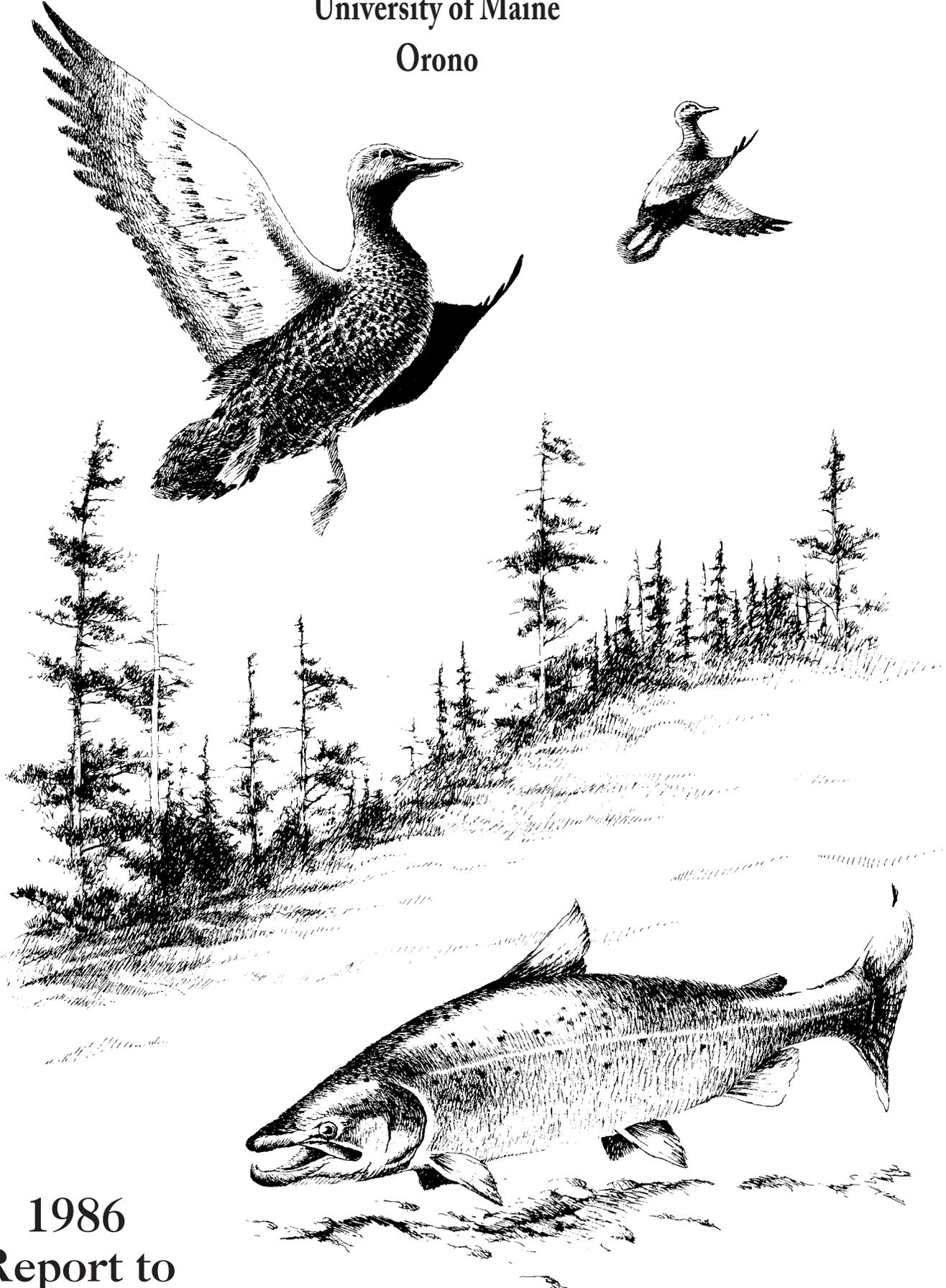


MAINE COOPERATIVE FISH AND WILDLIFE RESEARCH UNIT

University of Maine

Orono



1986
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

MAINE DEPARTMENT OF INLAND FISHERIES AND WILDLIFE

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

WILDLIFE MANAGEMENT INSTITUTE

October 1985 - September 1986



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.

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

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PERSONNEL AND COOPERATORS

COORDINATING COMMITTEE

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

William G. Valteau, Chairperson, 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

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Associate Professor of Wildlife and Zoology
John R. Moring, Assistant Leader for Fisheries
Associate Professor of Zoology
Matthew A. Miller, Wildlife Technician
Dennis B. Kingman, Jr., Wildlife Technician
Kathryn G. Hallett, Unit Secretary - Fisheries
Maxine L. Horne, Unit Administrative Secretary - Wildlife
Nancy Kealher, Secretary - Wildlife

Associated Faculty and Staff, Departments of Wildlife and Zoology

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College of Forest Resources, and Professor of Wildlife
William G. Valteau, Chairperson, Department of Zoology
College of Arts and Sciences, and Professor of Zoology
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William E. Glanz, Associate Professor of Zoology
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Malcolm L. Hunter, Jr., Associate Professor of Wildlife
Patrick W. Brown, Assistant Professor of Wildlife
Jerry R. Longcore, Wildlife Research Associate and Research
Wildlife Biologist, USFWS
Hewlette S. Crawford, Jr., Research Wildlife Biologist, USFS
Terry A. Haines, Professor of Zoology and Fishery Research
Biologist, USFWS
Patrick W. Bley, Zoology Research Associate
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Chet MacKenzie, Zoology Research Associate

Charles M. Jagoe, Zoology Research Associate
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 Jack Witham, Wildlife Research Associate
 Arlene K. Blumton, Wildlife Technician
 Catherine Frazer, Wildlife Technician

Maine Department of Inland Fisheries and Wildlife
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 Norman E. Trask, Deputy Commissioner
 Frederick B. Hurley, Jr., Director, Bureau of Resource Management
 Robert W. Boettger, 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

Personnel from many University departments as well as State, Federal, and private organizations are actively collaborating with the Unit. Individuals assisting with projects currently reported are listed in connection with the appropriate project summary.

GRADUATE STUDENTS

Name	Degree Candidacy	Support
Stephen M. Arthur	Ph.D.	MDIFW; MCFWRU; ME Trappers' Assoc. (NE Coastal Ch.)
Timothy D. Bowman	M.S.	AFCBP
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
Duane R. Diefenbach	M.S.	Hatch Act
Leslie J. Dubuc	M.S.	NPS
Diane R. Eggeman	M.S.	Delta Waterfowl & Wetland Research Station, U of M
Catherine A. Elliott	Ph.D.	IPC; MDIFW
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
Stanislas J. Pauwels	Ph.D.	USFWS
Cynthia M. Perry	Ph.D.	USFWS, U of M
Sumner M. Roberts	Ph.D.	McIntire-Stennis
David J. Santillo	M.S.	McIntire-Stennis
Richard E. Sayers, Jr.	Ph.D.	MDIFW, U of M, MCFWRU, PVCC
Sarah S. Stockwell	Ph.D.	Personal Funding

Michael E. Thompson	M.S.	MDIFW; MCFWRU; McIntire-Stennis
Joan G. Trial	Ph.D.	U of M
Beatrice E. Treiterer	M.S.	MDIFW: NTF
Peter D. Vickery	M.S.	NC; MAS; MPCB; MAAS; CB
Pralad B. Yonzon	Ph.D.	U of M; WWF

Graduate Students: Dissertations/Theses Completed This Period

Patrick W. Bley	M.S.
Paul D. Eiler	M.S.
Donald B. Englehardt	M.S.
Daniel J. Harrison	Ph.D.
Jonathan A. Jenks	M.S.
Walter N. Johnson, Jr.	M.S.
Dennis G. Jorde	Ph.D.
David J. Leptich	M.S.
Daniel G. McAuley	M.S.
Mark A. McCollough	Ph.D.
Stanislas J. Pauwels	M.S.
Mary F. Small	M.S.
Sarah S. Stockwell	M.S.

PERSONNEL NOTES

DR. DONALD E. SPALINGER accepted the position of Assistant Professor of Wildlife at the University and arrived in late August. Dr. Spalinger, a Post-Doctoral Research Associate at Washington State University prior to coming to Maine, will be teaching undergraduate and graduate courses and conducting research on ungulate nutrition.

The following fish graduate students obtained their degrees during the reporting period: **PATRICK BLEY** completed his M.S. degree in May, worked on a U.S. Fish and Wildlife Service contract for two months, and is currently working as an environmental biologist for a power company in Minnesota. **PAUL EILER** also completed his M.S. degree in May and is employed by the Minnesota Department of Natural Resources. **STANISLAS PAUWELS** completed his M.S. degree in December and is currently in the Ph.D. graduate program in Zoology at the University of Maine.

The following wildlife graduate students obtained their degrees at either the May or August graduation: **DANIEL HARRISON** received his Ph.D. degree and is currently employed as Big Game and Furbearer Project Leader for the Connecticut Department of Environmental Protection. **DENNIS JORDE** completed his Ph.D. program and is working as a Wildlife Biologist for the Branch of Migratory Bird Research, USFWS, Patuxent Wildlife Research Center. **MARK MCCOLLOUGH** received his Ph.D. degree and presently is employed by the Maine Caribou Transplant Committee, stationed at the University of Maine, Orono. **JONATHAN JENKS** received his M.S. degree in August and was accepted at Oklahoma State University

into their Ph.D. program. **WALTER N. JOHNSON, JR.** obtained his M.S. in May and is Assistant Refuge Manager at Bombay Hook National Wildlife Refuge. **DAVID LEPTICH** finished his M.S. program in May and is a Wildlife Biologist for the Idaho Department of Fish and Game. **DANIEL MCAULEY** completed his M.S. degree and continues working for the USFWS at the Patuxent Wildlife Research Center's Orono field office. **MARY SMALL** received her M.S. degree in August and is currently employed by Normandeau Associates. **DONALD ENGELHARDT** completed his M.S. program and is employed in New Hampshire. **SARAH STOCKWELL** completed her M.S. and is continuing on for her Ph.D. in Wildlife at the University of Maine.

COLLABORATING AGENCIES AND ORGANIZATIONS

Atlantic Flyway Cooperative Banding program,
 Atlantic Waterfowl Council - AFCBP
 Canadian Federal Government - NSERC
 Canadian Wildlife Service - CWS
 Coastal Blueberry, Inc. - CB
 Eagle Valley Environmentalists - EVE
 Holt Woodlands Research Foundation - HWRP
 International Paper Company - IPC
 Kennebec Log Driving Company - KLDC
 L.L. Bean, Inc. - LLB
 Libby Sporting Camps - LSP
 Maine Audubon Society - MAS
 Maine Department of Conservation - MDC
 Maine Department of Inland Fisheries and Wildlife - MDIFW
 Maine Pesticides Control Board - MPCB
 Maine Trappers' Association Northern Coastal Chapter - MTA-NECC
 Massachusetts Audubon Society - MAAS
 National Geographic Society - NGS
 National Marine Fisheries Service, Northeast Fisheries Center - NMFS
 National Park Service - NPS
 National Rifle Association - NRA
 National Wild Turkey Federation - NWT
 National Wildlife Federation - NWF
 Nature Conservancy - NC
 Maine Chapter - NC-MC
 North American Wildlife Foundation -
 Delta Waterfowl & Wetland Research Station - DWRS
 Penobscot County Conservation Club - PCCC
 Society of Sigma XI - SX
 St. Regis Paper Co. - SR
 University of Maine, Orono - U of M
 Graduate Student Board - GSB
 College of Forest Resources - CFR
 Hatch Act Funds - HAF
 McIntire-Stennis - MS
 College of Arts and Sciences - CAS
 Zoology Department - ZD

U.S. Environmental Protection Agency - EPA
U.S. Fish and Wildlife Service - FWS
 Alaska Fish and Wildlife Research Center - AFWRC
 National Fisheries Containment Research Center - NFCRC
 National Ecology Center - NEC
 National Wetlands Research Center - NWRC
 Office of Migratory Bird Management - OMBM
 Patuxent Wildlife Research Center - PWRC
U.S. Forest Service - USFS
 Northeast Forest Experiment Station - NEFES
 Pacific Northwest Forest and Range Experiment Station - PNFRES
U.S. National Park Service - NPS
Wheelabrator-Frye, Inc. (now part of Signal Fuels) - SF
World Wildlife Fund - WWF

POST-FLEDGING ECOLOGY AND POPULATION DYNAMICS OF BALD EAGLES IN MAINE

Investigator: M. A. McCollough

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

Cooperators/ Maine Department of Inland Fisheries and Wildlife
Project U.S. Fish and Wildlife Service
Support: Acadia National Park
The Nature Conservancy
Eagle Valley Environmentalists

Objectives:

- (1) Describe post-fledging behavior of bald eagles in Maine with emphasis on movements in relation to breeding areas, habitat use, and associated adult-juvenile relationships.
- (2) Obtain information on juvenile dispersal and movements and location of wintering areas in Maine.
- (3) Investigate winter activity and habitat use of adult and immature eagles in Maine.
- (4) Evaluate artificial feeding of bald eagles during the winter as a technique to: (a) improve survival of juvenile and adult eagles, (b) provide a contaminant-free supplement of eagle diet in the winter, and (c) enhance subsequent nesting attempts of adult eagles.

Project Status:

All requirements for the degree of Doctor of Philosophy (in Wildlife) were completed in May, 1986. An abstract of the dissertation follows:

Photographs of 135 wintering bald eagles (*Haliaeetus leucocephalus*) of known age from Maine were examined to document plumage changes. Criteria were established to age 1/2 year (Juvenal plumage), 1 1/2-year (Basic I), 2-1/2 year (Basic II), and 3-1/2 year (Basic III) eagles primarily from head plumage and iris, beak, and cere color. Body plumage varied between individuals and was not a reliable aging characteristic. Definitive plumage was observed in some 4 1/2-year (Basic IV) and all 5 1/2-year (Basic V) eagles. However, individuals were observed with gray or brown flecking in the head plumage up to 8 1/2-years-of-age. Photographs of wintering eagles demonstrated that yearly body molt is not complete.

A winter feeding program for bald eagles was conducted in Maine during 1981-1985. Over 98,000 kg of carrion were distributed to feeding stations in 4 major eagle wintering areas. Numbers of individual eagles using the feeding stations increased from 66 in 1981-82 to 274 in 1984-85. Observations of 203 different banded eagles indicated that the wintering birds were primarily from Maine and the Canadian Maritime Provinces. First- and second-year eagles depended on the feeding stations for most of their winter diet, and older eagles used the feeding stations less frequently. Dispersal of first-year eagles probably decreased as a result of feeding. Average regional productivity did not increase but local production near feeding sites was enhanced. Energetics of feeding, feeding interactions with corvids, and management implications are also discussed.

Resightings of 195 banded bald eagles at winter feeding stations in Maine from 1981-85 enabled calculation of survival estimates. Survival of first-year, second-year, and older eagles was 73%, 84% and 91%, respectively. Minimum age-specific survival estimates for eagles before feeding were 54%, 79% and 91%. Survival was much higher than previously reported and may have increased by as much as 18% for first- and second-year eagles as the result of winter feeding. Survival and productivity data indicate that Maine's bald eagle population should increase from 84 nesting pairs in 1981 to over 150 nesting pairs by the mid-1990s.

Eighteen young bald eagles in eastern Maine were observed from fledging to dispersal from their natal area. Young eagles stayed with their parents from 35 to 67 days before dispersing and relied entirely on their parents for food (primarily fish during this period). Home ranges of young eagles during the post-fledging period were smallest for island nest sites ($X = 8$ ha) and largest ($X = 69$ ha) for interior nest sites. Young eagles used primarily large, supercanopy white pines (*Pinus strobus*) and spruces (*Picea* spp.) for perch sites and perched near the nest or in adjacent forested riparian habitats. From 30 - 60% of the 1982-85 cohorts initiated a long distance dispersal along the Atlantic seaboard during their first winter. Most of the eagles returned to Maine by their second winter. By their second summer young eagles were adept at capturing their own food and wandered throughout eastern Maine and western New Brunswick.

Retention rates of plastic color bands, anodized rivet bands, vinyl-coated nylon band tags, and U.S. Fish and Wildlife Service rivet bands were determined by repeated observations of 157 triple-banded bald eagles at winter feeding stations in eastern Maine. Plastic color bands had the greatest loss rates and were removed by all birds by their fourth winter. Band tags, anodized rivet bands, and USFWS rivet bands were recommended as good markers for identifying individual bald eagles, if the anticipated distance between observers and marked eagles is consistently <100 m. Resightings of color-marked eagles has increased the proportion of Maine eagles reobserved from 8.2% to 56.3% and enabled the calculation of survival estimates. Details of materials and construction of color markers are given.

CONSTRUCTION AND VALIDATION OF A HABITAT MODEL
FOR MAINE'S BREEDING BALD EAGLES

Investigator: S. A. Livingston

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

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

Objectives:

- (1) Construct a model that will determine whether or not an area is potential bald eagle nesting habitat.
- (2) Test the predictability of the model on existing breeding areas in Maine and modify as appropriate.
- (3) Based on the validated habitat model, assess the availability of breeding habitat in Maine, and recommend methods of protection of potential breeding areas in view of current land-use regulation.

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 Maine Department of Inland Fisheries and Wildlife. To accommodate this projected influx of breeding eagles, potential nesting areas must be identified and protected. Resource management agencies realize the need for protecting important habitats because of increasing human exploitation, but often lack an adequate basis for specifying areas in need of protection. Habitat models can assist in defining these areas, and in documenting the basis for selecting sites.

Project Status:

Two habitat models to identify bald eagle nesting areas in Maine are currently being developed. A coastal model is being constructed based on data obtained from 40 active nests and 40 random sites along the coast. Data from approximately 25 active nests and 25 random sites adjacent to lakes are being used to build an inland model. Discriminant analysis will be used to construct the models, and a jackknife procedure will be used to test them.

Scientific literature on bald eagle nesting habitat in Maine and northern North America has been reviewed and used to develop the conceptual framework of the models. Variables describing forest stand characteristics are being measured within a 500 m radius of the nest. This distance is based on literature describing a minimal flushing

distance for incubating bald eagles. Variables describing ecosystem productivity (i.e., an indirect measure of prey availability) are being measured within a 1500 m radius of the active nest. A 1500 m distance is based on half the average minimum distance between nests of different breeding eagle pairs in sub-populations of the state believed to be at or near carrying capacity (i.e., substantial recruitment or loss of breeding pairs had not occurred in these regions over a 5-10 year period). In one of these sub-populations, only 1 of 8 radio-tagged fledglings was ever located farther than 1500 m from its natal nest during the post-fledging period, further supporting the use of a 1500 m distance around the nest. Variables describing human disturbance are being measured in both circular areas around the nest. Variables are being measured from stereoscopic pairs of aerial photos ranging in scale from 1:16000 to 1:24000. Approximately one-third of the nests have been measured and ground truthed as of October 1.

Future Plans:

Data collection will be completed in late 1986. Data analysis and model construction will begin then and continue through spring of 1987. Completion of thesis is anticipated in August 1987.

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 on 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:

Since May, 1986 three red pandas (one male, two females) have been captured by noosing them out of trees. They have been radio-collared and are located daily. Activity of each individual is checked (the collars have activity sensors) at 15 minute intervals for 24 hours, 5

days per month. Scats of pandas, serow, goral, and Himalayan black bear are collected monthly to determine diet overlap of these species. Vegetation plots in stands of ringal bamboo -- the red panda's presumed primary food -- are monitored twice a month to determine the extent of shoot growth and browsing.

In March a four-day workshop, "Wildlife Habitat and Population Analysis," was taught by Yonzon, Hunter, and Harry Jacobson (Mississippi State University) for 18 Nepali biologists, primarily faculty and graduate students at Tribhuvan University.

Future Plans:

Nine more red pandas will be radio-collared and monitored. Depending on the success of the first year's program, and the availability of funding, a second study area may be established.

The investigator will develop a course in wildlife and conservation biology at Tribhuvan University which will be offered after the completion of the project. It is hoped that such a curriculum will play a fundamental role in educating and recruiting future biologists.



The ecology of red pandas is being studied as part of a program designed to focus attention on forest wildlife in the Nepal Himalayas (Photo by A. Soukkala).

POTENTIAL HABITAT COMPETITION BETWEEN ATLANTIC SALMON AND BROOK TROUT
IN THE UPPER ST. JOHN RIVER SYSTEM

Investigator: P. W. Bley

Advisors: J. R. Moring, Chairperson
W. E. Glanz
B. M. McAlice

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

Objectives: (1) Quantify the habitat selection by brook trout
in waters of the upper St. John River system.
(2) Attempt to predict whether or not introduced
sea-run Atlantic salmon would compete with
brook trout for space and/or food.

Project Status:

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

With the continued interest in stocking sea run Atlantic salmon (*Salmo salar*) into New England rivers, questions have been raised as to the impact of salmon on resident game fish populations. Using the juvenile stages of landlocked salmon as models for the same stages of sea run salmon, habitat overlap and possible competition between salmon and brook trout (*Salvelinus fontinalis*) were examined. Field observations were conducted in tributaries of Maine's upper St. John River.

Two of these streams contained only brook trout, and one stream had coexisting brook trout and salmon populations. Spring, summer, and fall microhabitat selection (0+, 1+, 2+ age classes of each species) was determined using portable backpack electrofishing units, and then quantified in terms of water temperature, total stream discharge, depth, velocity, substrate, cover, and stream position.

In the absence of coexisting juvenile salmon, juvenile brook trout were distributed in all available stream habitats. Older and larger brook trout were found in deeper and faster stream currents. Over the course of the season, younger brook trout tended to move into habitats previously occupied by the next oldest year class. A niche shift occurred in the underyearling and age 2+ brook trout when sympatric with landlocked salmon. These ages of sympatric trout were excluded from habitat occupied by the correspondingly aged salmon (shallow, fast riffles and midstream positions). While no niche shift was observed in yearling brook trout, the low contribution of this age class to total sympatric brook trout biomass is evidence of competition with yearling salmon for a limiting resource. The effect of similar densities of

juvenile Atlantic salmon on sympatric brook trout juveniles is to limit the habitat available for brook trout and consequently to lower the brook trout biomass.

REPRODUCTION OF BLUEBACK CHAR

Investigators: F. W. Kircheis
C. MacKenzie
M. McElroy

Cooperator: J. R. Moring

Cooperators/
Project
Support: The Nature Conservancy
Maine Bureau of Public Lands

Objective: Describe the spawning behavior and fecundity of blueback char.

Scope:

The blueback char, a landlocked form of Arctic char, is rare, and perhaps is a threatened subspecies. It is managed as a separate "species" by the State of Maine. Genetically, it has been shown to be similar to Arctic char, but the spawning behavior appears to be unique. This spawning activity has not been adequately investigated or described.

Project Status:

Oneida trap nets and fyke nets were used to collect blueback char from three lakes in Deboullie-Red River Township (T15, R9). These lakes in central Aroostook County are among only a handful of lakes in Maine known to contain blueback char. Information was gathered on the population characteristics of all species collected in the lakes as well as the reproductive habits of blueback char.

Future Plans:

All field work has been completed and a final report was submitted to the funding agencies.

FISHERIES INDICES IN LAKE SEBASTICOOK AS AFFECTED BY WATER DRAWDOWN

Investigators: F. Jiffry
C. Fay
J. Snow
L. S. Weiss-Glanz
J. G. Trial

Advisors: J. G. Stanley, Chairperson (for F. Jiffry)
R. L. Vadas
S. Tyler

Cooperator: J. R. Moring

Cooperator/

Project

Support: Maine Department of Environmental Protection

Objective: Measure biological changes associated with water drawdown of Lake Sebasticook, Maine.

Scope:

In an effort to improve the water quality and fishery of the eutrophic Lake Sebasticook, water levels were drawn down over several years. Prior to and after these drawdowns, populations of fishes and freshwater mussels were studied in several interrelated projects.

The notable result was the elimination of almost all freshwater mussels following drawdown. Mussel movement was slower than the receding waters, so the mussels burrowed and eventually starved.

Project Status:

A final report was issued to the funding agency.

FOOD CHAIN OF SCHOODIC LAKE, MAINE

Investigator: R. E. Sayers, Jr.

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

Cooperators/
 Project

Support: Maine Department of Inland Fisheries and Wildlife

Objective: Quantify elements of the food chain in Schoodic Lake to indicate possible reasons for the poor productivity and growth of game fishes, and to recommend possible management options.

Scope:

The Schoodic Lake fisheries for landlocked salmon and lake trout have been poor for many years. The success rate for winter salmon anglers of 0.05 fish per angler-hour is well below the regional average. The regional manager has established as a goal landlocked salmon of 16 inches and 1 pound by the end of the second year of growth. Results of trapnetting operations in October, 1985 indicate that this goal is not being met despite drastic cuts in the salmon stocking rate. Lake trout growth also appears to be poor. Approximately 80% of all lake trout caught during the 1985 winter season were below the legal size limit of 18 inches. The most likely cause of slow salmonid growth is insufficient forage-fish populations. Several attempts have been made to establish a smelt population but these have been largely unsuccessful. The State of Maine requested a fishery investigation to assess the plankton and forage base and to recommend management options.

Project Status:

Winter feeding data were collected in February and March 1986 using stomachs from fish caught by ice anglers. The results indicated that Trichoptera larvae (immature caddis flies) were the most important winter food for salmon and that slimy sculpins and nine-spine sticklebacks were the most important food for lake trout. Attempts to collect summer data using horizontal and vertical gillnets were largely unsuccessful. These results are being summarized and will be submitted to the Maine Department of Inland Fisheries and Wildlife.

Future Plans:

The results of gillnetting operations will be submitted to management biologists and recommendations will suggest an introduction of smelt in spring 1987. Further studies will be terminated.

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 - National
Project 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. Of particular importance is the loss of Atlantic salmon stocks. Since the passage of the Anadromous Fish Conservation Act (PL 89-304) in 1965, major efforts are underway to restore 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 over harvesting, 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 are being reared and tested. Four sources are of sea run origin and two are from landlocked populations. One half of each source will be raised one to two pH units lower than its counterparts for six months. One sea run source and one landlocked source will continue to be reared at a lower pH until smoltification. At various lifestages from yolk sac fry through smolt, these fish will be subjected to various low levels of pH.

Lower lethal limits or EC_{50} 's will be 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 lowered pH levels during various periods of their lives and using these strains to enhance present populations, and (c) by describing the ionic changes (Na⁺, K⁺, 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:

Construction of test and rearing facilities is complete. Four life stages of six strains have been successfully tested, with appropriate data ready for analysis.

Future Plans:

Tests for two more life stages, pre-smolt and smolt, are planned for 1987. Histological samples, as well as whole body and blood analyses need to be completed in 1987. Examination of calcium levels at the cellular level will begin in 1987. A thesis will be completed by December 1988.

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 check list 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:

Monitoring of three study pools continued at Schoodic Peninsula in 1986, and data were recorded on the impact of Hurricane Gloria (September 1985) on the physical and biological components of the pools. Significant changes were noted, including the absence of small invertebrates and changes in pool morphology. Additional data were collected on algal associations of juvenile lumpfish and Atlantic seasnails. Most fishes preferred species of Laminaria. Work in fall 1985 involved monitoring of environmental conditions affecting emigration of fishes from tidepools to subtidal areas, primarily temperature and salinity. Numerous journal papers and reports have been published.

Future Plans:

Work in 1987 will primarily involve the preparation and publication of several manuscripts dealing with research results from 1979-1986.

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

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

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

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 U.S. Fish and Wildlife Service managers and other agencies.

Scope:

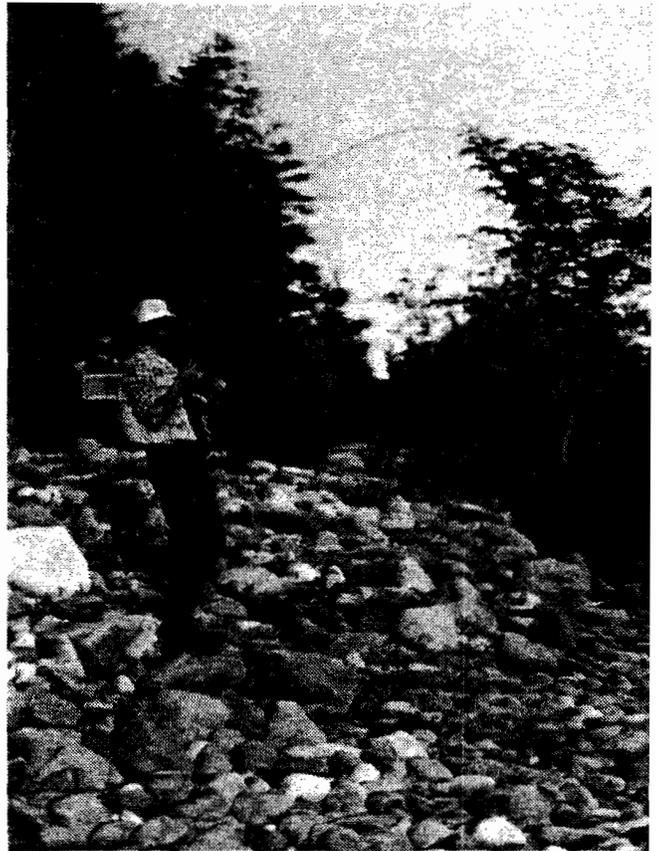
The U.S. Fish and Wildlife Service is currently refining several restoration models for Atlantic salmon. To maximize predictive confidence, accurate estimates of such factors as intragravel survival rates, mortality rates of returning adults, etc. must be included in the model. Much of the available 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:

A draft report has been prepared and is being peer reviewed.

Future Plans:

The draft report will be circulated to selected federal fish biologists in the Northeast. A final report will be issued early in 1987 by the FWS' Office of Information Transfer.



Fishing for Atlantic salmon is a popular recreational activity along the lower reaches of Maine's Penobscot River. Cooperative State-Federal research and management is resulting in increased runs (Photos by W. B. Krohn).

SONGBIRD AND SMALL MAMMAL POPULATIONS
IN MAINE RIPARIAN AND EDGE OAK-PINE FORESTS

Investigator: M. F. Small

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

Cooperators/
Project

Support: Holt Woodlands Research Foundation

Objectives:

- (1) Determine densities of bird and small mammal populations in riparian oak-pine forests and forests with a powerline edge.
- (2) Determine productivity of birds and small mammals in these study areas.
- (3) Compare the densities of various species in the riparian forest to their densities in the area with a powerline edge.
- (4) Compare the changes in vegetation height and composition near the powerline edge with those of a riparian zone.
- (5) Observe the effects of distance from edge upon species density.

Project Status:

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

The effects of abrupt forest-estuarine river and forest-powerline edges upon passerine and small mammal richness and density, and the effect of forest fragmentation upon songbird nesting success were investigated. Passerines were censused along line transects perpendicular to an edge on 4 study areas. Two study areas were beside rivers, and two beside powerlines. Densities were estimated with a modification of Emlen's technique. Density and richness were not consistently greater near either edge type than in the forest interior. Richness within 30 m of powerlines was greater than richness from 60 to 90 m of them. Different edge species occurred in the powerline and river edges.

Small mammals were live-trapped at 15-m intervals along transects perpendicular to an edge. One study area was beside a river, the other was beside a powerline. Ninety-six traps were set at each study area in July 1984, August 1984, and August 1985. Of those species most likely to be caught with Sherman live traps, white-footed mice (Peromyscus leucopus noveboracensis) and redback voles (Clethrionomys gapperi) were captured at both study areas. Woodland deer mice (Peromyscus maniculatus gracilis) and woodland jumping mice (Napaeozapus insignis)

were captured only in the study area beside a powerline, meadow voles (Microtus pennsylvanicus), only at the study area beside the river. Richness and total number of individuals caught were not related to distance from edge. In August of both years, white-footed mice were more abundant near the powerline edge than in the forest interior, and redback voles were less abundant near the powerline edge than farther within the forest. Woodland deer mice were less abundant near the powerline edge than farther within the forest in August 1985. Number of individuals was not different near the river than in the forest interior for any species.

Artificial nests containing 3 Japanese quail (Coturnix coturnix) eggs were placed at 15-m intervals along transects extending perpendicular from an edge. Four of the forest fragments studied were bordered on at least one side by a body of water wider than 10 m. The remaining four were completely bordered by land and narrow streams. A stepwise logistic regression showed that whether the land was partially surrounded by a wide body of water, the area of the fragment, and the interaction term between the two parameters were important in predicting the amount of predation in a forest tract. An edge/area ratio, percent of forest within 3 km, and the distance of each nest from an edge did not explain predation rates.

AVIAN USE OF LAKESHORE BUFFER STRIPS IN EASTERN MAINE

Investigator: W. N. Johnson, Jr.

Advisors: P. W. Brown, Chairperson
J. R. Gilbert
G. L. Jacobson

Cooperators/
Project

Support: McIntire-Stennis

Objectives:

- (1) Compare avian community parameters (i.e. diversity, richness, and density) between lakeshore buffer strips and undisturbed lakeshore.
- (2) Quantify the composition and structure, or other specific components of vegetation used by selected species for breeding and foraging.
- (3) Use the results of this study to evaluate the effects of habitat perturbations on breeding birds of lakeshore areas.

Project Status:

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

Avian use of a lakeshore buffer strip and an undisturbed lakeshore was examined in eastern Maine during 1984-85. Population densities and diversities were determined from bird censuses and compared between sites. A harvest index (HI) was developed to model avian response to different levels of timber harvest within the buffer strip. Predictive habitat models for the ovenbird (*Seiurus ayrocapillus*) and blackburnian warbler (*Dendroica fusca*) were created using discriminant function analysis (DFA) and vegetation data from the undisturbed lakeshore. Models were tested using the jackknife procedure, cross validation, and independent data. Two methods of model construction were compared.

Predictive models performed well in all validation tests. Classification rates of used habitat were excellent for the independent data sets, but poor for unused habitat. Univariate screening of variables before analysis increased model stability and had a negligible effect on classification rates.

Breeding bird density, diversity, and richness were lowest in the buffer strip. The undisturbed site contained a significantly greater ($p < 0.05$) density and diversity of birds in 1985. Densities of cavity and foliage nesters, and ground foragers were also greater in the undisturbed site ($p < 0.05$) in 1985. The HI was negatively correlated with tree density, basal area, and canopy cover, and positively correlated with shrub density and ground cover.

The blackburnian warbler was intolerant of harvesting. Nine species were moderately tolerant and responded negatively to increasing HI levels ($F = 33.2$, $p < 0.001$, $r = 0.54$). Eight species were associated with harvesting and responded positively to increasing levels of HI ($F = 44.8$, $p < 0.001$, $r = 0.60$). Management implications are discussed.

AQUATIC AND TERRESTRIAL RESOURCE INVESTIGATIONS OF
ACID PRECIPITATION AND ASSOCIATED METALS

Investigators: J. R. Longcore, Maine Field Station, PWRC
D. G. McAuley, Maine Field Station, PWRC
G. Pendleton, PWRC

Cooperators/ U.S. Fish and Wildlife Service
Project - Patuxent Wildlife Research Center (PWRC)
Support: Laurel, MD.
- National Fisheries Contaminant Research Center
Columbia, MO.

Objectives:

- (1) Measure and catalog pH and alkalinity of ponds, marshes, and other wetlands suitable for water-bird habitats.
- (2) Map wetland vegetation and classify vulnerable and resistant wetlands according to the criteria of the National Wetlands Inventory.
- (3) Document annual variability in waterbird abundance and productivity as related to wetland pH and measure survival of ring-necked duck ducklings and foods eaten on ponds of high and low pH.

Scope:

Acidification of lakes, ponds and other wetlands has reduced or eliminated some fish and aquatic invertebrate populations in some areas of the northeast. Most studies have been conducted on fish populations in high elevation lakes. Little is known of the effects that acidification might have on the avifauna that use these lakes and associated beaver flowages. This study is designed to evaluate wetland avian productivity and habitat relationships within an area of high vulnerability (based on bedrock characteristics) to acidification.

Project Status:

This project is now complete. Primary findings based on the hypotheses tested are as follows:

Hypothesis (1): Bedrock characteristics are not useful predictors of pH and alkalinity of small ponds and beaver flowages.

Findings: Just as for large, uncolored, headwater lakes, bedrock characteristics can be used to predict water pH and alkalinity for small ponds and beaver flowages with colored water. Based on the 200 ueq/l criterion of alkalinity, all wetlands (N = 29) in the low acid-neutralizing-capacity (ANC) area were below this criterion. In the high ANC study area, only one of 31 wetlands did not meet this criterion. Mean values of pH, alkalinity, and conductivity were higher on the high ANC study area ($P < 0.0001$) than on the low ANC area.

Hypothesis (2): There is no difference in invertebrate density and diversity among wetlands with different water chemistries.

Findings: For specific taxa sensitive to low pH, there were statistical differences in the mean number of invertebrates/sample between low (< 5.5) and high (> 5.5) pH. Orders negatively affected by low pH were Ephemeroptera, Basommatophora, Cladocera, and Isopoda. In fishless lakes, some acid-tolerant taxa were more abundant, especially Diptera and Hemiptera. Regardless of taxonomic level, most variance among taxa was associated with the level of wetland eutrophication and the amount of buffering capacity of the wetland. Several invertebrate taxa important for waterfowl did not occur in ponds with low pH.

Hypothesis (3): Substantial populations of aquatic birds and production of young are absent on low alkalinity (<200 ueq/l) wetlands.

Findings: Of the species studied, 21 bird species used study wetlands > 25 times in any given year and 22 additional species used these wetlands, but less regularly. Eleven other species that prey on marsh birds used these low ANC wetlands for hunting. Relatively dense numbers of waterfowl broods (mean = 82/year) occurred on the combined study area. Based on the 91 km² of habitat surveyed, the brood density was 1.1/km², which is high production.

Hypothesis (4): Foods eaten by ring-necked duck ducklings are not different among wetlands with different water chemistries.

Findings: Although the diet of ring-necked duck ducklings was diverse, acid-tolerant caddisflies and freshwater sponges made up 75% of the food eaten by ducklings on wetlands with low (< 6.1) pH. Only 15 other taxa were used as food on low pH wetlands. In contrast, on high (>6.1) pH wetlands caddisflies and sponges made up 52% of the diet and 31 other taxa were eaten. Acid-sensitive taxa (snails and clams) occurred only in ducklings from high pH wetlands.

Hypothesis (5): Survival of ring-necked duck broods and ducklings are not different among ponds with different water chemistries.

Findings: Total brood loss for female ring-necked ducks was 19%, which was similar to that for black ducks. Older ducklings (Class IIb-III) survived at a higher rate than younger ducklings, except when wetland pH was considered. The survival rate was 10% lower for the older ducklings than younger ducklings on ponds with low pH. The greatest difference (15%) in survival for these older ducklings was between the highest and lowest pH ponds. Because these older ducklings require large quantities of protein and energy to grow feathers and gain weight,

this lower survival rate seems related to lack of food on the low pH ponds. For those wetlands used by broods, the mean numbers of invertebrates was lower on the low pH ponds than on the high pH wetlands ($P < 0.001$).

Future Plans:

Formal close-out of the RWO will be initiated as soon as the final draft is printed. Several manuscripts will be prepared for submission to peer-reviewed journals.



Ring-necked ducks were marked with nasal saddles and studied on wetlands of low ($\text{pH} > 6.1$) and high ($\text{pH} < 6.0$) acidity. Invertebrates eaten by ducklings were less abundant and less diverse, and duckling survival was significantly lower, on high versus low acidity wetlands (Photo by D. G. McAuley).

SPECIES PROFILES OF FISHES AND SHELLFISHES OF THE GULF OF MEXICO
AND ATLANTIC OCEAN

Investigators: J. R. Moring
H. Hidu
K. H. Kelly
C. MacKenzie
D. M. Mullen
C. Newell
J. G. Stanley

Cooperators/

Project U.S. Fish and Wildlife Service - National Coastal
Support: Ecosystem Team, Slidell, LA.

Objective: Summarize and publish life history information dealing with economically important marine species for use in environmental assessments.

Scope:

Environmental alterations can be particularly severe for aquatic organisms. If regulatory agencies have access to up-to-date information on life histories, environmental requirements, fisheries, and the ecological role of impacted species, some potential problems can be avoided. The U.S. Fish and Wildlife Service and U.S. Army Corps of Engineers are producing a series of such "species profiles." Eventually, most of the important species of coastal fishes and shellfishes will be covered in concise booklets, presenting quantified information and references.

Project Status:

Project has been completed with the submission of the following ten profiles:

Four profiles were produced under an earlier contract. Currently, 10 profiles have been prepared and are in different stages of publication: American oyster (Gulf of Mexico), American oyster (mid-Atlantic), Atlantic herring (North Atlantic), American shad (mid-Atlantic), sea scallops (North Atlantic), blueback herring/alewives (North Atlantic), hard clam (North Atlantic), softshell clam (North Atlantic), American shad (North Atlantic), and American lobster (North Atlantic). Eight profiles were recently published and two profiles are currently at the Government Printing Office.

ECOLOGICAL EFFECTS OF LOG DRIVING IN RELATION TO NAVIGABLE RIVERS

Investigators: P. D. Eiler
J. R. Moring

Advisors: K. E. Gibbs, Chairperson (for Eiler)
W. A. Halteman
J. B. Dimond
J. R. Moring

Cooperators/
Project
Support: Kennebec Log Driving Company

Objectives:

- (1) Assess fish and invertebrate populations 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 sunk 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 impact of log salvaging on macroinvertebrates have been measured.

Project Status:

A final report will be prepared in December 1986. All requirements for the degree of Master of Science (Entomology) were completed by Paul Eiler in May 1986. An abstract of the thesis follows:

By the time log drives ended in 1976, an estimated 1-2 million cords of pulpwood had been lost in the Kennebec River system, primarily by sinking in Wyman Lake and Indian Pond. Salvaging of pulpwood has occurred in these two reservoirs since then. This study (1981) addressed the effects of sunken pulpwood logs on benthic habitat and macroinvertebrate biomass, composition, and distribution. Sunken pulpwood logs were balsam fir (*Abies balsamea*) or eastern spruce (*Picea* spp.) which averaged 14 cm in diameter by 122 cm in length. Most logs retained little bark. In Wyman Lake, logs were most abundant in the area where they were formerly held and formed into rafts; accumulations reached a height of 1 m above the sediment. Here logs provided 1.53 m² surface area per m² lake bottom and covered 32% of the sediment surface.

Sediment in this site contained significantly more bark, twigs and leaves (13% by weight) than sediment in two sites outside of the former holding area (1.7% and 2.4%). Sediment deposition rates are sufficient to bury a single log in 5-12 years or to cover heaviest log accumulations in 36-86 years.

Macroinvertebrates from cores of sediment were compared to those from logs collected in a 0.243 mm mesh bag. Biomass was significantly higher in sediment cores. Monthly mean values (May-August) were 100-1010 mg/m² log surface and 1890-5910 mg/m² sediment surface. Diptera dominated log biomass (35.4%) followed by Trichoptera (17.6%), Gastropoda (13.7%) and Ephemeroptera (13.4%). Taxa dominating in sediment were Diptera (43.8%), Ephemeroptera (16.1%), Megaloptera (16.0%) and Oligochaeta (12.6%). The biomass of macroinvertebrates from sediment was not significantly different among a site with many logs (holding area), a site with few logs, and a site with no logs. Densities in sediment were significantly higher than densities on logs. Mean values were 140-940 ind./m² log surface and 1,350-14,540 ind./m² sediment surface. Diptera (primarily Chironomidae) comprised 50-89% of log density and 88-99% of sediment density. Except for Diptera and Oligochaeta, identifications were made to genus, resulting in 44 genera from logs and 16 from sediment. Snails, elmid beetles, stoneflies and spongillaflies were collected only from logs, as were the mayfly families Heptageniidae, Ephemerellidae and Leptophlebiidae and several caddisfly genera reported to have a clinging or climbing habit. Amphipods and isopods were associated with logs or with sediment having a high bark content. Macroinvertebrate density was significantly lower in sediment beneath submerged logs, compared to nearby sediments, because of fewer Chironomidae. Biomass was not lower, attributable to increased numbers of Phylocentropus or Asellus or large specimens of Hexagenia or Sialis beneath logs. Several lines of evidence suggest that sunken pulpwood logs serve primarily as a surface for attachment and that pulpwood breakdown by macroinvertebrates is minimal. Some implications of this study relative to salvaging submerged logs are discussed.

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 three years our primary objective is to describe the structure of the plant and animal community. We are undertaking (1) a 100% inventory of trees (> 10 cm 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) phenological observations on life history events in 40 plant 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:

The fourth year of field work was 1985-86 and tasks 1, 3, 4, 5, 6, 7, 8, 9, and 10, as outlined above were completed.

Future Plans:

In 1986-87 we will harvest timber on ten 1 ha blocks of the experimental area arranged in a randomized block design and continue all ten aspects of the monitoring program.

SONGBIRD SPECIES DIVERSITY IN RELATION TO
THE STRUCTURE AND SIZE OF FOREST STANDS AND EDGES

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.

Scope:

This study will examine 3 aspects of the relationship between songbirds and various types of forest stands and forest-clearcut edges. First, the relationship between bird species diversity (BSD) and foliage height diversity (FHD) will be determined. Second, species-area curves for each stand type, and species-length curves for each edge type, will be constructed to determine "minimum area" required to include most species. Third, composition of the bird community using edge habitat will be compared to that in each of the adjacent habitats. The results of this study will then be discussed as they relate to the effects of forest management practices on habitat diversity and songbirds.

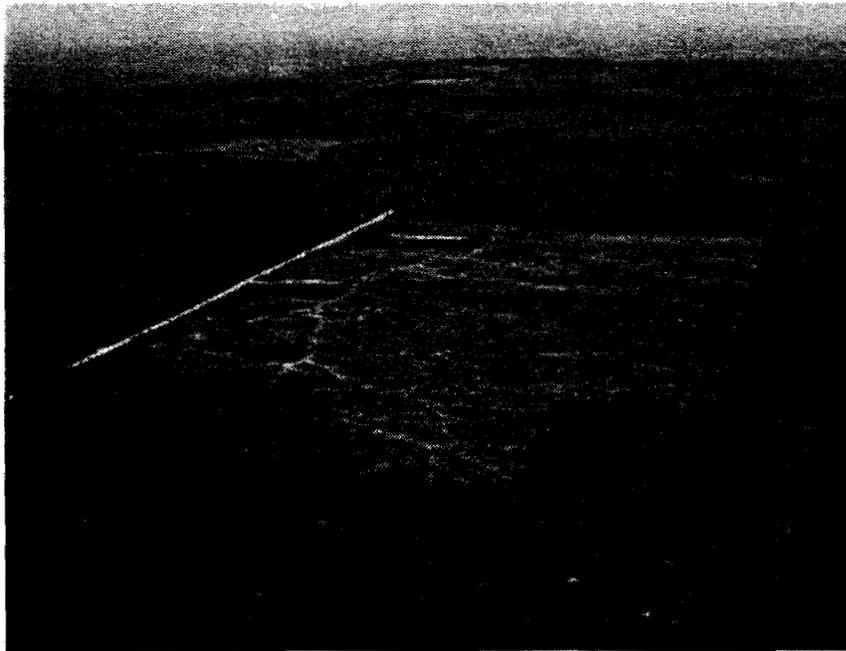
Project Status:

All field work has been completed. Four stands (softwood, hardwood, mixedwood, and clearcut), ranging from 40-64 ha, have been censused and vegetation data taken. Four edge types (softwood-clearcut, hardwood-clearcut, mixedwood-clearcut, and softwood-partial cut) have been censused in both 1984 and 1985, and vegetation data taken. Each edge type was censused along 1000 m of the edge, and in a plot 250 m

wide extending 250 m into each of the adjacent stand types. Data analyses is almost complete and writing has begun.

Future Plans:

Writing and analyses continuing; scheduled date of completion is December 1986.



Forestry, as illustrated by this 80-acre clearcut, is an integral part of Maine's economy and environment. A study on the effects of forest types and edge on songbird diversity is nearing completion (Photo by C. Elliott).

RESPONSE OF SONGBIRDS AND SMALL MAMMALS
TO GLYPHOSATE-INDUCED HABITAT CHANGES

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.

Scope:

Herbicides are commonly applied to regenerating forest stands in Maine, to release softwood seedlings from undesirable competition with deciduous trees and shrubs. When properly applied, herbicides are not toxic to wildlife; however, they do have a potential effect on wildlife through habitat modification.

There have been a few studies investigating effects of herbicide application for forest management on the habitat quality of wildlife species, and none have been conducted in the intensively managed spruce-fir forests of the northeastern United States. This study is designed to determine the effects of habitat changes resulting from treatment of clearcuts with Glyphosate (Roundup) on songbirds and small mammals.

Project Status:

The second, and final, year of fieldwork was completed in 1986. Six study sites in northern Maine represented a range of years following herbicide treatment from zero (control) to 3-years post treatment. Treatments studied in 1985 were untreated controls and 2-year post treatment sites. Treatments studied in 1986 were controls, 1-year post treatment, and 3-year post treatment sites.

Songbirds were censused for two breeding seasons. Preliminary results indicate lower bird densities on herbicide-treated areas. The difference seemed related to how much area of the treated sites was missed during herbicide treatment.

Small mammals were trapped during July and October of both study years. Small mammal captures were higher on untreated clearcuts than on treated clearcuts. Total numbers seem to be reduced for at least 3 years following treatment with herbicides. The abundance of songbirds and small mammals is being compared to differences in structure and composition of vegetation on treated and untreated sites.

Future Plans:

Analysis of data will be completed by December 1986. Thesis and manuscripts are scheduled for completion by May 1987.

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

Investigator: P. D. Vickery

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

Cooperators/ The Nature Conservancy - Maine Chapter
Project - Northeast Regional Office
Support: 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 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 affect 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:

This study has examined nesting densities and species diversity in relation to blueberry management. Permanent study plots were established in 1984 and monitored in 1985 and 1986 to measure nesting diversity and density under different management practices. Commercial blueberries are harvested or burned in alternate years. Study plots

were placed in both production-year fields and in non-production (burn year) fields. Nesting densities of four species (grasshopper sparrow, vesper sparrow, bobolink, and eastern meadowlark) were significantly greater on blueberry fields not treated with herbicide. Interestingly, species diversity did not appear to decline in herbicide-treated preferences with vegetation structure.

Future Plans:

Data analysis will continue and a M.S. thesis will be completed in December 1987.

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

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

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. 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 waters (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 order streams in New England are vulnerable to acidification. As a result, a long term monitoring program (LTM) 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:

Water quality data for the long term monitoring project are currently being analyzed for 1985, but the number of fishes collected in lakes increased from 1983 to 1985 for all lakes save one. Most of these additional fishes were minnow species.

Considerable work was completed on the stream fish project in 1986. Floating fish cages were constructed and installed after ice out in five of six study streams. Each cage was stocked with 50-60 age 1 Atlantic salmon and monitored, though vandalism was a problem. Eggs and alevins of Atlantic salmon were sampled from artificial spawning redds, though results with brook trout were generally a failure. Survival to hatching ranged from 7 to 48%, and survival to emergence ranged from 5 to 6%.

Water samples were collected from the stream project every 3 to 18 days, with the lowest pH levels occurring shortly after spring snowmelt, in March. Level of pH ranged from 5.49 to 6.35 in the six streams in March, and reached 6.20 to 6.79 by June.

All requirements for the degree of Master of Science (Zoology) were completed by Stanislas Pauwels in December 1985. An abstract of the thesis follows:

This research examined the possible effects of acidity on the number of fish species in 22 selected lakes in Maine, ranging in pH from 4.4 to 7.0. Three lakes had pH < 5.0 and contained no fish. The remaining 19 lakes were pH 5.4-7.0 and contained one to nine species of fish. Brook trout, golden shiner, and white sucker were ubiquitous, but common shiner and creek chub were absent from lakes with pH less than 6.0 and 5.9, respectively. The fishless lakes differed from the others primarily with respect to water chemistry variables related to acidity, i.e., pH, aluminum concentration, and divalent cation concentration. The lakes that contained fish did not differ in respect to these variables. For these lakes, the factors most related to number of fish species seem to have been habitat, quantity, and diversity. Cluster analysis identified two distinct fish species groups - depauperate and cyprinid-sucker -- but multiple comparison analysis failed to relate any measured chemical or physical variable to these two groups. Lakes in the depauperate group tended to be deep, and the lack of fish species in these lakes may have been the result of low productivity coupled with an absence of extensive littoral areas.

Future Plans:

The project has been funded for the second and third year of work. Artificial spawning channels will be constructed and operated on Baker Brook. Water quality and fish growth estimates will continue.

CONSTRUCTION AND EVALUATION OF HABITAT SUITABILITY INDEX MODELS
FOR JUVENILE ATLANTIC SALMON AND OTHER COLDWATER FISHES

Investigator: J. G. Trial

Advisors: J. G. Stanley, Chairperson
J. R. Gilbert
W. E. Glanz
T. A. Haines
J. B. Dimond

Cooperator: J. R. Moring

Cooperators/
Project
Support: Maine Cooperative Fish and Wildlife Research Unit
U.S. Fish and Wildlife Service - Western Energy
and Land Use Team, Ft. Collins, CO.

Objective: Develop a Habitat Suitability Index (HSI) model for juvenile Atlantic salmon and test that model and other HSI models for brook trout and other species of stream fishes.

Scope:

The U.S. Fish and Wildlife Service has developed the Habitat Evaluation Procedures (HEP), including HSI models, to assess impacts of water resource development projects, management alternatives, and other uses. A key assumption of HEP is that quality of habitat can be expressed as an index that is directly proportional to potential carrying capacity. HSI models provide the means of calculating an index of habitat quality.

The model developed for juvenile Atlantic salmon is mechanistic, using Suitability Index (SI) curves to represent the relationship between measurements of habitat (e.g., dissolved oxygen, water velocity, pH) and habitat quality. These SI are then combined mathematically into life stage component indices and finally into a species HSI. At each step in the model, there are assumptions about how habitat variables affect potential carrying capacity and how variables interact to determine potential carrying capacity. Tests of models include tests of assumptions made in constructing SI curves, calculating life stage components and final HSI. Tests also compare the species and component HSI values with population data to evaluate the performance of the model as a whole.

Project Status:

The Atlantic salmon HSI model for stream stages of the species as well as three other species have been completed and published. A test of overall model performance for brook trout, Atlantic salmon, blacknose dace, fallfish, and common shiner has been completed and published. Based on this test, the Atlantic salmon model has been revised and sent

to interested Fish and Wildlife Service and state biologists. Habitat measurements for 12 sites in the St. John River, Canada, have been collected as a final test of model performance. The overall performance encourages the refinement and use of models in the context for which they were developed.

Future Plans:

Preparation of a dissertation is in progress.

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 the potential research projects necessary for supplying needed information to management agencies.

Project Status:

A draft Discussion Paper has been submitted to the Land Use Regulation Commission and a discussion meeting will be held shortly with the Stream Committee. Preparation of the Final Report, including literature survey is underway.

Future Plans:

A draft and Final Report will be submitted to the Land Use Regulation Commission in January 1987.



Information on the impacts of sedimentation on aquatic organisms and water quality is being synthesized to assist land managers in Maine. Above, a biologist is weighing and measuring fish in a disturbed watershed (Photo by J. R. Moring).

NUTRITIONAL AND THERMODYNAMIC ASPECTS OF
THE ECOLOGY OF BLACK DUCKS WINTERING IN MAINE

Investigator: D. G. Jorde

Advisors: R. B. Owen, Jr., Chairperson
P. W. Brown
L. J. Kling
J. R. Longcore
M. A. Vietti

Cooperators/ College of Forest Resources -- Hatch Act Funds
Project Maine Department of Inland Fisheries and Wildlife
Support: U. S. Fish and Wildlife Service

Objectives:

- (1) Determine if the microclimates of roost sites influence black duck use and energetics.
- (2) Examine the nutrient content and true metabolizable energy of foods selected by wintering black ducks.
- (3) Determine the relationship between specific dynamic action and thermoregulation.

Project Status:

All requirements for the degree of Doctor of Philosophy (in Wildlife) were completed in May 1986. An abstract of the dissertation follows:

Causes of the 20-year decline of the continental population of black ducks (Anas rubripes) have focused primarily on the breeding grounds; however, there is an urgent need to investigate probable causes affecting their survival at wintering areas. Winter ecology of black ducks along the central coast of Maine was examined between 1982 and 1985 by focusing on the relationships between habitat use and the thermodynamics of microclimates, true metabolizable energy and nutrient content of winter foods, and heat of digestion and thermoregulation.

During winter the selection of microhabitats by black ducks was important in reducing heat loss from wind and maximizing the heat input from solar radiation during the day. Black ducks used shoreline rest sites when solar radiation was available during the day but preferred to swim in open water during the night. Measurements of microclimates at rest sites indicated that small differences in microclimate had a major influence on energy transfer, behavior, foraging strategy, and distribution of black ducks during winter.

Animal foods accounted for 96 percent of the diet of black ducks and consisted primarily of periwinkles (Littorina spp., blue mussels (Mytilus edulis), gammarus (Gammarus oceanicus), and soft-shell clams (Mya arenaria). Proximate analyses and force feeding trials indicated that the metabolizable energy obtained from these foods by captive black ducks was influenced by the type and level of food intake. True

metabolizable energy of black ducks before and after feeding indicated that the heat of digestion or specific dynamic effect (SDE) was compensatory for thermoregulation. Earthworms reduced the energy required for thermoregulation by approximately 50%. Black ducks had a metabolic rhythm of thermogenesis that cycled at 15 to 20 minute intervals, increased in frequency when food was digested, and then returned to pre-feeding rhythm patterns. The SDE and nutrient content of foods suggests that animal and plant diets of waterfowl have important implications on foraging strategies and survival during winter and on reproductive success during the breeding season.

BEHAVIOR AND HABITAT USE 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/

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

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.

Scope:

Recent studies indicate that sex-ratios of common goldeneyes differ among sites within study areas in several areas of their winter range. Researchers suggested that these local differences in distribution of the sexes may result from sex-specific differences in habitat preference, and females were predicted to be found in less harsh conditions. This study was designed to compare characteristics of habitats used by common goldeneyes according to sex/age and paired status. This study also investigates relationships between behavior and sex/age and paired status, and examines the influence of environmental conditions on behavior.

Project Status:

The second field season was completed on 31 March 1985. Censuses and behavior observations were conducted in riverine, inland tidal and coastal areas of central Maine. Sites in the study area were censused regularly to determine sex/age ratios and pairing chronologies. Behavior observations were made by focal-animal sampling. Individuals were observed for 10-minute periods, and behavior was recorded every 15 seconds. During the two field seasons, 523 census sightings and 419 behavioral observations were made.

Census and behavior sightings were plotted on large scale maps of observation sites. Habitat and climatic characteristics of each location were recorded. Water depth and substrate type were determined by returning to the sites by boat in April and May, 1985.

Preliminary findings indicated that the entire range of sex-ratios was unrelated to habitat and climatic conditions. However, climatic conditions associated with observations of 90% or greater adult males were different from climatic conditions associated with observations or 10% or less adult males in early winter. The mostly adult-male groups

were more often observed when temperatures were warmer, cloud-cover less, and wind speeds lower.

Future Plans:

Data are being analyzed to determine (1) relationships among sex/age/paired status and habitat use, and (2) behavior and habitat use of birds of each status. Thesis writing is under way. This project is expected to be completed in December 1986.

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
Graduate School, University of Maine

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.

Scope:

A major decline in the black duck population over the past 20-30 years has prompted increased studies to examine the possible causes of the decline and to gather information on the ecology of the black duck throughout its life cycle. Information on black ducks during the molting period is sparse. Only recently has extensive banding of male black ducks been conducted in the far northern areas where they molt.

The purpose of this study is to collect baseline information on the ecology of male black ducks during the post-breeding wing molt that will help clarify the strategies used during this stage of the life cycle, and provide banding data useful in harvest management.

Project Status:

During the summers of 1983 through 1986, 1093 black ducks were banded in Okak Bay, northern Labrador. From 1984 to 1986, a total of 310 flightless adult male black ducks were captured by hand or retrieving dog, and body weight and structural measurements were recorded for each duck.

During 1986, 26 flightless male black ducks were radio-marked to obtain information on survival, habitat use and movements while flightless. Radio-marked ducks were located and sighted, without flushing the bird, at least every third day, and approximate locations determined more often. Three of the 26 radio-marked black ducks were killed by predators. All but 5 of the surviving ducks were captured before they regained flight ability and radio transmitters were removed.

While some black ducks remained relatively sedentary, others travelled several miles on water and varied terrain.

Future Plans:

Data analysis will be completed during the fall of 1986 and thesis writing will be completed by spring of 1987.

HABITAT REQUIREMENTS AND POPULATION TRENDS OF BREEDING
BLACK DUCKS 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.
- (4) Attempt to determine if the restrictive harvest regulations in Maine and the Atlantic Flyway for black ducks has affected the population on the study area.

Scope:

Results of the Mid-winter Inventory of waterfowl in the Atlantic Flyway indicate that the black duck population has declined approximately 3% per year since 1955. Restrictive regulations have been established to reduce the harvest by at least 25% in the United States. Maine has established even more restrictive harvest regulations because more than 65% of all black ducks banded in Maine as flightless young, that are shot in their first hunting season, are killed in Maine.

The 151 km² 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% of the black duck's U.S. breeding habitat. 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% of the study area was classified as 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/km². In comparison, the prairie pothole region has approximately 8.0 wetlands/km². The water surface area/pond ranges from 0.10 to 60.46 ha (x=1.82 ha, 1980 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 1970s on the study area along with an accurate documentation of the wetland habitat. Surveys of waterfowl populations were conducted in the 1960s by the Maine Department of Inland Fisheries and Wildlife in the same area. These data can be used to assess breeding black duck population levels as related to changes in habitat quantity and quality. This provides an opportunity to calibrate black duck population levels to habitat changes, thus providing the possibility of evaluating the effects of exceptionally restrictive harvest regulations on breeding black duck population levels.

Project Status:

During the first field season a census was conducted of the breeding pairs of waterfowl and most of the wetlands were mapped. Invertebrates and water samples were collected from three beaver ponds, using several different techniques, to develop sampling methods for the habitat selection model.

Preliminary results indicate that the quality of wetland habitat has decreased on the study area, primarily because the townships have been open to beaver trapping. As a result of beaver trapping, 78% of the wetlands with beaver in 1980 are no longer occupied, and only three beaver flowages created since 1980 are still active. The number of breeding pairs of black ducks (35) is slightly greater than in 1980. The wood duck population is about the same (15 pair), while the number of hooded mergansers (10 pair), Canada geese (3 pair), and mallards (4 pair) has increased. The census was conducted too early in the spring to collect data on the number of green-winged teal and ring-necked duck pairs.

Future Plans:

This winter, invertebrate and water samples will be analyzed to determine which sampling techniques will be most effective for the habitat selection model. Also, the maps of wetlands will be planimetered to determine surface water area, size, and other wetland characteristics for comparison to 1980 data.

In 1987, a second census of the waterfowl population will be conducted, the wetland mapping will be completed, and data will be collected for the habitat selection model. Completion of the thesis is expected in December 1987.

SURVIVAL, HABITAT USE AND DISPERSAL OF
POST-FLEDGING 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, (PWRC),
Support: Laurel, MD
- Moosehorn National Wildlife Refuge (NWR)
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-fledging 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-fledging 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:

Survival rate estimates for 14 young females monitored in 1985 declined as the season progressed: September, .9253; October, .9203, November, .6708. The overall survival rate for the 92-day period was .6258, but because the survival rate for one period was substantially lower than the other 2 rates, it was appropriate to calculate fall survival as the product of the 3 periods, which equals .5712.

Future Plans:

In the current field season (1986), 67 black ducks were equipped with radio-transmitters in early September and are now being tracked

daily. Data on movements and habitat use and pairing status are being collected. No birds have died through October 14th. Nearly 20% of the birds are using habitats in New Brunswick where the hunting season opened October 1st. A final field season in the fall of 1987 will conclude the study.

A M.S. Thesis, a final report and several technical papers will be prepared in 1988.

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 water-bird 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 chironomic 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:

The first field season was conducted from May through July in 1985. Eighty-one adult and juvenile waterbirds were collected for food habits analysis. All birds and their internal organs were weighed to determine changes in body condition through the breeding season and to correlate food habits with reproductive status. Skins of adult ducks were preserved for laboratory analysis of molt to correlate body condition with molt cycle.

Physical factors of the wetlands where birds were collected were measured including water temperature, water depth, and dominant

vegetation present. Core and sweep samples were taken where birds were feeding to determine the relative availability of bottom dwelling and nektonic invertebrates. Invertebrate emergence traps were used to collect emerging adult insects from three wetland types throughout the field season for purposes of identifying dipterans to the species level.

Future Plans:

Data have been prepared for analysis and summary. Analysis of the data has begun and will be completed in December 1986. The final report will be completed in May 1987.

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.

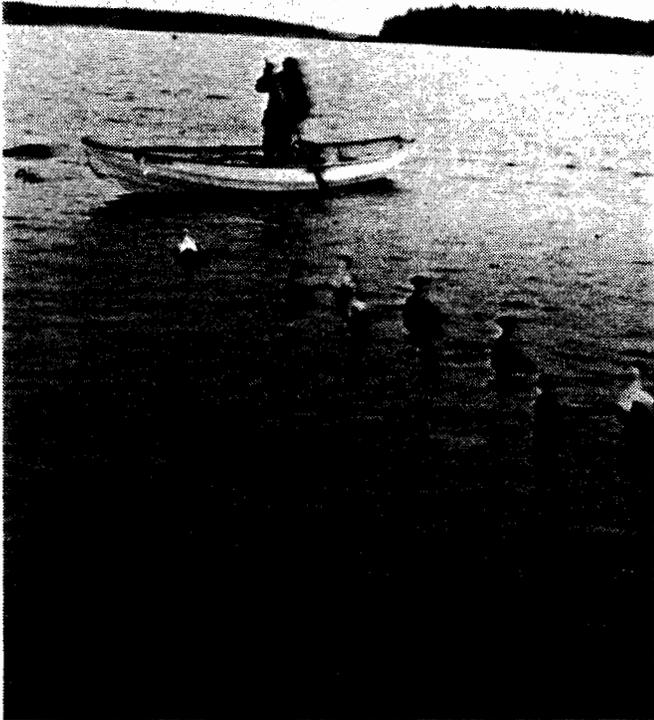
A need exists to document the species-habitat relationships to estimate impacts of development on this wildlife resource. The Habitat Suitability Index (HSI) model being developed is a measure of the quality of the nesting habitat and its capacity to support the eider.

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 (FWS) for review in August 1986.

Future Plans:

The HSI model is being reviewed by the FWS. Validation of the model (i.e., a comparison of model output of Maine islands of various breeding eider densities is underway). Information from both the review and the validation will be used in the final product. Completion of the HSI model for breeding American eiders is scheduled for March 1987.



As hunter interest in sea ducks, especially eiders, continues to increase, better information is needed on the impacts of human activities on coastal habitats (Photos by W. B. Krohn).

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 nation-wide 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:

Field work began in early May 1986 and intensified on May 19 with the spring arrival of nighthawks on campus. A minimum of six adult pairs were identified with the use of a ground census and a systematic search of all flat-topped roofs. Nine nesting attempts were identified. Of the 68 flat-topped roofs on campus, 49 are tar/gravel and 19 are black rubber. Of the 9 nests located, 8 were on tar/gravel and 1 was on rubber. This latter nest was located on 25 sq. ft. of gravel placed in the corner of a roof at the site where nighthawks nested during the 1985 season, immediately prior to the replacement of the existing tar/gravel roof with rubber. Data gathered during the first season indicate that rubber surfaces are unsuitable for nesting and that the nesting population was approximately the same size it was in 1976.

Three of the nine nesting attempts were successful, producing five chicks, two of which fledged in mid-August. Eggs from the remaining six nests disappeared during incubation, including two repeat nesting attempts apparently by the same bird on the same roof.

Future Plans:

The study will continue in May 1987. Nests will be monitored to attempt determining the causes of egg disappearance. Systematic ground census of booming males will be compared to the actual number and locations of nests to evaluate the effectiveness of censusing breeding nighthawks from the ground. Four of the eight roofs used in 1976 for nesting have been converted from gravel to rubber. Consideration is being given to placing gravel patches on these four rubber roofs in an effort to provide suitable nesting habitat. Monitoring will continue on all flat-topped roofs to determine nesting attempts and success by surface types (i.e.; tar/gravel, rubber with gravel patches, and rubber without gravel patches).

AMPHIBIANS, REPTILES AND SMALL MAMMALS OF MAINE'S PEATLANDS

Investigator: S. S. Stockwell

Advisors: M. L. Hunter, Jr., Chairperson
R. Davis
W. Glanz
J. 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 small mammals, and reptiles and amphibians that inhabit Maine's peatlands.
- (2) Quantify the relative abundances of these 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.

Project Status:

All requirements for the degree of Master of Science (in Wildlife Management) were completed in December 1985. An abstract of the thesis follows:

Amphibians, reptiles, and small mammals were captured in nine Maine peatlands using drift fences and pit traps. Animals were trapped in one example each of seven types of vegetation in 1983, and in three examples each of eight types of vegetation in 1984. Traps were operated from April to September.

In 8,733 trap nights (TN) 2,182 individuals of 13 amphibian and 1 reptile species were caught. Anurans represented 94% of all captures, salamanders 5%, and snakes <1%. Species richness ranged from 5-10 per vegetation type, and evenness was generally low. Rana sylvatica was the most abundant species in five vegetation types and composed 59% of all captures. Rana clamitans was the most abundant species in two vegetation types, and the second most abundant species in four types, composing 29% of all captures. Average capture rates of each species ranged from 0.1 to 146.8 per 1000 TN, and average capture rates in each vegetation type ranged from 95 to 490 per 1000 TN. Juveniles constituted 82% of all captures, and were most abundant in July and August.

In 8,733 trap nights, 822 small mammals of 12 species were trapped; 67% of all captures were Sorex cinereus and 13% were Zapus hudsonius. Ten other species each composed 1-4% of all captures. Species richness

ranged from 5-11 per vegetation type. Sorex cinereus and Z. hudsonius were trapped in all eight types of vegetation, whereas other species were trapped in 4-7 types. Sorex cinereus was the most abundant species caught in every type of vegetation except in shrub thicket, where Z. hudsonius was the most abundant. Average capture rates of each species ranged from .07-6.3 per 100 TN. Differences in capture rates and percentages of captures among vegetation types were low; at the extreme, three times as many small mammals were caught in wooded heath as in moss-Chamaedaphne. Overall abundance and species richness were negatively correlated with distance of trap site from the nearest upland. Between April and September, the highest capture rate occurred during August (18.4/100 TN; 36% of all captures).

ANALYSIS OF RED FOX AND COYOTE HOME RANGE USE IN RELATION TO
ARTIFICIAL SCENT MARKS

Investigator: D. B. Engelhardt

Advisors: J. A. Bissonette, Chairperson
W. E. Glanz
W. B. Krohn

Cooperators/

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

Objective: Examine the responses of free-ranging coyotes and red foxes to the placement of scent marks within their respective home ranges.

Project Status:

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

The range expansion of coyotes (*Canis latrans*) into Maine caused concern among biologists and trappers about the possibility of negative effects on the red fox (*Vulpes vulpes*) population. Researchers in Maine and elsewhere found evidence of spatial segregation between the two species, suggesting avoidance of coyote-occupied areas by red foxes. Scent marking has been associated with territorial maintenance in both species. The purpose of this study was to determine whether scent (urine) marking is the cue that stimulates avoidance of coyotes by red foxes.

A series of 7 experimental scent-mark trials was conducted. In the first phase of each trial the home range of a radio-collared red fox or coyote was determined by intensive telemetry. In phase 2, water was distributed through the home range to test whether human presence would interfere with the subject's movements. In phase 3, artificial scent marks of coyote or red fox urine were placed in the home range.

The telemetry data for each trial were analyzed to test the general null hypothesis that home range use did not change among phases. First, a clustering program assigned each location to a particular region in the home range. (Regions refer to intensively-used core areas and extensively-used foraging areas). The area, center of activity, and usage of each region were then compared among phases. Following rejection of the general null hypothesis, a specific hypothesis was tested comparing the observed home range changes with those expected for a particular reaction to the experimental scent.

Home range use changed significantly in all 7 completed trials. Regional centers of activity changed location in at least 78.2% of all

between-phase comparisons, and usage of the regions was dependent upon treatment. However, the changes could only be correlated with presence of the scent in 2 trials where adult male conspecific urine was applied to the home range of a female yearling subject. In 4 trials where coyote urine was applied to red fox home ranges, the home range changes could not be attributed to presence of the scent. In conclusion, coyote scent marks alone are insufficient to stimulate an avoidance reaction by red foxes.

Any area of suitable habitat not being intensively used by coyotes can probably be used by red foxes. Red foxes can also use smaller areas of habitat than coyotes. Although some fox habitat probably was removed by coyotes when they colonized the state (perhaps reducing statewide fox densities), there seems to be enough remaining to support a healthy red fox population.

COYOTE DISPERSAL, MORTALITY, AND SPATIAL RELATIONSHIPS
WITH RED FOXES IN MAINE

Investigator: D. J. Harrison

Advisors: J. A. Bissonette, Chairperson
J. A. Sherburne
W. E. Glanz
P. W. Brown
W. B. Krohn

Cooperators/

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

Objectives:

- (1) Describe the social factors influencing coyote populations in eastern Maine, including territory size and composition, territorial fidelity, and the prevalence of non-territorial adult coyotes.
- (2) Evaluate the mechanisms of juvenile coyote dispersal, including proportion emigrating, and the distance, timing, direction, and sex-specific patterns.
- (3) Determine the effect of resident coyotes on the spatial distribution of red foxes in eastern Maine.

Project Status:

All requirements for the degree of Doctorate of Philosophy (in Wildlife) were completed in August 1986. An abstract of the dissertation follows:

Coyote (Canis latrans) dispersal, mortality, denning ecology, and spatial relationships with red foxes (Vulpes vulpes) were studied in Maine during 1981-1984. Sixty-five juvenile (< 1 year) coyotes, 8 adult (> 2 years) coyotes, and 11 adult (>1 year) red foxes were captured and ear-tagged. Forty-seven juvenile coyotes, 8 adult coyotes and 11 adult red foxes were equipped with radio collars.

Coyote pups began to move short distances from dens at 6-8 weeks of age. The radius and rate of pup movements increased with age. Large increases from September to October in pup home range sizes (+194%) and movement rates (+59%) were associated with the breakup of the family group and onset of dispersal. Movements of pups stabilized by late fall; neither their rates of travel nor their home range sizes were different from those of adults by early winter. Predispersal home range sizes were not different between 8 juvenile males ($x = 43.0 \text{ km}^2$) and 6 juvenile females ($x = 45.0 \text{ km}^2$).

Dispersal of juvenile coyotes began during late September of their first year. Peaks in onset of dispersal occurred during October-November and during February-March. No dispersals were initiated during late December-January. Timing of dispersal coincided with periods of

highest inter-family strife. Eighty-six percent of pups (N = 36) dispersed during their first year of life; 100% departed prior to 1.5 years of age. Most coyotes completed dispersal between 1 and 2 years of age.

Minimum distance dispersed averaged 94 km for 11 juvenile female coyotes and 113 for 9 juvenile males; distances averaged 98 km for 7 coyotes monitored until completion of dispersal. There were no differences ($P > 0.10$) between sexes in the proportion, timing, or distance of dispersal. Coyotes homed along their initial bearing of dispersal ($P < 0.025$), thus they maximized distances from natal areas. Water barriers deflected movements of dispersing coyotes and resulted in concentrations of dispersers adjacent to water features.

Delayed dispersal and pack formation have previously been associated with coyote populations subsisting on large food items. Predominant first year dispersal and lack of pack formation by coyotes in Maine, despite high use of white-tailed deer (*Odocoileus virginianus*), suggests that low food densities preclude delayed dispersal and pack formation in this population.

Mortality was documented for 57% of tagged juvenile coyotes and indicated that human causes were responsible for 92% of documented deaths. Tag recovery rates were higher ($P < 0.10$) for coyotes aged 0.5-1.5 years than for those older than 1.5 years. Based on telemetry data, annual survival rates of pups from 6 - 58 weeks of age were 0.59. Survival was lower among juvenile females (0.39) than among juvenile males (0.93), suggesting that females were more susceptible to human caused mortality. Sixty percent of pup mortality rate was attributable to human causes. Annual survival rate from 0.5 - 1.5 years was lower for dispersers (0.47) than for residents (0.74).

Annual home ranges of 6 adult red foxes averaged 14.7 km^2 . Fox home ranges were equated to the 46.4 km^2 mean home range for 8 adult coyotes by the relationship: Metabolic Home Range Size = km^2/kg body weight 0.87 . Seventy-eight percent of the difference in mean home range size between coyotes and foxes was attributable to greater metabolic requirements of coyotes.

No fox captures (N = 11) occurred within core portions of coyote territories despite more intensive trapping effort in core portions. Home ranges of foxes were situated outside of coyote territories and along boundaries between adjacent coyote groups. Fox home ranges were associated with water features; however, no use by foxes of lakeshores or riparian zones within coyote territories was observed. Interspecific territoriality between coyotes and red foxes likely resulted from interference competition and avoidance of coyote territories by red foxes. The presence of resident coyotes limits the available habitat for red foxes in Maine. Smaller spatial requirements enable foxes to persist in boundary areas and prevent their complete displacement from regions occupied by coyotes.

SUMMER HOME RANGE AND HABITAT USE BY MOOSE IN NORTHERN MAINE

Investigator: D. J. Leptich

Advisors: J. R. Gilbert, Chairperson
G. J. Matula, Jr.
M. L. McCormack

Cooperators/

Project McIntire-Stennis

Support: Maine Department of Inland Fisheries and Wildlife

Objectives:

- (1) Examine the summer home range characteristics, including size and utilization distribution, of free-ranging moose.
- (2) Describe 24-hour patterns of summer habitat selection by moose.
- (3) Describe the characteristics of moose calving sites in Maine.

Project Status:

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

Summer habitat selection by moose in northern Maine was examined during the summers of 1984 and 1985. Thirteen radio-collared moose (6M:7F) were monitored from late May to late August each summer. Moose were monitored using ground telemetry during all 24 hours of the summer day and 1313 relocations were obtained.

Telemetry was used to determine the location of moose calving sites. An initial effort was made to describe moose calving sites in Maine using a more quantitative approach than previously has been attempted. Ten calving sites were compared to 20 random sites. Step-wise discriminant function analysis was used to select variables that best described the differences between the two groups. Six variables were important in distinguishing calving sites from random sites. The discriminant function describing site differences is presented. Validation of the model by the jackknifed classification procedure demonstrated that the model correctly classified 96.7% of the sites.

Moose summer home range size was estimated in six different ways. Summer home range size averaged approximately 25 square kilometers. There was no detectable difference between the home range sizes of bulls and cows, and considerable individual variation was evident. Plots of home range boundaries indicated both summer home range fidelity and extensive overlap of the home ranges of different individuals.

Summer habitat selection was found to vary by both sex and time of day. Females generally used lowland forest types more than males, and in greater proportion than would be expected from availability. Cut areas were also more important to females than to males. Conversely, males used upland forest types more than females, and in greater proportion than would be expected from availability. Males and females both used aquatic areas in proportion to their availability.

The use of softwood, cut-over, and aquatic cover types was found to vary temporally on a daily basis. The patterns of daily variation in cover type selection indicate that thermal cover, food availability, and perhaps available light may all play roles in determining the daily patterns of cover type use.

SYNERGISTIC RELATIONSHIPS AMONG IMPORTANT WINTER FORAGES
OF WHITE-TAILED DEER

Investigator: J. A. Jenks

Advisors: D. M. Leslie, Jr., Chairperson
R. B. Owen, Jr.
B. A. Barton
G. J. Matula

Cooperators/

Project

Support: McIntire-Stennis

Objectives:

- (1) Determine if synergisms exist among important winter forages of white-tailed deer using in vitro digestion.
- (2) Determine whether certain winter forage combinations can decrease rumen turnover time in captive white-tailed deer.
- (3) Determine rumen protozoa numbers in captive white-tailed deer on known winter diets.

Project Status:

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

Synergistic relationships among important winter forages used by white-tailed deer (Odocoileus virginianus borealis) in Maine were examined with passage rate estimates and in vitro digestions. Eight captive white-tailed deer fawns were maintained on winter diets from 15 January to 31 March 1985 to determine passage rate of digesta. Diets were formulated containing equal portions of white cedar (Thuja occidentalis), balsam fir (Abies balsamea), eastern hemlock (Isuga canadensis), and mixed spruce (Picea spp.). Diets also contained a lichen component (Usnea spp. and Evernia mesomorpha) of 0, 5, 15, and 25%. Four trials were conducted with 4 deer per trial. Fawns were randomly assigned to 1 of the 4 diets for a 9-14 day pretrial period to allow for confinement effects and fed approximately 30 g of conifers (7-8 g/species) that had been labeled with ytterbium chloride ($\text{YbCl}_3 \cdot 6\text{H}_2\text{O}$) (x binding affinity = 1264 ug Yb/g DM) as part of their daily ration. Feces were collected for 120-168 hr post dosing and subsamples analyzed for Yb using atomic absorption spectrophotometry. Total mean retention time (TMRT), or the average time a particle of digesta remains in the gastro-intestinal tract, was not significantly different among diets containing different proportions of the lichen component ($P > 0.05$). However TMRT was correlated with dry matter intake ($P < 0.01$), average minimum daily temperature ($P < 0.01$, apparent dry matter digestibility ($P < 0.025$), and weight loss (kg/day) ($P < 0.05$). Fawns on similar diets displayed different responses to the parameters examined. Therefore,

stressed fawns may lose body weight and be unable to survive winter in relatively good habitat. In vitro dry matter digestibilities (DMD) of forages and diets used in passage rate trials were low when digested with cow inoculum. Expected in vivo DMD estimates determined with deer inoculum were significantly higher ($P < 0.0001$) than those determined with cow inoculum. Percent dietary lichen was positively correlated with expected in vivo DMD (deer inoculum), but 0-25% lichen estimates were significantly lower ($P < 0.001$) than apparent digestibilities calculated during passage rate trials. Lowered in vivo DMD (deer inoculum) may have resulted from inherent error in the in vitro technique or dietary synergisms among conifers that may aid deer during winter by increasing digestible energy of winter diets to maintenance levels.



A female white-tailed deer fawn, subject of a recently completed winter diet study (Photo by J.A. Jenks).

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:

Several marine mammal species interact with commercial fisheries through direct and indirect competition for fish, entanglement of the marine mammal in nets, and damage to fishing gear. In New England, the potential for such conflicts has increased with the concurrent intensification of inshore fishing pressure and increase in marine mammal numbers. Because the number of harbor seals has increased dramatically following Federal protection, the status, distribution, and discreteness of their population have become a concern to several fisheries. In addition to their potential role as competitive predators, seals and other marine mammals, such as the harbor porpoise, are caught accidentally in fishing gear. Although these entanglements may result in monetary loss to the fishermen and biological loss to the marine mammal populations involved, they may also provide a population sample from which valuable and often inaccessible life history data may be obtained.

Project Status:

Since 1981, 118 harbor seal pups have been tagged in order to monitor seasonal movements of individuals in New England; 13 were tagged in June 1986. In addition to telemetric relocations, 31 sightings of seals tagged from 1983 to 1986 have been reported. Among these reports are 5 mid-winter sightings on Cape Cod and Nantucket Island, sightings of a tagged yearling and 2 pups in Nova Scotia, 1 pup in New Brunswick and numerous sightings of pups offshore in Maine waters. Results of these returns indicate that harbor seal pups (1) are capable of long distance (30-200 km) movements from their natal areas within 1 month of weaning, (2) contribute to the transient seal population that overwinters in southern New England, and (3) are involved in direct conflicts with both U.S. and Canadian fisheries.

A small-take exemption to the Marine Mammal Protection Act was drafted and obtained on behalf of the New England groundfish gillnetters to allow the incidental taking, reporting, and salvage of small numbers of marine mammal species in the course of fishing operations. Twelve harbor porpoise carcasses were collected from fishermen in 1986 and necropsied to determine the age, sex, health, reproductive condition, and food habits of animals taken as by-catch. Other data collected by project observers on active fishing vessels will be used to develop a profile of gear characteristics relative to marine mammal capture rate.

The success of this small-take exemption program has prompted the examination of other New England fisheries which incidentally capture small numbers of marine mammals and may qualify for a similar exemption to the Marine Mammal Protection Act.

Aerial surveys of the harbor seal population of the New England Coast were conducted in March and June. In March, 10,500 harbor seals were observed, while the count of all ledges in June resulted in 13,000 observed. This is higher than the 10,487 observed in June of 1981. Local counts for distribution of harbor seals were also conducted in December of 1985 and September of 1986 in Blue Hill Bay.

Future Plans:

This project will terminate in January of 1987. Final reports on all aspects are being prepared.

THE MAINE AMPHIBIAN AND REPTILE ATLAS PROJECT (MARAP)

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

In the project's third year new information on the distribution and relative abundance of herpetiles continues to be gathered although the number of significant range extensions reported has declined. Species thought to be rare are still seldom reported thus corroborating early impressions which led to the designation of black racer and eastern box turtle as state endangered species, spotted turtle and Blanding's turtle as state threatened, and ribbon snake as a species of special concern. The eastern box turtle remains the only species thought to exist in Maine but for which we have not collected a definitive record.

Future Plans:

It is currently planned to devote two more field seasons to the project.

ECOLOGY OF FISHERS IN SOUTH-CENTRAL MAINE

Investigator: S. M. Arthur

Technicians: D. Kingman
M. Miller

<u>Field</u>	T. Goldstein	D. Valteau
<u>Assistants/</u>	P. Hesketh	E. Vaughan
<u>Volunteers:</u>	K. Meddleton	J. Waring
	K. Moses	K. Worden

Advisors: J. R. Gilbert, Co-chairperson
W. B. Krohn, Co-chairperson
M. D. Ashley
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, 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.

Scope:

The fisher is the largest terrestrial member of the weasel family currently inhabiting Maine, with males usually 90-110 cm long and weighing 4-5 kg. A high-priced pelt, recent record-setting harvest levels, and a past history of over-exploitation make the fisher one of the most important furbearers in North America, yet little is known about the species' ecology. This study is examining the ways in which fisher behavior and habitat requirements affect their populations in northern Waldo County Maine, an area of high fisher abundance. Information gained through telemetry and winter snow tracking will be used to determine fisher home range dynamics and the relationship between fisher movements, habitat use, and small mammal distribution.

Project Status:

A total of 35 fishers were captured and equipped with radio-collars. Individuals were located several times per week, for periods ranging from a few days to 24 months. Home ranges of adults were generally 10-20 km² although some were considerably larger. Fishers preferred coniferous trees for resting sites, except in mid-winter, when ground burrows were also used. Fisher habitat use for hunting was investigated by monitoring individuals for 24-hour periods from June-August, 1985 and 1986. Understory density was sampled on 40 10 m² plots

located in areas of intensive fisher activity. These results will be compared with data from random plots sampled in 1985 to test for habitats selected by hunting fishers. During January - March, 1985 and 1986, fisher trails in snow were followed for 36 km, and 54 km of random transects were surveyed. The habitat types and number of prey tracks that were encountered will be compared between transects and fisher trails. Fisher scats were also collected, and showed that snowshoe hares, squirrels, mice, porcupines, apples, and other fruits were eaten by fishers. During the fall, 1985 fur trapping season, 12 (57%) of 21 radio-collared fishers were caught by trappers. Most mortality occurred in the juvenile age class. During spring, 1985, only 1 of 5 adult female fishers evidently gave birth; in 1986, 4 of 5 may have reproduced. Only 3 dens were located; the other females evidently lost or abandoned their litters.

Future Plans:

Trapping efforts will continue through the beginning of the 1987 trapping season (October 28) so that approximately 11 adult and 10 juvenile fishers will be available for monitoring during the season, to determine the harvest rate. Any fishers that are still radio-collared at the end of the trapping season will then be recaptured and the collars will be removed, except that adult females may be monitored occasionally until spring, 1987 to determine the denning rate. Data analysis is currently under way and should be completed by early spring, 1987. Thesis completion is scheduled for June, 1987.



Technician Kathleen Meddleton weighs one of 35 fishers that have been radio-collared. Monitoring of these radio-equipped animals is providing data on the habitats needed to manage Maine's most valuable furbearer (Photo by S. M. Arthur).

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
Support: Maine Department of Inland Fisheries and Wildlife
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.

Scope:

Young forest communities are important components of good moose range. In Maine, these habitats are largely the result of tree harvesting, but in other areas they may be created by fire or flooding.

The thriving populations of moose currently found throughout much of northern Maine are a result of logging operations conducted during the past several decades. These operations varied in the type of cut and methods used; hence, the characteristics of the resulting cut-overs are quite diverse.

This project was designed to assess which cut-overs, out of the diverse array available, were being used by moose. To accomplish this, adult moose were radio-collared and monitored from the air throughout the year, supplemented occasionally, by ground radio-tracking and direct observation. Habitat information for sites used by moose was obtained at the time of aerial relocation and from forest cover-type maps. Logging history was determined from site characteristics and landowner records.

Project Status:

All field work for this project was completed on 30 August 1984. Preliminary results are as follows:

A total of 991 relocations were obtained (825 aerial, 158 ground telemetry observations, and 8 direct observations) from 36 radio-collared adult moose (13 males and 23 females) that were radio-collared on two study areas.

Moose movements were plotted and home range sizes calculated using the minimum convex polygon method. In the winter of 1983, the home ranges of four bulls averaged 6.06 km^2 (range $1.13 - 12.77 \text{ km}^2$), whereas

the 10 radio-collared cows had an average home range of 9.24 km² (range 0.99 - 21.50 km²).

Other seasonal home ranges calculated in km² were: (1) Summer 1983- bulls: mean = 15.97 (n=10), range 0.72 - 45.53; cows: mean = 28.94 (n=19), range 3.83 - 126.33; (2) Fall 1983 - bulls: mean = 11.67 (n=9), range 0.27 - 41.13; cows: mean = 6.38 (n=17), range 0.20 - 41.37; (3) Winter 1984 - bulls: mean = 1.30 (n=9), range 0.33 - 2.87; cows: mean = 1.92 (n=20), range 0.13 - 9.15; and (4) Summer 1984 - bulls: mean = 31.48 (n=9), range 6.70 - 120.54; cows: mean = 25.21 (n=21), range 3.30-108.23.

The number of relocations used to calculate home ranges was small (winter: mean = 4.95, range 3 - 6; summer: mean = 11.15, range 3 - 30; fall: mean = 3.9, range 3 - 5), but the results suggest, as other telemetry studies in Maine have shown, that moose home ranges in Maine are larger than have been reported in most other studies of moose populations that do not make seasonal migrations. This is particularly true during the summer months.

Twenty-four hour movements of moose were quantified during the summer of 1983. Bull and cow movements were similar with 24-hour moves ranging from 0 to 13 km (mean = 1.70 km); however, when moves were to or from a pond used for feeding on aquatic plants, 24-hour movements averaged 4.62 km.

Future Plans:

All movement data and habitat data has been analyzed. A first draft of the thesis has been written. Completion of the work is anticipated by December 1986.

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

Investigator: M. Chillelli

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

Cooperators/
Project
Support: Maine Department of Inland Fisheries and Wildlife
Maine Cooperative Fish and Wildlife Research Unit
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 dynamics model has been written in GW-BASIC, tested, and verified. The model reflects the annual cycle of white-tailed deer in Maine and has been divided into 3 major compartments: 1) reproduction/summer-early fall, 2) harvest, and 3) winter-early spring. Mortality and reproductive rates are being determined to reflect any variations by sex, age, and week. The functional relationships for the reproductive period have been formulated and they estimate 1) fetal sex ratio by age of dam, 2) age-specific birth frequency, and 3) age-specific reproductive rates. The 3 compartments will include the following mortality rates:

- summer/early fall - neonatal mortality, predation, poaching, poaching-crippling, road kill;
- harvest - bow harvest, bow crippling, resident and nonresident firearm harvest, firearm crippling, predation, poaching, poaching-crippling, road kill; and
- winter-early spring - winter severity mortality, winter accident, winter predation, poaching, poaching-crippling, road kill.

Future Plans:

Functional relationships for estimating age, sex, and week-specific mortality rates for the harvest, winter-early spring, and summer-early fall periods will be formulated and tested. The relationships for mortality and reproduction will then be integrated into the model. During model development, deficiencies in current information will become apparent; this will help to guide future data collections and analyses. Sensitivity analyses will determine those parameters that cause the greatest change in output and that should be estimated with the greatest accuracy. MDIFW biologists will be involved in developing estimates of mortality rates that are difficult to measure (i.e., poaching and crippling). Simulation runs will be performed to examine the long-term effects of various management strategies and to make useful conditional predictions concerning the ecology of deer in Maine.

The writing of a Ph.D. dissertation has begun with the projected date of completion being June 1987.

NESTING ECOLOGY, HABITAT USE AND REPRODUCTIVE SUCCESS 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.

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 habitat used by these turkeys and changes in habitat use during the nesting period.

Scope:

Wild turkeys once existed in the southern portion of Maine but were extirpated before the advent of legal protection. Reintroductions in the late 1970s have resulted in expanding populations in southern (centered in York County) and south-central (centered in Waldo County) Maine. Little is known about the breeding characteristics and requirements of the wild turkey in Maine. Turkeys nesting in Maine, especially the flock in Waldo County, are considered at the edge of their northern range. Information on nesting ecology is critical to the selection of future release sites, and to the population itself if it is to expand and be successfully managed as a game species.

Project Status:

Twenty turkeys were captured during the first cannon-netting season during the fall and winter of 1985-86. Thirteen birds were fitted with radio units (8 females, 5 males). Two of the radioed juvenile females were preyed upon, and one juvenile male slipped his collar over the winter.

Intensive gobbling surveys run during the month of April indicated peak gobbling activity followed spring break-up of the male flocks and coincided with the spring break-up of female flocks during the third week in April. Juvenile males moved the farthest from wintering grounds ($x = 27.07$ km), followed by juvenile females ($x = 12.87$ km), adult males and adult females.

Females were located on a daily basis beginning April 1 through August 15. Hens began laying during the second week of April, incubation began during the third week of April and broods hatched during the last week of May and the first week of June. Females layed an average clutch of 14 eggs ($n = 5$), and 90% of the eggs hatched. Weekly brood counts showed poult mortality was highest during the first 3 weeks of life, averaging 50%. No poults were lost after the fifth week of life. Hen mortality was 50% and was mainly due to predation.

Nesting females had an average home range of 4.3 sq. km. Dairy farms were located within .5 km of all the home ranges. Preliminary vegetation analysis of nest sites show a preference for relatively open canopy cover. Three out of the four successful nest sites were located in clearcuts.

Future Plans:

Trapping of an additional 15 female turkeys has begun and will continue through March of 1987. Extensive and intensive gobbling survey routes will be run again in April to determine the distribution of wild turkeys in Waldo County. Data collection of nesting ecology and reproductive success on the radioed hens will resume in April.



The ecology of wild turkeys is being studied in south-central Maine, at the northern-most limits of the species' range (Photo by B. Treiterer).

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/

Project

Support:

U. S. National Park Service
- Acadia National Park, Bar Harbor, ME
- 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 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.

Scope:

The river otter (Lutra canadensis) exists throughout much of North America where the harvest is properly regulated and suitable habitat remains. In eastern North America, otters exist in all coastal states and provinces from the Gulf of Mexico to northern Quebec. Otters are widely distributed in inland Maine, but their status and distribution in coastal Acadia National Park (ANP) located in Maine's central coast on MDI, is unknown.

ANP is bordered by private lands along much of its perimeter. Because trapping is allowed on private lands adjacent to the park, there is concern that the island-wide population of otters may be overharvested. The purpose of this study is to provide insight into the distribution and ecology of river otters in ANP to facilitate park management of the species.

Project Status:

The distribution of river otters on MDI has been determined over three seasons: summer/fall 1985, winter/spring 1985-86, and summer/fall 1986. All of the accessible stream channels and wetland perimeters within MDI's 39 watersheds have been examined for otter sign at least once per season. Preliminary results indicate that otter use is centered on the eastern half of the island. However, portions of five

watersheds on the island's western side are also used, at least on a seasonal basis.

To date, 212 presumed otter scats have been collected along the watersheds of MDI. Scats are currently being examined and recognizable prey remains are being separated for later identification.

All fieldwork assessing potential otter habitat and beaver activity, by watershed, was completed on 31 August 1986. Human disturbance and habitat characteristics of those watersheds used and not used by otters will be statistically compared. The purpose of this analysis is to identify those factors which influence the suitability of MDI's watersheds as otter habitat.

Future Plans:

Sign surveys will continue during the 1986-87 winter/spring season when snow tracing conditions are favorable. Priority will be given to searching those watersheds where little or no otter sign have been found to date. Scat analyses will continue throughout the winter as new materials are collected during survey efforts.

A number of habitat variables still require measurement using an electronic planimeter. Work will begin when the planimeter becomes available, sometime before December 1986 and is expected to be completed by January 1987. Analysis of habitat data will begin shortly thereafter; following completion, the final thesis will be written. Project completion is anticipated in summer 1987.

POPULATION DYNAMICS OF PACIFIC WALRUSES

Investigator: S. Hills

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

Cooperators/ProjectSupport:

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 walruses (composition, distribution, movements and behavior) on the existing population estimates.
- (3) Determine the distribution and movements of walruses relative to pack ice distribution, bathymetry, and other environmental parameters.
- (4) Evaluate the past censuses of walruses in relation to the distribution information collected in 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:

The project began September 1986. Objective 1 is being addressed with the aid of consulting personnel at Telonics in Arizona, Massachusetts General Hospital Anesthesiology Department, and the University of Maine's Department of Animal Science.

Future Plans:

Technique development, including design and testing of satellite transmitters, and immobilization procedures, will continue this winter and spring, with initial deployment planned for June of 1987.



Walrus resting on Round Island, Alaska. More reliable information is needed on walrus population characteristics to guide management of this international resource (Photo by S. Hills).

FOOD INTAKE BY DEER IN SOUTHEAST ALASKA

Investigator: D. E. Spalinger

Cooperators/

Project

Support:

USDA Forest Service - Pacific Northwest Forest and
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:

The initial phase of research was completed in August, 1986. This work included the testing of several of the hypothesized functional relationships between forage intake rates in deer and the characteristics of forage quality and available biomass. Data analysis and the progress report for phase I is expected to be completed by December, 1986.

Future Plans:

Phase II startup is expected by mid-summer of 1987. The objectives of this research are to complete and test a model of forage selection and intake for Sitka black-tailed deer, incorporating the physiological constraints on digestion and fill and the function relationships between foraging time, intake and nutritional characteristics of the available foods. The model will then be tested with tame black-tailed deer on an island in Southeast Alaska (June 1988-June 1990).

PUBLICATIONS, THESES AND DISSERTATIONS,
AND PROFESSIONAL TALKS GIVEN

SCIENTIFIC PUBLICATIONS

- Allan, T. 1985. Seasonal changes in habitat use by Maine spruce grouse. *Can. J. Zool.* 63:2378-2742.
- Allen, S.K., Jr., H. Hidu, and J.G. Stanley. 1986. Abnormal gametogenesis and sex ratio in triploid soft-shell clams (*Mya arenaria*). *Biol. Bull.* 170:198-210.
- Brown, P.W., and M.L. Hunter, Jr. 1985. Potential effects of insecticides on the survival of dabbling duck broods. *J. Minn. Acad. of Sci.* 50:41-44.
- Brown, P.W. 1986. Food habits of breeding white-winged scoters. *Can. J. Zool.* 64:1652-1654.
- Harrison, D.J., and J.R. Gilbert. 1985. Denning ecology and movements of coyotes in Maine during pup rearing. *J. Mammal.* 66:712-719.
- Hunter, M.L., Jr., and J.W. Witham. 1985. Effects of a carbaryl-induced depression of arthropod abundance on the behavior of Parvinae warblers. *Can. J. Zool.* 63:2612-2616.
- Hunter, M.L., Jr., A. Kacelnik, J. Roberts, and M. Vuillemoz. 1986. Directionality of avian vocalizations: a laboratory study. *Condor* 88:371-375.
- Hunter, M.L., Jr., J.J. Jones, J.W. Witham, T. Mingo. 1986. Biomass and species richness of aquatic macrophytes in four Maine (USA) lakes of different acidity. *Aquat. Botany* 24:91-95.
- Hunter, M.L., Jr., J.J. Jones, K. E. Gibbs, and J.R. Moring. 1986. Duckling responses to lake acidification: do black ducks and fish compete? *Oikos* 47:26-32.
- Jenks, J., D.M. Leslie, Jr., and H.C. Gibbs. 1986. Anomalies of the skull of a white-tailed deer fawn from Maine. *J. Wildl. Diseases.* 22:286-289.
- Jenks, J., A. G. Clark, R. T. Bowyer. 1986. Sex and age determination for fisher using radiographs of canine teeth: a response. *J. Wildl. Manage.* 50:277-278.
- Litvaitis, J.A., J.A. Sherburne, and J.A. Bissonette. 1985. Influence of understory characteristics on snowshoe hare habitat use and density. *J. Wildl. Manage.* 49:866-873.

- Litvaitis, J.A., J.A. Sherburne, and J.A. Bissonette. 1986. Bobcat habitat use and home range size in relation to prey density. *J. Wildl. Manage.* 50:110-117.
- Litvaitis, J.A., A.G. Clark, and J.H. Hunt. 1986. Prey selection and fat deposits of bobcats (*Felis rufus*) during autumn and winter in Maine. *J. Mammal.* 67:389-392.
- Moring, J.R. 1985. Relation of angler catch rates and effort to reductions in numbers of trout stocked in five Oregon streams. *N. Am. J. Fish. Manage.* 5:575-579.
- Moring, J.R. 1986. Seasonal presence of tidepool fish species in a rocky intertidal zone of northern California, USA. *Hydrobiologia* 134:21-27.
- Moring, J.R., P.D. Eiler, M.T. Negus, and K.E. Gibbs. 1986. Ecological importance of submerged pulpwood logs in a Maine reservoir. *Trans. Am. Fish. Soc.* 115:335-342.
- Moring, J.R., and M.E. Moring. 1986. A late leptocephalus stage of a conger eel, *Conger oceanicus*, found in a tidepool. *Copeia* 1986, No. 1:222-223.
- Perry, C.M., J.M. Gauvin, and H.D. Booth. 1986. ¹⁴C-labeled PCB uptake in the freshwater clam, *Anodonta grandis*. *Mich. Acad. Sci., Arts, and Letters* 18:213-219.
- Strong, P.I.V., J.A. Bissonette, and R. Souza. 1986. A case of brood mixing by common loons. *Wilson Bull.* 98:478-479.

TECHNICAL AND SEMI-TECHNICAL PUBLICATIONS

- Bissonette, John A. (editor) 1986. Is good forestry good wildlife management? *Maine Agric. Expt. Stn., Univ. of Maine, Misc. Publ.* No. 689. 377pp.
- Coutu, S., and P.W. Brown. 1986. Influence of highways on water chemistry vegetation, and invertebrates in a central Maine wetland. Final Report to Maine Dept. of Trans. Tech. Serv. Div., Tech. Pap. 86-1, April 1986. 36pp.
- Goodell, B.S., A. Kimball, and M.L. Hunter, Jr. 1986. Application of wood science to the creation and maintenance of snags for wildlife. Pages 135-139 in J.A. Bissonette (ed.). Is good forestry good wildlife management? *Maine Agric. Expt. Stn., Univ. of Maine, Misc. Publ.* No. 689. 377pp.
- Halpin, M.A., and J.A. Bissonette. 1986. The history of occurrence of red fox in Maine: presettlement to 1984. *Maine Agric. Expt. Stn., Univ. of Maine, Misc. Publ.* No. 683. 45pp.

- Harrison, D.J. 1986. Coyotes in the Northeast: their history, origin, and ecology. *Appalachia* 182:30-39.
- Hunter, M.L., Jr. 1985. Forests, forestry and fauna. *Habitat* 2:30-34.
- Hunter, M.L., Jr. 1986. The diversity of New England forest ecosystems. Pages 35-47 in J.A. Bissonette (ed.). Is good forestry good wildlife management? *Maine Agric. Expt. Stn., Univ. of Maine, Misc. Publ. No. 689*. 377pp.
- Kelly, K.H., and J.R. Moring. 1986. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (North Atlantic) - Atlantic Herring. *USFWS Biol. Rep. 82 (11.38)* and *U.S. Army Corps of Eng. Rep. TR-EL-82-4*. 22pp.
- Mackenzie, C. 1986. The blueback trout. *Maine Fish and Wildl.* 28(2):13-15.
- Mackenzie, C., and J.R. Moring. 1985. Species profiles (North Atlantic) - American lobster. *USFWS Biol. Rep. 82 (11-33)* and *U.S. Army Corps of Eng. Rep. TR-EL-82-4*. 19pp.
- Mackenzie, C., L.S. Weiss-Glanz, and J.R. Moring. 1985. Species profiles (Mid-Atlantic) - American shad. *USFWS Biol. Rep. 82 (11-37)* and *U.S. Army Corps of Eng. Rep. TR-EL-82-4*. 18pp.
- Moring, J.R. 1986. Catching and cooking the western crayfish. *Fishing World* 33:40-42.
- Moring, J.R., and G. Garman. 1986. Damariscove Island: history and beauty off the Maine coast. *New England's Coastal Journal*, Spring 1986:17-20.
- Moring, J.R., and G. Garman. 1986. The value of riparian zones for fisheries. Pages 81-90 in J.A. Bissonette (ed.). Is good forestry good wildlife management? *Maine Agric. Expt. Stn., Univ. of Maine, Misc. Publ. No. 689*. 377pp.
- Mendall, H.L. 1986. Identification of eastern races of the common Eider. Pages 82-88 in A. Reed (ed.). *Eider ducks in Canada. Can. Wildl. Serv. Rept. Ser. No. 47*. 177pp.
- Reed, A., P. Dupuis, A. Bourget, and H.L. Mendall. 1986. Races of the common Eider wintering in the Gulf of St. Lawrence. Pages 89-91 in A. Reed (ed.). *Eider ducks in Canada. Can. Wildl. Serv. Rept. Ser. No. 47*. 177pp.
- Small, M.F., and W.N. Johnson, Jr. 1986. Wildlife management in riparian habitats. Pages 69-81 in J.A. Bissonette (ed.). Is good forestry good wildlife management? *Maine Agric. Exp. Stn., Univ. of Maine, Misc. Publ. No. 689*. 377pp.

- Stanley, J.G. 1985. Species profiles (Mid-Atlantic) - hard clam. USFWS Biol. Rep. 82(11.41) and U.S. Army Corps of Eng. Rep. TR EL-82-4. 24pp.
- Stockwell, S.S., and M.L. Hunter, Jr. 1985. Distribution and abundance of birds, amphibians and reptiles, and small mammals in peatlands of central Maine. A report to the Maine Dept. of Inland Fisheries and Wildlife.
- Todd, C.S. and R.B. Owen, Jr. 1986. Management of bald eagle and osprey nest sites. Pages 141-148 in J.A. Bissonette (ed.). Is good forestry good wildlife management? Maine Agric. Exp. Stn., Univ. of Maine, Misc. Publ. No. 669. 377pp.
- Trial, J.G., F. Jiffry, L. Glanz, and J.R. Moring. 1986. Fisheries indices and shellfish populations in Sebasticook Lake as affected by water drawdown. Final Rept. to Maine Dept. Environ. Prot. 66pp.

THESES AND DISSERTATIONS

- Bley, P.W. 1986. Seasonal habitat selection of juvenile brook trout (*Salvelinus fontinalis*) and landlocked Atlantic salmon (*Salmo salar*): evidence of competition. M.S. Thesis, Univ. of Maine, Orono. 69pp.
- Eiler, P.D. 1986. Effects of sunken pulpwood logs on benthic habitat and macroinvertebrates in Wyman Lake, a reservoir on the Kennebec River, Maine. M.S. Thesis, Univ. of Maine, Orono. 58pp.
- Engelhardt, D.B. 1986. Analysis of red fox and coyote home range use in relation to artificial scent marks. M.S. Thesis, Univ. of Maine, Orono. 62pp.
- Harrison, D.J. 1986. Coyote dispersal, mortality, and spatial relationships with red foxes in Maine. Ph.D. Dissertation, Univ. of Maine, Orono. 109pp. 10pp. Appendix.
- Jenks, J.A. 1986. Synergistic relationships among important winter forages of white-tailed deer. M.S. Thesis, Univ. of Maine, Orono. 55pp.
- Johnson, W.N., Jr. 1986. Avian use of a lakeshore buffer strip in eastern Maine. M.S. Thesis, Univ. of Maine, Orono. 54pp.
- Jorde, D.G. 1986. Nutritional and thermodynamic aspects of the ecology of black ducks wintering in Maine. Ph.D. Dissertation, Univ. of Maine, Orono. 114pp.
- Leptich, D.J. 1986. Summer habitat selection by moose in northern Maine. M.S. Thesis, Univ. of Maine, Orono. 42pp.

- McAuley, D.G. 1986. Ring-necked duck productivity in relation to wetland acidity: nest success, duckling diet and survival. M.S. Thesis, Univ. of Maine, Orono. 71pp.
- McCullough, M.A. 1986. The post-fledging ecology and population dynamics of bald eagles in Maine. Ph.D. Dissertation, Univ. of Maine, Orono. 105pp.
- Pauwels, S.J. 1985. The influence of acidity on fish species distribution in selected Maine lakes. M.S. Thesis, Univ. of Maine, Orono. 35pp.
- Small, M.F. 1986. Response of songbirds and small mammals to power-line and river edges of Maine oak-pine forests. M.S. Thesis, Univ. of Maine, Orono. 58pp.
- Stockwell, S.S. 1985. Distribution and abundance of amphibians, reptiles, and small mammals in eight types of Maine peatland vegetation. M.S. Thesis, Univ. of Maine, Orono. 70pp.

PROFESSIONAL TALKS PRESENTED

- Arthur, S. "Seasonal changes in resting site selection by fishers in Maine." Poster presented at Amer. Society of Mammalogists meeting at Univ. of Wisc. Madison, June 1986.
- Arthur, S. "Fisher Studies in Maine." Paper presented at the annual meeting of the Northeast Fur Resources Technical Committee, Davis, West Virginia, September, 1986.
- Arthur, S. "Fisher Ecology." Slide show presented to meeting of Regional Biologists, Me. Dept. Inland Fisheries and Wildlife, Bangor, September 1986. 25 attendees.
- Bley, P.W. "Habitat selection by brook trout." Migratory Fish Res. Inst. Seminar Series, Univ. of Maine, April 1986. 25 attendees.
- Bley, P.W., and J.R. Moring. "Seasonal habitat selection of brook trout and Atlantic salmon and the effect of competition." Northeast Fish and Wildl. Conf., Hershey, PA, April 1986. 100 attendees.
- Bley, P.W. "Competition between brook trout and Atlantic salmon." Seminar to meeting of regional biologists, Me. Dept. Inland Fisheries and Wildlife, Augusta, May 1986. 32 attendees.
- Bley, P.W. "Habitat selection by juvenile Atlantic salmon and brook trout: evidence of competition." North Am. Salmon Res. Center Seminar Series, St. Andrews, NB, May 1986. 10 attendees.

- Chilelli, M. "Overview of Maine deer herd population model." Presented to meeting of regional biologists, Me. Dept. Inland Fisheries and Wildlife, Bangor, September 1986. 25 attendees.
- D'Anieri, P., M. L. McCormack, Jr., and D. M. Leslie. "The small mammal community in a glyphosate conifer release treatment in Maine." Presented at 40th Annual Meeting Northeastern Weed Science Society. Boston, MA. January 1986. Second place for Best Paper.
- Eggeman, D. R., and P. W. Brown. Influence of environmental conditions, sex, age, and paired status on behavior of common goldeneyes in winter. Presented at American Ornithologist's Union Annual Meeting, Mississippi State, MS. July 1986.
- Elliott, C.A. "Songbird diversity and forest edges." Paper presented at the 1986 Maine Audubon Bird Conference, Brunswick, Maine, April 1986.
- Frazer, C. "Black duck research at UMO." Paper presented at the North-Graduate Student Conference, McGill University, Montreal, Quebec, Canada with Tim Bowman and Duane Diefenbach, February 1986.
- Garman, G.C., and J.R. Moring. "Changes in the diet and annual production of two boreal-river fishes following clearcut deforestation." Poster presented at Ann. Meet., Am. Fish. Soc., Providence, RI., September 1986. 300 attendees.
- Hunter, M.H., Jr., and P. Yonzon. "Wildlife habitat and population analysis workshop." Taught four-day workshop for faculty and graduate students of Tribhuvan University in Nepal. March 1986.
- Hunter, M.L., Jr. "Effects of lake acidification on waterfowl: do ducks and fish compete?" Talk presented at Unity College, September 1985. 50 students and staff attendees.
- Hunter, M.L., Jr. "Forests, forestry and wildlife." University of Maine Forestry Seminar, September 1985. 25 faculty attendees.
- Hunter, M.L., Jr. "Forests, forestry and wildlife." Talk presented at Yale University, October 1985. 25 students and staff attendees.
- Hunter, M.L., Jr. "Effects of intensive harvesting on wildlife." Talk presented at Wood Energy Conference, Maine Audubon Society, Waterville, October 1985. 80 professional attendees.
- Hunter, M. L., Jr. "Maintaining biological diversity on a local level." Maine Endangered Species Conference, December 1985. 125 professional and general public attendees.
- Hunter, M.L., Jr. "Forests, forestry, and wildlife." Presented at Univ. of New Hampshire, May 1986. 40 faculty and student attendees.

- Hunter, M.L., Jr. and P. Yonzon. "Future trends in wildlife conservation in Nepal." Talk presented at Nepal Natural Resources Forum, Kathmandu, April 1986. 25 professional attendees.
- Jenks, J.A. "Synergistic relationships among important winter forages of white-tailed deer (Odocoileus virginianus)." Paper presented at Annual Meeting of American Society of Mammalogists; Univ. of Wisconsin, Madison. June 1986.
- Jenks, J.A. "Synergistic relationships among important winter forages of white-tailed deer." Wildlife Noontime Seminar, Univ. of Maine, April 1986. 30 students and faculty attendees.
- Krohn, W.B. "Molt migration of Rocky Mountain Canada geese." Slide presentation to the UMO Wildlife Seminar Series, November 1985. 40 faculty and student attendees.
- Krohn, W.B. "The future of wildlife and wildlife management in Maine." Comments presented before the Governor's Commission on Outdoor Recreation in Maine. July 1986. 35 attendees
- Krohn, W.B. "On-going wildlife research activities of the Maine CFWRU." Presented to meeting of Regional Biologists, Me. Dept. of Inland Fisheries and Wildlife, Bangor. September 1986. 25 attendees.
- Leptich, D.J. and J.R. Gilbert. "Characteristics of moose calving sites in Northern Maine as determined by multivariate analysis: A preliminary investigation." Paper presented at the 22nd N. Am. Moose Conf., Fredericton, N.B., Canada, May 1986.
- McCullough, M. "Bald eagle ecology in Maine." Talk presented at Univ. of New Hampshire Student Chapter of The Wildlife Society, November 1985. 22 attendees.
- Moring, J.R. "Ecology of rocky intertidal fishes." Univ. of Delaware, College of Marine Studies, Lewes, DE, November 1985. 25 attendees.
- Moring, J.R. "Ecology of rocky intertidal fishes." Univ. of Delaware, Newark, DE, November 1985. 10 attendees.
- Moring, J.R. "Ecological significance of submerged pulpwood logs in a Maine reservoir." Murray State Univ., Murray, KY, May 1986. 20 attendees.
- Moring, J.R. "Intertidal food habits and algal associations of juvenile Cyclopterus lumpus and Liparis atlanticus." Ann. Meet., Am. Soc. Ichthyol. and Herpetol., Victoria, BC, June 1986. 75 attendees.
- Moring, J.R. "Rainbow smelt culture." Baitfish Culture Course, U.S. Fish and Wildl. Serv., Fisheries Academy, Orono, ME, July 1986. 45 attendees.

- Moring, J.R. "Development of a sportfishery for sea-run brown trout." Joint site visit meeting for UNH/UM Sea Grant Program, Prouts Neck, ME, September 1986. 25 attendees.
- Moring, J.R., R.L. Youker, and R.M. Hooton. "Age structures and movements of potamodromous cutthroat trout of the Willamette Valley, Oregon. Poster presented at Ann. Meet., Am. Fish. Soc., Providence, RI, September 1986. 300 attendees.
- Owen, R.B., Jr. "Eagles in Maine." Talk presented at Unity College Lecture Series, October 1985. 100 academic attendees.
- Owen, R.B., Jr. "Herbicides, Wildlife and Forest Management." 2-day field trip organized and presented for Maine Chapter of The Wildlife Society. July 1986.
- Santillo, D. "Glyphosate and wildlife habitat in Maine." Talk presented to foresters, agriculturalists, and industries involved with herbicides, January 1986.
- Santillo, D. "Glyphosate and wildlife habitat in Maine." Paper presented at Northeastern Weed Science Society Meeting, Boston, Mass., January 1986.
- Santillo, D. "Songbirds and Small Mammals on Herbicide-treated clearcuts in Maine." Paper presented at Northeast Graduate Wildlife Conf., February 1986.
- Santillo, D. "Songbirds and small mammals on Glyphosate-treated clearcuts." Talk presented to Tour of Field Sites for Maine Chapter of The Wildlife Society, July 1986. 25 attendees.
- Santillo, D. "Effects of Glyphosate-induced habitat changes on songbirds and small mammals." Field presentation to Coop. Forestry Research Unit Advisory Committee, August 1986. 20 paper industry representatives and state professional attendees.
- Trial, J.G. "An annotated bibliography: the environmental effects of spruce budworm control programs in the eastern United States and Canada." Poster presented at 10th Ann. Meet., E. Spruce Budworm Res. Work Conf., Orono, ME, January 1986. 50 attendees.
- Wynne, K.M. "Harbor seals in New England." Presented poster and answered questions for ca. 150-200 visitors at the Darling Center, Walpole, ME.
- Wynne, K.M. "Complexities of marine mammal research and management." Invited lecture at: Environmental Science Seminar Series, Unity College. April 1986.

TALKS PRESENTED

- Arthur, S. "Fisher ecology." Slide show presented at Union River Chapter Maine Trappers Association, Ellsworth, October, 1985. 30 attendees.
- Arthur, S. "Fisher ecology." Slide show presented at Aroostook County Maine Trappers' Association, Presque Isle, October, 1985. 25 attendees.
- Arthur, S. "Fisher ecology." Slide show presented at Penobscot Valley Chapter Maine Trappers' Association, Kenduskeag, November, 1985. 20 attendees.
- Arthur, S. "Fisher ecology." Slide show presented at Hampden Academy Adult School, Hampden, December 1985. 10 attendees.
- Arthur, S. "Fisher ecology." Slide show presented to 7th grade class, Winterport School, December 1985. 40 attendees.
- Arthur, S. "Fisher ecology." Talk presented to Lawrence High School, Fairfield, Maine, March 1986.
- Arthur, S.. "Fisher ecology". Talk presented to a meeting of the Central Maine Chapter of the Maine Trappers' Association, Palmyra, Maine, August 1986.
- Arthur, S. "Fisher ecology". Slide show presented to Veazie Salmon Club, Veazie, September 1986. 25 attendees.
- Chilelli, M. "Wildlife and wildlife careers." Talk presented to elementary school children at U of M, July 1986. 6 student, 2 teacher attendees.
- DeBruyckere, L. "Alaska tundra wildlife." Presented talk to senior citizens at housing development in Bangor, February 1986. 10 attendees.
- Elliott, C.A. "Wildlife conservation, ecology, and management." Presented to 7 groups of teenagers attending the Penobscot County Conservation Association Conservation Camp at Camp Jordan, August 1986. 70 attendees.
- Hunter, M.L., Jr. "Managing your land for wildlife." Talk presented at Ellsworth Rotary Club, October 1985. 50 general public attendees.
- Hunter, M.L., Jr. "A global approach to wildlife conservation." Maine Audubon Society, February 1986. 50 general public attendees.
- Hunter, M.L., Jr. Led field trip through Sunkhaze Meadow, September 1986. 22 attendees.
- Jenks, J.A. "Synergistic relationships among important winter forages of white-tailed deer." March 1986. 15 students and faculty.

- Jenks, J.A. "Jamie the deer: a look at a captive white-tailed deer." April 1986. 60 Boy Scouts and parents.
- Jenks, J.A. "A Look at the captive wildlife research facility." April 1986. 80 4-H students and parents.
- Jenks, J.A. Careers Day (wildlife management) at George Stevens Academy. May 1986. 45 high school student attendees.
- Jenks, J.A. "Captive deer research." Presented to Maine Scholars, May 1986. 400 high school student attendees.
- Jenks, J.A. Deer research at the University of Maine and on-going research in wildlife management at the University of Maine." Presented to in-coming college students and parents. May 1986. 45 attendees.
- Jenks, J.A. "Deer research in Maine featuring Jamie the deer". Presentation at Windover Day Camp, Dixmont, Maine, July 1986. 60 student attendees.
- Krohn, W.B. "Ecology and management of Canada geese." Slide presentation to the wildlife freshman seminar, October 1985. 30 student and faculty attendees.
- Krohn, W.B. "Woodcock population and habitat trends." Presented a slide talk to the Penobscot County Conservation Association. December 1985. 70 attendees.
- Krohn, W.B. "Woodcock population and habitat trends." Presented a slide talk to the Penobscot Salmon Club, February 1986. 40 attendees.
- Leptich, D.J. "Welcome to Kenya." Talk presented to wildlife professionals, faculty, grad students, and staff of UMO. Approximately 45 attendees.
- Leptich, D.J. "Welcome to Kenya: the people and wildlife of Kenya." Talk presented to UMO Student Chapter of TWS, October 1985. 25 undergraduate attendees.
- Leptich, D.J. "Moose ecology and management in Maine." Talk presented at Dexter Fish & Game Club, December 1985. 30 attendees.
- McCullough, M.. "Bald eagle program." Talk presented at the 30th Anniversary of the Butler Co. Conservation School, Butler, PA, August 1985. 190 attendees.
- McCullough, M. "Population dynamics of endangered species." Lecture presented to Wildlife Population Ecology class, University of New Hampshire, Durham, November 1985. 17 attendees.

- McCullough, M. "Ecology of bald eagles in Maine." Talk presented to National Audubon Expedition Institute, November 1985. 24 attendees.
- McCullough, M. "Bald eagles in Maine." Talk presented to Hammond Street Congregational Church, November 1985. 25 attendees.
- McCullough, M. "Bald eagles in Maine" - seminar presented to Bangor Sportsmen's Show. March 1986. 55 public attendees.
- McCullough, M. "Careers in wildlife" - 2 talks presented to students at E. Corinth High School. October 1985. 40 student attendees.
- Moring, J.R. "Effects of logging on streams". Sunkhaze Chapter, Trout Unlimited, Brewer, ME, April 1986. 60 attendees.
- Moring, J.R. "Fisheries research by the Maine Cooperative Fish and Wildlife Research Unit." Penobscot County Conservation Assoc., Brewer, ME, September 1986. 98 attendees.
- Owen, R.B., Jr. "Eagles in Maine." Talk presented at Merrymeeting Chapter, Audubon Society, September 1985. 50 public attendees.
- Owen, R.B., Jr. "Management of bald eagles in Maine." Talk presented at Orono-Old Town Kiwanis, November 1985. 40 attendees.
- Owen, R. B., Jr. "Endangered species management in Maine." Talk presented at UMO Outing Club, December 1985. 25 attendees.
- Owen, R.B., Jr. "Frontiers in marine biology." 2-day class presented for high school teachers. July 1986.
- Owen, R.B., Jr. "Mathematics and biology." 1-day class presented for high school teachers. July 1986.
- Santillo, D. "Non-game wildlife, and nongame research." Talk presented to wildlife class at Ellsworth High School, September 1986. 20 student attendees.
- Sayers, R.E., Jr. "Fish identification." Presented to 7 groups of teenagers attending the Penobscot County Conservation Association Conservation Camp at Camp Jordan, August 1986. 70 attendees.
- Trial, J.G. "Streamside entomology." Ellsworth Chapter, Trout Unlimited, Ellsworth, ME, April 1986. 20 attendees.

PROFESSIONAL MEETINGS ATTENDED

- Arthur, S. Attended Amer. Soc. of Mammalogists Meeting in Madison, Wis. June 1986.
- Chilelli, M. Attended the Northeast Deer Technical Committee Meeting at Fairlee, Vt., September 1986.
- Debruyckere, L. Attended Midwest Fish and Wildlife Conference in Ann Arbor, Michigan. November 1985.
- Devaul, H. Attended NAMMA Annual Meeting (North Atlantic Marine Mammal Association) at New England Aquarium, Boston, Mass., March 1986.
- Elliott, C.A. Attended the 4-H Natural Resource Program Kick-off for 4-H leaders, agents, and teachers, at Tanglewood 4-H Camp in Lincolnville, Maine. Taught a session on basic ecology and led an activity on land-use planning, September 1986.
- Hunter, M.L., Jr. Attended Meeting of International Ornithology Congress, Ottawa, Ontario, Canada, June 1986. Participated in round-table discussion of "Acid Precipitation and Birds."
- Moring, J.R. Attended Maine Shellfish Conference, Rockport, ME, November 1985.
- Moring, J.R. Attended 1986 Fisherman's Forum, Rockport, ME, March 1986. Participated in fisheries technology panel discussion.
- Owen, R.B., Jr. Attended Meeting of International Ornithology Congress, Ottawa, Ontario, Canada, June 1986.

