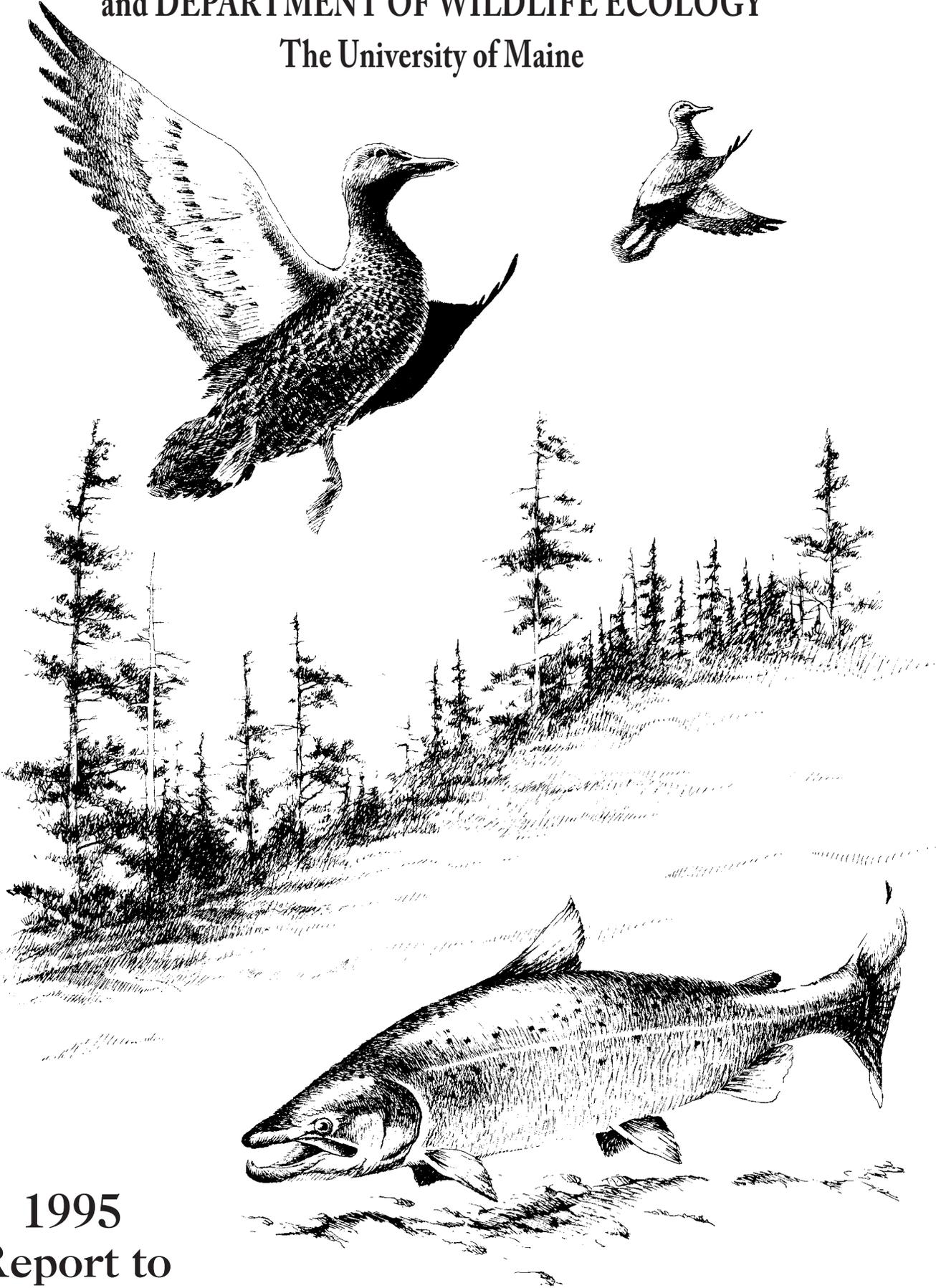


MAINE COOPERATIVE FISH AND WILDLIFE RESEARCH UNIT
and DEPARTMENT OF WILDLIFE ECOLOGY

The University of Maine



1995
Report to
Cooperators

—Mark McCollough '86

MAINE COOPERATIVE FISH AND WILDLIFE RESEARCH UNIT

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COOPERATORS

UNIVERSITY OF MAINE

MAINE DEPARTMENT OF INLAND FISHERIES AND WILDLIFE

NATIONAL BIOLOGICAL SERVICE, U.S. DEPARTMENT OF THE INTERIOR

WILDLIFE MANAGEMENT INSTITUTE

October 1994 - September 1995

Compiled and Edited by
William B. Krohn and John R. Moring

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 313 Murray Hall and is within the Department of Zoology, College of Sciences; the Unit's Wildlife Program is located in 206 Nutting Hall and is within the Department of Wildlife Ecology, College of Natural Resources, Forestry, and Agriculture.

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PERSONNEL AND COOPERATORS

COORDINATING COMMITTEE

Maine Department of Inland Fisheries and Wildlife
Ray B. Owen, Jr., Commissioner

University of Maine

James R. Gilbert, Chairperson, Department of Wildlife Ecology, College of Natural Resources,
Forestry, and Agriculture
J. Malcolm Shick, Chairperson, Department of Zoology, College of Sciences

National Biological Service
W. Reid Goforth, Director, Division of Cooperative Research

Wildlife Management Institute
Rollin D. Sparrowe, President

UNIT PERSONNEL

Unit Staff:

William B. Krohn, Unit Leader, Professor of Wildlife Ecology and Cooperating Professor of Zoology
John R. Moring, Assistant Unit Leader for Fisheries, Professor of Zoology
Susan Anderson, Unit and USFWS-LSC Administrative Assistant - Fisheries
Nancy Knight - Unit Administrative Assistant - Wildlife Ecology
Shirley L. Moulton, Secretary - Wildlife Ecology

Associated Faculty and Staff, Departments of Wildlife Ecology and Zoology:

James R. Gilbert, Chairperson, Department of Wildlife Ecology, College of Natural Resources, Forestry, and Agriculture, and Professor of Wildlife Ecology
T. Malcolm Shick, Chairperson, Department of Zoology, College of Sciences, and Professor of Zoology
William E. Glanz, Associate Professor of Zoology and Cooperating Associate Professor of Wildlife Ecology
Kevin J. Boyle, Associate Professor, Department of Agriculture and Resource Economics, and Cooperating Associate Professor of Wildlife Ecology
Daniel J. Harrison, Associate Professor of Wildlife Ecology
Malcolm L. Hunter, Jr., Professor of Wildlife Ecology
Allan O'Connell, Faculty Associate and Leader, Cooperative National Park Unit, NBS
Raymond J. O'Connor, Professor of Wildlife Ecology
Frederick A. Servello, Associate Professor of Wildlife Ecology
Jerry R. Longcore, Faculty Associate, Wildlife, and Research Wildlife Biologist, NBS
James A. Sherburne, Director, International Programs and Professor of Wildlife Ecology
Terry A. Haines, Professor of Zoology and Fishery Research Biologist, NBS
Ruth W. Perry, Research Assistant, Zoology
Elizabeth Moore, Research Assistant, Wildlife Ecology
Jack Witham, Assistant Scientist, Wildlife Ecology
Thomas P. Hodgman, Research Associate, Wildlife Ecology
Malcolm T. Jones, Research Associate, Wildlife Ecology

Maine Department of Inland Fisheries and Wildlife:

Ray B. Owen, Jr. Commissioner
Matthew Scott, Deputy Commissioner
Frederick B. Hurley, Jr., Director, Bureau of Resource Management
Kenneth D. Elowe, Director, Wildlife Division
Peter M. Bourque, Director, Fisheries and Hatcheries Division
George J. Matula, Jr., Supervisor, Wildlife Resource Assessment Group
Kendall Warner, Supervisor, Fisheries Research and Management Section

GRADUATE STUDENTS

Name	Degree Candidacy	Support
Andrew P. Allen	M.S.	USEPA
John Bartlett	Ph.D.	EPA
Bradley F. Blackwell	Ph.D.	MCFWRU, USFWS
Randall B. Boone	Ph.D.	MCFWRU, NBS
Merrie A. Cartwright	Ph.D.	U of M, MDIFW
Theodore D. Chapin	M.S.	McIntire-Stennis
Phillip G. de Maynadier	Ph.D.	McIntire-Stennis
Stephen S. Ditchkoff	M.S.	McIntire-Stennis
Diana M. Eignor	Ph.D.	USFWS and USACOE
Mustapha El Hamzaoui	Ph.D.	USAID/USDA
Carol R. Foss	Ph.D.	USFS, USFWS, Switzer Env. Fellowship
Merry Gallagher	M.S.	U of M, MDIFW
Stephen L. Glass	Ph.D.	ANP
Christopher F. Hartleb	Ph.D.	MDIFW
Mitschka J. Hartley	Ph.D.	McIntire-Stennis
Catherine M. Johnson	Ph.D.	NBS, U of M
Malcolm T. Jones	Ph.D.	CPM
Lisa A. Joyal	M.S.	U of M
Siti C. Kaniawati	M.W.C.	Indonesia
Mary Kay Kenney	M.S.	U.S. Natl. Marine Fisheries and DEP
Henry J. Lachowski	M.S.	U of M, McIntire-Stennis
Laurance Lisle	M.W.C.	Personal Funding
Robert A. Long	M.S.	Acadia - NPS
Paula MacKay	M.S.	Hatch
Andrew P. Madden	M.S.	MDIFW, U of M
Angela C. Matz	Ph.D.	Acadia - NPS
Karen E. McCracken	Ph.D.	U of M
Craig R. McLaughlin	Ph.D.	Personal Funding
Laura M. Monti	M.S.	Holt Woodlands Research Foundation
Dawn L. Nelson	M.S.	Holt Woodlands Research Foundation
David C. Payer	Ph.D.	MDIFW, CFRU, U of M
Anne M. Perillo	M.S.	USFWS, USFS, MDIFW
John G. Poulsen	Ph.D.	Consortium of pesticide manufacturers
Michael W. Powell	M.S.	U of M
James W. Schneider	Ph.D.	McIntire-Stennis
Steven L. Shepard	M.S.	BHE
Craig P. Stafford	M.S.	U of M
James Stahlnecker	M.S.	MDMR
Marcia L. B. Summers	M.S.	Personal Funding (Grad. School Assistantship)
Emy E. Suwarni	M.S.	USAID/Indonesia

DISSERTATIONS AND THESES COMPLETED THIS PERIOD

Student	Degree Candidacy	Support
Theodore D. Chapin	M.S.	McIntire-Stennis
Steven S. Ditchkoff	M.S.	McIntire-Stennis

Siti C. Kaniawati	M.W.C.	Indonesia
Mary Kay Kenney	M.S.	NMFS
Robert A. Long	M.S.	Acadia/NPS
Steven L. Shepard	M.S.	BHE
Craig P. Stafford	M.S.	U of M
Emy E. Suwarni	M.S.	USAID/Indonesia

PERSONNEL NOTES

The following people received graduate degrees in Wildlife Ecology, or Wildlife Conservation, in December, May or August:

TED CHAPIN completed his M.S. program and is currently working as a Research Associate at the University of Maine under the direction of Professor Dan Harrison. **STEVE DITCHKOFF** received his M.S. degree and is a Ph.D. candidate at Oklahoma State University. **SITI KANIAWATI** received a M.W.C. and has returned to Indonesia where she is employed by the Ministry of Forestry. **EMY SUWARNI** completed her M.W.C. program and also returned to Indonesia. **MARY KAY KENNEY** received her M.S. degree and is now residing in Washington State, caring for her new baby son. **ROBERT LONG** completed his M.S. program and returned to his native California.

STEVE SHEPARD received an M.S. degree in Zoology and is working for a private consulting firm in Maine. **CRAIG STAFFORD** received an M.S. degree in Zoology and is employed by a private consulting firm in Colorado.

RAY OWEN continued on leave, serving as Commissioner of the Maine Department of Inland Fisheries and Wildlife. **NANCY KNIGHT** joined the staff as the Administrative Assistant for the Maine Cooperative Fish and Wildlife Research Unit and the Department of Wildlife Ecology.

COLLABORATING AGENCIES AND ORGANIZATIONS

Audubon Society of New Hampshire
 Bangor Hydro-Electric - BHE
 Baxter State Park - BSP
 Boise Cascade - BC
 Bowater-Great Northern Paper, Inc. - BGNP
 Champion International Corporation - CI
 Davis Conservation Association - DCA
 Hirundo Wildlife Refuge - HWR
 Holt Woodlands Research Foundation - HWRF
 James River Corporation - JRC
 Maine Atlantic Salmon Authority - MASA
 Maine Audubon Society - MAS
 Maine Bureau of Public Lands - MBPL
 Maine Department of Conservation - MDC
 Maine Department of Environmental Protection - MDEP
 Maine Department of Inland Fisheries and Wildlife - MDIFW
 Maine Forest Service - MFS
 Maine Geologic Survey - MGS
 Maine Image Analysis Lab - MIAL

Maine Office of Geographic Information Systems - MOGIS
National Council of the Paper Industry for Air and Stream Quality Improvement - NCASI
National Marine Fisheries Service - NMFS
New Brunswick Fish and Wildlife Branch - NBFW
New Hampshire Fish & Game Department - NHFG
New Hampshire Department of Resources and Economic Development -
 Division of Forests and Lands
Oak Ridge National Laboratory
 Environmental Sciences Division
Seven Islands Land Company
Switzer Environmental Fellowship Program
University of Maine - U of M
 Association of Graduate Students - AGS
 College of Natural Resources, Forestry, and Agriculture
 Cooperative Forestry Research Unit - CFRU
 Department of Forest Management - DFM
 Department of Wildlife Ecology - DWE
 Forest Ecosystem Research Program - FERP
 McIntire-Stennis - MS
 Maine Agricultural and Forest Experiment Station - MAFES
U.S. Department of Commerce
 National Maine Fisheries Service - NMFS
U.S. Environmental Protection Agency - EPA
 Environmental Laboratory, Corvallis, OR
U.S. Fish and Wildlife Service - FWS
 Lake Umbagog National Wildlife Refuge
 Neotropical Migratory Bird Program - NMBP
USDA Agricultural Research Service
USDA Economic Research Service - ARS
USDA Forest Service - USFS
 Forestry Sciences Laboratory, Corvallis, OR
 Pacific Northwest Region, Portland, OR
USDI National Biological Service - NBS
 Leetown Science Center - LSC
 Cooperative Park Studies Unit - CPSU
 Patuxent Wildlife Research Center - PWRC
USDI National Park Service
 Acadia National Park
Wagner Forest Management, Ltd. - WFM

CONTAMINANT BURDENS AND ECOLOGY OF BALD EAGLES NEAR ACADIA NATIONAL PARK

Investigator: A. C. Matz

Advisors: J.R. Gilbert, Co-Chairperson
A. F. O'Connell, Co-Chairperson
K. E. Carr
W. E. Glanz
D. J. Harrison
W. B. Krohn
R. B. Owen, Jr.
C. A. Todd

*Cooperators/
Project
Support:* University of Maine -
Department of Wildlife Ecology
National Park Service -
Cooperative Park Studies Unit
Acadia National Park
Maine Department of Inland Fisheries and Wildlife
Maine Department of Environmental Protection
U.S. Fish and Wildlife Service

Objectives:

- 1) Measure contaminant levels in eggs, chicks, adults, prey items, and sediments or sessile marine animals within nesting territories of bald eagles on Maine's central coast.
- 2) Describe disturbance stress, winter stress, home range and foraging areas for selected nesting pairs.
- 3) Relate all factors to eagle productivity using a multivariate analysis.

SCOPE: The reproductive rate of Maine's eagles is 10-40% below rates of other recovering populations. This 4-year, Ph.D. level study will identify factors responsible for low productivity in coastal eagles. Contaminants are a main focus, as this study follows a 2-year U.S. Fish and Wildlife Service/University of Maine study which found extremely high levels of persistent compounds (PCBs and organochlorine insecticides) in coastal eagle nestlings.

PROJECT STATUS: In the 1995 field season, eagle nestling blood was collected and will be analyzed for contaminant levels. These levels will be correlated with immune function and hormonal status. Bald eagle prey items representing several trophic levels were collected and will be analyzed for contaminants. A report on disturbance at specific nests in and near Acadia National Park will be completed by October 1995. Previously radio-tagged adult bald eagles were monitored to determine home range area.

FUTURE PLANS: Collected samples will be analyzed for contaminants. Weather and food supply data will be analyzed with eagle productivity and contaminant levels to determine relationships. Project completion is expected in December 1996.

FISHERIES RESOURCES:**UPSTREAM MIGRATION OF ATLANTIC SALMON IN THE PENOBSCOT RIVER**

Investigator: S. L. Shepard

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

*Cooperators/
Project
Support:* Bangor Hydro-Electric Company

Objective: Document and correlate environmental factors influencing upstream movements of Atlantic salmon.

SCOPE: Even with adequate fish passage facilities, upstream-migrating adult Atlantic salmon are delayed by each dam. However, it has not been documented whether part of these delays may be due to environmental factors such as streamflow. Using radio telemetry, this project correlates the movement patterns of salmon with measurements of environmental parameters.

PROJECT STATUS: All requirements for the degree of Master of Science (in Zoology) were completed in August 1995. An abstract of the thesis follows:

Restoration of Atlantic salmon, *Salmo salar*, to the Penobscot River in Maine has met with limited success to date. Research in freshwater has emphasized migration problems created by dams. Fish passage research was initiated jointly by the Maine Atlantic Sea-Run Salmon Commission and the Bangor Hydro-Electric Company in 1987. This research was later broadened to examine environmental issues of flow and temperature. From 1988 through 1992, radio transmitters were placed in the stomachs of 1089 returning adult Atlantic salmon which were then released at several locations in the lower Penobscot River. Radio-tagged Atlantic salmon were monitored with receivers and data loggers at six hydroelectric dams and by mobile tracking from airplanes, trucks and boats. Radio-tagged Atlantic salmon made no net upstream progress for weeks at a time during the summer. When directed upstream movements were initiated, salmon passed through multiple fishways and often made net progress of 20 to 40 km in five to ten days. Atlantic salmon passed through fishways below 23°C, but higher temperatures were associated with fewer radio-tagged Atlantic salmon passages and reduced captures at the Veazie Dam fishway trap. Above a threshold of approximately 23°C, increasing temperatures caused Atlantic salmon to cease movement and seek refuge in stream mouths where they usually remained until high temperatures abated. Daily average temperatures of 26°C to 27°C were associated with salmon mortalities. When radio-tagged Atlantic salmon migrated upstream to the Piscataquis and Mattawamkeag rivers, migrations often ceased again, apparently due to low flows in these unregulated tributaries. Mainstem and East Branch flows were artificially high due to releases of stored water and there was no indication that migrations were impeded by the lowest flows observed in these areas. In contrast, high main stem flows may have inhibited upstream passage at lower Penobscot River dams as a result of attraction to spillway flows which compete with turbine flows where fishway entrances were typically located. Low velocity areas such as impoundments were not suitable holding habitat and radio-tagged Atlantic salmon moved rapidly through these areas. Radio-tagged Atlantic salmon were generally found in areas of moderate to high velocity and moderate to shallow depth.

POPULATION STUDIES OF MAINE INTERTIDAL FISHES

- Investigator:** J. R. Moring
- Cooperators/
Project
Support:** University of Maine
- Objectives:**
- 1) Identify environmental conditions associated with arrival and departure of fishes in the intertidal zone.
 - 2) Identify and quantify algal and food associations of intertidal fishes.
 - 3) Develop a species checklist of Maine tidepool fishes.

SCOPE: Intertidal fishes are unique members of the intertidal ecosystem. Tidepools serve a nursery function, and young of economically important offshore fishes utilize tidepools as refuges and nurseries. 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 23 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 with movements of juvenile grubbies and shorthorn sculpins are ongoing. One paper on the subject was published in 1995 and a talk was presented.

FUTURE PLANS: Work dealing with intertidal movements of sculpins will continue in 1996, along with experiments on Atlantic seasnail feeding and innovative fish marking techniques. Additional manuscripts are being prepared.

GROWTH, SURVIVAL, AND PERFORMANCE OF STOCKED BROOK TROUT IN LAKES WITH HEAVY COMPETITION

- Investigator:** C. F. Hartleb
- Advisors:** J. R. Moring, Chairperson
J. H. Dearborn
K. E. Gibbs
W. H. Howell
I. L. Kornfield
- Cooperators/
Project
Support:** Maine Department of Inland Fisheries and Wildlife
Maine Cooperative Fish and Wildlife Research Unit
- Objective:** Compare growth, survival, and angler return of stocked spring yearling brook trout in waters with heavy competition and waters with limited competition.

SCOPE: The State of Maine currently stocks yearling brook trout in bodies of water where angling demand

is high, but where competition from other species (smallmouth bass, yellow perch, white perch, suckers, chain pickerel) may make such use cost-ineffective. There are no data on survival or performance of such stocked fish in these marginal waters, but this policy is relatively common in southern and central Maine. The study involves a sampling program in two lakes to analyze growth of brook trout and food habits of trout and competing species over two seasons. Growth rates and survival will be compared and used in a model to predict potential success of stocking in Maine lakes.

PROJECT STATUS: The second field season has been completed and a computer model has been developed.

FUTURE PLANS: A series of runs of the model will be conducted over winter 1995-1996, along with dissertation writing. A Ph.D. dissertation is expected in May 1996.

COMPETITION BETWEEN WHITE PERCH AND ILLEGALLY-INTRODUCED BLACK CRAPPIE

Investigator: A. P. Madden

Advisors: J. R. Moring, Chairperson
J. G. Trial
W. E. Glanz

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

Objective: Document the impacts of illegally-introduced black crappie on growth and population structure of white perch.

SCOPE: Black crappie have been illegally introduced into several waters of Maine. In recent years, the species has been introduced into Herman Pond, long the home of a popular white perch fishery, as well as smallmouth bass and chain pickerel. Black crappies have successfully reproduced and the population numbers have increased substantially, possibly to the detriment of white perch. This project examines the impact of this introduced centrachid on the native white perch.

PROJECT STATUS: Field work is nearly completed, with additional samples to be taken in late fall 1995. Data analysis is underway.

FUTURE PLANS: Data analysis will continue over winter 1995-1996 and a Master of Science degree is anticipated for May 1996.

ECOLOGICAL INTERACTIONS BETWEEN FISHES AND INVERTEBRATES IN AN ESTUARY IN SOUTHERN MAINE

Investigator: M. A. Cartwright

Advisors: J. R. Moring, Chairperson
J. G. Trial
J. H. Dearborn

M. Dionne
R. S. Steneck

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

Objectives: Analyze benthic and planktonic prey items available to fishes utilizing the Little River estuary and relate availability to selection in a dynamic system.

SCOPE: Estuaries are commonly assumed to be important nursery grounds for juvenile marine fishes. In recent years, the stocking of brown trout (*Salmo trutta*) in the lower rivers of several coastal estuaries has shown rapid growth when fish move into estuaries. This project examines this ecosystem from both the predator and prey aspects. Collections of juvenile fishes in the estuary will be related to salinity and tidal differences and shifting availability of prey items over time, season and tidal cycles.

PROJECT STATUS: Two field seasons have been completed at the Wells National Estuarine Research Reserve and data are being analyzed to detect possible trends and hypotheses to be tested. A Ph.D. dissertation is expected in May 1996.

DISTRIBUTION AND STATUS OF PICKEREL (*Esox* spp.) IN CENTRAL AND SOUTHERN MAINE

Investigator: M. Gallagher

Advisors: J. R. Moring, Chairperson
L. J. Kling

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

Objectives: Determine the status of grass pickerel in the state and to establish a biological data base for chain pickerel.

SCOPE: An unusual pickerel, identified as a grass pickerel (*Esox americanus vermiculatus*), was collected in a stream near Bath, Maine in 1977. Since that time there have been unconfirmed reports of other non-chain (*E. niger*) pickerel esocids observed near that location and in other parts of the state. If grass pickerel or the closely-related subspecies, redbin pickerel (*E. americanus americanus*), still exist in Maine, they may be candidates for special protection under Maine's laws. Despite the wide distribution and popularity of chain pickerel, little biological data on age structure, length/weight, age specific length, spawning characteristics, and distribution are available. This project will address both questions during field work in 1996.

PROJECT STATUS: The project is just beginning. Field work will occur in 1996, and a Master of Science degree is expected in May 1997.

HABITAT RESOURCES:

**AN ASSESSMENT OF THREE DIFFERENT
CONSERVATION SYSTEMS IN INDONESIA:
STRICT NATURE RESERVES, WILDLIFE SANCTUARIES AND NATIONAL PARKS**

Investigator: E. E. Suwarni

Advisors: J. A. Sherburne, Chairperson
D. J. Harrison
J. F. Tynon

*Cooperators/
Project
Support:* USAID/Indonesia

Objectives:

- 1) Examine and compare management structures, approaches, and objectives in selected and representative Nature Reserve, Game Reserve, and national park located in one province.
- 2) Understand management infrastructure and approach for each area.
- 3) Assess the obstacles to effective management of programs in each area.
- 4) Assess and evaluate the relative effect these obstacles have on effective management of each area.

SCOPE: Indonesia has several conservation areas. Some of these, nature reserves and game reserves, have long histories on the islands. In recent years, another and more encompassing system of managing natural resources has been established - the national park. Each of these three major systems has different objectives and is operated under a different management approach and infrastructure. Yet all three are designed for the same overall purpose, i.e., to conserve and manage Indonesia's valuable natural resources. As the interaction of these three primary systems evolves, it will be necessary to assess and evaluate the effectiveness of the different conservation areas, as well as the overlapping management approaches. This research will address the first important step in that process by exploring and assessing policy and management factors, structure, approaches, facilities and programs applied in each system.

PROJECT STATUS: All requirements for the degree of Master of Science (in Wildlife Ecology) were completed in May 1995. An abstract of the thesis follows:

There are three conservation management systems in Indonesia, Strict Nature Reserves, Wildlife Sanctuaries, and National Parks. I examined the management practices, administrative structures, approaches, and objectives at a representative site for each management system and assessed the obstacles to meeting the objectives. I then evaluated the relative effect these obstacles have on management for each area.

Obstacles to meeting the management objectives in Strict Nature Reserves are: a) little public support because local people do not receive direct benefits from protected areas, b) the Rangers are bored because they are given no direction for management related work, c) funds are limited for inventory and monitoring activities, d) little attention is given to planning, and e) limited transportation support for the Rangers.

In wildlife sanctuaries the high floral and faunal diversity creates conflict between recreation and conservation objectives. Further, lack of local government involvement results in conflict between the sanctuary manager carrying out management objectives and local interests. In national parks obstacles include the different perceptions of the purpose of the park (local government wants to develop recreation

activities, whereas the Park Services restricts human activities), and inadequate skills and knowledge of the Rangers required to adequately do their job.

Overcoming some obstacles in meeting the management objectives of all three protected areas can be achieved by similar methods such as improving the socio-economics of local communities by assisting in the establishment of home industries, or constructing irrigation systems for agriculture and fishery, maintaining good communication between protected area officials and local government, and improving the skills and capabilities of the Rangers.

Overall, this study indicates there are three priorities that ought to be considered and implemented to achieve better management of protected areas: 1) local community understanding, communication, and involvement, 2) baseline natural resources inventories, and 3) strengthening of protected area personnel capacities.

APPLICATION OF SATELLITE DATA TO MONITOR NEOTROPICAL MIGRANT BIRD HABITAT IN CENTRAL AMERICA

Investigators: J. A. Hepinstall
S. A. Sader

*Cooperators/
Project
Support:* USDI National Biological Service -
Patuxent Wildlife Research Center
University of Maine -
Department of Forest Management

Objectives:

- 1) Apply computer-aided processing of satellite data to map and monitor neotropical habitat availability for avian migrants wintering in Central American study sites.
- 2) Use developed habitat classifications for selected areas of Belize and natural vegetation maps of the country to develop human disturbance maps.
- 3) Combine disturbance maps and bird species survey data to model potential density and distribution for selected species of avian migrants in Belize.

SCOPE: In order to provide more complete habitat availability maps, natural vegetation maps for Belize have been combined with previously classified imagery to produce human-disturbance maps. These maps were combined with wintering migratory and resident bird species data, gathered from several field visits over the past 5 years, into summary maps showing species richness, distribution, and relative abundance. Total winter avian population estimates for all areas with adequate field data were also calculated.

PROJECT STATUS: An international conference, co-organized by the USNBS, University of Maine, and the National Autonomous University of Mexico, was held in Veracruz, Mexico, November 5-7, 1993. The conference was well attended by U.S. and Mexican professionals and also included several participants from other Central American countries and Canada. Proceedings from the conference, including 23 peer-reviewed papers and numerous poster paper abstracts were published in October 1995.

Land cover classification images of Belize were combined with digitized natural vegetation maps to create potential human versus natural classes of savanna, shrub savanna, and broadleaf shrub. Bird species data were combined with modified habitat data extrapolated for all of Belize using 4 satellite images and the potential natural vegetation map of the country. Chandler Robbins met with University of Maine personnel in Fall 1994 and finalized methods and publication procedures for this project. A final report including abundance and density maps for approximately 300 species was completed June 1995.

FUTURE PLANS: This project has been completed.

A LONG-TERM FOREST ECOSYSTEM STUDY

Investigators: M. L. Hunter, Jr.
A. J. Kimball
A. S. White
J. W. Witham
E. H. Moore

*Cooperators/
Project
Support:* Holt Woodlands Research Foundation
McIntire-Stennis

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 (>10 2 cm DBH) and intensive inventories of tree regeneration, (all trees are being individually numbered and, on 12 tracts, 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 forests' 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 1995, tasks 3, 4, 5, 6, 7, 8, 9, and 10 as outlined above, were completed, and three graduate student projects (red oak regeneration, salamander abundance and distribution, and insects associated with the bark of dead trees) were initiated.

FUTURE PLANS: The 1995 field season will replicate the 1994 field season with additional work on salamander distribution and abundance, snags, red oak regeneration, and forest gap dynamics and their

effects on forest understory plants.

EFFECTS OF HEAVY METALS ON FISHES AND EAGLES OF THE NORTHEASTERN UNITED STATES

Investigators: T. A. Haines
R. W. Perry

Advisors: T. A. Haines, Chairperson (for Abbott, Eignor, Powell, Stafford)
I. J. Fernandez
S. A. Norton
J. R. Moring

*Cooperators/
Project
Support:* USDI National Biological Service -
Leetown Science Center

Objective: Analyze aspects of heavy metals in waters of northern New England and the potential influence on fishes and bald eagles.

SCOPE: High concentrations of mercury have been found in fish and wildlife in locations remote from industrial discharges or mercury-bearing rock. Such conditions have been documented for fish and bald eagles in Maine. Atmospheric deposition of mercury emitted to the atmosphere from fossil fuel combustion, refuse incineration, or industrial processes and deposited with rain and snow is believed to be the major source of mercury to these areas. The problem occurs primarily in areas where waters are low in acid neutralizing capacity. Other factors such as acidification, construction of impoundments, and increased temperature may increase bioavailability of mercury. Conversely, treatment of waters with lime may reduce bioavailability. In order to manage this threat, information is needed on the source of mercury, the factors that control bioavailability, and possible remedial techniques.

PROJECT STATUS: Project has ended. An M.S. thesis still needs completion by M. Powell.

MERCURY CONTAMINATION IN MAINE PREDATORY FISHES

Investigator: C. P. Stafford

Advisors: T. A. Haines, Chairperson
H. B. Dowse
J. R. Moring

*Cooperators/
Project
Support:* USDI National Biological Service -
Leetown Science Center

Objective: Analyze aspects of heavy metals in waters of northern New England and the potential influence on fishes and bald eagles.

SCOPE: High concentrations of mercury have been found in fish and wildlife in locations remote from

industrial discharges or mercury-bearing rock. Such conditions have been documented for fish and bald eagles in Maine. Atmospheric deposition of mercury emitted to the atmosphere from fossil fuel combustion, refuse incineration, or industrial processes and deposited with rain and snow is believed to be the major source of mercury to these areas. The problem occurs primarily in areas where waters are low in acid neutralizing capacity. Other factors such as acidification, construction of impoundments, and increased temperature may increase bioavailability of mercury. Conversely, treatment of waters with lime may reduce bioavailability. In order to manage this threat, information is needed on the source of mercury, the factors that control bioavailability, and possible remedial techniques.

PROJECT STATUS: All requirements for the degree of Master of Science (in Zoology) were completed in December 1994. An abstract of the thesis follows:

In order to characterize mercury contamination of fish in Maine, predatory species were collected from 117 randomly selected lakes. The collection goal from each lake was five fish of the same species within specified size guidelines. Skinless, boneless fillets of fish from each lake were composited, homogenized, and analyzed for total mercury. The two most abundant species, brook trout (*Salvelinus fontinalis*) and smallmouth bass (*Micropterus dolomieu*), were also analyzed individually. The composite fish analysis indicates high levels of mercury exist in Maine predatory fishes, particularly in large and long-lived species. High levels of mercury in the composites do not seem to be concentrated near point sources. Mercury concentration of individual brook trout was positively related to fish size, lake elevation, and watershed:lake area ratio, and negatively correlated with lake water sulfate. Mercury concentration of individual smallmouth bass was positively correlated with fish size and lake water color. Mercury concentrations in predatory fishes seem to be controlled by life history patterns as well as physical and chemical characteristics of lakes.

QUANTIFYING THE RELATIONSHIP OF FOREST ROADS TO MAINE'S MARTEN HARVEST WITH A GEOGRAPHIC INFORMATION SYSTEM

Investigator: T. P. Hodgman

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

Objective: Examine the relationship between Maine's marten harvest and trapper access and habitat types using spatial analyses.

SCOPE: The remote habitat occupied by American marten (*Martes americana*) has offered some protection from overexploitation. However, continued construction of logging roads has provided marten trappers with access to previously inaccessible areas. Past studies on the effects of trapper access on Maine's marten harvest did not account for misreporting the location of capture nor the spatial arrangement of habitat types and forest roads. This study attempts to overcome these limitations. Also, a supervised classification of a 1986 Landsat TM image ("leaf on") will be used to identify habitat types. This classification will be part of a GIS, which also includes roads and township borders for approximately 75 townships in northern Maine. After removing the area occupied by unsuitable marten habitat (i.e. water, recent clearcuts, etc.) in each township cluster, comparisons will be made between the harvest of marten and the amount and spatial arrangement of forest roads and habitat types.

PROJECT STATUS: Processing of satellite imagery for the habitat database is complete. A database of primary and secondary roads for the entire study area is complete and has been edited. Preliminary analysis of harvest data has begun.

FUTURE PLANS: Final analysis of harvest, access, and habitat data will be performed in late 1995 and early 1996.

SEED PREDATION BY SMALL MAMMALS ON THREE TREE SPECIES IN SOUTHERN MAINE

Investigator: K. E. McCracken

Advisors: M. L. Hunter, Jr., Chairperson
W. E. Glanz
D. J. Harrison
R. J. O'Connor
A. S. White

**Cooperators/
Project
Support:** Holt Woodlands Research Foundation
University of Maine

Objectives:

- 1) Determine whether intensity of seed predation varies among habitats (continuous forest and four types of forest gap).
- 2) Determine which animals are relatively more effective at removing three species of tree seeds (i.e., "small" rodents [mice and voles], "large" rodents [squirrels], or other potential avian and mammalian seed predators).
- 3) Investigate other possible correlates of seed predation (i.e., seed size, seed preference, time of day, lunar cycle).
- 4) Investigate the response of small mammals (population levels, animal condition) to temporal and spatial variation in seed fall.

SCOPE: Many species of small mammals in temperate forests depend on tree seeds for a substantial portion of their diet. Thus, temporal and spatial variation in seed fall may profoundly affect animal condition, reproduction, and survival, resulting in dramatic intra- and inter-annual fluctuations in population levels. This study examines how temporal and spatial variation in seed fall of three species of trees [red maple (*Acer rubrum*), northern red oak (*Quercus rubra*), and white pine (*Pinus strobus*)], affect small mammal populations in the Holt Forest, an oak-pine ecosystem in southern Maine.

PROJECT STATUS: Three field seasons have been completed. For two years, removal rates of red maple, red oak, and white pine seeds were monitored during their respective periods of seed fall, in five habitat types (ledge, dead tree, and small harvest gaps, matched by size; large harvest gaps, and forest), and in four treatment regimes (seeds on the open ground, or in a wire cage, with one section that excludes all mammalian and avian seed predators, one that allows access to mice and voles only, and one that allows access to mice, voles, and larger mammalian seed predators, primarily chipmunks and squirrels). This was again replicated with red maple seeds in June 1993, and was replicated at a subset of sites with red oak and white pine seeds in October. In 1992, rates of seeds removed nocturnally versus diurnally were monitored for three days to substantiate the observed patterns. In late August, small mammal abundance at experimental sites was quantified by four nights of trapping during all three years.

Removal rates of red maple seeds have been monitored all three years in large harvest gaps and continuous forest, during full and new-moon periods, to test whether small mammals shift their foraging microhabitat to sites with more cover (under a bush versus three meters away) as ambient light increases.

In 1992, red oak acorns and white pine seeds were placed together in trays and covered with 3 cm of

sand to determine which species was preferred.

Other aspects of seed predation investigated include effects of: 1) acorn size, and 2) preference of seed predators for oak or pine seeds, on rates of seed removal.

Ten years of data from the Holt Forest are currently being analyzed to assess the density response and animal weights (as an index of condition) of small mammals to temporal and spatial variation in seed fall.

An additional set of experiments was designed for October 1993 based on preliminary results from analysis of both field observations and the long-term data sets, and included seed preference trials with captive *Peromyscus leucopus* and *Clethrionomys gapperi* to investigate effects of seed size and tannin level of red oak and white pine seeds on palatability.

FUTURE PLANS: Revise and defend dissertation.

AN INVESTIGATION OF FORESTRY-AMPHIBIAN RELATIONSHIPS IN MAINE

- Investigator:* P. de Maynadier
- Advisors:* M. L. Hunter, Jr., Chairperson
W. E. Glanz
D. J. Harrison
M. A. McCollough
R. J. O'Connor
- Cooperators/
Project
Support:* Maine Agricultural and Forest Experiment Station
McIntire-Stennis
Hirundo Wildlife Refuge
University of Maine -
Association of Graduate Students
National Council of the Paper Industry for Air & Stream Quality Improvement
- Objectives:*
- 1) Document the amphibian community in managed and mature forest stands and identify microhabitat variables of potential importance.
 - 2) Investigate the effects of forest-clearcut edges of various contrast on the habitat use of resident and dispersing amphibians.
 - 3) Determine the effects of logging roads on the abundance and movement patterns of adjacent amphibian populations.
 - 4) Conduct a comprehensive review of forestry-amphibian relationships and generate management guidelines for amphibian conservation in managed forest landscapes.

SCOPE: Forest fragmentation has potentially profound effects on the isolation of wildlife populations and is presently a major threat to biological diversity worldwide. Forest landscapes are increasingly bisected by human development, including 1) linear features such as roads, power and gas right of ways, and rail lines, and 2) block features such as agriculture and clear-cuts. It is important to understand the permeability of these barriers to the movements of various wildlife taxa. Formerly continuous populations which become isolated may exhibit metapopulation dynamics and may be more prone to extinction through demographic, genetic, or environmental stochasticity. In order to better understand the importance of barriers as isolating mechanisms, this study will quantify amphibian response to Maine's forest roads and clearcut edges.

In addition, there is increasing public pressure on Maine's industrial forest managers to provide for multiple uses on their ownerships including non-game wildlife habitat. Despite their relative inconspicuousness amphibians are the most abundant terrestrial vertebrate group in the northeast and may

serve an important role in forest ecosystem dynamics. In an effort to better understand the response to common silvicultural practices this study quantifies the abundance and richness of amphibians between recently harvested and mature hardwood and mixedwood stands.

PROJECT STATUS: Upland forest-clearcut edges chosen from a gradient of high to low contrast were sampled using drift-fences built perpendicular to the forest edge. Captures of snakes, amphibians and small mammals were monitored continuously from June to September, 1992-1993. The trapping technique is especially effective at capturing a large abundance and richness (15 spp.) of aquatic dispersing and upland resident amphibians. Preliminary analysis reveals a general decline in richness and abundance across the gradient from forest to clearcut habitat. Species-specific responses included generalists (e.g. American toad) and relative forest specialists (e.g. wood frog and redback salamander); however, no species was found to specialize on clearcut or nonforested habitat.

In order to better understand the effect of forest edge habitat on amphibian movements a semi-natural experimental approach was used in the 1993 and 1995 field seasons. Cultured wood frog larvae were released adjacent to abrupt forest/powerline edges and their movements monitored using an enclosed, circular drift-fence design. It appears that even recently metamorphosed wood frogs avoid non-forested habitat during dispersal when given the choice.

In the spring of 1992, paired drift-fences were placed adjacent to a logging road edge and in the forest interior serving as treatment and controls, respectively. This design allowed for tests of potential barrier effects the road might have on amphibian and small mammal movements. As a group, salamanders made significantly more movements through the forest than equivalent movements across the road (a narrow, gated forest track). However, for those animals that approached the road's edge there was no filtering of movements for any species. A wider (15 m), heavily used logging road was studied in 1993 (the Stud Mill road) and its effects on movements were compared to those of the narrower (5 m) forest track. Generally, anuran movements were unaffected by even the larger road barrier, but salamander captures in roadside traps were only 20% of those in forested controls suggesting that the larger road significantly inhibited movements by this group between bisected populations of the forest. It appears that forest roads can act as both a quantitative and qualitative filter to amphibian movements, but that their influence is unlikely to affect population dynamics.

Finally, drift-fence arrays were established in a replicated (6), block design of uncut, selectively cut and clearcut northern hardwood stands in north-central Maine to evaluate the impact of partial and complete canopy removal on local amphibian populations. Habitat data collected surrounding each of the eighteen arrays included % canopy, shrub and ground cover, litter depth and type, density of coarse woody debris and stand basal area. Traps were monitored from June to October 1994.

FUTURE PLANS: Field work for the project is completed. Data analysis is nearly finished and thesis completion is scheduled for the winter of 1995/96. A review paper on North American forestry-amphibian relationships has recently been submitted to the National Council for the Paper Industry for Air and Stream Quality Improvement (NCASI).

AN ANALYSIS OF BIODIVERSITY IN NEW ENGLAND: GIS ASSESSMENT OF TERRESTRIAL VERTEBRATE DIVERSITY IN MAINE

Investigator: R. B. Boone

Advisors: W. B. Krohn, Chairperson
M. K. Beard-Tisdale
M. L. Hunter, Jr.
G. L. Jacobson, Jr.
M. A. McCollough

R. J. O'Connor

*Cooperators/
Project
Support:* USDI National Biological Service
University of Maine
Maine Department of Inland Fisheries and Wildlife
Maine Department of Conservation
Maine Office of Geographic Information Systems
Champion International Corporation
Bowater-Great Northern Paper, Inc.
New Brunswick Fish and Wildlife Branch

Objectives:

- 1) Develop detailed range maps of non-fish vertebrate species in Maine, using literature on species-habitat relations, and expert review.
- 2) Create species richness maps for various groups of species (e.g., neotropical migrant birds), and compare them to areas managed for natural vegetation, to identify gaps in biodiversity protection.
- 3) Correlate species richness distributions with woody plant distribution, climatic variables, and geomorphology, to characterize factors determining the distribution of Maine terrestrial vertebrates.
- 4) Determine the usefulness of selected ecological factors to measure the likelihood of a species' occurrence being correctly predicted by Gap Analysis.

SCOPE: Developing and implementing recovery plans for species that are threatened or endangered is expensive, disruptive, and may be unsuccessful. Conservation plans are best implemented when species are common and with broad ranges, when more options are available for managers. Gap Analysis is a tool that identifies, on a regional scale, areas of high species richness and relates these locations to areas already managed for natural vegetation. Managers can use the results of the Maine Gap Analysis in regional land management decisions, specifically to provide adequate habitat to maintain species populations.

In additional research, I wish to determine why groups of species in Maine are distributed unevenly. I will compare species richness maps with woody plant species richness, climatic variables, and geomorphology, to prioritize the importance of variables in determining vertebrate species richness. I will relate my findings to: 1) the utility of plant diversity in predicting vertebrate diversity; 2) theoretical predictions of the relationship of amphibians, reptiles, birds, and mammals to landscape variables; and 3) potential effects of global climate change on vegetation in conservation lands.

PROJECT STATUS: Phase I of Maine Gap Analysis is almost complete (awaiting the final habitat map from the University of Massachusetts). Phase II is well underway, with the development of the habitat map using aerial videography and ancillary databases as training information. For details about habitat mapping in Phase II of Gap Analysis, see the report that follows this one.

As part of Maine Gap Analysis, and for use in other research, we have contracted the acquisition of aerial videography along 48 Breeding Bird Survey routes in Maine. During fall 1995, 26 of these routes were flown. We anticipate completing the flights in 1996. This videography will be used in an assessment of the accuracy of the predicted distributions of birds in Maine based upon Gap Analysis.

Species synopses have been developed for each of the 278 terrestrial vertebrates that breed in Maine. The amphibian and reptile synopses are finalized, mammals have been reviewed and await final editing, and birds synopses are being reviewed. Synopses have been used to assist personnel of the Maine Forest Biodiversity Project, and have been used by commercial forest industry personnel. After being finalized, the species synopses will be used in my research. To date, I plan to use the range maps to research the effect of generalizing distributions to coarser political units (e.g., counties). Ultimately, they will be reformatted to

be more concise, and published in two volumes.

We purchased from a local contractor a digital database of land ownership and an accompanying paper map. We are coordinating with the Maine State Planning Office to ensure that Maine conservation lands are accurately mapped, and made current to 1993.

Efforts to develop scores for how well species should be predicted by Gap Analysis have expanded. As part of my research, I will be developing predictable scores for the species of Maine and selected western states where Gap Analyses have been completed. Predictability as assigned using ecological variables will be compared to species lists from conservation areas to test agreement. Should correlations be high, others conducting Gap Analysis will be able to judge *a priori* which species should require more effort during modeling.

FUTURE PLANS: As part of Maine Gap Analysis, public lands will be classified as to the level of biodiversity conservation they provide. I will be finalizing the species synopses that we have developed for Maine, and will be completing a thesis. We may meet with other Gap personnel this winter to further the research on predictability scores for vertebrates. After additional base information (e.g., climatic information, geomorphology) is acquired, I will complete research analyzing the distribution of species in Maine.

DEVELOPMENT AND TESTING A VEGETATION COVER MAP FOR MAINE

Investigator: Zhangshi Yin

Advisors: S. A. Sader
W. B. Krohn

*Cooperators/
Project
Support:* USDI National Biological Service
Maine Cooperative Fish and Wildlife Research Unit
University of Maine -
Department of Forest Management
Department of Wildlife Ecology
Maine Image Analysis Laboratory

Objectives:

- 1) Use aerial videography as ground truth in classification and testing.
- 2) Classify satellite images and create a vegetation cover map of Maine at a 100,000 scale.
- 3) Evaluate the map accuracy and make it at least 80% accuracy for major cover type.
- 4) Prepare final report and publications.

SCOPE: Since biodiversity is decreasing and many wildlife species and their habitats are becoming threatened, we need more comprehensive information for conservation efforts. A major data needed is a reliable statewide vegetation cover map to provide a base for predicting distribution of wildlife species. Ground investigation is time consuming, expensive and inefficient in a large area. Satellite images have advantages for investigations covering a large area. This research uses aerial videography and satellite images to classify vegetation covers and make a vegetation map for Maine.

PROJECT STATUS: The dates and format of satellite images have been selected. Satellite images, specifically Landsat TM, from summer 1991 and fall 1993 will be used. We already have all nine scenes of 1991 data. Six scenes of 1993 data have been obtained and processed, the other three have been ordered. The aerial videography with the video frames positioned geographically using by Global Positioning System

be used to identify satellite image signature. The videography transects 7,100 km statewide in summer 1994 and fall 1994 were obtained. Maine was divided into 8 portions and 6 to 8 examples of each habitat within each portion were checked. Habitats on videography were printed out and 120 sites were visited to check the relationship between videography and ground truth. A catalog of videography has been developed to use as reference in classifying satellite data and in testing the resulting map.

FUTURE PLANS: By December 1995, all images will be converted to the same format, coordinates and grid size. A Maine boundary with 10 km beyond state line will be created and used to mask satellite images. Different images are calibrated to the same reflectance by overlap areas between scenes. Therefore, all images are mosaiced to make Maine satellite image composite. By August 1996, cloud areas will be masked out. Each date satellite images with six bands except thermal band will be compressed to three bands by principal component analysis. The three bands from each date images will be registered to a file. Various ecoregions will be delineated and classified individually. Supervised, unsupervised and guided clustering algorithm will be used. The classification result is used to produce the Maine vegetation cover map. The vegetation map accuracy will be evaluated using samples from the aerial videography.

AN ANALYSIS OF BIODIVERSITY ALONG THE MAINE COAST: INSULAR HABITATS AND VERTEBRATE DIVERSITY

Investigator: C. M. Johnson

Advisors: W. B. Krohn, Chairperson
R. L. Dressler
J. R. Gilbert
W. E. Glanz
A. E. Hutchinson
J. R. Moring

*Cooperators/
Project
Support* USDI National Biological Service
U.S. Fish & Wildlife Service
University of Maine -
Department of Wildlife Ecology
Maine Department of Inland Fisheries and Wildlife
Maine Office of Geographic Information Systems
Maine Geologic Survey

Objectives:

- 1) Create species richness maps for vertebrates breeding and wintering along the Maine coast, and compare their location to conservation lands to identify gaps in biodiversity protection.
- 2) Develop a database detailing historical surveys of Maine's seabird nesting islands, and measure current use of selected islands by 3 species of breeding seabirds.
- 3) Compare current use and nest density data for selected seabird islands with historical patterns of island use to assess the temporal stability.
- 4) Evaluate habitat and social factors affecting the distribution of breeding seabirds in Maine.

SCOPE: A Gap Analysis is currently underway for the State of Maine, identifying areas of high vertebrate species richness during the breeding season. However, the vast majority of the islands along the Maine coast fall well below the minimum mapping unit size used for this statewide analysis. Further, the

traditional approach to Gap Analysis focuses on terrestrial ecosystems, with vegetation mapping providing the foundation for predicting distributions of most species. For this coastal analysis, base mapping will include aquatic variables as well as terrestrial vegetation mapping. This spatial database will be used in combination with other biotic and abiotic variables (e.g., island size and human disturbance levels), to formulate coastal species-habitat models. These models will be used to predict seasonal (breeding and wintering) distributions of vertebrate species along the Maine coast.

Beyond determining patterns of species richness, I will be examining the temporal stability of habitat use in this dynamic environment. On a relatively short term time scale, I will assess seasonal variability in species richness patterns by comparing results for the breeding and wintering seasons. Long term temporal patterns of habitat use will be assessed for selected seabird species, using survey data collected over the past 80 years. Spatial patterns of seabird island use also will be examined in relation to a variety of physical and biological habitat factors.

PROJECT STATUS: Data collection for the coastal Gap Analysis portion of this study is essentially complete, with the exception of a portion of the bathymetry for the Maine coast (Penobscot Bay). Also, I am working on updating the conservation lands database (based on the Maine State Planning Office's 1993 map). A pilot study for development of the vegetation/substrate map is being developed by an independent contractor, using extensive aerial videography taken in 1994 in conjunction with LANDSAT imagery. The results of this pilot study should be available by the end of the year; following this, a procedure for the coastwide vegetation map will be determined.

I have completed the historical seabird database for selected species, based on a literature review of historical survey information from approximately 1910 to the 1970's to the present time. I am just beginning the analysis of long-term temporal patterns of habitat use based on this historical data.

Islands in Penobscot Bay known to support breeding populations of cormorants, black-backed gulls or herring gulls were surveyed in early summer 1994. As a result of this pilot study, these islands were again surveyed at one week intervals from late May to early July 1995. I took photos of approximately 110 islands at an altitude of 500 feet with a 35mm camera (70-210mm zoom lens) and slide film. Nest counts are currently underway using the slides. These islands will be surveyed again in 1996; the same methodology will be used, with the addition of two flights earlier in May to better determine the species' peak nesting dates for each island.

FUTURE PLANS: My priority for the next few months is completion of the species synopses for birds wintering in Maine, and development of breeding season habitat models for seabirds. Island surveys and nest counts for the species noted above will be conducted in the spring and early summer of 1996. Once the coastwide vegetation map is developed, species richness maps will be completed for the Maine coast.

HABITAT SELECTION BY WINTERING WATERFOWL IN COASTAL FRESHWATER WETLANDS OF MOROCCO; THE CASE OF MEHDIYA WETLAND

Investigator: M. El Hamzaoui

Advisors: J. A. Sherburne, Chairperson
W. B. Glanz
D. J. Harrison
F. L. Newby
D. G. McAuley

*Cooperators/
Project* USAID/USDA

Support:

- Objectives:*
- 1) Examine the distribution and abundance of wintering avifauna in Lake Mehdiya, Morocco, and associated marshlands.
 - 2) Determine temporal and seasonal (fall and winter) differences in habitat use by wintering waterfowl.
 - 3) Determine the relation between habitat variables (e.g., vegetation cover and density, water depth) and waterfowl use of the site.
 - 4) Assess the impacts of grazing and recreation activities on wintering waterfowl populations.
 - 5) Develop a comprehensive conservation plan for freshwater wetlands of Morocco.

SCOPE: Coastal freshwater wetlands of Morocco are important in contributing to biodiversity. They are, however, extremely vulnerable natural habitats. The few remaining freshwater wetlands are used extensively by the human populations surrounding them, as well as by the migratory waterfowl which use these sites as wintering areas.

Virtually nothing is known about the use of freshwater wetlands by wintering waterfowl as well as the extent of various human activities. The proposed study will determine seasonal habitat use of freshwater wetlands by wintering waterfowl. Physical, chemical, and biological variables of selected habitats will be identified. The impact of diverse human activities on wetland resources and functions will be evaluated. The above information is important to developing an overall comprehensive conservation strategy that would ensure sustainable and multiple use of freshwater wetlands resources of Morocco.

PROJECT STATUS: Field research is currently being conducted in Morocco.

TOXICOLOGICAL AND ECOLOGICAL EFFECTS OF MOSQUITO CONTROL METHODS AT BOMBAY HOOK NATIONAL WILDLIFE REFUGE, DELAWARE

Investigators: D. M. Eignor
T. A. Haines

Advisors: T. A. Haines, Chairperson (for Eignor)
R. J. Van Beneden
J. H. Dearborn
J. R. Moring

*Cooperators/
Project
Support* U.S. Fish and Wildlife Service
USDI National Biological Service -
Patuxent Environmental Science Center
Leetown Science Center

Objective: Determine the effects of pesticides used for mosquito control on non-target organisms in salt marsh habitat at Bombay Hook National Wildlife Refuge.

SCOPE: For many years, Bombay Hook National Wildlife Refuge has been sprayed with a variety of pesticides to reduce mosquito breeding. Aerial spraying is initiated on short notice, based on field counts in breeding areas. The primary larvicide is the organophosphate temephos (Abate). The bacterial toxin, *Bacillus thuringiensis*, and the growth hormone methoprene (Altoside), have been used to a much lesser extent. The primary adulticides are the organophosphate naled (Dibrom), and Scourge (the synthetic

pyrethroid resmethrin plus piperonyl butoxide). With the exception of several caged fish and shrimp trials performed about 20 miles south of Bombay Hook, no recent field tests have been conducted to examine possible non-target impacts of mosquito control spraying at the Refuge.

PROJECT STATUS: Field samples of sediment and invertebrates were collected from reference and sprayed plots at Bombay Hook NWR. An analytical method for determination of the pesticide (Temephos) and its breakdown products was developed in conjunction with chemists at Patuxent Environmental Science Center. Samples are being processed for invertebrate content and pesticide concentration. A laboratory toxicity testing system is being constructed to determine the sublethal effects of the pesticide on selected marsh organisms.

FUTURE PLANS: Sublethal effects of Temephos on selected invertebrate and fish species will be determined. There were very few invertebrates in the sediment samples to enable any conclusions as to pesticide effects. A thesis is anticipated in June 1997.

FACTORS AFFECTING FOOD CHAIN TRANSFER OF MERCURY IN THE VICINITY OF THE NYANZA SITE, SUDBURY RIVER, MASSACHUSETTS

Investigators: T. A. Haines
R. W. Perry
M. W. Powell
R. T. Finlayson

Advisors: T. A. Haines Chairperson (for Powell)
L. E. Katz
J. R. Moring
S. A. Norton

**Cooperators/
Project Support:** U.S. Fish and Wildlife Service, Region 5
U.S. Environmental Protection Agency, Region 1
USDI National Biological Service -
Leetown Science Center

Objectives: Determine total and methyl mercury concentrations in water, sediment, invertebrates, and fish in reference and contaminated sites in the Sudbury River in order to determine the importance of sediment reservoirs of mercury in the continuing contamination of fish and wildlife resources in the river.

SCOPE: The Nyanza site on the Sudbury River was used by several companies involved in the manufacturing of textile dyes and dye intermediates during the period from 1917 to 1978. As a result, large quantities of chemical wastes were disposed of on-site, or discharged into surface waters draining into the Sudbury River. The contaminants of concern include mercury plus other metals. Previous studies have documented extensive mercury contamination of sediments and biota in the Sudbury River downstream of the site, but sufficient information is not available to make a risk-based cleanup decision for the contaminated river reaches. This study addressed some of the data needs required for the cleanup decisions.

PROJECT STATUS: All field samples have been collected. Analytical methods for determination of methyl mercury in prey organisms have been developed and analyses are now in progress. A computer model of mercury biogeochemistry in the Sudbury River has been developed and is now being tested. Graduate student R. Todd Finlayson has joined the project to work on mercury speciation in invertebrates and forage

fish.

FUTURE PLANS: Computer model development will be completed in 1995. Analyses of methyl mercury in prey organisms will be completed in 1996. A thesis is expected in December 1995, and another in December 1996.

WILDLIFE COMMUNITIES OF VERNAL POOLS IN SOUTHERN MAINE

Investigator: A. M. Perillo

Advisors: M. L. Hunter, Jr.
M. A. McCollough
K. E. Gibbs
S. C. Gawler

**Cooperators/
Project
Support:** Maine Department of Inland Fisheries and Wildlife
University of Maine -
Department of Wildlife Ecology
U.S. Fish and Wildlife Service
U.S. Forest Service
U.S. Environmental Protection Agency

Objectives:

- 1) Describe the biotic community of vernal pools in southern Maine, including reptile, amphibian, macroinvertebrate, and plant species;
- 2) Characterize the physical, chemical, and biological parameters that contribute to the value of these pools for wildlife; and
- 3) Develop guidelines for predicting wildlife values of vernal pools in southern Maine.

SCOPE: Wetlands are well-recognized as highly productive communities, and in Maine are used by a disproportionate number of state-listed rare, threatened and endangered species. Currently, Maine laws generally protect only wetlands greater than 10 acres. Small wetlands in southern Maine are in immediate peril, due primarily to residential development causing habitat degradation and loss. Recent studies have demonstrated that several populations of the state-threatened spotted and Blanding's turtles are centered in wetland complexes in southern Maine dominated by vernal pools. Vernal pools are also extremely important breeding habitat for many amphibian species, serving as centers for mating, egg deposit, embryonic development, larval development, and metamorphosis. Many amphibian species return to their natal pools to breed. Therefore, local populations of state-threatened turtles and many amphibian species could be severely limited or extirpated by loss of vernal pools. The information collected in this study will provide a basis for consideration of additional protection initiatives for small wetlands in Maine.

PROJECT STATUS: Forty-five vernal pools were selected for study in York County, Maine. Field work was completed during April-September 1994 and 1995. Data collection included counting amphibian egg masses, trapping larval amphibians and aquatic invertebrates, surveying to determine the presence and abundance of reptiles, amphibians and other vertebrate species using the pools, and conducting aural surveys of breeding frogs and toads using the pools. Other data collected included water temperature, depth, pH, and conductivity, pool shrinkage and hydroperiod, pool flora, vegetation type, structure and percent cover for all vegetation growing within or overhanging pools, and average tree height and forest type of area surrounding pools.

FUTURE PLANS: Currently, invertebrate samples are being sorted for identification to family or general levels. After completion of invertebrate identification, all data will be analyzed and final thesis prepared.

BARK INVERTEBRATES OF WHITE PINE AND RED OAK SNAGS IN A SOUTHERN MAINE FOREST

Investigator: D. L. Nelson

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

Project Support: Holt Woodlands Research Foundation
University of Maine -
Department of Wildlife Ecology

Objectives:

- 1) Document the invertebrates on and within the bark of standing dead pines and oaks in a southern Maine forest;
- 2) Relate variability in abundance and species composition of these invertebrates to characteristics of the snags and their local environment;
- 3) Model the dynamics of snag production and decay

SCOPE: Dead wood is an important component of many forest ecosystems. Trees in various stages of decay contribute structural diversity to forests, serve as long-term nutrient sources and sinks, reduce erosion, contribute to soil development and enrichment, influence seedling establishment, provide habitat for mammals, birds, amphibians, reptiles, invertebrates, plants, and fungi, and retain moisture through times of drought. Current forest management practices often discriminate against dead trees, which are reduced through thinnings and short rotations, eliminated as both fire and safety hazards, and destroyed to prevent the spread of timber pests and diseases. These practices may alter the size, species composition, and recruitment rate of dead trees, affect patterns of decay and nutrient cycling, and cause ecosystem simplification. The importance of dead trees to forest ecosystems, and the impacts of forestry upon them, are relatively recent discoveries. Investigation of the many roles and functions of dead wood is still largely incomplete. This study is designed to address issues of invertebrate and dead tree conservation. I wish to quantitatively explore the links between snag condition and the community attributes of bark invertebrates. I also wish to explore the dynamics of snag production and decay. This knowledge could be important for issues involving management of forest resources.

PROJECT STATUS: The first field season took place during May-August 1995, and concentrated on testing various methodologies. Over the course of the summer, approximately 800 organisms, representing at least fourteen orders of invertebrates, were collected from a combined total bark surface area of 1 m². Techniques to be adopted in future field seasons are as follows. Information regarding the condition of sample snags and their surroundings will be recorded, and surface-dwelling invertebrates will be collected from bark into alcohol with a small paintbrush. Bark samples will be taken with an 11 cm hole saw attached to a battery-powered drill, and invertebrates will be extracted into alcohol with small Berleze funnels. All invertebrates will be sorted to at least the family level using a 30-power dissecting microscope.

FUTURE PLANS: Prior to the next field season, my methodology will be practiced and perfected. Pine and oak snags will be chosen for sampling, based on data obtained from complete timber inventories conducted

in 1984 and 1988.

RELATIONSHIPS BETWEEN MARTEN PREY DENSITIES AND MICROHABITAT CHARACTERISTICS IN NORTHERN MAINE

Investigator: H. J. Lachowski

Advisors: D. J. Harrison, Chair
F. A. Servello
W. E. Glanz

*Cooperators/
Project
Support:* University of Maine -
Department of Wildlife Ecology
McIntire-Stennis

Objectives:

- 1) Document seasonal food habits of marten on our study site in northern Maine.
- 2) Estimate small mammal densities in different forest types classified based on overstory type, tree height, canopy closure, and stocking density (mature mixed wood, mature hardwood, mature softwood, regenerating forest, and stands with severe spruce-budworm damage), and test for differences in densities of preferred prey species across types.
- 3) Evaluate which microhabitat characteristics are the best predictors of small mammal densities across those habitats.

SCOPE: Recent research on habitat selection by American marten (*Martes americana*) in Maine indicates disproportionately high use of stands affected by spruce-budworm. This may result from large volumes of coarse woody debris, an important habitat feature for marten, in these stands. Small mammal populations have been shown to be positively correlated with coarse woody debris. Thus, the reason that marten select microhabitats with large volumes of coarse woody debris might be related to prey abundance and availability.

We will investigate the relationship between microhabitat characteristics and densities of prey species that comprise the majority of the marten diet. Marten scats collected over the past 6 years will be analyzed for percent occurrence of prey items. Small mammals will be live-trapped in 5 habitat types (mature mixedwood, mature hardwood, mature softwood, regenerating forest, and stands with severe spruce-budworm damage). Microhabitat characteristics will be measured on the trapping grids and then analyzed to determine if small mammals demonstrate habitat selection at the stand level (based on overstory type) or the microhabitat level.

PROJECT STATUS: In 7,808 trap nights, we totaled 1,852 captures of 867 individuals [56% red-backed voles (*Clethrionomys gapperi*), 28% deer mice (*Peromyscus maniculatus*), 12% shrews (*Sorex cinereus*, *Blarina brevicauda*)]. Microhabitat characteristics were sampled at 320 locations across the 5 habitat types. Transects (n = 240) for snowshoe hare pellet counts were established and cleared of all pellets at the beginning of the leaf-off season. Preliminary data analysis has begun.

FUTURE PLANS: Small mammal trapping protocol will be repeated next summer. Snowshoe pellets will be counted at the end of the leaf-off season. Final data analysis will be conducted after summer 1996, with an anticipated completion of the final thesis by December 1996.

REDBACK SALAMANDER (*PLETHODON CINEREUS*) HABITAT PREFERENCES IN A MAINE OAK-PINE FOREST

Investigator: L. M. Monti

Advisors: M. L. Hunter, Jr.
I. J. Fernandez
R. J. O'Connor

*Cooperators/
Project Support:* Holt Woodlands Research Foundation
University of Maine -
Department of Wildlife Ecology

- Objectives:*
- 1) Evaluate the use of artificial refugia as a valuable method for the assessment of redback salamander populations.
 - 2) Estimate the density of the redback salamander population in an eastern oak-pine forest.
 - 3) Assess how microhabitat variables affect the distribution and abundance of the redback salamander in an oak-pine forest, with special emphasis placed on coarse woody debris.

SCOPE: The redback salamander (*Plethodon cinereus*) is a very common species of terrestrial amphibian. Monitoring its population density and establishing its habitat preferences are important for at least two reasons. First, this species may play a key role in ecosystem function, in part through its sheer abundance. Second, the sensitivity of amphibians to their environments might render them useful indicators of overall ecosystem health. In order to monitor the population density of redback salamanders, accurate censusing methods must be available. Current methods are not well suited to this species or to repetitive measurements. A relatively new technique, involving coverboards placed on the forest floor and monitored at regular intervals, has been utilized for the past seven years at the Holt Forest. However, its efficacy has not yet been closely examined, nor have the data been used to establish habitat preferences of this species. This study will attempt to evaluate the coverboard method and use data obtained with this technique to estimate the redback salamander population at the Holt Forest, determine the habitat preferences of that species, and answer specific questions about certain habitat components.

PROJECT STATUS: The first field season involved the establishment of 60 new "salamander stations" modelled after the 60 already in use at the Holt Forest. All 120 were monitored throughout the summer. In order to determine which portion of the salamander population was using the stations, individuals found at the 60 new sites were toe-clipped to allow for recognition of individuals. To determine habitat preferences, the vegetation and the soil at each of the 60 older stations were characterized. This data set and the data resulting from six years of salamander counts at these stations were used to look for correlations between salamanders abundance and habitat variables. In another area of the forest, an examination of the preferences of redbacks in terms of the size, species, and level of decay of logs used as refugia was undertaken.

FUTURE PLANS: In light of some of the initial results from the summer field season, laboratory studies to examine the effects of low pH on redback salamanders from the Holt Forest will be performed. More intensive studies of the behavior of salamanders when presented with artificial refugia are also necessary and will be carried out in the upcoming field season.

WILDLIFE RESOURCES - MIGRATORY BIRDS:

ECOLOGY OF THE DOUBLE-CRESTED CORMORANT IN THE LOWER PENOBSCOT RIVER: EMPHASIS ON SMOLT PREDATION

Investigator: B. F. Blackwell

Advisors: W. B. Krohn, Chairperson
J. R. Gilbert
J. R. Moring
W. E. Glanz
F. A. Servello

*Cooperators/
Project
Support:* U.S. Fish and Wildlife Service - WO, Federal Aid
USDI National Biological Service
Maine Department of Inland Fisheries and Wildlife
Maine Atlantic Salmon Authority

Objectives:

- 1) Monitor cormorants at roosting and foraging areas, determine time of roost departure and return, and locate foraging locations relative to smolt migration.
- 2) Quantify seasonal variation in cormorant food habits during spring and summer.
- 3) Estimate the number of cormorant days of predation during the spring migration of Atlantic salmon smolts through the Penobscot River.
- 4) Estimate the number of Atlantic salmon smolts eaten by cormorants in the Penobscot River ecosystem.

SCOPE: Populations of double-crested cormorants (*Phalacrocorax auritus*) increased in size and distribution during the past 30 years across the United States and southern Canada, most likely responding to protection afforded by amendments to the Migratory Bird Treaty Act and reduction in DDT contamination. With this increase has come the perception of cormorants competing with humans for fish. Potential loss of commercial and sport fisheries to cormorants is a growing concern in Maine, particularly given the multi-million dollar efforts by federal, state, and private organizations to restore the Atlantic salmon (*Salmo salar*).

Measures to control double-crested cormorants have been implemented in Maine. However, control programs can prove to be counterproductive by increasing the proportion of young birds attaining breeding status, and possible shifting of breeders to other areas. Further, control programs implemented without accurate prediction or quantification of the effects of predation on individual prey species cannot be justified.

The most accurate means of estimating the biomass of prey removed from a system by cormorants is direct sampling of food habits via collection of stomach samples. By comparison of food habits data relative to time and feeding location with estimates of cormorant days of predation, quantities of prey species consumed can be estimated.

PROJECT STATUS: All data have been tabulated and analyzed, and the dissertation has been drafted.

FUTURE PLANS: Anticipated review of the dissertation by the graduate committee will occur this fall. The dissertation will be defended in December.

**MACROINVERTEBRATES IN BROOD-REARING WETLANDS OF WATERFOWL
(ANATIDS) IN FORESTED AND AGRICULTURAL
LANDSCAPES IN NORTHERN MAINE**

Investigator: L. J. Boobar

Advisors: K. E. Gibbs (Advisor)
J. R. Longcore (Field Advisor)
R. B. Davis
W. A. Halteman
R. B. Owen, Jr.

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

Objectives:

- 1) Determine if macroinvertebrate diversity is different among waterfowl brood-rearing wetlands in two landscapes (forested and agricultural) in northern Maine.
- 2) Relate invertebrate diversity and productivity to wetland water chemistry, periphyton production, vegetation structure, and wetland morphology.
- 3) Evaluate the suitability of incorporating these data in a Geographic Information System.

SCOPE: During the field seasons of 1993-1996 selected wetlands in each landscape will be sampled for macroinvertebrates using several techniques (cylinder sampler, activity traps, sweep nets). Data on invertebrates will be related to wetland features, including water chemistry and chlorophyll-a. Hypotheses of differences in variables between forested and agricultural landscapes will be tested.

PROJECT STATUS: (Activities for the period October 1, 1994 to September 30, 1995.) In this third and final field season of sampling 119 samples (70 samples on June 22 and 49 on July 11) were obtained with activity traps from five waterfowl brood-rearing wetlands. From 20 to 23 June 68 samples (14 cylinder and 44 sweep net) were collected. These 187 samples are part of the 1,472 samples collected during the three years of sampling. All 1,472 samples have been sorted and invertebrates and vertebrates identified to their lowest practical taxonomic level. Water samples were collected in July from ponds sampled and have been analyzed by Sawyer Analytical Laboratory. Further collaboration with Dr. Paul Spangler, Smithsonian Institution for species identification of aquatic beetles (Coleoptera: Dytiscidae) has led to nine new records for the State of Maine. The 1993 and 1994 data have been entered in D-Base and data verification is nearly complete. Spatial data covering the study area have been collected from state and federal agencies. The brood-rearing ponds sampled for invertebrates have been digitized. A program for viewing and exploring these spatial data has been written in Arc Macro Language (AML). The Ph.D. graduate student successfully completed his written and oral comprehensive examinations during this period.

FUTURE PLANS: The graduate student will conduct exploratory data analysis using standard ecological and spatial techniques. Promising relationships will be tested statistically. The graduate student will write and defend his dissertation, and graduate. Appropriate sections of the dissertation will be submitted to peer review journals for publication. The scheduled completion date for the Research Work Order supporting this work is December 1996.

NATIONAL PATTERNS OF BIRD ABUNDANCE AND DIVERSITY

Investigators: R. J. O'Connor
M. T. Jones

*Cooperators/
Project* U.S. Environment Protection Agency -
Environmental Laboratory, Corvallis, OR

Support: U.S. Forest Service -
Forestry Sciences Laboratory, Corvallis, OR
Pacific Northwest Region, Portland, OR
Oak Ridge National Laboratory, Oak Ridge, TN -
Environmental Sciences Division

Objectives:

- 1) Develop a database of avian species distribution compatible with the EMAP hexagon grid from 1990 Breeding Bird Survey data and develop maps of avian species richness.
- 2) Evaluate the effects of scale on the correlations between bird and AVHRR land classification distributions.

SCOPE: Patterns of species richness are poorly understood. This study will evaluate the correlations of avian distribution and richness with land cover characteristics derived from 1 kilometer resolution Advanced Very High Resolution Radiometer (AVHRR) satellite imagery. AVHRR data, when combined with existing species distribution data (e.g., Breeding Bird Survey), may prove to be a cost-effective method of evaluating changes in species richness over time. Additionally, by varying the number of land cover classes we will study the effects of scale on the correlations between species distributions and land cover classes.

PROJECT STATUS: Breeding Birds Survey (BBS) data were used to obtain the species richness data for each location with a route. In addition, the incidence of each species at each route (the proportion of surveys between 1981 and 1990 on which the species of interest was detected at the route) was calculated for each species. The diversity data and the individual species incidence data were each related to satellite imagery data using Classification and Regression Tree (CART) techniques. The satellite data was complemented with climate data from the Hierarchical Climate Network (HCN) and with some other data (road densities, waterways densities, land ownership). These analyses provided a series of wildlife-habitat relationships at the 1 km resolution of the AVHRR imagery. The analyses were conducted at multiple scales of habitat aggregation and image filtering. Comparison of the results suggested that there was little gain in using aggregation and/or filtering, and further analysis was conducted on the basis of the unaggregated and unfiltered landcover characteristics classification. These data were used to develop a prototype risk assessment map for the coterminous United States.

FUTURE PLANS: This project is being completed under its present auspices and manuscripts are being prepared for publication. Additional work to incorporate information on stressor data as modifiers of avian distribution will be pursued under alternate funding.

SITE FIDELITY OF SONGBIRDS IN SELECTIVELY HARVESTED AND UNHARVESTED MIXED WOODS

Investigator: M. J. Hartley

Advisors: M. L. Hunter

R. J. O'Connor
 A. S. White
 W. B. Halteman
 W. A. Glanz

*Cooperators/
 Project Support:* University of Maine -
 Forest Ecosystem Research Program
 Department of Wildlife Ecology
 Maine Department of Inland Fisheries and Wildlife
 U.S. Forest Service

Objectives:

- 1) Describe changes in breeding bird communities on sites that are experimentally harvested or left unharvested.
- 2) Estimate site fidelity (i.e., annual return rates) of breeding migratory songbirds on experimental sites, and determine if timber harvesting affects site fidelity.
- 3) Compare productivity indices of breeding songbirds among harvested and unharvested sites.

SCOPE: Forests are dynamic ecosystems that may only be fully understood through long-term research projects that focus on many different aspects of structure, function, and biotic communities within and between stands. The Forest Ecosystem Research Program (FERP) was recently formed to address such long-term research issues. The FERP has established nine long-term research sites at the Penobscot Experimental Forest (PEF). These 10 ha stands are grouped into three groups of three plots--"triplets"--that will be randomly treated with light selection cutting (1% annual harvest, with many retention trees), moderate selection cutting (2% annual harvest, with some retention trees), or no cutting (i.e. control). These three replicates are all within one 1400 ha mixed-wood forest that is set aside for long-term ecosystem research. My role in the FERP is to study how harvest treatments affect one aspect of forest biodiversity: the bird community. If forest harvests cause migratory songbirds to be displaced from their territories of previous years, this would result in negative impacts on their productivity after harvests.

PROJECT STATUS: My first field season took place during the summer of 1995. No FERP areas had been harvested yet, so this season will serve as a pre-treatment benchmark for comparisons to future years. Territorial birds were spot-mapped on the nine research areas. Approximately 300 migratory songbirds were individually color-marked on seven of the nine FERP research areas. Techniques for capturing territorial males were refined. Also, behavioral observations of productivity were collected, and all nests found were monitored throughout the summer.

FUTURE PLANS: Next summer (1996) I will continue to spot-map and intensively color-band birds on all nine research areas. I will attempt to mark all breeding songbirds of several focal species, on all nine areas. This summer will produce the first return rates for birds in a "harvested" triplet. Also, to study displacement after habitat destruction, I will color-mark birds in a 10 ha area that will be clearcut after the breeding season. During the following summer (1997), I will study territory locations of birds displaced from the clearcut, to investigate the often theorized occurrence of birds "flooding" areas around a cut.

DEVELOPMENT AND APPLICATION OF OBSERVATION-BASED TECHNIQUES FOR ASSESSING FOREST SONGBIRD NESTING SUCCESS

Investigator: C. R. Foss

Advisors: M. L. Hunter, Jr., Chairperson
 W. A. Halteman
 W. B. Krohn
 R. J. O'Connor
 R. S. Seymour

Cooperators/ University of Maine
Project Switzer Environmental Fellowship Program
Support: McIntire-Stennis
 U.S. Fish & Wildlife Service -
 Neotropical Migratory Bird Program
 Lake Umbagog National Wildlife Refuge
 USDA Forest Service
 N.H. Fish & Game Department
 N.H. Department of Resources and Economic Development -
 Division of Forests and Lands
 Wagner Forest Management, Ltd.
 Boise Cascade
 James River Corporation
 Maine Bureau of Public Lands
 Seven Islands Land Company
 Audubon Society of New Hampshire

Objectives:

- 1) Assess the effectiveness of reproductive index ranking of territories and fledgling surveys as indices of nesting success in forests.
- 2) Identify any behavioral biases that may skew reproductive index ranks for particular species.
- 3) Determine the relative effectiveness of sampling points and transects in fledgling surveys.
- 4) Determine effective sampling radii for fledglings.
- 5) Determine appropriate seasonal and diurnal periods for fledgling surveys.
- 6) Assess effects of partial cutting in spruce-fir forests on species composition, abundance, and nesting success of breeding bird communities using behavior mapping and reproductive index ranking.

SCOPE: Recent concerns about the relationships among forest fragmentation, harvesting practices, and biological diversity have increased the need for data on avian distribution, abundance, and productivity in forested landscapes. Recent population declines of some songbird species, notably some neotropical migrants, have underscored the need to understand patterns of reproductive success for forest songbirds. Selection management has been championed by some conservation groups as an alternative to clearcutting, providing for both timber and wildlife habitat needs while minimizing ecosystem disturbance. Research has yet to address many important questions about impacts of selection harvests on native wildlife.

This study explores the potential for observation-based survey techniques to provide relatively cost-effective indices to avian nesting success in forested habitats, and uses a combination of established and newly developed field survey techniques to study relationships between cutting intensity in spruce-fir stands and species composition, abundance, and nesting success of forest birds.

STATUS: Pilot field work was conducted during May-August 1994, involving surveys on 12 20-ha plots, 4 each in managed hardwoods, spruce-fir forest, and regenerating clearcuts in northern New Hampshire. Surveys included a modified spot-mapping method, which focused on observations of breeding behaviors, and point and transect surveys, which focused on detection and identification of fledged young. Results

indicated that transect surveys were more effective than point surveys in detecting fledglings, and that morning surveys were more productive than those conducted in late afternoon. The combination of survey techniques in the pilot year documented 60 bird species which appeared to be maintaining territories on the 12 study areas, and 403 encounters with fledglings or family groups of 50 species.

The 1995 field season initiated the study of effects of partial cutting in spruce-fir forest. Field work conducted during May-August 1995 involved behavior mapping of all birds encountered on 11 20-ha plots in managed spruce-fir forest. Treatments on the 11 plots ranged from no cutting in the past 60 years through commercial thinning to progressively heavier partial cuts, conducted during the past 3-5 years. Behavior mapping yielded 11352 observations of 76 species among the 11 sites, including 1051 observations of fledgling or family groups representing 35 species.

FUTURE PLANS: Preliminary data analysis and preparation for further field work will take place during the fall and winter months. Surveys will be continued on the spruce-fir sites for at least one more field season. Collection of habitat data is scheduled for late summer and fall of 1996.

EFFECTS OF LANDSCAPE PATTERN ON BIRD COMMUNITIES IN AGROECOSYSTEMS, AT MULTIPLE SPATIAL SCALES AND LEVELS OF HABITAT RESOLUTION

Investigator: J. G. Poulsen

Advisors: R. J. O'Connor, Chairperson
M. L. Hunter
J. R. Gilbert
F. A. Drummond
K. J. Boyle
W. A. Halteman

*Cooperators/
Project
Support:* USDA Agricultural Research Service

Objectives:

- 1) Test an extant model predicting bird species richness of windbreaks.
- 2) Examine the effect of habitat class aggregation in predictions of bird community components.
- 3) Determine the spatial scale at which variance in bird community compositions is best explained.

SCOPE: The primary goal of this project is to examine the extent to which spatial scale and habitat resolution determine the predictive power of environmental correlates of species richness of breeding bird communities.

The decline of many wild flora and fauna species has been severe in agroecosystems around the world. In Europe and North America, changes in abundance of species and communities of the fauna and flora during the past two or three decades have been associated with the intensification of farming practices, and similar patterns have been suggested for Asia and Australia. Since about 50% of the earth's terrestrial ecosystems is managed for agriculture, including open range and highly managed pastures, biodiversity also needs to be maintained and enhanced in agroecosystems.

Bird distribution patterns are affected directly by the methods of management of non-crop areas (e.g., hedgerows and adjacent natural habitat), and at a larger scale by the agricultural landscape structure. Landscape structure and management of non-crop areas are in turn affected by agricultural practices. Only a

few studies have, however, looked at landscape level patterns of agricultural practices, and distribution of crop versus non-crop land on bird species communities.

Nebraska has been chosen to be a case study to test a Bird Species Richness Index (BSRI) model in the Great Plains. The model predicts wildlife species richness in shelterbelts on the basis of specific habitat variables: foliage height diversity, number of snags/ha, average height of the tallest shelterbelt row, and shelterbelt size.

The relative degree of spatial dependence of bird communities will be evaluated using data from the National Biological Service's Breeding Bird Survey. The BBS records provide data on the occurrence of avian species based on randomly located roadside routes across the Great Plains. This will be used to determine the relative degree of spatial dependence of bird communities, to determine how variable the bird communities are over time, and to compare these large scale results with the small scale results found during the field study.

A separate study was also conducted, designed experimentally to examine area-sensitivity of birds (particularly grassland species) in several areas of Nebraska.

PROJECT STATUS: The field study was completed in 1995. The distribution of breeding birds in each of 28 study areas in Nebraska was surveyed and the habitat variables mentioned above were collected. Additional landscape variables to provide regional context for the farms were also collected.

FUTURE PLANS: Target date for project completion is December 1996.

THE EFFECTS OF AGRICULTURE ON WILDLIFE: A STUDY OF NON-USE VALUES

Investigators: K. Boyle
R. J. O'Connor
R. Bishop
M. Welsh

**Cooperators/
Project
Support:** USDA Economic Research Service

Objectives: The primary objective is to estimate the values of selected wildlife closely associated with agriculture. Emphasis will be on non-use, rather than use, values, with the Farm Conservation Receive Program receiving special attention because of its immediate policy implications.

A secondary objective is to eliminate biases in the valuation process.

SCOPE: The Farm Conservation Reserve Program (CRP) is a long-term (ten years, and probably to be renewed) Federal program to retire highly erodible farmland from cultivation. The program costs are known, as are some of the consequences, largely beneficial, for wildlife. This project seeks to develop methods of assigning valuation to these wildlife benefits, so as to properly value the full costs and benefits to society of this program.

Initial analysis of the Birds and Agriculture database in the Department will be used to document the areas of and trends in bird species changes with respect to the CRP. This information will be used to design a set of survey questions describing scenarios of CRP change and their wildlife consequences and asking respondents to describe how they value these changes. Following testing in a series of focal groups, the survey will be administered to natural and regional demographically-controlled samples totalling ca. 3,000

people.

PROJECT STATUS: Project completion is scheduled for December 1997.

THREATS TO BIODIVERSITY

Investigator: J. G. Bartlett

Advisors: R. J. O'Connor, Chairman
Others to be determined

*Cooperators/
Project
Support:* U.S. Environmental Protection Agency

Objectives:

- 1) To compile selected databases of information about anthropogenic stressors of biodiversity.
- 2) To develop methods of quantifying the impacts of stressors on biodiversity.

SCOPE: Many anthropogenic factors impact biodiversity, but their effects have rarely been quantized. Recent work by O'Connor and his students has developed methods of using remotely sensed land use and pattern data in conjunction with climate data to quantify their effects on avian species diversity within the coterminous U.S. The present project is a collaboration with researchers at the University of California at Santa Barbara to compile anthropogenic stressor data for use with these methods.

Initially, potential sources of data are being reviewed as to relevance and consistency and cost-effectiveness of converting to digital database format. Suitable data will be converted to format consistent with current land-use and climate data. A third stage will focus on analysis of the data using decision-tree analysis and development of new models.

PROJECT STATUS: Completion is scheduled for December 1997.

SPATIAL PATTERNING OF WATERSHEDS AND THE DEVELOPMENT OF AVIAN BIOINDICATORS OF LAKE QUALITY

Investigator: A. P. Allen

Advisors: R. J. O'Connor, Chairman

*Cooperators/
Project
Support:* U.S. Environmental Protection Agency
University of Maine -
Department of Wildlife Ecology

Objectives:

- 1) To refine and evaluate candidate avian indicators of the environmental quality of northeastern lakes.
- 2) To determine the role of spatial patterning of land use as a stressor of lake quality.

SCOPE: Earlier research developed preliminary indicators of lake quality in the northeastern U.S. based on

the proportional representation of different guilds of bird species within the lake bird community. These indicators were shown to be correlated with lake chemistry and with road density in the surrounding watershed. The present work seeks to extend these findings by taking into account land use and its patterning within the watershed. Initial analyses will examine lakeside habitat and pattern of correlation with bird community structure, particularly under various schema to habitat aggregation. Once this is complete, watershed pattern will be determined using conventional G.I.S. methodology and tested to see whether knowledge of pattern provides an incremental gain in the predictability of current models.

PROJECT STATUS: Completion is scheduled for August 1996.

SPATIO-TEMPORAL DYNAMICS AND THE CORE-SATELLITE MODEL

Investigator: M. T. Jones

Advisors: R. J. O'Connor, Chairperson
J. R. Gilbert
M. L. Hunter
K. Tinsdale-Beard
J. A. Wilson

*Cooperators/
Project
Support:* Consortium of Agricultural Manufacturers
U.S. Environmental Protection Agency

Objective:

- 1) Empirically evaluate the predictions of Hanski's core-satellite model using BBS data.
- 2) Evaluate simpler alternatives such as the Taylor Power Law to explain observed patterns.

SCOPE: Analysis and interpretation of the population effects of pesticide use on wildlife requires understanding the underlying dynamics over space and time. This project focuses on the core-satellite model developed by J. Hanski. The model posits certain assumptions about how populations change and derives predictions about the frequency distributions of abundance classes and frequency of occurrence of species. This project empirically evaluates the validity of these assumptions and predictions, using Breeding Bird Survey data for New England as the test dataset. Completion is scheduled for December 1995.

PROJECT STATUS: Analysis is largely complete. The dynamics of New England bird populations proved to be regionally heterogenous, necessitating partitioning of the data into three sub-regions. The core-satellite model proved to have little predictive power unless extensively re-parameterized, in which case it loses much of its conceptual simplicity. Alternative analyses based on Taylor's Power Law provided simpler explanations of most of the patterns detected.

WILDLIFE RESOURCES - OTHER THAN MIGRATORY BIRDS:

HARBOR SEAL POPULATION TRENDS AND HABITAT USE IN MAINE

Investigator: M. K. Kenney

Advisors: J. R. Gilbert, Chairperson
W. B. Krohn
J. A. Wilson

Cooperators/ National Marine Fisheries Service
Project Maine Department of Environmental Protection
Support: Maine Department of Inland Fisheries and Wildlife
University of Maine -
Department of Wildlife Ecology

Objectives:

- 1) Estimate population size of eastern Atlantic harbor seals on Maine's coast and compare with the 1982 and 1986 population surveys.
- 2) Document harbor seal distribution and habitat use during pupping and molting seasons to identify high use coastal areas.

SCOPE: Small sections of the coast of Maine have been surveyed for harbor seals since 1971. Two complete censuses of Maine's coastal ledges were conducted in 1981 and 1986 indicating an increase in the population. Most harbor seal pups are born north of the New Hampshire/Maine border during late May and early June at sheltered sites. By August the pups have dispersed while adults aggregate on the outer ledges to begin their molt.

The National Marine Fisheries Service (NMFS) contracted with the University of Maine to conduct a population survey during pupping season, replicating the 1981 and 1986 June surveys. Both this June survey and an August survey provided information on habitat use and changes in distribution during these annual periods of stress.

PROJECT STATUS: All requirements for the M.S. degree (in Wildlife Ecology) were completed in December 1994. The abstract follows:

To document abundance and distribution of harbor seals (*Phoca vitulina*) in Maine, aerial surveys were flown along the coast between the Canadian and New Hampshire borders during pupping season of early June 1993 and during the molting season in mid-August 1993. Change in population size was determined by comparing the results of the June survey to censuses flown using the same techniques during the pupping seasons of 1981, 1982, and 1986. Characteristics of size, distance to mainland, and distance to boat launch were measured of potential haulout sites using a geographic information system (GIS). Chi square goodness of fit was used to test the hypothesis that seals use sites in proportion to their availability.

The 1993 spring census counted 28,810 seals including 4,250 pups. This represented an annual rate of increase of 8.7% between 1981 and 1993. A difference was observed between regions in productivity of pups. The percent of pups within the south region was 8%, in the middle region 15%, and within the downeast region 20%. An increase in pup counts was observed in all regions since 1981. The August census was 26,054 individuals or 91% of the June count.

The smallest (<0.3 ha) and largest (10-350 ha) size classes were used less than expected in all survey years and the tidal ledges (no substrate above high tide) were used more than expected for pupping sites and molting sites when compared with available sites. Use of islands for pupping within 0.25 km of the mainland was less than expected in all survey years, while sites within the interval of 1-10 km were used more than expected in 1993. There was a significant shift in abundance away from the mainland between June and August. Site distance to boat launches was not significant for any year of use.

INFLUENCE OF LANDSCAPE PATTERN AND FOREST TYPE ON USE OF HABITAT BY MARTEN IN MAINE

Investigator: T. D. Chapin

Advisors: D. J. Harrison, Chairperson
 W. B. Krohn
 S. A. Sader
 K. D. Elowe

*Cooperators/
 Project
 Support:* McIntire-Stennis

Objectives:

- 1) Assess the relationship of spatial characteristics of residual forest patches with marten use of habitat in an industrial forest landscape.
- 2) Evaluate the relationship between landscape pattern and home range area of marten.
- 3) Investigate seasonal habitat selection by marten in a forest preserve.
- 4) Compare habitat selection by marten in a forest preserve and in a trapped, industrial forest landscape.

SCOPE: Some of the highest densities of marten recorded occur in Baxter State Park, an area of contiguous forest with an abundance of mature hardwoods (beech, birch, and maple). This association seems contrary to the habitat associations that have been developed for marten, based primarily on studies in the western U.S. Some studies in the Eastern U.S. have documented that marten may use mixed-wood or even hardwood stands extensively. Habitat quality for marten may be related to the amount of structure on the forest floor. If the amount of ground structure is not related to cover type, assessment of habitat selection based on cover types alone may be misleading. Thus, in the west, where softwood forests have more ground structure than hardwoods (aspen), cover-type selection probably reflects marten habitat associations. In the east, however, the relationship between cover type and ground structure may be less distinct. To better understand the habitat associations of marten in the east, I investigated selection by marten in a forest preserve for forest cover types that reflect the relative abundance of ground structure.

The literature suggests that extensive timber harvesting may detriment habitat quality for marten. The specific characteristics of landscape pattern that affect marten habitat use are poorly understood. Marten have been documented to use remnant stands as small as 300 m². However, characteristics such as isolation of stands have not been examined relative to use by marten. I investigated the influence of spatial characteristics of forest patches, such as size, shape, and isolation, on spatial use of habitat by marten in an industrial forest landscape. I also related measures of landscape pattern in marten home ranges with home range size, to evaluate the theory of home range size as an indicator of habitat quality.

PROJECT STATUS: All requirements for the degree of Master of Science (in Wildlife Ecology) were completed in August 1995. An abstract of the thesis follows:

American marten (*Martes americana*) are generally considered an associate of mature forests and their populations are susceptible to over-harvesting and habitat loss. Despite the potential for clearcutting to fragment habitat of area-sensitive, forest-dependent species such as marten, few studies have evaluated the influence of landscape pattern on use of habitat and spatial distribution of marten in areas with extensive timber harvesting. Thus, I examined relationships among measures of landscape pattern and spatial use of habitat by 33 (17 male and 16 female) resident and 32 (17 male and 15 female) non-resident adult (≥ 1 year) marten in an extensively logged landscape.

Area of forest stands (>6 m in height) used by resident marten (median = 27 ha, $n = 12$) was greater ($P < 0.003$) than stands that contained no locations (median = 1.5 ha, $n = 128$); no stands <2.7 ha ($n = 88$) contained locations ($n = 1,188$) of residents. Further, stands used by residents were closer to the nearest stand larger than 2.7 ha (i.e., the smallest stand that contained locations; $P = 0.057$) and to a large (637 km²) forest preserve ($P = 0.075$) than stands that contained no locations. However, there was no difference in distance to nearest stand of any size ($P = 0.219$) between stands used by residents and

stands containing no locations. I also examined the potential influence of landscape pattern on spatial use of habitat by marten at 4 spatial scales ranging from 10 to 250 ha. At all 4 spatial scales, grid cells that contained locations of resident marten had a higher percent forest >6 m in height ($P \leq 0.008$) and intersected stands of greater area ($P \leq 0.006$) than cells containing no locations. At cell sizes of 125 ha and 250 ha, used cells intersected fewer residual stands ($P \leq 0.024$). Analyses for non-residents revealed similar effects of stand area and isolation, despite that non-residents exhibited greater variability of stand use. Home ranges ($n = 27$) of all resident adult marten were composed of >60% forest cover >6 m in height. Shape indices were not different ($P \geq 0.490$) between used cells and cells containing no locations. Marten used forest types within their home ranges irrespective of forest edges. Although distance between marten locations and forest edge were significantly different ($P = 0.049$) from expected, expected distances exceeded observed distances by only 10 m. The median size of the largest forest stand in marten home ranges was 1.5 km² for females and 2.5 km² for males; thus, contiguous forest patches of 1.5-2.5 km² may be necessary to maintain resident marten in logged landscapes. My results concur with companion studies that concluded marten select habitat at a landscape scale, and indicate that landscapes characterized by few, large residual forest stands close in proximity received greater occupancy by resident marten than areas with small isolated stands. Thus, forest planning aimed at reducing fragmentation via retaining large residual stands may help to maintain resident adult marten in extensively logged landscapes.

Although marten have been consistently associated with mature conifer-dominated forests, evidence exists that suggests complex vertical and horizontal woody structure are important habitat components. Further, because of the combined effects of trapping and timber harvesting on marten populations, information about marten habitat associations in an untrapped, unlogged landscape is needed as a baseline for comparisons with trapped, timber-harvested landscapes. Therefore, I investigated seasonal habitat selection of 38 (20 male and 18 female) marten in the absence of trapping and timber harvesting, in Baxter State Park, Maine.

During summer (1 May-31 October), marten used forest types disproportionate to availability within their home ranges ($P = 0.030$). Stands with substantial spruce-budworm (*Choristoneura fumiferana*) mortality (<50% overstory canopy closure) had the highest selection index during summer, which was significantly higher ($P = 0.003$, pairwise rejection level = 0.008) than the mature (>12 m in height), well-stocked (>50% canopy closure) mixed forest type. No significant differences in selection index were detected among mature well-stocked coniferous, deciduous, or mixed forest types. During winter (1 November-30 April), marten used forest types proportionate to availability within home ranges ($n = 7$ males, 1 female). My results suggest that marten do not require dense or coniferous canopy cover and are consistent with the hypothesis that vertical and horizontal structural complexity may be a more important habitat component than species composition of the forest overstory. Thus, post-harvest techniques, such as on-site delimiting and slash management, may enhance the quality of regenerating forest stands for marten habitat. Further research examining the separate effects of trapping and timber harvesting would provide valuable information about marten habitat requirements and assist in managing the species in trapped, timber-harvested landscapes.

ANNUAL SURVIVAL AND CAUSE-SPECIFIC MORTALITY OF WHITE-TAILED DEER FAWNS, AND RELATIVE ABUNDANCE OF SNOWSHOE HARE ON MOUNT DESERT ISLAND, MAINE

Investigator: R. A. Long

Advisors: D. J. Harrison, Co-Chairperson
A. F. O'Connell, Jr., Co-Chairperson
J. R. Gilbert
A. S. White

Cooperators/
Project
Support: USDI National Park Service

- Objectives:
- 1) Document cause specific mortality rates of white-tailed deer fawns on Mount Desert Island (MDI), Maine.
 - 2) Estimate the relative abundance of snowshoe hare on MDI and compare this with a population from the mainland.

SCOPE: Studies of utilization of key browse species by white-tailed deer (*Odocoileus virginianus*) in 1980 and 1990 on Mount Desert Island, Maine concluded that deer populations were stable or had declined over this period. MDI is closed to all deer hunting and the study's findings are contrary to trends seen in other non-hunted populations in the eastern U.S. where deer numbers have increased in response to the absence or reduction of predators and changes in land management practices. In some places deer densities are at the point where they are negatively affecting natural plant communities and malnourishment is occurring. This is not the case on MDI where studies have shown no over-utilization of vegetation and a healthy deer population. In the mid-1980's a study was initiated to examine cause-specific mortality rates of adult deer and also to investigate deer/coyote interactions on MDI. To augment this study, a companion study was initiated to look specifically at cause specific rates of fawn mortality on MDI utilizing radio-telemetry techniques.

In addition, previous studies of food habits of eastern coyotes (*Canis latrans*) on MDI suggest a lower use of snowshoe hare (*Lepus americanus*) than on the adjacent mainland. Therefore, the relationship between hare density and understory density will be evaluated as an index to the abundance of hares on MDI to determine if the lower use is related to a lower availability. This information will be useful in evaluating differences in social behavior and food use by coyotes on MDI and the adjacent mainland. Additionally, patterns of relative snowshoe hare abundance and use by coyotes will be compared between MDI and a previous study on the mainland in hopes of gaining some insight into factors affecting the social behavior of coyotes.

PROJECT STATUS: All requirements for the M.S. degree (in Wildlife Ecology) were completed in August 1995. The abstract follows:

White-tailed deer (*Odocoileus virginianus*) lack intrinsic mechanisms to maintain populations below K-carrying capacity. Thus, deer populations on a large island where most predators have been extirpated and hunting is prohibited should be limited by food resources. This is not the case on Mount Desert Island (MDI), Maine, where the deer population is stable or declining and is below forage carrying capacity. Studies elsewhere have suggested that low recruitment, associated with high mortality rates of fawns, may contribute to declines in deer populations. Thus, we monitored cause-specific mortality of fawns (n = 29) from birth to 1 year of age during 1991-95.

Annual rate of fawn survival was 0.26. Rate of predator-caused mortality was 0.52, with coyote (*Canis latrans*) predation (n = 8) accounting for at least 47% of mortalities from all causes (n = 17). Mortality rate from drowning was 0.24 (n = 3), and mortality rate associated with deaths from vehicles was 0.14 (n = 3). An index to home-range (MINDIST) was not different between a sample of fawns that died prior to 60 days of age (n = 6) and fawns that survived (n = 12). Of fawns radio-collared as neonates, 10 of 14 mortalities occurred during the first 2 months of life. Survival rate from 6 months to 1 year was 0.65; 4 mortalities (2 predation, 2 drowning) were observed during this interval. A subgroup of fawns (n = 11) captured near the Sand Beach area had a higher rate of survival to 1 year of age (S = 0.67) than did fawns from all other areas (n = 18, S = 0.00). Recruitment to 1 year of age was lower than has been observed in other northeastern deer populations. Low recruitment associated with multiple causes of fawn mortality may be limiting deer populations in some areas on MDI; however, differential rates of fawn survival throughout MDI may explain an apparent patchy distribution of deer.

The relative consumption of deer and alternate prey species by coyotes may relate to their social

organization on MDI. Coyotes across North America exhibit a wide range of group sizes, from a single pair, to extended family groups (packs). The tendency for coyotes to form packs has been linked to the proportion of large prey (typically ungulates) in their diet; however, it is not known whether prey size influences group size, or whether other ecological factors (e.g., lack of exploitation, saturation of territories) cause formation of social groups that subsequently consume larger prey. Coyotes on MDI exhibit pack behavior and consume more deer, and fewer snowshoe hare (*Lepus americanus*), than was reported for a population on the adjacent mainland, where coyotes did not form packs. Therefore, I compared the relative density of snowshoe hare between MDI and the mainland using an index to hare abundance. Lower densities of hare on MDI would suggest that coyotes on MDI forage opportunistically (i.e., they consume relatively more deer because hare densities are low), and would support the hypothesis that coyotes form packs to increase their foraging efficiency on large prey. In contrast, higher hare densities on MDI would suggest that coyotes do not necessarily need to consume deer, and may be forming packs for reasons other than increasing foraging efficiency on deer.

Density of snowshoe hare, hare fecal pellet density, and understory stem density have been shown to be related in Maine. I counted understory stems on 46 transects on MDI and used the relationship between stem cover units [SCU = understory deciduous stems + (3 x understory coniferous stems)] and hare pellets, in addition to information on the distribution of SCU's throughout MDI, to estimate a median pellet density of 2076 pellets/ha/4 months on MDI. This value corresponded with an estimated hare density of 0.060 hare/ha. On the mainland study site median pellet density was estimated as 1103 pellets/ha/4 months, which corresponded with an estimated hare density of 0.032 hare/ha. Mean pellet density, and therefore hare density, was significantly higher on MDI (1.9 fold) than on the mainland. Coyotes, therefore, may be forming groups on MDI for reasons unrelated to snowshoe hare density or acquisition. This finding supports the hypothesis that coyotes on MDI may exhibit group formation because of territory saturation and reduced dispersal opportunities, but is not consistent with the hypothesis that group formation has developed because of a need to increase foraging efficiency on deer.

NUTRITIONAL STATUS AND FOOD AVAILABILITY OF WHITE-TAILED DEER DURING WINTER IN MAINE

Investigator: S. S. Ditchkoff

Advisors: F. A. Servello, Chairperson
K. D. Elowe
M. R. Stokes

*Cooperators/
Project
Support:* McIntire-Stennis

Objectives:

- 1) Compare the nutritional status of deer in northern and central Maine during winter.
- 2) Compare the nutritional status of deer in small and large wintering areas in northern Maine during winter.
- 3) Compare relative availability of high quality forage, including litterfall, for deer in harvested and unharvested softwood stands during winter.

SCOPE: Deer wintering areas are critical to the survival of deer during winter in Maine, and therefore it is important that these areas be protected and managed to provide optimal deer winter habitat. By using urine analysis techniques to evaluate the nutritional condition of deer as winter progresses, it may be possible to gain insight into the quality of particular wintering areas. This technique has only recently been developed

and has had limited testing in field situations. Thus, the ultimate goal of this portion of the study is to evaluate urine analysis techniques for use in Maine.

Previous research suggests that deer may not be able to subsist solely on hardwood browse during winter, but may require high quality forages such as lichens and litterfall to increase overwinter survival. Yet, typical deer wintering area management prescribes cutting in wintering areas to maintain a variety of timber age classes and increase the biomass of available woody browse, thus reducing, or eliminating, litterfall and lichens previously available to deer.

PROJECT STATUS: All requirements for the M.S. degree (in Wildlife Ecology) were completed in December 1994. The abstract follows:

Wintering habitat is critical for white-tailed deer (*Odocoileus virginianus*) populations near the northern limits of their range. Urinary indices, which can be used to evaluate the nutrition of deer populations, have potential as direct measures of the quality of deer wintering habitat from a nutritional perspective. I examined the ability of urinary indices to detect expected temporal changes in the nutritional status of deer populations and to differentiate between deer populations in regions with different winter severity. During 1 January-31 March, 1993 I collected and analyzed urine samples from deer in 4 central Maine deer wintering areas (DWA), 4 large northern Maine DWA's, and 2 small northern Maine DWA's. Winter severity was statistically greater ($P < 0.05$) in northern than central Maine; however, urea N:C ($\bar{x} = 74$) and K:C ($P = 0.55$) did not differ between regions. Differences in winter severity likely had minor influences on the energetic demands of deer during 16 Feb-31 Mar due to severe wintering conditions in both regions, and thus nutritional status differences were not apparent in urinary metabolite concentrations. Urinary potassium (K):creatinine (C) ratios decreased ($P < 0.002$) and urea nitrogen (N) :C increased ($P < 0.001$) in individual DWA's as winter progressed, indicating a reduction in forage intake and deteriorating physiological condition, respectively. Power analyses indicated that 40 urine samples should be collected from individual DWA's to detect differences in the nutritional status of individual deer populations, and 7 DWA's should be sampled when comparing the nutritional status of deer in groups of DWA's.

Deer wintering areas in Maine are managed through timber harvest to create a mosaic of softwood stands of varying ages that will perpetually maintain >50% of the area as winter shelter for deer. However, litterfall, which may be an important food source for deer during winter, is reduced or eliminated when softwood stands are harvested. I measured litterfall and hardwood browse biomass in harvested and unharvested sections of 3 DWA's in central Maine during January-March, 1994 to determine effects of harvest on the relative availability of high quality forages. Hardwood forage biomass was greater ($P < 0.001$) in harvested than unharvested sites, and litter biomass exceeded ($P = 0.004$) woody browse biomass in unharvested sites. More forage (including litter) was available in unharvested than harvested sites at relatively high mean diet quality levels [1.9 kcal/g DDM ($P = 0.037$), 2.1 kcal/g DDM ($P = 0.023$)]. However, biomass availability estimates on unharvested sites may be high because litter particle size may limit consumption, and deer may forage inefficiently for litter. Litter components have greater nutritional value than most hardwood and conifer browses, thus minimal additions of litter to deer diets may increase mean diet quality significantly.

POPULATION ECOLOGY OF FEMALE BLACK BEARS IN MAINE

Investigator: C. R. McLaughlin

Advisors: R. J. O'Connor, Co-chairperson
G. J. Matula, Jr., Co-chairperson
W. A. Halteman
D. J. Harrison
W. B. Krohn

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

- Objectives:*
- 1) Describe the survival, fecundity, and population densities of female black bears living in MDIFW study areas from 1982-1990.
 - 2) Assemble the above parameter estimates into a predictive population model.

SCOPE: The black bear has evolved into an important trophy big-game species in Maine, with considerable public interest in the welfare of the resource. Since 1985 Maine Department of Inland Fisheries and Wildlife's (MDIFW) bear management goal has been to maintain 1985 levels of bear distribution and abundance (21,000 bears).

Increasing harvest pressure and changing habitat conditions necessitate careful monitoring of the state's bear population to meet management objectives. Greater knowledge of population dynamics is needed to reliably assess impacts of management actions and habitat alterations on the bear resource.

This research is designed to document age-specific survival and fecundity of female bears in Maine, and describe their population dynamics. Of particular interest are the impacts fluctuating fall food supplies and hunting harvests have on the growth rate of female bear populations.

These relationships are being investigated using a computer model based upon parameter estimates from field data. The model should improve prediction of population responses to management actions and habitat changes. It may also enhance MDIFW's ability to monitor the state's bear population. Model construction and testing includes extensive sensitivity analysis to provide insight as to the type and precision of data needed. The model should also become a vehicle for developing and testing statewide monitoring techniques. Observed changes in population status of bears living within MDIFW study areas have provided a basis for evaluating harvest-related monitoring techniques. The model will eventually be used to further test the sensitivity of new monitoring techniques over a wide range of population conditions.

PROJECT STATUS: Survival and reproduction data have been analyzed. Several preliminary computer models have been constructed in QuickBasic. Each succeeding model included additional components; the current model describes the life history of female bears in considerable detail. The model is a Leslie matrix design, and accommodates variation in survival during 2 periods (pre-hunting season and hunting season), fluctuating age of first reproduction, and variation in frequency of various-sized litters, litter sex ratios, and litter production. Density dependent survival of subadults is assumed to be the principal factor regulating population growth in the absence of harvest. Current focus is on sensitivity analysis, both to determine the relative importance of the incremental components in the series of models and to indicate what precision is needed in the input data. Additional complexity (i.e., stochastic effects and behavioral influences) will be incorporated into the model structure, with progressive sensitivity analysis as appropriate.

FUTURE PLANS: Sensitivity should also help identify minimum acceptable sampling intensities for population parameters. After the model is refined using Spectacle Pond data, it will be tested by starting with data collected on the Bradford study area in central Maine. Comparisons of model output to observed changes in population dynamics on the Bradford area will be made, and if further model refinement is required, data from the Stacyville study area (northcentral Maine) can be utilized for further testing.

POPULATION STATUS AND HABITAT USE OF BLANDING'S AND SPOTTED TURTLES IN SOUTHWESTERN MAINE

Investigator: L. A. Joyal

Advisors: M. L. Hunter, Jr., Chairperson
M. A. McCollough
D. J. Harrison
K. E. Gibbs

*Cooperators/
Project
Support:* Davis Conservation Association
Maine Department of Inland Fisheries and Wildlife
Maine Audubon Society
University of Maine

Objectives:

- 1) Estimate population size; density; and sex, size, and age structure.
- 2) Characterize home ranges and terrestrial movements, and determine if they are affected by wetland isolation.
- 3) Document hatching dates, hatching success, hatchling movements, and habitat use by hatchling turtles.
- 4) Characterize wetlands and upland areas used by each species and determine if certain habitats are used at different times of the year or for different activities.

SCOPE: Both the Blanding's and the spotted turtle are believed to be declining throughout their geographic range. Although both species are listed as threatened in Maine, the past and present population status of each species is poorly known. Nevertheless, known populations of Blanding's and spotted turtles occur primarily in York County, where the human population is rapidly growing. Increased development associated with human growth has resulted in the filling of many wetlands and possibly the pollution of others. Development may also fragment habitat and cause turtle populations to become isolated and face a greater risk of local extinction. Wetlands less than ten acres, commonly used by both species, are not protected through existing state legislation. Habitat information is needed in order to implement habitat protection measures through the Maine Endangered Species Act and Natural Resources Protection Act.

PROJECT STATUS: The second and last field season is nearly completed. Wetland surveys were done in a second study area as well as repeated in the original study area. Radio-transmitters were again placed on turtles of both species to determine movements and habitat use. These turtles are still being monitored periodically until hibernation when the transmitters will be removed. Nests will be dug up in October to determine clutch sizes and hatching success. Efforts to determine movements and habitat use of hatchlings were unsuccessful due to inclement weather. Data analysis is in progress.

FUTURE PLANS: Revise and defend thesis.

EFFECTS OF TIMBER HARVESTING AND TRAPPING ON HABITAT SELECTION AND POPULATION CHARACTERISTICS OF AMERICAN MARTEN IN NORTHERN MAINE

Investigator: D. C. Payer

Advisors: D. J. Harrison, Chairperson
K. D. Elowe
J. R. Gilbert
W. B. Krohn
R. J. Seymour

*Cooperators/
Project
Support*

Maine Department of Inland Fisheries and Wildlife
University of Maine -
Cooperative Forestry Research Unit
Department of Wildlife Ecology
National Council of the Paper Industry for Air and
Stream Improvement
Maine Forest Service
McIntire-Stennis
Baxter State Park

- Objectives:*
- 1) Document and compare seasonal habitat selection and population characteristics (i.e., home range size, inter- and intra-sexual home range overlap, density, age and sex structure, survival and percent females lactating) by martens in an untrapped forest preserve, an untrapped industrial forest, and a trapped industrial forest.
 - 2) Compare microhabitat characteristics among areas receiving high, low or no use-intensity by resident, non-juvenile martens in an industrial forest with trapping closure and a forest preserve.

SCOPE: Much recent research with implications for management of the American marten (*Martes americana*) in the U.S. and Canada has focused on habitat alteration associated with timber harvesting. Although habitat loss through timber harvest has undoubtedly contributed to declines of some marten populations, the relative contribution of increased marten harvest following the construction of forest roads has not been fully elucidated. This is a significant oversight in light of the species' vulnerability to overharvest associated with ease of capture, low reproductive rates and relatively high pelt value. In fact, overtrapping has been implicated in large-scale declines of marten populations during the early 1900's, and has also contributed to declines in some modern populations.

The effects of timber harvesting and trapping on marten population viability must be isolated to effectively manage for sustained marten populations while providing reasonable opportunities for exploitation of forest products (i.e., timber and fur). We will attempt to isolate these effects by concurrently studying marten habitat associations at three spatial scales (position of the home range on the landscape, selection for overstory characteristics within the home range and use of microhabitat features within selected occupied areas) and population characteristics in three contiguous sites in northcentral Maine. The sites differ in regards to habitat alteration and trapping pressure as follows: 1) timber harvest and trapping; 2) timber harvest and no trapping; and 3) neither timber harvest nor trapping.

PROJECT STATUS: We radiocollared 48 (21 F, 27 M) and 55 (22 F, 33 M) martens on the three study sites in 1994 and 1995, respectively. Approximately 6,000 relocations have been obtained via ground and aerial telemetry through 15 September 1995. In 1995 we sampled microhabitat features in 360 randomly-placed plots in areas receiving high, low or no marten use-intensity within the industrial forest. Preliminary data analysis has begun.

FUTURE PLANS: The microhabitat-sampling protocol used in the industrial forest will be repeated in 1996 within the forest preserve. Martens will be trapped and radiocollared annually through June 1997. Relocations of radiocollared animals will be obtained through April 1998. Scheduled project completion date is August 1998.

**PUBLICATIONS, THESES AND DISSERTATIONS,
PROFESSIONAL AND PUBLIC TALKS GIVEN, AND AWARDS**

SCIENTIFIC PUBLICATIONS

- BLACKWELL, B.F., and J.A. SINCLAIR. 1995. Evidence of secondary consumption of fish by double-crested cormorants. Marine Ecology Progress Series 123:1-4.
- BLACKWELL, B.F., P.D. DOERR, J.M. REED, and J.R. WALTERS. 1995. Inbreeding rate and effective population size: A comparison of estimates from pedigree analysis and a demographic model. Biological Conservation 71(3):299-304.
- FOSS, C.R. (editor). 1995. The Atlas of Breeding Birds in New Hampshire. Audubon Society of New Hampshire, Concord, and Arcadia Chalford Publishing Corp., Dover, NH. 414pp.
- GRAY, P.B., and F. A. SERVELLO. 1995. Energy intake relationships for white-tailed deer on winter browse diets. Journal of Wildlife Management 59:147-152.
- HAINES, T.A., C.C. ABBOTT, J.M. RYAN, and M.W. POWELL. 1995. Mercury biogeochemistry at the Bear Brook watersheds in Maine. (Abstract). Acid Reign '95, Kluwer Academic Publishers, Gothenburg, Sweden:253.
- HARTLEY, R.A., and J.R. MORING. 1995. Differences in mortality between largemouth and smallmouth bass caught in tournaments. North American Journal of Fisheries Management 15:666-670.
- HODGMAN, T.P., D.J. HARRISON, D.D. KATNIK, and K.D. ELWE. 1994. Survival in an intensively trapped marten population in Maine. Journal of Wildlife Management 58:593-600.
- HUNTER, M.L., JR., and A. HUTCHINSON. 1994. The virtues and shortcomings of parochialism: Conserving species that are locally rare, but globally common. Conservation Biology 8:1163-1165.
- HUNTER, M.L., JR., R.K. HITCHCOCK, and B. WYCKOFF-BAIRD. 1995. Women and wildlife in southern Africa. Pages 93-96 in D. Ehrenfeld (ed.) Readings from Conservation Biology: Wildlife and forests. Blackwell Science, Cambridge, MA. 248pp.
- HUNTER, M.L., JR., G.L. JACOBSON, JR., and T. WEBB. 1995. Paleocological and the coarse-filter approach to maintaining biological diversity. Pages 14-24 in D. Ehrenfeld (ed.) Readings from Conservation Biology: Plant conservation. Blackwell Science, Cambridge, MA. 221pp.
- KATNIK, D.D., D.J. HARRISON, and T.P. HODGMAN. 1994. Spatial relations in a harvested population of marten in Maine. Journal of Wildlife Management 58:600-607.
- KIMBALL, A., J. WITHAM, J. RUDNICKY, A. WHITE, and M.L. HUNTER, JR. 1995. Harvest-created and natural canopy gaps in an oak-pine forest in Maine. Bulletin of the Torrey Botanical Club 122:115-123.
- KITSOS, A., JR., M.L. HUNTER, JR., J.H. SABINS, and A. MEHTA. 1995. A guide to the identification of some Indian mammal hairs. Chapter 10 in S.H. Berwick and V.B. Saharia (editors), The development of international principles and practices of wildlife research and management: Asian and American approaches. Oxford University Press, Delhi.

- KROHN, W.B., K.D. ELWE, and R.B. BOONE. 1995. Relations among fishers, snow, and martens: development and evaluation of two hypotheses. The Forestry Chronicle 71(1):97-105.
- MORING, J.R. 1994. Color phases of lumpfish fry. Maine Naturalist 2:11-14.
- MORING, J.R., J. MARANCIK, and F. GRIFFITHS. 1995. Changes in stocking strategies for Atlantic salmon restoration and rehabilitation in Maine, 1871-1993. American Fisheries Society Symposium 15:38-46.
- MORING, J.R., and P.H. NICHOLSON. 1994. Evaluation of three types of artificial habitats for fishes in a freshwater pond in Maine, USA. Bulletin of Marine Science 55:1149-1159.
- PARAGI, T.F., S.M. ARTHUR, and W.B. KROHN. 1994. Seasonal and circadian activity patterns of female fishers, *Martes pennanti*, with kits. Canadian Field-Naturalist 108(1):52-57.
- ROSENFELD, R.N., J.M. SCHNEIDER, J.M. PAPP, and W.S. SEEGAR. 1995. Prey of peregrine falcons breeding in west Greenland. Condor 97:763-770.
- SCHOOLEY, R.L., C.R. McLAUGHLIN, W.B. KROHN, and G.J. MATULA. 1994. Spatiotemporal patterns of macrohabitat use by female black bears during fall. International Conference Bear Research and Management 9(1):339-348.
- SMITH, T.R., and T.A. HAINES. 1995. Mortality, growth, swimming activity and gill morphology of brook trout (*Salvelinus fontinalis*) and Atlantic salmon (*Salmo salar*) exposed to low pH with and without aluminum. Environmental Pollution 90(1):33-40.
- SPICER, A.V., J.R. MORING, and J.G. TRIAL. 1995. Downstream migratory behavior of hatchery-reared, radio-tagged Atlantic salmon (*Salmo salar*) smolts in the Penobscot River, Maine, USA. Fisheries Research 23:255-266.
- VERA, C.J., and F. A. SERVELLO. 1994. Effects of paper mill sludge in spruce-fir forests on wildlife in Maine. Journal of Wildlife Management 58:719-727.
- VICKERY, P., M.L. HUNTER, JR., and S. MELVIN. 1994. Effects of habitat area on the distribution of grassland birds in Maine. Conservation Biology 8:1087-1097.
- VICKERY, P., and M.L. HUNTER, JR. 1995. Do artificial song-perches affect habitat use by grassland birds in Maine? American Midland Naturalist 133:164-169.
- YONZON, P.B. and M.L. HUNTER, JR. 1995. 1995. Cheese, tourists, and red pandas in the Nepal Himalayas. Pages 217-223 in D. Ehrenfeld (ed.) Readings from Conservation Biology: The social dimension. Blackwell Science, Cambridge, MA. 234pp.

TECHNICAL AND SEMI-TECHNICAL PUBLICATIONS

- deMAYNADIER, P. 1995. The discovery of an erythristic red-backed salamander, *Plethodon cinereus*, in Maine. Natural History Note for Herpetological Review 26(4).
- deMAYNADIER, P., and M.L. HUNTER, JR. 1995. "A review of the North American literature on forestry-amphibian relationships." Technical Bulletin for the National Council of the Paper Industry for Air and Stream Quality Improvement, Inc.

- FROST, H.C., and W.B. KROHN. 1994. Capture, care, and handling of fishers (Martes pennanti). Maine Agricultural and Forest Experiment Station, Technical Bulletin 157, University of Maine, Orono. 38pp.
- HAINES, T.A. 1994. Atmospheric deposition and movement of mercury in small stream watersheds in Maine. (Abstract). Society of Environmental Toxicology and Chemistry, 15th Annual Meeting:87.
- HARRISON, D.J. Foreword. Pp. 1-3 in G. Parker. Eastern coyote: the story of its success. Chelsea Green Publishing Company, White River Junction, VT.
- HARRISON, D.J. 1994. Effects of timber harvesting and trapping on population characteristics, habitat selection, and area occupancy by American martens in northern Maine. Maine Agricultural and Forest Experiment Station Miscellaneous Report No. 389. Pp. 34-35.
- HARTLEB, C.F. 1995. Designing research projects with little funding. Fisheries 20(3):38.
- HARTLEY, M. 1994. Passerine abundance and productivity indices in grasslands managed for waterfowl nesting cover. Pages 322-327 in Transactions of the 59th North American Wildlife and Natural Resources Conference.
- HARTLEY, M. 1995. When he found out he was dying. The Onion Peel, August 1995, Issue #5:11.
- HEPINSTALL, J.A., S.A. SADER, and A. ESTRADA. 1995. Comparison of forest extent in the Sierra de los Tuxtlas, Veracruz, Mexico: 1976-1990. *In* M. Wilson and S.A. Sader (editors), Conservation of neotropical migratory birds in Mexico. Maine Agricultural and Forest Experiment Station Miscellaneous Report No. 727. 288pp.
- KELLY, C., E.O. GARTON, W.B. KROHN, L.S. MILLS, J.M. SCOTT, K. WILLIAMS, and B. CSUTI. 1994. Assessing the predictive ability of Gap Analysis vertebrate distribution maps. *In* Scott, J. M. (compiler). A handbook for Gap Analysis, USDI National Biological Survey, University of Idaho, Moscow, ID.
- KROHN, W.B., and M.C. COULTER. 1994. Howard L. Mendall, 1909-1994. Wildlife Society Bulletin 22(3):527-529.
- KROHN, W.B. 1994. The fisher: old-growth specialist or northern-forest generalist? National Biological Survey, Research Information Bulletin 77. 2pp.
- MORING, J.R. 1994. Arthur Hill: western actor, miner, and law officer. Sunflower University Press, Manhattan, Kansas. 115pp.
- MORING, J.R., and M.A. CARTWRIGHT. 1994. Displaced largemouth bass exhibit less homing in large lakes and at nonspawning times of the year. National Biological Survey, Research Information Bulletin 98. 2pp.
- MORING, J.R., and K. HOCKETT. 1994. Predator avoidance response in Atlantic salmon. National Biological Survey, Research Information Bulletin 97. 2pp.
- MORING, J.R. 1995. Book review of Goldfield: The Last Gold Rush on the Western Frontier (by Sally Zanjani, Ohio University Press, Athens, 1992). Journal of the West 34:102.

- O'CONNELL, A.F., JR., F.A. SERVELLO, and S.D. WHITCOMB. 1995. Spruce grouse on Mt. Desert Island. Park Service 15:10-11.
- SADER, S.A., and J.P. SPRUCE. 1995. A guide for satellite monitoring of land cover in southern Mexico and Central America. Pages 226-234 in M. Wilson and S. A. Sader (editors), Conservation of neotropical migratory birds in Mexico. Maine Agricultural and Forest Experiment Station Miscellaneous Report No. 727. 288pp.
- SADER, S.A., and J.A. HEPINSTALL. 1995. Application of satellite imagery to monitor wintering neotropical migrant bird habitat in Central America. Final Report, Maine Cooperative Fish and Wildlife Research Unit Cooperative Agreement 14-16-0009-1557, RWO 27, University of Maine, Orono, ME. 45pp.
- SERVELLO, F.A., B. GRIFFITH, K.S. RAYMOND, and W.E. ESCHHOLZ. 1995. Effects of glyphosate on winter habitat of moose in Maine. Maine Agricultural and Forest Experiment Station Miscellaneous Report No. 395. 19pp.
- SPRUCE, J.P., S.A. SADER, C.S. ROBBINS, and B.A. DOWELL. 1995. Accuracy of migrant landbird habitat maps produced from Landsat TM data: Two case studies in southern Belize: *In* M. Wilson and S.A. Sader (editors), Conservation of neotropical migratory birds in Mexico. Maine Agricultural and Forest Experiment Station Miscellaneous Report No. 727. 288pp.
- STAFFORD, C., and T.A. HAINES. 1994. Mercury concentrations in predatory fishes from Maine lakes. (Abstract). Society of Environmental Toxicology and Chemistry, 15th Annual Meeting:E6.
- WILSON, M. and S.A. SADER (editors). 1995. Conservation of neotropical migratory birds in Mexico. Maine Agricultural and Forest Experiment Station Miscellaneous Report No. 727. 288pp.

THESES AND DISSERTATIONS

- CHAPIN, T.G. 1995. Influence of landscape pattern and forest type on use of habitat by marten in Maine. Master of Science Thesis, University of Maine, Orono. 100pp.
- DITCHKOFF, S.S. 1994. Nutritional Status and food availability of white-tailed deer during winter in Maine. Master of Science Thesis, University of Maine, Orono. 77pp.
- KENNEY, M.K. 1994. Harbor seal population trends and habitat use in Maine. Master of Science Thesis, University of Maine, Orono. 100pp.
- LONG, R.A. 1995. Annual survival and cause-specific mortality of white-tailed deer fawns, and relative abundance of snowshoe hare on Mount Desert Island, Maine. Master of Science Thesis, University of Maine, Orono. 83pp.
- SHEPARD, S.L. 1995. Atlantic salmon spawning migrations in the Penobscot River, Maine: fishways, flows, and high temperatures. Master of Science Thesis, University of Maine, Orono. 111pp.
- STAFFORD, C.P. 1994. Mercury contamination in Maine predatory fishes. Master of Science Thesis, University of Maine, Orono. 50pp.

SUWARNI, E.E. 1995. An assessment of three different conservation systems in Indonesia: Strict nature reserves, wildlife sanctuaries and national parks. Master of Science Thesis, University of Maine, Orono.

PROFESSIONAL TALKS PRESENTED

BARTLETT, J., and D.A. BUEHLER. "Modeling priority neotropical migrants in the southern Appalachians." The Wildlife Society Conference, Portland, OR, September 1995.

BLACKWELL, B.F., W.B. KROHN, and R.B. ALLEN. "Foods of nestling double-crested cormorants in Penobscot Bay, Maine: spatial and temporal comparisons." Colonial Waterbird Society 18th Annual Meeting, Wrightsville Beach, NC, November 2-6, 1994.

BOONE, R.B., R.I. BARTLETT, A.P. GUAY, W.B. KROHN, and S.A. SADER. "Use of aerial videography to create a habitat map for Maine." (Poster). Gap Analysis Program Annual Workshop, Fayetteville, AR, August 7-10, 1995.

BOONE, R.B., and W.B. KROHN. "Testing vertebrate distributions predicted from Maine Gap Analysis: moving beyond comparisons with management areas." (Poster). Gap Analysis Program Annual Workshop, Fayetteville, AR, August 7-10, 1995.

CHAPIN, T.G., and D.J. HARRISON. "Marten use of residual stands in an industrial forest landscape in Maine." 51st Annual Northeast Fish and Wildlife Conference, Ocean City, MD, April 8-12, 1995.

CHAPIN, T.G., and D.J. HARRISON. "Marten use of residual stands in an industrial forest landscape in Maine." Second International Martes Symposium, Edmonton, Alberta, August 12-16, 1995.

deMAYNADIER, P., and M.L. HUNTER, JR. "Ecosystem management in forested landscapes." USDA Forest Service training on applying principles of ecosystem management, Milwaukee, WI, February 15, 1995.

deMAYNADIER, P., and M.L. HUNTER, JR. "The effects of forest roads on amphibian movements in Maine." 1995 Northeast Wildlife Graduate Student Conferences, University of Sherbrooke, Quebec, Canada, February 24-26, 1995.

deMAYNADIER, P., and M.L. HUNTER, JR. "The effects of forest roads on amphibians movements in Maine." Society for Conservation Biology Conference, Colorado State University, Fort Collins, CO, June 7-11, 1995.

DITCHKOFF, S.S., and F.A. SERVELLO. "Importance of litterfall as a winter food resource for white-tailed deer in Maine." The 51st Northeast Association Fish and Wildlife Association Conference, Ocean City, MD, April 10-12, 1995.

ESCHHOLZ, W.E., K.S. RAYMOND, F.A. SERVELLO, B. GRIFFITH, and W.B. KROHN. "Moose activity in clear-cuts after conifer release with glyphosate." 49th Annual Meeting of the Northeastern Weed Science Society, Boston, MA, January 4-5, 1995.

FROST, C.H. and W.B. KROHN. "Factors affecting reproductive success of captive fishers." Second International *Martes* Symposium, Edmonton, Alberta, August 13-16, 1995.

- GILBERT, J.R. 1994. "Status of seals in New England waters." Presentation to the Marine Mammal Commission, Woods Hole, MA, November 16, 1994.
- GILBERT, J.R. 1995. "Status of seals in Northern New England waters." Presentation at Status of Pinnipeds in New England. New England Aquarium, July, 1995.
- HARRISON, D.J. "Evidence for external regulation in an unmanaged deer population." Conference on Science of Overabundance, Front Royal, VA, November 10-11, 1994.
- HARRISON, D.J. "Relative influences of timber harvesting and trapping on marten populations in Maine." Spring Meeting of Forest Resources Research Advisory Committee, University of Maine, Orono, April 11, 1995.
- HARRISON, D.J., D.M. PHILLIPS, T.G. CHAPIN, D.P. KATNIK, and T.P. HODGMAN. "Population performance and habitat selection by American marten: a need to reassess accepted paradigms and conservation practices." Second International *Martes* Symposium, Edmonton, Alberta, August 12-16, 1995.
- HARTLEB, C.F., and J.R. MORING. "A comparison of a bioenergetics model and field surveys on the survival of stocked brook trout." Atlantic International Chapter, American Fisheries Society, Annual Meeting, Gorham, NH, September 26, 1995.
- HEPINSTALL, J.A. "Using Bayesian statistics and Breeding Bird Survey data to classify satellite imagery." Integrating Spatial Information Technology Conference, Portland, ME, November 15, 1994.
- HEPINSTALL, J.A. "How representative of Maine's available habitat types are Breeding Bird Survey routes in Maine?" Society for Conservation Biology Conference, Fort Collins, CO, June 11, 1995.
- HODGMAN, T.P. and D. J. HARRISON. "Survival in a heavily harvested marten population: a preliminary assessment." Poster Session at Annual Meeting of the Maine Cooperative Forestry Research Unit, Millinocket, ME, September 20, 1995.
- HODGMAN, T.P., D.J. HARRISON, D.M. PHILLIPS, and K.D. ELowe. "Survival of marten in an untrapped forest preserve in Maine." Second International *Martes* Symposium, Edmonton, Alberta, August 12-16, 1995.
- HUNTER, M.L. "A triad approach to land use allocation." Department of Forest Science, Texas A&M University, College Station, TX, October 10, 1994.
- HUNTER, M.L. "Alternatives for managing lands of low productivity." Texas Forestry Association, San Antonio, TX, October 14, 1994.
- HUNTER, M.L. "Biological landscapes." USDA Forest Service, Nashville, TN, December 7, 1994.
- HUNTER, M.L., JR. "A landscape approach to ecosystem management." Keynote paper presented at the Boreal Forest Ecosystem Management Symposium, Edmonton, Alberta, January 31, 1995.
- HUNTER, M.L. "Ecosystem management for timber, wildlife, and biodiversity." Plenary speaker at the meeting of the Missouri Chapters of Society of American Foresters, The Wildlife Society, and the American Fisheries Society, Lake of the Ozarks, MO, February 2, 1995.

- HUNTER, M.L., JR. and A. WHITE. "Ecological thresholds and the definition of old-growth forests." Society for Conservation Biology Conference, Fort Collins, CO, June 8, 1995.
- HUNTER, M.L. JR. "Insects, entomologists, and the conservation of biological diversity." Acadian Entomological Society, Campobello Island, New Brunswick, June 26, 1995.
- HUNTER, M.L., JR. "Maintaining forest diversity." USDA Forest Service, Clemson, SC, September 22, 1995.
- KROHN, W.B. "Predicted vertebrate distributions from Gap Analysis: considerations in the design of statewide accuracy assessments." Invited slide presentation to the Gap Analysis Symposium, ACSM/ASPRS Convention, Charlotte, NC, February 18, 1995.
- KROHN, W.B., W.J. ZIELINSKI, and R.B. BOONE. "Relations among fishers, snow, and martens in California: results from small-scale spatial comparisons." Second International *Martes* Symposium, Edmonton, Alberta, August 13-16, 1995.
- KROHN, W.B., and R.B. BOONE. "Gap Analysis in Maine: A progress report." Invited slide presentation to a conference sponsored by the Appalachian Mountain Club entitled Landscape-level studies in northern New England: where are we and where are we going? Pinkham Notch, NH, September 28, 1995.
- LONG, R.A., S.L. GLASS, D.J. HARRISON, and A.F. O'CONNELL. "Cause-specific mortality of white-tailed deer fawns on Mount Desert Island, Maine." Northeast Wildlife Graduate Student Conference, Sherbrooke, Quebec, February 25-26, 1995.
- LONG, R.A., S.L. GLASS, D.J. HARRISON, and A.F. O'CONNELL. "Cause-specific mortality of white-tailed deer fawns on Mount Desert Island, Maine." 51st Annual Northeast Fish and Wildlife Conference, Ocean City, MD, April 9-12, 1995.
- LONG, R.A., D.J. HARRISON, S.L. GLASS, and A.F. O'CONNELL. "Annual survival and cause-specific mortality of white-tailed deer fawns on Mount Desert Island, Maine." 21st Maine Biological and Medical Sciences Symposium, Bar Harbor, ME, June 8-9, 1995.
- MCCALL, T.C., T.P. HODGMAN, D.R. DIEFENBACH, and R.B. OWEN, Jr. "Dynamics of beaver populations: implications for ecosystem management." Second International Conference of The Wildlife Society. Portland, OR, September 12-17, 1995.
- MONTI, L., M.L. HUNTER, JR., J. WITHAM, A. KIMBALL, and E. MOORE. "Three methods for measuring relative population densities of the redback salamander, *Plethodon cinereus*." North American Amphibian Monitoring Program, September 27-29, 1995.
- MOORE, E.H., and J.W. WITHAM. "From forest to farm and back again: Land use history as a dimension of ecological research in coast Maine." Poster presentation at the Society of American Foresters 1995 National Convention, Portland, ME, October 28-November 1. Received a recognition of excellence award in the Ecology and Biology Subject Area.
- MORING, J.R. "Forestry impacts on water quality." 1995 Maine Water Resources Conference, Augusta, ME, May 5, 1995.
- MORING, J.R. "The early culture of Atlantic salmon in Maine, 1871-1900." Poster paper at the Annual Meeting of the American Fisheries Society, Tampa, FL, August 30, 1995.

- O'CONNOR, R.J. "An avian prototype of a national biodiversity assessment." Biodiversity Research Consortium "All Hands" Meeting, Corvallis, OR, November 1-3, 1994.
- O'CONNOR, R.J. "Continental bird distribution and the use of agricultural land across the United States." Clark Ornithology Symposium: The ever changing relationship of birds and agriculture. Ohio Wesleyan University, Delaware, OH, March 3, 1995.
- O'CONNOR, R.J., and M.T. JONES. "A prototype biodiversity risk assessment for the United States." Ninth annual meeting of the Society for Conservation Biology: Conservation Initiatives, Fort Collins, CO, June 10, 1995.
- O'CONNOR, R.J., and D.B. CARR. "A prototype national biodiversity assessment using interpolated bird distribution data." American Statistical Association annual meeting, Orlando, FL, August 11-18, 1995.
- O'CONNOR, R.J. Panel member of the North American Workshop on the Monitoring of Ecosystems, Mexico City, September 18-22, 1995.
- O'CONNOR, R.J. "Global climate and terrestrial ecosystems: Focus 4: biodiversity and ecological complexity." Cedar Creek Natural History Area, Bethel, MN, September 23-27, 1995.
- PHILLIPS, D.M., and D.J. HARRISON. "Seasonal changes in density, range area, and range fidelity of American marten in a forest preserve." Second International *Martes* Symposium, Edmonton, Alberta, August 12-16, 1995.
- ROBBINS, C.S., B.A. DOWELL, J. FALLON, and J.A. HEPINSTALL. "Predicting population declines from habitat change in Belize." Poster presentation at Wilson Ornithological Society Meeting, Williamsburg, VA, May 4-6, 1995.
- RAYMOND, K.S., and F.A. SERVELLO. "Big game and herbicide interactions." Meeting of Monsanto Agriculture Company, Springfield, MA, March 15, 1995.
- RAYMOND, K.S., J.K. VREELAND, W. E. ESCHHOLZ, F. A. SERVELLO, and B. GRIFFITH. "Effects of glyphosate on the nutritional ecology of moose and deer in Maine." The 49th Annual Meeting Northeastern Weed Science Society, Boston, MA, January 4-5, 1995.
- SCHNEIDER, J.W., K.P. REESE, J.W. CONNELLY, J.H. KLOTT, and B.B. DAVITT. "Winter food habits of Columbian sharp-tailed grouse in southeastern Idaho." The Wildlife Society Second Annual Conference, Portland, OR, September 12-18, 1995.
- SERVELLO, F.A. "Effects of herbicides on moose." Northeast Moose Group Meeting, Ashland, ME, April 30-March 1, 1995.
- SERVELLO, F.A., B. GRIFFITH, K.S. RAYMOND, W.E. ESCHHOLZ, and W.B. KROHN. "Effects of glyphosate use in forest management on moose habitat in Maine: 1-2 and 7-11 years posttreatment." The 31st North American Moose Conference, New Brunswick, CANADA, May 1-2, 1995.
- SERVELLO, F.A., B. GRIFFITH, K.S. RAYMOND, W.E. ESCHHOLZ, and W.B. KROHN. "Effects of glyphosate on winter foraging ecology of moose in Maine." Second Annual Conference of The Wildlife Society, Portland, OR, September 12-15, 1995.

SERVELLO, F.A. "Potential of snow-urine indices as measures of deer wintering area quality." Deer Wintering Area Management Workshop, Ashland, ME, May 31, 1995.

PUBLIC TALKS PRESENTED

CHAPIN, T.G. "Influence of landscape pattern and forest type on use of habitat by marten in Maine." Seminar presented to Department of Wildlife Ecology, University of Maine, Orono, June 15, 1995.

deMAYNADIER, P. "Mount Toubkal National Park: A cooperative effort by the U.S. Peace Corps and the Moroccan Department of Natural Resources." Talk given to members of The Wildlife Society, University of Maine, November 15, 1995.

GILBERT, J.R. "Harbor seals in Maine." Talk given to Knights of Columbus, Hampden, Maine, October 12, 1994.

GILBERT, J.R. Interview with Maine Public Radio regarding harbor seals and gray seals in New England, April, 1995.

HARRISON, D.J. "The effects of scale on habitat selection." Guest speaker in graduate course on evaluation of wildlife habitats, University of Maine, Orono, October 7, 1994.

HARRISON, D.J. "Incorporating marten habitat requirements into forest management activities." Presentation and field tour, Cooperative Forestry Research Unit Annual Meeting, Millinocket, ME, September 20-21, 1995.

HARTLEY, M. "The world of birds." Wilderness Scouts, United Baptist Church, Old Town, ME, February 11, 1995.

HARTLEY, M. "The importance of wildlife research experience for undergraduates." University of Maine Student Chapter of The Wildlife Society, March 17, 1995.

HARTLEY, M. "Maine partners in flight." Colby College, Waterville, ME, May 24, 1995.

HODGMAN, T.P. "Pine Marten in New Hampshire." Interview for a nongame segment of New Hampshire Fish and Game Magazine, conducted by Brenda Sharpentier, November 15, 1994.

HUNTER, M.L. "Biodiversity and ecological reserves." National Audubon Society, Stowe, VT, April 27, 1995.

HUNTER, M.L. "Basic principles of ecology." USDA Forest Service, Televideo throughout southern U.S., May 10, 1995.

HUNTER, M.L. "Managing forest diversity at large spatial and temporal scales." Joseph Jones Ecological Research Center, Newton, GA, July 20, 1995.

HUNTER, M.L. Taught a session of forest ecosystem management. Silviculture Workshop, U.S. Forest Service, Asheville, NC, August 13, 1995.

HUNTER, M.L. "Managing forests at large spatial and temporal scales." USDA Forest Service, Clemson University, Clemson, SC, September 22, 1995.

- KROHN, W.B. Introduced a 22 minute video entitled "Secrets of the Fisher," at the Second International *Martes* Symposium, Edmonton, Alberta, August 13-16, 1995. The video, which documents recent fisher research at the University of Maine, was produced by the Maine Department of Inland Fisheries and Wildlife, and has been shown on public television throughout northern New England and eastern Canada.
- KROHN, W.B. "Fishers: forest specialist or generalist?" Penobscot County Conservation Association, Brewer, ME, September 7, 1995.
- KROHN, W.B. "What's new with fisher habitat research?" Department of Wildlife Ecology Seminars, University of Maine, Orono, September 20, 1995.
- LONG, R. "Annual survival and cause-specific mortality of white-tailed deer fawns, and relative abundance of snowshoe hare on Mount Desert Island, Maine." Seminar presented to Department of Wildlife Ecology, University of Maine, Orono, June 16, 1995.
- LONG, R. "Mortality of white-tailed deer fawns in Acadia National Park." Talk presented to research and management staff, Acadia National Park, Bar Harbor, ME, August 30, 1995.
- MATZ, A. "Acadia's bald eagles: recovery or decline?" College of the Atlantic Natural History Museum Summer Lecture Series, Bar Harbor, ME, July 26, 1995.
- MORING, J.R., and P.E. PETRIK. "The Lewis and Clark Expedition: integrating science, history, language, and sociology." ISIS Program Seminar Series, University of Maine, October 13, 1994.
- MORING, J.R. "Actress, teacher: the influence of Julia and Emelie Melville on the American theatre." Women in the Curriculum Seminar Series, University of Maine, November 29, 1994.
- MORING, J.R., and C.R. SCHWINTZER. "Using case studies: the Irish Potato Famine." ISIS Program Seminar Series, University of Maine, April 14, 1995.
- MORING, J.R. "Fishes of Maine." McGraw School, Hampden, ME, April 26, 1995.
- MORING, J.R. "Tidepool fishes." Head Start Program, Searsport, Maine: then accompanied students on a field trip to Moose Point State Park, July 19, 1995.
- MORING, J.R. "Fisheries research." Swan Lake Association, Searsport, ME, September 11, 1995.
- PAYER, D. "The National Park Service response to the Exxon Valdez oil spill." Talk given to the Student Chapter of The Wildlife Society, University of Maine, January 28, 1995.
- PAYER, D. "Necropsy techniques and condition indices for the white-tailed deer." Talk given to the members of WLE 410, University of Maine, April 17, 1995.
- SCHNEIDER, J.W. "Prey of peregrine falcons breeding in West Greenland." Talk presented to the Student Chapter of The Wildlife Society, University of Maine, Orono, January 31, 1995.
- SCHNEIDER, J.W. "Winter ecology of Columbian sharp-tailed grouse in Idaho." Wildlife Ecology Seminar Series, University of Maine, February 20, 1995.

SERVELLO, F.A. "Ecology of the Porcupine Caribou Herd in the Arctic National Wildlife Refuge."
Department of Wildlife Ecology Seminar Series.

SERVELLO, F.A. Speaker on a field trip for the Sportsman-Landowner Alliance of Maine sponsored by
Seven-Island Company, October, 12, 1994.

SERVELLO, F.A. "The ecology of the Porcupine Caribou Herd in the Arctic National Wildlife Refuge."
Presentation to the Western Maine Audubon Society, Farmington, ME, November 21, 1994.

SERVELLO, F.A. "Spruce Grouse Ecology in Acadia National Park." Presentation and field trip for the
Resources in Acadia Program, Acadia National Park, May 19, 1995.

WITHAM, J.W. "Holt Research Forest - A long term forest ecosystem study." Talk given to members of the
Merrymeeting Audubon Society, Bath Maine, October 24, 1995.

AWARDS, HONORS, AND APPOINTMENTS

BLACKWELL, B.F. Received the Maine General Alumni Association Award for assistance in travelling to a
professional conference to present research, October 26, 1994.

BLACKWELL, B.F. Received the Howard L. Mendall Memorial Scholarship for work with Migratory Birds,
April 1995.

CARTWRIGHT, M.A., and C.F. HARTLEB. Appointed Newsletter Editors, Northeastern Division, American
Fisheries Society.

deMAYNADIER, P. Elected to Phi Kappa Phi, 1995.

FOSS, C.R. Elected to Phi Kappa Phi, April 1995.

FOSS, C.R. Appointed to New Hampshire Forest Sustainability Standards Work Team, June 1995.

FOSS, C.R. Appointed Co-coordinator, New Hampshire Partners in Flight Working Group, September 1995.

HUNTER, M.L. Appointed by the Governor of Maine to the Maine Council on Sustainable Forest
Management.

HUNTER, M.L. Received a Pew Fellowship in Conservation and the Environment.

KROHN, W.B. Received a performance award from the USDI National Biological Service.

LOWELL, B. Summer Upward Bound employee with the Maine CFWRU, won the cash award for best oral
presentation of a research project, University of Maine Summer Upward Bound Program.

MORING, J.R. Received a performance award from the USDI National Biological Service.

MORING, J.R. Elected a Fellow of the American Institute of Fishery Research Biologists.

