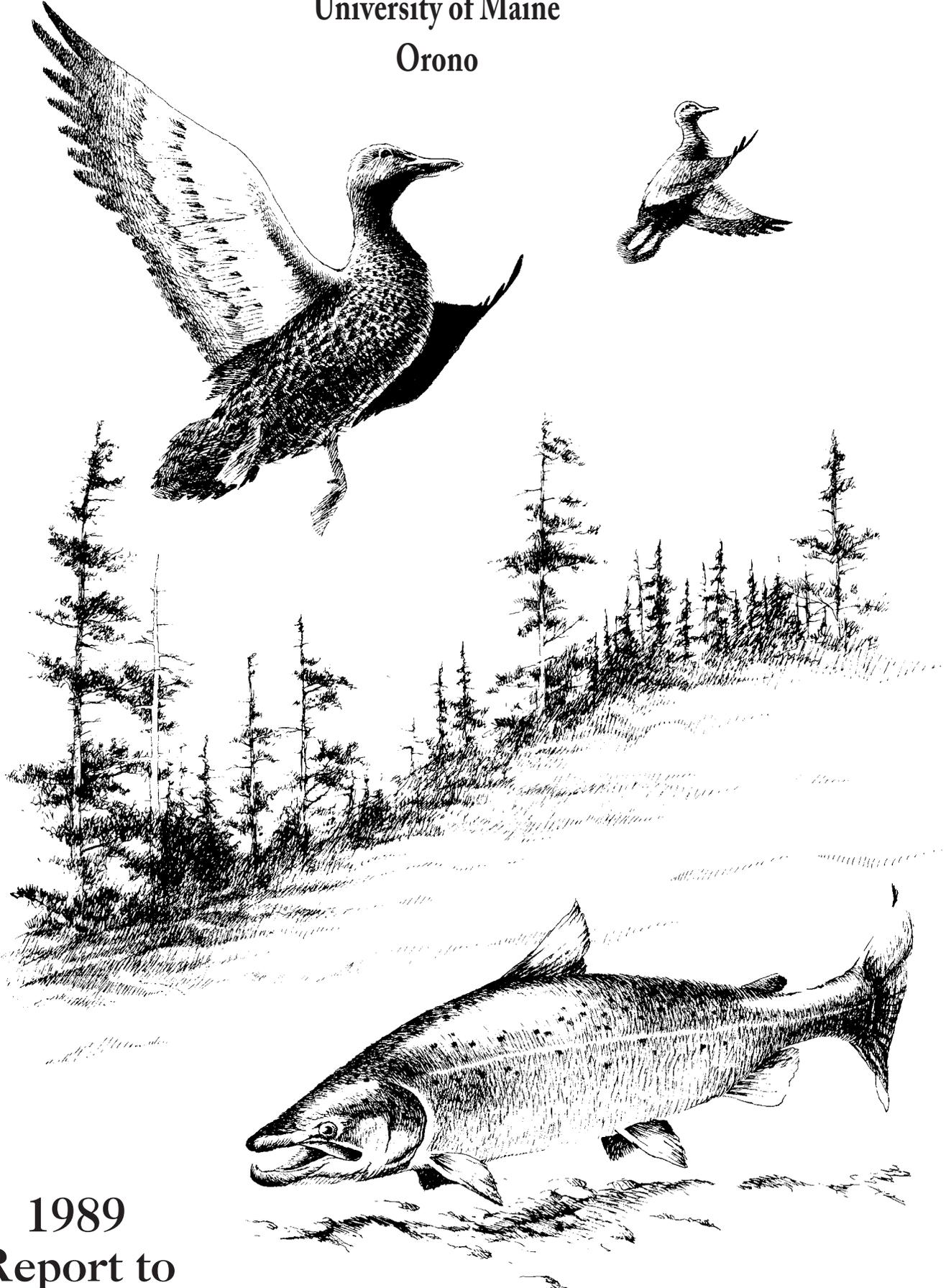


MAINE COOPERATIVE FISH AND WILDLIFE RESEARCH UNIT

University of Maine

Orono



1989
Report to
Cooperators

—Mark McCollough '86

MAINE COOPERATIVE FISH AND WILDLIFE RESEARCH UNIT

240 Nutting Hall*
University of Maine
Orono, Maine 04469



COOPERATORS

UNIVERSITY OF MAINE

DEPARTMENT OF INLAND FISHERIES AND WILDLIFE

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

WILDLIFE MANAGEMENT INSTITUTE



October 1988 - September 1989



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

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PERSONNEL AND COOPERATORS**COORDINATING COMMITTEE**

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

University of Maine
Ray B. Owen, Jr., Chairperson, Department of Wildlife, College of Forest Resources
James D. McCleave, Chairperson, Department of Zoology, College of Sciences

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

Wildlife Management Institute
Laurence R. Jahn, President

UNIT PERSONNEL**Unit Staff:**

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

Associated Faculty and Staff, Departments of Wildlife and Zoology:

Ray B. Owen, Jr., Chairperson, Department of Wildlife College of Forest Resources, and
Professor of Wildlife
James D. McCleave, Chairperson, Department of Zoology College of Sciences, and Professor
of Zoology
James R. Gilbert, Professor of Wildlife
William E. Glanz, Associate Professor of Zoology and Cooperating Associate Professor of
Wildlife
Kevin J. Boyle, Assistant Professor, Department of Agriculture and Resource Economics, and
Cooperating Assistant Professor of Wildlife
Daniel J. Harrison, Assistant Professor of Wildlife
Malcolm L. Hunter, Jr., Associate Professor of Wildlife
Raymond J. O'Connor, Associate Professor of Wildlife
Frederick A. Servello, Assistant Professor of Wildlife
Jerry R. Longcore, Wildlife Research Associate and Research Wildlife Biologist, USFWS
James A. Sherburne, Coordinator, International Natural Resources and Agricultural Programs
Hewlette S. Crawford, Jr., Research Wildlife Biologist, USFS
Terry A. Haines, Professor of Zoology and Fishery Research Biologist, USFWS
Mark A. McCollough, Senior Scientist, Wildlife
Ruth W. Perry, Zoology Technician
Jack Witham, Assistant Scientist, Wildlife
Thomas Hodgman, Wildlife Research Associate
Susan Anderson, Administrative Assistant, USFWS-NFCRC

Maine Department of Inland Fisheries and Wildlife:

William J. Vail, Commissioner
Norman E. Traşk, Deputy Commissioner
Frederick B. Hurley, Jr., Director, Bureau of Resource Management
Gary Donovan, Director, Wildlife Division
Peter Bourque, Director, Fisheries and Hatcheries Division
George J. Matula, Jr., Supervisor, Wildlife Resource Assessment Group
Kendall Warner, Supervisor, Fisheries Management Section

GRADUATE STUDENTS

Name	Degree Candidacy	Support
Beverly Agler	M.S.	Personal Funding
Brian Bogaczyk	M.S.	USFWS-WO, MCFWRU
Randall P. Boone	M.S.	Pesticide manufacturers
Andrea Colnes	M.W.C.	McIntire-Stennis, Personal Funding
Holly Devaul	M.S.	U of M, MCFWRU, MDIFW, HMSA
Mustapha El-Hamzaoui	M.S.	USAID/USDA
Brian Gray	M.S.	McIntire-Stennis
Richard A. Hartley	M.S.	MDIFW
Susan Hills	Ph.D.	USFWS-AFWRC
Sarah Hooper	M.S.	McIntire-Stennis
Malcolm T. Jones	M.S.	Pesticide manufacturers
Donald Katnick	M.S.	McIntire-Stennis
T. Bruce Lauber	M.S.	Pesticide manufacturers
Thomas C. McCall	Ph.D.	Hatch; McIntire-Stennis
Daniel B. McKinley	M.S.	USFS - WMNF and GMNF
Craig R. McLaughlin	Ph.D.	Personal Funding
Leslie H. Mink	M.S.	MDIFW, MCFWRU
Enama Mugangu	Ph.D.	AFGRAD, Rockefeller Foundation
Thomas F. Paragi	M.S.	MDIFW; MCFWRU
Stanislas J. Pauwels	Ph.D.	USFWS, U of M, ASF
Cynthia M. Perry	Ph.D.	USFWS, U of M, PCCA, MCFWRU, ASF
Mary M. Robbins	Ph.D.	USFWS
Gregory P. Romig	M.S.	USFS - WMNF and GMNF
Jill M. Ryan	M.S.	USFWS, U of M
Tamia Rudnicki	M.S.	McIntire-Stennis
Midori Saeki	M.S.	NPS
Richard E. Sayers, Jr.	Ph.D.	MDIFW, U of M, MCFWRU, PCCA, MDMR
Robert L. Schooley	M.S.	U of M, MDIFW
Lisa A. Shively	M.S.	McIntire-Stennis
Todd R. Smith	M.S.	USFWS
Sarah S. Stockwell	Ph.D.	Personal Funding
Johannes Subijanto	M.S.	HIID
Marcia Summers	M.S.	Personal Funding (Grad. School Assistantship)
W. Matthew VanderHaegen	Ph.D.	U of M, USFWS (NEC, MNWR), PCCA, HWR, TBF
Agnes Vanderpool	M.S.	USFWS - NEAFL
Eleta J. Vaughan	M.S.	U of M
Sharri A. Venno	M.S.	Personal Funding
Christopher Vera	M.S.	Resource Conserv. Serv., Inc., Scott Paper Company
Peter D. Vickery	M.S.	NC; MAS; MPCB; MAAS; CB
Andrew A. Whitman	M.S.	U of M
Lois Winter	M.S.	NPS
Pralad B. Yonzon	Ph.D.	U of M; WWF

Graduate Students: Dissertations/Theses Completed This Period

Andrea Colnes	M.W.C.	Personal Funding, McIntire-Stennis
Leslie H. Mink	M.S.	MDIFW
Lisa A. Shively	M.S.	McIntire-Stennis
Joan G. Trial	Ph.D.	USFWS
Pralad B. Yonzon	Ph.D.	U of M; WWF

PERSONNEL NOTES

DR. RAY B. OWEN, JR. returned January 1, 1989 as Chair of the Department of wildlife after a year's sabbatical. He spent several months writing manuscripts that have now been accepted for publication and about 3 months in Alaska.

DR. FREDERICK SERVELLO accepted the position of Assistant Professor in Wildlife and arrived at the University on January 1, 1989. Dr. Servello was teaching at the University of Kentucky prior to moving to Maine.

DR. BRAD GRIFFITH is the new Assistant Unit Leader for Wildlife. He was at the University of Idaho before coming to Maine. **DR. MARYELLEN CHILELLI** was hired as an Assistant Scientist in Wildlife to work on the Otter Project with Dr. Griffith.

The following wildlife graduates received their degrees at either December, May, or August graduations: **LISA SHIVELY** received her M.S. degree and is presently working in Alaska on a deer nutrition study. **ANDREA COLNES** received the first Master of Wildlife Conservation degree--a new non-thesis degree program in the Department of Wildlife.

In fisheries, **JOAN TRIAL** received her Ph.D. degree and is employed as a fisheries research biologist for the Maine Department of Inland Fisheries and Wildlife in Bangor. **DAN MCKINLEY** is completing his thesis while employed by the U.S. Forest Service, Green Mountain National Forest. **LESLIE MINK** recently prepared a stream assessment guidebook for the Atlantic Salmon Federation and is now employed by the U.S. Forest Service.

COLLABORATING AGENCIES AND ORGANIZATIONS

Atlantic Salmon Federation - ASF
 Coastal Blueberry, Inc. - CB
 DuPont
 Hawk Mountain Sanctuary Association - HMSA
 Hirundo Wildlife Refuge - HWR
 Holt Woodlands Research Foundation - HWRF
 International Paper Company - IPC
 Kennebec Log Driving Company - KLDC
 King Mahendra Trust for Nature Conservation - KMTNC
 L.L. Bean, Inc. - LLB
 Maine Atlantic Sea-Run Commission - MASRC
 Maine Audubon Society - MAS
 Maine Department of Conservation - MDC
 Maine Department of Environmental Protection - MDEP
 Maine Department of Inland Fisheries and Wildlife - MDIFW

Maine Department of Marine Resources - MDMR
Maine Land Use Regulation Commission - MLURC
Maine Pesticides Control Board - MPCB
Massachusetts Audubon Society - MAAS
National Geographic Society - NGS
National Rifle Association - NRA
National Wildlife Federation - NWFED
Nature Conservancy - NC
 Maine Chapter - NC-MC
 NE Regional Office - NC-NE
Nepal Department of National Parks and Wildlife - NDNPW
North American Wildlife Foundation -
 Delta Waterfowl & Wetland Research Station - DWRS
Penobscot County Conservation Association - PCCA
Resource Conservation Services, Inc. - RCS
Rockefeller Foundation - RF
Scott Paper Company - SP
Taylor's Bait Farms, Inc. - TBF
Tribhuvan University -TU
University of Maine - U of M
 Association of Graduate Students - AGS
 College of Sciences - CS
 Zoology Department - ZD
 College of Forest Resources - CFR
 Hatch Act Funds - HAF
 McIntire-Stennis - MS
 College of Applied Sciences and Agriculture
 Department of Agricultural Resource Economics - ARE
 Graduate School
U.S. Dept. of Agriculture - USDA/USAID
U.S. Fish and Wildlife Service - FWS
 Alaska Fish and Wildlife Research Center - AFWRC
 Alaska Regional Office - ARO
 Moosehorn National Wildlife Refuge - MNWR
 National Ecology Center - NEC
 National Fisheries Contaminant Research Center - NFCRC
 National Fishery Research and Development Lab - NFRDL
 Northeast Anadromous Fisheries Laboratory - NAFL
 Office of Information Transfer - OIT
 Patuxent Wildlife Research Center - PWRC
 Region 5, Federal Assistance - R-5/FA
 Washington Office - WO
U.S. Forest Service - USFS
 White Mountain National Forest - WMNF
 Green Mountain National Forest - GMNF
U.S. National Park Service - NPS
 Acadia National Park - ANP
 Boston Regional Office - BRO
World Wildlife Fund - WWF

PROJECT REPORTS

ENDANGERED AND THREATENED SPECIES:

NEPAL-HIMALAYAS RED PANDA PROJECT

- Investigator:* P. B. Yonzon
- Advisors:* M. L. Hunter, Jr., Chairperson
W. E. Glanz
R. B. Owen, Jr.
- Cooperators/
Project
Support:* World Wildlife Fund
Environment and Policy Institute, East-West Center
Department of National Parks and Wildlife Conservation
King Mahendra Trust for Nature Conservation
Tribhuvan University
- Objectives:*
- (1) Develop techniques for assessing the distribution and status of red pandas.
 - (2) Provide basic information on red panda ecology regarding habitat selection, diet, and social systems.

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

A two-year ecological study of red pandas was carried out in the Langtang National Park, Nepal. The study emphasized developing methods for studying red pandas, and a broad array of data on habitat selection, movements, diet, and social system was gathered.

Besides the study on red panda ecology for long-term conservation, a technical training component was incorporated into this project. A key component of this program was the involvement of Nepali biologists in conservation research. Graduate students from Tribhuvan University were involved by undertaking related, short-term studies.

PROJECT STATUS: A Ph.D. dissertation was completed in September 1989. The abstract follows:

Red pandas (*Ailurus fulgens*) were studied in Langtang National Park from 1986-87. The 22.2 km² study area had an estimated population of nine and seven animals in 1986 and 1987, respectively. Mating occurred from late January through March, and females were polyestrous. The litter size was 1-2 cubs. Mortality among cubs was 83-86% (5-6 cubs) and 67% (4 cubs) in 1986 and 1987, respectively. Although adult mortality was not observed in 1986, 44% (4 animals) died in 1987. Mortality in adults and young was associated with disturbance from *chauri* grazing and other human-related activities.

Droppings comprised 54-100% *jhapra* leaves. *Chauri* herds also grazed extensively in the

study area throughout the monsoon. However, direct competition from *jhapra* leaves was probably not critical as the vertical distribution of feeding activity was different (t -test = 6.46, $P < 0.0005$). *Chauri* consumed foliage primarily below 2 m and red pandas above 2 m. Pandas also ate *jhapra* shoots of larger diameter ($\bar{x} = 10 \pm 2.2$ mm) and fruits of *Sorbus* and mushrooms.

Home range sizes varied from 1.4 - 11.6 km². Utilization of five different habitat types was different in all seasons ($X^2 = 63.3$, d.f. 12, $P < 0.0005$) and fir-*jhapra* the preferred habitat. Their altitudinal range was 2900 - 3900 m. Based on the altitudinal range and preference for fir-*jhapra* habitat, geographical information system was used to estimate that Langtang contained 73 animals in four populations.

Red pandas were active at all times of the day (56% overall) with major peaks at dusk and dawn and two minor peaks at mid-day and around mid-night. This extensive activity may be an adaptation to their low-quality diet of *jhapra* leaves.

If mortality levels of the red panda in the study area are characteristics of all isolated populations, the red panda is threatened with local extinction. Because intensive *chauri* grazing is associated with cheese production, a lower production of more expensive cheese may save Langtang's red pandas from extinction and also allow subsistence farmers to exploit resources without destroying the environment.

FISHERIES RESOURCES:

TESTING HABITAT MODELS FOR BLACKNOSE DACE AND ATLANTIC SALMON

Investigator: J. G. Trial

Advisors: J. G. Stanley, Chairperson
W. E. Glanz
J. B. Dimond
J. R. Gilbert
W. B. Krohn

*Cooperators/
Project
Support:* U. S. Fish and Wildlife Service
University of Maine

Objective: To test and modify existing models for blacknose dace and Atlantic salmon.

SCOPE: Habitat suitability models are commonly used for evaluating habitat capacity to support various species of animals and to use in conjunction with mitigation projects and environmental assessments. Such models are often based on composites of published and unpublished data and need to be evaluated. This project evaluated such models for two species, blacknose dace and Atlantic salmon.

PROJECT STATUS: The project is completed and an abstract of the doctoral dissertation follows:
Habitat Suitability Index (HSI) models for blacknose dace (*Rhinichthys atratulus*) and juvenile Atlantic salmon (*Salmo salar*) were tested using data from 35 streams in Maine and New Brunswick. The HSI models consisted of a series of curves that described relationships between environmental

variables and habitat quality. For each site, an index value was determined for each life stage by combining indices for habitat variables into a component index. In turn, component indices were combined to give a species HSI.

The research had four phases: (1) predicted habitat values from suitability curves and component indices were compared to population density and habitats selected by individual fish, (2) published HSI models were analyzed for internal logic, (3) the models were revised using the results of the first two steps, and (4) published and revised models were tested against a new set of data. Because the models were designed to detect relative differences in habitat quality among sites, the tests correlated rankings of sites based on annual populations with component indices and HSI.

The published curves for percent shade, percent pools, and stream width in the blacknose dace model were not predictive. Curves tested using data on the depth, velocity, and substrate selected by blacknose dace and Atlantic salmon were predictive. The geometric mean of suitability values, commonly used to calculate component indices in the published models, was equally or less predictive than component indices calculated using the product of suitability values. Ranks of HSI from the published model for blacknose dace did not correlate with ranks of dace density ($P = 0.70$), while the revised model HSIs were rank correlated with density ($P = 0.07$).

The published Atlantic salmon model was predictive for the fry component ($P = 0.016$), but not the parr component ($P = 0.81$). However, ranks of the HSI and juvenile density were correlated ($P = 0.025$). The revised model did not improve the rank correlation between the parr component and density ($P = 0.81$) or HSI and juvenile density ($P = 0.07$).

BIOLOGY OF WHITE PERCH IN LAKE GEORGE, MAINE

Investigator: L. H. Mink

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

*Cooperators/
Project
Support:* Maine Department of Inland Fisheries and Wildlife
Penobscot County Conservation Association

Objectives:

- (1) To describe the age structure and food habits of white perch in Lake George, Maine
- (2) To compare the food habits of white perch and sea-run alewives in two ponds in central-coastal Maine to assess possible competition for food resources between the two species.

SCOPE: The Maine Legislature has directed the Maine Department of Marine Resources (DMR) to restore sea-run alewives to their former range in Maine. Such restoration has caused concern among other state agencies that alewives may adversely affect gamefishes already established in such waters. A cooperative project is underway between the DMR, MDIFW, and the University to study the fishes and plankton in Lake George for three years prior to the experimental introduction of sea-run alewives, then continue to study the fish community for several years after introduction.

This project concentrates on the pre-introduction status of white perch in Lake George. To compare food habits of white perch and alewives, collections are also being made in two other ponds, Biscay and North, where the two species already co-exist. The results will form part of the pre-introduction component of the overall study.

PROJECT STATUS: The project has been completed and an abstract of the Master of Science thesis follows:

The recent introduction of anadromous alewives (*Alosa pseudoharengus*) to their historic habitats in the inland waters of Maine has prompted a cooperative study by several natural resource agencies of the State of Maine. The objective of this study is to determine the impact of alewives on present fish populations.

Due to similar ecological requirements, white perch (*Morone americana*) and alewives could have greatly overlapping niches. Food habits and growth rates of the white perch population in Lake George in Canaan, Maine, were monitored prior to alewife introduction there in 1990. White perch populations that were sympatric with anadromous alewives were also sampled in two coastal Maine lakes: Biscay Pond and North Pond.

Schoener's Index of Overlap was used to calculate diet overlap between the two species. In North Pond, diet overlap between alewives and white perch increased from 0.17 to 0.97 as the summer progressed. Almost complete diet overlap was due to predation on young-of-the-year alewives. The white perch populations with sympatric alewives were more piscivorous than the Lake George population, which primarily consumed Cladocera. Growth of the white perch population in Lake George was intermediate between the growth rates of white perch in the other two lakes, suggesting that anadromous alewives do not have a strong negative impact on white perch populations.

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

Investigator: R. E. Sayers, Jr.

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

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

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

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

One brook serves as a project control, with brook trout populations studied below and above the barrier. The second brook receives an introduction of salmon in the downstream section in the second year with the upstream serving as a control. The third brook receives an introduction of

salmon in the lower section in the first year, with the salmon removed for the second year and the upstream trout population as a control. The fourth brook has two natural barriers. The downstream section contains native populations of brook trout and landlocked salmon. The middle section receives an introduction of sea-run salmon in both years, and the upstream section, with native brook trout, serves as a control.

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

PROJECT STATUS: Field work has been completed following some additional population estimates conducted on the study streams in summer 1989. The dissertation is being prepared.

FUTURE PLANS: A doctoral dissertation will be completed in fall 1989, with an intended graduation of December 1989.

POPULATION STUDIES OF MAINE INTERTIDAL FISHES

Investigator: J. R. Moring

**Cooperators/
Project
Support:** National Geographic Society
The Nature Conservancy
University of Maine

Objectives:

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

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

Surveys since 1979 have identified 22 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: Experiments detailing movements, retention, and translocation of lumpfish were conducted in summer 1988 and 1989. Additional studies on color phases of lumpfish and retention of shorthorn sculpins in tidepools were initiated. A paper on results was presented at the annual meeting of the American Society of Ichthyologists and Herpetologists; a paper was published and another paper was accepted.

FUTURE PLANS: Experiments in 1990 will focus on movements of rock gunnels and food habits of shorthorn sculpins. Two papers are planned for publication and presentation.

EVALUATION TECHNIQUES FOR DISTINGUISHING STOCKS OF ATLANTIC SALMON

Investigator: C. M. Perry

Advisors: J. R. Moring, Chairperson
W. A. Halteman
T. A. Haines
S. J. Hunter
S. Tyler

*Cooperators/
Project
Support:* U.S. Fish and Wildlife Service -
National Fishery Research and Development Lab., Wellsboro, PA
Penobscot County Conservation Association
University of Maine

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

SCOPE: The acidification of lakes, rivers and streams in eastern North America, with its impending loss of species diversity, has become a major concern to conservationists. Since the passage of the Anadromous Fish Conservation Act (PL 89-304) in 1965, major efforts are underway to 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 overharvesting, pollution, and acidification of home waters have affected these efforts.

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

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

Lower lethal limits of EC_{50} 's were calculated along with photographic, histological, and physiological (whole body and blood serum chemistry) analyses at each life stage for each source.

This information should prove useful in (1) determining which life stage of each strain is most sensitive, thereby alerting biologists to the increased need for protection; (2) choosing a strain whose overall survival may be improved by its tolerance of lower pH levels during various periods of their lives and using these strains to enhance present populations; and (3) 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: Two papers were accepted for publication based on material submitted for the final report for the Wellsboro work. Samples were collected in 1988 for electron microscope examination of the role of calcium in Atlantic salmon subjected to heavy metals and low pH.

FUTURE PLANS: Samples of Atlantic salmon will be processed and examined, with a doctoral dissertation expected in summer 1990.

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

- Investigator:* D. B. McKinley
- Advisors:* J. R. Moring, Chairperson
W. B. Krohn
J. D. McCleave
- Cooperators/
Project
Support:* U.S. Forest Service -
White Mountain National Forest, Laconia, NH
Green Mountain National Forest, Rutland, VT
- Objectives:*
- (1) Determine what level of sampling stream segments provides usable estimates compared to current procedures of sampling entire streams.
 - (2) Measure habitat shifts by juvenile Atlantic salmon following changes in fish densities.

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

PROJECT STATUS: All field work has been completed. The investigator has taken a position with the U.S. Forest Service and is completing a thesis and the final report. Project funding ends in December 1989.

FUTURE PLANS: A final report will be completed before the end of December 1989. A Master of Science thesis is expected in spring 1990.

USE OF HABITATS BY ATLANTIC SALMON AND TROUT
ON NATIONAL FORESTS IN NEW HAMPSHIRE AND VERMONT

Investigator: G. P. Romig

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

*Cooperators/
Project* U.S. Forest Service -
White Mountain National Forest, Laconia, NH

Support: Green Mountain National Forest, Rutland, VT

Objective: To determine microhabitat preferences of Atlantic salmon and compare microhabitat preferences of brook, brown, and rainbow trout.

SCOPE: The U.S. Forest Service has management authority for habitat in the National Forests. In order to improve habitat that is important for juvenile Atlantic salmon, accurate microhabitat measurements must be compiled. Because Atlantic salmon are being stocked in waters already home to populations of brook, brown, and/or rainbow trout, competition for habitat is a real possibility, and one that needs to be documented.

PROJECT STATUS: Field work has been completed. Microhabitat measurements have been conducted on study streams in New Hampshire and Vermont using snorkel surveys. In addition, unique enclosure experiments have examined microhabitat changes following introduction of different salmonid species. Cover appears to be a significant factor affecting salmonid biomass and distribution.

FUTURE PLANS: Final field measurements will be conducted in fall 1989. A Master of Science thesis is expected in May 1990.

DELAYED MORTALITY OF BLACK BASSES FOLLOWING TOURNAMENTS

Investigator: R. A. Hartley

Advisors: J. R. Moring, Chairperson
P. W. Reno
W. E. Glanz

*Cooperators/
Project* Maine Department of Inland Fisheries and Wildlife
Penobscot County Conservation Association

Support:

Objectives:

- (1) To document tournament mortality and delayed mortality in basses following tournaments.
- (2) To document changes in dissolved oxygen in holding tanks of boats during tournaments.

SCOPE: Bass populations are abundant throughout Maine, and interest in bass angling has increased dramatically. Well over 100 tournaments are now scheduled on Maine lakes and ponds annually. Though most bass are released alive following tournaments, studies in other states, particularly in the South, have indicated that delayed mortality can be high. As Maine tournaments occur in cooler climates, with both smallmouth and largemouth bass, studies are needed to document such potential mortality. Any deaths that occur are likely due to the effects of handling and stress.

Changes in dissolved oxygen levels in tournament boats will be measured on several occasions in 1989. Three lakes have been selected for study. Each has a tournament scheduled in late spring, mid-summer, and fall. Fifty bass processed through a tournament will be held in live cages for 48 hours following each tournament. Surviving fish will be weighed and measured, and tagged. A scale sample will be collected for aging.

PROJECT STATUS: Field work has been completed. Dissolved oxygen levels in live wells show dramatic decreases following the introduction of individual basses. Delayed mortality, in general, appears to be minimal, but levels depend on tournament practices and handling techniques.

FUTURE PLANS: Data will be analyzed during winter 1989-1990. A Master of Science thesis is expected by December 1990.

ECONOMIC IMPACTS OF AN IMPROVED SPORTFISHERY ON THE LOWER KENNEBEC RIVER WATERSHED

Investigator: V. A. Trefts

Advisors: K. J. Boyle, Chairperson
S. D. Reiling
J. R. Moring

**Cooperators/
Project
Support:** Maine Department of Marine Resources

Objective: To conduct an economic survey and analysis of potential scenarios for improving the sportfishery of the lower Kennebec River as it relates to the Edwards Dam.

SCOPE: Edwards Dam, on the Kennebec River in Augusta, provides an impassable barrier to the upstream migration of anadromous fishes, such as Atlantic salmon, striped bass, rainbow smelt, and American shad. This blockage, along with polluted waters, eliminated most such runs of fishes in the Kennebec River by the mid-nineteenth century. The water quality of the river has now improved to a point where these fishes can survive and runs are starting to be restored. However, passage is still blocked at Edwards Dam. The dam is due for relicensing soon and the potential for improving the sportfishery on the river needs to be assessed. An economic survey will be conducted that will address several possible scenarios involving increased fisheries management practices, removal of the dam, provision for fish passage, or combinations of the three.

PRESENT STATUS: Preliminary biological surveys and assessments have been made and an economic assessment procedure is being developed. A progress report was recently submitted that outlined the overall biological assessment of the sportfishery.

FUTURE PLANS: Economic questionnaires will be mailed to selected anglers in winter 1990. A final report will be submitted in 1990. A Master of Science thesis is expected in 1990.

DOWNSTREAM MORTALITY OF ATLANTIC SALMON SMOLTS
IN THE PENOBSCOT RIVER, MAINE

Investigator: A. M. Vanderpool

Advisors: J. R. Moring, Chairperson

*Cooperators/
Project
Support:* U.S. Fish and Wildlife Service
Northeast Anadromous Fisheries Laboratory

Objective: To document the extent of mortality in downstream-migrating smolts of Atlantic salmon in the Penobscot River, Maine.

SCOPE: The Atlantic salmon restoration program has high natural visibility and priority. Yet, returns to United States rivers have been quite low, averaging only 0.6% from smolt to returning adult in the Penobscot River, Maine, and only 0.2 to 0.3% in the Merrimack and Connecticut rivers of southern New England. This excessive mortality can occur during the downstream passage of smolts in the river, in the estuary, and on the high seas. Of these, the downstream portion may be the least difficult to assess.

This project will track radio-tagged smolts from release to the lower Penobscot River, and trap smolts using Archimedes screw smolt traps. Marked lots of smolts will be followed downstream from the Enfield self-release ponds. The first two years of work will involve radio tracking and the evaluation of smolt traps. The second two years will involve monitoring of survival percentages and evaluating the sources of mortality.

PROJECT STATUS: The project will begin in fall 1989, and sampling and operational plans are being formulated.

FUTURE PLANS: Initial field work will begin during the smolt run of spring 1990, with direct sampling from March through June, and some additional sampling later in the summer. A Master of Science thesis is expected in May 1991.

HABITAT RESOURCES:

ESTABLISHING ENVIRONMENTAL BASELINES: A PROGRAM OF LONG-TERM MONITORING ON A SYSTEM OF ECOLOGICAL RESERVES IN THE STATE OF MAINE

Investigator: A. L. Colnes

Advisors: M. L. Hunter, Jr., Chair
S. A. Norton
R. B. Owen, Jr.

*Cooperators/
Project
Support:* McIntire-Stennis

- Objectives:*
- (1) To define the applications of the proposed system of ecological reserves.
 - (2) To identify the overall design criteria for the system of reserves including a discussion of site location, size, physical design, and internal structure.
 - (3) To outline the design of the monitoring program.
 - (4) To identify an appropriate administrative structure (i.e., ownership and management of reserves) for the program.

PROJECT STATUS: All requirements for the degree of Master of Wildlife Conservation were completed in June 1989. An abstract of the report follows:

This paper presents a framework for a program of long-term environmental monitoring and research to be carried out on a system of ecological reserves to be established in the State of Maine. The focus of the monitoring program is to provide reliable baseline information on key ecosystem parameters, to track changes in these parameters over time, and to record the levels of certain widely dispersed contaminants present in the State of Maine. Intensive monitoring activities will be conducted on one or two sites within the reserve system. The remaining reserves are intended to provide secure sites for a wide range of activities including research and monitoring, conservation of biological diversity, and environmental education.

Large reserves located in representative terrestrial and aquatic habitats throughout the State would best meet the needs of the monitoring program. Potential reserve sites include National and State parks, forests, and other reserves; lands held by land trusts and other similar organizations; and private holdings.

The monitoring program is designed to provide high quality long-term data on baseline ecological conditions and to track the status of selected widespread contaminants in abiotic and biotic systems. It is also intended to serve as an early warning system for the ecological effects of contaminants. While recommendations for specific monitoring activities in terrestrial and aquatic activities are presented in this paper, finalization of the monitoring program will depend on site selection and on the results of pilot studies.

The University of Maine is recommended as the most appropriate administrative body for coordination of program activities. This institution occupies a stable and central position in the community and also possesses a combination of resources and expertise that are uniquely suited to managing the diverse array of activities envisioned for the reserve system.

**ECONOMIC EVALUATION OF CONSUMPTIVE AND NONCONSUMPTIVE
USES OF MAINE'S FISH AND WILDLIFE RESOURCES**

- Investigators:* K. J. Boyle, Co-advisor
S. D. Reiling, Co-advisor
L. Demirelli, Asst. Scientist
M. L. Phillips, Research Assistant
V. A. Trefts, Graduate Research Assistant
E. J. Rudnicki, Jr., Graduate Research Assistant
- Cooperators/
Project
Support:* University of Maine -
Department of Agricultural and Resource Economics
Maine Legislative Commission to Study the Impact of Game
and Nongame Species on Maine's Economy
Maine Department of Inland Fisheries and Wildlife
Maine Department of Marine Resource
Maine Cooperative Fish and Wildlife Research Unit
- Objectives:*
- (1) Estimate monetary values, use rate, and expenditures associated with the use of selected species and groups of species of Maine's recreational fish and wildlife resources. This will be done using data from surveys that are developed and administered as part of the study.
 - (2) Consumptive and nonconsumptive users' motivations for participating in fisheries and wildlife-related activities will be identified as part of the survey effort.
 - (3) The surveys will be designed to evaluate improved consumptive and/or nonconsumptive use opportunities for selected species where possible.
 - (4) Where possible, the results of objectives (1), (2), and (3) will be partitioned by resident and nonresident strata.
 - (5) An economic analysis of trapping activities within Maine, including trapping itself and the other production aspects of the trapping industry in Maine as hides and animals products are processed and resold, will be conducted.
 - (6) Analyze funding mechanisms for fish and wildlife management in other states and evaluate the potential usefulness of these structures for Maine.

SCOPE: Management of Maine's fish and wildlife resources has reached a significant crossroad. Increasing use, both consumptive and nonconsumptive, and changing habitat conditions make it necessary to take a serious look at the status of Maine's fish and wildlife populations and the characteristics of users of these resources. As part of this effort, the Maine Legislature established the "Commission to Study the Impact of Game and Nongame Species on Maine's Economy" (Public Law 349, Section 38, 1987). The Commission contracted with the University of Maine to study the characteristics and preferences of Maine residents and nonresidents who use the state's fish and wildlife resources.

PROJECT STATUS: Survey work is continuing in 1989. In 1988, 4,000 hunters, 4,000 inland anglers, and 200 trappers were surveyed. In 1989, an additional 4,500 hunters, 3,000 inland anglers, and approximately 1,000 marine sport anglers are being surveyed. The final survey work will be

conducted early in 1990. Data processing and initial analyses have begun on the data sets.

FUTURE PLANS: The next year will be dedicated to analyzing all of the data collected over the first two years and documenting the results of the study in a report to be submitted to the Maine legislative "Commission to Study the Impact of Game and Nongame Species on Maine's Economy."

A LONG-TERM FOREST ECOSYSTEM STUDY

Investigators: M. L. Hunter, Jr.
A. J. Kimball
A. S. White
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.

Our primary objective is to describe the structure of the plant and animal community. We are undertaking (1) a 100% inventory of trees (>10cm DBH) and intensive inventories of tree regeneration, (all trees are being individually numbered and, on 12 ha locations, mapped); (2) a complete description of the vascular plant vegetation using the relevé technique; (3) an inventory of all breeding bird territories; (4) transect surveys of nonbreeding birds; (5) small mammal trapping; (6) salamander quadrat counts; (7) observations of reproductive efforts (flowering and fruiting) for 13 herb and shrub species; (8) estimates of seed 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 five years of gathering baseline data, in 1987 we began 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: In 1989, tasks 3, 4, 5, 6, 7, 8, 9, and 10, as outlined above, were completed, and a new study investigating predation on bird nests in tree fall gaps, ledge openings, and patchcuts was initiated.

FUTURE PLANS: The 1990 field season will replicate the 1989 field season.

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

Investigator: P. D. Vickery

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

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

Objectives:

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

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

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

PROJECT STATUS: Data collection is complete. Thesis preparation is near completion.

FUTURE PLANS: Revise and complete thesis.

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

- Investigators:* J. M. Ryan
T. R. Smith
M. M. Robbins
S. J. Pauwels
T. A. Haines
R. W. Perry
- Advisors:* T. A. Haines, Chairperson (for Robbins, Smith, Ryan, and Pauwels)
J. R. Moring
K. E. Gibbs
M. L. Hunter, Jr.
J. D. McCleave
S. A. Norton
B. D. Sidell
G. L. LaCroix
- Cooperators/* U.S. Fish and Wildlife Service -
Project National Fisheries Contaminant Research Center, Columbia, MO
Support: National Fisheries Research Center - Leetown
- Objective:* Analyze levels of acidity and related water chemistry in waters of northern New England and their potential influence on distribution of fishes.

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

A survey was conducted of 226 headwater lakes and low order streams in the six New England states. Acidic surface water (pH<5) occurred in every state, with 8% of the waters severely acidified, and 29% with pH levels <6. It was found that a substantial portion of the headwater lakes and low water streams in New England are vulnerable to acidification. As a result, a long-term monitoring program (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: Final laboratory analyses are being completed, with a doctoral dissertation expected in May 1990.

FUTURE PLANS: Three new projects involving heavy metals and acid precipitation and fishes will be designed and financed using recently awarded funds.

MANAGEMENT OF RIPARIAN FORESTS FOR WILDLIFE

Investigator: S. T. Hooper

Advisors: R. J. O'Connor, Co-Chairperson
S. M. Melvin, Co-Chairperson
H. S. Crawford
D. J. Harrison

*Cooperators/
Project
Support:* McIntire-Stennis

Objectives:

- (1) Assess wildlife use of forested riparian zones in Maine for consideration in land-use planning.
- (2) Determine if the extent to which wildlife use riparian zones is associated with specific habitat types, vegetation parameters, or just the presence of the stream.

SCOPE: The importance of understanding wildlife use of riparian zones in Maine stems from development and logging along riverine systems. The potential disturbance or destruction of these riparian habitats and their associated wildlife is an issue land-use planners must consider in setting buffer zones along streams.

This study seeks to monitor wildlife use of a broad spectrum of riparian habitats. Habitat components are being evaluated to determine to which vegetation parameters, if any, wildlife are responding.

Field work will consist of breeding bird censusing, mammalian fecal pellet counts, and vegetation sampling. Bird species distributions and fecal pellet count data are being analyzed in relation to distance from the stream. Vegetation variables will be correlated with wildlife data to test for any associations.

PROJECT STATUS: Fieldwork in 1987 and 1988 revealed substantial problems in generalizing results from a small number of intensively studied sites. In summer 1989, field effort was switched to extensive surveys of some 23 sites throughout Maine, to obtain a representative sample of the types of riparian land that planners must deal with. Statistical analysis of the bird and vegetation data thus gathered is in progress.

A review of the existing wildlife data on eastern riparian habitats was presented at a conference in Portland, Maine in March 1989.

FUTURE PLANS: Fecal pellet data appropriate to the new protocol will be gathered in the course of the final year of the project. Further fieldwork on bird distributions will be directed only to filling gaps evident from analysis of the 1989 results.

INTEGRATING WILDLIFE RESOURCES INFORMATION INTO LOCAL PLANNING:
A HANDBOOK FOR MAINE COMMUNITIES

Investigator: S. A. Venno

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

*Cooperators/
Project* University of Maine
Maine Department of Inland Fisheries and Wildlife

Support:

- Objectives:*
- (1) Identify and discuss Federal and state laws related to conservation of wildlife habitats at the local level.
 - (2) Suggest guidelines whereby towns set their own objectives and identify protection strategies consistent with existing laws and local needs.
 - (3) Identify and discuss options and tools available to towns for protecting wildlife habitats.

SCOPE: Growth management has become a statewide issue as development pressures spread from southern and coastal Maine to inland lakes and mountains. This has created concern about the impact of this growth on natural resources, including wildlife. A number of changes in Maine's land-use laws reflect this concern. Specifically, the state legislature has passed a law requiring municipalities to adopt comprehensive plans and ordinances by 1996. General guidelines adopted by the state as planning goals for towns include protection of essential (T/E species) and significant (species of special concern) wildlife habitats. Although a wealth of information exists about wildlife, their habitats, and various land-use protection strategies, there is a need for a synthesis of this information in a form easily accessible to towns and adaptable to the local planning process.

PROJECT STATUS: This work is being done in partial fulfillment of the requirements for the degree of Master of Wildlife Conservation. An outline of the research report has been completed, and writing has begun.

FUTURE PLANS: The report will be submitted in a format suitable for use as a handbook by planners, citizens, and others involved in integrating habitat information into town plans. Completion of the report is expected in December 1990.

FRUGIVORY AND SEED DISPERSAL IN OAK-PINE FOREST

- Investigator:** A. A. Whitman
- Advisors:** M. L. Hunter, Chair
C. Campbell
W. E. Glanz
- Cooperators/
Project
Support:** Holt Woodlands Research Foundation
Association of Graduate Students
Sigma Xi
University of Maine
- Objectives:**
- (1) Determine fruit production and phenology in oak-pine forest.
 - (2) Determine if small mammals are important frugivores for fruit producing plants.
 - (3) Compare the quality of seed dispersal by birds to that of carnivorous mammals.

SCOPE: Seed dispersal and frugivory by wildlife are poorly understood in the temperate zone. Food habits of opportunistic frugivores such as birds, canids, and mustelids are commonly studied. This approach fails to determine the significance of this plant-animal interaction to the animal or the plant involved. More detailed studies are considering the importance of fruit to animals from an energetic stand point, but the importance of frugivores to plants as seed dispersers is poorly understood. To better understand the importance of frugivores to plants, this study 1) determines the availability of fruit and its removal, and 2) investigates the dispersal of one species, wild sarsaparilla (*Aralia nudicaulis*) by birds and mammals.

PROJECT STATUS: Fruit production is highly variable between sites and years in oak-pine forest. Twenty-nine species of fruiting plants were present, but only 13 fruited in the three years of the study. *Maianthemum canadense*, *Aralia nudicaulis*, and *Cornus canadensis* were by far the most dominant fruit.

Fruit production peaks in early August, though the main fruiting period runs from July to September. Small mammals remove about 50% of *M. canadense* and *C. canadensis* fruit, but little or no fruit of *A. nudicaulis* or *V. angustifolium*. Of these four species, *A. nudicaulis* is most quickly removed, *M. canadensis* the least. Foxes also remove much fruit of *A. nudicaulis*.

Foxes are better dispersers of *A. nudicaulis* than birds. Virtually all seedling recruitment are from fox dispersed seeds which are found on game trails. Game trails may be better sites for seeds to be dispersed to than forest sites to which birds disperse seeds. Game trails have less leaf litter (which shades seedlings), and more soil disturbance which may enhance germination and establishment.

FUTURE PLANS: To make a complete comparison of seed dispersal by birds versus mammals, I will estimate dispersal distance by each, based on telemetry and gut passage time data. I will also complete seed germination trials on seeds passed through hermit thrushes and foxes. Field work will be completed during the summer of 1990.

**HABITAT SELECTION BY THE AFRICAN BUFFALO
IN VIRUNGA NATIONAL PARK, ZAIRE**

- Investigator:** E. T. Mugangu
- Advisors:** J. R. Gilbert, Co-chairperson
M. L. Hunter, Jr., Co-chairperson
W. E. Glanz
G. L. Jacobson, Jr.
J. A. Sherburne
- Cooperators/
Project
Support:** Institut Zairois pour la Conservation de la Nature, Departement de
l'Enseignement Superieur de la Republique du Zaire
University of Maine
AFGRAD, United States Agency for International Development
Rockefeller Foundation
- Objectives:**
- (1) Estimate densities of African buffalo (*Syncerus caffer*) in Virunga National Park.
 - (2) Assess habitat selection by buffalo.
 - (3) Test whether buffalo select habitats which maximize energy or protein intake and simultaneously minimize competition and predation risks.

SCOPE: Mechanisms that determine habitat selection in large ungulates are poorly understood. To date, only models that relate large mammals to single factors such as food and structure of the environment have been shown to determine habitat selection. However, it is likely that animals respond to a complex array of biotic and abiotic factors in their environment when they select their habitat. This study endeavors to test the hypothesis that buffalo select habitats that best enhance their fitness by optimizing food intake while minimizing competitive inhibitions and predation risks. In addition, since the loss of suitable habitats for large mammals in Africa is threatening their existence, the results of this study will have practical implications for the management of buffalo in Virunga and around the parkland.

PROJECT STATUS: Three field seasons have been completed. A habitat map of the study area, the Ishasha plateau (400 sq. km), was drawn and presented to the Institut Zairois pour la Conservation de la Nature. Transects were established in different habitat types ranging from open grasslands to closed forests. These transects were run seasonally to count live animals (diurnal use) and bone and carcasses (indices of predation rates). Also, plant samples were collected at sites used by buffalo and at random sites. These plant samples were sun dried and weighed to determine vegetative biomass. Additional samples were collected for further chemical analysis to determine qualitative factors (e.g., protein, carbohydrate and other nutrients) in buffalo food at selected sites and random sites. Analyses of the data are underway.

FUTURE PLANS: The dissertation will be completed in May 1990 and the Final Report of the project for the Institut Zairois pour la Conservation de la Nature will be ready in September 1990.

BIRD POPULATION TRENDS AND AGRICULTURE

Investigators: R. P. Boone, M. T. Jones, T. B. Lauber

Advisors: R. J. O'Connor, Chairperson
K. J. Boyle
J. R. Gilbert
Advisory Committee from sponsors
G. S. Butcher (Cornell University)

*Cooperators/
Project* Consortium of pesticide manufacturers
U. S. Fish and Wildlife Service
Support:

SCOPE: This project seeks to analyze extant data on bird populations in the U. S. in relation to changes in agricultural practice and pesticide usage. Bird data for the last 25 years (or longer) are available from the U.S. Fish and Wildlife Service (USFWS) Breeding Birds Survey and the Audubon Christmas Bird Counts; nest record data are available from the Laboratory of Ornithology at Cornell University (a subcontractor for the project); and agricultural statistics are being obtained from the five-yearly Census of Agriculture of the U.S. Department of Commerce. The USFWS is also providing support and access to data on the Farm Conservation Reserve Program. Other datasets are being used as appropriate. The data will be subjected to statistical analysis in search of evidence as to the interactions between bird numbers and agricultural land management.

EFFECTS OF LANDSPREADING PULP AND PAPER MILL SLUDGE IN REGENERATING FORESTLAND ON WILDLIFE POPULATIONS

Investigator: C. J. Vera

Advisors: F. A. Servello, Chairperson

*Cooperators/
Project* Resource Conservation Services, Inc.
Scott Paper Company
Support:

Objectives:

- (1) Determine the effects of landspreading pulp and paper mill sludge on the density and diversity of breeding birds.
- (2) Determine the effects of landspreading pulp and paper mill sludge on the relative abundance and diversity of small mammals and amphibians.
- (3) Determine the effects of landspreading pulp and paper mill sludge on invertebrate abundance and vegetative species composition and structure and examine the relationships of these effects with breeding bird, small mammal, and amphibian population changes.

SCOPE: Pulp and paper mill sludge contain a range of organic matter, nitrogen, phosphorus, and lime which may improve soil structure and enhance plant growth. Landspreading pulp and paper mill sludge may not only benefit plants and soils but also keeps these materials out of expensive and scarce landfill space. However, this landspreading has the potential to affect wildlife populations through habitat modification.

There have been few studies investigating effects of landspreading pulp and paper mill sludge on sites representative of those chosen for landspreading in Maine. This study is designed to determine the effects of landspreading these materials in regenerating forestlands on wildlife populations.

PROJECT STATUS: Eight 60-70 acre study sites were selected in western Maine, based on vegetative composition and structure, forest management history, and soils type in July-August 1989.

FUTURE PLANS: Four sites will receive sludge at operational spreading rates in August-September 1990, and four sites will serve as controls. Pre-spreading population and habitat studies will be done in spring-summer 1990, followed by 2 years of post-spreading studies in treatment and control sites.

EFFECTS OF TIMBER HARVESTING IN DEER WINTERING AREAS ON WHITE-TAILED DEER NUTRITIONAL ECOLOGY

Investigator: P. B. Gray

Advisors: F. A. Servello, Chairperson

**Cooperators/
Project
Support:** McIntire-Stennis

Objectives:

- (1) To determine relationships between dietary digestible energy content and digestible energy and nitrogen intake for white-tailed deer.
- (2) To determine the effects of timber harvesting methods on the interaction of food quality and availability in winter and early spring in spruce-fir deer wintering areas.

SCOPE: Mature spruce-fir forest stands are critical habitat for white-tailed deer (*Odocoileus virginianus*) in Maine. The high value of timber on these sites and the desire to salvage trees damaged by spruce budworm not only creates a strong demand to utilize timber, but provides an opportunity for integrated management of timber resources and deer winter habitat. However, the relative importance of shelter and foraging habitat in wintering areas is poorly understood as is the relative value of timber harvesting methods. Assessing the value of timber harvest relative to deer nutrition requires an understanding of the interactions of forage quality and quantity and its relationship to deer requirements and nutritional limitations. The purpose of this project is to determine limitations of deer for using poor quality winter diets and to use this information in an assessment of forage production and diet quality in wintering areas.

PROJECT STATUS: Project planning began in September 1989.

FUTURE PLANS: In Phase 1 (1989-1991), fawns will be raised at the UM Captive Animal Research Facility. A series of digestion trials will be conducted using natural winter diets spanning a range of digestible energy content. In field experiments, variation in forage quality will be studied to develop sampling designs for future forage production studies. In the second part of the project, forage production and quality measurements will be made in clearcut and selection or shelterwood harvested forest stands. These data will be used to model the interaction of forage production, forage quality, and nutritional limitations of deer to assess the relative value of timber harvest methods.

WILDLIFE RESOURCES - MIGRATORY BIRDS:

BIRDS OF MAINE'S PEATLANDS

- Investigator:* S. S. Stockwell
- Advisors:* M. L. Hunter, Jr., Chairperson
R. B. Davis
W. E. Glanz
J. R. Longcore
- Cooperators/
Project
Support:* Maine Department of Inland Fisheries and Wildlife
Signal Fuels, Inc.
Maine Chapter of The Nature Conservancy
Maine Land Use Regulation Commission
Maine Department of Environmental Protection
- Objectives:*
- (1) Identify those species of birds that inhabit Maine's peatlands.
 - (2) Quantify the abundances of each species relative to peatland vegetation and hydrology.
 - (3) Determine whether large, commercially valuable peatlands differ in their "value" to wildlife from smaller, non-commercially valuable peatlands.
 - (4) Determine which of five environmental factors (foliage height diversity, area of peatland, peatland-foliage height diversity, type of peatland, and peatland vegetation diversity) are important in influencing bird species composition, bird species richness, and bird density in peatlands.

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

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

PROJECT STATUS: Birds were censused in eight Maine peatlands of varying types and sizes during May and June of 1984. Eight distinct vegetation types occurred in the peatlands. A variable-width transect method was used to census birds and estimate densities from a modified Emlen method and the Fourier Series Estimator in program TRANSECT.

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

Foliage height diversity (FHD, vertical heterogeneity of vegetation) was the best predictor of bird species composition (BSC), bird species richness (BSR), bird species diversity (BSD), and bird density (BD) in eight types of peatland vegetation. As foliage height diversity increased, bird species composition changed, species richness increased, species diversity increased, and density increased.

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

FUTURE PLANS: Revise and complete thesis.

USE OF THE AREA OCCUPIED METHOD TO SURVEY WOODLAND HAWKS IN MAINE

- Investigator:* H. Devaul
- Advisors:* W. B. Krohn, Chairperson
W. E. Glanz
R. J. O'Connor
- Cooperators/
Project* Maine Department of Inland Fisheries and Wildlife -
Endangered and Non-game Wildlife Grants Program
- Support:* Maine Cooperative Fish and Wildlife Research Unit
Hawk Mountain Sanctuary Association
- Objectives:*
- (1) Estimate the proportion of area occupied by woodland hawk species in comparable blocks of land representing different land use in Maine.
 - (2) Provide field data from northern and central Maine for a comparison with previous and concurrent studies in other eastern and midwestern locations.
 - (3) Evaluate the usefulness of the survey technique using computer simulations.

SCOPE: The status of breeding birds of prey in Maine is not well-known. Although the *Atlas of Breeding Birds of Maine, 1978-1983* was recently compiled (P. Adamus, Maine Dept. Inland Fisheries and Wildlife, 1987), and falconers have knowledge of local populations, a systematic survey had not been conducted prior to 1987. This project was initiated to field-test the "Area Occupied" method (Geissler and Fuller 1987, pp. 533-538 in Proc. 1986 Sect. Survey Research Meth., Amer. Stat. Assoc.) of analyzing survey data from areas representative of land use in Maine. Intensive commercial harvesting occurs over a large portion of northern Maine, and land-use is gradually intensifying in southcentral Maine, modifying potential breeding habitats. Raptors characteristically have large home ranges, are easily disturbed at the nest site, and often return to the same nest or tract of land year after year. Land-use practices and disturbance by humans influence the suitability of an area. It is important to know how various land uses, particularly forest management, affect the

species composition of breeding birds of prey before large areas are so modified as to become unsuitable. A survey technique which produces reliable results is necessary to obtain this information and to provide baseline data for future monitoring. The Area Occupied (AO) method is designed for use with rare or uncommon species and has been used with success in other eastern and midwestern locations.

PROJECT STATUS: Weekly point-counts were conducted during the breeding season in 3 study areas. In 1987, 2 areas in northcentral Maine were surveyed, a commercially-harvested area (Telos) and an adjacent unharvested area (Baxter). In 1988, an area in southcentral Maine was surveyed, representative of mixed agriculture and small woodlot management (Waldo). Of the 8 species potentially present in the areas, 4 species (broad-winged, red-tailed, red-shouldered, and sharp-shinned hawk) were observed in Baxter, 5 species (broad-winged, red-tailed, and sharp-shinned hawk, American kestrel, and northern harrier) were observed in Telos, and all 8 species (broad-winged, red-shouldered, sharp-shinned, and Cooper's hawk, northern goshawk, American kestrel, and northern harrier) were observed in Waldo. AO estimates and probability of detection (PD) were obtained using a computer program available from Patuxent Wildlife Research Center in Laurel, MD. These data show that the proportion of area occupied for broad-wings ranged from a low in Telos (47%), intermediate in Waldo (78%), to a high in Baxter (100%). Red-tailed hawks were observed too infrequently in Waldo to produce an estimate, occupied an estimated 9% of Baxter, and 93% of Telos. Red-shouldered hawks were absent in Telos, observed too infrequently for analysis in Baxter, and occupied an estimated 29% of the Waldo study area. Low PD's were obtained for all species, ranging from 0 for those with insufficient data, to 6% for broad-wings in Baxter and red-tails in Telos, to a high of 23% for American kestrels in Telos.

Comparisons between species and study areas were confounded by overlapping confidence intervals at the 95% level, indicating limits to the AO technique. Thus, computer simulations were conducted to investigate the limits and sensitivity of the technique. Simulated survey data were generated for 336 combinations of 3 input parameters; the "actual" AO, the PD, and the number of repetitions of a survey route. The AO estimates for each simulated data set were compared to the input values, and relative bias (RB) was calculated for the AO estimate and its confidence intervals (RCI). RB values were large and fluctuated greatly at low PD values, but stabilized as PD increased (point of stabilization defined as critical PD). Three-dimensional plots of critical PD, RCI, and RB against AO and number of repetitions revealed the following trends: 1) critical PD decreased as the number of repetitions increased, but was not affected by actual area occupied; 2) confidence intervals decreased with increasing area occupied, but were not affected by the number of visits; and 3) actual AO values greater than 26% were necessary if relative confidence intervals $< \pm 50\%$ of the AO estimate were to be obtained. In addition, for a given number of repetitions, a $PD \geq PD$ critical was necessary to obtain AO estimates that are unbiased. When pilot studies are done and PD is known, results from these simulations will aid in determining the number of repetitions necessary to obtain a desired level of accuracy.

FUTURE PLANS: Analyze data and complete thesis (in Wildlife Management) by December 1989.

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

- Investigator:* W. M. VanderHaegen
- Advisors:* W. B. Krohn, Co-chairperson
R. B. Owen, Jr., Co-chairperson
F. A. Servello
W. E. Glanz
A. S. White
- Cooperators/
Project
Support:* University of Maine
Maine Cooperative Fish and Wildlife Research Unit
U.S. Fish and Wildlife Service -
National Ecology Center, Fort Collins, CO.
Moosehorn National Wildlife Refuge, Calais, ME.
Penobscot County Conservation Association
Hirundo Wildlife Refuge
Taylor's Bait Farms
- Objectives:*
- (1) Determine and compare vegetation and food availability at hardwood and softwood sites used by woodcock.
 - (2) Examine micro-climate regimes and activity budgets of woodcock in different cover types.
 - (3) Document spring food habits.
 - (4) Use the above results to develop a spring energetics model.

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

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

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

PROJECT STATUS: The third and final field season has been completed. A total of 2970 hours of activity data and 1008 hours of concurrent microclimate data were collected on 13 radio-tagged females. Earthworm densities were monitored at sites used by radio-tagged woodcock and at

reference transects. Eggs were collected from radio-tagged woodcock for analysis of energy content. Twenty woodcock were collected for analysis of energy reserves and early spring food habits. Metabolic trials with captive-reared woodcock were completed and values obtained for standard metabolic rate, lower critical temperature, apparent metabolizable energy, and costs of activity and thermoregulation.

FUTURE PLANS: Data analysis and model development will continue into the next report period. Target date for project completion is May 1989.

APPLICATION OF SATELLITE IMAGERY TO QUANTIFY HABITAT OF WINTERING NEOTROPICAL MIGRANTS IN BELIZE

Investigator: J. P. Spruce

Advisors: S. A. Sader

*Cooperators/
Project
Support:* U.S. Fish and Wildlife Service -
Patuxent Wildlife Research Center
University of Maine -
Department of Forest Management

Objectives:

- (1) Apply computer-assisted processing of satellite imagery to quantify the extent of habitat types for wintering neotropical migrants in a Belize study site.
- (2) Extrapolate estimates of bird habitat use for selected habitat types on the basis of satellite data and field sampling.

SCOPE: Habitat manipulation by humans is occurring throughout the tropics, and the impact of land use change on migratory bird populations is believed to be significant yet difficult to quantify. Evaluation of habitat availability and use by wintering migrants in the neotropics is costly to apply on a regional level using ground-based methods. However, ground-based sampling results can be extrapolated to large land areas if remote sensing techniques are combined with representative field data. This two-stage approach reduces survey costs, and it allows a method to estimate broad geographic trends in bird/habitat associations at more meaningful scales as compared to local area field surveys.

PROJECT STATUS: Landsat thematic mapper satellite imagery has been processed for the southern Belize study site. A preliminary habitat type map was generated using digital image processing facilities in the Maine Image Analysis Laboratory at the College of Forest Resources, University of Maine. Sader spent a week with U.S. Fish and Wildlife Service co-investigators in Belize to field-check the habitat classification image and locate representative field sampling locations for bird identification and banding. The habitat type map is being modified on the basis of field visits and interpretation of aerial photography acquired from the Royal Air Force in Belize.

FUTURE PLANS: A progress report was submitted September 30, 1989. The project is expected to be expanded to a second field site in southeastern Belize to allow field sampling of agricultural habitats (e.g., citrus) that do not exist in the current study site. Another satellite data set will be acquired and processed for the new site. Estimates of bird/habitat use will be generated for both sites after more field data has been collected during the 1989-90 field season.

**THE EFFECTS OF CLEARCUT SIZE AND SHAPE ON BIRD SPECIES
RICHNESS AND NEST PREDATION RATES IN NORTHEASTERN MAINE**

Investigator: T. C. Rudnicky

Advisors: M. L. Hunter, Jr., Chairperson
R. J. O'Connor
A. S. White

*Cooperators/
Project
Support:* McIntire-Stennis

- Objectives:*
- (1) Determine how the size, shape, vegetation, and isolation of clearcuts affect species richness and structure of the bird community.
 - (2) Determine how the size and vegetation of clearcuts and the surrounding edge affect the predation rate on eggs of ground nesting birds.
 - (3) Determine if there are "zones" of nest predation within clearcuts, edges, and forests, and identify the major nest predators within defined predation zones.

SCOPE: The size of a habitat patch can greatly influence the number of species present. While many studies have examined bird communities in forest fragments of different sizes, little information is available on the distribution and diversity of birds in clearcuts of different size. Thus, information gathered in this study will aid in the understanding of species area requirements of early successional birds and will complement research designed to facilitate wildlife management in dynamic forest landscapes.

To understand bird-habitat relationships it is important to study reproductive success in different habitats. Placement of the nest (ground or arboreal), its distance from an edge, amount of cover, and size of surrounding habitat contribute to nesting success. Most nest predation studies have examined predation rates along edges and in forests. The proposed predation study will look at predation rates in clearcuts as well as forests and edges. Although the results can only be used as an index to real nest predation, they will be comparable to other artificial nest studies and will lend insight into the predation pressures experienced by ground nesting birds.

PROJECT STATUS: The first field season has been completed. Preliminary analyses of bird censusing data showed white-throated sparrows, common yellowthroats, and chestnut-sided warblers to be the most common species in the clearcuts sampled. Bird species richness per clearcut ranged from 3 species in some of the smallest cuts (2-ha) to 24 species in the largest cut (107-ha). A total number of 54 species were observed over the course of the census period.

Nest predation data revealed a higher predation rate in forest sites (13.7%) than in clearcuts (2.6%). Preliminary analysis of the predation data revealed no distance to edge effect.

FUTURE PLANS: Some of the clearcuts examined during 1989 will be recensused in 1990. Additional clearcuts and some forest patches fragmented by the cuts may be added to the study. The nest predation study will continue.

WILDLIFE RESOURCES - OTHER THAN MIGRATORY BIRDS:

MECHANICS OF THE FORAGING BEHAVIOR OF BOREAL HERBIVORES

Investigator: L. Shively

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

*Cooperators/
Project
Support:* McIntire-Stennis
Northeast Forest Experiment Station

- Objectives:*
- (1) Determine the relationship of winter browse abundance and patchiness to foraging efficiency and net energy intake in white-tailed deer, moose, and caribou.
 - (2) Determine the effect of bite size on intake rates of snowshoe hare, deer, caribou, and moose.
 - (3) Compare components of foraging behavior among 4 vertebrate herbivores based on body size and molar surface.
 - (4) Compare biomass/intake rate predictions developed in pen trials with data obtained in field experiments with tame deer in forest stands.

SCOPE: Rising demands on forest resources in Maine, especially mature conifer timber, have instigated the development of regulations for timber harvest in areas critical to wintering white-tailed deer. Current regulations in northern Maine, however, are based on some previous deer yard studies which stressed the shelter component of the habitat. Because timber stands heavy enough to provide shelter cannot also provide adequate food, these regulations may be inadequate for optimum survival and reproduction of deer. In addition, timber operations have greatly affected winter habitat of other forest herbivores including moose and snowshoe hare. Thus, we must understand how structural and nutritional stand characteristics affect the foraging efficiency and energetics of wintering herbivores. Because body size and morphology affect nutritional requirements and energy expenditures of animals, habitat quality can be defined by different mixes of cover and forage patches for snowshoe hare, white-tailed deer, caribou, and moose.

PROJECT STATUS: All requirements for degree of Master of Science (Wildlife Management) were completed in August 1989. An abstract of the thesis follows:

I examined the individual and combined effects of bite size, plant fibrousness, plant density, and body size on dry matter (DM) intake rate of tame moose (*Alces alces*), white-tailed deer (*Odocoileus virginianus*), caribou (*Rangifer tarandus*), and snowshoe hare (*Lepus americanus*). Animals were offered natural foods varying in fibrousness and bite size in artificial "pastures" to test these relationships. Intake rate of the 4 herbivores increased 2-10 fold due to bite size alone. Results were consistent with the hypothesis that biting indirectly influences intake rate by interrupting food processing (chewing and swallowing). Intake rate was greater on maple leaves (37% Neutral Detergent Fiber, NDF) than on dormant maple stems (64%) for moose and deer, but was similar for hares. The theoretical maximum intake rate (R_{max}) scaled to body weight^{0.66} of 9 herbivores was not significantly different than that predicted from the allometric relationship between occlusal surface area of the molars and body weight. This further emphasizes the importance of food

processing on the intake rate of large herbivores.

Travel speed of moose and deer increased asymptotically with distance between patches (groups of 1-9 stems), but was not different between yearling moose and deer ($P > 0.05$). Patch density influenced the intake rate of moose and deer only at biomass densities below about 2 kg/ha. This was consistent with the hypothesis that plant density affects intake rate only when the time necessary to travel between patches exceeds the time needed to process food acquired at the previous patch.

When deer and moose were presented with identical forages, moose took significantly greater bite sizes and had greater intake rates than deer (ANOVA, $P < 0.05$), but took a similar number of bites per stem. However, moose also browsed stems to a greater diameter than deer, resulting in a lower DE energy content of their diet.

Moose and deer took more bites per stem and moose took larger bites as biomass density and patch size (number of stems) declined, and distance between patches increased (ANOVA, Tukey's multiple comparisons test, $P < 0.05$), which enabled them to maintain maximum dry matter intake rates of low biomass but reduced diet quality. I conclude that the mechanical constraints on intake rate may influence diet selection by large herbivores. Consequently, habitat evaluation and population modelling efforts should consider the effects of bite size, patch size, and patch density on intake rate of large herbivores.

In a second experiment, 3 hand-reared white-tailed deer were released into a deer wintering area in mid-January, 1989, to examine food habits and forage preference, foraging behavior, activity patterns, and energetics. Red maple and arboreal lichens jointly composed > 40% of the composite diet (37 trials), whereas balsam fir, spruces, and dry ferns, grasses, and sedges composed > 68% of the available biomass. Preference indices (PI) for plants varied among trails, and only 7 of 43 plants or plant parts had PI with 95% confidence intervals that did not overlap 1. DM intake rate was not related to available biomass and was lower than that recorded for captive deer in artificial pastures.

Activity periods were continuously monitored by a remote telemetry system and averaged 103 min., for a total of 12 hours/day. Using predictions of energy expenditure of activity and basal metabolism, I estimated that the deer would lose an average of 0.18 kcal/min while foraging, and 7.16 kcal/min while resting, resulting in a total body loss of 10 kg during the experiment. The deer actually lost 14 kg during 44 days in the DWA.

I suggest that when using tame, free-ranging animals to test hypotheses about responses to weather and habitat features, the researcher release 2-3 times as many deer as needed to account for potential transmitter failure, predation/poaching, and individual temperament of the animals.

POPULATION DYNAMICS OF PACIFIC WALRUSES

Investigators: J. R. Gilbert
S. Hills

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

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

- 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 (herd 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 on objectives 2 and 3.

SCOPE: Existing walrus population estimates fail to account for herd 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: Airborne video imagery and 35-mm color photography were evaluated as tools to aid counting walruses on pack ice. Flights were conducted in a USFS Beech Queen-Air twin-engined aircraft over the pack ice in the Northern Bering Sea between 23 and 31 May, 1989. Initially, two super-VHS cameras were mounted in the belly port of the aircraft, one oriented vertically and a second angled forward and to the side. Later one of the cameras was hand-held and used as an aide to count individual groups.

Walruses were not readily distinguishable on the vertical or near-vertical video imagery. Either their images were too small or the strip width covered was too narrow. Individual walruses could often be distinguished in the low-oblique frames. While walrus images were sometimes more distinguishable on the 35-mm film than on the low-oblique imagery, the video imagery was adequate to count numbers in groups and was of a more consistent quality.

Walrus surveys were conducted between 24 June and 6 July in the Western Chukchi and Bering seas in cooperation with Soviet scientists. Using an AN-26 Aeroflot aircraft, we jointly conducted surveys to determine distribution of walruses in the pack ice of the Chukchi and Bering seas at this time of year and to assess whether censuses conducted during this period were more likely to produce reliable results than censuses at other times. We flew 10,232 km of survey lines, during which we observed approximately 9700 walruses, 1000 gray whales, and lesser numbers of ringed, ribbon, spotted, and bearded seals, and polar bears.

Led by Sue Hills, a group of U.S. and Soviet scientists attempted to deploy satellite transmitters on walruses in the Bering Sea from May 15 to May 28. Based in Gambell on St. Lawrence Island, numerous attempts were made to locate walruses, but because of unusual ice conditions, the walruses were not in the Gambell area.

In early July, Sue Hills and two other U.S. scientists travelled to the Soviet Union at the invitation of Soviet scientists. They successfully deployed 6 satellite transmitters and 6 VHF transmitters on female walruses that were on the beach at Rudder Spit in the Gulf of Anadyr. VHF receivers were left for the Soviet scientists to monitor the movements of the walruses this fall.

FUTURE PLANS: Several manuscripts are in preparation. In cooperation with Lyman McDonald of the University of Wyoming, we are conducting computer simulations of the behavior of the Hurowitz-Thompson adaptive sampling estimator as a possible procedure for walrus censusing.

Initial plans for the 1990 Joint Soviet-U.S. Walrus Survey will be made this fall. Additional efforts to deploy satellite transmitters are anticipated in 1990.

REPRODUCTIVE BIOLOGY OF FEMALE FISHERS IN SOUTHCENTRAL MAINE

- Investigator:* T. F. Paragi
- Field Assistants:* S. K. Crowley
T. P. Hodgman
E. A. Pfalzer
M. L. B. Summers
- Advisors:* W. B. Krohn, Chairperson
J. R. Gilbert
W. A. Halteman
D. J. Harrison
K. D. Elowe, Ex-Officio
- Cooperators/Project Support:* Maine Department of Inland Fisheries and Wildlife
Maine Cooperative Fish and Wildlife Research Unit
- Objectives:*
- (1) Estimate the proportion of females giving birth and average number of young produced per successful female.
 - (2) Develop and evaluate indices to reproduction and recruitment.
 - (3) Examine denning and postweaning biology of fisher families from spring to early fall.

SCOPE: The Maine Department of Inland Fisheries and Wildlife maintains a uniform trapping season for terrestrial furbearers, and conservative management requires careful harvesting of those species most vulnerable to overharvest. The fisher is a keystone species because of its low reproductive rate, relative vulnerability to land trappers, and valuable pelt.

Wildlife Management Units (WMUs) 4 and 7 in southcentral Maine support the highest trapper densities and WMU 7 the highest harvest density of fishers in Maine. With good road access throughout this region, more should be known about the potential impact of the harvest on the fisher population. A recent study of fisher ecology in this region suggested that parturition rates were substantially lower than pregnancy rates estimated from counts of corpora lutea, the conventional index to reproductive success in fishers. Also, little is known about the litter size, neonatal mortality, and denning habits of wild fishers.

PROJECT STATUS: Two of 3 adult female fishers (age 2 and older) monitored in 1989 denned by mid March. One mother slipped her collar in late March. The other mother had 3 kits (eartagged in late April) and was monitored for den attendance until late April with a telemetry receiver and stripchart recorder.

Kit survival was confirmed in 1988 by livetrapping ear-tagged kits or receiving ear tags from trappers. Spring recruitment in the den (n=4 adult females and 7-8 kits) was 1.8-2.0 kits per adult female; the minimum estimate of survival was 57%-63% of all kits from denning to trapping season; and fall recruitment prior to trapping season was 0.94 kits per adult female (range 0.64-1.24). Survival rates for 1988 were estimated from deaths of radio-collared fishers, and these will be used

with recruitment estimates to determine whether the fisher population in southcentral Maine can sustain itself given the current conditions.

Hemorrhage sites, assumed to correspond to sites of implantation and placental scars, were easily detected in fisher uteri during necropsies. These sites were used to determine the percentage of adult female fishers that had at least implanted and probably whelped kits. A sample of adult females from the harvest in New Hampshire (1987) and Vermont (1988) will be analyzed and compared to average annual denning rate of radio-collared adult females.

Activity patterns of 4 female fishers with kits were examined by sampling for signal fluctuations from radio collars during 4 periods of the circadian cycle from April-June 1988. Comparisons between females and periods are being made, both preweaning and postweaning, along with comparisons of females with and without kits in 1988-89. Den attentiveness is being analyzed for females with kits (one female each in 1988-89). Kit development will be described, as will characteristics of 32 den trees. The spatial relationships of 4 mother-kit pairs radio-collared simultaneously during 1988-89 are also being described.

FUTURE PLANS: A monetary reward will be offered to trappers to ensure the return of ear-tagged and radio-collared fishers in 1989. Carcasses of fishers will be examined to determine harvest composition and obtain reproductive tracts from central Maine. The target date for project completion is May 1990.

A SURVEY OF METASTRONGYLID PARASITES IN MAINE CERVIDS

- Investigator:** B. A. Bogaczyk
- Advisors:** W. B. Krohn, Co-advisor
H. C. Gibbs, Co-advisor
R. L. Dressler
M. A. McCollough
- Cooperators/
Project
Support:** U.S. Fish and Wildlife Service -
Washington Office
Maine Department of Inland Fisheries and Wildlife
Maine Caribou Transplant Corporation
Maine Cooperative Fish and Wildlife Research Unit
- Objectives:**
- (1) Determine if woodland caribou held at the University of Maine harbor *Elaphostrongylus cervi* or other metastrongylid parasites.
 - (2) Determine if the nematode muscleworm, *Parelaphostrongylus andersoni*, is present in Maine's white-tailed deer.
 - (3) Assess the state-wide prevalence of the nematode brainworm, *P. tenuis*, in Maine's white-tailed deer.

SCOPE: This study is investigating the occurrence and distribution of three parasite species known or suspected to infect Maine cervids: *E. cervi*, *P. andersoni*, and *P. tenuis*.

Woodland caribou transported from Newfoundland, Canada to Maine in 1986 for a reintroduction attempt may be harboring a nematode roundworm, *E. cervi*, potentially harmful to moose. To prevent accidental introduction of this parasite, all caribou will be tested and only animals negative for *E. cervi* will be released.

Another parasitic nematode, *P. andersoni*, has been documented in deer and caribou

throughout North America. However, its presence has not been investigated in Maine. If *P. andersoni* is not found in Maine, future *P. tenuis* surveys could be based on recovery of spike-tailed larvae from deer feces. If *P. andersoni* or some other lungworm species is present, this survey technique would be invalid, because five species of parasitic lungworms found in North American cervids produce spike-tailed larvae that are indistinguishable from one another.

The nematode brainworm, *P. tenuis*, is benign, though ubiquitous, in Maine deer, but it causes a lethal neurologic disease in moose and caribou. Inexplicably, Maine's moose population has maintained or continued to increase. A mid-1960's survey of *P. tenuis* in deer showed a statewide incidence of 76%. Maine's deer density declined from the 1960's until about 1980, and has been decreasing ever since. I will compare results of my survey to those from the 1960's to determine if changes in Maine's *P. tenuis* distribution and incidence have accompanied the changes in deer density.

The nematode brainworm, *P. tenuis*, also causes a lethal neurologic disease in caribou. The record of reintroductions of woodland caribou into former ranges now inhabited by white-tailed deer carrying the brainworm has been poor; all 7 reintroductions into areas inhabited by deer have been failures, whereas 24 of 29 attempts to reintroduce caribou into areas without deer were successful. Baseline data on *P. tenuis* will be useful in this and future caribou for reintroductions.

PROJECT STATUS: All caribou held at the University of Maine were tested for metastrongylid parasites. Fecal samples from each animal were examined in December 1988, and January, February, and March of 1989. Tests failed to find evidence of any caribou shedding spike-tailed larvae. Of the 11 caribou born in 1987 and surviving into their second year, 1 died as an indirect result of *P. tenuis* infection. Of the 11 born in 1988 and surviving into their second year, 3 died as either a direct (n = 2) or indirect (n = 1) result of *P. tenuis*. A fourth brainworm mortality was suspected; however, the carcass was too decomposed to permit a confident necropsy. The 1987 cohort was reared in an area not frequented by wild deer in recent years. In contrast, the 1988 cohort was raised in a pen erected in 1987; the area had previously been frequented by wild deer.

Thirty-seven Maine deer have been examined for infection by *P. andersoni*, with no worms found to date. In areas where this parasite occurs, reported infection rates range from 18-74%. Given this data, it seems likely that *P. andersoni* does not occur in Maine deer, or if it does, at unusually low levels (<10%).

The prevalence of *P. tenuis* in Maine deer was determined by examining deer heads collected between November 1988 and July 1989. Over 400 deer heads, distributed across the major sex and age classes, were obtained and 372 were examined for adult *P. tenuis*. Eighty percent were infected with at least one worm. No significant differences exist between infection rates by sex, nor between yearlings and adults ($P > .05$). However, fawns had significantly lower infection rates than older deer ($X^2 = 14.2$, 1 df, $P < .05$).

FUTURE PLANS: Deer carcasses will be examined for *P. andersoni* until a sample size of 50 is attained. Head collection and examination will be repeated during the November 1989 deer season. Captive caribou will again be monitored between January and March 1990. Laboratory work and data accumulation will cease March 1990. Completion of the thesis is scheduled for May 1990.

HOME RANGE AND HABITAT USE OF FEMALE
BLACK BEAR IN MAINE

Investigator: R. L. Schooley

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

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

Objectives:

- (1) Compare home range characteristics, movements, and seasonal habitat use among female black bears from 3 dissimilar study areas in Maine.
- (2) Determine what characteristics of tolerant hardwood stands in northern Maine are correlated with use by female bears during the fall.

SCOPE: Once considered a nuisance species, the black bear is now a desirable big game species in Maine. Harvest levels of black bears have increased steadily in the 1980's, and interest in hunting bears in Maine seems to be at an all-time high. This change in the status of black bears has increased the need to understand the species' spatial organization and habitat requirements.

The predicted trend in the Maine forest industry of increased harvesting of hardwood species could greatly affect the forested habitat available to black bears. Mast-producing hardwood species such as American beech and northern red oak are important sources of fall bear foods. In particular, beechnuts are evidently the primary fall food of bears in northern Maine where alternative food sources such as oaks, agricultural crops, and abandoned apple orchards are limited or nonexistent.

Between 1982 and 1987, the Maine Department of Inland Fisheries and Wildlife placed radio collars on approximately 120 female bears in 3 study areas that differed in geology, vegetation, land use, and hunting pressure. Collared bears were radio-tracked by small fixed-wing airplanes. Data from 65 female bears being monitored in 1988 will also be analyzed.

I will test several hypotheses including (1) annual home range sizes are greatest in the northern study area where food resources are most limited, (2) fall movements out of annual home ranges are most frequent in the northern study area, and (3) use of tolerant hardwood stands by bears in the fall is positively correlated with basal area of American beech within the stand.

PROJECT STATUS: I have completed initial analyses of habitat selection and denning dates, and results support hypotheses 1 and 2. Female black bears in northern Maine selected hardwood-dominated stands during falls when beechnuts were produced (1986 and 1988), but not when nuts were scarce (1987). About 75% of the bears were located in hardwood-dominated stands during the falls of 1986 and 1988, whereas <40% of the bears were located in hardwood-dominated stands during fall of 1987. Female bears in northern Maine also entered dens later in 1986 and 1988 (mid-November) when beechnuts were available, compared with 1987 (mid-October).

FUTURE PLANS: During fall of 1989 I will continue analyzing data. Emphasis will be on movements of bears, size of home ranges, and possible associations between weather variables and denning dates. The thesis should be completed by December 1989.

MODELING THE DYNAMICS OF MAINE'S BLACK BEAR POPULATION

Investigator: C. R. McLaughlin

Advisors: R. J. O'Connor, Chair
W. A. Halteman
W. B. Krohn
G. J. Matula, Jr.

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

Objective: To construct a population model for black bear in Maine.

SCOPE: The project seeks to integrate data gathered to date by MDIFW personnel into a formal computer population model, to serve as guidance for future research and management. Current effort is directed to analysis of these data to determine values for the input parameters needed for the model.

PROJECT STATUS: Work has concentrated on the analysis of accumulated population data at three study sites, to derive values of the population parameters required for the intended population model. Potential models are being reviewed as to their suitability for use with bear dynamics.

FUTURE PLANS: Portions of available bear population models will be incorporated into a bear population model specific to Maine. Derived input parameters will be entered in the Maine specific bear model and the dynamics of the bear population will be analyzed.

OCCURRENCE AND DISTRIBUTION OF COYOTES AND RED FOXES IN ACADIA NATIONAL PARK

Investigator: L. Winter

Advisors: D. J. Harrison, Chairperson
J. A. Sherburne
S. M. Melvin

*Cooperators/
Project
Support:* U.S. National Park Service -
Acadia National Park, Bar Harbor, Maine
North Atlantic Regional Office, Boston, Ma.
University of Maine -
Department of Wildlife

Objectives:

- (1) To determine the presence or absence of breeding coyotes on Mount Desert Island.
- (2) To characterize movements of radio-collared coyotes and red foxes on Mount Desert Island.
- (3) To assess the distribution of radio telemetry relocations in relation to specific physical characteristics of the landscape.

- (4) To examine home range overlap between coyotes and red foxes.
- (5) To compare chronology and proportion of radio-collared juvenile coyotes that disperse from Mount Desert Island with earlier mainland studies.

SCOPE: Acadia National Park on Mount Desert Island (MDI) provides habitat for mammalian predators including red foxes (*Vulpes vulpes*) and coyotes (*Canis latrans*). Sketchy and incomplete records suggest that red fox have been present on MDI throughout the 20th century. In contrast, coyotes were not recorded on Mount Desert Island until 1981. No detailed or scientifically verifiable information on the status of fox and coyote on MDI is currently available.

This broad-based ecological study includes live-trapping, radio telemetry, howling surveys, and snow track surveys. In addition, other researchers will be conducting scent post surveys and food habit studies in cooperation with this project. Concurrently, another study is being conducted to assess the effects of snowshoe hare and white-tailed deer on plant succession in Acadia. Together, these studies will provide complementary information on the mammalian community and its influence on natural systems in Acadia National Park.

PROJECT STATUS: Ten red foxes and 10 coyotes have been captured, and 10 foxes and 7 coyotes have been equipped with radio transmitters. Radio-equipped animals are being located 3-6 times per week, day and night. Timing and proportion of juvenile coyotes dispersing from MDI is being monitored. To date, three coyotes have dispersed from MDI.

Howl surveys were conducted at 97 stations established throughout MDI during August 1988. The survey was repeated during August 1989. Responses in 1988 confirmed the presence of a minimum of 3 coyote groups with offspring. Results for 1989 indicate a minimum of 5 coyote groups with offspring.

Snow track surveys along 100 km of permanent transect lines were followed 24-48 hours after snowfall during winters 1988 and 1989. Seventy km of transects have been completed.

FUTURE PLANS: Live trapping for foxes and coyotes will continue to be a major project activity through fall 1989. Radio telemetry of radio-collared animals will continue until the end of March 1990. During fall 1989, telemetry data will be coded and entered into computer files for preliminary home range and spatial use analysis. During winter 1990, the remaining 30 km of snow track surveys will be completed. Field work will be completed by the end of March, 1990. Results will be analyzed and the thesis will be completed by September 1990.

INFLUENCE OF BROWSING BY DEER, HARE, AND BEAVER ON VEGETATION AT ACADIA NATIONAL PARK

Investigator: M. Saeki

Advisors: D. J. Harrison, Chairperson
F. A. Servello
W. E. Glanz
G. L. Jacobson

**Cooperators/
Project
Support:** U.S. National Park Service -
Acadia National Park, Bar Harbor, ME
Regional Office, Boston, MA.
University of Maine -
Department of Wildlife

- Objectives:*
- (1) Quantify plant species present in the different habitat types in Acadia National Park.
 - (2) Quantify browsing intensity of white-tailed deer, snowshoe hare, and beaver among differing habitat types and plant species.
 - (3) Compare browse availability among burned and unburned areas.
 - (4) Characterize succession as influenced by fire and the browsing habits of deer, hare, and beaver.
 - (5) Provide baseline data for future studies of the relationship of deer, hare, beaver, and vegetation in Acadia National Park.

SCOPE: White-tailed deer, snowshoe hare, and beaver are the major herbivores at Acadia National Park (ANP). This park totals approximately 16,000 ha on Mt. Desert Island (MDI) and Isle au Haut (IH). In 1947, a wildfire burned 6,880 ha on the east side of MDI, while most of the west side and IH were unburned. Following the fire, populations of white-tailed deer, snowshoe hare, and beaver increased substantially in the burned areas. This study will assess the influence of browsing by these herbivores on post-fire succession in ANP.

Browse availability-utilization for white-tailed deer (Baird 1966, M.S. thesis, Univ. Maine, Orono; McLaughlin 1968, M.S. thesis, Univ. Maine, Orono; Gilbert and Harrison 1982, Final report, Contract CX1600-8-0045, USDI, National Park Serv., North Atlantic Reg.) and for snowshoe hare (Gilbert and Harrison *op cit.*) has been previously studied at ANP. This project serves as a follow-up study of browsing by white-tailed deer and snowshoe hare and initiates an assessment of the impact on vegetation by beaver. Vegetation will be surveyed along permanent transects and within permanent exclosures to estimate utilization and availability. Population levels of herbivores will be assessed by relative abundance of tracks and fecal pellets along survey lines. Nutritional condition of the white-tailed deer will be assessed by fecal nitrogen levels during late winter.

PROJECT STATUS: Approximately 100 km of permanent transects were established for winter track surveys and vegetation plots. Seventy kilometers of snow surveys were completed during the winters of 1988 and 1989. Two hundred fifteen vegetation plots (2 m x 25 m) on MDI and 17 plots on IH were surveyed during summer 1989. Surveys included stem counts, twig counts, and diameter at the point of browsing for selected browse species. Deer and hare fecal pellet group counts were also counted within all plots.

A vegetation inventory on four exclosures on MDI and two exclosures on IH was completed during summer 1988. Two control plots were also inventoried for each exclosure. An exclosure was constructed within active beaver habitat on MDI, and a baseline vegetation inventory was completed on this site and on two adjacent control plots during summer 1989.

FUTURE PLANS: Twigs of the selected browse species will be collected in fall 1989, and a weight-diameter regression analysis will be conducted to quantify browse utilization from the average diameter at the point of browsing for each species. Snow tracking survey for deer and hare will be continued on the remaining 30 km of unsampled transects. Fecal samples of deer will be collected for the fecal nitrogen analyses during late winter of 1990.

The projected date for project completion is September 1990.

RELATIONSHIP OF BEAVER MANAGEMENT AND WATERFOWL PRODUCTION
IN SOUTHCENTRAL MAINE

Investigator: T. C. McCall

Advisors: R. B. Owen, Jr., Chairperson
D. J. Harrison
W. B. Krohn
W. A. Halteman
J. R. Longcore
P. O. Corr, Ex-Officio
K. D. Elowe, Ex-Officio

*Cooperators/
Project
Support:* McIntire-Stennis
Maine Cooperative Fish and Wildlife Research Unit
Maine Department of Inland Fisheries and Wildlife
Maine Trappers Association
National Rifle Association
Penobscot County Conservation Association

- Objectives:*
- (1) Determine the annual density of beaver on a trapped area and an area recently closed to trapping.
 - (2) Compare the annual density of breeding pairs of selected waterfowl species between both areas.
 - (3) Compare the number of wetlands and surface area of water on both areas.
 - (4) Compare the quality of vegetation to waterfowl on both areas.

SCOPE: The black duck population has declined steadily since 1950, and overharvest is thought to be the primary factor. Therefore, since 1981 the annual harvest in Maine has been reduced 60%. Once the population increases, habitat may likely be a limiting factor.

Beaver flowages have been recognized for years as high quality habitat for waterfowl and many other wildlife species. Recent data suggest that excessive trapping may reduce the availability and quality of wetlands and their associated wildlife. This study is designed to provide data for better management of beaver to (1) ensure maximum waterfowl and other wildlife habitat, (2) ensure a sustainable beaver harvest, (3) minimize impact of beaver damage, and (4) maximize aesthetic enjoyment of wildlife for the public.

The Dixmont Area will be closed to beaver trapping for 3 years beginning in 1989, whereas the Montville Area will remain open to trapping. The 150 km² Dixmont Area corresponds to the location of 3 previous waterfowl graduate studies conducted during the past 30 years. This area consists of Dixmont, Jackson, Monroe, and Newburgh townships in Waldo County, Maine. The Montville Area is Montville township.

PROJECT STATUS: The first field season has been completed. In October 1989, counts of beaver caches on the Dixmont and Montville Areas were made from fixed-wing aircraft and from the ground to determine the number of active lodges. Eighty-five beaver were live-trapped and tagged with colored ear tags to determine the average number of beaver per lodge and dispersal. On the Montville Area, trappers were interviewed to determine the harvest of beaver in 1989 and to collect teeth for aging. From April-May 1989, breeding-pair counts of selected waterfowl species were compared on each area using counts from a helicopter and observers on the ground. The number and sizes of wetlands and the types of vegetation associated with each wetland were determined using

aerial photos. From July-September 1989, each of the 180 wetlands was visited to verify the accuracy of the data obtained from the photos. One water sample was collected from each wetland and was analyzed for apparent color, pH, and specific conductivity. Six water-control devices were installed at road culverts to prevent damming by beaver.

FUTURE PLANS: In 1990 and 1991 the collection of data will be replicated. The anticipated date of completion is December 31, 1991.

ANALYSIS OF RIVER OTTER HARVEST AND REPRODUCTIVE DATA IN THE NORTHEASTERN U.S., 1970-88

Investigators: M. Chilelli
B. Griffith
D. J. Harrison

**Cooperators/
Project
Support:** U. S. Fish and Wildlife Service -
Region 5 Federal Aid
Northeast Fur Resources Technical Committee

Objectives: (1) Evaluate existing river otter data from the northeastern U.S.
(2) Develop a region-wide protocol for the subsequent collection of river otter biological and harvest data.

SCOPE: With the CITES listing of the river otter, the U. S. Fish and Wildlife Service (USFWS) is required to ascertain that harvest strategies in individual states are not detrimentally affecting the species prior to issuing export permits. Because the USFWS relies on recommendations from individual states regarding their harvest strategies, it is essential to Federal and state management agencies that the soundness of the data used to reach these decisions be evaluated.

PROJECT STATUS: During May and June 1989, furbearer project leaders from the 13 states (Conn., Del., Me., Md., Mass., N.H., N.J., N.Y., Pa., R.I., Vt., Va., and W. Va.) composing the study area were informed of the purposes of this study and provided with a detailed list of data needed for the analysis. Data collection and compilation into databases commenced in July. Currently there are >4500 river otter necropsy records and >580 citations of articles pertaining to river otters compiled into databases. Tooth aging samples are being examined to assess the consistency of aging techniques applied throughout the states.

FUTURE PLANS: Analysis of river otter harvest and reproductive data began in October 1989. The final report will be completed by April 1990.

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SERVELLO, F.A., T. L. Edwards, and B. U. Constantin. 1989. Managing coyote problems in Kentucky. University of Kentucky Cooperative Extension Service No. FOR-37.

THESES AND DISSERTATIONS

COLNES, A.L. 1989. Establishing environmental baselines: A program of long-term monitoring on a system of ecological reserves in the State of Maine. M.W.C. Report, University of Maine, Orono. 71pp.

MINK, L.H. 1989. Interactions of white perch (*Morone americana*) and anadromous alewife (*Alosa pseudoharengus*) in two coastal lakes and the potential for competition in an inland lake in Maine. M.S. Thesis, University of Maine, Orono. 83pp.

SHIVELY, L. 1989. Mechanics of the foraging behavior of boreal herbivores. M.S. Thesis, University of Maine, Orono. 96pp.

TRIAL, J.G. 1989. Testing habitat models for blacknose dace and Atlantic salmon. Ph.D. dissertation, University of Maine, Orono. 128pp.

YONZON, P.B. 1989. Ecology and conservation of the red panda in the Nepal-Himalayas. Ph.D. dissertation, University of Maine, Orono. 159pp.

PROFESSIONAL TALKS PRESENTED

ARTHUR, S.M., W.B. KROHN, and T.F. PARAGI. 1989. "Fishers and forests." Poster presentation at Forest and wildlife management in New England: What can we afford? Joint meeting of the New England SAF, Maine Chapter of TWS, and Atlantic International Chapter of the AFS, Portland, ME, March 15-17, 1989.

BOGACZYK, B.A. "Survey of *P. tenuis* in Maine's white-tailed deer." Paper presented at the Northeast Wildlife Graduate Student Conference, University of New Hampshire, Durham, February 10-12, 1989.

COLNES, A. "A proposed framework for long-term monitoring of the ecosystem level effects of contaminants in Maine." Paper presented at the Northeast Wildlife Graduate Student Conference, University of New Hampshire, Durham, February 10-12, 1989.

DEVAUL, H., and W.B. KROHN. 1989. "Breeding woodland hawks and forest management." Poster presentation at Forest and wildlife management in New England: What can we afford? Joint meeting of the New England SAF, Maine Chapter of TWS, and Atlantic International Chapter of the AFS, Portland, ME, March 15-17, 1989.

ELLIOTT, C.A. "How to recognize wildlife habitat and habitat management opportunities." Talk presented to 100 foresters and natural resource managers, North Conway, NH, October 25, 1988.

ELLIOTT, C.A. "Reorganizing wildlife habitat and habitat management opportunities." Paper presented to 65 professionals in natural resources attending workshop on Woodlots and Woodlands: Looking Beyond the Trees, White River Junction, VT, December 6, 1988.

- ELLIOTT, C.A. "How to recognize wildlife habitat and habitat management opportunities." Paper given at workshop on Woodlots and Woodlands: Looking beyond the Trees, White River Junction VT, December 6, 1988. 65 foresters and other natural resource professionals attended.
- GRIFFITH, B. "Translocation as a species conservation tool: status and strategy." Paper presented to meeting of the research staff of Patuxent Wildlife Research Center (USFWS), Laurel, MD, February 13, 1989.
- GRIFFITH, B. "Translocation as a species conservation tool." Invited paper, Northeast Biodiversity Workshop, Jeffersonville, VT, April 18-19, 1989.
- GRIFFITH, B. "Translocation as a species conservation tool." Talk presented to 40 professionals, Department of Wildlife, University of Maine, Orono, February 7, 1989.
- GREAR, J.S., N.V.L. BROKAW, K.J. TRIPLETT, and A.A. WHITMAN. "Tree composition and community structure of a sub-tropical wet forest in Belize." Paper presented at meeting of Organization for Tropical Studies, 6-10 August 1989, Toronto, Canada.
- HARRISON, D.J. "Distribution, productivity, and food habits of a recently established coyote population in Connecticut." Paper presented at the Northeast Fish and Wildlife Conference, Ellenville, NY, May 7-10, 1989.
- HARRISON, D.J. "Dispersal characteristics of juvenile coyotes: Implications for social organization." Paper presented to the 69th Annual Meeting of the American Society of Mammalogists, Fairbanks, AK, June 11-15, 1989.
- HOOPER, S. "Managing riparian zones for wildlife in Maine: A proposal." Paper presented at the Northeast Wildlife Graduate Student Conference, University of New Hampshire, Durham, February 10-12, 1989.
- HOOPER, S. "Wildlife and riparian zones in the Northeast: a brief overview." Paper presented at Forest and wildlife management in New England: what can we afford? Joint meeting of the New England SAF, Maine Chapter of TWS, and Atlantic International Chapter of the AFS, Portland, ME, March 15-17, 1989.
- HUNTER, M.L., JR. "Spatial and temporal patterns in forested landscape--implications for conservation." Talk presented to 24 professionals at Dartmouth College, October 14, 1988.
- HUNTER, M.L., JR. "Towards a conceptual definition of old-growth forests." Talk presented to 40 professionals, Wildlife Department, University of Maine, Orono, November 1988.
- HUNTER, M.L., JR. "Paleoecology and the coarse filter approach to maintaining biological diversity." Talk presented to 50 professionals, Wildlife Department, University of Maine, Orono, March 4, 1989.
- HUNTER, M.L., JR., and R. SEYMOUR. "A combined voluntary-mandatory approach to fostering diverse, productive forests in Maine." Paper presented at Forest and wildlife management in New England: what can we afford? Joint meeting of the New England SAF, Maine Chapter of TWS, and Atlantic International Chapter of the AFS, Portland, ME, March 15-17, 1989.

- HUNTER, M.L., JR. "Acid rain and wildlife." Talk presented to 50 students and faculty, Bates College, May 15, 1989.
- HUNTER, M.L., JR. "Managing the forest landscape at a regional scale." Paper presented at Northeast Biodiversity Workshop, Jeffersonville, VT, April 18-19, 1989.
- HUNTER, M.L., JR. "Managing forests for spatial heterogeneity to maintain biological diversity." GIS Colloquium, Orono, May 1, 1989. 15 attended.
- HUNTER, M.L., JR. "Gorillas in the mist; buffalos in the dust." Talk presented to 35 professionals, Wildlife Department, University of Maine, Orono, May 2, 1989.
- JACOBSON, G., M.L. HUNTER, JR, E. GRIMM, and T. WEBB. "Biotic responses to rapid climate change since the last glaciation indicates low probability of long-term community integrity." Paper presented at a meeting of the Society for Conservation Biology, Toronto, Ontario, August 6, 1989.
- KROHN, W.B. "Update of wildlife research at the Maine Cooperative Fish and Wildlife Research Unit." Talk presented to the Wildlife Division, Maine Department of Inland Fisheries and Wildlife, Greenville, October 12, 1988.
- KROHN, W.B., S.M. ARTHUR, and T.F. PARAGI. "Differential vulnerability of fishers to fall trapping: a preliminary assessment." Paper presented at Northeast Fish and Wildlife Conference, Ellenville, NY, May 9, 1989.
- McCALL, T.C. "Comparison of tame-deer enclosures and forage analysis for determining the carrying capacity of white-tailed deer." Presented at University of Maine Wildlife Seminar Series, November 1988. 40 attended.
- McCALL, T.C. "Arctic ecology." Lecture to Ecology class, University of Maine, Orono, December 1988. 20 students attended.
- McCOLLOUGH, M.A. "Are logging and caribou compatible?" Paper presented at Forest and wildlife management in New England: what can we afford? Joint meeting of the New England SAF, Maine Chapter of TWS, and Atlantic International Chapter of the AFS, Portland, ME, March 15-17, 1989.
- MINK, L.H. "Comparison of alewife (*Alosa pseudoharengus*) and white perch (*Morone americana*) diets in two Maine lakes. Paper presented at the 1989 Northeast Fish and Wildlife Conference, Ellenville, NY, May 9, 1989.
- MORING, J.R. "Ecology of juvenile lumpfish, *Cyclopterus lumpus*, in the rocky intertidal zone." Migratory Fish Research Institute Seminar Series, University of Maine, January 20, 1989.
- MORING, J.R. "Effects of logging activities on aquatic resources of northern streams." Convocation Seminar at the College of Forest Resources, University of Georgia, Athens, GA, February 24, 1989.
- MORING, J.R. "Restoration of Atlantic Salmon and studies of intragravel and juvenile stages." College of Forest Resources Seminar Series, University of Georgia, Athens, GA., February 24, 1989.

- MORING, J.R. "Restoration of Atlantic Salmon and studies of intragravel and juvenile stages." Seminar presented at the University of Washington, Seattle, WA., April 20, 1989.
- MORING, J.R. "A review of salmon aquaculture in the United States." Invited address, annual meeting of the American Society of Animal Science, Northeastern Section, Orono, ME., July 10, 1989.
- MORING, J.R., and S.W. MORING. "Growth and retention of juvenile lumpfish (*Cyclopterus lumpus*)." Paper presented at the annual meeting of the American Society of Ichthyologists and Herpetologists, San Francisco, CA., June 18, 1989.
- O'CONNOR, R.J. "Ecology of migrants compared to residents." Review lecture presented at Max-Planck-Institut fur Verhaltenphysiologie Symposium on *Physiological and Ecophysiological Aspects of Bird Migration*, Tutzing, FRG, October 18-20, 1988.
- O'CONNOR, R.J. "Comparative ecology of migrants and residents." Seminar at Department of Biology, Queen's University, Ontario, Canada, September 21, 1989.
- O'CONNOR, R.J. "Homage to St. Patrick, or why there are so few bird species in Ireland." Seminar to Ecology and Evolutionary Biology Group, Queen's University, Ontario, Canada, September 21, 1989.
- OWEN, R.B., J. LONGCORE, J. RINGELMAN, and K. REINECKE. "Breeding biology and habitat use of black ducks." Poster presentation given at Forest and wildlife management in New England: what can we afford? Joint meeting of the New England SAF, Maine Chapter of TWS, and Atlantic International Chapter of the AFS, Portland, ME, March 15-17, 1989.
- SAYERS, R.E., JR. 1989. "Effects of introducing Atlantic salmon on native brook trout." Paper presented at the 1989 Northeast Fish and Wildlife Conference, Ellenville, NY, May 9, 1989.
- SCHOOLEY, R.L. "Habitat use and movements of female black bears in Maine." Paper presented at the Northeast Wildlife Graduate Student Conference, University of New Hampshire, Durham, February 10-12, 1989.
- SHIVELY, L. "Analysis of the functional response--the relationship between intake and diet choice." Paper presented at 3rd Workshop on Energetics and Nutrition of Wild Ruminants, Ft. Collins, CO., January 17-20, 1989. 50 attended.
- VICKERY, P.D. "The effect of incidental predation on grassland birds at the Kennebunk Plains, Maine." Paper presented to Bowdoin College Science Seminar, Brunswick, ME, March 1989.
- VICKERY, P.D., M.L. HUNTER, JR., and J. WELLS. "Incidental skunk predation on grassland bird nests." Paper presented at the Wilson Ornithological Society Annual Conference, Philadelphia, PA, June 1988.
- WHITMAN, A. "Dispersal of *Aralia nudicaulis* by birds and mammals." Paper presented at the Northeast Wildlife Graduate Student Conference, University of New Hampshire, Durham, February 10-12, 1989.

WHITMAN, A., M.L. HUNTER, JR., and J. WITHAM. "Population dynamics of wild sarsaparilla, *A. nudicaulis*." Poster presentation at Forest and wildlife management in New England: what can we afford? Joint meeting of the New England SAF, Maine Chapter of TWS, and Atlantic International Chapter of the AFS, Portland, ME, March 15-17, 1989.

WHITMAN, A., M.L. HUNTER, JR., and J. WITHAM. "Population dynamics of ramets *Aralia nudicaulis*." Poster presentation given at the Ecological Society of America meeting, Toronto, Canada, 6-10 August 1989.

WITHAM, J., and M.L. HUNTER, JR. "Small mammal population fluctuations - habitat effects. Poster presentation at Forest and wildlife management in New England: what can we afford? Joint meeting of the New England SAF, Maine Chapter of TWS, and Atlantic International Chapter of the AFS, Portland, ME, March 15-17, 1989.

WITHAM, J., M.L. HUNTER, JR., and A.S. WHITE. "Holt Research Forest." Poster presentation at Forest and wildlife management in New England: what can we afford? Joint meeting of the New England SAF, Maine Chapter of TWS, and Atlantic International Chapter of the AFS, Portland, ME, March 15-17, 1989.

PUBLIC TALKS PRESENTED

ALI, S. "Wildlife and conservation in North India." Talk presented to The Game Conservancy, United Kingdom, June 15, 1989.

ELLIOTT, C.A. "How to recognize wildlife habitat and habitat management opportunities." Paper given at workshop "Woodlots and Woodlands: Looking beyond the trees," Ramada Inn, Bangor, October 11, 1988.

ELLIOTT, C.A. "Managing your woodlot for wildlife." Talk presented to 15 members of the Dover-Foxcroft Chapter of the Small Woodland Owners Association of Maine, November 29, 1988.

ELLIOTT, C.A. "Habitat management for furbearers." Talk presented to 22 members of the Central Maine Trappers Association, Palmyra, December 7, 1988.

ELLIOTT, C.A. "Managing your woodlot for wildlife." Talk presented to Hancock County ASCS, Ellsworth, ME, December 15, 1988. 20 members of the County Commission attended.

ELLIOTT, C.A. "Managing woodlots for wildlife." Talk presented to 21 forestry/logging students at Mount Blue High School, Farmington, ME, February 16, 1989.

ELLIOTT, C.A. "Managing your woodlot for wildlife." Talk presented to 14 UMCES woodland volunteers at Androscoggin-Sagadahoc County Office, Auburn, ME, February 19, 1989.

ELLIOTT, C.A. "Backyards and woodlots - How to attract more wildlife to your land." Talk presented at Eastern Maine Sportsman's Show, Orono, March 11, 1989. 35 attended.

ELLIOTT, C.A. "Backyards and woodlots - How to attract more wildlife to your land." Talk given to Downeast Chapter, Maine Audubon Society, Southwest Harbor, May 18, 1989. 25 attended.

- ELLIOTT, C.A. "Backyards and woodlots - How to attract more wildlife to your land." Talk presented to Hancock County Homemakers Association, Bucksport, ME, May 24, 1989. 75 attended.
- HUNTER, M.L., JR. "Gorillas in the mist; buffalos in the dust." Talk presented to 20 members of the Student Chapter of The Wildlife Society, Orono, ME, April 18, 1989.
- KROHN, W.B. "Biology and status of Maine's eider ducks." Slide presentation to Wildlife Freshman Seminar. University of Maine, Orono, September 28, 1989. 60 attended.
- KROHN, W.B. Introduced U.S. Fish and Wildlife Service video, "In Celebration of America's Wildlife," at Penobscot County Conservation Association meeting, January 5, 1989. 90 attended.
- KROHN, W.B. Gave lectures to undergraduate Wildlife Policy class, "Organization of the U.S. Fish and Wildlife Service," and "An Overview of the Service's Migratory Bird Program." University of Maine, Orono, February 2, 1989.
- McCALL, T.C. "Trapping in Alaska." Talk presented at the Central Coastal Chapter, Maine Trappers Association, September 1988. 20 attended.
- McCALL, T.C. "Beaver trapping in Alaska." Talk presented at the Maine Trappers Association Annual Fall Rendezvous, Dixmont, September 1988. 100 attended.
- McCALL, T.C. "Trapping in Alaska." Slide show presented to Northern Coastal Chapter, Maine Trappers Association, October 1988. 20 attended.
- McCALL, T.C. "Beaver trapping in Alaska." Demonstration and slide show to Annual Fur Rendezvous of the Maine Trappers Association, October 1988. 150 attended.
- McCALL, T.C. "Trapping in Alaska." Slide show presented to Kenduskeag Chapter, Maine Trappers Association, December 1988. 15 attended.
- McKINLEY, D.B. "Stream habitat improvement." Talk presented at 51st Eastern Maine Sportsman's Show, Orono, March 11, 1989.
- MINK, L.H. "Aquaculture in Cameroon." Lecture presented to the Fishery Biology class, University of Maine, November 7, 1989. 23 attended.
- MINK, L.H. "Aquaculture in Cameroon." Seminar presented as part of the Aquaculture Seminar Series, University of Maine, February 17, 1989. 7 attended.
- MINK, L.H. "Alewives and white perch in Maine lakes." Talk presented at the 51st Annual Eastern Maine Sportsman's Show, Orono, March 12, 1989. 10 attended.
- MINK, L.H. "Comparison of alewife (*Alosa pseudoharengus*) and white perch (*Morone americana*) diets in two Maine lakes. Seminar presented to Graduate Student Forum, University of Maine, May 1, 1989.
- MORING, J.R. "Northern pike and chain pickerel research in the Belgrade Lakes." Talk presented to the Fisheries and Hatcheries Division, Maine Department of Inland Fisheries and Wildlife, Waterville, May 2, 1989.

- MORING, J.R. "Coolwater fish aquaculture." Lecture presented to Aquaculture class, University of Maine, November 10, 1988. 9 attended.
- MORING, J.R. "Salmon ranching and cage culture." Lecture presented to Aquatic Food Webs class, University of Maine, December 15, 1988. 10 attended.
- O'CONNOR, R.J. "Biological characteristics of avian invaders." Seminar given at Manomet Bird Observatory, Manomet, MA, July 10, 1989.
- O'CONNOR, R.J. "The work of the British Trust for Ornithology." Seminar given at Manomet Bird Observatory, Manomet, MA, July 11, 1989.
- O'CONNOR, R.J. "Avian habitat dynamics." Seminar given at Manomet Bird Observatory, Manomet, MA, July 13, 1989.
- OWEN, R.B., JR. "Forest Practices Act - wildlife considerations." Talk given to the Energy and Natural Resources Committee, Maine Legislature, February 9, 1989.
- OWEN, R.B., JR. "Bald eagles in Maine." Three talks given at Eastern Maine's Sportsman's Show, University of Maine, Orono, March 10-12, 1989.
- PARAGI, T.F. "Reproductive biology of female fishers in southcentral Maine." Talk given to Maine Trappers Association Fall Rendezvous, Dixmont, September 11, 1988. 100 attended.
- PARAGI, T.F. "Reproductive biology of female fishers in southcentral Maine." Talk given to Maine Trappers Association Central Maine Chapter, Palmyra, October 2, 1988. 25 attended.
- PARAGI, T.F. "Reproductive biology of female fishers in southcentral Maine." Talk given to Maine Trappers Association Coastal Chapter, Belfast, October 6, 1988. 15 attended.
- PARAGI, T.F. "Reproductive biology of female fishers in southcentral Maine." Talk given to Maine Trappers Association Aroostook County Chapter, March 14, 1989. 20 attended.
- SAYERS, R.E., JR. "Great Lakes fisheries." Lecture presented to Fishery Biology class, University of Maine, October 9, 1988. 22 attended.
- SAYERS, R.E., JR. "Stocking salmon: effects on brook trout?" Talk presented at the 51st Eastern Maine Sportsman's Show, Orono, March 11, 1989.
- SAYERS, R.E., JR. "Introducing Atlantic salmon: competitive effects on brook trout." Seminar presented to Graduate Student Forum, University of Maine, May 1, 1989.
- VANDERHAEGEN, W.M. "Energetic approach to habitat selection." Lecture presented to Wildlife Habitat class, Univ. Maine, Orono, February 1989.
- VANDERHAEGEN, W.M. "Energetics of the American Woodcock." Lecture presented to Univ. of Maine Summer Camp, Moosehorn NWR, Calais, May 1989.
- VICKERY, P.D. "The natural history and conservation needs of Belize, Central America." Talk presented to seminar series, Maine Audubon Society, February 1989.

VICKERY, P.D. "The importance of invertebrates as wildlife." Testimony given to Fisheries and Wildlife Committee, Maine Legislature, April 1989.

WITHAM, J. "Holt Forest tour and discussion of forestry issues. "Talk presented to Maine Audubon Society Teacher's Workshop, Holt Forest, June 28, 1989.

PROFESSIONAL MEETINGS ATTENDED

BOGACZYK, B.A. Attended winter meeting of Maine Chapter of The Wildlife Society, Augusta, January 26, 1989.

BOGACZYK, B.A. Attended the Northeast Wildlife Graduate Student Conference, University of New Hampshire, Durham, February 10-12, 1989.

BOGACZYK, B.A. Attended the joint meeting of the New England SAF, Maine Chapter of TWS, and Atlantic International Chapter of the AFS, "Forest and wildlife management in New England: What can we afford?" Portland, ME, March 15-17, 1989.

CHILELLI, M. Attended the Northeast Fur Resources Technical Committee Workshop, Charlottetown, P.E.I., Canada, September 6-8, 1989.

CHILELLI, M. Attended Northeast Fisher Workshop, Concord, NH, June 20, 1989.

COLNES, A. Attended the Northeast Wildlife Graduate Student Conference, University of New Hampshire, Durham, February 10-12, 1989.

ELLIOTT, C.A. Attended meeting of foresters and natural resource managers, "Woodlots and Woodlands: Looking Beyond the Trees." North Conway, NH, October 25, 1988.

ELLIOTT, C.A. Attended the North American Wildlife and Natural Resources Conference, Washington, D.C., March 19-22, 1989.

ELLIOTT, C.A. Attended the joint meeting of the New England SAF, Maine Chapter of TWS, and Atlantic International Chapter of the AFS, "Forest and wildlife management in New England: What can we afford?" Portland, ME, March 15-17, 1989.

GRIFFITH, B. Attended the Northeast Fur Resources Technical Committee Workshop, Charlottetown, P.E.I., Canada, September 6-8, 1989.

GRIFFITH, B. Attended the joint meeting of the New England SAF, Maine Chapter of TWS, and Atlantic International Chapter of the AFS, "Forest and wildlife management in New England: What can we afford?" Portland, ME, March 15-17, 1989.

GRIFFITH, B. Attended Northeast Fisher Workshop, Concord, NH, June 20, 1989.

GRIFFITH, B. Attended USFS Northeast Biodiversity Workshop, Jeffersonville, VT., April 18-19, 1989.

GRIFFITH, B. Attended White Mountain National Forest Scientific Advisory Committee meeting, Jeffersonville, VT, April 20, 1989.

- HARRISON, D.J. Attended the joint meeting of the New England SAF, Maine Chapter of TWS, and Atlantic International Chapter of the AFS, "Forest and wildlife management in New England: What can we afford?" Portland, ME, March 15-17, 1989.
- HARRISON, D.J. Attended the Northeast Fish and Wildlife Conference, Ellenville, NY, May 8-9, 1989.
- HARRISON, D.J. Attended the 69th Annual Meeting of the American Society of Mammalogists, Fairbanks, AK, June 11-15, 1989.
- HOOPER, S. Attended the Northeast Wildlife Graduate Student Conference, University of New Hampshire, Durham, February 10-12, 1989.
- HOOPER, S. Attended the joint meeting of the New England SAF, Maine Chapter of TWS, and Atlantic International Chapter of the AFS, "Forest and wildlife management in New England: What can we afford?" Portland, ME, March 15-17, 1989.
- HUNTER, M.L., JR. Attended the joint meeting of the New England SAF, Maine Chapter of TWS, and Atlantic International Chapter of the AFS, "Forest and wildlife management in New England: What can we afford?" Portland, ME, March 15-17, 1989.
- HUNTER, M.L., JR. Attended the North American Wildlife and Natural Resources Conference, Washington, D.C., March 19-22, 1989.
- HUNTER, M.L., JR. Attended a meeting of the Society for Conservation Biology, Toronto, Ontario, August 6, 1989.
- HUNTER, M.L., JR. Attended the American Inst. Biology Scientific Conference, Toronto, Ontario, August 6-10, 1989.
- KROHN, W.B. Attended the joint meeting of the New England SAF, Maine Chapter of TWS, and Atlantic International Chapter of the AFS, "Forest and wildlife management in New England: What can we afford?" Portland, ME, March 15-17, 1989.
- KROHN, W.B. Attended the Northeast Fish and Wildlife Conference, Ellenville, NY, May 8-9, 1989.
- KROHN, W.B. Attended the Northeast Fur Resources Technical Committee Workshop, Charlottetown, P.E.I., Canada, September 6-8, 1989.
- McCOLLOUGH, M.A. Attended the joint meeting of the New England SAF, Maine Chapter of TWS, and Atlantic International Chapter of the AFS, "Forest and wildlife management in New England: What can we afford?" Portland, ME, March 15-17, 1989.
- MCKINLEY, D.B. Attended the Northeast Fish and Wildlife Conference, Ellenville, NY, May 6-10, 1989.
- MINK, L.H. Attended the Northeast Fish and Wildlife Conference, Ellenville, NY, May 6-10, 1989.
- MORING, J.R. Attended the Spring Executive Committee Meeting of the American Fisheries Society, Corpus Christi, TX, March 8-13, 1989.

MORING, J.R. Attended the Northeast Fish and Wildlife Conference, Ellenville, NY, May 6-10, 1989.

MORING, J.R. Attended the annual meeting of the American Society of Ichthyologists and Herpetologists, San Francisco, CA, June 17-23, 1989.

MORING, J.R. Attended the annual meeting of the American Society of Animal Science, Northeastern Section, Orono, ME, July 9-10, 1989.

MORING, J.R. Attended the annual meeting of the American Fisheries Society, Anchorage, AK, September 1-8, 1989.

O'CONNOR, R.J. Attended Max-Planck-Institut fur Verhaltenphysiologie Symposium on *Physiological and Ecophysiological Aspects of Bird Migration*, Tutzing, FRG, October 18-20, 1988.

O'CONNOR, R.J. Attended Environmental Protection Agency Population Biology Research Strategy Workshop, Corvallis, OR, February 2-3, 1989.

O'CONNOR, R.J. Attended Conference on Pesticides in Terrestrial and Aquatic Environments, Virginia Water Research Center, Richmond, VA, May 11-12, 1989.

O'CONNOR, R.J. Attended the joint meeting of the New England SAF, Maine Chapter of TWS, and Atlantic International Chapter of the AFS, "Forest and wildlife management in New England: What can we afford?" Portland, ME, March 15-17, 1989.

O'CONNOR, R.J. Attended American Ornithologists' Union Conference, University of Pittsburgh, August 8-11, 1989.

OWEN, R.B., JR. Attended the North American Wildlife and Natural Resources Conference, Washington, D.C., March 19-22, 1989.

OWEN, R.B., JR. Attended the joint meeting of the New England SAF, Maine Chapter of TWS, and Atlantic International Chapter of the AFS, "Forest and wildlife management in New England: What can we afford?" Portland, ME, March 15-17, 1989.

PARAGI, T.F. Attended Northeast Fisher Workshop, Concord, NH, June 20, 1989.

RUDNICKY, T. Attended the joint meeting of the New England SAF, Maine Chapter of TWS, and Atlantic International Chapter of the AFS, "Forest and wildlife management in New England: What can we afford?" Portland, ME, March 15-17, 1989.

SAYERS, R.E., JR. Attended the 1989 Northeast Fish and Wildlife Conference, Ellenville, NJ, May 6-10, 1989.

SCHOOLEY, R.L. Attended the Northeast Wildlife Graduate Student Conference, University of New Hampshire, Durham, February 10-12, 1989.

SERVELLO, F.A. Attended the North American Wildlife and Natural Resources Conference, Washington, D.C., March 19-22, 1989.

- SERVELLO, F.A. Attended Northeast Fish and Wildlife Conference, Ellenville, NY, May 7-10, 1989.
- VAUGHAN, E. Attended the Northeast Wildlife Graduate Student Conference, University of New Hampshire, Durham, February 10-12, 1989.
- VENNO, S. Attended the Northeast Wildlife Graduate Student Conference, University of New Hampshire, Durham, February 10-12, 1989.
- VICKERY, P.D. Attended the Wilson Ornithological Society Annual Conference, Philadelphia, PA, June 1988.
- WHITMAN, A. Attended the Northeast Wildlife Graduate Student Conference, University of New Hampshire, Durham, February 10-12, 1989.
- WHITMAN, A. Attended the joint meeting of the New England SAF, Maine Chapter of TWS, and Atlantic International Chapter of the AFS, "Forest and wildlife management in New England: What can we afford?" Portland, ME, March 15-17, 1989.
- WITHAM, J. Attended the joint meeting of the New England SAF, Maine Chapter of TWS, and Atlantic International Chapter of the AFS, "Forest and wildlife management in New England: What can we afford?" Portland, ME, March 15-17, 1989.
- WITHAM, J. Attended the Maine Audubon Society Teachers Workshop, Holt Forest, June 28, 1989.

AWARDS AND HONORS

- GRIFFITH, B. Appointed as a member of the White Mountain National Forest Scientific Advisory Committee.
- HUNTER, M.L., JR. Selected as an Elective Member of the American Ornithologists' Union.
- KROHN, W.B. Appointed by the Commissioner, Maine Department of Inland Fisheries and Wildlife, to the Steering Committee for Project WILD.
- MINK, L.H. Received the Horace Bond Scholarship for Fisheries from the Penobscot County Conservation Association, November 1988.
- MORING, J.R. President-elect and President of the American Fisheries Society, Northeastern Division, and served on the Executive Committee of the American Fisheries Society. Also served as Chairman of the Coordinating Committee for the Migratory Fish Research Institute through December 1988, and was re-appointed to the Graduate Faculty through 1994.
- MUGANGU, T.E. Awarded an African Dissertation Internship RF 87001 #17 by the Rockefeller Federation to fund work on habitat selection by buffalo in Zaire.
- OWEN, R.B., JR. Appointed to the Baxter Park Advisory Board, January 2, 1989.
- OWEN, R.B., JR. Appointed Director, Natural Resources Council of Maine, January 13, 1989.

OWEN, R.B., JR. Appointed by the Commissioner, Maine Department of Inland Fisheries and Wildlife, to the Steering Committee for Project WILD.

PERRY, C.M. Received an Olin Fellowship from the Atlantic Salmon Federation.

VICKERY, P.D. Awarded a fellowship for graduate study by the Switzer Foundation.

WHITMAN, A. Awarded \$400 by Sigma Xi to fund work on dispersal of *Aralia nudicaulis* seeds by birds, March 25, 1989.

