping crane); and 3 live greater sandhills at the New Orleans Zoo.

Even though the technique and instruments used in sexing cranes are not fully perfected, much progress has been made.

Taxonomic review of the woodpeckers.—There has been no taxonomic review of the American woodpeckers in the past century. A review was undertaken last year and is being conducted jointly with an ornithologist at the University of Illinois. A survey of the literature on woodpeckers is essentially complete, and examination of specimens of each genus has begun. The work is expected to continue during 1964.

Variation and hybridization in flickers.—Study of flickers was initiated in 1955 and has progressed to the point where the work consists largely in summarizing and applying statistical tests to the data, and preparing manuscripts and drawings for publication. A major manuscript (260 pages) dealing with hybridization in flickers has been prepared and submitted for publication. Summarizing of data on about 4,000 specimens (and involving about 30 characters for each) will continue during the coming year.

Fluorescence studies.—The hairs of many mammals in Trinidad were examined for pathogenic fungi such as ringworm, which fluoresce when activated by longwave (3660A.U.) ultraviolet light. The fur, teeth, and nails of certain live and freshly dead mammals, especially bats, also were found to fluoresce in varying colors and intensities.

The excellent collections at the National Museum afforded opportunity to continue these investigations. Random examinations of a number of diverse mammals and birds were made, using both longwave and shortwave ultraviolet lamps of the Division of Mineralogy, National Museum. Further checks were made of various substances used in skin preparation, such as arsenic, alum, borax, and salt, to rule out some obvious variables.

A brief survey of a large series of rats, taken over many years by different collectors in both Old and New World localities, showed that both *Rattus rattus* and *R. norvegicus* fluoresced a brilliant green-blue, while members of the *R. rajah* group of the Malaysian region, failed to react under black light. Of special interest was one specimen, assigned to *R. rattus*, which failed to fluoresce; on careful examination it was found to represent a different genus, probably *Mastomys*.

Among the pocket gophers, *Geomys* fluoresced while *Thomomys* did not. Of the bats, *Myotis subulatus* fluoresced but *M. lucifugus*, *M. keeni*, and *M. sodalis* did not. Similar species of African gerbils were more easily distinguished under ultraviolet light than under ordinary electric illumination. A cursory examination of some typical bird groups indicated that some owls and nighthawks reacted to black light. In particular, the down feathers of certain great horned owls fluoresced variously from a fiery blood red to shades of vivid orange.

This study suggests that the technique may be a useful taxonomic tool. The extent of its usefulness can be determined only after a systematic examination of the study collections, necessarily a long-term project. Required will be special longwave light equipment, probably of a portable type. The possible ramifications of such studies, even if practical in only a relatively few critical cases, are considered startling.

The Mammals of Maryland.—The first draft of the project report is nearing completion. Fifty-five of the 62 land mammals occurring in Maryland have been studied and their distribution within the State mapped. Each species or subspecies is discussed with reference to the following categories: Taxonomy, type locality, general distribution, distribution in Maryland, distinguishing characteristics, measurements (cranial and

external), habitat and habits, specimens examined, and remarks. It is expected that the first draft of the manuscript will be completed in early 1964, and that by the end of the year it will be submitted in final form for publication.

Walrus studies.—Under an agreement with the U.S. Public Health Service, various sections of a manuscript on the Pacific walrus were completed and reviewed by Bureau personnel. It is expected that the walrus manuscript will be completed in the spring of 1964.

COOPERATIVE WILDLIFE RESEARCH UNITS

The nationwide Cooperative Wildlife Research Unit program, active in 18 States, is in its 29th year. Objectives of the program are to (1) conduct research basic to the management of wildlife resources, (2) facilitate the training of wildlife personnel at the college level, (3) provide technical assistance to conservation agencies in their wildlife management problems, and (4) promote education through demonstration, lecture, and publication.

Each Unit is supported by the cooperating State's Land Grant University and Game and Fish Department, by the Wildlife Management Institute, and by the Bureau of Sport Fisheries and Wildlife. All of the Units have additional fund sources, and most Units have projects specifically financed by granting agencies. Each Unit is administered by a Coordinating Committee including representatives of the University, the Game and Fish Department, and the Bureau of Sport Fisheries and Wildlife.

A new Unit was activated in 1963 at South Dakota State University, Brookings, the 18th in the system.

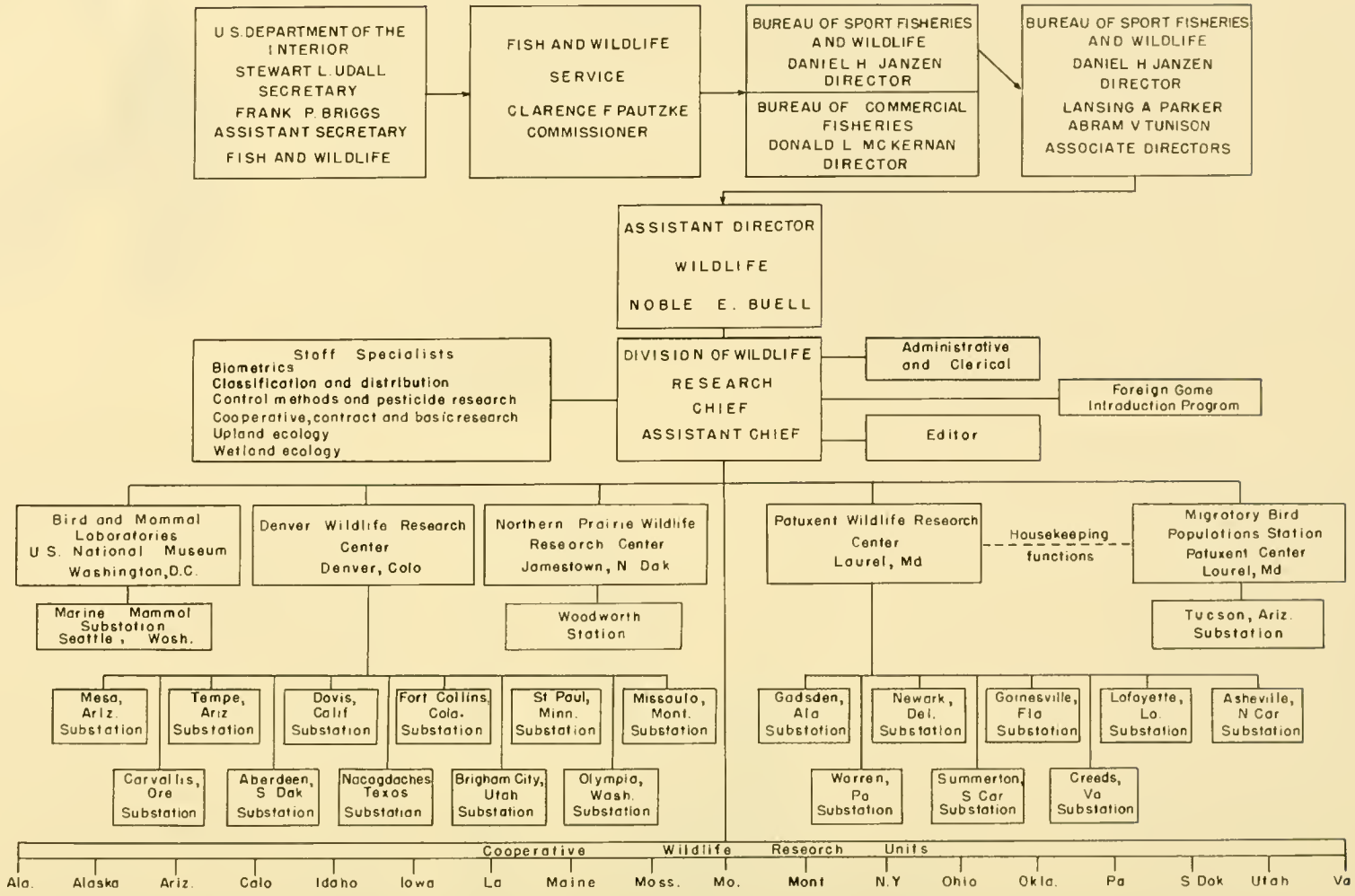
Results of research completed during the year are reported under applicable program activities of the Bureau. The 18 Units and Unit leaders are listed in appendix D, and the 135 publications for the year are listed in appendix E.

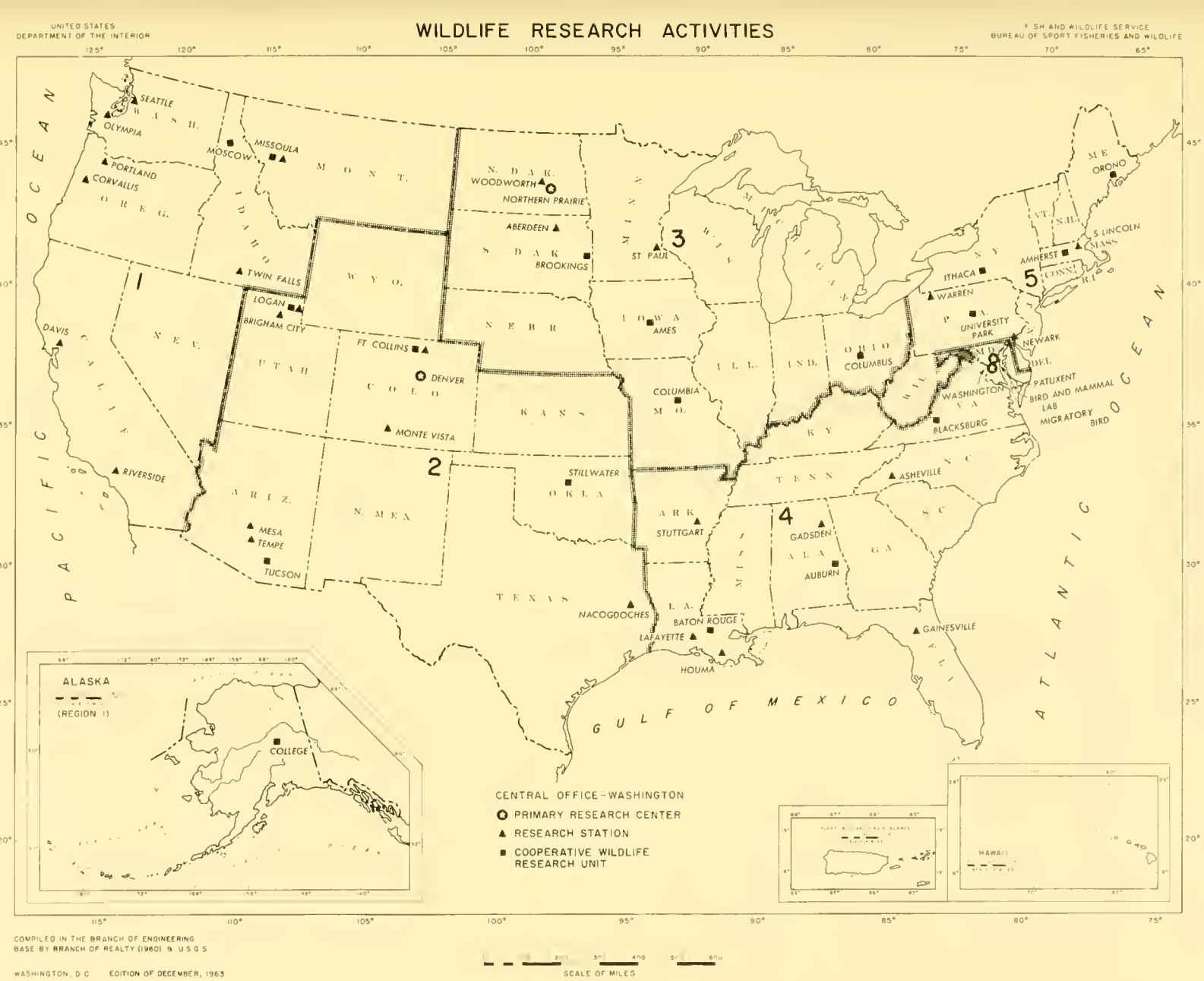
Wildlife graduates at Unit schools.—Since the inception of the Unit program in 1935, a total of 4,083 students have graduated from universities where Cooperative Wildlife Research Units are located. This number includes 2,906 with bachelors' degrees, 1,019 with masters' degrees, and 158 with doctoral degrees.

During the school year of 1962–63, the following received wildlife degrees from the Unit schools: Bachelors, 162; masters, 50; doctors, 21; total, 233. About 72 percent of the recipients of advanced degrees received financial aid or equipment from the Units.

Employment of 1962–63 graduates.—The 233 wildlife graduates from Unit schools in 1962–63 were absorbed into the wildlife profession, except for 18 entering military service and 25 of non-wildlife or unknown employment. Wildlife employment thus claimed 89 percent of the bachelors' graduates, 98 percent of the masters' graduates, and 100 percent of the doctoral graduates. Wildlife employment was distributed as follows: State and Provincial conservation or game and fish departments, 42; Federal conservation agencies, 38; teaching (wildlife and related), 11; and with private agencies or as individual operators, 6.

Appendix A--Organization Chart of the Division of Wildlife Research, 1963





COMPILED IN THE BRANCH OF ENGINEERING
BASE BY BRANCH OF REALTY (1960) & U S G S

WASHINGTON, D C EDITION OF DECEMBER, 1963

Appendix C—FUNDS AVAILABLE

Appropriated Funds	1961	Budget for fiscal year— 1962	1963	1964
Waterfowl management	$322,000	$439,000	$543,000	$698,000
Other migratory bird research	259,300	314,000	322,000	351,000
Upland wildlife	156,000	199,000	207,000	213,000
Pesticide-wildlife	371,000	423,000	548,000	662,000
Diseases-parasites	146,500	167,000	172,000	377,500
Control methods	358,000	393,000	660,000	1,042,500
Classification, distribution, and life history	144,000	144,000	148,000	154,500
Cooperative Wildlife Research Units	186,500	221,000	254,000	260,000
Total, research projects	1,943,300	2,300,000	2,854,000	3,758,500
Management of Patuxent Wildlife Research Center	89,000	157,000	157,000	179,000
Foreign game introduction program	52,940	53,000	53,800	55,000
Construction	700,000	120,000	509,000	579,500
Total	2,785,240	2,630,000	3,573,800	4,572,000
Funds From Other Sources				
Federal Aviation Agency	100,000	200,000	190,000	----------
Army Corps of Engineers	12,000	13,750	11,600	7,000
Private contributions	9,400	2,100	----------	----------
Quartermaster General	17,000	15,000	20,000	20,000
Bureau of Land Management	4,000	4,000	4,000	----------
U.S. Forest Service	5,000	5,000	5,000	----------
Grand total	2,932,640	2,869,850	3,804,400	4,599,000

Appendix D—OFFICES AND RESPONSIBLE PERSONNEL, DIVISION OF WILDLIFE RESEARCH

Central Office

Carlson, C. Edward	Chief of Division	Department of the Interior
Coutts, James M	Asst. Chief of Division	Washington 25, D.C.

Staff Specialists

Aldrich, Dr. John W	Classification and Distribution.	U.S. National Museum
Dale, Dr. Fred H	Upland Ecology	Interior Building
Dykstra, Walter W	Pesticides-Animal Control.	Interior Building
Erickson, Dr. Ray C	Wetland Ecology	Interior Building
Harris, Dr. Van T	Editor	Interior Building
Heath, Robert G	Biometrician	Patuxent Wildlife Research Center, Laurel, Md.
Yeager, Dr. Lee E	Head, Cooperative Wildlife Research Units.	Interior Building

Bird and Mammal Laboratories—U.S. National Museum

Manville, Dr. Richard H	Director of Laboratories	U.S. National Museum
Kenyon, Karl W	Field Biologist, Marine Mammals	Marine Mammal Substation, Sand Point NAS, Seattle, Wash.

Cooperative Wildlife Research Unit Leaders

Baker, Dr. Maurice F	Leader	Alabama Cooperative Wildlife Research Unit Auburn University Auburn, Ala.
Baskett, Dr. Thomas S	Leader	Missouri Cooperative Wildlife Research Unit University of Missouri Columbia, Mo.
Craighead, Dr. John L	Leader	Montana Cooperative Wildlife Research Unit Montana State University Missoula, Mont.
Dalke, Dr. Paul D	Leader	Idaho Cooperative Wildlife Research Unit University of Idaho Moscow, Idaho
Glover, Dr. Fred A	Leader	Colorado Cooperative Wildlife Research Unit Colorado State University Fort Collins, Colo.
Haugen, Dr. Arnold O	Leader	Iowa Cooperative Wildlife Research Unit Iowa State Univeristy Ames, Iowa
Klein, Dr. David R	Leader	Alaska Cooperative Wildlife Research Unit University of Alaska College, Alaska
Lindzey, Dr. James S	Leader	Pennsylvania Cooperative Wildlife Research Unit Forestry Building Pennsylvania State University University Park, Pa.

Cooperative Wildlife Research Unit Leaders—Continued

Low, Dr. Jessop B	Leader	Utah Cooperative Wildlife Research Unit Utah State University Logan, Utah
McGinnes, Dr. Burd S	Leader	Virginia Cooperative Wildlife Research Unit Virginia Polytechnic Institute Blacksburg, Va.
Mendall, Howard L	Leader	Maine Cooperative Wildlife Research Unit University of Maine Orono, Maine
Newsom, John D	Leader	Louisiana Cooperative Wildlife Research Unit School of Forestry Louisiana State University Baton Rouge, La.
Peterle, Dr. Tony J	Leader [1]	Ohio Cooperative Wildlife Research Unit The Ohio State University 1735 Neil Ave. Columbus, Ohio
Springer, Dr. Paul F	Leader	South Dakota Cooperative Wildlife Research Unit South Dakota State College College Station, Brookings, S. Dak.
Sheldon, Dr. William G	Leader	Massachusetts Cooperative Wildlife Research Unit University of Massachusetts Amherst, Mass.
Sowls, Dr. Lyle K	Leader	Arizona Cooperative Wildlife Research Unit University of Arizona Tucson, Ariz.
Stebler, Dr. Adolph M	Leader	Oklahoma Cooperative Wildlife Research Unit 408 Life Sciences Building Oklahoma State University Stillwater, Okla.
Thompson, Dr. Daniel Q	Leader	New York Cooperative Wildlife Research Unit Fernow Hall Cornell University Ithaca, N.Y.

Denver Wildlife Research Center

Williams, Cecil S	Director	Building 45 Denver Federal Center Denver, Colo.
Welch, Jack F	Assistant Director	

Senior Scientists in Charge of Field Stations

Jensen, Wayne I	Bacteriologist	Post Office Box 603 Bear River Migratory Bird Refuge Brigham City, Utah
Stoudt, Jerome H	Biologist	Van Slyke Building 116½ South Main St. Aberdeen, S. Dak.

[1] Resigned Dec. 31, 1963; became Acting Leader on Jan. 1, 1964, pending appointment of a Leader.

Dodge, Dr. Wendell E	Biologist	210 East Union Ave. Olympia, Wash.
Evans, James	Biologist	Nutria Control Station Houma, La.
Goodrum, Phil D	Biologist	814 Sarah Ann St. Nacogdoches, Tex.
Gashwiler, Jay S	Biologist	323 Extension Hall Oregon State College Corvallis, Oreg.
Halvorson, Curtis H	Biologist	c/o Forest Experiment Station Federal Building Missoula, Mont.
Zajanc, Adolph	Biologist	Field Station Administration University of California Davis, Calif.
Krefting, Laurits W	Biologist	204 Green Hall University of Minnesota St. Paul, Minn.
Reid, Vincent H	Biologist	206 Forestry Building Colorado State University Fort Collins, Colo.
Royall, Willis C., Jr	Biologist	Post Office Box 1006 Mesa, Ariz.
Stewart, Robert E	Biologist	118 3d Ave. NE. Jamestown, N. Dak.
Webb, Edward L	Biologist	Arizona State University Tempe, Ariz.

Northern Prairie Wildlife Research Center

Nelson, Harvey K	Director	General Delivery Jamestown, N. Dak.

Migratory Bird Populations Station

Crissey, Walter F	Director	Laurel, Md.
Geis, Dr. Aelred D	Assistant Director	

Senior Scientist in Charge of Field Station

Blankenship, Dr. Lytle H	Biologist	Arizona Cooperative Wildlife Research Unit University of Arizona Tucson, Ariz.

Patuxent Wildlife Research Center

Dustman, Dr. Eugene H	Director	Laurel, Md.

Senior Scientists in Charge of Field Stations

Lynch, John J	Biologist	Box 477 University of Southwestern Louisiana Lafayette, La.
Spencer, Henry J	Biologist	3700 East University Ave (Post Office Box 131) Gainesville, Fla.
Johnson, Frank M	Biologist	c/o Southeast Forest Experiment Station U.S. Forest Service Asheville, N. C.

Senior Scientists in Charge of Field Stations—Continued

Linehan, John T.	Biologist	Agricultural Building University of Delaware Newark, Del.
Rosene, Walter, Jr.	Biologist	Room 304–5 Post Office Building Gadsden, Ala.
Sharp, Dr. Ward M.	Biologist	Post Office Box 809 Northeast Forest Experiment Station U.S. Forest Service Warren, Pa.

Appendix E—LIST OF PUBLICATIONS, JANUARY 1–DECEMBER 31, 1963

[*Authors affiliated with two or more stations; publications listed under the affiliation of each author]

Central Office

ALDRICH, JOHN W.

1963. Geographic orientation of American Tetraonidae. Journal of Wildlife Management, vol. 27, no. 4, p. 529–545.

1963. Population systematics in bird conservation. Proceedings of the 13th International Ornithological Congress, vol. 2, p. 819–830.

1963. Status of the whooping crane and conservation efforts. Modern Game Breeding, vol. 33, no. 1, p. 14–16.

1963. (Review of) The migration of birds, by Jean Dorst. Atlantic Naturalist, vol. 18, no. 4, p. 254–256.

BUMP, GARDINER.

1963. History and analysis of Tetraonidae introductions into North America. Journal of Wildlife Management, vol. 27, no. 4, p. 855–867.

*BUREAU OF SPORT FISHERIES AND WILDLIFE

1963. Wildlife research: problems, programs, progress. Division of Wildlife Research. Circular 166. 66 p.

DALE, FRED H.

1963. (Review of) Birds and woods, by W. B. Yapp. Atlantic Naturalist, vol. 18, no. 4, p. 265–266.

ERICKSON, RAY C.

1963. Oil pollution and migratory birds. Atlantic Naturalist, vol. 18, no. 1, p. 5–14.

GEORGE, JOHN L.

1963. Nuisance birds—is control possible? National Agricultural Chemical Association News and Pesticide Review, vol. 21, no. 5, p. 6–7.

1963. (Review of) Whose woods are these: the story of the National Forests, by Michael Frome. Doubleday and Company, Inc., Garden City, N.Y. American Midland Naturalist, vol. 69, no. 2, p. 511–512.

1963. (Review of) Conservation in the United States, by R. M. Highsmith, J. G. Jensen, and R. D. Rudd. Atlantic Naturalist, vol. 18, no. 4, p. 260–262.

LEEDY, DANIEL L.

1963. (Review of) The relationship of the Peary and Barren Ground Caribou, by T. H. Manning. American Institute of Biological Scientists, vol. 13, no. 1, p. 43.

Bird and Mammal Laboratories

BUREAU OF SPORT FISHERIES AND WILDLIFE.

1963. Fur catch in the United States, 1962. Wildlife Leaflet 452. 4 p.

1963. Big game inventory for 1962. Bureau of Sport Fisheries and Wildlife, Wildlife Leaflet no. 454, p. 1–4 (processed).

BURLEIGH, THOMAS D.

1963. Geographic variation in the cedar waxwing (*Bombycilla cedrorum*). Proceedings of the Biological Society of Washington, vol. 76, p. 177–180.

GREENHALL, ARTHUR M.

1963. A bamboo mongoose trap. Bureau of Sport Fisheries and Wildlife, Wildlife Leaflet no. 453, p. 1–4.

1963. Use of mist nets and strychnine for vampire control in Trinidad. Journal of Mammalogy, vol. 44, no. 3, p. 396–399.

GREENHALL, A. M., ET AL.

1963. Tacaribe virus, a new agent isolated from *Artibeus* bats and mosquitoes in Trinidad, West Indies. American Journal of Tropical Medicine and Hygiene, vol. 12, no. 4, p. 640–646.

KENYON, KARL W.

1963. Recovery of a fur bearer—coveted pelt caused sea otter decimation. Natural History, vol. 72, no. 9, p. 12–21.

1963. Further observations of whooper swans in the Aleutian Islands, Alaska. Auk, vol. 80, no. 4, p. 540–542.

1963. (Review of) Fauna of the Aleutian Islands and Alaska Peninsula, by O. Murie and V. B. Scheffer. Journal of Wildlife Management, vol. 27, no. 2, p. 306.

KENYON, K. W., and CLIFFORD H. FISCUS.
1963. Age determination in the Hawaiian monk seal. Journal of Mammalogy, vol. 44, no. 2, p. 280–282.
MANVILLE, RICHARD H.
1963. Altitude record for mallard. Wilson Bulletin, vol. 75, no. 1, p. 92.
1963. (Review) of) International Zoo Yearbook, by Jarvis and Morris. Journal of Mammalogy, vol. 44, no. 2, p. 286–287.
1963. Dental anomalies in North American lynx. Zeitschrift für Säugetierkunde (Berlin), vol. 28, no. 3, p. 166–169.
1963. Accidental mortality in bats. Mammalia (Paris), vol. 27, no. 3, p. 361–366.
1963. Articles on caenolestid, dingo, elephant, and nutria. Encyclopedia Britannica, 15th ed. Chicago.
PARADISO, JOHN L.
1963. The type locality of *Tamias striatus fisheri*. Journal of Mammalogy, vol. 44, no. 4, p. 579–580.
SCHEFFER, V. B., and K. W. KENYON.
1963. Baculum size in pinnipeds. Zeitschrift für Säugetierkunde (Berlin), vol. 28, no. 1, p. 38–41.
1963. Elephant seal in Puget Sound, Wash. Murrelet, vol. 44, no. 2, p. 23–24.
SHORT, LESTER L., Jr.
1963. Hybridization in the wood warblers *Vermivora pinus* and *V. chrysoptera*. Proceedings of the 13th International Ornithological Congress, vol. 1, p. 147–160.
1963. (Review of) Birds and woods, by W. B. Yapp. Ecology, vol. 44, no. 4, p. 829.

Denver Wildlife Research Center

FARM JOURNAL.
1963. Watch for this bird. September issue, p. 44–T. (Condensation by editor of article by John W. De Grazio.)
FINLEY, R. B., Jr., and R. E. PILLMORE.
1963. Conversion of DDT to DDD in animal tissue. American Institute of Biological Sciences Bulletin, vol. 13, no. 3, p. 41–42.
KEITH, JAMES O., and ELDRIDGE G. HUNT.
1962. Pesticide-wildlife investigations of California. Proceedings of the 2d Annual Conference on the Use of Agricultural Chemicals in California (sponsored by the University of California, Davis, Calif., January 8, 1963).
GASHWILER, JAY S.
1963. Pouch capacity of Cooper's chipmunks. Murrelet, vol. 44, no. 1, p. 7–8.
KREFTING, L. W.
1963. Beaver of Isle Royale. Naturalist, vol. 14, no. 2, p. 1–11.
KREFTING, L. W., and HENRY L. HANSEN.
1963. Use of phytocides to improve deer habitat in Minnesota. Proceedings of the Southern Weed Conference, vol. 16, p. 209–216.
REID, VINCENT H.
1963. Trends in small rodent and rabbit populations. *In* Hydrologic and biotic characteristics of grazed and ungrazed watersheds of the Badger Wash Basin in western Colorado, 1953–58, Geological Survey Water-Supply Paper 1532–B, p. B70–B72.
ROBINETTE, W. L.
1963. Weights of some of the larger mammals of Northern Rhodesia. The Puku, The Occasional Papers of the Department of Game and Fisheries, Northern Rhodesia, no. 1, p .207–215.
STEPHENSON, G. K., P. D. GOODRUM, and R. L. PACKARD.
1963. Small rodents as consumers of pine seed in East Texas uplands. Journal of Forestry, vol. 61, no. 7, p. 523–526.
WARD, A. LORIN, and JAMES O. KEITH.
1963. Feeding habits of pocket gophers on mountain grasslands, Black Mesa, Colo. Ecology, vol. 43, p. 744–749.

Northern Prairie Wildlife Research Center

NELSON, HARVEY K.
1963. Restoration of breeding Canada goose flocks in the North Central states. Transactions of the 28th North American Wildlife and Natural Resources Conference, p. 133–150.

Patuxent Wildlife Research Center

BUCKLEY, JOHN L.
1963. (Review of) A naturalist in Alaska, by Adolph Murie. Chesapeake Science, vol. 4, no. 1, p. 63–64.
BUCKLEY, JOHN L., and JAMES B. DEWITT.
1963. 1963 progress report—pesticide-bald eagle relationships. A Florida Notebook, National Audubon Society Annual Convention, Miami, Fla., November 9–13, 1963, p. 15–20.
*BUTLER, PHILIP A., and PAUL F. SPRINGER.
1963. Pesticides—a new factor in coastal environments. Transactions of the 28th North American Wildlife and Natural Resources Conference, p. 378–390.
CLARK, GORDON MARSTON.
1963. Observations on the nasal mites of the eastern brown-headed cowbird (*Molothrus ater ater*). Proceedings of the Helminthological Society of Washington, vol. 30, no. 2, p. 173–176.
DAVEY, STUART P.
1963. Effects of chemicals on earthworms: a review of the literature. Bureau of Sport Fisheries and Wildlife, Special Scientific Report: Wildlife no. 74, p. 1–20.
HERMAN, CARLTON M.
1963. Disease and infection in the Tetraonidae, Journal of Wildlife Management, vol. 27, no. 4, p. 850–854.
1963. (Review of) Tuberculosis in animals, edited by J. N. Ritchie and and W. D. McCrae. Chesapeake Science, vol. 4, no. 1, p. 64.

JOHNSON, FRANK M., and ROBERT L. DOWNING.
1963. Preliminary investigations of deer census techniques applicable to the Southeast. Proceedings, Society of American Foresters, Atlanta, Ga., 1962, p. 162–165.

KLAWITTER, RALPH A., JACK STUBBS, and FRANK M. JOHNSON.
1963. Tests of arasan 75-endrin 50W rodent repellent on shumard and swamp chestnut oak acorns. U.S. Forest Service Research Note SE–4, p. 1–2.

LOCKE, LOUIS N.
1963. Multicentric neurofibrosarcoma in a Canada goose, *Branta canadensis*. Avian Diseases, vol. 7, no. 2, p. 196–202.

LUMSDEN, R. D., D. E. ELLIS, and JOHN L. SINCOCK.
1963. A survey of fungi associated with lesioned and chlorotic sago pondweed (*Potamogeton pectinatus*). Plant Disease Reporter, vol. 47, no. 7, p. 689–693.

LYNCH, JOHN J., CHARLES D. EVANS, and V. C. CONOVER.
1963. Inventory of waterfowl environments of prairie Canada. Transactions 28th North American Wildlife and Natural Resources Conference, p. 98–108.

MEANLEY, BROOKE.
1963. Nesting ecology and habits of the dickeissel on the Arkansas Grand Prairie. Wilson Bulletin, vol. 75, no. 3, p. 280.
1963. Prenesting activity of the purple gallinule near Savannah, Ga. The Auk, vol. 80, no. 4, p. 545–547.

MEANLEY, BROOKE, and JOHN S. WEBB.
1963. Nesting ecology and reproductive rate of the red-winged blackbird in tidal marshes of the upper Chesapeake Bay region. Chesapeake Science, vol. 4, no. 2, p. 90–100.

MITCHELL, ROBERT T.
1963. The floodlight trap—a device for capturing large numbers of blackbirds and starlings at roosts. Bureau of Sport Fisheries and Wildlife, Special Scientific Report: Wildlife no. 77, p. 1–14.

RIPLEY, THOMAS H., FRANK M. JOHNSON, and WILLIAM H. MOORE.
1963. A modification of the line intercept method of sampling understory vegetation. Journal of Range Management, vol. 16, no. 1, p. 9–11.

ROSENE, WALTER J., and DANIEL W. LAY.
1963. Disappearance and visibility of quail remains. The Journal of Wildlife Management, vol. 27, no. 1, p. 139–142.

SCHMID, FREDERICK C.
1963. Record longevity of a wild red-shouldered hawk. Bird-Banding, vol. 34, no. 3, p. 160.

SEUBERT, JOHN L.
1963. Research on methods of trapping the red-winged blackbird (*Agelaius phoeniceus*). Angewandte Ornithologie, Band 1, Heft 3–4, p. 163–170.

SHARP, WARD M.
1963. The effects of habitat manipulation and forest succession on ruffed grouse. The Journal of Wildlife Management, vol. 27, no. 4, p. 661–671.

*SPRINGER, PAUL F.
1963. Fish and wildlife aspects of chemical mosquito control. Proceedings, Fifteenth Annual Meeting New Jersey Mosquito Extermination Association and Nineteenth Annual Meeting American Mosquito Control Association, Atlantic City, N.J., March 12–15, 1963, p. 194–206.
1963. Wildlife management concepts compatible with mosquito suppression. Proceedings of the Conference for Coordinated Program on Wildlife Management and Mosquito Suppression, Yosemite National Park, Calif., October 15–18, 1962, p. 31–39.

STEENIS, JOHN H.
1963. Relation of screening to field testing in development of plant control methods. Proceedings Northeastern Weed Control Conference, vol. 17, p. 439–442.

STEENIS, JOHN H., and VERNON D. STOTTS.
1963. Abstract—Progress report on distribution and control of Eurasian watermilfoil in the Chesapeake Bay Region, 1962. Proceedings of the Southern Weed Conference, vol. 16, p. 341–342.

STEWART, PAUL A.
1963. Abnormalities among brown-headed cowbirds trapped in Alabama. Bird-Banding, vol. 34, no. 4, p. 199–202.

Migratory Bird Populations Station

Wildlife publications

CONAWAY, C. N., H. M. WIGHT, and K. C. SADLER.
1963. Annual production by a cottontail population. Journal of Wildlife Management, vol. 27, no. 2 p. 171–193.

CRISSEY, WALTER F.
1963. The Northeastern States as a separate waterfowl management unit. Proceedings of the Northeastern Wildlife Conference, Portland, Maine, April 14–17, p. 1–11.

GEIS, AELRED D.
1963. Role of hunting regulations in migratory bird management. Transactions of the 28th North American Wildlife and Natural Resources Conference, p. 167–172.

GEIS, AELRED D., and RICHARD D. TABER.
1963. Measuring hunting and other mortality. *In* Wildlife Investigational Techniques, The Wildlife Society, second edition, p. 284–298.

KACZYNSKI, CHARDES F., and WILLIAM H. KIEL, Jr.
1963. Band loss by nestling mourning doves. Journal of Wildlife Management, vol. 27, no. 1, p. 271–279.

MARTIN, FANT W.
1963. Woodcock status report—1963. Bureau of Sport Fisheries and Wildlife, Special Scientific Report: Wildlife no. 76, p. 1–43.

Robbins, Chandler S.
1963. The seasons—October, November, December, 1962. Maryland Birdlife, vol. 19, no. 4, p. 109.
1963. The seasons—January, February, March, 1963. Maryland Birdlife, vol. 19, no. 2, p. 29–53.
1963. The seasons—April, May, June, 1963. Maryland Birdlife, vol. 19, no. 3, p. 68–77.
1963. The seasons—July, August, September, 1963. Maryland Birdlife, vol. 19, no. 4, p. 98–107.
1963. Second record of clay-colored sparrow in Maryland. Maryland Birdlife, vol. 19, no. 1, p. 16–21.

Tomlinson, Roy E.
1963. A method for drive-trapping dusky grouse. Journal of Wildlife Management, vol. 27, no. 4, p. 563–566.

Wight, Howard M.
1963. Mourning dove status report—1963. Bureau of Sport Fisheries and Wildlife, Special Scientific Report: Wildlife no. 73, p. 1–34.

Administrative reports

Staff, Migratory Bird Populations Station, and Vernon D. Stotts.
1963. Roost trapping of wood ducks. Administrative Report no. 15, Migratory Bird Populations Station, p. 1–2.

Staff, Migratory Bird Populations Station.
1963. Relationship between length of season and number of duck stamps sold. Administrative Report no. 16, Migratory Bird Populations Station, p. 1–8.

Wight, Howard M.
1963. A preliminary report on mourning dove recovery rates in relation to hunting regulations. Administrative Report no. 17, Migratory Bird Populations Station, p 1–4.

Geis, Aelred D., Robert I. Smith, and Stephen V. Goddard.
1963. Blue-winged teal band recovery and annual mortality rates. Administrative Report no. 18, Migratory Bird Populations Station, p. 1–11.

Wight, Howard M.
1963. The role of pre- and post-season banding in mourning dove research. Administrative Report no. 19, p. 1–18.

Smith, Robert I.
1963. Lesser scaup and ring-necked duck shooting pressure and mortality rates. Administrative Report no. 20, p. 1–18.

Smith, Robert I., Stephen V. Goddard, and Aelred D. Geis.
1963. Analysis of some wood duck handings and report on the 1962 wood duck banding program. Administrative Report no. 21, Migratory Bird Populations Station, p. 1–25.

Geis, Aelred D., and Robert I. Smith.
1963. Recovery rates from 1962 pre-hunting season bandings of mallards and black ducks. Administrative Report no. 22, p. 1–18.

Heath, Robert G.
1963. Waterfowl harvest and hunter activity in the United States during the 1962 hunting season. Administrative Report no. 23, Migratory Bird Populations Station, p. 1–19.
1963. Analysis of Utah's 1962 controlled whistling swan season. Administrative Report no. 24, Migratory Bird Populations Station, p. 1–8.

Heath, Robert G., and M. Edwin Rosasco.
1963. National survey of waterfowl hunting on various types of land ownership. Administrative Report no. 25, Migratory Bird Populations Station, p. 1–34.
1963. Hunter opinion survey of restrictive duck hunting regulations. Administrative Report no. 26, Migratory Bird Populations Station, p. 1–23.

Geis, Aelred D., and Samuel M. Carney.
1963. Age ratios of ducks killed during the 1962 hunting season compared to those during prior years. Administrative Report no. 27, Migratory Bird Populations Station, p. 1–9.

Smith, Robert I.
1963. Estimate of the number of wood ducks in the 1961 and 1962 pre-hunting season populations of the Mississippi and Atlantic Flyways. Administrative Report no. 28, Migratory Bird Populations Station, p. 1–4.

Carney, Samuel M.
1963. Effect of the change in the daily bag limit in 1962 on the wood duck kill in the Mississippi Flyway. Administrative Report no. 29, Migratory Bird Populations Station, p. 1–3.

Carney, Samuel M., and Aelred D. Geis.
1963. Occurrence of scaup and ring-necked duck as "Bonus Scaup" during the 1962 season. Administrative Report no. 30, Migratory Bird Populations Station, p. 1–6.
1963. Mallard sex ratios in the 1962 hunting kill. Administrative Report no. 31, Migratory Bird Populations Station, p. 1–6.

Carney, Samuel M., and Alfred J. Godin.
1963. Comparison between the 1961 and 1962 species composition of the kill by flyways. Administrative Report no. 32, Migratory Bird Populations Station, p. 1–2.

Carney, Samuel M.
1963. Decreases in the duck kill that might be anticipated due to reductions in the daily bag limit. Administrative Report no. 33, Migratory Bird Populations Station, p. 1–9.

Carney, Samuel M., M. Edwin Rosasco, and Robert P. Shanahan.
1963. Increases in the total duck and mallard kill that might be anticipated due to increases in the daily bag limit. Administrative Report no. 34, Migratory Bird Populations Station, p. 1–10.

Geis, Aelred D., M. Edwin Rosasco, and Samuel M. Carney.
1963. Extent of the change in waterfowl kill and hunting activity between the 1961 and 1962 hunting seasons. Administrative Report no. 35, Migratory Bird Populations Station, p. 1–5.

Smith, Robert I.

1963. A summary of information relating to wood duck populations and harvest. Administrative Report no. 36, Migratory Bird Populations Station, p. 1–4.

Staff, Migratory Bird Populations Station.

1963. Hunting success in relation to consistency of hunter purchase of duck stamps. Administrative Report no. 37, Migratory Bird Populations Station, p. 1–2.

Godin, Alfred J., and Samuel M. Carney.

1963. Comparisons between hunters' reports and spy-blind observations during the 1961–62 and 1962–63 hunting seasons. Administrative Report no. 38, Migratory Bird Populations Station, p. 1–10.

Martin, Fant W.

1963. Effect of regulations on size of the woodcock kill. Administrative Report no. 39, Migratory Bird Populations Station, p. 1–5.

Cooperative Wildlife Research Units

ALABAMA

Wildlife publication

Baker, M. F.

1963. New fire ant bait. Highlights of Agricultural Research, vol. 10, no. 2, p. 16.

ALASKA

Wildlife publications

Courtright, A. M.

1963. Range management and the genus *Rangifer:* A review of selected literature. University of Alaska, M. S. thesis, p. 1–172.

Dean, F. C.

1963. (Review of) A naturalist in Alaska by Adolph Murie. Journal of Wildlife Management, vol. 27, no. 2, p. 308–310.

Roberts, H. A.

1963. Aspects of the life history and food habits of rock and willow ptarmigan. University of Alaska, M. S. thesis, p. 1–108.

ARIZONA

Wildlife publications

Brown, W. H., J. W. Stull, and L. K. Sowls.

1963. Chemical composition of the milk fat of the collard peccary. Journal of Mammalogy, vol. 44, no. 1, p. 112–113.

Simmons, N. M., S. Levy, and J. Levy.

1963. Observation of desert bighorn sheep lambing, Kofa Game Range, Arizona. Journal of Mammalogy, vol. 44, no. 3, p. 433.

Sowls, L. K.

1963. Life in the desert. Audubon Nature Bulletin Series 31, no. 2, p. 1–6.

1962. Life in freshwater marshes. Audubon Nature Bulletin Series 30, no. 2, p. 1–6.

Sowls, L. K., and P. S. Minnamon.

1963. Glass beads for marking home ranges for mammals. Journal of Wildlife Management, vol. 27, no. 2, p. 299–302.

Fishery publications

Gerdes, J. H., and W. J. McConnell.

1963. Food habits and spawning of the thread-fin shad in a small, desert impoundment. Arizona Academy of Science, vol. 2, no. 3, p. 113–116.

McConnell, W. J.

1963. Primary productivity and fish harvest in a small desert impoundment. Transactions of the American Fisheries Society, vol. 92, no. 1, p. 1–12.

COLORADO

Wildlife publications

Evans, K. E., and D. L. Gilbert.

1963. Grouse of the grasslands. Colorado Outdoors, vol. 12, no. 6, p. 15–18.

Loveless, C. M., J. Coffelt, D. E. Medin, and L. E. Yeager.

1963. A photoelectric-cell device for use in wildlife research. AIBS Bulletin, vol. 14, p. 55–57.

Martin, W. E., and D. L. Gilbert.

1963. Field wildlife studies in Colorado. Second Edition, Colorado State University, p. 1–79.

Roughton, R. D.

1962. A review of literature on dendrochronology and age determination of woody plants. Colorado Department of Game, Fish and Parks, Technical Bulletin no. 15, p. 1–99.

Ryder, R. A.

1963. White pelicans. Colorado Outdoors, vol. 12, no. 6, p. 14–19.

Sandfort, W.

1963. We can have more pheasants. Colorado Outdoors, vol. 12, no. 3, p. 1–6.

Short, H. L.

1963. Rumen fermentations and energy relationships in white-tailed deer. Journal of Wildlife Management, vol. 27, no. 2, p. 184–195.

Wagar, J. V. K.

1963. History and problems of the Poudre Canyon. The Wildlife Society, Central Mountains and Plains Section, Transactions, Seventh Annual Summer Conference, vol. 7, p. 1. (Abstract)

1963. The deterioration of recreation under intensive use. The Wildlife Society, Central Mountains and Plains Section, Transactions, Sixth Annual Summer Conference, vol. 6, p. 20. (Abstract)

1963. In such manner and by such means. U.S. National Park Service, Midwest Region Superintendents' Conference Transactions, p. 125–138.

1963. Should we hunt in the National Parks? Colorado Outdoors, vol. 12, no. 2, p. 28–30.

1963. Chapter 8: Parks and recreational development. *In* Careers in conservation—opportunities in natural resources. Edited by Henry Clepper for the Natural Resources Council of America. Ronald Press, New York, p. 141–153.

YEAGER, L. E.
1963. Marten. Colorado Outdoors, vol. 12, no. 1, inside front cover.

YEAGER, L. E., and A. D. COLEMAN.
1963. A profile of the marten. Colorado Outdoors, vol. 12, no. 1, p. 1–5.

YEAGER, L. E., C. M. LOVELESS, and H. L. SHORT.
1963. Effects of the environment on a wild deer population—A base for radioecological studies. U.S. Atomic Energy Commission, Offsite Ecology Research, Division of Biology and Medicine: TID–13358 (1st rev.), p. 11–15 (processed).

IDAHO

Wildlife publication

DALKE, P. D., D. B. PYRAH, D. C. STANTON, J. E. CRAWFORD, and E. F. SCHLATTERER.
1963. Ecology, productivity and management of sage grouse in Idaho. Journal of Wildlife Management, vol. 27, no. 4, p. 811–841.

IOWA

Wildlife publications

ANDREWS, R. D.
1963. Evaluation of tests for pullorum and Newcastle disease with wholeblood samples collected on seriodiscs. Avian Diseases, vol. 7, no. 2, p. 193–196.

ANDREWS, R. D., A. O. HAUGEN, and L. Y. QUINN.
1963. Antibodies of pullorum and Newcastle disease virus in pheasants. Journal of Wildlife Management, vol. 27, no. 2, p. 220–224.

ERRINGTON, P. L.
1963. The pricelessness of untampered nature. Journal of Wildlife Management, vol. 27, no. 2, p. 313–320.
1963. The phenomenon of predation. American Scientist, vol. 51, no. 2, p. 180–192.
1963. Muskrat populations. Iowa State University Press, p. 1–665.

ERRINGTON, P. L., R. J. SIGLIN, and R. C. CLARK.
1963. The decline of a muskrat population. Journal of Wildlife Management, vol. 27, no. 1, p. 1–8.

HAUGEN, A. O.
1963. Man and conservation. Iowa Waltonian, vol. 5, no. 3, p. 2.
1963. An improved technique for preserving deer uteri. Journal of Wildlife Management, vol. 27, no. 1, p. 142–143.

HAUGEN, A. O., and D. L. TRAUGER.
1963. Ovarian analysis for data on corpora lutea changes in whitetailed deer. Proceedings of the Iowa Academy of Science, vol. 69, p. 231–238.

KLIMSTRA, W. D., P. A. VOHS, Jr., and J. D. CHERRY.
1963. Strip-mined lands for recreation. Illinois Wildlife, vol. 18, no. 4, p. 6–8.

MOORMAN, R. B.
1963. Why not crop your farm pond! Iowa Farm Science, vol. 16, no. 6, p. 3–5.

ROSLIEN, D. J., P. L. FORE, and A. O. HAUGEN.
1963. Blood parasites in relation to pheasants and quail in Iowa. Proceedings of the Iowa Academy of Science, vol. 69, p. 239–244.

VOHS, P. A., Jr., and D. BIRKENHOLZ.
1963. Response of bobwhite quail to management of some Illinois strip-mined lands. Transactions of the Illinois Academy of Science, vol. 55, no. 1, p. 13–19.

WELLER, M. W.
1963. Resolution of respect: Paul L. Errington, 1902–1962. Bulletin of the Ecological Society of America, vol. 44, no. 2, p. 55–58.

WELLER, M. W., and L. H. FREDRICKSON.
1963. Small mammal prey of some owls wintering in Iowa. Iowa State Journal of Science, vol. 38, no. 2, p. 151–160.

WRIGHT, V., and P. OTTE.
1963. A central Iowa pheasant nesting study, 1961. Proceedings of the Iowa Academy of Science, vol. 69, p. 252–259.

Fishery publications

BUCHHOLZ, M. M. and K. D. CARLANDER.
1963. Failure of yellow bass, Roccus *mississippiensis*, to form annuli. Transactions, American Fisheries Society, vol. 92, no. 4, p. 384–400.

CARLANDER, K. D.
1963. Editor's Foreword. (*In* Symposium on freshwater fishery problems in Europe.) Transactions of American Fisheries Society, vol. 92, no. 3, p. 258.
1963. An age record for tagged walleye. Iowa Conservationist, vol. 22, no. 5, p. 34.

CARLANDER, K. D.
1963. Chapter 4: Fisheries. *In* Careers in Conservation—Opportunities in Natural Resources. Edited by Henry Clepper for the Natural Resources Council of America. The Ronald Press, New York, p. 37–50.
1963. Yellow bass comeback at Clear Lake? Iowa Conservationist, vol. 22, p. 44–45.

CARLANDER K. D., R. S. CAMPBELL and W. I. IRWIN.
1963. Chapter 11: Mid-continent States. *In* Limnology in North America. Edited by David G. Frey. University of Wisconsin Press, Madison, p. 317–348.

DINSMORE, J. J.
1962. Life history of the creek chub, with emphasis on growth. Proceedings of the Iowa Academy of Science, vol. 69, p. 296–301.

NEAL, R. A.
1963. Black and white crappies in Clear Lake, 1950–1961. Iowa State Journal of Science, vol. 37, no. 4, p. 425–445.

SMALL, L. F.
1963. Effect of wind on the distribution of chlorophyll *a* in Clear Lake, Iowa. Limnology and Oceanography, vol. 8, no. 4, p. 426–432.

WELKER, B. D.
1963. Summer food habits of yellow bass and black bullheads in Clear Lake. Proceedings of the Iowa Academy of Science, vol. 69, p. 286–295.

MAINE

Wildlife publications

HARTMAN, F. E.
1963. Estuarine winter habitat for black ducks. Journal of Wildlife Management, vol. 27, no. 3, p. 339–347.

MOULTON, J. C.
1963. Notes on the small mammals of the Weskeag River Region, Knox County, Maine. Maine Field Naturalist, vol. 19, no. 5, p. 67–70.

ROBINSON, W. L.
1963. Winter record of the American coot in Maine. Maine Field Naturalist, vol. 19, no. 5, p. 71.

MASSACHUSETTS

Wildlife publications

HESTER, A. E.
1963. A plastic wing tag for individual identification of passerine birds. Bird-Banding, vol. 34, no. 4, p. 213–217.

WENTWORTH, B. C., and W. J. MELLEN.
1963. Egg production and fertility following various methods of insemination in Japanese quail (*Coturnix coturnix japonica*). Journal of Reproduction Fertility, no. 6, p. 215–220.

MISSOURI

Wildlife publications

CHAMBERS, G. D.
1963. Corn a staple food of doves wintering in northern Missouri. Journal of Wildlife Management, vol. 27, no. 3, p. 486–488.

ELDER, W. H.
1963. Game management (section under heading "Wildlife Conservation"). Encyclopedia Britannica (1963 edition), p. 601c–601d.
1963. (Review of) The waterfowl of the world, by Jean Delacour. Journal of Wildlife Management, vol. 27, no. 1, p. 146–147.

FRANKEL, A. I., and T. S. BASKETT.
1963. Color marking disrupts pair bonds of captive mourning doves. Journal of Wildlife Management, vol. 27, no. 1, p. 124–127.

HOLLER, N. R., T. S. BASKETT, and J. P. ROGERS.
1963. Reproduction in confined swamp rabbits. Journal of Wildlife Management, vol. 27, no. 2, p. 179–183.

KORSCHGEN, L. J., and T. S. BASKETT.
1963. Foods of impoundment- and stream-dwelling bullfrogs in Missouri. Herpetologica, vol. 19, no. 2, p. 89–99.

Fishery publications

CARLANDER, K. D., R. S. CAMPBELL, and W. H. IRWIN.
1963. Chapter 11: Mid-continent States. *In* Limnology in North America. Edited by David G. Frey. University of Wisconsin Press, Madison, p. 317–348.

CARUFEL, L. H., and A. WITT, Jr.
1963. Range extension of the gizzard shad, *Dorosoma cepedianum*, into North Dakota. Copeia, no. 1, p. 178.

HANSON, W. D., and R. S. CAMPBELL.
1963. The effects of pool size and beaver activity on distribution and abundance of warm-water fishes in a north Missouri stream. American Midland Naturalist, vol. 69, no. 1, p. 136–149.

POOLE, R. L., D. R. KEUSTER, and A. WITT, Jr.
1963. The status of spearfishing and the use of SCUBA in fish management programs in the freshwaters of the United States. Transactions of the American Fisheries Society, vol. 92, no. 1, p. 30–33.

MONTANA

Wildlife publications

CRAIGHEAD, F. C., Jr., J. J. CRAIGHEAD and R. S. DAVIES.
1963. Radio-tracking of grizzly bears. *In* Bio-Telemetry. Pergamon Press, p. 133–148.

CRAIGHEAD, F. C., Jr., and R. J. DAVIES.
1963. A field guide to Rocky Mountain wildflowers. Peterson Field Guide Series, Houghton-Mifflin Company, p. 1–277.

FORRESTER, D. J., and C. M. SENGER.
1963. Bighorns and lungworm. Montana Wildlife (April), p. 2–7.
1963. Effect of temperature and humidity on survival of first stage *Protostrongylus stilesi* larvae. Experimental Parasitology, vol. 13, no. 2, p. 83–89.

FORRESTER, D. J., and R. S. HOFFMAN.
1963. Growth and behavior of a captive bighorn ram. Journal of Mammalogy, vol. 44, no. 1, p. 116–118.

PENGELLY, W. L.
1963. The art of social conservation. Naturalist (Fall), Minnesota Natural History Society, vol. 14, no. 3, p. 4–15.
1963. Timberlands and deer in the northern Rockies. Journal of Forestry, vol. 61, no. 10, p. 734–740.

WRIGHT, P. L.
1963. Chapter 6: Variations in reproductive cycles in North American mustelids. *In* Delayed Implantation. Edited by Allen C. Enders, University of Chicago Press, p. 77–97.

NEW YORK

Wildlife publications

CASE, N. A., and O. H. HEWITT.
1963. Nesting and productivity of the redwinged blackbird in relation to habitat. The Living Bird, Second Annual of the Cornell Laboratory of Ornithology, p. 7–20.

ERICKSON, H. R.
1963. Reproduction, growth, and movement of muskrats inhabiting small water areas in New York State. New York Fish and Game Journal, vol. 10, p. 90–117.

HEWITT, O. H.
1963. Development of a road-side count method of census of breeding red-winged blackbirds, *Agelaius phoeniceus*. Angewandte Ornithology, vol. 2, no. 1, p. 123–126.
1963. Counting grouse in the Arnot Forest. Cornell Plantations, vol. 18, no. 4, p. 59–61.

Saunders, J. K., Jr.

1963. Food habits of the lynx in Newfoundland. Journal of Wildlife Management, vol. 27, no. 3, p. 384–390.

1963. Movements and activities of the lynx in Newfoundland. Journal of Wildlife Management, vol. 27, no. 3, p. 390–401.

Simkin, D. W.

1963. Tagging moose by helicopter. Journal of Wildlife Management, vol. 27, no. 1, p. 136–139.

Smith, S. E., R. W. Gardner, and G. A. Swanson.

1963. A study of the adequacy of cobalt nutrition in New York deer. New York Fish and Game Journal, vol. 10, no. 2, p. 225–227.

Swanson, G. A.

1963. (Editor) Pesticides—their use and effect. New York State Joint Legislative Committee on Natural Resources, Assembly Chamber, Albany 1, New York, p. 1–110.

Thompson, D. Q.

1963. (Review of) Silent Spring, by Rachel Carson. Wilson Bulletin, vol. 75, no. 1, p. 106–107.

Thompson, D. Q., and R. A. Person.

1963. The eider pass at Point Barrow, Alaska. Journal of Wildlife Management, vol. 27, no. 3, p. 348–356.

OHIO

Wildlife publications

Eberhardt, L., T. J. Peterle, and R. Schofield.

1963. Problems in a rabbit population study. Wildlife Monographs, No. 10, p. 1–51.

Giles, R. H., Jr., and T. J. Peterle.

1963. Distribution of aerially applied malathion S^{35} in a forest ecosystem. The International Symposium on the Use and Application of Radioisotopes and Radiation in the Control of Plant and Animal Insect Pests. April 22–26, Athens, Greece. *In* Radiation and Radioisotopes Applied to Insects of Agricultural Importance, IAEA, Vienna, Austria, p. 55–84.

OKLAHOMA

Wildlife publications

Atkins, B. O., and F. F. Copelin.

1963. New fish and wildlife management and research opportunities in Oklahoma. Proceedings of the Oklahoma Academy of Science, vol. 43, p. 227–229.

Baumgartner, F. M.

1963. Audubon Field Notes, vol. 17, no. 1, p. 45–46; no. 3, p. 339–341; no. 4, p. 414–415; no. 5, p. 468–469.

Costly, N.

1963. Population explosions concern wildlife research unit. Oklahoma State University, Research Foundation, Research Reports, vol. 1, no. 5, p. 1.

Goertz, J. W.

1963. Some biological notes on the plains harvest mouse. Proceedings, Oklahoma Academy of Science, vol. 43, p. 123–125.

Jones, R. E.

1963. Identification and analysis of lesser and greater prairie chicken habitat. Journal of Wildlife Management, vol. 27, no. 4, p. 757–778.

Williamson, H. G., G. B. Wint, and F. F. Copelin.

1963. Preliminary report on the first four years of the Oklahoma waterfowl and upland game harvest survey, 1958–1961. Proceedings of the Oklahoma Academy of Science, vol. 43, p. 242–247.

Fishery publications

Copeland, B. J., and T. C. Dorris.

1963. Photosynthetic productivity in oil refinery effluent holding ponds. Journal of Water Pollution Control Federation, p. 1104–1111.

Dorris, T. C., B. J. Copeland, and G. J. Lauer.

1963. Limnology of the middle Mississippi River. IV. Physical and chemical limnology of river and chute. Limnology and Oceanography, vol. 8, no. 1, p. 79–88.

Dorris, T. C., D. Patterson, and B. J. Copeland.

1963. Oil refinery effluent treatment in ponds. Journal of Water Pollution Control Federation, p. 932–939.

Houser, A.

1963. Loss in weight of sunfish following aquatic vegetation control using the herbicide silvex. Preceedings, Oklahoma Academy of Science, vol. 43, p. 232–237.

Jackson, S. W., Jr.

1963. Summary of returned tagged fishes from Recreation Lake, Mohawk Park, Tulsa, Oklahoma, April 29–September 5, 1960. Proceedings, Oklahoma Academy of Science, vol. 43, p. 238–242.

Minter, K. W.

1963. Succession in net plankton populations in a series of waste treatment ponds. Proceedings of the Oklahoma Academy of Science, vol. 43, p. 140–143.

Moore, G. A., and M. E. Sisk.

1963. The spectacle of *Elasoma zonatum* Jordan. Copeia, no. 2, p. 347–350.

Riggs, C. D., and G. A. Moore.

1963. A new record of *Moxostoma macrolapidotum pisolabrum*, and a range extension for *Percina shumardi* in the Red River, Oklahoma and Texas. Copeia, no. 2, p. 451–452.

Shelton, W. L.

1963. Ovarian morphology of the threadfin shad, *Dorosoma petenense* (Le Seur). Proceedings of the Oklahoma Academy of Science, vol. 43, p. 145–148.

PENNSYLVANIA

Wildlife publications

Carroll, W. M., and R. G. Wingard.

1963. Public and private recreational land use issues. Farm Economics, Extension Service, Pennsylvania State University, June, p. 1–4.

Lindzey, J. S.

1963. Protecting fruit crops from bird depredations. Pennsylvania Fruit News, May, p. 1–4.

Sharp, W. M.

1963. The effects of habitat manipulation and forest succession on ruffled grouse. Journal Wildlife Management, vol. 27, no. 4, p. 664–671.

Wingard, R. G.

1963. Wildlife development depends on access to land. United States Department of Agriculture, Washington, Extension Service Review, vol. 34, no. 6, p. 103–105.

WINGARD, R. G., and W. M. CARROLL.
1963. Signs of the future. Pennsylvania State University, Science for the Farmer, vol. 10, no. 4, p. 9.

WINGARD, R. G., W. M. CARROLL, E. P. FARRAND, S. E. FORBES, and H. A. ROBERTS.
1963. Deer management in Pennsylvania. United States Department of Agriculture, Extension Service, University Park, Pennsylvania, p. 1–20.

WINGARD, R. G., W. M. CARROLL, and C. J. WINFIELD.
1963. Rural land use planning. United States Department of Agriculture, Extension Service, Special Circular, University Park, Pennsylvania, p. 1–24.

SOUTH DAKOTA

Wildlife publications

BUTLER, P. A., and P. F. SPRINGER.
1963. Pesticides—a new factor in coastal environments. Transactions of the 28th North American Wildlife and Natural Resources Conference, p. 378–390.

DEWITT, J. B., W. H. STICKEL, and P. F. SPRINGER.
1963. Wildlife studies, Patuxent Wildlife Research Center, 1961–62. Pesticide—wildlife studies: a review of Fish and Wildlife Service investigations during 1961 and 1962. Fish and Wildlife Service, Circular 167, p. 74–96.

NELSON, K. S.
1963. Hosting our hunters. South Dakota State College of Agriculture and Mechanic Arts, Cooperative Extension Service, F. S. 170, p. 1–2.

SPRINGER, P. F.
1963. Fish and wildlife aspects of chemical mosquito control. Proceedings of the 50th Annual Meeting of the New Jersey Mosquito Extermination Association, and 19th Annual Meeting of American Mosquito Control Association, p. 194–206.

UTAH

Wildlife publications

BERRYMAN, J. H.
1963. Crops to share. Utah Fish and Game, vol. 19, no. 3, p. 20–21.
1963. Logan canyon road controversy: anatomy of a principle. National Parks Magazine, no. 137, p. 90

CHURA, N. J.
1963. Diurnal feeding periodicity of juvenile mallards. Wilson Bulletin, vol. 75, no. 1, 2, p. 90.

LOW, J. B., FLORA BARDWELL, and ETHELWYN WILCOX.
1963. Food for thought. Utah Fish and Game Magazine, vol. 19, no. 10, p. 14–15.

LOW, J. B., GRACE J. SMITH, and ETHELWYN WILCOX.
1963. A way to better venison. Farm and Home Science, vol. 22, no. 3, p. 62–63, 84.

NYGREN, L. R.
1963. Unusual feeding behavior of fur seal pup. Journal of Mammalogy, vol. 44, no. 1, p. 123.
1963. A contribution toward the bibliography of the *Alectoris* partridge. Utah Cooperative Wildlife Research Unit, Special Report no. 9, Utah State University, p. 1–20 (mimeographed).

SIGLER, W. F., and R. R. MILLER.
1963. Fishes of Utah. Utah State Department of Fish and Game, p. 1–203.

STOKES, A. W.
1963. Agonistic and sexual behavior of the chukar partridge (*Alectoris graeca*). Animal Behaviour, vol. 11, no. 1, p. 121–134.

STOKES, A. W., and D. BALPH.
1963. On the ecology of a population of Uinta Ground Squirrels. American Midland Naturalist, vol. 69, no. 1, p.10–126.

WAGNER, F. H.
1963. The jackrabbit in its western habitat. Farm and Home Science, vol. 24, no. 3, p. 64–65, 78–80.

WAGNER, F. H., and D. C. BESODNY.
1963. An evaluation of pheasant stocking through the day-old chick program in Wisconsin. Wisconsin Conservation Department, Technical Bulletin no. 23, p. 1–84.

VIRGINIA

Wildlife publications

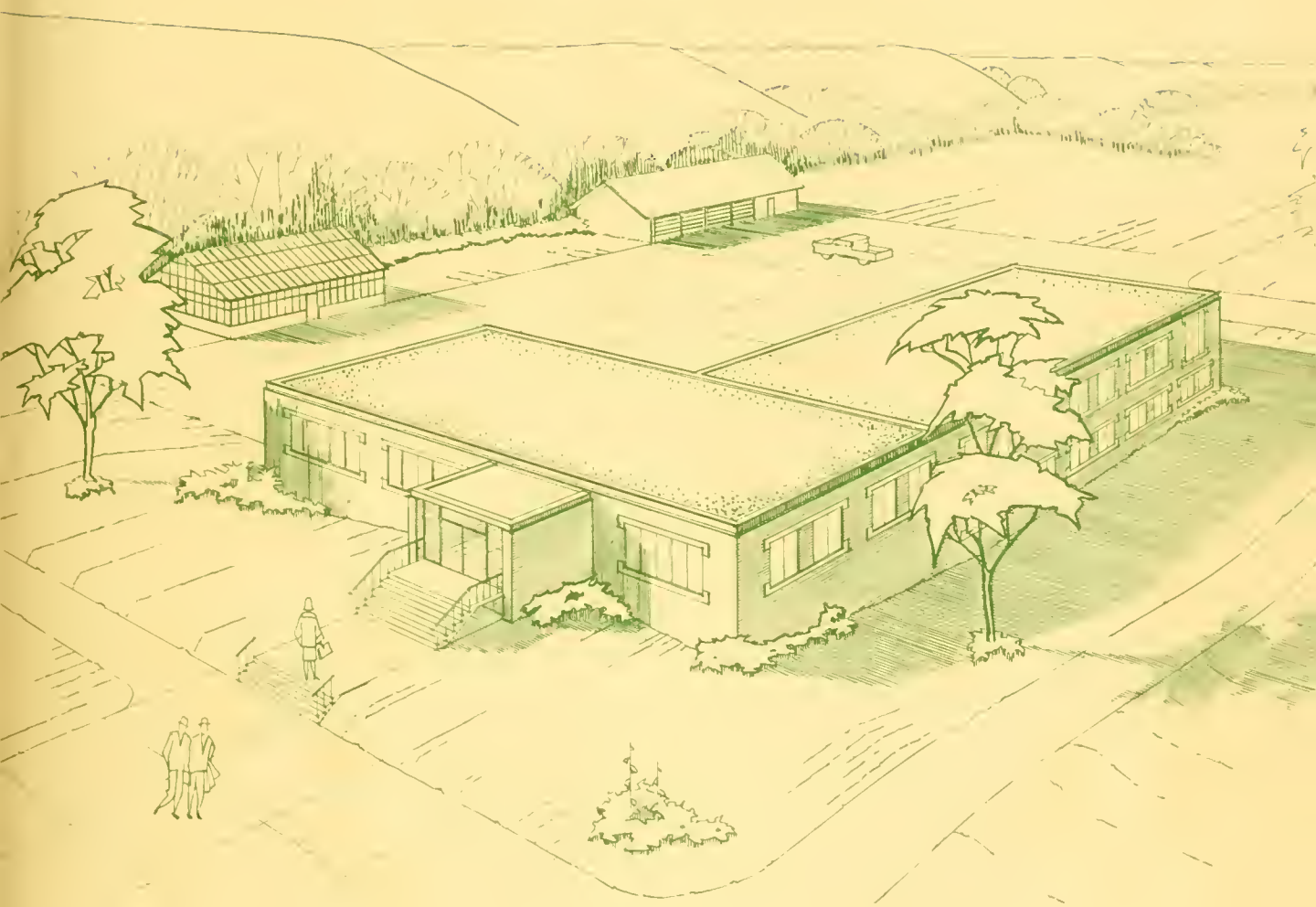
BACHANT, J. P.
1963. A self-operating camera unit for recording wild turkey abundance and distribution. Virginia Academy of Science (Roanoke), p. 1–4 (mimeographed).

MCGINNES, B. S., and T. H. RIPLEY.
1963. Evaluation of wildlife response to forest-wildlife management—a preliminary report. Proceedings of the Society of American Foresters, Washington, D.C., p. 167–171.

PATTON, D. R.
1963. Forest cutting and its influence on browse production. Virginia Academy of Science Meeting (Roanoke), p. 1—4 (mimeographed).

THOMPSON, R. L., and B. S. MCGINNES.
1963. A comparison of eight types of mast traps. Journal of Forestry, vol. 61, no. 9, p. 679–680.

U.S. GOVERNMENT PRINTING OFFICE: 1964 O—734–563



Architect's sketch of Headquarters Building, Northern Prairie Wildlife Research Center, under construction in 1964.

RESEARCH

THE

KEY

TO

PROGRESS

RESEARCH

HELPS TO PRODUCE

AND

MAINTAIN

OUTDOOR

RECREATIONAL

OPPORTUNITIES