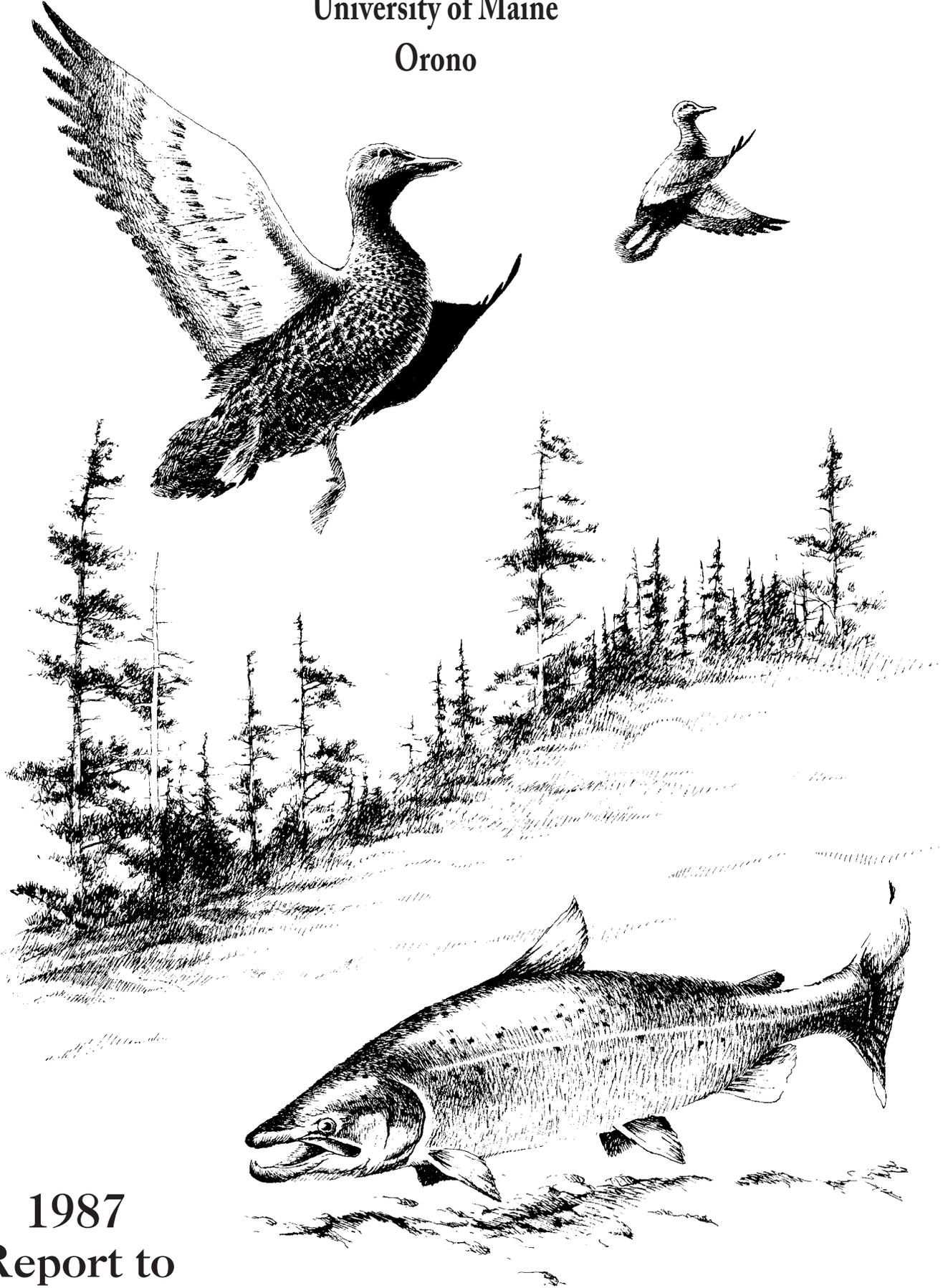


# MAINE COOPERATIVE FISH AND WILDLIFE RESEARCH UNIT

University of Maine

Orono



1987  
Report to  
Cooperators

—Mark McCollough '86

MAINE COOPERATIVE FISH AND WILDLIFE RESEARCH UNIT



240 Nutting Hall\*  
University of Maine  
Orono, Maine 04469



COOPERATORS

UNIVERSITY OF MAINE

DEPARTMENT OF INLAND FISHERIES AND WILDLIFE

FISH AND WILDLIFE SERVICE, U.S. DEPARTMENT OF THE INTERIOR

WILDLIFE MANAGEMENT INSTITUTE

October 1986 - September 1987



This report details the research objectives, procedures, and findings of numerous investigators. Since data contained may be preliminary and inconclusive, permission to reproduce or publish any of the contents of this report in any way is withheld pending specific authorization from the Unit Leader.

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\*The Unit's Fisheries Program is located in Murray Hall and is part of the Department of Zoology, College of Arts and Sciences; the Unit's Wildlife Program is located in Nutting Hall and is part of the Department of Wildlife, College of Forest Resources.



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PERSONNEL AND COOPERATORS

**COORDINATING COMMITTEE**

Maine Department of Inland Fisheries and Wildlife  
William J. Vail, Commissioner

University of Maine, Orono  
Ray B. Owen, Jr., Chairperson, Department of Wildlife  
College of Forest Resources

William G. Valteau, Chairperson (Oct.-June), Department of Zoology  
James D. McCleave, Chairperson (July 1), Department of Zoology  
College of Arts and Sciences

U.S. Fish and Wildlife Service  
W. Reid Goforth, Supervisor, Cooperative Fish and Wildlife  
Research Units Center

Wildlife Management Institute  
Laurence R. Jahn, Vice President

**UNIT PERSONNEL**

Unit Staff

William B. Krohn, Unit Leader  
Associate Professor of Wildlife and Zoology  
John R. Moring, Assistant Leader for Fisheries  
Associate Professor of Zoology  
Kathryn G. Hallett, Unit Secretary - Fisheries  
Maxine L. Horne, Unit Administrative Secretary - Wildlife  
Nancy Kealiher, Secretary - Wildlife  
Shirley Moulton, Secretary - Wildlife

Associated Faculty and Staff, Departments of Wildlife and Zoology  
Ray B. Owen, Jr., Chairperson, Department of Wildlife  
College of Forest Resources, and Professor of Wildlife  
William G. Valteau, Chairperson, Department of Zoology  
College of Arts and Sciences, and Professor of Zoology  
James D. McCleave, Chairperson (July 1), Department of Zoology  
College of Arts and Sciences, and Professor of Zoology  
James R. Gilbert, Associate Professor of Wildlife  
William E. Glanz, Associate Professor of Zoology  
and Cooperating Associate Professor of Wildlife  
Kevin J. Boyle, Assistant Professor, Department of Agriculture  
and Resource Economics, and Cooperating Assistant Professor  
of Wildlife  
Malcolm L. Hunter, Jr., Associate Professor of Wildlife  
Raymond O'Connor, Associate Professor of Wildlife  
Patrick W. Brown, Assistant Professor of Wildlife  
Donald E. Spalinger, Assistant Professor of Wildlife

Jerry R. Longcore, Wildlife Research Associate and Research  
 Wildlife Biologist, USFWS  
 James A. Sherburne, Coordinator, International Natural  
 Resources and Agricultural Programs  
 Hewlette S. Crawford, Jr., Research Wildlife Biologist, USFS  
 Terry A. Haines, Professor of Zoology and Fishery Research  
 Biologist, USFWS  
 Clemon Fay, Zoology Research Associate  
 Charles M. Jagoe, Zoology Research Associate  
 Mark A. McCollough, Wildlife Research Associate  
 Kathleen M. Wynne, Wildlife Research Associate  
 Ruth Williams, Zoology Technician  
 Jack Witham, Assistant Scientist  
 Daniel Licht, Wildlife Research Associate  
 Susan Anderson, Administrative Secretary, USFWS-NFCRC  
 Maine Department of Inland Fisheries and Wildlife  
 William J. Vail, Commissioner  
 Norman E. Trask, Deputy Commissioner  
 Frederick B. Hurley, Jr., Director, Bureau of Resource  
 Management  
 Gary Donovan, Director, Wildlife Division  
 Peter Bourque, Director, Fisheries and Hatcheries Division  
 George J. Matula, Jr., Supervisor, Wildlife Division Research  
 Section  
 Kendall Warner, Supervisor, Fisheries Management Section

#### GRADUATE STUDENTS

Name	Degree Candidacy	Support
MaryEllen Chilelli	Ph.D	MDIFW; MCFWRU; NRA
Andrea Colnes	M.S.	McIntire-Stennis
Lisa A. DeBruyckere	M.S.	USFWS - Refuge Division
Holly Devaul	M.S.	U of M, MCFWRU, MDIFW
Duane R. Diefenbach	M.S.	Hatch Act
Leslie J. Dubuc	M.S.	NPS
Catherine Frazer	M.S.	USFWS
Scott W. Herke	M.S.	MDIFW, MCFWRU, U of M
Susan Hills	Ph.D.	USFWS-AFWRC
Charles M. Jagoe	Ph.D.	USFWS
Susan A. Livingston	M.S.	MDIFW
Leslie H. Mink	M.S.	MDIFW, MCFWRU
Glenn P. Morlock	M.S.	TA
Enama Mugangu	Ph.D.	AFGRAD
Stanislas J. Pauwels	Ph.D.	USFWS
Cynthia M. Perry	Ph.D.	USFWS, U of M, PCCA, MCFWRU
Summer M. Roberts	Ph.D.	McIntire-Stennis
Richard E. Sayers, Jr.	Ph.D.	MDIFW, U of M, MCFWRU, PCCA
Robert L. Schooley	M.S.	TA
Lisa A. Shively	M.S.	McIntire-Stennis

Sarah S. Stockwell	Ph.D.	Personal Funding
Beatrice E. Treiterer	M.S.	MDIFW, NWTF
W. Matthew VanderHaegen	Ph.D.	NEC, MCFWRU, U of M
Eleta J. Vaughan	M.S.	TA, Zoology
Sharri A. Venno	M.S.	Personal Funding
Peter D. Vickery	M.S.	NC; MAS; MPCB; MAAS; CB
Andrew A. Whitman	M.S.	TA
Pralad B. Yonzon	Ph.D.	U of M; WWF

#### Graduate Students: Dissertations/Theses Completed This Period

Stephen M. Arthur	Ph.D.
Timothy D. Bowman	M.S.
Diane R. Eggeman	M.S.
Catherine A. Elliott	Ph.D.
David J. Santillo	M.S.
Michael E. Thompson	M.S.

#### PERSONNEL NOTES

DR. RAYMOND O'CONNOR accepted the position of Associate Professor of Wildlife and arrived at the University in late August. Dr. O'Connor was Director of the British Trust for Ornithology for 9 years prior to accepting this appointment at the University of Maine. Raymond has been a Lecturer at University College of North Wales, Bangor, and Queen's University, Belfast. The courses that Dr. O'Connor will be teaching to undergraduates and graduates will be in the area of population dynamics, computer simulation and modeling.

DR. PATRICK BROWN accepted the Assistant Unit Leader (for Wildlife) position at the West Virginia Cooperative Fish and Wildlife Research Unit. He left the University in August. NANCY KEALIHAR transferred to Quaternary Studies and was replaced as secretary by SHIRLEY MOULTON. DANIEL LICHT (M.S., Texas A&M, 1987) was employed as a Research Associate for the Wildlife Department. MARK McCULLOUGH (Ph.D., Univ. of Maine, 1986) was hired as a Research Associate and principal investigator for the Caribou Transplant Project. As of September 1, STEPHEN ARTHUR was employed as a Research Associate for the Maine Cooperative Fish and Wildlife Research Unit.

DR. JAMES MC CLEAVE assumed duties as Chairman of the Department of Zoology in July, replacing DR. WILLIAM VALLEAU.

The following Wildlife graduates received their degrees at either the May or August commencements: TIMOTHY BOWMAN received his M.S. and is currently employed by the U.S. Fish and Wildlife Service at the Stillwater National Wildlife Refuge in Nevada. DIANE EGGEMAN finished her M.S. program and is employed as a waterfowl biologist by the Florida Fresh Water Fish and Game Commission. CATHERINE ELLIOTT completed her Ph.D. studies and has been hired by the University of Maine as a Fish

and Wildlife Extension Specialist. DAVID SANTILLO obtained his M.S. degree and is working in New York State for an environmental consulting firm. MICHAEL THOMPSON received his M.S. degree and is working for the Maine Department of Environmental Protection.

#### COLLABORATING AGENCIES AND ORGANIZATIONS

Atlantic Flyway Cooperative Banding Program,  
Atlantic Waterfowl Council  
Canadian Wildlife Service - CWS  
Coastal Blueberry, Inc. - CB  
Dupont  
Great Northern Paper Company - GNPC  
Holt Woodlands Research Foundation - HWRF  
International Paper Company - IPC  
Kennebec Log Driving Company - KLDC  
King Mahendra Trust for Nature Conservation  
L.L. Bean, Inc. - LLB  
Maine Atlantic Sea-Run Commission  
Maine Audubon Society - MAS  
Maine Cooperative Forestry Research Unit - MCFRU  
Maine Department of Conservation - MDC  
Maine Department of Environmental Protection - MDEP  
Maine Department of Inland Fisheries and Wildlife - MDIFW  
Endangered and Non-game Wildlife Grants Program  
Maine Land Use Regulation Commission  
Maine Pesticides Control Board - MPCB  
Maine Trappers Association  
State Association - MTA  
Northern Coastal Chapter - MTA-NCC  
Massachusetts Audubon Society - MAAS  
National Geographic Society - NGS  
National Rifle Association - NRA  
National Wild Turkey Federation - NWTF  
Maine Chapter - NWTF-MC  
National Wildlife Federation - NWFED  
Nature Conservancy - NC  
Maine Chapter - NC-MC  
NE Regional Office  
Nepal Department of National Parks and Wildlife  
North American Wildlife Foundation -  
Delta Waterfowl & Wetland Research Station - DWRS  
Tribhuvan University  
University of Maine - U of M  
Association of Graduate Students - AGS  
College of Arts and Sciences - CAS  
Zoology Department - ZD  
College of Forest Resources - CFR  
Hatch Act Funds - HAF  
McIntire-Stennis - MS  
College of Life Sciences and Agriculture

Department of Agricultural Resource Economics  
Graduate School  
Maine Cooperative Forestry Research Unit  
U.S. Fish and Wildlife Service - FWS  
Alaska Fish and Wildlife Research Center - AFWRC  
Alaska Regional Office - ARO  
Moosehorn National Wildlife Refuge - MNWR  
National Ecology Center - NEC  
National Fisheries Contaminant Research Center - NFCRC  
National Fishery Research and Development Lab - NFRDL  
National Wetlands Research Center - NWRC  
Office of Information Transfer - OIT  
Patuxent Wildlife Research Center - PWRC  
Region 5, Newton Corner, MA  
Selawik National Wildlife Refuge - SNWR  
U.S. Forest Service - USFS  
Pacific Northwest Forest and Range Experiment Station - PNFRES  
White Mountain National Forest - WMNF  
Green Mountain National Forest - GMNF  
U.S. National Marine Fisheries Service - NMFS  
Northeast Fisheries Center  
U.S. National Park Service - NPS  
Acadia National Park  
Boston Regional Office  
Wheelabrator-Frye, Inc. (now part of Signal Fuels) - SF  
World Wildlife Fund - WWF

CONSTRUCTION AND VALIDATION OF NESTING HABITAT MODELS  
FOR BALD EAGLES IN MAINE

Investigator: S. A. Livingston

Advisors: R. B. Owen, Jr., Co-chairperson  
W. B. Krohn, Co-chairperson  
W. E. Glanz

Cooperators/ Maine Department of Inland Fisheries and Wildlife  
Project U.S. Fish and Wildlife Service -  
Support Region 5, Newton Corner, MA.  
Maine Cooperative Fish and Wildlife Research Unit

Objectives

- (1) Construct a model that will determine if an area is potential bald eagle nesting habitat.
- (2) Test the predictability and stability of the models through cross validation.
- (3) Apply models on historically used nests to assess their potential for re-establishment.

Scope:

The number of breeding bald eagles in Maine has been steadily increasing during the past decade. A goal of 150 breeding pairs of bald eagles by the year 2000 has been set by the Northern States Bald Eagle Recovery Team. To accommodate this projected influx of breeding eagles and meet the population goal, potential nest sites must be identified and protected. Resource managers, however, often lack the information necessary to specify areas in need of protection. Habitat models can document the features that eagles use to select nest sites, and assist in identifying these areas.

Project Status:

Data on habitat features were collected from 82 active bald eagle nests and 88 random sites. Four models were developed using discriminant analysis. Each model is to be used in a different habitat: lake, river, marine mainland, and marine island. Model outputs were tested using cross validation.

The marine island model correctly classified 75% of the sites, whereas the remaining models classified at least 90% of the sites correctly. In all habitat types, the percentage of correct classification by the full model and by cross validation was similar, indicating model validity. Lower misclassification by the marine island model may be because bald eagles in this habitat type feed primarily on seabirds and therefore use a different strategy to exploit a habitat that is much more open than lake, river, and marine mainland habitats. Thus, appropriate variables may not have been measured in island habitats.

Overall, nesting habitat is characterized as being close to water bodies of sufficient size with a diverse food base, and removed from human disturbance. This is in agreement with the literature. But the importance of different habitat components varies across habitat types. Potential lakes are characterized by low disturbance and minimal area of land harvested for timber. Although eagles are selecting lakes with a diversity of warm water fish species ( $P < 0.01$ ), the variable representing this was not indicated in the final model. Timber harvesting and human disturbance, variables that were in the final lake model, may preclude eagles from nesting on productive lakes that support their food base. Marine mainland sites are near undisturbed shorelines with shallow waters and a diversity of diadromous fish species. Larger, relatively undisturbed rivers also characterize nesting habitat in Maine. Bald eagles in marine island habitat select nest sites low in human disturbance, but not necessarily near shallow, productive water.

Models have been applied to 15 historic nests in southern Maine, and 13 still have potential as nesting habitat. Protection efforts should focus on these nests to aid in reaching the established population goal.

#### Future Plans:

The thesis is being written and defense is expected in November 1987.



Maine currently has approximately 90 pairs of nesting bald eagles (inactive nest in upper right corner). Recovery plans for this endangered species call for building Maine's population to 150 active nests, and accomplishing this goal requires the identification and protection of potentially suitable habitats (Photo by W. B. Krohn).

## NEPAL-HIMALAYAS RED PANDA PROJECT

Investigator: P. B. Yonzon

Advisors: M. L. Hunter, Jr., Chairperson  
W. E. Glanz  
R. B. Owen, Jr.

Cooperators/ World Wildlife Fund  
Project Nepal Department of National Parks and Wildlife  
Support King Mahendra Trust for Nature Conservation  
Tribhuvan University

Objectives:

- (1) Develop techniques for assessing the distribution and status of red pandas.
- (2) Provide basic information on red panda ecology regarding habitat selection, diet, and social systems.

Scope:

Red pandas (*Ailurus fulgens*), the sole species in an endemic monotypic family of the Himalayas and adjacent ranges, have become rare because of ever-increasing deforestation. Although there have been more than a dozen studies on captive populations of red pandas, little is known about their distribution and status in the wild. Red pandas are a protected species in Nepal and CITES has included them in Appendix II, whereby they are subjected to strict trade regulations to avoid exploitation. Because red pandas are stenotypic, they could serve as an indicator of ecological conditions in those habitats to which they are adapted. In conserving habitats for red panda, it is probable that the life requisites of many species in the community will also be satisfied. Thus, it is likely to be a sensitive index of ecosystem integrity.

A two-year ecological study of red pandas will be carried out in the Langtang National Park, Nepal. The study will emphasize developing methods for studying red pandas, e.g., radio-telemetry, scent-stations, track and scat counts, and a broad array of data on habitat selection, movements, diet, and social system will be gathered.

Not only will the study provide the baseline data on red panda ecology essential for developing a long-term conservation plan, but a technical training component is also incorporated into this project. A key component of this program is the involvement of Nepali biologists in conservation research. Graduate students from Tribhuvan University will be involved by undertaking related, short-term studies.

Project Status:

Six pandas (three of each sex) have been radio-collared and their activity and movement patterns regularly monitored. Home ranges varied

from 1.02-9.62 square kilometers with little intrasexual overlap. Pandas were active at all times of day, resting in trees when not moving. Two species of bamboo comprised 80% of the diet, with fruit comprising much of the remainder.

Future Plans:

Field work will terminate in October 1987 and data analysis initiated.

## EVALUATION TECHNIQUES FOR DISTINGUISHING STOCKS OF ATLANTIC SALMON

Investigator: C. M. Perry

Advisors: J. R. Moring, Chairperson  
W. A. Halteman  
T. A. Haines  
S. Tyler  
H. L. Kincaid

Cooperators/ U.S. Fish and Wildlife Service -  
Project National Fishery Research and Development Laboratory,  
Support: Wellsboro, PA.

Objective: Describe the impacts of varying levels of pH on the survival, growth, development and calcium levels of several strains and brood stocks of Atlantic salmon.

Scope:

The acidification of lakes, rivers and streams in eastern North America, with its impending loss of species diversity, has become a major concern to conservationists. Since the passage of the Anadromous Fish Conservation Act (PL 89-304) in 1965, major efforts are underway to rest ore and enhance the U. S. populations of Atlantic salmon within its endemic range. However, obstructions to upstream movement such as dams, highly developed commercial fishing leading to overharvesting, pollution, and acidification of home waters have affected these efforts.

The U.S. Fish and Wildlife Service's Research and Development Laboratory in Wellsboro, Pennsylvania is charged with determining the effect of acidification on Atlantic salmon. Work on the tolerance of some salmonids to acid waters have shown species differences. Investigations of low pH tolerance on various strains of salmonid species have been inconclusive. This project proposes to shed more light in this area of strain differences.

In this project, six sources of Atlantic salmon taken from various sites in the northeast were reared and tested. Four sources were of sea run origin and two were from landlocked populations. One-half of each source was raised one to two pH units lower than its counterparts for six months. One sea-run source and one landlocked source continued to be reared at a lower pH until smoltification. At various life stages from yolk sac through smolt, these fish were subjected to various low levels of pH.

Lower lethal limits of EC<sub>50</sub>'s were calculated along with photographic, histological, and physiological (whole body and blood serum chemistry) analysis at each life stage for each source.

This information should prove useful in (a) determining which life stage of each strain is most sensitive, thereby alerting biologists to the increased need for protection there; (b) choosing a strain whose overall survival may be improved by their tolerance of lower pH levels during various periods of their lives and using these strains to enhance present populations; and (c) by describing the ionic changes (Na<sup>+</sup>, K<sup>+</sup>, Ca) taking place in these fish during pH exposure (static test and long-term rearing), a more complete explanation of the low pH effect may come to light.

#### Project Status:

The laboratory work at the NFRDL has been completed, and three project papers, together forming the Final Report, are nearing completion. Whole body samples have been processed and are being analyzed at a laboratory at Pennsylvania State University.

#### Future Plans:

The Final Report will be issued by February 28, 1988. Additional testing on early life stages of salmon may take place in 1988, with the development of new techniques for the detection of impacts of acidic conditions on fishes. A dissertation is expected December 1988 or spring 1989.

## POPULATION STUDIES OF MAINE INTERTIDAL FISHES

Investigator: J. R. Moring

Cooperators/ National Geographic Society

Project The Nature Conservancy

Support: University of Maine

Objectives:

- (1) Identify environmental conditions associated with arrival and departure of fishes in the intertidal zone.
- (2) Identify and quantify algal and food associations of intertidal fishes.
- (3) Develop a species checklist of Maine tidepool fishes.

Scope:

Intertidal fishes are unique members of the intertidal ecosystem. Tidepools serve a nursery function, and young of economically important offshore fishes utilize tidepools as a refuge and nursery. Because of specific algal and habitat associations, these fishes can be susceptible to environmental contaminants in coastal waters, both of a direct and indirect nature.

Surveys since 1979 have located 21 species of tidepool fishes in Maine. The movements of the rock gunnel have been examined in marking studies, and algal associations and food habits of lumpfish and Atlantic seasnails have been quantified. Three study pools on Schoodic Peninsula have been studied since 1981, and work has also involved the first description of rock gunnels as the first intermediate host of the digenean fluke, Cryptocotyle lingua.

Project Status:

The project is ongoing and currently emphasizes the completion of several manuscripts. Two papers have been published, another manuscript has been completed, and three other manuscripts are being prepared.

Future Plans:

Additional collecting of Atlantic seasnails and shorthorn sculpins is planned for fall 1987 and the 1988 season.

AGE, GROWTH, AND MORTALITY SOURCES OF JUVENILE ATLANTIC SALMON  
IN STREAMS

Investigators: P. W. Bley  
J. R. Moring

Cooperators/ U.S. Fish and Wildlife Service -  
Project Office of Information Transfer, Ft. Collins, CO.  
Support:

Objective: Prepare a report summarizing the current published and unpublished information on age, growth, and sources of mortality of juvenile Atlantic salmon in streams for use by the U.S. Fish and Wildlife Service managers and other agencies.

Scope:

The U.S. Fish and Wildlife Service is currently refining several restoration models for Atlantic salmon. To maximize predictive confidence, accurate estimates of such factors as intragravel survival rates, mortality rates of returning adults, etc., must be included in the model. Much of the available data on age, growth, and sources of mortality of juvenile Atlantic salmon in streams is unpublished, or scattered throughout the literature. A report consolidating this information into one source is needed for managers developing salmon restoration models.

Project Status:

The project is completed and a Final Report, as part of the U.S. Fish and Wildlife Service's Biological Report Series, is scheduled for release in fall 1987.

COMPARISON OF TWO STREAM HABITAT ASSESSMENT TECHNIQUES IN THE  
WHITE AND GREEN MOUNTAIN NATIONAL FORESTS

Investigator: J. R. Moring

Cooperators/ U.S. Forest Service -  
Project White Mountain National Forest, Laconia, NH  
Support: Green Mountain National Forest, Rutland, VT

Objective:

- (1) Determine what level of sampling stream segments provides usable estimates compared to current procedures of sampling entire streams.
- (2) Determine whether population estimates of stream salmonids made in selected reaches provide comparable results to those made for entire stream lengths.

Scope:

Habitat surveys are an integral part of the fisheries management program on the U.S. National Forests (NF). These surveys are used to quantify existing habitat conditions, identify limiting factors, prescribe enhancement measures (where feasible), and integrate fish habitat management concerns with other proposed land uses (timber, recreation, etc.). This information may be used to develop prescriptions at both the NF level and project planning levels. The focus of the fisheries programs in the White and Green Mountain NFs is Atlantic salmon restoration. At present, knowledge of existing habitat capability of most forest streams for this species is fairly general in nature and, in many instances, is unknown. There is a need to determine this capability, along with the identification of opportunities to enhance limiting habitat conditions, where feasible. Therefore, there is a need for intensive habitat surveys on most of the streams on both National Forests. The technical subcommittees for both the Merrimack and Connecticut River Atlantic salmon restoration programs have recommended a methodology to be utilized by the Forest Service for these surveys. This methodology is based on one developed in Maine and cost estimates range from \$466 to \$621 per kilometre (\$750-\$1,000 per mile). Alternative ways to improve habitat survey efficiency need to be explored, especially in light of limited funding for the entire program. One approach which needs to be investigated is the use of representative reaches, whereby the habitat data collected within sample sections of these reaches is assumed to be representative of the entire reach. If this approach were feasible, a larger amount of stream miles could be surveyed for the same amount of money.

Project Status:

The project began in September 1987 and data collection has not been initiated.

Future Plans:

A graduate student will be recruited for admission in January 1988. Field work will take place from spring to fall 1988 at 10 stream sites in the Green Mountain and White Mountain National Forests. Project completion date is expected to be September 1989.

## SURVIVAL OF ATLANTIC SALMON AND STEELHEAD RAINBOW TROUT

Investigators: J. R. Moring  
P. W. Bley

Cooperators/ U.S. Fish and Wildlife Service -  
Project Office of Information Transfer, Ft. Collins, CO.  
Support:

Objective: Prepare a report summarizing the current published and unpublished information on survival in fresh and salt water of Atlantic salmon and steelhead rainbow trout, for use by the U.S. Fish and Wildlife Service managers and other agencies.

Scope:

The U.S. Fish and Wildlife Service is currently refining several restoration models for Atlantic salmon. To maximize predictive confidence, accurate estimates of such factors as ocean and freshwater survival rates must be included in the model. As steelhead rainbow trout are close relatives of sea-run Atlantic salmon, comparative data on survival for this species would be advantageous to use as well. Much of the available data on survival of Atlantic salmon and steelhead trout is unpublished, with limited published papers. A report consolidating this information into one source is needed for managers developing salmon restoration models.

Project Status:

The project is completed and a draft Final Report, in the form of a U.S. Fish and Wildlife Service Biological Report, will be submitted in October 1987. The Biological Report is expected to be issued by the printers in FY 1988.

## ECOLOGY OF NORTHERN PIKE IN MAINE

Investigator: S. W. Herke

Advisors: J. R. Moring, Chairperson  
J. D. McCleave  
I. L. Kornfield

Cooperators/ Maine Department of Inland Fisheries and Wildlife  
Project University of Maine  
Support:

Objective: To provide data on movements, age and growth, and food habits of northern pike in the Belgrade Lakes region of Maine.

Scope:

Northern pike (*Esox lucius*) were illegally introduced to the Belgrade Lakes region of Maine in the late 1970s. Since that time, pike have spread to four lakes and the Kennebec River. There is virtually no information on the species in Maine, and fish managers need accurate information on food habits, movements, age and growth, spawning locations and conditions, and other aspects of the life history. The species is now being actively pursued by anglers, and fish up to 9 kg (20 lbs.) have been taken in increasingly popular ice and open water fisheries. It is important to know if habitat requirements of pike parallel those of chain pickerel (*E. niger*).

The project involves collecting pike and chain pickerel from Long, Great, and North ponds, and Messalonskee Lake using gill nets, trap nets, and angling. Radio tags will be placed on larger pike and pickerel, and all escocids will be tagged with Floy anchor tags. Scales will be collected from all pike and pickerel, and the habitat of capture location will be described in terms of depth, water temperature, and vegetation. A selected number of pike and pickerel will be examined for food habits. Additional samples of scales, stomachs, and length-weight data will be provided from specimens collected by anglers at derbies and from creel clerks.

Project Status:

Field work is continuing through fall 1987. Approximately 12 pike have been collected, and radio tags have been placed on two fish. Additional information on capture locations, length, and weight has been secured from anglers, and scale samples have been returned to the laboratory.

Future Plans:

Plans are to place additional radio tags on northern pike captured in the fall, track them periodically during the winter, and, hopefully, track them to spawning grounds in April. Anticipated completion of the thesis is summer 1988.



A graduate student checks tracings from a depth sounder to locate northern pike habitat. Pike have recently been introduced into Maine, and a study is underway to understand the ecology of this species (Photo by J. R. Moring).

IMPACTS OF STOCKING SEA-RUN ATLANTIC SALMON  
ON NATIVE POPULATIONS OF BROOK TROUT

Investigator: R. E. Sayers, Jr.

Advisors: J. R. Moring, Chairperson  
W. A. Halteman  
W. E. Glanz  
J. R. Gilbert  
J. D. McCleave

Cooperators/ Maine Department of Inland Fisheries and Wildlife  
Project Maine Cooperative Fish and Wildlife Research Unit  
Support: Maine Atlantic Sea-Run Salmon Commission

Objective: To document impacts of stocking sea-run Atlantic salmon on native populations of brook trout through measurements of habitat selection and population structure and numbers.

Scope:

Because salmon restoration is an active and successful program in Maine waters, documented evidence of competition and/or displacement is needed by management agencies. Building on work by former graduate student Pat Bley, this study examines different species interactions over a two-year period. The design looks at trout and/or salmon on four brooks near Kingsbury, Maine. Each brook has a natural or artificial barrier preventing fish from downstream from affecting trout populations in upstream areas.

One brook serves as a project control, with brook trout populations studied below and above the barrier. The second brook receives an introduction of salmon in the downstream section in the second year with the upstream serving as a control. The third brook receives an introduction of salmon in the lower river both years, with the upstream trout population as a control. The fourth brook has two natural barriers. The downstream section contains native populations of brook trout and landlocked salmon. The middle section receives an introduction of sea-run salmon in the first year, and the upstream section, with native brook trout, serves as a control.

Fish population estimates will be made at regular intervals in each year, using a three pass removal technique. Habitat selection will be determined, using backpack electrofishers to identify locations of trout and salmon. Bottom substrate, water velocity, and depth of location will be measured and related to age and species of fish.

Project Status:

The project is ongoing and will continue through another field season.

Future Plans:

Field work will continue in late fall 1987, and resume from spring to fall 1988. Anticipated date of the thesis is spring 1989.

SONGBIRD SPECIES DIVERSITY AND HABITAT USE IN RELATION TO  
THE STRUCTURE AND SIZE OF FOREST STANDS AND  
FOREST-CLEARCUT EDGES IN NORTH-CENTRAL MAINE

Investigator: C. A. Elliott

Advisors: J. R. Gilbert, Chairperson  
P. W. Brown  
W. E. Glanz  
G. L. Jacobson  
T. Saviello

Cooperators/

Project International Paper Company

Support: Maine Department of Inland Fisheries and Wildlife

Objectives:

- (1) Determine songbird species diversity (BSD) in various forest stand types and ages.
- (2) Determine the effect of sample size on BSD for each stand type.
- (3) Determine BSD in edge habitat composed of various stand types and ages.
- (4) Determine the effect of length of edge on BSD for each edge type.
- (5) Determine the relationship between bird species composition of the edge zone and that of the adjoining habitats.
- (6) Use the results of this study to predict the effects of forest management practices on songbird habitat and BSD.

Project Status:

All requirements for the degree of Doctor of Philosophy (in Wildlife) were completed in May 1987. An abstract of the dissertation follows:

Songbird species composition, density, and diversity were determined in relation to the vegetation structure of forest, clearcut and forest-clearcut edge habitats using the spot-mapping technique. Study areas included 4 stands of 39.8-64.0 ha in clearcut, hardwood, mixedwood, and softwood habitats, and 4 edge habitats that were composed of clearcuts adjacent to hardwood, mixedwood, and softwood stands, and a partial cut adjacent to a softwood stand.

In 2 of 8 instances, density increased significantly with distance from the edge into the forest, and in 1 of 8 instances with distance from the edge into the cut. Diversity increased significantly with distance from the edge into the forest in 2 of 8 instances. For all other instances, there was no relationship between number of species, density, or diversity with distance from edge.

Most bird species had maximum density between 75 and 175m from the edge. Only one species, American robin, had maximum density within the edge zone, and one species, black-throated green warbler, had maximum density in the forest strip adjacent to the edge zone.

Species-length curves were constructed, using length of edge rather than area, from bird censuses done in plots 100m wide (50m into the cut and 50m into the forest) along 1000m of edge. Comparison of these species-length curves to curves for 100x1000m strips within stand-plots showed that stand-strips had significantly more territorial species than edges. The edges were of less value as songbird breeding habitats than were the stands.

There is no evidence that the abrupt, high-contrast edges examined have a positive effect on the number of songbird species, their density, or diversity. There is little evidence that songbirds, except possibly American robins, require this type of edge habitat.

There was a positive relationship between bird species diversity (BSD) and foliage height diversity (FHD) when both cut and forest habitats were examined and when forest habitats only were examined. There was no relationship between BSD and FHD in cut habitats only. Increases in BSD were primarily because of increases in number of species (richness), and increases in FHD were because of increases in both number of layers of foliage present (richness) and the distribution of foliage among the layers (evenness). Examination of the relationship between FHD and various measures of the vegetation indicated that maximum height of the canopy is a sufficient predictor of FHD. Similarly, minimum and average height of the canopy, number of snags per ha, number of small stems per ha, and area are sufficient predictors of BSD.

RESPONSE OF SMALL MAMMALS AND SONGBIRDS TO HERBICIDE-  
INDUCED HABITAT CHANGES ON CLEARCUTS IN MAINE

Investigator: D. J. Santillo

Advisors: P. W. Brown, Chairperson  
A. Filairo  
W. E. Glanz  
M. L. McCormack, Jr.  
R. B. Owen, Jr.

Cooperators/ Great Northern Paper  
Project Maine Department of Inland Fisheries and Wildlife  
Support: Maine Cooperative Forestry Research Unit  
Maine Cooperative Fish and Wildlife Research Unit

Objectives:

- (1) Determine the effects of herbicide-induced vegetational changes on species composition, densities, and distribution of breeding birds.
- (2) Determine effects of herbicide-induced vegetational changes on the relative abundance and species composition of the small mammal community.
- (3) Examine abundance of birds and small mammals in relation to vegetation structure and composition.
- (4) Observe patterns in the response of small mammals and breeding birds to herbicide treatment over a range of 1 to 3 years following treatment.

Project Status:

All requirements for the degree of Master of Science (in Wildlife Management) were completed in May 1987. An abstract of the thesis follows:

The effects of herbicide-induced habitat changes on small mammals and songbirds were investigated in north-central Maine during 1985-86. Changes in small mammal and songbird populations were compared to differences in vegetation on untreated and herbicide-treated clearcuts 1 to 3 years after application of herbicides for conifer release. Six study sites were selected: 2 each of untreated controls, before to 1 year post-treatment, and 2 to 3 years post-treatment.

Small mammals were trapped on each study clearcut by snap and pit-trapping on 8x8 station grids spaced at 15m intervals. Fewer small mammals were captured on herbicide-treated clearcuts than on untreated clearcuts for all 3 years post-treatment. Insectivores (Soricidae) accounted for 72% of all small mammals captured, and were less abundant ( $P < 0.001$ ) on 1 to 3 year post-treatment sites. Herbivore-granivores

(Microtinae) were less abundant on 1 ( $P < 0.01$ ) and 2 year ( $P < 0.001$ ) post-treatment sites. Omnivores (Cricetinae, Zapodidae) were equally abundant on treated and untreated clearcuts. Differences in small mammal populations were explained by a reduction of invertebrate and plant food on herbicide-treated sites, and the herbicide-induced reduction in cover.

Songbirds were censused by spot-mapping on 10 ha plots within each study clearcut. Total bird densities were lower on herbicide-treated clearcuts ( $P < 0.05$ ). The common yellowthroat (Geothlypis trichas), Lincoln's sparrow (Melospiza lincolni), and alder flycatcher (Empidonax alnorum) were less abundant ( $P < 0.05$ ) on herbicide-treated clearcuts. Bird response at 1 year post-treatment was related to the presence of contiguous untreated habitat with the same clearcut. Bird densities increased on the untreated portion of a clearcut proportionally to a decrease observed on the 1 year post-treatment portion. Bird densities were only slightly reduced on a 1 year post-treatment site without abundant untreated vegetation within the same clearcut. The influence of site tenacity and time lag in response of birds to the habitat alteration was discussed. Pockets of vegetation missed during application of herbicides (skips) were found to be important as a source of cover and food. Songbird densities were correlated to complexity of vegetation, regardless of treatment.

## ECOLOGICAL EFFECTS OF LOG DRIVING IN RELATION TO NAVIGABLE RIVERS

Investigators: J. R. Moring  
K. E. Gibbs

Cooperators/Project

Support: Kennebec Log Driving Company

Objectives:

- (1) Assess fish and invertebrate population and water quality in areas of the Kennebec River with and without submerged pulpwood logs.
- (2) Make predictions as to the potential ecological impacts of log salvaging.
- (3) Measure movements and ecological associations of freshwater mussels.

Scope:

Until log driving was stopped in 1976 by environmental lawsuits, several million cords of pulpwood logs sank in the Kennebec River system. It is not known whether the loss of logs in log driving is beneficial or harmful to the environment. Short-term detrimental changes in water quality are known to occur, but long-term effects are unknown. Since 1979, studies have been conducted in Wyman Lake and Indian Pond to assess this environmental alteration. Field work on the impacts of the log drives on macroinvertebrates has been completed, and impacts of log salvaging on macroinvertebrates have been measured.

Project Status:

This project is completed. A final report in the form of a journal article has been issued. An abstract is as follows:

Three species of fishes, longnose suckers (Catostomus catostomus), white suckers (C. commersoni), and golden shiners (Notemigonus crysoleucas), showed an attraction to submerged logs. Yellow perch (Perca flavescens), the most numerous fish species collected, did not exhibit a clear association with submerged logs. Food habits of yellow perch shifted from a largely planktonic diet in areas lacking submerged logs to a diet dominated by benthic macroinvertebrates in areas containing logs. The amount of bark in the sediment was highest at the sites containing the most submerged logs, particularly in the former log holding area, but this had no clear effect on invertebrate biomass. Total biomass of macroinvertebrates was significantly greater in the sediment than on logs in all sites. Because logs are being covered with sediment at a relatively rapid rate, the ecological importance of this submerged habitat is continually changing, particularly in shallow areas.

AN INITIAL EXAMINATION OF THE ECONOMIC VALUE AND USE OF  
MAINE'S INLAND FISH AND WILDLIFE RESOURCES

Investigator: Kevin J. Boyle

Cooperators/ University of Maine -  
Project Department of Agricultural Resource Economics  
Support: Maine Department of Inland Fisheries and Wildlife  
Maine Department of Conservation  
Maine Cooperative Fish and Wildlife Research Unit

- Objective:
- (1) Estimate, based on existing data, the monetary values that the public (residents and nonresident visitors) hold for specific species and groups of species of inland fish and wildlife. Estimates of consumptive and nonconsumptive use values and total values will also be developed where possible.
  - (2) Estimate current levels of consumptive and nonconsumptive use of inland fisheries and wildlife, and make preliminary projections of future use.
  - (3) Identify the gaps and shortcomings in currently available data so that needs for future research can be specifically identified.

Scope:

In 1985, the 112th Maine Legislature established the Maine Forests for the Future Program (Chapter 488, Public Laws of 1985). The objectives of the initial phase of this program are to assess the existing forest resources within the State, and to examine the future supply potential and demand for these resources. These objectives have important implications for the Department of Inland Fisheries and Wildlife (MDIFW). Given the status of the existing forest conditions and projections of future forest conditions, the MDIFW will evaluate the implications for fish and wildlife habitats and the resulting effects on population sizes and composition. However, habitat conditions and other biological dimensions are not the only determinates of the future of Maine's fish and wildlife. There is also a human dimension that interacts through the public's use of wildlife, both consumptive (hunting, fishing, and trapping) and nonconsumptive (e.g., bird watching). The evaluation of this interaction requires an assessment of the values the public holds for Maine's fish and wildlife and their use of these resources. The research proposed here is designed to assist the MDIFW's assessment of the economic aspects of fisheries and wildlife resources for the Forest for the Future Program. This assessment, which was based on existing national (U.S. Fish and Wildlife Service) and state (MDIFW) data, will also provide the foundation for additional, more detailed economic studies in the future.

Project Status:

This project was completed and a final report was submitted to the funding agencies in September 1987. Key findings were as follows:

During 1980, there were 364,100 residents and nonresidents who fished Maine's inland lakes and streams, and the number of individuals purchasing fishing licenses increased significantly over the period 1973 to 1983, with an average increase of 1,447 anglers. Resident and nonresident anglers spent approximately \$93 million in Maine during 1980 for equipment and other durable gear, and on travel-related items. These direct expenditures generated a total impact of approximately \$32 million in personal income for Maine's economy and supported 4,980 jobs. The net value that resident and nonresident anglers placed on freshwater fishing in Maine during 1980 was estimated to be \$109 million. There were an estimated 214,300 residents and nonresidents who hunted in Maine during 1980, and the number of individuals purchasing hunting licenses increased significantly over the period 1973 to 1983, with an average increase of 2,760 hunters each year. Resident and nonresident hunters spent approximately \$42.3 million in Maine during 1980 for equipment and other durable gear, and on travel-related items. These direct expenditures generated a total impact of approximately \$14 million in personal income for Maine's economy and supported 2,260 jobs. It was not possible to estimate the net value of hunting in Maine with existing data sources. However, a value was estimated for resident and nonresident deer hunting, the principal big game species, of \$22.5 million. During 1980, 81% of Maine's population (approximately 818,800) 6 years of age and older participated in nonconsumptive activities related to fish and wildlife resources. Forty percent of the nonconsumptive participants were also anglers and/or hunters. Due to data limitations, expenditures and values were not estimated for nonconsumptive activities. National studies, and studies conducted in other states, indicate that such numbers may be substantial when estimated for Maine.

These findings suggest that the current funding of the MDIFW is inequitable, since over 70% of the MDIFW's current budget is derived from the sale of fishing and hunting licenses. A substantial proportion of Maine residents are not anglers or hunters, but do enjoy nonconsumptive uses of the State's fish and wildlife resources, and yet are not directly supporting management programs. In addition, expenditures by consumptive and nonconsumptive users generate economic activities that contribute income and support jobs for Maine's residents. Via expenditures, Maine residents who are neither consumptive nor nonconsumptive users may also benefit from fish and wildlife resources. In fact, viewed from this perspective, nonresident use can be viewed as an export industry for the State as a whole. Thus, the clientele which benefits from the State's fish and wildlife resources is more broad based than the restricted user groups currently supporting management programs.

## A LONG-TERM FOREST ECOSYSTEM STUDY

Investigators: M. L. Hunter, Jr.  
A. J. Kimball  
J. W. Witham

Cooperators/Project

Support: Holt Woodlands Research Foundation

Objectives:

- (1) Describe the structure of the plant and animal communities in an oak-pine forest ecosystem.
- (2) Investigate the effect of woodlot management on community structure.
- (3) Document phenological, interannual, and long-term changes in community structure.

Scope:

Thousands of people own woodlots, and they control a resource that is not currently being adequately managed despite a growing demand for forest products. To many landowners, perhaps most, economic return from timber extraction is secondary to considerations such as recreation, aesthetics, and wildlife. In the absence of management advice, these people often choose not to manage their land at all. Thus, there is a great need for information on how to manage small woodlots, particularly in ways that maintain or enhance wildlife and similar values.

This study is being conducted for 20 years on a 120 ha, red oak-white pine woodlot in Arrowsic, Maine, called the Holt Forest. We have selected a 40 ha tract and divided it into forty 1 ha blocks with 20 ha serving as a control area and 20 ha as an experimental area.

During the first five years, our primary objective is to describe the structure of the plant and animal community. We are undertaking (1) a 100% inventory of trees (>10cm DBH) and intensive inventories of tree regeneration, (all trees are being individually numbered and, on 12 ha locations, mapped); (2) a complete description of the vascular plant vegetation using the releve technique; (3) an inventory of all breeding bird territories; (4) transect surveys of nonbreeding birds; (5) small mammal trapping; (6) salamander quadrat counts; (7) observations of reproductive efforts (flowering and fruiting) for 13 herb and shrub species; (8) estimates of litter and fruit production; (9) general surveys of canopy insect abundance; and (10) meteorological observations. These data, largely population estimates, are integrated by area units (usually 0.25 ha blocks) and analyzed to portray the forest's community structure. After three years we will begin managing the experimental area with three objectives: (1) increase wood production; (2) increase wildlife diversity and abundance; and (3) maintain the forest's aesthetic value. By continuing to monitor populations and processes, we can attain the second objective. Over the course of 20 years we will

begin to understand how the community changes seasonally and from year to year; this is the essence of the third objective.

Project Status:

All the trees on the forests (ca. 34,000) were individually numbered in 1987, along with about 600 individuals of 13 shrubs and herbs. Additionally, tasks 3, 4, 5, 6, 8, 9, and 10, as outlined above, were completed. On ten 1 ha blocks timber harvest was initiated.

Future Plans:

In 1988, regular monitoring of animal populations will continue, and detailed, post-harvest measurements of vegetation will be made.

THE EFFECT OF BLUEBERRY MANAGEMENT ON THE  
NESTING ECOLOGY OF BLUEBERRY BARREN AVIFAUNA

Investigator: P. D. Vickery

Advisors: M. L. Hunter, Jr., Chairperson  
P. W. Brown  
W. E. Glanz  
G. Jacobson

Cooperators/ The Nature Conservancy -  
Project Maine Chapter  
Support: Northeast Regional Office  
Maine Audubon Society  
Maine Pesticides Control Board  
Massachusetts Audubon Society  
Coastal Blueberry, Inc.  
Dupont

Objectives:

- (1) Identify the species composition and relative abundance of birds found nesting on blueberry barrens in southern Maine.
- (2) Identify the vegetational requirements of birds nesting on blueberry barrens.
- (3) Determine the impact of blueberry management on the avian community of nesting on these barrens.

Scope:

Though blueberry barrens comprise a relatively small part of Maine's total acreage, these areas form a special ecosystem with a distinctive breeding avifauna. Bird life has co-existed with blueberry management for many decades. Recent introduction of the herbicide hexazinone (Velpar) on blueberry barrens may alter the vegetation sufficiently to have a detrimental effect on birds nesting in this ecosystem.

The Kennebunk Blueberry Barrens support a small but unique group of breeding birds. These include upland sandpiper, horned lark, bobolink, eastern meadowlark, vesper sparrow, Savannah sparrow, and grasshopper sparrow. The latter species is considered a rare nesting bird throughout New England and is experiencing significant, long-term declines throughout its range. The Kennebunk Blueberry Barrens supports the second largest grasshopper sparrow population, some 30 pairs, presently known in New England.

Project Status:

The fourth summer of research has been completed, and data is being analyzed.

Future Plans:

Complete data analysis and write manuscripts to fulfill M.S. thesis requirements.

EFFECTS OF ACID PRECIPITATION ON DISTRIBUTION OF FISHES  
IN LAKES OF THE NORTHEASTERN UNITED STATES

Investigators: C. M. Jagoe  
S. J. Pauwels  
C. W. Fay  
T. A. Haines  
R. Williams

Advisors: T. A. Haines, Chairperson (for Jagoe and Pauwels)  
J. R. Moring  
K. E. Gibbs  
M. L. Hunter, Jr.  
J. D. McCleave  
S. A. Norton  
B. D. Sidell  
G. L. LaCroix

Cooperators/  
Project  
Support: U.S. Fish and Wildlife Service -  
National Fisheries Contaminant Research Center,  
Columbia, MO.

Objective: Analyze levels of acidity in waters of northern  
New England and related water chemistry to  
distribution of fishes.

Scope:

Acid precipitation is of particular concern in New England and elsewhere, given the negative impacts of such acidity on fishes and other aquatic life. Specific sampling sites have been established to monitor water quality and fish populations.

A survey was conducted of 226 headwater lakes and low order streams in the six New England states. Acidic surface water (pH<5) occurred in every state, with 8% of the waters severely acidified, and 29% with pH levels <6. It was found that a substantial portion of the headwater lakes and low water streams in New England are vulnerable to acidification. As a result, a long term monitoring program (LIM) was established at a site in Maine in October 1982. Water quality is monitored on a regular basis, and fish populations are sampled once each year at the time of the fall overturn. Intensive studies of stream fishes, a sub-project, are designed to measure specific changes in fishes at different life stages--particularly eggs and alevins--in six study streams.

Project Status:

The project is ongoing, and field work will continue during the 1987-1988 season.

Future Plans:

Plans for 1988 include work dealing with levels of mercury and its potential effects on fishes as part of the Watershed Acidification Project. The project may be extended beyond the current September 1988 completion date.

## EFFECTS OF SEDIMENTATION ON STREAMS

Investigators: J. R. Moring  
G. C. Garman

Cooperators/  
Project

Support: Maine Land Use Regulation Commission

Objective: Prepare a discussion paper on the potential impacts of sedimentation on streams and aquatic resources, and to prepare a literature review and research agenda for future studies.

Scope:

Sedimentation in streams is a concern to aquatic biologists and land managers. Sediment from logging, road construction, and other forms of land disturbance can cause fish mortality and have adverse indirect impacts on fishes, invertebrates, and water quality. This project entails preparation of a report summarizing the impacts of sedimentation and outlining a potential research project necessary for supplying needed information to management agencies.

Project Status:

The work has been completed and a Final Report was issued in June 1987.

INFLUENCE OF ENVIRONMENTAL CONDITIONS ON DISTRIBUTION AND  
BEHAVIOR OF COMMON GOLDENEYES WINTERING IN MAINE

Investigator: D. R. Eggeman

Advisors: P. W. Brown, Chairperson  
W. E. Glanz  
W. A. Halteman  
J. R. Longcore

Cooperators/ Delta Waterfowl and Wetlands Research Station -  
Project Manitoba, Canada  
Support: University of Maine -  
Graduate School

Objectives: (1) Examine intraspecific differences in habitat use.  
(2) Compare relationships between habitat and behavior of common goldeneyes among groups based on sex, age, and paired status.

Project Status:

All requirements for the degree of Master of Science (in Wildlife Management) were completed in December 1986. An abstract of the thesis follows:

Relationships between environmental conditions and distribution of common goldeneyes (Bucephala clangula) wintering in Maine were studied in 1983-85. The influence of environment, sex, age and paired status on behavior of common goldeneyes was also investigated. I used censuses to determine distributions, focal-animal sampling to quantify behavior, and habitat and weather characteristics to describe environmental conditions.

Differences in distribution between males and females, and between paired and unpaired common goldeneyes (Bucephala clangula) wintering in Maine were related to specific habitat and climatic variables. Wind speed, wind direction, time-of-day, tide stage, date, and site explained differences in distribution between males and females in early winter. In late winter, sex-specific distribution was attributed to wind direction, type of substrate, and time-of-day. The relative importance of substrate type in explaining distribution of males and females may be related to the availability of benthic invertebrates as food resources. Contrary to predictions, adult males were not consistently associated with harsher environmental conditions than females and juvenile males. The first pairs of common goldeneyes were observed in late December. Differences in distribution between paired and unpaired females were attributed to water depth and site. Perhaps paired females dominated unpaired females and excluded them from preferred feeding sites in shallower water. Sex-specific distributions of common goldeneyes were explained by different environmental variables in early and late winter.

Effects of individual variables, specifically wind direction and time-of-day, on distribution of males and females also differed between early and late winter. Based on this evidence, and on the increase in the amount of courtship and pairing in the population during late winter, I suggest that increased social activity modified the birds' response to weather and habitat conditions as winter progressed.

In 855 observations, common goldeneyes spent 67% of the time feeding, 13% resting, 12% locomoting, 5% in comfort movements, 2% interacting (with conspecifics), and 1% alert. The amount of time spent in all activities was similar among categories of sex, age, and paired status in early winter ( $P \geq 0.01$ ). In late winter, time spent in locomotion, comfort movements and alert behavior was similar among bird categories. However, the amount of time spent feeding, resting, and interacting was different among sex, age, and paired categories in late winter. Behavioral differences among sex, age, and paired categories supported hypotheses contending that paired birds may gain energetic advantages; paired birds spent less time feeding and more time resting than other goldeneyes. Time spent feeding was only explained by complex sets of weather and habitat variables, and combinations of variables were different among sex, age and paired categories. Substrate type and weather-exposure variables were related to amount of time spent feeding by all goldeneyes.

ECOLOGY OF MALE BLACK DUCKS MOLTING IN LABRADOR

Investigator: T. D. Bowman

Advisors: P. W. Brown, Chairperson  
R. B. Owen, Jr.  
J. R. Longcore  
K. E. Gibbs

Cooperators/ Canadian Wildlife Service  
Project Atlantic Flyway Cooperative Banding Program  
Support: U.S. Fish and Wildlife Service  
University of Maine -  
Graduate School

Objectives:

- (1) Investigate the ecological requirements of molting male black ducks by determining: body condition changes during the wing molt, habitat use by molting black ducks, and chronology of the wing molt.
- (2) Obtain information, through banding, on the harvest, wintering, and breeding areas of male black ducks molting in Labrador.

Project Status:

All requirements for the degree of Master of Science (in Wildlife Management) were completed in May 1987. An abstract of the thesis follows:

Most waterfowl undergo an annual simultaneous wing molt and are flightless for 3-5 weeks. Information on the molt for black ducks (*Anas rubripes*) is lacking. This study provides baseline information on the ecology of male black ducks during the wing molt. During the summers of 1983-1986, I captured molting black ducks by hand in Okak Bay, Labrador. No black ducks were found nesting and 98% of all ducks captured were male. Flightless black ducks were found most often in willow (*Salix* sp.) (40% of all sites), but also were frequently located in shoreline cavities (14%) and emergent herbaceous vegetation (14%) near freshwater wetlands. Only 12% used saltwater habitats. Sites used by molting black ducks were often far from open water (e.g.,  $X=12m$  for willow sites). Male black ducks may use certain microhabitats and remain sedentary during the wing molt to avoid predators, benefit thermodynamically, and conserve energy needed for the growth of new flight feathers.

To calculate rates of feather growth, I measured primary feathers of all molting black ducks, and recaptured some ducks later during molt. Rates of growth were most consistent for the 5th, 6th, 7th, and 8th primaries, and were higher during early molt than in late molt. Male black ducks could fly when their primaries were 82% of the definitive

length. I estimated the flightless interval for black ducks as 27-30 days. Molt chronology was highly synchronous among years, and peak flightlessness (e.g., the highest proportion flightless) occurred about mid-July each year. About 50% of all black ducks became flightless within a one-week period in each year. Mean body weight declined 24% during wing molt, with an average daily weight loss of 12.2g. No birds were observed feeding during the molt. Body weight increased by 37% within 7 weeks of completion of wing molt. Black ducks at Okak Bay seemed to meet the energy demands of molt by: (1) increasing fat stores before the wing molt; (2) remaining sedentary during molt, thereby reducing energy demands; and (3) catabolizing fat and muscle tissue.

In 1986, I radio-marked 26 male black ducks to study survival and movements during wing molt. Twelve ducks remained in the areas where they were marked, but 10 ducks moved to different watersheds (4 slipped radios or their status was unknown). Marked ducks moved an average of 0.21 km/day for 2-4 day observation intervals. For ducks that were monitored to the end of the wing molt, the average distance between the initial capture site and the most distant location was 1.82 km (range=0.46-6.80 km). At least 2 radio-marked ducks were killed; both had left the watershed where they were captured. I estimated the molt-period (29 days) survival rate at 0.874 (95% confidence interval=0.68-0.987) using the Mayfield method. This survival rate should be considered a minimum because my disturbance (i.e., capture, handling, banding) may have caused some birds to move and become more susceptible to predation. Rates of feather growth and weight loss were not different for radio-marked ducks and for unmarked ducks, suggesting there was minimal to no effect of the transmitters on ducks.

Fidelity of black ducks to molting areas was documented. Twenty-nine banded male black ducks were captured molting on the study area in 2 different years, and 3 molting birds were captured in 3 consecutive years. Of those ducks recaptured, 52% molted on the same pond where they molted in a previous year. When assumed natural mortality and crippling loss are considered, an estimated minimum of 10% of the surviving ducks returned to the molting area 1 year after banding. Returning birds not observed would raise this figure even higher.

## HABITAT SUITABILITY INDEX MODEL FOR THE AMERICAN EIDER

Investigators: A. K. Blumton  
R. B. Owen, Jr.  
W. B. Krohn

Cooperators/

Project U.S. Fish and Wildlife Service -  
Support: National Wetlands Research Center, Slidell, LA.

Objectives: (1) Develop a nesting Habitat Suitability Index  
for the American eider.  
(2) Field test key variables in the model.

Scope:

The common eider, a sea-going duck, is found near offshore shoals and islands around the world's northern coasts; however, Maine supports the only major breeding population of the eider duck in the lower 48 states. Crucial to the eider's life cycle, the islands of Maine are being subjected to increasing recreational and coastal developments creating potential disturbances to eider breeding colonies. During recent years interest in the eider has increased both in terms of viewing and hunting.

A need exists to document the species-habitat relationships to estimate impacts of development on this wildlife resource. The Habitat Suitability Index (HSI) model being developed is a measure of the quality of the nesting habitat and its capacity to support the eider.

Project Status:

An initial model was developed and reviewed by biologists knowledgeable of eider ecology in Maine. Comments from these biologists were incorporated into the draft model submitted to the U.S. Fish and Wildlife Service in June 1987. A test of the model (i.e., a comparison of model output with Maine islands of various breeding eider densities) was also done. Results of the test indicated that the model was useful for ranking eider nesting islands, and for distinguishing heavy and lightly used islands, but not for estimating the number of breeding eiders using an individual island.

FEEDING ECOLOGY OF NORTHERN PINTAILS, AMERICAN WIGEON, AND  
LONG-BILLED DOWITCHERS AT THE SELAWIK NATIONAL WILDLIFE REFUGE, ALASKA:  
POTENTIAL EFFECTS OF MOSQUITO CONTROL

Investigator: L. A. DeBruyckere

Advisors: P. W. Brown, Chairperson  
W. E. Glanz  
K. E. Gibbs  
J. R. Longcore

Cooperators/ U.S. Fish and Wildlife Service -  
Project Selawik National Wildlife Refuge, AK  
Support: Regional Office, Anchorage AK

Objectives:

- (1) Determine the diets of northern pintails, American wigeon, and long-billed dowitchers during the breeding season.
- (2) Determine the spatial and temporal distribution of foods consumed by the above species.
- (3) Make management recommendations on the use of Bacillus thuringiensis israelensis in Alaska based on the food habits of three waterbird species breeding on the tundra.

Scope:

Blackflies and mosquitoes are considered pest species in many zoogeographical regions because of their role in disease transmission and the effects of mass biting on man and livestock. The potential exists to spray Bacillus thuringiensis israelensis (BTI) in tundra areas of Alaska to control dipteran populations. BTI reduces blackfly, mosquito, and chironomid populations, all three of which are potential food sources for adult and juvenile waterbirds breeding in these areas. The purpose of this study is to assess the potential effects of BTI use in tundra regions of Alaska based on the food habits of waterbirds breeding there.

Project Status:

Field work was finished in August 1987, and analysis of data and preparation of the final report is nearing completion. A brief summary of the project follows:

In northern pintails, the proportion of invertebrates in the diet did not change among 5 prelaying (27%), 11 laying (33%), and 16 postlaying (28%) females, although specific foods varied. Animal foods accounted for 69% of the diet of 12 Class I pintail ducklings, 54% of 12 Class II ducklings, and 69% of the diet of 3 Class III ducklings. The most abundant invertebrates for Class I ducklings were plecopterans,

dipterans, hemipterans, and tripchopterans. Plecopterans and pelycypods were the most abundant invertebrates in the diet of Class II ducklings.

American wigeon females consumed no animal foods during prelaying (N=7), 22% during laying (N=3), and 8% during postlaying (N=21). Animal foods accounted for 34% of the diet of Class I ducklings (N=17) and 8% of the diet for Class II ducklings (N=12). Corixids, trichopterans, and dipterans were the most important invertebrate foods for Class I ducklings, whereas dipterans, tripchopterans and gastropods were the most abundant animal foods for Class II ducklings.

Abundance of invertebrates in food samples for northern pintail and American wigeon differed from sweep samples made at collection sites, but was similar to bottom core samples. Northern pintail and American wigeon females and their young seemed opportunistic in food use. Foods consumed seemed to be influenced by phenological changes in available wetlands and their associated plant and invertebrate foods.

#### Future Plans:

The thesis and final report will be completed in November 1987.

## BIRDS OF MAINE'S PEATLANDS

Investigator: S. S. Stockwell

Advisors: M. L. Hunter, Jr., Chairperson  
R. B. Davis  
W. E. Glanz  
J. R. Longcore

Cooperators/ Maine Department of Inland Fisheries and Wildlife  
Project Signal Fuels, Inc.  
Support: Maine Chapter of The Nature Conservancy  
Maine Land Use Regulation Commission  
Maine Department of Environmental Protection

Objectives:

- (1) Identify those species of birds that inhabit Maine's peatlands.
- (2) Quantify the relative abundances of each species to peatland vegetation and hydrology.
- (3) Determine whether large, commercially valuable peatlands differ in their "value" to wildlife from smaller, non-commercially valuable peatlands.
- (4) Determine which of five environmental factors (foliage height diversity, area of peatland, peatland-foliage height diversity, type of peatland, and peatland vegetation diversity) are important in influencing bird species composition, bird species richness, and bird density in peatlands.

Scope:

Peatlands are one of the last remaining undisturbed ecosystems in the northeast. Thus, the State of Maine has an unusual opportunity to develop a comprehensive plan for conserving Maine's peatlands. However, before this project was initiated, no surveys of the wildlife in Maine's peatlands had been conducted. Before issuing mining permits or establishing peatland preserves, the State needs to know what bird species depend on peatlands for their continued survival, if any, and whether certain species are restricted to particular types or sizes of peatlands.

This study relates the abundances and distributions of birds in eight Maine peatlands to peatland vegetation, size, and geomorphology.

Project Status:

I censused birds in eight Maine peatlands of varying types and sizes during May and June of 1983 and 1984. Eight distinct vegetation types occurred in the peatlands. A variable-width transect method was used for censusing, and estimated bird densities from a modified Emlen

analysis and the Fourier Series Estimator in program TRANSECT. I included all species observed on or flying over the area when calculating species richness.

Foliage height diversity (FHD) and peatland vegetation diversity were calculated (PVD) with the Shannon Index. Peatland-FHD was defined as the average FHD of a peatland. Dendrograms of peatland were drawn and vegetation type similarity was based on both bird species composition and species occurrence plus abundance.

During the two-year study, 104 bird species were identified. Bird species richness ranged from 48 to 81 per peatland and from 46 to 76 per vegetation type. Overall bird density ranged from 4 to 11 birds per ha in each peatland, and from 3 to 19 birds per ha in each vegetation type. Densities of each species in each peatland and vegetation type were highly variable, and most species were abundant in only a few types of vegetation. Densities ranged from 1 to 160 birds per 40 ha, with the common yellowthroat being the most abundant species in 5 of 8 peatlands and 4 of 8 vegetation types.

Neither type nor size of a peatland affected bird species composition (BSC), bird species richness (BSR), or bird density (BD) in a predictable pattern. Foliage height diversity was the best predictor of BSC, BSR, and BD in eight types of peatland vegetation. As foliage height diversity increased, bird species composition changed, species richness increased, and density increased. Most peatlands, however, are a heterogeneous collection of vegetation. Bird species richness in eight peatlands was best related to the interacting variables of PVD, peatland-FHD, and area, and density was best related to the interacting variables of peatland-FHD and PVD. Thus, vegetation heterogeneity seems to be as, or more, important than vegetation structure in influencing BSR and BD in peatlands. The high number of species recorded in peatlands relative to other habitats lends support to the hypothesis that patchiness, rather than foliage height diversity, is most important in influencing bird diversity.

#### Future Plans:

Finish analysis and write thesis.

CHANGES IN THE POPULATION OF BREEDING BLACK DUCKS AND WETLAND HABITATS  
IN SOUTH-CENTRAL MAINE

Investigator: D. R. Diefenbach

Advisors: R. B. Owen, Jr., Chairperson  
P. O. Corr  
W. A. Halteman  
W. B. Krohn  
J. L. Longcore

Cooperators/ College of Forest Resources, Hatch Act Funds  
Project Maine Department of Inland Fisheries and Wildlife  
Support: Maine Cooperative Fish and Wildlife Research Unit

Objectives:

- (1) Determine the change in number, size, and composition of wetlands since 1980 on the study area in south-central Maine.
- (2) Determine the number of breeding pairs of black ducks and other waterfowl species on the study area.
- (3) Develop a mathematical model of the selection of beaver flowages by breeding pairs of black ducks based on physical/chemical/biological characteristics of the habitat.

Scope:

Results of the Mid-winter Inventory of waterfowl in the Atlantic Flyway indicate that the black duck population has declined approximately three percent per year since 1955. Restrictive regulations have been established to reduce the harvest by at least 25 percent in the United States. Maine has established even more restrictive harvest regulations because more than 65 percent of all black ducks banded in Maine as flightless young that are shot in their first hunting season are killed in Maine.

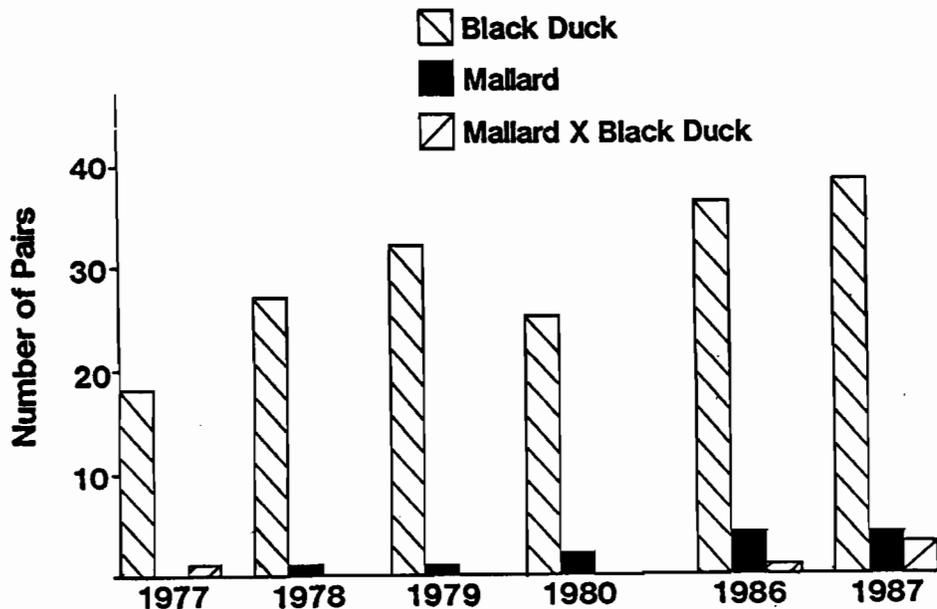
The 151 km<sup>2</sup> study area is located in southern Dixmont and northern Monroe townships of south-central Maine. This is in the northern hardwoods-spruce ecoregion and is characteristic of 18 percent of the black duck's breeding habitat in the United States. From the first settlement in 1800 until the early 1900's, the area was an important crop and timber producing region; however, as of 1975 only 12 percent of the study area was active agricultural land. The landscape has a broken, diverse appearance with much abandoned farmland reverted to early and mid-successional stages.

Wetland density on the study area is approximately 0.74 wetlands/km<sup>2</sup>. In comparison, the prairie pothole region has approximately 8 wetlands/km<sup>2</sup>. The water surface area per pond ranges from 0.10 to 60.46 ha ( $\bar{x}$ =1.42 ha, 1986 data) with the largest wetlands being ericaceous peatlands.

An intensive census of the black duck breeding and nesting population was conducted by the U.S. Fish and Wildlife Service in the late 1970's on the study area along with an accurate documentation of the wetland habitat. Surveys of waterfowl populations were conducted in the 1960's by the Maine Department of Inland Fisheries and Wildlife in the same area. These data can be used to assess the number of breeding black ducks as related to changes in habitat quantity and quality. This provides an opportunity to calibrate the number of black ducks to habitat changes, thus providing the possibility of evaluating the effects of exceptionally restrictive harvest regulations on the population of breeding black ducks.

Project Status:

Results of the 1986-87 censuses indicate that the number of breeding pairs of black ducks, mallards, and black ducks x mallards are greater than during 1977-80:



One simple measure of the amount of available habitat to waterfowl is surface water area (SWA). The SWA ranged from 168 to 207 ha during 1977-80 ( $\bar{x}$ =180 ha), while in 1986 SWA was 158 ha (data for 1987 have not been completely analyzed but indicate even less SWA). An indicator of the amount of quality habitat is the number of beaver flowages that are active. Nearly two-thirds of the wetlands on the study area are created or modified by beaver. In 1977-80 there were 28-36 active impoundments ( $\bar{x}$ =30.8), while in 1986 there were only 15, and in 1987, 18 active impoundments, a reduction of nearly 50%. Breeding pairs of black ducks are often attracted to new beaver flowages because they provide good cover, abundant invertebrate food resources, and stable water levels. These results support the general observation that the amount, and quality, of waterfowl habitat has declined in the study area.

There are 9 man-made impoundments on the study area, excluding small farm ponds, that were constructed with the intent of creating waterfowl habitat. They seem to be preferred by mallards; 58% of all mallard sightings during 1986-87 were on man-made impoundments compared to less than 10% of all black duck sightings. We believe that disturbance and possibly lack of vegetative cover in man-made ponds make them less suitable for black ducks.

One of the recommendations by the Atlantic Waterfowl Council for increasing the black duck breeding population was intense beaver management and construction of water-control structures. Wetland habitat management will certainly benefit all species of waterfowl; however, in south-central Maine at the present time wetland habitat may not be limiting black ducks. Man-made wetlands may not necessarily help the black duck because mallards tend to select man-made impoundments or wetlands with greater human-related activity. Therefore, man-made impoundments will not only tend to be avoided by black ducks, but they will help establish mallard populations.

Wetland management in the northeast can be most effectively done by intensive beaver management, and these wetlands are preferred habitat for the black duck. However, black ducks are still probably being affected more by harvest than by habitat availability on the breeding grounds. Also, it is clear that even in Maine, the most northeasterly state, the mallard is expanding its breeding range into an area that was formerly exclusive habitat of the black duck.

#### Future Plans:

Two seasons of fieldwork have been completed, and data are now being compiled and analyzed. The thesis is to be completed in December 1987.



Fifty-eight percent of all mallards sighted during 1986-87 were on man-made impoundments (upper), whereas 90% of all black duck sightings were on natural wetlands, and black ducks preferred beaver-created wetlands (lower) (Photos by D. R. Diefenbach).

SURVIVAL, HABITAT USE AND DISPERSAL OF  
POST-FLEDGLING BLACK DUCKS IN MAINE

Investigators: J. R. Longcore, Maine Field Station, PWRC  
D. G. McAuley, Maine Field Station, PWRC  
C. Frazer, Graduate Assistant

Cooperators/ U.S. Fish and Wildlife Service -  
Project Patuxent Wildlife Research Center, Laurel, MD.  
Moosehorn National Wildlife Refuge, Calais, ME.

Objectives:

- (1) Estimate a survival rate of hatching-year female black ducks during the non-hunting period from mid-August to October 1st and for the period until birds leave Maine.
- (2) Determine habitat use, bird movements from the Refuge, and pairing activity during this post-fledgling period.
- (3) Determine changes in habitat use, if they occur, after hunting season opens October 1st and until birds migrate in late December.

Scope:

The black duck population has declined drastically over the last 30 years. In an effort to ascertain the reasons for this decline, there has been an increase in research on black duck ecology. Information on survival and the relative importance of specific causes of mortality, particularly of young ducks, is lacking.

The purpose of this study is to determine survival of post-fledgling black ducks in the fall, with particular emphasis on determining the extent of natural mortality. Radio telemetry will be used to determine survival. This technique also allows for the gathering of information on other aspects of black duck ecology such as habitat use and dispersal of ducks from natal areas.

Project Status:

The 90-day survival rate estimate for 61 HY female black ducks monitored in 1986 was 0.667. This value is similar to our 1985 estimate (0.6258) based on 15 ducks. Mortality increased from 0 deaths in September, and 6 deaths in October to 8 deaths in November. One duck died in December. In addition to this non-hunting mortality, an additional duck was shot in November and 3 more in December. Predators caused most non-hunting mortality; 5 by fox or coyote, 4 by mink, 4 raptors, 1 unknown mammal. One duck died in a trap. In 3 instances cause of death was unknown. Although there was no statistical difference, ducks above mean mass (N=30) survived at a greater rate (.737) than those (N=31) below the mean mass (.606). After ducks either crossed into New Brunswick (where black ducks were legal game) or

migrated, 4 ducks were shot. Habitat use was mostly of palustrine wetlands in all months, but there was a slight shift to riverine habitats in October as ice covered some lentic wetlands. Many of the ducks migrated in mid-November to winter in the mid-Atlantic states, while some ducks (N=14) remained on the New Brunswick-Maine coast.

Future Plans:

Sixteen HY female black ducks and 5 HY males are currently being monitored. Warm temperatures (no killing frost through September), and low water from late summer drought at the Refuge, kept birds away from bait sites resulting in the low numbers captured thus far. Attempts will be made to place transmitters on 50 additional HY females. Tracking will continue to mid-December and attempts will be made to identify where ducks migrate to winter.

An M.S. thesis will be prepared by the graduate assistant, and several technical papers and the RWO report will be written in 1988.

## COMMON NIGHTHAWKS AT THE UNIVERSITY OF MAINE, ORONO

Investigator: V. Marzilli II

Advisors: W. E. Glanz, Chairperson  
W. B. Krohn

Cooperators/ Maine Department of Inland Fisheries and Wildlife -  
Project Endangered and Non-game Wildlife Grants Program  
Support: Maine Cooperative Fish and Wildlife Research Unit

Objectives:

- (1) Examine the suitability of roofs surfaced with black rubber versus tar/gravel for nesting nighthawks.
- (2) Test a ground census procedure by comparing the number and location of booming male nighthawks censused from the ground to actual nest sites.

Scope:

Flat-topped roofs at the University of Maine and elsewhere provide nesting habitat for common nighthawks (*Chordeiles minor*). Nighthawks are typically seen in the northern part of their range from mid-May through early September, at dusk and dawn primarily, darting and diving erratically in pursuit of flying insects. Males can be observed throughout the summer diving (booming) above potential nest sites. A 1976 study provides an estimate of the population size and breeding success on the Orono campus and serves as a basis for comparison. Of special concern is the effect that replacing tar/gravel roofs with black rubber surfaces will have on breeding nighthawks. Since 1981, 19 rubber-surface roofs have been installed on campus, and there appears to be a nationwide trend favoring the use of rubber on new and replacement flat-topped roofs. The impact of this trend on nesting nighthawks is unknown.

Project Status:

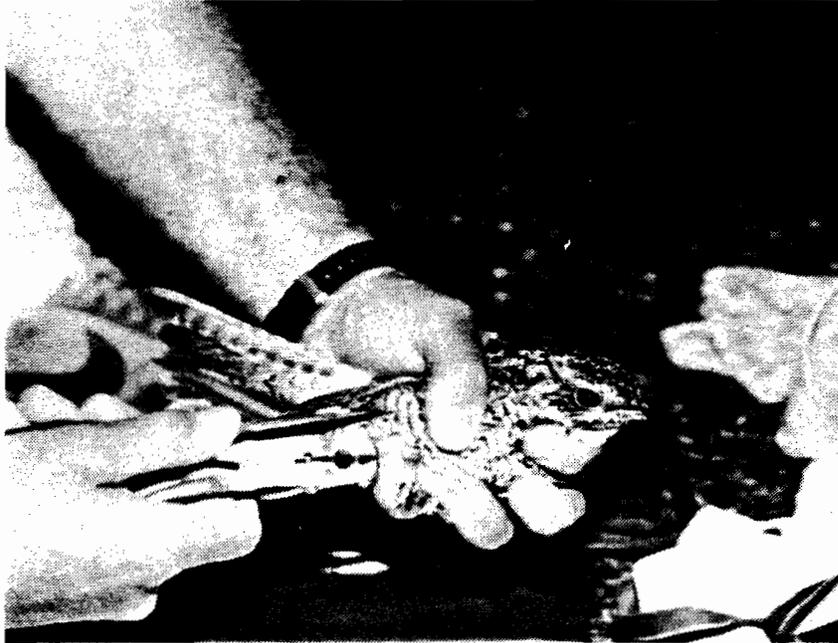
Data from the 1986 and 1987 field seasons indicate that nighthawks on the University of Maine campus prefer to nest on gravel surfaces of flat-topped buildings, especially on the southwest or southeast corners close to parapets. Gravel provides a stable surface upon which the eggs rest, as well as camouflage for resting and incubating nighthawks. Parapets apparently provide shelter from wind, rain, and sun, and reduce the likelihood of detection by aerial predators.

Six nighthawk nests were identified and monitored throughout the 1987 season; all were successful, producing a total of 10 chicks and 8 fledglings. All nests were situated on gravel surfaces, including two on separate, experimental patches of 25 square feet of gravel placed on rubber roofs.

A refined ground census revealed a 1:1 relationship between consistently booming adult males and active nests. Booming occurred directly above or within approximately 75 feet of the nest site. Exceptions include males booming over intruding males and males booming over females leaving or returning to nests. Booming intensity and frequency was greatest during the period of courtship and incubation, and decreased steadily following hatching when adults increased the time spent collecting food for developing chicks.

Future Plans:

A progress report covering the 1986 and 1987 data is being written for the Maine Department of Inland Fisheries and Wildlife. Plans are being made to publish the final results.



The common nighthawk is being studied on the University of Maine campus to determine the effect on nesting habitat of replacing tar/gravel roofs with rubber surfaces. A nighthawk being banded (upper) and another bird protecting its chick (lower) (Photos by V. Marzilli).

SURVEY OF BREEDING WOODLAND HAWKS  
AS RELATED TO FOREST MANAGEMENT

- Investigator: H. Devaul
- Advisors: W. B. Krohn, Chairperson  
W. E. Glanz  
R. J. O'Connor
- Cooperators/ Maine Department of Inland Fisheries and Wildlife -  
Project Endangered and Non-game Wildlife Grants Program  
Support: Maine Cooperative Fish and Wildlife Research Unit  
University of Maine
- Objectives:
- (1) Estimate the proportion of area occupied by woodland hawk species in comparable blocks of land representing different forest management practices, and relate the location of breeding raptors to forest characteristics.
  - (2) Evaluate the usefulness of the survey technique in a northern Maine setting, providing results from Maine for a comparison with previous and concurrent studies in other eastern and midwestern locations.
- Scope:

The status of breeding birds of prey in Maine is not well-known. Although an Atlas of Breeding Birds of Maine was recently compiled (Adamus 1987), and falconers have knowledge of local populations, a systematic survey had not been conducted prior to 1987. This project was initiated to determine the relationship between communities of breeding woodland hawks and large-scale forest management practices. Intensive commercial harvesting occurs over a large portion of northern Maine, modifying potential breeding habitat on an annual basis. Raptors characteristically have large home ranges, are easily disturbed at the nest site, and often return to the same nest or tract of land year after year. Land-use practices and disturbance by humans influence the suitability of an area, which is reflected in the use of an area by a raptor species. It is important to know how various land uses, particularly forest management, affect the species composition of breeding birds of prey before large areas are so modified as to become unsuitable. A knowledge of the current status of breeding diurnal raptors in relation to existing habitat, and the ability to predict and monitor changes in these breeding populations are fundamental to managing these species.

### Project Status:

Two areas were surveyed during the 1987 field season, an unharvested region (Baxter State Park) and a commercially harvested region (Telos) adjacent to it in north-central Maine. With the exception of a scientific forestry area in the north, Baxter Park has been left unmanaged for over 50 years, with no cutting or blowdown removal occurring. The Telos area is located to the west of Baxter and is owned by Great Northern Paper Company. This area is intensively managed, providing a mosaic of variously-sized clearcuts and stripcuts, mostly cut within the last decade, as well as areas of regrowth. Each study area comprises 4 townships (6x6 mile blocks) and is accessible by unimproved roads. The study was designed to estimate the conditional probability of detection (PD) and proportion of area occupied (AO) for each species in each area, following the method of Geissler and Fuller (1987). Surveys were conducted using broadcasts of great horned owl calls to enhance the detectability of nesting birds. Forty stations in each area were chosen, all at least 1.3 km (.8 mi.) apart. Stations were visited during the morning hours on a weekly basis, resulting in 9-11 visits to each, totalling 870 station visits during the course of the study. A standard pattern of great horned owls calls were broadcast at each station, pre-recorded from a source tape supplied by the U.S. Fish and Wildlife Service's Patuxent Wildlife Research Center (PWRC).

### Future Plans:

Data are currently being analyzed to calculate PD and AO for each species in each habitat. Preliminary results show marked differences between the two areas, but thorough analyses await the assistance of a computer program supplied by PWRC. Measurements of percent cover and cover type will be made from aerial photos to more accurately describe the variation in habitat between the two study areas. Plans for the 1988 field season include a return to the harvested area Telos, lending insight into year-to-year variation in PD and AO values within a study area. A third area will also be surveyed, chosen to represent a moderate land-use practice between the extremes of Telos and Baxter. Simulations will be used to help design the 1988 survey effort.

ENERGETIC ASPECTS OF WOODCOCK HABITAT USE DURING  
THE BREEDING SEASON AT THE MOOSEHORN NATIONAL WILDLIFE REFUGE

Investigator: W. M. Vander-Haegen

Advisors: W. B. Krohn, Co-chairperson  
R. B. Owen, Jr., Co-chairperson

Cooperators/ University of Maine  
Project Maine Cooperative Fish and Wildlife Research Unit  
Support: U.S. Fish and Wildlife Service -  
National Ecology Center, Fort Collins, CO.  
Moosehorn National Wildlife Refuge, Calais, ME.

Objectives:

- (1) Determine and compare vegetation and food characteristics of hardwood and softwood covers used by woodcock and compare to randomly selected hardwood and softwood sites.
- (2) Examine micro-climate regimes and activity budgets of woodcock in different cover types.
- (3) Document spring food habits and determine the feasibility of developing a spring condition index.
- (4) Use the above results to evaluate existing woodcock spring habitat models.

Scope:

The Atlantic population of the American woodcock is declining, and available data suggest that habitat loss is the primary cause. To reverse this decline, habitat protection and improvement programs based on sound biological data must be developed and implemented. Although a number of habitat models have been developed for woodcock on the breeding grounds, basic assumptions in these models remain untested.

The Moosehorn National Wildlife Refuge (NWR) has a substantial population of breeding woodcock, and timber management on the refuge has created a variety of cover types representing those most available to northern-breeding woodcock. In 1986, the Maine Field Station of Pautuxent Wildlife Research Center and Moosehorn NWR began a four-year study to examine woodcock survival, productivity, and habitat use on the refuge. This study will provide base line data on population dynamics and macro-habitat use. The large sample of birds that will be radioed during this study also provides an opportunity to examine spring habitat use from an energetic perspective. Results from several recent studies indicate that spring is a critical period for woodcock populations, yet the relationship between cover type, micro-climate, and woodcock activity has not been examined in detail.

In 1987, the Maine CFWRU and Moosehorn NWR initiated a companion study to examine energetic considerations, including micro-habitats and activity budgets, influencing habitat use by woodcock on the breeding grounds. This study will examine micro-habitat use and activity budgets of, and micro-climate effects on, woodcock during early spring through early summer. These data, combined with energetic studies on captive birds and supplemented by population data collected concurrently by the Pautuxent/Moosehorn study, will provide a basis for modeling woodcock habitat requirements. The ultimate goal of this study is to develop a breeding habitat model for woodcock based on both energy and resource needs.

#### Project Status:

The initial field season (March-June 1987) has been completed. Data on vegetation structure and composition, soil characteristics, and earthworm abundance were collected at 101 diurnal sites used by radio-marked birds during the pre-nesting, nesting, and post-nesting periods. Remote monitoring stations recorded data on activity of instrumented males and females during the pre-nesting period, and of females with broods. Micro-climate data were collected concurrently in the covers used by monitored birds. The activity-recording system was tested and calibrated using data from captive instrumented birds. Nineteen birds were collected for analysis of energy reserves and early spring food habits. These data are currently being analyzed.

#### Future Plans:

Additional field data will be collected during 1988 and 1989. Captive woodcocks will be raised during 1988 for use in laboratory studies of metabolism and thermoregulation. Target date for project completion is October 1989.



The eastern population of the American woodcock, largely due to abandoned farmlands reverting from brushlands to forestlands, has declined almost 3% per year since the mid-1960s. Better data are needed on what determines habitat quality to improve habitat management techniques (Photo by W. B. Krohn).

## HARBOR SEAL POPULATION AND MARINE MAMMAL-FISHERIES INTERACTIONS

Investigators: J. R. Gilbert  
K. M. Wynne

Cooperators/  
Project U.S. National Marine Fisheries Service -  
Support: Northeast Fisheries Center, Woods Hole, MA.

Scope:

The Marine Mammal Protection Act of 1972 granted Federal protection to harbor seals (*Phoca vitulina*) and other marine mammals, and has led to increased populations. In Pacific coastal waters, concurrent increases in seal numbers and fishing pressure have resulted in direct and indirect conflicts, including competition, gear and catch damage, and incidental marine mammal captures. The potential for similar conflicts exists in the western North Atlantic. In order to assess the harbor seal's status in New England and its potential for conflicts with commercial fisheries, the Northeast Fisheries Center contracted with the University of Maine to examine the abundance, distribution, movements, and discreteness of the harbor seal populations in New England. To address these objectives, aerial surveys were conducted to determine seal distribution and abundance, and a pup tagging program was initiated to enable the identification of individuals and monitor of their movements.

Project Status:

The project has been completed and a summary of major findings follows:

A significant fraction of the Maine harbor seal population moves southward to the Cape Cod area in the winter. The March 1981 survey covered from Rhode Island north to Monhegan Island, and the March 1986 survey covered the waters of Maine. These indicate that about one-third of the harbor seal population is south of the Maine border during the winter and early spring.

Maine is the primary breeding and pupping area for all of New England's harbor seals. Harbor seals use the ledges in the inner bays for pupping and breeding early in the summer and shift to outer ledges during July and August to molt. Tagged pups often move far from their birth site within a month after birth. Several of the pups tagged in Blue Hill Bay, Maine were recovered by fishermen in New Brunswick and Nova Scotia.

In June 1981, 10,483 harbor seals were counted from the air on ledges in Maine. In June 1986, 12,917 harbor seals were counted. Because these were total counts, the only variability associated with these counts is that of the fraction hauled out at the time of surveying.

The evidence that the harbor seal population has been increasing since the enactment of the Marine Mammal Protection Act is not unequivocal. Repeated counts in our study area showed that harbor seals shift their distribution from the inside to the outer ledges as the summer progresses. However, the comparison of the June counts for the Casco Bay Region in 1973, 1981, and 1986 indicates a significant increase in the harbor seal population. The total coastal count for June 1986 is higher than the one in 1981. Broken down by region of the Maine coast, the 1986 counts were higher in 9 areas, lower in 4 areas, and within 100 individuals in 9 areas. Highest gains in population were in the Boothbay-Sheepscot Bay region and the Eastern Bay region. Therefore, the preponderance of data indicate the seal population in Maine has increased since 1973, and probably since 1981. Earlier impressions that the population is doubling every 7 years are not substantiated by re-examination of the data.

HABITAT USE AND HOME RANGE CHARACTERISTICS  
OF MOOSE IN NORTHERN MAINE

Investigator: M. E. Thompson

Advisors: J. R. Gilbert, Chairperson  
G. J. Matula  
M. D. Ashley

Cooperators/

Project Maine Department of Inland Fisheries and Wildlife  
Support: McIntire-Stennis

Objectives: (1) Quantify seasonal habitat use and home range characteristics of moose.  
(2) Compare these parameters for moose using areas of different logging intensities.

Project Status:

All requirements for the degree of Master of Science (in Wildlife Management) were completed in May 1987. An abstract of the thesis follows:

Seasonal home range and habitat use characteristics of adult moose (*Alces alces*) in northern Maine were studied from January 1983 through September 1984 using radio telemetry. Thirty-seven moose (14 M:23 F) were located 786 times using aerial telemetry, 246 times by triangulation, and 26 times by direct observation.

A median home range of 7.12 km<sup>2</sup> was observed during the winter of 1983, in which snow did not appear to restrict moose movements. During the winter of 1984, snow accumulations exceeded 70cm for most of the winter, and the median home range was only 1.55 km<sup>2</sup>. Summer home ranges varied from 5-126 km<sup>2</sup>, but were typically between 20-30 km<sup>2</sup>. The median fall home range was approximately 3 km<sup>2</sup>. In 1984, most moose occupied the same seasonal home range used in 1983. Seasonal home ranges of individual moose often overlapped, or, if disjunct, were within approximately 7 km of each other.

Throughout the year, moose spent the majority of their time at elevations below 367 m, which, in this part of Maine, is the transition zone from spruce-fir dominated forests to northern hardwood forests at higher elevations. During summer, moose preferred to use lowlands below 305 m elevation with flat slopes, which is where ponds used for feeding on aquatic plants are located. Cows spent a greater proportion of their time in lowlands than bulls did. South and west aspects were used more often than other aspects during winter.

During fall and winter, moose were found in logged areas that were usually cut less than 30 years previous and had abundant supplies of browse and uncut stands of mature spruce and fir that could be used for

shelter. Habitat use in summer expanded to include hardwood-dominated cutovers, aquatic areas, and lowland black spruce and cedar forests.

Moose in this part of Maine are dependent upon logged areas for meeting food and shelter requirements, and incorporating the needs of moose in forest management plans is suggested.

ECOLOGY OF FISHERS IN SOUTH-CENTRAL MAINE

Investigator: S. M. Arthur

Field

Assistant: J. Waring

Advisors:

J. R. Gilbert, Co-chairperson  
W. B. Krohn, Co-chairperson  
W. E. Glanz  
G. J. Matula

Cooperators/

Maine Department of Inland Fisheries and Wildlife

Project

Maine Cooperative Fish and Wildlife Research Unit

Support:

Maine Trappers Association -  
State Association  
Northern Coastal Chapter

Objectives:

- (1) Evaluate fisher home range size and dynamics.
- (2) Determine fisher habitat use and its relation to small mammal distribution.
- (3) Document fisher activity patterns.
- (4) Document fisher food habits.

Project Status:

All requirements for the degree of Doctor of Philosophy (in Wildlife) were completed in August 1987 (for December graduation). An abstract of the dissertation follows:

Home range characteristics, habitat use, food habits, and activity patterns of 43 radio-collared fishers (*Martes pennanti*) were studied from January, 1984-January, 1987, in a 500 km<sup>2</sup> area in south-central Maine. Fishers were live-trapped in cage traps and padded-jaw foothold traps, and recaptured by darting them out of trees and by trapping them at burrows.

Minimum convex polygon home range areas during May-December averaged 16.3 km<sup>2</sup> for 6 adult females (range=8.1-39.1) and 30.9 km<sup>2</sup> for 7 adult males (range=10.6-78.2); the means were not statistically different (T-test, P>0.2). Ranges of adult females were stable in size and location seasonally and between years. Adult males travelled widely during March-May, and shifted their home ranges between years. Ranges of adults did not overlap with others of the same sex, except for males during the spring. Adult females shifted their ranges to avoid other females, and to occupy areas left vacant by the removal of females by trappers. Adult males also shifted their ranges to include vacant areas, and 1 male was severely injured in a fight with another fisher. Juveniles (N=20 males, 4 females) travelled widely before establishing more stable ranges during their second summer.

Apples were the most common food in scats collected during winter. Hares (Lepus americanus), porcupines (Erethizon dorsatum), and several species of mice, voles, shrews, and squirrels also were common.

Fishers travelled through all forested habitats and were never found in open areas. During winter, fishers rested in burrows and hunted intensively in dense, brushy areas with many hare tracks. During summer, fishers usually rested in the branches of coniferous trees, and were active in all habitat types. Tree cavities were used as rest sites during spring and fall and as natal dens.

Fishers were active most often during early morning and evening, although some activity occurred throughout the day. Less activity occurred during the winter than the summer, and movements were shorter. Behavior patterns suggested that females with young kept them in tree cavities for about 8 weeks during April and May. From mid-June until September, the young probably accompanied their mothers, before becoming independent in late summer.

## THE ECOLOGY OF RIVER OTTERS ON MOUNT DESERT ISLAND, MAINE

Investigator: L. J. Dubuc

Advisors: R. B. Owen, Jr., Co-chairperson  
W. B. Krohn, Co-chairperson  
C. J. Schell  
W. E. Glanz  
G. J. Matula

Cooperators/ U.S. National Park Service -  
Project Acadia National Park, Bar Harbor, ME  
Support: Regional Office, Boston, MA

Objectives:

- (1) Determine the present distribution of river otters on Mount Desert Island (MDI).
- (2) Determine the food habits of river otters and the effect of preferred prey availability on otter distribution throughout MDI.
- (3) Evaluate the biotic and abiotic parameters that provide the essential habitat for river otters on MDI.
- (4) Determine the influence of fire disturbance and subsequent beaver activity on the development of river otter habitat on MDI.

Project Status:

All requirements for the degree of Master of Science (in Wildlife Management) were completed in September 1987 (for December graduation). An abstract of the thesis follows:

This study was conducted to define and quantify the ecological factors affecting the distribution and status of river otter (Lutra canadensis) in Acadia National Park (ANP) on Mount Desert Island (MDI), Maine.

The distribution of otters was determined by searching for otter sign on all watersheds on MDI during 2 winter and 2 summer field seasons between August 1985-March 1987. Otter sign was documented on 25 of 39 watersheds during 207 sign-searches.

Otter selected watersheds that had the highest proportion of active beaver wetlands and avoided those with no beaver ( $P < 0.0001$ ). Beaver activity provided a stable water supply, influenced wetland productivity, and provided a source of den and resting sites.

The level of beaver activity was affected by the distribution of deciduous species such as aspen (Populus spp.) and birch (Betula spp.). These species developed as a result of a 6,800 ha fire that occurred in 1947. Beavers used the burned watersheds more than expected ( $P < 0.01$ ). Slowly, these early successional species will be replaced by conifers

such as spruce (*Picea* spp.) and fir (*Abies* spp.), and suitability of the habitat for beaver, and therefore otter, will be reduced.

The diversity of prey items in 200 otter scats was lower during winter than during summer ( $P < 0.0001$ ). Fish (85% occurrence) were the predominant food item in 47 scats collected during the winter, while amphibians and reptiles (69% occurrence) and fish (61% occurrence) were present most often in the 153 scats collected during the summer. This seasonal change in the diversity of prey consumed by otters reflected the seasonal shift in habitats used. During summer, the most common foods were species that inhabit shallow freshwater wetlands. During winter, marine species were more common.

A predictive model of habitat use by otters was developed by comparing 19 watersheds used by otters during 2 or more field seasons with 14 unused watersheds. Of 47 habitat variables initially measured, 4 were identified as providing the greatest degree of discrimination between used and unused watersheds. Otter use was negatively associated with the proportion of mixed hardwood-conifer stands in forested areas adjacent to waterways (MHDCON), and positively associated with the number of beaver flowages (ALLBEAV), watershed length (TOTL), and average shoreline diversity (MIRREG). These variables were combined in the discriminant function:

$$f(x) = -5.40 - 11.94\text{MHDCON} + 5.08\text{ALLBEAV} + \\ 4.75\text{TOTL} + 2.09\text{MIRREG};$$

where: + = used, - = unused.

The model had an overall correct classification rate of 94%.

To maintain or improve the status of otters on MDI, the NPS should conduct periodic sign surveys to monitor population status, maintain patches of early successional vegetation along waterways, and ensure that otters have access to marine resources by establishing resource protection zones.



On Mount Desert Island, Maine, a recently completed study found a close relationship between beaver and river otters. Beaver-created or modified wetlands support an abundance of fishes and frogs, major items in the otter's diet, along with providing isolation and safe resting places (Photo by W. B. Krohn).

THE MAINE AMPHIBIAN AND REPTILE ATLAS PROJECT (MARAP)

Investigators: M. L. Hunter, Jr.  
J. K. Arbuckle  
J. J. Albright

Advisors: B. Burgason  
S. Davis  
A. Ritter

Cooperators/ The Nature Conservancy  
Project The Maine Audubon Society  
Support: Maine Department of Inland Fisheries and Wildlife

Objectives:

- (1) Determine the status and distribution of amphibians and reptiles in Maine, particularly rare species and those that reach their range limit here.
- (2) Describe the general ecology (e.g., habitat selection and life history) of Maine's herpetiles.

Scope:

There are approximately 35 species of amphibians and reptiles occurring in Maine, of which 20 probably reach the limit of their range here. One or more species have probably been extirpated from the state, and there may well be species occurring here that have not been previously recorded. There is little knowledge about the status, distribution, and ecology of Maine's herps, and this is the reason MARAP was initiated. Nearly 100 volunteers from around the state have been issued instruction manuals and record cards to report their observations of herps. These cards will be computer encoded and range maps generated.

Project Status:

All species of reptiles and amphibians known to occur in Maine have been reported in the MARAP project with the exception of the timber rattlesnake, a species believed to be extirpated.

Future Plans:

MARAP will be terminated after the 1988 field season and a book "The Amphibians and Reptiles of Maine" will be written.

## MODELING THE POPULATION DYNAMICS OF MAINE'S WHITE-TAILED DEER

Investigator: M. E. Chilelli

Advisors: J. R. Gilbert, Co-chairperson  
W. B. Krohn, Co-chairperson  
G. J. Matula  
M. L. McCormack  
W. L. Soule

Cooperators/ Maine Department of Inland Fisheries and Wildlife  
Project Maine Cooperative Fish and Wildlife Research Unit  
Support: National Rifle Association

Objectives: (1) Develop a model that describes the annual fluctuations of white-tailed deer in Maine.  
(2) Predict sustained annual harvest rates for antlered and antlerless deer in selected wildlife management units.

Scope:

As demands placed on natural resources by different consumer groups increase, management decisions become more complex. Comprehensive management plans, utilizing all available data, are necessary to provide a sustained harvest of white-tailed deer while ensuring a healthy population. Models, consisting of a set of hypotheses that define how an ecological system functions, provide a means of relating hypotheses, tracking the populations as management proceeds, and allowing experimentation (i.e., simulation) of alternative management strategies.

The overall goal of this project is to develop a predictive population dynamics model for white-tailed deer in Maine. The development of this model will not only integrate the large and varied data array provided by the Maine Department of Inland Fisheries and Wildlife, but will help to identify interactions among various parameters pertaining to white-tailed deer ecology, pinpoint weaknesses in current data sets, and help guide future management and research endeavors.

Project Status:

The framework of the population dynamic model has been written in GW-BASIC, tested, and verified. This model reflects the annual cycle of white-tailed deer in Maine and has been divided into 3 major compartments: (1) fall harvest period, (2) winter-early spring period, and (3) reproduction/summer-early fall. Mortality and reproductive rates were determined to reflect variations by sex, age (fawn, yearling, and adult), and month (or subsection). The functional relationships for the reproductive period have been formulated, and they estimate (1) fetal sex ratio by age class of dam, (2) age class-specific birth frequency, and (3) age class-specific reproductive rates. The harvest

compartment was split into 4 subsections: (1) pre-bow, (2) bow, (3) firearm, and (4) post-firearm. The 4 harvest subsections had functional relationships derived to estimate the following mortality rates:

pre-bow	(population mortality rates) - coyote predation, bobcat predation, dog predation, poaching, road kill;
bow	(population mortality rates) - bow harvest, bow crippling, coyote predation, bobcat predation, dog predation, poaching, road kill;
firearm	(age class and sex-specific mortality rates) - firearm harvest, firearm crippling, coyote predation, bobcat predation, dog predation, poaching, road kill; and
post-firearm	(population mortality rates) - coyote predation, bobcat predation, dog predation, poaching, road kill.

The winter period had functional relationships formulated for these age class, sex, and month-specific mortality rates: winter severity, coyote predation, bobcat predation, dog predation, poaching, and road kill. During the summer period, monthly mortality rates were considered to be mean population rates, except during June and July for which 2 sets of mortality rate estimates were derived: 1) newborn fawns, and 2) the remainder of the population. The mortality rate relationships derived for the summer period include: neonatal mortality, coyote predation, bobcat predation, dog predation, poaching, and road kill.

#### Future Plans:

The relationships for mortality and reproductive rates will be integrated into the model. Sensitivity analyses will be used to determine those parameters that cause the greatest change in output and that should be estimated with the greatest accuracy. Simulation runs will be performed to examine the long-term effects of various management strategies and to make conditional predictions concerning the ecology of deer in Maine. Thesis will be completed by early spring 1988.

NESTING ECOLOGY AND HABITAT USE OF  
WILD TURKEYS IN SOUTH-CENTRAL MAINE

Investigator: B. E. Treiterer

Advisors: P. W. Brown, Chairperson  
G. J. Matula  
W. A. Halteman

Cooperators/ Maine Department of Inland Fisheries and Wildlife  
Project National Wild Turkey Federation  
Support: Maine Chapter of the National Wild Turkey Federation  
National Rifle Association  
L. L. Bean, Inc.  
Maine Cooperative Fish and Wildlife Research Unit

Objectives:

- (1) Document nesting chronology, proportion of females nesting, nest site characteristics, and the success of eggs and nests of free-ranging turkeys in south-central Maine.
- (2) Determine the types of nesting and brood habitat used by female turkeys with broods during the breeding season.

Scope:

The eastern wild turkey (*Meleagris gallopavo sylvestris*) occupied the southern portion of Maine until the late 1700s, but extensive clearing of the land for farming and unregulated hunting led to their extirpation. It is unclear how far north and inland the population ranged. Trap and transfer efforts in the late 1970s and early 1980s resulted in expanding populations in southern (centered in central York County) and south-central (centered in Waldo County) Maine. The breeding characteristics and the habitat requirements of wild turkeys in Maine were unknown. Although turkeys exhibit remarkable adaptability in areas previously thought to be marginal habitat, the birds are at the edge of their historic range in Maine. The goal of this study was to provide baseline information on the habitat requirements during the winter and breeding seasons, and reproductive characteristics, home ranges and dispersal distances of female wild turkeys in Waldo County, Maine. This information is needed to wisely choose future release sites, especially in areas where winter food and brood rearing habitat may be limiting.

Project Status:

All field work has been completed. A total of 63 birds were captured during the fall and winter trapping period between 1985 and 1987. Twenty-seven birds were fitted with backpack transmitters (11 adult females, 11 juvenile females, 1 adult male, and 4 juvenile males). Turkeys were located at least once a week during the winter to monitor

survival and daily after April 1 to determine nesting chronology and survival.

In 1987, snow depths and days with snow exceeding 30 cm were greater ( $P < 0.05$ ) than in 1986. Survival, natality and recruitment rates of female turkeys were compared between the two winters. Extended periods of deep snow resulted in no population growth because of low winter survival (44%), and reduced natality and recruitment rates ( $P < 0.05$ ).

Overstory and understory characteristics of 9 nest sites in Waldo County were consistent with findings in other parts of wild turkey range. Slash seemed to provide concealment of the hen and eggs during the early part of incubation when herbaceous vegetation was not yet available. Overstories at nest sites are usually 50-90% open. Females seem to prefer relatively dense understories which conceal the hen and eggs without hampering the females' ability to detect and escape approaching predators.

Home range sizes of 8 hens with broods averaged 251 ha, which is within the range reported in other studies. Old fields, hayfields, cornfields and hardwood stands were used more ( $P < 0.05$ ) than expected, whereas softwood and mixed stands were used less ( $P < 0.05$ ). Fields provide invertebrates, primarily insects, which comprise 75-90% of the diet of poults during the first few weeks of life. As the poults get older, the diet shifts from animal to plant matter such as mast, soft fruits and herbaceous vegetation.

#### Future Plans:

Writing of final thesis continues; scheduled date of graduation is December 1987.

## POPULATION DYNAMICS OF PACIFIC WALRUSES

Investigator: J. R. Gilbert  
S. Hills

Advisors: J. R. Gilbert, Chairperson  
W. E. Glanz  
W. A. Halteman  
M. L. Hunter, Jr.  
W. B. Krohn

Cooperators/

Project  
Support: U.S. Fish and Wildlife Service -  
Alaska Fish and Wildlife Research Center,  
Anchorage, AK.

Objectives:

- (1) Techniques development and evaluation
  - a. Adapt existing satellite telemetry technology to walrus, including packaging, sensors, and attachment procedures.
  - b. Develop immobilization techniques for walrus on the pack ice.
- (2) Determine the effect of behavioral patterns of walrus (composition, distribution, movements and behavior) on the existing population estimates.
- (3) Determine the distribution and movements of walrus relative to pack ice distribution, bathymetry, and other environmental parameters.
- (4) Evaluate the past censuses of walrus in relation to the distribution information collected on objectives 2 and 3.

Scope:

Existing walrus population estimates fail to account for composition, movement, distribution, and behavioral patterns. Sampling effort is shared by the U.S. and the U.S.S.R., and population estimates are attempted once every five years. Sampling effort currently lacks coordination and design and, therefore, lacks credibility; results are limited to determining overall population trend. Adaptation and implementation of available satellite telemetry techniques to walrus will potentially address the majority of the problems associated with current estimates, and thus help to provide a more reliable data base for management of this international wildlife resource.

Project Status:

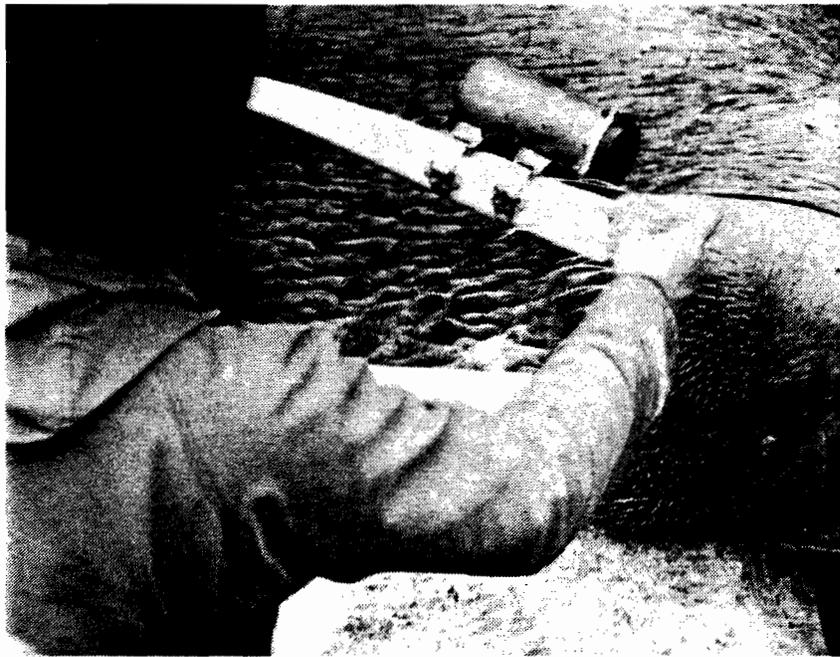
From late June through August, experiments were conducted on Round Island in Bristol Bay, Alaska, to determine the best procedure for

immobilizing walrus and attaching transmitters. Three VHF transmitters and one satellite transmitter were successfully attached during the summer. We found that drugs could be administered using dart guns, crossbows, and jab poles. We received much help and cooperation in this effort from the U.S. Fish and Wildlife Service, the Alaska Department of Fish and Game, and the Canadian Wildlife Service.

Graduate student Sue Hills is participating in a fall cruise on a Soviet trawler to collect biological samples from walrus being harvested. She also hopes to determine patterns of haulout and compare behavior on the ice with behavior observed on the beaches of Round Island in hopes that a capture technique can be developed for the pack ice.

#### Future Plans:

Improvements will be made in the satellite transmitters and casings during the winter. We also plan to work with veterinarians to develop more reliable drugging procedures for walrus. A second field season is planned, preferably in the pack ice of the Chukchi Sea.



Attaching a satellite transmitter to an adult male walrus on Round Island, Alaska (Photo by J. R. Gilbert).

## FOOD INTAKE BY DEER IN SOUTHEAST ALASKA

Investigator: D. E. Spalinger

Cooperators/ USDA Forest Service -  
Project Pacific Northwest Forest and  
Support: Range Experiment Station, Juneau, AK.

Objectives:

- (1) Develop a model of diet selection and intake for Sitka black-tailed deer in the spruce-hemlock forests of southeast Alaska.
- (2) Synthesize deer nutritional studies into one model for predicting metabolic response of deer to habitat and potential carrying capacity of habitats in southeastern Alaska.

Scope:

The effects of forest management on the carrying capacity of habitat for deer is a major environmental concern in southeast Alaska. Carrying capacity depends primarily on the quantity and quality of available food and the diet selected by deer. The species composition and nutritional quality of the diet depends on the availabilities of forages and their palatabilities to deer. As the availabilities of forage species shift, seasonally or as a result of management or habitat type, the composition and quality of deer diets shift, resulting in large changes in potential carrying capacity. Consequently, the ability to predict carrying capacity is a function of the accuracy with which the diet composition is predicted under the various conditions imposed upon deer.

It is hypothesized that diet selection is a function of the nutritional quality of the vegetation components and time constraints associated with forage harvesting. Qualitative aspects of the food affect nutrient availability and food processing capabilities (i.e., factors affecting or limiting the physical capacity of the digestive tract and turnover of the undigested residues in the tract). Factors which affect the availability of the animal to harvest food include aspects of forage quality as well (cell wall concentration or mean cell wall thickness), but also include the functional parameters of bite size, forage distribution, and abundance (biomass). This study is designed to test these hypotheses in a two-phase experiment.

Project Status:

Phase I. The analysis of the functional response in foraging in Sitka black-tailed deer.

The initial phase of research is completed. The hypothesis that forage intake rate of Sitka black-tailed deer is a function of plant

availability (biomass), bite size, and forage fibrousness was tested in a series of experiments on captive deer. Deer were offered single-species diets of 8 commonly consumed plants on artificial pastures, with distributions adjusted to simulate various forage availabilities. Under the conditions of the trials, intake rate was not found to be a function of plant availability, except when deer were consuming plants of small bite size at densities less than  $0.5 \text{ g/m}^2$ . Intake rate was highly correlated to bite size, and also to plant fibrousness, as measured by neutral detergent fiber concentration. We conclude from this study that intake rate is a function of processing constraints (chewing) imposed by plant tissues. Bite size is highly correlated to intake rate because as bite size declines, the animal attempts to compensate by increasing bite rate, which directly competes with chewing. Consequently, the ability to consume forage declines. The results of this study suggest that forage selection by large herbivores such as black-tailed deer may be significantly affected by characteristics such as bite size. Although biomass or availability may greatly affect carrying capacity, this variable may not affect intake rates of deer under most grazing conditions.

#### Future Status:

Phase II startup has begun in southeastern Alaska. Nine black-tailed deer have been hand-reared and released on Channel Island near Wrangell, Alaska. These animals will be used in a pilot study during the winter 1987-88 to test research methods and obtain preliminary foraging data. Dr. Michael Gillingham will be hired in the spring of 1988 to begin field work on Channel Island at that time. Models of foraging are currently being developed to predict diet selection by tame deer on Channel Island.

HABITAT SUITABILITY FOR VERTEBRATE HERBIVORES  
IN RELATION TO FOREST STAND CHARACTERISTICS

Investigator: Lisa Shively

Advisors: D. E. Spalinger, Chairperson  
H. S. Crawford  
W. E. Glanz

Cooperators/

Project

Support: McIntire-Stennis

- Objectives:
- (1) To determine the relationship between browse abundance, browse quality, and snow depth to foraging efficiency in white-tailed deer, moose and caribou.
  - (2) To determine the relation between forage removal rates, browsing intensity and foraging decision-making in the three animals in relation to snow depth (energy expenditure for traveling).
  - (3) To determine foraging bout lengths and travel distances of deer, moose and caribou offered varying densities of browse in winter in order to predict optimal forage patch sizes for the three ungulates.

Scope:

Deer, moose and caribou require both cover and forage to survive the winter. Optimum cover (closed canopy conifer stands) and optimum forage production cannot be provided at the same location. It follows that winter habitat quality will be directly related to the distance which the animals must travel to forage (from the bedding location) and the density and quality of the forage available in the patches. Because of the differences in body size, foot loading, and nutritional requirements of the three species, it is expected that optimum habitat quality will be defined by different mixes of cover and forage patches for each animal. In addition, the density of snow and the abundance and quality of browse will affect each species differently. To accomplish the objectives of the research, we will conduct a series of foraging trials beginning in the winter of 1987-88, using approximately 10 white-tailed deer, 3 moose, and 2-4 caribou. The foraging trials will be conducted in pens erected at the ungulate research facility located on the Orono campus. Browse density will be modified artificially in these pens, and animal responses (foraging bout length, distance traveled, bite rate, bite size, food intake rate and energy expenditure) will be measured. Responses to snow depth will be obtained opportunistically as snow depth varies over the winter. Energy expenditure will be calculated from animal characteristics, snow depth and density, and distance travelled.

Project Status:

Preparations for the experiments began in the spring of 1987. We acquired and bottle-raised 9 deer fawns (6 of which were born to animals in the captive herd), one moose calf, and 2 caribou calves this last summer, which, along with 4-8 other deer, 2 moose, and possibly 2 other caribou, will be used in the foraging experiments beginning in November 1987. In order to house and care for the animals, several additions to the facility have been made. The barn was expanded from 1600 sq. ft. to 2560 sq. ft., and 5 indoor-outdoor animal stalls were built. Corrals and fenced corridors were added to facilitate animal management. Work is now under way to complete the experimental pens for the foraging experiments.

Future Plans:

Foraging experiments are scheduled to begin in November 1987 and continue through the winter of 1987-88 and 1988-89.

## SYNTHESIS OF MAINE PREDATOR STUDIES

Investigator: S. M. Arthur  
W. B. Krohn

Cooperators/  
Project Maine Department of Inland Fisheries and Wildlife  
Support: Maine Cooperative Fish and Wildlife Research Unit

Objective: Develop an annotated bibliography covering recent research of Maine's major terrestrial furbearing predators.

Scope:

The Maine Cooperative Fish and Wildlife Research Unit and the University of Maine have conducted a series of research projects concerning Maine's furbearing predators during the last decade. More than a dozen graduate studies have been completed, resulting in numerous theses, technical papers, and other reports. The research covered the ecology of bobcats, coyotes, red foxes, fishers, and pine martens, and was funded primarily by the Maine Department of Inland Fisheries and Wildlife (MDIFW). The purpose of the annotated bibliography is to bring this information together in a concise manner, and thereby make it more available for use by research and management biologists, particularly MDIFW personnel.

Project Status:

Work on the project began in September 1987. A collection of all theses, publications, and reports is being made, and contacts with the principal investigators of each project have been initiated. A preliminary outline has been prepared and is currently being revised.

Future Plans:

An initial draft will be completed by January 31, 1988, and the final report will be finished by June 30, 1988.

PUBLICATIONS, THESES AND DISSERTATIONS,  
AND PROFESSIONAL TALKS GIVEN

SCIENTIFIC PUBLICATIONS

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- NEGUS, M.T. 1987. The influence of submerged pulpwood on feeding and condition of fishes in a reservoir. Hydrobiologia 148(1):63-72.
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- STRONG, P.T.V., S.A. LaValley, and R.C. Burke II. 1987. A colored plastic leg band for common loons. Journal of Field Ornithology 58(2):218-221.
- STRONG, P.T.V., J.A. Bissonette, and J.S. Fair. 1987. Reuse of nesting and nursery areas by common loons. Journal of Wildlife Management 51(1):123-127.
- TISCHENDORF, J.S.W., C. Frazer, and T.G. Grubb. 1987. Interactions between bald eagles (Haliaeetus leucocephalus:Accipitridae) and river otters (Lutra canadensis:Mustelidae). The Southwestern Naturalist 32(2):286-287.

#### TECHNICAL AND SEMI-TECHNICAL PUBLICATIONS

- ARTHUR, S. 1986. Fisher project update. Pages 29-30 in Maine Trappers Association Newsletter, Winter 1986-87. 32pp.
- BLUMTON, A.K., R.B. Owen, Jr., and W.B. Krohn. 1987. Habitat suitability index models: American eider (nesting). Final report submitted to U.S. Fish and Wildlife Service, National Coastal Ecosystem Team, Slidell, LA. 24pp.
- DUBUC, L.J. 1987. Otter, beaver and fire. Page 27 in Maine Trappers Association Newsletter, Fall Yearbook. 44pp.
- GARMAN, G.C., and J.R. Moring. 1987. Impacts of sedimentation on aquatic systems: a literature review and proposed research agenda. Final report to Maine Land Use Regulation Commission, Committee on Stream Research. 35pp.
- HUNTER, M.L., Jr. 1987. Wildlife comes to Oxford. American Oxonian 74:14-16.

- KROHN, W.B., and R.B. Owen, Jr. 1987. Maine wildlife: is our future growing? Page 13 in The Maine Forester 1987, College of Forest Resources, University of Maine, Orono. 98pp.
- MORING, J.R. 1986. Pulp in the Kennebec River. Maine Fish and Wildlife 28(4):27-29.
- MORING, J.R. 1986. Seasonality and habitat associations of three species of tidepool fishes. Final Report to National Geographic Society. 28pp.
- MULLEN, D.M., C.W. Fay, and J.R. Moring. 1986. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (North Atlantic) - alewife/blueback herring. U.S. Fish and Wildlife Service Biological Report 82 (11.56). 21pp.
- MULLEN, D.M., and J.R. Moring. 1986. Species profiles (North Atlantic) - sea scallop. U.S. Fish and Wildlife Service Biological Report 82 (11.67). 13pp.
- NEWELL, C.R., and H. Hidu. 1986. Species profiles (North Atlantic)-softshell clam. U.S. Fish and Wildlife Service Biological Report 82 (11.53). 17pp.
- STANLEY, J.G., and M.A. Sellers. 1986. Species profiles (mid-Atlantic) - American oyster. U.S. Fish and Wildlife Service Biological Report 82 (11.65). 25pp.
- STANLEY, J.G., and M.A. Sellers. 1986. Species profiles (Gulf of Mexico) - American oyster. U.S. Fish and Wildlife Service Biological Report 82 (11.64). 25pp.
- WEISS-GLANZ, L.S., J.G. Stanley, and J.R. Moring. 1986. Species profile (North Atlantic) - American shad. U.S. Fish and Wildlife Service Biological Report 82 (11.59). 16pp.

#### THESES AND DISSERTATIONS

- ARTHUR, S.M. 1987 Ecology of fishers in south-central Maine. Ph.D. dissertation, University of Maine, Orono. 112pp.
- BOWMAN, T.D. 1987. Ecology of male black ducks molting in Labrador. M.S. Thesis, University of Maine, Orono. 60pp.
- DUBUC, L.J. 1987. Ecology of river otters on Mount Desert Island, Maine. M.S. Thesis, University of Maine, Orono. 76pp.
- EGGEMAN, D.R. 1986. Influence of environmental conditions on distribution and behavior of common goldeneyes wintering in Maine. M.S. Thesis, University of Maine, Orono. 117pp.

- ELLIOTT, C.A. 1987. Songbird species diversity and habitat use in relation to vegetation structure and size of forest stands and forest-clearcut edges in north-central Maine. Ph.D. dissertation, University of Maine, Orono. 84pp.
- SANTILLO, D.J. 1987. Response of small mammals and breeding birds to herbicide-induced habitat changes on clearcuts in Maine. M.S. Thesis, University of Maine, Orono. 74pp.
- THOMPSON, M.E. 1987. Seasonal home range and habitat use by moose in northern Maine. M.S. Thesis, University of Maine, Orono. 47pp.

#### PROFESSIONAL TALKS PRESENTED

- ARTHUR, S. June 1987. Home range characteristics of fishers in Maine. American Society of Mammalogists Annual Meeting, Albuquerque, NM.
- DESGRANGES, J-L., and M.L. Hunter, Jr. March 1987. Duckling response to lake acidification. North American Wildlife and Natural Resources Conference, Quebec City.
- DIEFENBACH, D. February 1987. Habitual requirements and population trends of breeding black ducks in south-central Maine. Northeast Graduate Wildlife Conference, Acadia University, Wolfville, NS.
- DIEFENBACH, D., R.B. Owen, Jr., J.R. Longcore, and J.K. Ringelman. August 1987. Populations of breeding waterfowl and wetland habitats in south-central Maine: ten years of change. Symposium on the Ecology and Management of Breeding Waterfowl, Winnipeg, Manitoba.
- DIEFENBACH, D., J.D. Nichols, H.H. Obrecht III, and J.E. Hines. August 1987. Survival rates, harvest rates, winter distribution patterns, and fidelity to wintering areas of sympatric mallards and American black ducks: a comparative analysis on the ecology and management of breeding waterfowl. Symposium on the Ecology and Management of Breeding Waterfowl, Winnipeg, Manitoba.
- DUBUC, L.J. December 1986. Ecology of river otters on Mount Desert Island, Maine. College of Forest Resources, Dow Griffee Committee, University of Maine, Orono, ME.
- DUBUC, L.J. February 1987. Distribution and ecology of river otters in Acadia National Park. Northeast Graduate Student Conference, Acadia University, Wolfville, NS.
- DUBUC, L.J., R.B. Owen, Jr., and W.B. Krohn. March 1987. Ecology of the North American river otter on Mount Desert Island, Maine. Science and Resource Management in Northeast U.S. National Parks, University of Massachusetts, Amherst, MA.

- DUBUC, L.J. June 1987. Assessing habitat quality for river otters on Mount Desert Island, Maine. American Society of Mammalogists Meeting, Albuquerque, NM.
- FRAZER, C. February 1987. Current wildlife research at the University of Maine. Northeast Graduate Student Conference, Acadia University, Wolfville, NS.
- FRAZER, C. August 1987. Fall dispersal and home range of post-fledgling American black ducks in Maine. Symposium on the Ecology and Management of Breeding Waterfowl, Winnipeg, Manitoba.
- GILBERT, J.M. December 1986. Results of 1985 U.S. Walrus Survey. Marine Mammals Committee, U.S.-U.S.S.R. Cooperative Agreement for Joint Research on Environmental Concerns in the North Pacific, Seattle, WA.
- HUNTER, M.L., Jr. March 1987. Managing forests for spatial heterogeneity to maintain biological diversity. North American Wildlife and Natural Resources Conference, Quebec City.
- LIVINGSTON, S. December 1986. Bald eagle nesting habitat. Maine Department of Inland Fisheries and Wildlife regional biologists, Bangor, ME.
- LIVINGSTON, S. February 1987. Construction and validation of a habitat model for Maine's breeding bald eagles. Northeast Graduate Wildlife Conference, Acadia University, Wolfville, NS.
- MORING, J.R. October 1986. Development of a sea-run brown trout sportfishery. Maine-New Hampshire Sea Grant Site Visit Conference, Prouts Neck, ME.
- MORING, J.R. May 1987. Fisheries research directions in Maine. Seminar presented at the National Fishery Research and Development Laboratory, Wellsboro, PA.
- MORING, J.R. May 1987. Restoring Atlantic salmon to Maine: overcoming physical and biological problems in the estuary. Coastal Zone '87, the Fifth Symposium on Coastal and Ocean Management, Seattle, WA.
- OWEN, R.B., Jr. November 1986. Integrating forestry and wildlife management on Maine industrial forest lands. Maine Audubon Society's Spruce-Fir Task Force, Rockland, ME.
- OWEN, R.B., Jr. February 1987. Maine's land use regulation. Eastern Maine Forest Forum, Bangor, ME.
- OWEN, R.B., Jr. March 1987. Wildlife research in the College of Forest Resources. Eastern Maine Forest Forum, Bangor, ME.

- SANTILLO, D.J. May 1987. Response of songbirds and small mammals to glyphosate-induced habitat changes. Northeast Fish and Wildlife Conference, Boston, MA.
- SPALINGER, D.E. April 1987. Plant defenses against large herbivores: are toxins the only way? Seminar in Botany, University of Maine, Orono.
- STRONG, P.T.V., and J.A. Bissonette. September 1987. Activity patterns of common loons in large lakes in Maine. Presented to 1987 North American Conference and Workshop on Loon Research and Management, Cornell University, New York.
- TREITERER, B. September 1986. Nesting ecology and habitat use of wild turkeys in Maine. 23rd Northeast Wild Turkey Workshop, Brooksville, ME.
- TREITERER, B. February 1987. Nesting ecology and habitat use of wild turkeys in Maine. Northeast Graduate School Wildlife Conference, Acadia University, Wolfville, NS.

## PUBLIC TALKS PRESENTED

- ARIHUR, S. "Fisher ecology." Talk presented at Waterville Chapter, Maine Trappers Association, October 1986. 25 attendees.
- ARIHUR, S. "Furbear ecology and management." Lectures presented to undergraduate wildlife classes, University of Maine, November and December 1986. 100 attendees.
- ARIHUR, S. "Fisher ecology." Talk presented at Ellsworth High School Science Class, December 1986. 25 attendees.
- ARIHUR, S. "Fisher ecology." Talk presented at South Paris Chapter, Maine Trappers Association, December 1986. 50 attendees.
- ARIHUR, S. "Fisher ecology." Talk presented at Maine Trappers Association Board of Directors meeting, Augusta, December 1986. 40 attendees.
- ARIHUR, S. "Fisher ecology." Talk presented at the Monroe Sportsman's Club, January 1987. 15 attendees.
- ARIHUR, S. "Fisher ecology." Talk presented at the Ellsworth Chapter, Maine Trappers Association, February 1987. 30 attendees.
- ARIHUR, S. "Fisher ecology." Talk presented at the Belfast Chapter, Maine Trappers Association, February 1987. 15 attendees.

- ARTHUR, S. "Ecology of the fisher in south-central Maine." Invited slide presentation at the Harris Center for Conservation Education, Hancock, NH., March 1987. 75 attendees.
- ARTHUR, S. "Wildlife research opportunities." Talk presented to Unity College, March 1987.
- ARTHUR, S. "Ecology of fishers in Maine." Slide show presented to Piscataquis River Chapter, Maine Trappers Association, April 1987.
- ARTHUR, S. Wildlife telemetry - Demonstration presented to 100 high school students and parents at College of Forest Resources Open House, University of Maine, Orono, April 1987.
- ARTHUR, S. "Ecology of the fisher." Slide show and telemetry demonstration presented at the Maine 4-H Animal Science Day, University of Maine, Orono, April 1987. 24 attendees.
- ARTHUR, S. "Fisher ecology." Seminar presented at the White Memorial Forest Nature Center, Litchfield, CT., May 1987. 25 attendees.
- ARTHUR, S. "Ecology of fishers in Maine." Talk presented to Penobscot County Conservation Association, Brewer, ME., June 1987. 100 attendees.
- ARTHUR, S. "Ecology of fishers in south-central Maine." Presented at wildlife noontime seminars, University of Maine Wildlife Department, September 1987.
- DUBUC, L.J. "The ecology of river otters on Mount Desert Island, Maine." Presented at Acadia National Park, September 1987. 20 park resource and interpretive personnel.
- DUBUC, L.J. "The ecology of river otters on Mount Desert Island, Maine." M.S. Thesis seminar. Students and faculty of the University of Maine, Orono, September 1987.
- HERKE, S.W. "Ecology of northern pike." Seminar presented at State of Maine's Sportsman's Show, Augusta, March 1987. 80 attendees.
- HILLS, S. Talk on summer research plans presented to meeting of Eskimo Walrus Commission, Nome, Alaska, April 13-15, 1987.
- HUNTER, M.L., Jr. "A global approach to wildlife conservation." Talk presented to University of Maine at Farmington, October 1986. 20 student attendees.
- HUNTER, M.L., Jr. "Acid rain and wildlife." Talk presented to Bowdoin College, October 1986. 35 student attendees.
- HUNTER, M.L., Jr. "A global approach to wildlife conservation." Talk presented to Unity College, January 1987. 40 student attendees.

- HUNTER, M.L., Jr. "A global approach to wildlife conservation." Talk presented to Maine Audubon Society, February 1987. 35 attendees, general public.
- HUNTER, M.L., Jr. "Acid rain and wildlife." Talk presented to College of the Atlantic, April 1987. 25 student attendees.
- HUNTER, M.L., Jr. "A global approach to wildlife conservation." Talk presented to Bath Garden Club, May 1987. 40 attendees, general public.
- HUNTER, M.L., Jr. "The Maine amphibians and reptiles atlas project." Maine Audubon Society, September 1987. 35 public attendees.
- KROHN, W.B. "Ecology of fisher in south-central Maine." Slide presentation to the Sunkhaze Chapter, Trout Unlimited, Brewer, ME., October 1986. 30 attendees.
- KROHN, W.B. "An overview of waterfowl management in North America." Lecture to undergraduate wildlife class, December 1986. 25 attendees.
- KROHN, W.B. "Organization and functions of the U.S. Fish and Wildlife Service," "Migratory bird program of the U.S. Fish and Wildlife Service." Lectures to undergraduate wildlife policy class, January 1987. 25 attendees.
- KROHN, W.B. "An overview of the Maine Predator Project." Invited presentation at the Harris Center for Conservation Education, Hancock, N.H., March 1987. 75 attendees.
- KROHN, W.B. "Maine Chapter of The Wildlife Society's Position on an Act to Establish the 1987 Deer Season (LD 291)." Position statement given to the Maine Legislative Committee on Inland Fisheries and Wildlife, Augusta, March 1987. 40 attendees.
- KROHN, W.B. Represented the Maine Chapter of The Wildlife Society at a public panel advising the Commissioner, Maine Department of Inland Fisheries and Wildlife, on how to spend the state's \$5 million habitat bond issue. April - June (3 meetings) 1987. 20-25 attendees per meeting.
- KROHN, W.B., S.M. Arthur, and D. Licht. Presented an exhibit of recent research on predator ecology at the Maine Trappers Association Annual Fall Rendezvous, Dixmont, ME., September 12, 1987. 80 attendees.
- LIVINGSTON, S. "Construction and validation of a habitat model for Maine's breeding bald eagles." Talk presented to the Northeast Wildlife Graduate Student Conference, Acadia University, Wolfville, NS., February 1987. 50 attendees.

- LIVINGSTON, S. Presentation with Bart the bald eagle to Bangor YWCA Discovery House preschool children, May 1987. 40 attendees.
- LIVINGSTON, S. Presentation with Bart the bald eagle to 150 Bath area 6th grade students, May 1987.
- LIVINGSTON, S. "Bald eagle ecology." Talk presented with Bart the bald eagle to Maine Upward Bound students, June 1987. 15 attendees.
- LIVINGSTON, S. "Bald eagle ecology." Talk presented with Bart the bald eagle to a high school summer conference on the University of Maine campus, August 1987. 40 attendees.
- LIVINGSTON, S. "Bald eagle ecology." Talk presented with Bart the bald eagle to Branch Lake YMCA camp, August 1987. 120 attendees.
- MORING, J.R. "Careers in marine fisheries." Lecture presented to Introduction to Marine Sciences class, University of Maine, April 27, 1987. 50 attendees.
- MORING, J.R. "Coolwater fish aquaculture." Lecture presented to Aquaculture class, University of Maine, November 1986. 12 attendees.
- MORING, J.R. "Effects of logging on aquatic systems." Lecture presented to freshman wildlife class, University of Maine, October 1986. 40 attendees.
- MORING, J.R. "Fish anatomy," "Fishes of Maine," and "Fishery regulation." Lectures presented at Maine Warden's School, Orono, April 1987. 15 attendees.
- OWEN, R.B., Jr. "Maine's endangered species." Talk presented to Bangor Nature Club, Bangor, February 1987. 60 attendees.
- OWEN, R.B., Jr. "Deer management in Maine." Testimony before the Maine Legislative Fish and Wildlife Committee, Augusta, ME., March 1987.
- OWEN, R.B., Jr. "Economic values of fish and wildlife to Maine's economy." Testimony before the Governor's Economic Council, Bangor, ME., April 1987.
- OWEN, R.B., Jr., and W.B. Krohn. "An overview of the Wildlife Program at the University of Maine." Lecture to Maine Warden School, April 1987. 15 attendees.
- OWEN, R.B., Jr. "Maine's endangered species." Talk given to the Orono Daughters of the American Revolution, Orono, ME., April 1987. 20 attendees.

- OWEN, R.B., Jr. "Management and funded needs for Maine's endangered species." Testimony before the U. S. Senate Subcommittee on Endangered Species, Portland, ME., May 1987
- OWEN, R.B., Jr. "The forest immortal." Talk presented on Maine Scholar's Day, Orono, May 1987. 15 attendees.
- OWEN, R.B., Jr., and D. Spalinger. "Maine's deer and eagles - research and management." Talk presented on Maine Scholar's Day, Orono, May 1987. 50 attendees.
- OWEN, R.B., Jr. "Wildlife ecology." Talk presented at ecology workshop, Maine High Adventure Program, Sebomouk Lake, ME., June 1987. 35 attendees.
- OWEN, R.B., Jr. "Woodcock habitat requirements." Workshop on Woodcock Management on Industrial Forest Lands. Portland, ME., September 1987.
- SANTILLO, D.J. "Response of breeding birds and small mammals to herbicide-induced habitat changes." Wildlife noontime seminar, Wildlife Department, University of Maine, Orono, ME., April 1987.
- SANTILLO, D.J. "Response of songbirds and small mammals to herbicide-induced habitat changes." Presented at forestry staff meeting of Great Northern Paper Company, Millinocket, ME., May 1987. 50 foresters.

#### PROFESSIONAL MEETINGS ATTENDED

- ARTHUR, S. Attended the annual meeting of the Northeast Fisher Working Group, Concord, NH., May 1987.
- ARTHUR, S. Attended American Society of Mammalogists Meeting in Albuquerque, NM., June 1987.
- DEVAUL, H. Attended North Atlantic Marine Mammal Association Conference, Boston, MA., March 1987.
- DIEFENBACH, D. Attended the Northeast Graduate Wildlife Conference, Acadia University, Wolfville, NS., February 1987.
- DIEFENBACH, D. Attended Symposium on the Ecology and Management of Breeding Waterfowl, Winnipeg, Manitoba, August 18-23, 1987.
- DUBUC, L.J. Attended Northeast Graduate Wildlife Conference, Acadia University, Wolfville, NS., February 1987.
- DUBUC, L.J. Attended the National Park Service Northeast Research Meeting, Amherst, MA., March 1987.

- DUBUC, L.J. Attended American Society of Mammalogists Meeting in Albuquerque, NM., June 1987.
- FRAZER, C. Attended Northeast Graduate Wildlife Conference, Acadia University, Wolfville, NS., February 1987.
- FRAZER, C. Attended Symposium on the Ecology and Management of Breeding Waterfowl, Winnipeg, Manitoba, August 1987.
- HILLS, S. Attended meeting of Eskimo Walrus Commission, Nome, Alaska, April 1987.
- HUNTER, M.L., Jr. Attended the North American Wildlife and Natural Resources Conference, Quebec City, March 1987.
- HUNTER, M.L., Jr. Participated in and led field trip to Machias Seal Island for 30 members of North American Benthological Society, June 1987.
- KROHN, W.B. Attended 52nd North American Wildlife and Natural Resources Conference, Quebec City, March 1987.
- LIVINGSTON, S. Attended Northeast Graduate Wildlife Conference, Acadia University, Wolfville, NS., February 1987.
- MORING, J.R. Attended Remotely Operated Vehicles Conference, San Diego, CA., March 1987.
- MORING, J.R. Attended Coastal Zone '87 Symposium, Seattle, WA., May 1987.
- MORING, J.R. Attended annual meeting of the North American Benthological Society, Orono, ME., June 1987.
- MORING, J.R. Attended Northeast Aquaculture Conference, Portland, ME., August 1987.
- OWEN, R.B., Jr. Attended 52nd North American Wildlife and Natural Resources Conference, Quebec City, March 1987.
- OWEN, R.B., Jr. Attended 44th Northeast Fish and Wildlife Conference, Boston, MA., May 1987.
- OWEN, R.B., Jr. Attended Northeast Wildlife Teachers Meeting, Boston, MA., May 1987.
- OWEN, R.B., Jr. Attended Symposium on the Ecology and Management of Breeding Waterfowl, Winnipeg, Manitoba, August 18-23, 1987.
- OWEN, R.B., Jr. Attended Workshop on Woodcock Management on Industrial Forest Lands, Portland, ME., September 9-10, 1987.

OWEN, R.B., Jr. Attended the National Park Service Coordinating Meeting for Long-term Inventory and Monitoring of Natural Resources at Acadia National Park, Bar Harbor, ME., September 14, 1987.

SANTILLO, D.J. Attended 44th Northeast Fish and Wildlife Conference, Boston, MA., May 1987.

SPALINGER, D.E. Attended Northeast Wildlife Conference, Boston, MA., May 1987.

SPALINGER, D.E. Attended Northeast Wildlife Educators Meeting, Cranberry Lake, NY., July 1987.

TRETTNER, B. Attended 23rd Northeast Wild Turkey Workshop, Brooksville, ME., September 1986.

TRETTNER, B. Attended Northeast Graduate Wildlife Conference, Acadia University, Wolfville, NS., February 1987.

#### AWARDS

MORING, J.R. Received a Special Achievement Award for Research, November 1986, and a promotion based on research productivity, May 1987, from the U.S. Fish and Wildlife Service.

SAYERS, R., Jr. Received Horace Bond Scholarship for Fisheries from the Penobscot County Conservation Association, October 1986.

SANTILLO, D. Presented scholarship of \$1,000 by New England Outdoor Writers' Association at annual meeting, Worcester, MA., January 1987.

YONZON, P. Received the Brown Prince Award for Science and Technology from the Royal Nepal Academy of Science and Technology, June 1987.



