

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

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UNIVERSITY OF MAINE

MAINE DEPARTMENT OF INLAND FISHERIES AND WILDLIFE

BIOLOGICAL RESOURCES DIVISION, U.S. GEOLOGICAL SURVEY

WILDLIFE MANAGEMENT INSTITUTE

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Compiled and Edited by  
William B. Krohn and Cynthia S. Loftin

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 Leader, Maine Cooperative Fish and Wildlife Research Unit, and Chair, Department of Wildlife Ecology.

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## **PERSONNEL AND COOPERATORS**

### **COORDINATING COMMITTEE**

Maine Department of Inland Fisheries and Wildlife  
Lee Perry, Commissioner

University of Maine

James R. Gilbert, Chairperson, Department of Wildlife Ecology, College of Natural Sciences, Forestry, and Agriculture

Christopher S. Campbell, Co-Chair, Department of Biological Sciences, College of Natural Sciences Forestry, and Agriculture

Susan Hunter, Co-Chair, Department of Biological Sciences, College of Natural Sciences Forestry, and Agriculture

USGS Biological Resources Division

Michael W. Tome, Supervisor, Cooperative Research Units

Wildlife Management Institute  
Scot J. Williamson, Northeastern Representative

## UNIT PERSONNEL

### Unit Staff:

William B. Krohn, Unit Leader, Professor of Wildlife Ecology, and Cooperating Professor of Zoology  
Vacant, Assistant Unit Leader for Fisheries  
Cynthia S. Loftin, Assistant Unit Leader for Wildlife and Assistant Professor of Wildlife Ecology  
Susan Anderson, Unit and USGS-LSC Administrative Assistant - Fisheries  
Nora Ackley, Unit Administrative Assistant II - Wildlife Ecology  
Theresa Libby, Secretary - Wildlife Ecology

### Associated Faculty and Staff, Departments of Wildlife Ecology and Biological Sciences:

Frederick A. Servello Chairperson, Department of Wildlife Ecology, College of Natural Sciences, Forestry, and Agriculture, Associate Professor of Wildlife Ecology  
Christopher S. Campbell, Chairperson, Department of Biological Sciences, College of Natural Sciences, Forestry and Agriculture, and Professor of Plant Systems  
William E. Glanz, Associate Professor of Zoology and Cooperating Associate Professor of Wildlife Ecology  
Susan E. Gerken, Research Associate, Wildlife Resources  
James R. Gilbert, Professor of Wildlife Ecology, and Cooperating Professor of Marine Sciences  
Daniel J. Harrison, Professor of Wildlife Ecology  
Jeff Hepinstall, Scientist, Wildlife Ecology  
Malcolm L. Hunter, Jr., Professor of Wildlife Ecology  
Raymond J. O'Connor, Professor of Wildlife Ecology  
Judith Rhymer, Assistant Professor of Wildlife Ecology  
Heather L. Rustigian, Associate Scientist, Wildlife Ecology  
Jerry R. Longcore, Research Wildlife Biologist, USGS and Faculty Associate, Wildlife Ecology  
Terry A. Haines, Professor of Zoology and Fishery Research Biologist, USGS  
Jack Witham, Assistant Scientist, Wildlife Ecology

### Maine Department of Inland Fisheries and Wildlife:

Lee E. Perry, Commissioner  
Frederick B. Hurley, Jr., Deputy Commissioner  
Kenneth D. Elowe, Director, Bureau of Resource Management  
G. Mark Stadler, Director, Wildlife Division  
Peter M. Bourque, Director, Fisheries and Hatcheries Division  
George J. Matula, Jr., Supervisor, Wildlife Resource Assessment Group  
Eugene A. Dumont, Supervisor, Regional Wildlife Management Section  
Kendall Warner, Supervisor, Fisheries Research and Management Section

## GRADUATE STUDENTS

<b>Name</b>	<b>Degree Candidacy</b>	<b>Support</b>
Volker Bahn	Ph.D.	BRD, MCFWRU, U of M
Michael S. Bank	Ph.D.	USGS-BRD, U of M, NPS, DAPTF, ENR

Sarah C. Billig	M.S.	MCCS, NSFA, PCTC
Pamela Bryer	M.S.	NPS- ANP
Steven P. Campbell	Ph.D.	HWRF, U of M
Rebecca Chalmers	M.S.	USGS-BRD, U of M, NPS
Sharon Fleming	M.S.	MASC, NMFS
Carol R. Foss	Ph.D.	U of M, USFWS, SEFP, MCS, USFS
Angela K. Fuller	Ph.D.	MDC
Merry Gallagher	Ph.D.	MDMR, MDIFW, U of M
Brian J. Hearn	Ph.D.	U of M, NRC-CFS, NDFRA-WD, WNMF, CPP, AC
Shane Heath	M.S.	U of M, USFWS, FPL, MDIFW
Tara Y. Henrichon	M.S.	USGS-BRD, U of M
Jessica A. Homyack	M.S.	MCFRU, NCASI, USFWS
Shannon Kearney	M.S.	U of M, USFWS, FPL, MDIFW
Morgan Kelly	M.S.	MDIFW, MOHF, SPP, USFWS, U of M
Jon McCloskey	Ph.D.	USGS-BRD, U of M, USFWS
Joanna L. Murray	M.S.	MDIFW, MOHF, FWS, U of M, MCS
Dawn L. Nelson	Ph.D.	HWRF, U of M
Marcy Nelson	M.S.	NMFS, U of M, MDMR
Stephanie L. Orndorff	M.S.	USGS-BRD, MCFWRU, U of M, MOHF
Dustin W. Perkins	Ph.D.	U of M, MCS, MCCS, CFRU, PCTC, IP, MP
Jordan Perkins	M.S.	U of M, MOHF, MDIFW
Steven C. Renner	M.S.	COA, U of M
Teresa M. Sauer	M.S.	USFWS, U of M
Emily G. Schilling	Ph.D.	NSF, MOHF, MDIFW
James Stahlnecker	M.S.	MDMR, MDIFW
Carol A. Strojny	M.S.	USDA, USFS, U of M
Dale A. Tyson	M.S.	U of M, USGS-BRD

## DISSERTATIONS AND THESES COMPLETED THIS PERIOD

Student	Degree Candidacy	Support
Amy Gullo	M.S.	U of M, NPS
Mitschka J. Hartley	Ph.D.	U of M, MDIFW, USDA, USFS, COS, AWRP
Jennifer M. Lowry	M.S.	U of M, MDIFW, MOHF, PCCA
Sandra M. Schaefer	M.S.	GAP, USGS- BRD, MCFWRU, U of M
Emily G. Schilling	M.S.	MDIFW, U of M
Shelley Spohr	M.S.	NWTF, WF, UM, CDEP

## PERSONNEL NOTES

**AMY GULLO** received her M.S. degree in Zoology and is currently exploring employment options. **MITSCHKA HARTLEY** received his Ph.D. degree in Wildlife Ecology and is employed by the National Audubon Society, as a wildlife and forest ecologist in the New York State office. He is leading a research project to determine how forest harvest intensity affects bird, amphibian, and carrion beetle communities in northern hardwood forests. **JENNIFER LOWRY** received her M. S. degree in Wildlife Ecology and is employed by Jackson Laboratory in Bar Harbor, ME. **SANDRA SCHAEFER** received her M.S. degree in Wildlife Ecology and is employed by James W. Sewall Company in Old Town, ME. **EMILY GAENZLE SCHILLING** received her M.S. degree in Ecology and Environmental Sciences and is now a Ph.D. student in Ecology and Environmental Sciences, University of Maine.

**SHELLEY SPOHR** received her M.S. degree in Wildlife Ecology and is employed by the Department of Natural Resources at the Mashantucket Pequot in Mashantucket, CT.

It is with great regret that we note the death of **Dr. John R. Moring**, the Maine Unit's Assistant Leader for Fisheries. After almost two decades of faithful service to the Maine Unit, John died unexpectedly in May 2002 and is greatly missed by many. John's obituary was published in the July 2002 issue of *Fisheries*.

## **COLLABORATING AGENCIES AND ORGANIZATIONS**

Abitibi Consolidated - AC  
American Wildlife Research Foundation - AWRF  
Audubon Society of New Hampshire - ASNH  
Boise Cascade - BC  
College of the Atlantic – COA  
    Allied Whale - AW  
Connecticut Department of Environmental Protection -  
    Wildlife Division - CDW  
Cooper Ornithological Society - COS  
Corner Brook Pulp & Paper - CPP  
Crown Vantage Inc. - CVI  
Declining Amphibian Population Task Force - DAPTF  
Eastern National Park Research Fund - ENPRF  
Florida Caribbean Science Center - FCSC  
Florida Power Light Energy - FPL  
Holt Woodlands Research Foundation - HWRF  
International Paper - IP  
James River - JR  
Lake Umbagog National Wildlife Refuge - LUNWR  
Maine Atlantic Salmon Commission - MASC  
Maine Audubon Society - MAS  
Maine Bureau of Public Lands - MBPL  
Maine Chapter of the Nature Conservancy - MCNC  
Maine Department of Inland Fisheries and Wildlife - MDIFW

Maine Department of Marine Resources - MDMR  
Maine Outdoor Heritage Fund - MOHF  
Manomet Center for Conservation Sciences - MCCC  
Mead Paper - MP  
National Council of the Paper Industry for Air and Stream Quality Improvement - NCASI  
National Fish and Wildlife Foundation - NFWF  
National Science Foundation - NSF  
    GK-12 Teaching Fellowship –GK-12TF  
National Wild Turkey Federation -  
    Connecticut Chapter - CCNWTF  
Natural Resources Canada - NRC  
    Canadian Forest Service -CFS  
New Hampshire Fish and Game Department - NHFG  
New Hampshire Department of Resources and Economic Development -  
    Division of Forests and Lands – NHDFL  
Newfoundland Department of Forest Resources and Agrifoods  
    Wildlife Division - NDFRA  
Penobscot County Conservation Association - PCCA  
Plum Creek Timber Company - PCTC  
Rachel Carson National Wildlife Refuge - RCNWR  
Seven Islands Land Company - SILC  
Switzer Environmental Fellowship Program - SEFP  
University of Maine - U of M  
    Association of Graduate Students - AGS  
    College of Natural Sciences, Forestry, and Agriculture – NSFA  
    Sea Grant Program - SGP  
        Cooperative Forestry Research Unit - CFRU  
        Department of Biological Sciences - DBS  
        Department of Forest Ecology - DFE  
            Forest Ecosystem Research Program - FERP  
        Department of Wildlife Ecology – DWE  
            Faculty Research Fund - FRF  
        Forest Ecosystem Science - FES  
        McIntire-Stennis - MCS  
    Maine Agricultural and Forest Experiment Station - MAFES  
U.S. Department of Agriculture - USDA  
    Forest Service – USFS  
        Penobscot Experimental Forest - PEF  
        National Research Initiative Competitive Grants Program - NRICGP  
U.S. Department of Commerce - USDC  
    National Marine Fisheries Service - NMFS  
U.S. Department of the Interior - USDI  
    U.S. Fish and Wildlife Service - FWS  
        Neotropical Migratory Bird Program - NMBP  
        Moosehorn National Wildlife Refuge - MNWR  
        Partnerships for Wildlife Program - PWP  
        Region 5 - R5  
    USGS Biological Resources Division - BRD  
        Cooperative Park Studies Unit - CPSU

Gap Analysis Program - GAP

Maine Cooperative Fish and Wildlife Research Unit - MCFWRU

National Park Service - NPS

Acadia National Park – ANP

Patuxent Wildlife Research Center - PWRC

State Partnerships Program - SPP

Wagner Forest Management, Ltd. - WFM

Western Newfoundland Model Forest - WNMF

Wildlife Forever - WF

## ENDANGERED AND THREATENED SPECIES:

### POPULATION ECOLOGY OF BLACK TERNS IN MAINE

- Investigator:* F. A. Servello
- Cooperators/  
Project  
Support:* University of Maine -  
Department of Wildlife Ecology  
Maine Department of Inland Fisheries and Wildlife  
U.S. Fish and Wildlife Service, Partnerships for Wildlife Program  
Maine Outdoor Heritage Fund  
Florida Power Light Energy
- Objectives:*
- 1) Determine the annual local survival of breeding adult black terns (*Chlidonias niger*) in Maine, site fidelity to individual wetlands, and movement rates among wetlands.
  - 2) Determine breeding success at black tern colonies and factors influencing rates of nest and chick losses.
  - 3) Determine the relative effects of demographic parameters on population rates of change for black terns using demographic models, and use stochastic modeling to evaluate extinction risk and management strategies.

*SCOPE:* The black tern was formally state-listed as an endangered species in Maine in 1997, a legal status it also has in a number of states in the northern U.S. In Maine and the northeastern U.S., black tern populations are disjunct from the core breeding range in North America and are relatively small. The Maine population has approximately 75-100 breeding pairs distributed among 6-8 colony sites. With a few exceptions studies of black tern ecology in North America have focused on nest success, nesting habitat, and breeding behavior, apparently because the low and variable reproductive success may be a contributing factor in the slow recovery of this species and the low densities in peripheral regions such as the northeastern U.S. Information on recruitment, survival, and site fidelity needed to examine population dynamics issues is insufficient. Other than annual census data, little is known about the basic population characteristics or limiting factors of black terns in Maine. This project will provide information needed to assess the vulnerability of the existing population to extinction and management strategies for increasing population size.

*PROJECT STATUS:* The sixth year of field work has been completed. Nest success has been measured in 6-7 colonies and fledging success has been measured in 2-6 colonies each year. Movement rates and patterns as well as survival estimates are being determined from banding studies. A population model for black terns has been completed and used to evaluate priorities for population research. Evaluation of management strategies via modeling analyses is in progress.

*FUTURE PLANS:* Completion of final technical reports in 2003.

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### INFLUENCE OF FOREST PRACTICES ON STAND- AND SUB-STAND SCALE HABITAT SELECTION OF LYNX IN NORTHERN MAINE

- Investigator:* A. K. Fuller
- Advisors:* D. J. Harrison, Chair  
W. E. Glanz  
W. B. Halteman  
W. B. Krohn  
J. Wilson
- Cooperators/* Maine Cooperative Forestry Research Unit

*Project Support:* Maine Department of Inland Fisheries and Wildlife  
Maine Agricultural and Forest Experiment Station  
U. S. Fish and Wildlife Service  
Maine Chapter of The Nature Conservancy

*Objectives:*

- 1) Evaluate stand-scale habitat selection by lynx using snowtracking.
- 2) Develop a model to determine which habitat variables best predict sub-stand scale habitat selection by lynx across a range of forest types.
- 3) Describe substand-scale features of rest sites used by lynx and lynx activities.
- 4) Describe spatial-use and movement patterns of lynx.

*SCOPE:* This project will utilize radiocollared lynx, representing the only verified population in the eastern United States, to evaluate the effects of forest practices on this federally threatened species. Lynx (*Lynx canadensis*) occur across much of the northern United States and Canada, but little is known about lynx-habitat relationships in eastern North America. Results of the few habitat studies conducted on lynx throughout their North American range have been extrapolated to areas with potentially unique ecologies, including differences in climate, prey abundance, predator-prey communities, and rates of forest succession. Because precommercial thinning (PCT) is commonly practiced in Maine, and has been previously associated with reduced abundances of snowshoe hares, it is important to determine the direct and indirect effects of silvicultural practices such as PCT on habitat choice by wide ranging species that depend on hares, such as lynx. Silvicultural practices that create early successional stages may increase densities of snowshoe hare and associated foraging opportunities for lynx. However, habitat use by lynx may be associated with more than just access to snowshoe hare, such as overstory and understory features related to protection from predation. Determining sub-stand scale habitat selection by lynx will be useful for evaluating the effects of alternative silvicultural practices on lynx and their prey.

*PROJECT STATUS:* Three lynx (2F, 1M) were snow tracked for 31.8 km between 4 January and 28 March 2002 and random straight-line transects were sampled within the home ranges of the three lynx for 55 km. Vegetation was sampled with 341 plots along the lynx trail and within 605 plots along random transects. The second winter field season is scheduled for winter 2002-2003.

*FUTURE PLANS:* the final field season will be conducted during winter 2002-2003, and a final report is scheduled to be completed by 2004.

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## THE EFFECTS OF PREDATION ON NEST SUCCESS AND CHICK SURVIVAL OF BLACK TERNS IN MAINE

*Investigator:* S. R. Heath

*Advisors:* F. A. Servello, Chair  
C. S. Loftin  
W. E. Glanz  
M. A. McCollough

*Cooperators/  
Project Support:* University of Maine  
U. S. Fish and Wildlife Service  
Florida Power Light Energy-Maine Hydro  
Maine Department of Inland Fisheries and Wildlife

*Objective:*

- 1) Determine the effects of microhabitat at nest sites, wetland-scale characteristics, and nest dispersion on predation of black tern nests.
- 2) Identify patterns of disturbance in black tern colonies during incubation, with an emphasis on the nocturnal period.
- 3) Determine if predation limits fledging rate.

*SCOPE:* Understanding the factors that limit nest and fledgling success is critical for designing conservation strategies for black terns in Maine. Previous research in Maine suggests that nest predation, water levels at colony sites, and nest location may be interrelated. We will use one year of nesting data that we collected in 2002 along with data previously collected in 1997-2001 in a multivariate analysis of the habitat and nest variables that may influence the probability of nest predation. Some stand and landscape-level variables will be measured using geographic information systems, aerial photography, and National Wetland Inventory maps.

Previous research on black tern colonies in Maine have indicated that food resources are not limiting the growth of black tern chicks, suggesting that predation may be a primary cause of chick loss. Predator enclosures and chick growth analyses will be used to determine chick survival and growth in the absence of predation. In addition patterns of disturbance and nest attentiveness will be measured at individual nests through use of temperature sensors placed in the nest cup.

*PROJECT STATUS:* The fieldwork has been completed. In 2002, nesting data were collected for approximately 90 nests in 6 colonies. Data on growth and survival were collected from a total of 30 predator enclosures and 60 chicks. GIS analysis of the full six years of nesting data will be undertaken in summer 2003.

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## FACTORS AFFECTING LEAST TERN PRODUCTIVITY IN MAINE

*Investigator:* J. C. Perkins

*Advisors:* F. A. Servello, Chair  
J. M. Rhymer  
J. Kelley  
M. A. McCollough

*Cooperators/  
Project  
Support:* University of Maine  
Maine Outdoor Heritage Fund  
Maine Department of Inland Fisheries and Wildlife  
Rachel Carson National Wildlife Refuge  
Maine Audubon Society

*Objective:*

- 1) Determine rates for major reproductive parameters of the least tern population in Maine including clutch size, hatchability, nest success, chick survival, and fledgling success.
- 2) Evaluate management alternatives for increasing least tern productivity.
- 3) Determine rates of nest losses to predators, storm tides, and other factors, and identify predator species if possible.
- 4) Determine temporal patterns and intensity of predator and non-predator disturbances at the largest Maine colony (Crescent Surf Beach) during the incubation period, with an emphasis on predator activity.
- 5) Document spatial patterns of nest losses within colonies due to predation, storms, and other factors.
- 6) Examine temporal patterns in vegetation, shape, and other characteristics of beaches used by least terns for nesting, and determine relationships with colony occurrence.

*SCOPE:* The least tern is a state-listed endangered species in Maine. Historically, there may have been as many as 20 potential nesting sites within Maine. In the last 25 years, there have been only 12 sites on which least terns have produced successful nests, and only seven sites have produced successful nests in the last five years. The goals of this project are to understand the factors influencing population growth and occurrence in Maine and to provide information on nesting ecology, predation, and disturbance for making recommendations on future management.

*PROJECT STATUS:* The first year of field work has been completed. In 2002, a total of 235 nests were monitored in four colonies. We documented clutch size, hatchability, and nest success for all nests and determined causes of

nest loss. Fledgling success and departure from colony sites were recorded for 103 color-banded chicks at two colonies. We tested the use of temperature data loggers to monitor nest attentiveness, and plan to expand this study in 2003.

*FUTURE PLANS:* A second year of field work will be conducted in 2003.

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## **FISHERIES RESOURCES:**

### **RELATIONSHIPS BETWEEN STREAM GEOMORPHOLOGY AND FISH COMMUNITY STRUCTURE AND DIVERSITY IN MAINE**

*Investigator:* E. G. Schilling

*Advisors:* J. R. Moring, Chair  
A. D. Huryn  
J. G. Trial

*Cooperators/  
Project  
Support:* Maine Department of Inland Fisheries and Wildlife  
Maine Cooperative Fish and Wildlife Research Unit  
University of Maine – Department of Biological Sciences

*Objective:* To supplement existing databases with field measurements to determine whether fish community structure can be predicted by measurements of stream habitat characteristics.

*SCOPE:* The State of Maine has stream survey data for a number of coolwater streams in the state. By incorporating other stream habitat types into a more extensive data base, we hope to find trends for predicting the fish community composition and numbers associated with a spectrum of habitats. The supplemental field work was completed in 2001.

*PROJECT STATUS:* All requirements for a M. S. degree in Ecology and Environmental Sciences were met in August 2002. The thesis abstract follows:

Predicting patterns in species distribution and abundance for resource management and conservation is a major focus of applied ecology. The primary objective of this study was to determine if there is a predictable relationship between stream geomorphology and fish community structure, native species richness, and native salmonid abundance in Maine. Specifically, I examined relationships between fish assemblages and geomorphic stream types, as delineated by the Rosgen classification system (Rosgen 1996). Fifty-three stream reaches in Maine were classified, and fish communities within the reaches were characterized using backpack electrofishing. Species richness was lowest in A-type streams (i.e., steep, entrenched, confined) which supported brook trout (*Salvelinus fontinalis*) and slimy sculpins (*Cottus cognatus*). Richness was highest in C-type streams (i.e., low gradient, meandering with broad, well defined flood plains). Salmonids were in greatest abundance in B- (i.e., moderately entrenched, moderate gradient) and C-type streams.

A secondary objective was to identify environmental correlates of fish community structure using a geographic information system (GIS). Specifically, I examined relationships between fish community attributes (e.g., species richness, species distribution) and watershed landcover, proximity to dams, biophysical region, and elevation. Fish species richness was negatively correlated with elevation and was significantly different among different biophysical regions in the state. Atlantic salmon (*Salmo salar*) distribution was significantly correlated to watershed landcover.

The ability to predict species distribution and abundance based on physical stream characteristics and biophysical region has important implications for watershed and fisheries management. Collecting data on geomorphic variables is more efficient and is less invasive than sampling fish communities through the use of electrofishers and gill nets. GIS is an important tool that can be used to predict species richness and distribution. Data on broad-scale environmental variables, such as landcover and elevation, are easily obtained using GIS coverages, thus reducing the need for extensive field work. Ultimately, the ability to identify which stream reaches may contain diverse fish assemblages and/or abundant salmonid populations will contribute to decision-making for

watershed conservation and channel restoration efforts.

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## THE VALUE OF ROCKWEED (*Ascophyllum nodosum*) AS HABITAT FOR TIDEPOOL FISHES

*Investigator:* A. Gullo

*Advisors:* J. R. Moring, Chair  
M. L. Hunter  
R. L. Vadas

*Cooperators/  
Project  
Support:* Maine Department of Inland Fisheries and Wildlife  
University of Maine – Department of Biological Sciences  
National Park Service

*Objective:* To document the fish communities associated with rockweed (*Ascophyllum nodosum*) at several locations along the coast of Maine, and demonstrate how algal height affects biodiversity.

*SCOPE:* Rockweed is now being harvested in great quantities along the coast of New Brunswick, and such harvesting is increasing in Maine. Studies in Canada have indicated that juvenile pollock (*Pollachius virens*) utilize patches of rockweed as refuges from predators. Rockweed also serves to concentrate prey items for inshore fishes, and there is some selection of the algae for attachment by lumpfish (*Cyclopterus lumpus*) and other fishes. Recently, environmental groups have expressed concern that extensive commercial harvesting of rockweed may harm fish and invertebrate nursery communities along the coast of Maine. This project attempts to document the specific animals associated with rockweed and their dependence on this marine algae.

*PROJECT STATUS:* All requirements for a M. S. degree in Zoology were met in August 2002. The abstract follows:

Tidepool fishes are an interesting and commercially valuable guild of fishes that reside in tidepools at low tide. Tidepool fishes of the North Atlantic Coast reside in tidepools only during the late spring to fall months, and are typically juveniles of subtidal adult species. Tidepool fishes on the Pacific Coast of North America have been studied extensively, but species of the North Atlantic Coast have rarely been studied. An important area of study is the use of different tidepool microhabitats by fishes, specifically the use of rockweed (*Ascophyllum nodosum*) fringe, which is present in many tidepools. Rockweed is an algal species that grows extensively on the North Atlantic Coast, and it is important due to the current commercial harvest of rockweed along many shores, including the coast of Maine. The objectives of this study were to document the presence of fish species within the rockweed fringe, and to assess the short-term effects of experimental removal of rockweed fringe.

The study took place along the coast of Maine during the summer of 2001 at three sites: Schoodic Point, Great Wass Island, and Quoddy Head. Fishes and invertebrates were sampled in nine tidepools at each site on three occasions before treatment. Previously assigned experimental treatments (no removal, half removal (fringe length of 15cm), or full removal of the rockweed fringe) were then performed. Four sampling periods followed treatment to assess short-term effects on fishes, invertebrates, and physical characteristics of the pool.

At least 5 species of fishes, *Cyclopterus lumpus*, *Myoxocephalus scorpius*, *Myoxocephalus aeneus*, *Pholis gunnellus*, and *Liparis atlanticus*, utilize rockweed fringe habitat. Experimental results are unclear due to high variation within treatments because of the high variability between individual tidepools. However, rockweed was found to host high numbers of invertebrates commonly preyed upon by tidepool fishes, and thus we assume that the removal of rockweed can have impacts on the food base available to fishes. Physical and behavioral characteristics of these fishes, specifically camouflage and modes of attachment, indicate that these species are well adapted to utilizing the habitat, perhaps as a refuge from predators. Rockweed is a species of algae that is vitally important to marine life, and this study has implications for the regulation of commercial rockweed harvesting.

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## INVENTORY OF INTERTIDAL AND ESTUARINE FISHES OF ACADIA NATIONAL PARK

- Investigators:* P. Bryer  
A. Jordan
- Supervisor:* L. J. Kling
- Cooperators/  
Project Support:* National Park Service - Acadia National Park  
University of Maine - School of Marine Sciences  
Maine Cooperative Fish and Wildlife Research Unit
- Objectives:*
- 1) To inventory fish species found in tidepools at locations adjacent to Park lands on Mount Desert Island and Schoodic Peninsula, and
  - 2) To conduct more detailed inventories of estuarine fishes at Northeast Creek, Frazer Creek, Bass Harbor Marsh, and up to 10 other locations over different seasons and estuarine locations.

*SCOPE:* Acadia National Park (ANP) is part of the National Park Service's Northeast Temperate Network, and inventory and monitoring activities are becoming increasingly important to the long-term management goals of ANP. Summaries of past studies of freshwater fish resources of ANP have been issued (Bowes et al. 1999) and more detailed inventories (with relative abundance assessments) are undergoing final reviews (Moring et al. 2001). However, detailed inventories of fishes of estuaries and intertidal areas adjacent to Park lands are limited.

Fishes inhabiting these mixing areas between the land and ocean are extremely important components of ecosystems (Edwards et al. 1982). Estuaries are typically the most productive regions of coastal waters, and tidepools serve important nursery and refuge functions for many commercially-important species of marine fishes in Maine waters, such as juvenile pollock (*Pollachius virens*), Atlantic herring (*Clupea harengus*), winter flounder (*Pleuronectes americanus*), and lumpfish (*Cyclopterus lumpus*). As a consequence, future Park management may rely heavily on baseline inventories of species presence and their relative abundance.

In this project fishes are being inventoried during two field seasons, 2001 and 2002. This is strictly an inventory process and is not intended to be a long-term monitoring protocol. Thus, quantitative sampling procedures that will allow for repetitive comparisons in future years will not be utilized. Rather, the objective is to sample as many diverse habitats as possible in the intertidal and estuarine zones to maximize the resultant species lists.

*PROJECT STATUS:* Most of the field work has been completed for this project with the exception of recording GPS locations of some of the sampled intertidal areas and all of the sampled estuary sites.

*FUTURE PLANS:* The recording of GPS locations will be completed during the spring of 2003. The field notes for 2002 will be entered into Microsoft Access database. Progress report and manuscript on intertidal fishes will be prepared.

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## INVESTIGATIONS INTO THE CULTURE OF RAINBOW SMELTS

- Investigator:* Michael Hachey
- Supervisor:* L. J. Kling  
M. Gallagher
- Cooperators/  
Project Support:* University of Maine - School of Marine Sciences  
Aquaculture Research Center  
Maine Department of Inland Fisheries and Wildlife

## Maine Cooperative Fish and Wildlife Research Unit

*Objective:* To demonstrate a cost-effective and environmentally friendly method for rearing rainbow smelts in intensive re-circulating aquaculture systems that will allow individuals to hatch and grow disease free smelts as an additional source for the retail baitfish market.

*SCOPE:* Rainbow smelt (*Osmerus mordax*) are an anadromous species native to eastern North America. The historic distribution encompasses the Atlantic coastal drainage from New Jersey to Labrador with a few native landlocked populations occurring within this range (Scott and Crossman 1973). Native rainbow smelt stocks support important commercial and recreational fisheries in Maine as well as significantly contribute to estuarine food web dynamics of coastal waterways. However, the anadromous life history coupled with the nature of the fisheries, place this species at great risk of overexploitation. Because demand as recreational sportfish, commercial baitfish and for the human food market continues to be high, we propose to culture this multi-purpose fish in order to relieve the current levels of exploitation on the native spawning populations.

Historically, Gulf of Maine stocks of rainbow smelt supported significant commercial fisheries in Maine (T. Squiers and H. Ryder, Maine Department of Marine Resources [MDMR], pers. comm.). At the turn of the twentieth century, U.S. catches of Gulf of Maine smelt exceeded 1.2 million pounds annually (MDMR, 1994). Recent trends indicate a significant decline in the commercial catch of rainbow smelt in Maine as well as Atlantic Canada. Although smelt landings are only voluntarily reported in Maine, anecdotal evidence supports both a decline of anadromous spawning runs (T. Squiers, MDMR pers. comm. and extreme under-reporting of commercial catches (H. Ryder, MDMR, pers. comm.).

Currently, the commercial fishery in Maine is largely driven by the baitfish market (Frost and Trial 1993, Kircheis 1998). Commercial smelters provide smelt primarily for sportfish anglers to use as live bait. The estimated value of rainbow smelt used as bait in Maine was \$2.71 million in 1991 (Kircheis 1998). Commercial harvesters target both inland and anadromous runs, and both are used to supply the existing market. Economic estimates consistently illustrate a shortfall between supply and demand (Frost and Trial 1993, M. Gallagher, Maine Department of Inland Fisheries and Wildlife [MDIFW], unpubl. data). This sentiment is also re-iterated by smelt retailers and wholesalers (O. Fenderson 1992, MDIFW, unpubl. data, and M. Gallagher, MDIFW, pers. comm.). Compounding this shortfall, MDIFW does not allow the importation of live baitfish from other states.

In addition, the smelt recreational fishery is regulated by a two-quart daily catch limit with no record of numbers of actual participants or reporting requirements. Anadromous rainbow smelt are legally caught in winter months through the estuarine ice in a hook and line fishery with no catch limit. Additionally, rainbow smelt can be dip netted 2-quart daily limit while on their spawning migration. Fishing opportunities of some individual runs are further restricted due to closure by MDIFW or MDMR.

A current survey being conducted by MDIFW (with a 17% return rate to date) revealed an average statewide retail price of \$5.89/doz and an average sales rate of 110 dozen per week, with January through May being the primary season for baitfish sales. Of the survey respondents, 70% of the retailers thought that summer sales were possible with adequate supply. Ninety three percent of retailers reported an interest in a culture option. Sixty seven percent of the wholesalers (those people licensed to fish wild populations expressed an interest in learning culture techniques, but only 47% of wholesalers would rather culture fish than capture wild stocks.

The first attempts at culturing the rainbow smelt began in the 1860s, by Charles G. Atkins with eggs from Messalonskee Lake (Kendall 1926). Since this period, limited amounts of success have been achieved using various culture techniques. More commonly, smelt eggs are deposited in ponds, and the hatched larvae feed on existing plankton sources. Intensive culture has been less successful because of limitation on live food production and/or poor nutritional quality of the live food. Moreover, weaning of the fish onto a commercially prepared diet has been problematic resulting in almost total mortality (Moring, 1997, Moring, pers. comm. 2002). Baskerville-Bridges (pers. comm.), a former graduate student of this laboratory, has demonstrated the first ever weaning success of the Delta smelt. In this project we will demonstrate cost-effective production techniques to produce Rainbow smelts, starting with techniques we have found to be successful with other marine larval fish which we will modify to use with the Rainbow smelt.

*PROJECT STATUS:* Preliminary trials were conducted in May 2002. Eggs and milt were collected from wild rainbow smelt and brought to the Aquaculture Research Center (ARC) at the University of Maine in Orono. In addition wild smelts were captured and brought to ARC for spawning. Both stripping of eggs and milt and natural spawning were successful. Larvae were fed enriched rotifers and some successful survival was achieved.

*FUTURE PLANS:* In Central Maine, gamete and spawning fish collection is possible from mid-March through the end of May. This spring (2003), we will evaluate the efficacy of new chemicals for their effectiveness in controlling fungal growth on the eggs, since this was shown to be a problem in our preliminary trials. In addition we will evaluate commercial live food enrichment products to optimize nutritional quality of the live food organisms for larval smelts. And finally, we will develop an optimal weaning strategy for moving the fry from live food to a commercially prepared larval diet.

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## MOVEMENTS OF AMERICAN EELS IN FRESHWATER LAKES

*Investigator:* M. Gallagher

*Advisors:* W. E. Glanz , co-chair  
J. G. Trial, co-chair  
A. D. Huryn  
J. D. McCleave  
F. W. Kircheis

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

*Objective:* To document seasonal and daily movement patterns of American eels and relate these movements to habitat and environmental conditions.

*SCOPE:* Little is known about the commercially-important American eels in their freshwater residence, especially their habitat selection and patterns of movement. This project captured eels and tracked their movements using surgically-implanted radio transmitters. In Year 1, all field work was conducted in Hermon Pond. In Year 2, the studies were expanded to include several other ponds, along with habitat mapping of ponds.

*PROJECT STATUS:* All field work has been completed and the dissertation is being written.

*FUTURE PLANS:* Analysis of data will be completed during 2001-2002. A Ph.D. dissertation is expected in May 2003.

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## ALTERNATIVE METHODS FOR ENUMERATING JUVENILE ATLANTIC SALMON (*Salmo salar*) AND STUDYING THEIR DISTRIBUTION IN MAINE RIVERS

*Investigator:* S. L. Fleming

*Advisors:* K. E. Webster, Co-chair  
J. R. Trial, Co-chair  
J. F. Kocik

*Cooperators/  
Project  
Support:* Maine Atlantic Salmon Commission  
National Marine Fisheries Service  
Maine Cooperative Fish and Wildlife Research Unit

*Objective:*

- 1) Test three alternative techniques for estimating juvenile Atlantic salmon populations in Maine rivers as possible replacements for electrofishing; and
- 2) Develop density distributions of juvenile Atlantic salmon as related to physical parameters of sites.

*SCOPE:* Atlantic salmon populations in eight Maine rivers have been placed on the Endangered Species List. The common method of assessing stream populations of juvenile salmon is backpack electrofishing – a potentially harmful technique. This project observes juvenile Atlantic salmon in various river conditions using the less invasive techniques of snorkeling, streamside viewing, and overhead observation. In addition, while conducting the snorkeling technique, locations of fishes were flagged and density distributions for the site were analyzed.

*PROJECT STATUS:* All fieldwork has been completed and data are being analyzed.

*FUTURE PLANS:* A Master of Science thesis is expected to be completed in May 2003. A manual detailing methods for conducting juvenile Atlantic salmon surveys using the snorkeling technique will be prepared for the Maine Atlantic Salmon Commission.

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## **HABITAT RESOURCES:**

### **ASSESSMENT OF METHODS FOR TESTING THE RELIABILITY OF WILDLIFE OCCURRENCE MODELS USED IN GAP ANALYSIS**

*Investigator:* S. M. Schaefer

*Advisors:* W. B. Krohn, Chair  
D. J. Harrison  
S. A. Sader  
R. B. Boone (*ad hoc* member)

*Cooperators/  
Project  
Support:* U. S. Geological Survey, Biological Resources Division - Gap Analysis Program  
Maine Cooperative Fish and Wildlife Research Unit  
Department of Wildlife Ecology, University of Maine

*Objectives:*

- 1) Determine if there is a relationship between the percent of errors reported and the type of test data available (long-term versus short-term field inventory), the size of test site, and definition of what constitutes a breeding species.
- 2) Determine if the commission errors reported for predicted occurrences of avian species from Maine Gap Analysis related to *a priori* measures of ease of inventory termed Likelihood Of Occurrence Ranks.
- 3) Partition out the potential sources of error (i.e., range limits, habitat map, habitat model) in the predicted avian occurrences using the Breeding Bird Survey as the standard of comparison.

*SCOPE:* Predicted vertebrate occurrences from gap analysis, a national program of the USGS Biological Resources Division, are currently tested by comparison with existing species lists for a selected conservation area. The reporting of omission error (percentage of species that occur on the area but are not predicted) and commission error (percentage of species not reported on an area that are predicted) for a state project gives an indication of how well the models and data layers used correctly predicted species occurrences. Limitations associated with the current method of accuracy assessment range from variability in the size of test sites used, to the difficulty that comes with trying to qualitatively interpret the omission and commission error. The purpose of this research is to explore these limitations and questions so that future tests of predicted vertebrate occurrences can be strengthened.

*PROJECT STATUS:* All requirements for a M. S. degree in Wildlife Ecology were met in August 2002. The abstract follows:

Habitat association models designed to predict species occurrence are often tested by used by comparing predictions to field observations. Two types of error are then reported, omission (% of species not predicted but present on a site) and commission (% of species predicted but not present on a site). The purpose of this research

was to assess the Maine Gap Analysis vertebrate predictions using the traditional site-specific approach and to determine what factors influence the amounts of error reported. I also developed a species-specific approach for testing the accuracy of the vertebrate predictions and compared these results to the site-specific method.

When tested with the site-specific approach, the Maine Gap habitat models were found to have low omission errors (medians across all sites: 0.0% for both amphibians and birds, 10.0% for reptiles, and 5.4% for mammals) and higher commission errors (medians across all sites: 0.0% for amphibians, 5.0% for reptiles, 18.9% for mammals, and 91.9% for birds). Error rates were influenced by factors such as test site size and survey length, how species are defined as present, and how likely a species is to be observed during a field survey. Using a liberal definition of avian occurrence on a site increased omission error with a corresponding decreased in commission error. As test site size and field survey length increased, commission error decreased ( $p > 0.003$ ). How likely a species is to be observed during a field survey also influenced commission error. Using an *a priori* ranking system called Likelihood Of Occurrence Ranks (LOORs) the commission error for birds decreased as the species' LOOR increased ( $p = -0.87$  to  $-1.0$ ).

To date, testing of multiple-species predictions has focused on calculating site-specific error rates. Omission and commission errors are reported by taxonomic class for each site and across the entire state. An alternative approach would be to use the same data to look at the discrepancies for each species across all of the test sites. This approach would compare the predictions to field records of presence or absence for each species on sites within their range limit. Assumptions of data completeness were used to calculate error ranges that indicated model performance and variability of the error for each species. Commission *error range* was significantly correlated with species distribution ( $p = -0.583$ ,  $P < 0.000$ ), as well as with the likelihood of detecting a species in the field ( $p = -0.657$ ,  $P < 0.000$ ). In cases where high *error range* is reported for a species with a high LOOR the most likely cause for the over prediction is in the model. However, if a species has a low LOOR and a high *error range*, the over prediction error is likely caused by incompleteness in the test data. Site-specific and species-specific approaches to testing predicted occurrences are calculated from the same data, but provide different information. Therefore, I recommend that both approaches be used when testing predicted occurrences of multiple vertebrate species.

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## REPRESENTATIONAL ANALYSES OF CONSERVATION LANDS IN MAINE

*Investigator:* S. L. Orndorff (Painton)

*Advisors:* W. B. Krohn, Chair  
M. L. Hunter  
M. K. Beard-Tisdale

*Cooperators/  
Project  
Support* USGS Biological Resources Division  
Maine Cooperative Fish and Wildlife Research Unit  
University of Maine -  
Department of Wildlife Ecology  
Maine Outdoor Heritage Fund

*Objectives:*

- 1) Measure how similar the abiotic and biotic variables are on conservation areas versus non-conservation areas of Maine.
- 2) Aggregate the variables and spatially analyze the highly under-represented areas from the represented areas on the major biophysical regions of Maine.
- 3) Conduct a representational analysis on the most under-represented biophysical region of the state with similar abiotic and biotic variables.
- 4) Assess the degree to which terrestrial vertebrates and major environment variables are represented on state and Federal wildlife management lands in Maine.

*SCOPE:* While the State of Maine continues to purchase conservation areas, no scientific analysis has been done to determine the role of existing conservation areas in conserving the state's natural heritage. A set of conservation areas that is as representative as possible of Maine's natural diversity has the greatest chance of

conserving the biodiversity, and uncoordinated and unplanned decisions may seriously compromise progress toward that goal. Thus, the purpose of this study is to assess how well the conservation areas in Maine are representing the natural diversity of the state.

*PROJECT STATUS:* The conservation areas in Maine were incorporated into a digital database (scale = 1:100,000), which was analyzed to determine whether or not the current conservation areas are representative of Maine's natural variability. This analysis was separated into three chapters. In the first chapter, twelve variables (10 abiotic and 2 biotic) were analyzed on conservation areas versus non-conservation areas using a Geographic Information System (GIS) at a 1.86 x 1.86 km resolution. Maine was divided into biophysical regions using GIS and cluster analyses and for this analysis were modified into five roughly equal-sized regions. The representativeness of the variables will be compared for the five regions in the state. In the second chapter, a similar analysis was conducted on the most under-represented region at a 94.6 x 94.6-m resolution. Similar variables were analyzed (5 abiotic and 2 biotic) along with a threat and opportunity variable, road density. The areas identified as under-represented by this analysis are important areas for conservation acquisition, assuming the State of Maine's goal is to have a sample of conservation areas that fully represents the natural diversity in the state. The third chapter assessed the contribution of State Wildlife Management Areas (WMAs) and Federal National Wildlife Refuges (NWRs) to conservation in Maine. In addition to determining the extent to which Maine's terrestrial vertebrates are represented on these lands, representative analyses of major environmental variables such as elevation, slope, mean temperature, and snowfall were also completed.

*FUTURE PLANS:* The thesis was successfully defended and final editorial changes are being made.

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## A LONG-TERM FOREST ECOSYSTEM STUDY

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

*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 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) small mammal trapping; (5) salamander cover object counts; (6) estimates of seed and fruit production; (7) general surveys of canopy insect abundance; (8)

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 2002, tasks 3, 4, 5, 6, 7, 8, and portions of task 1 as outlined above, were completed.

*FUTURE PLANS:* The 2003 field season will primarily focus on timber inventory with additional work on plants and trees.

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

*Investigator:* D. L. Nelson

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

*Cooperators/  
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 the Holt Research Forest.
- 2) Relate variability in abundance and taxa composition of these invertebrates to characteristics of the snags and their local environment.
- 3) Document the characteristics and availability of snags within the Holt Research Forest from 1984 to 1996.

*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. Of all organisms that use decaying wood, invertebrates compose possibly the largest and most diverse group. Invertebrates also play essential roles in the process of wood decomposition. Even so, comparatively little is known about the ecology of most wood-loving invertebrates.

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 implications of such practices on forest ecosystems are just beginning to be investigated.

This study is designed to address issues relating to invertebrate and dead tree conservation. We wish to quantitatively explore the links between snag condition and the community attributes of bark invertebrates. We also wish to explore the dynamics of snag production and decay. This knowledge could be important for the wise management of forest resources.

*PROJECT STATUS:* During 2001, the timber inventories conducted in 1984, 1988, and 1996 were used to examine the numbers and kinds of snags available in the forest, and the rate of snag production and fall.

*FUTURE PLANS:* A final thesis is in preparation.

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## DOCUMENTATION OF SAVANNAH RIVER MARSH CONVERSION AND MODIFICATION OF SPATIAL VEGETATION SUCCESSION MODEL

*Investigator:* T. Y. Henrichon

*Advisors:* C. S. Loftin, Chair  
M. K. Beard-Tisdale  
S. A. Sader  
R. J. O'Connor

*Cooperators/  
Project Support:* Maine Cooperative Fish and Wildlife Research Unit  
U.S. Geological Survey, Biological Resources Division  
Department of Wildlife Ecology, University of Maine  
U.S. Fish and Wildlife Service, Savannah National Wildlife Refuge

*Objectives:*

- 1) Document current vegetation community distributions in the marshes of the Savannah National Wildlife Refuge.
- 2) Compare recent vegetation distributions to previously mapped distributions (1986, 1993, and 2000) to document landscape-level marsh conversion.
- 3) Assess the accuracy of marsh conversion predictions made in 1990 by of marsh change expected by 2000.

*SCOPE:* The Savannah National Wildlife Refuge (NWR) is responsible for management and protection of the freshwater and brackish marshes occurring within its borders and adjacent to the Savannah River harbor. During the past several decades changes to the flows and bathymetry of the Savannah River and harbor have occurred that may be altering the vegetation communities in the marshes of the adjacent NWR. A recent proposal to deepen the harbor basin resulted in a Draft Environmental Impact Statement (EIS). Conclusions of the Draft EIS suggesting no significant impact to the vegetation distributions in response to the proposed actions have been questioned. This project will determine the type and extent of change in vegetation community distributions that have occurred during the past decade, examine the performance of a marsh vegetation succession model that predicts marsh change anticipated during this period, and Make recommendations of change to the succession model to address prediction error.

*PROJECT STATUS:* SPOT satellite imagery was programmed and received for July 2000, October 2000 and April 2001. Landsat satellite imagery was received for May 1993 and October 1994. An area including the Savannah National Wildlife Refuge and adjacent Savannah River was subset from each of these images. All imagery was geometrically corrected and registered to the 1990 vegetation map of the same area for comparisons. The imagery has been classified and vegetation associations are currently being assigned to the classified imagery. Ground truthing data gathered during June 2000 and October 2000 were used as training sites for satellite image classification. Vegetation and salinity transect data collected during these trips will be used to refine classification and marsh change analyses. Early results indicate that a conversion from intermediate to freshwater marsh has occurred, suggesting that proposed harbor deepening could prevent further return of the marsh to a freshwater condition, and also may cause a reversion to intermediate and brackish condition.

*FUTURE PLANS:* A final report is in preparation.

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## RIPARIAN BUFFER WIDTHS AND AMPHIBIAN COMMUNITIES IN WESTERN MAINE: EXPERIMENTAL AND RETROSPECTIVE APPROACHES

*Investigator:* D. W. Perkins

*Advisors:* M. L. Hunter, Chair  
P. G. deMaynadier  
W. B. Haltemen  
J. M. Hagan  
C. S. Loftin  
R. J. Seymour

*Cooperators/  
Project  
Support:* University of Maine  
McIntire-Stennis  
Manomet Center for Conservation Science  
Cooperative Forestry Research Unit, University of Maine  
National Fish and Wildlife Foundation  
Plum Creek  
International Paper  
Mead Paper  
Seven Islands Company

*Objectives:*

- 1) Determine if amphibian densities and species richness in and adjacent to headwater streams change 1-2 years after harvesting.
- 2) Determine if changes in amphibian densities and species richness vary with buffer strip width.
- 3) Determine if there is an effect on amphibian densities and species richness in these headwater stream areas 5-10 years post-harvest.

*SCOPE:* Forests are the dominant ecosystem in the northeastern United States and therefore harbor much of the region's biodiversity. However, timber production is economically important in this region. Due to biodiversity and economic reasons, ecologists and foresters seek timber management practices that do not degrade ecosystems and maintain biodiversity while still maintaining profit margins. Riparian areas provide habitat for a broad array of species, are critical to maintaining stream water quality, and have been identified by the forest industry in Maine as a key area of concern. To protect these riparian areas many forestry companies leave buffer strips. It is unclear whether current regulations are adequate for water quality and biodiversity. We will use amphibians to study the effects of different buffer widths on riparian biota along first order streams in western Maine using experimental and retrospective approaches.

*PROJECT STATUS:* This study is being conducted in the mountainous west-central region of Maine (latitude 45 25'00", longitude 70 35'00"). Treatments in the experimental approach consists of 0 m (0'), 11 m (35'), 23 m (75') buffers with clearcuts adjacent to the buffer, and a 200 m partially harvested unit. For the experimental approach, there is one year of pre-treatment data (2001) and two years of post-treatment data (2002-03). For the retrospective approach eight streams will be selected that have been harvested in the last 4-10 years. Four streams have a 23 m buffer with clearcut adjacent to the buffer strip. Four streams have a 200 m partially harvested unit. For both approaches pitfall traps and drift fences are being used to capture terrestrial species. We are conducting in-stream linear transect surveys turning over suitable rocks for stream salamanders. During the 2001 season we collected pre-treatment data on 15 experimental streams. We also collected data on 3 more retrospective streams. Between 2000 and 2001 we have data on 6 retrospective streams. In 2001 during 86,923 trapnights we captured 2212 amphibians of 10 different species. During aquatic surveys we caught an additional 485 amphibians of 4 species.

*FUTURE PLANS:* The 2002 field season just began, field work will continue through 2003. This study will be done in conjunction with a study on water quality and aquatic invertebrates by Manomet Center for Conservation Science. Data from both studies will be combined to give powerful comprehensive conclusions. Together the implications of these studies could affect forest management decisions for riparian areas across northeastern North America. These studies will aid in maintaining the enhancing the health of managed forest ecosystems by determining whether existing regulations are sufficient to maintain the biotic integrity of small streams in managed forests.

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## HABITAT ASSESSMENT SUPPORT TO THE MAINE DEPARTMENT OF INLAND FISHERIES AND WILDLIFE

- Investigators:* H. L. Rustigian  
W. B. Krohn
- Advisory Committee:* G. M. Stadler  
E. A. Dumont  
G. J. Matula, Jr.  
R. L. Dressler
- Cooperators/  
Project Support:* Maine Department of Inland Fisheries and Wildlife (MDIFW)  
Maine Cooperative Fish and Wildlife Research Unit  
University of Maine - Department of Wildlife Ecology  
Maine Outdoor Heritage Fund
- Objectives:*
- 1) Develop and apply a GIS-based approach to automate the evaluation of MDIFW-identified and delineated inland waterfowl and wading bird habitats (WWH) in organized towns utilizing MDIFW WWH evaluation criteria.
  - 2) Develop and apply a GIS-based approach to automate the delineation and evaluation of inland waterfowl and wading bird habitats statewide utilizing MDIFW WWH delineation procedures and evaluation criteria.
  - 3) Use Maine Gap Analysis (ME-GAP) data to assess the relationship between MDIFW and automated ratings and predicted occurrences of wetland associated non-fish vertebrate species.
  - 4) Determine feasibility of using existing MDIFW waterfowl and wading bird occurrence data to statistically assess the relationship between MDIFW WWH ratings and waterfowl and wading bird diversity and abundance and to refine MDIFW WWH rating criteria.

*SCOPE:* Maine's Natural Resources Protection Act regulates the human alteration of significant wildlife habitat. This law requires MDIFW to identify and map significant wildlife habitat, including high and moderate value waterfowl and wading bird habitats. MDIFW has used 5 criteria to assess WWH value, specifically: dominant wetland type, wetland diversity, wetland size, wetland type interspersion, and percent open water. During the past 9 years, WWH identification, delineation, and evaluations have been completed for organized towns only due to the time consuming process of manually deriving the necessary information from aerial photographs and Maine Wetland Inventory (MWI) and National Wetland Inventory (NWI) paper maps. However, newly available statewide digital NWI data allow for the process to be automated using a Geographic Information System (GIS), drastically increasing efficiency, cost effectiveness, and objectivity of applying WWH evaluation criteria.

The biological relevance of the WWH evaluation system, which uses basic measures of wetland habitat structure to assess inland wetland value for Maine waterfowl and wading birds, has not yet been validated. MDIFW waterfowl and wading bird survey data could be used to statistically assess the performance of the WWH ratings system. Such an analysis would ensure that the most valuable wetlands for wading birds and waterfowl have been identified across the state and can be used to refine the WWH ranking criteria by statistically comparing bird diversity and abundance to wetland attributes. Automating, assessing, and refining the WWH evaluation process will enable MDIFW to ensure NRPA protection of high and moderate value WWHs throughout the state and aid in achieving many MDIFW management goals.

*PROJECT STATUS:* A 63-page final contract report, entitled "GIS-Based Evaluation of Waterfowl and Wading Bird Habitats in Maine," was submitted and accepted. The abstract is as follows:

The Maine Department of Inland Fisheries and Wildlife (MDIFW) has the authority under the state's Natural Resources Protection Act to identify and conserve high and moderate value waterfowl and wading birds habitats (WWH). While MDIFW has developed a manual system for identifying high and moderate value non-tidal

wetlands for waterfowl and wading bird habitat, it is so labor and time intensive that approximately 10% of the state's WWHs have been evaluated. Our objectives are to: (1) automate the existing non-tidal WWH delineation process and evaluation system, (2) compare results for individual WWHs in Kennebec County to determine if the automated system is operating similarly to the manual system, (3) apply the automated system to all mapped wetlands in Maine, and (4) determine if the ratings related to and the predicted presence of wetland birds and other vertebrate groups and the observed presence of wading birds. Boundaries and partially completed manual ratings for 3,448 WWHs in organized towns in Maine provided by MDIFW and digital National Wetlands Inventory maps for Maine were used in a Geographical Information System (GIS) to automate the WWH delineation and evaluation process. A series of programs in ARC Macro Language for ARC/INFO GIS were written to analyze WWH wetland composition from the NWI map to evaluate the following 5 WWH criteria: dominant wetland type, habitat size, diversity of wetland types, wetland type interspersion, and percent open water. Over 68% of WWHs rated moderate or high by MDIFW's manual system were also rated moderate or high by the automated system. The automated system delineated over 18,000 WWHs across Maine, 44% of which were rated high or moderate, and this percentage varied little regionally. Predicted occurrences of vertebrate species regularly breeding in Maine, obtained from the Maine Gap Analysis Project, were used to determine if WWH ratings related to the predicted presence of wetland vertebrates. Species were placed into three groupings differing in level of wetland habitat specialization: wading birds and waterfowl, wetland-associated non-fish vertebrate species (divided into wetland-associated amphibians and reptiles, mammals, and birds), and wetland-using non-fish vertebrate species. Non-parametric methods (Kruskall-Wallis analysis of variance and Spearman correlation) were used to test for a linear relationship between WWH category (i.e. high, moderate, and low) and number of predicted species occurrences. High and moderate wetlands had significantly higher predicted use across all vertebrate classes than those rated low. In addition, high rated WWHs had a significantly higher number of observed wading bird species present than WWHs rated moderate or low. Due to the reliance of the automated system on NWI maps, which are based on interpretation of aerial photographs taken mostly in the mid-1980s, and the dynamic nature of Maine's inland wetlands, especially hydrological modifications by beaver (*Castor canadensis*), we recommend field checking any wetlands rated low or of concern to local biologists.

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## SIMULATING WETLAND-LANDSCAPE FIRE DISTURBANCE AND SUCCESSION TO DEMONSTRATE POTENTIAL FOR CHANGES IN AMPHIBIAN PRESENCE/ABSENCE

*Investigator:* J. McCloskey

*Advisors:* C. S. Loftin, Chair  
L. Smith  
S. A. Sader  
W. B. Halteman  
G. L. Jacobsen

*Cooperators/  
Project  
Support:* USGS-BRD Florida Caribbean Science Center  
United States Fish and Wildlife Service  
Maine Cooperative Fish and Wildlife Research Unit  
University of Maine – Department of Wildlife Ecology

*Objectives:*

- 1) Use satellite data to create a land cover map showing dominant vegetation associations within the Okefenokee Swamp.
- 2) Develop vegetation change detection maps by comparing current and past vegetation maps.
- 3) Develop statistical model (e.g., transitional matrix) to simulate spatial and temporal effects of water levels and fire on vegetation composition and structure.
- 4) Develop logistic regression model to predict presence/absence of specific amphibian species within the swamp given specific vegetation types.

*SCOPE:* The Okefenokee National Wildlife Refuge (ONWR) is a mosaic of several wetland communities covering

approximately 1700 km<sup>2</sup>. Many amphibian species found within ONWR are obligatorily linked to water. Human activity (particularly fire suppression, logging, dredging, peat mining, and water impoundment) within ONWR may cause changes in the swamps natural hydrologic and fire regime. Such changes may be permanently altering the vegetation composition and structure of the swamp, thereby adversely affecting amphibian populations. This study will determine how changing fire and water levels effect the vegetation spatial distributions, composition and structure within ONWR. Subsequently, we will determine associations between existing vegetation and presence/absence of amphibians.

*PROJECT STATUS:* SPOT satellite data was received for May 2001 and an unsupervised vegetation classification has been completed. Digital aerial photographs were used for training and an accuracy assessment of a supervised vegetation classification of the SPOT imagery (84% accurate with 18 vegetation classes). Development of the vegetation succession model in underway.

*FUTURE PLANS:* The 2001 vegetation map will be compared to the 1990 map to determine from-to changes in vegetation. Amphibian data collected by the Florida Caribbean Science Center along with vegetation maps will be used to develop statistical models that predict presence/absence of amphibians. In addition, models will be developed to simulate vegetation succession given specific fire and water level scenarios.

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## VEGETATION RESPONSE TO IMPOUNDMENT MANAGEMENT AT MOOSEHORN NATIONAL WILDLIFE REFUGE

*Investigators:* D. Tyson  
C. S. Loftin  
J. R. Longcore

*Assistants:* C. Currier  
H. Alcock

*Cooperators/  
Project  
Support:* University of Maine, Department of Wildlife Ecology – Graduate School  
U. S. Geological Survey, Biological Resources Division – Cooperative Unit Program  
Maine Cooperative Fish and Wildlife Research Unit  
U. S. Fish and Wildlife Service, Moosehorn National Wildlife Refuge

*Objectives:*

- 1) Develop impoundment vegetation maps using ground surveys and ArcGIS software to compare to previously documented vegetation distributions.
- 2) Assess past and present hydrological data to characterize impoundment hydrology and relate to vegetation history.

*SCOPE:* Moosehorn National Wildlife Refuge staff created 53 wetlands between 1950-1970 in an attempt to provide suitable waterfowl habitat. Since construction these wetlands have been managed by water level manipulation. Surveys were conducted in the mid-1980s to create wetland vegetation maps to document dominant vegetation types, to document bird use of the impoundments, and to collect invertebrate specimens in floating-leaved and emergent vegetation. The purpose of the current study is to determine changes in vegetation distributions and composition since these earlier surveys were conducted, and relate these changes to hydrological management of the refuge impoundments.

*PROJECT STATUS:* Vegetation surveys were completed during summer 2002. Fifty-two wetlands were mapped. Maps have been digitized, and water level and precipitation databases are under development.

*FUTURE PLANS:* Vegetation change analyses and comparisons to water level data will be completed during the next year, and a final report will be completed.

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## A UNIFIED STRATEGIC APPROACH TO THE MODELING OF TERRESTRIAL VERTEBRATE OCCURRENCES

- Investigator: V. Bahn
- Advisors: W. B. Krohn, Chair  
R. J. O'Connor, Chair  
M. K. Beard-Tisdale  
W. B. Halteman  
G. L. Jacobson
- Cooperators/  
Project Support: USGS Biological Resources Division – Gap Analysis Program  
Maine Cooperative Fish and Wildlife Research Unit  
University of Maine – Department Wildlife Ecology
- Objectives:
- 1) Review current concepts and techniques for modeling terrestrial vertebrate occurrences.
  - 2) Identify the most critical steps in modeling the occurrence of terrestrial vertebrates that need improvement.
  - 3) Improve terrestrial vertebrate occurrence modeling through integration of ecological processes.
  - 4) Construct a theoretical framework for terrestrial vertebrate modeling.

**SCOPE:** This project aims at supplying a review of the current modeling concepts and techniques for terrestrial vertebrate occurrences with the ultimate goal of finding a unified approach to such modeling. The scope is to cover all relevant kinds of the aforementioned models with particular emphasis on their assumptions and underlying philosophies using a top-down approach, in contrast to a review of mathematical details of concrete models. The focus is on the underlying theory, not the practical details of models. The elucidation of model characteristics that are responsible for the ability of models to separate relevant information and processes from noise (due to random and/or marginal processes) is of particular interest, because these characteristics are responsible for capturing the essence of the ecological processes underlying vertebrate distributions. These characteristics can also serve as a way to categorize models and provide guidance in the appropriate application of modeling techniques.

If one decomposes models into their parts - ecological model, data model, statistical model and selection model - it becomes apparent that some parts have received much more attention than others over the last decades. Specifically, with the advent of affordable computing power, the statistical model has received dis-proportionate attention. In contrast, the ecological model or underlying ecological process, which plays an important role in the distribution of species, has been neglected.

**PROJECT STATUS:** Due to the theoretical focus of the project, much emphasis has been put on literature review and strategic thinking. In the spring and summer of 2002 an extensive collection and review of relevant literature was conducted. Based on the existing emphases and tendencies in terrestrial vertebrates distribution modeling, some neglected areas were identified and a general overview of the field was gained.

**FUTURE PLANS:** We plan on continuing the literature review, not only covering specific modeling techniques but also the associated ecological theory and processes as well as the historical and philosophical foundations of distribution modeling. As a next step, we plan to identify potential categories that could help organizing distribution models such as dynamic vs. static, correlative vs. constraint, and causal vs. descriptive models. A specific emphasis will be on incorporating ecological processes into distribution models by hypothesizing effects of life-history characteristics on distribution.

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FISH HOSTS, POPULATION STRUCTURE, AND LANDSCAPE CONTROL  
OF THE DISTRIBUTION OF TWO RARE ATLANTIC SLOPE FRESHWATER MUSSELS  
IN MAINE, THE YELLOW LAMPMUSSEL (*Lampsilis cariosa*) AND

## THE TIDEWATER MUCKET (*Leptodea ochracea*)

*Investigators:* C.S. Loftin  
A. Huryn  
J. Rhymer  
M. Kelly (MS student)  
P. Wick (MS student)

*Cooperators:* USGS-BRD Eastern Region State Partnership Program  
Department of Wildlife Ecology, University of Maine  
Department of Biological Sciences, University of Maine  
Maine Cooperative Fish and Wildlife Research Unit (MCFWRU)

- Objectives:*
- 1) Increase our understanding of the demography and genetic structure of populations of yellow lampmussels and tidewater muckets in Maine.
  - 2) Continue research to identify host fish species for these mussel species and relate host fish and mussel distributions.
  - 3) Identify landscape-scale factors indicating suitable mussel and host fish habitat.
  - 4) Spatially relate the genetic and demographic composition of existing populations of the tidewater mucket and yellow lampmussel to these factors and distribution of their fish hosts.

Objectives 1 and 2 will be addressed by Drs. Judith Rhymer and Alex Huryn (University of Maine) as part of the State Partnership Project. Objective 3 will be addressed by Dr. Cynthia Loftin, MCFWRU. The investigators will collaborate to address Objective 4.

*SCOPE:* The declining condition of the world's aquatic environments is resulting in a loss of aquatic biodiversity. Freshwater bivalves are experiencing drastic declines in distribution and number due to a variety of disturbances. North America contains the greatest diversity of freshwater bivalves in the world, yet more than half of the remaining species are threatened with extinction. Although in many cases mussel decline can be attributed to manipulations of the local environment, forces at a larger scale may contribute to the occurrence and structure of mussel communities. Cumulative effects of upstream and stream-side land uses and hydrological modifications may affect mussel occurrence in a watershed, potentially deteriorating quality of occupied sites or leading to population isolation due to unsuitable hydrological conditions between occupied sites. These modifications may lead not only to a change in mussel community composition, but also to a change in ecosystem structure and function resulting from modification of the density and composition of the bivalve community. However, mussel distributions may also be somewhat independent of habitat conditions and more tightly regulated by abundance and diversity of host fish. Efforts to conserve North America's remaining mussel populations must recognize the complexity of relationships among potential determinants of mussel community composition, distribution, and demography and the multiple scales at which those relationships occur (Vaughn 1997).

Distributions of Maine's mussel species have been documented by Maine's Department of Inland Fisheries and Wildlife (MDIFW). The tidewater mucket (*Leptodea ochracea*) and the yellow lampmussel (*Lampsilis cariosa*) are state-listed as threatened species due to their scattered, declining populations. Surveys are currently underway to document age distributions at the occupied sites to determine whether populations are sustainable and to describe the genetic structure of these mussel populations. Two species of host fish (white perch, *Morone americana*, and yellow perch, *Perca flavescens*) for the yellow lampmussel have been identified in laboratory studies, and their distributions in Maine are documented in a MDIFW database. Studies to identify other host fish species are underway. The relationships of these mussel and host fish distributions to watershed conditions such as stream connectivity, dam locations, riparian land use, and hydrological condition have not been examined. Identification of landscape- and local-scale conditions of stream reaches, river segments, and ponds and lakes occupied by these mussels and their fish hosts, and an understanding of the spatial relationships of genetic structure and demography of the remaining mussel populations and occurrence of their host fish (which have a history of relocations throughout the state for fisheries management) are critical to conservation of these mussel species. Given that Maine contains some of the last, significant populations of the tidewater mucket and yellow lampmussel in eastern North America, and its watersheds are relatively undeveloped, conservation of these species may hinge on protection of the

populations that remain in Maine.

*PROJECT STATUS:* Development of the spatial database of mussel population, fish host, and mussel genetics data will begin during January 2003. Spatial analyses will be conducted during spring 2003.

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## ENVIRONMENTAL FACTORS ASSOCIATED WITH UNIQUE LAKE COMMUNITIES IN MAINE

*Investigators:* C.S. Loftin, Co-chair  
A. Huryn, Co-chair  
D. Anderson  
E. Schilling (PhD student)

*Cooperators:* Maine Outdoor Heritage Program  
Maine Department of Inland Fisheries and Wildlife  
University of Maine -  
Department of Wildlife Ecology  
Department of Biological Sciences  
National Science Foundation Research Fellowship  
Maine Cooperative Fish and Wildlife Research Unit

*Objectives:*

- 1) Determine the effects of the introduction of fish on macroinvertebrate communities of fishless lakes in Maine.
- 2) Identify attributes of macroinvertebrate communities that indicate fishlessness.
- 3) Identify geomorphic and geographical factors controlling the distribution and abundance of fishless lakes in Maine.
- 4) Build GIS-based models predicting the probability that a given lake is fishless.
- 5) Assess the accuracy of the models using macroinvertebrate indicator species

*SCOPE:* Throughout much of the 20<sup>th</sup> century, the introduction of game fish to inland waters of the United States and Canada was conducted at a furious pace. The goal of these introductions was generally to enhance game-fishing opportunities. In some cases lakes and streams with native fish species, such as members of the Cyprinidae, were stocked with other species considered more desirable as game fish. In other cases, lakes and streams that were truly “fishless” were stocked. Until recently, fishless lakes were viewed as having little or no value to society, as indicated by the term “barren” that was widely used to describe them. Over the past several decades, however, there has grown a considerable body of knowledge supporting views of such “barren” water bodies as habitats for uniquely structured animal communities, as excellent trophic habitats for waterfowl, and as landscape-level source habitats for amphibians and other biota.

Over the past several decades, financial support for the documentation and management of the biodiversity and ecological integrity of public lands has increased. This has resulted in considerable effort toward the enumeration, conservation, and restoration of fishless lakes. However, accurate estimates of the number and distribution of these habitats, prior to the widespread stocking efforts of the mid- to late 20<sup>th</sup> century, are few. Estimates for six of Canada’s western mountain parks indicate that over 20% of their lakes have been altered through introductions of non-native fish. The situation in the United States is more extreme. Fewer than 45% of the 16,000 high lakes in the western mountains remain unstocked, although 95% were naturally fishless. The rehabilitation of stocked lakes is now a priority for national park management in North America.

Maine Department of Inland Fisheries and Wildlife (MDIFW) has documented at least 30 fishless ponds in Maine; many ponds currently with fish are known to have been fishless prior to stocking. Documented fishless ponds and stocked but previously fishless ponds (and perhaps previously fishless ponds that were stocked and are now populated with naturalized stock) occur throughout the state, many in watershed headwaters. This wide distribution suggests that other fishless ponds likely exist. The ability to predict the likelihood that a particular pond is currently or historically fishless based on its landscape setting and geomorphic features would assist the MDIFW in balancing recreational management objectives with the responsibility to protect unique wildlife habitats. We will sample invertebrates in ponds in selected regions of Maine that are currently “fishfull” and compare those with

ponds that have various degrees of fishlessness (naturally and those with a history of stocking). These data will be combined with geomorphic and geographic information to develop GIS-based models predicting locations of ponds that are most likely, naturally fishless. Macrovertebrate indicator species will be used to assess the accuracy of model predictions during subsequent field sampling.

*PROJECT STATUS:* During summer 2002 several lakes were selected to conduct preliminary surveys of fish presence and invertebrate composition. We concentrated on ponds in Hancock, Washington, and Piscataquis Counties to include ponds at high and low elevations and 2 geomorphic regions. Twenty ponds were selected with an *a priori* expectation of fish presence condition (11 fishless and 9 fish-full) based on investigator knowledge and communication with scientists familiar with the ponds of interest. Some of the ponds expected to be fishless actually contained fish. We collected samples from the benthos, water column, and littoral fringe and are currently examining their contents.

*FUTURE PLANS:* We will determine ponds to sample during 2003 based on sample analyses conducted during fall 2002 and winter 2003. A GIS database will be constructed during this period for use in selecting spatial variables that may affect fish presence. We will also develop field plans for a complementary study to begin summer 2003 that will reconstruct historic fish presence/absence using paleolimnologic techniques to examine remains of invertebrates stored in lake sediments.

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## **WILDLIFE RESOURCES - MIGRATORY BIRDS:**

### **EFFECTS OF SMALL-GAP TIMBER HARVESTS ON SONGBIRD COMMUNITY COMPOSITION AND SITE-FIDELITY: AN EXPERIMENTAL APPROACH**

*Investigator:* M. J. Hartley

*Advisors:* M. L. Hunter, Chair  
R. J. O' Connor  
A. S. White  
W. B. Halteman  
W. E. Glanz

*Cooperators/  
Project  
Support:* University of Maine -  
Forest Ecosystem Research Program  
Department of Wildlife Ecology  
Maine Department of Inland Fisheries and Wildlife  
USDA Forest Service  
Cooper Ornithological Society  
American Wildlife Research Foundation

*Objectives:*

- 1) Describe changes in breeding bird communities on sites that are experimentally harvested (with selection silviculture), as compared to unharvested stands.
- 2) Determine if selective timber harvesting affects site fidelity of Ovenbirds and Hermit Thrushes, as estimated by: (a) annual return rates, and (b) distance between territories of successive years.

*SCOPE:* Forests are dynamic ecosystems that may only be understood through long-term research projects that focus on many different aspects of structure, function, and biota within and between stands. The Forest Ecosystem Research Program (FERP) was formed to address such long-term research issues. The FERP has established nine long-term research sites (10 ha each) at the Penobscot Experimental Forest (PEF). These nine stands are grouped into three replicates of "triplets" (three plots) that are treated with light selection cutting (10% harvest, with many retention trees), moderate selection cutting (20% harvest, with some retention trees), or no cutting (i.e., control). These three replicates are all within one 1400 ha mixed-wood forest. Our role in the FERP is to study how these

treatments affect one aspect of biodiversity in the forest: breeding bird communities. Timber harvesting may change songbird species composition or territory densities for some species. Even if the community is similar after harvesting, a reduction in the rate that migratory songbirds reoccupy territories of previous years would indicate that logging has a detrimental effect on breeding productivity.

*PROJECT STATUS:* All requirements for the Ph.D. degree in Wildlife Ecology were completed in June 2002. The abstract follows:

I investigated how small-gap timber harvests affect bird communities on nine sites (10 ha each) in the Penobscot Experimental Forest. Sites were grouped into three replicated "blocks" (three sites each) that were randomly treated with one of three treatment levels: 10% harvest, 20% harvest, and no harvest (i.e., control). I examined how treatments affected breeding songbirds in terms of their community composition and site-fidelity. I surveyed bird territories and marked individuals on all research sites over four consecutive summers, including 1-3 years before and after each site was harvested. My analyses show no evidence that harvest treatments affected avian communities. The same group of species was numerically dominant on both treatment and control sites examined before and after harvests. Species richness and abundance of bird territories did not differ significantly among groups, nor did densities of individual species. Statistical power was limited due to small sample sizes, but power analyses indicate a high probability of detecting differences of 20-30% in total abundance among groups, and much smaller differences in richness. Overall, yearly variations in bird densities were much stronger than differences between treatments and controls. Of the 164 Hermit Thrushes and 126 Ovenbirds captured, a constant proportion of 0.56 and 0.36, respectively, were recaptured annually. Of these 90% of Hermit Thrush and 81% of Ovenbirds were recaptured on the same site in successive years, regardless of the sites treatment status. However, there was a significantly higher tendency for Hermit Thrush to disperse to new sites if they were captured on treated versus control sites in the previous year.

In Chapter 3 I hypothesize that annual fluctuations in bird densities may have been driven largely by predator (i.e., red squirrel) population dynamics. Previous research has shown that avian nest-predation by red squirrels (*Tamiasciurus hudsonicus*) can strongly affect local breeding productivity of birds, and that red squirrel populations are regionally synchronous. I examined four lines of evidence that are consistent with the premise that squirrel population fluctuations can affect bird populations over large areas. Squirrel populations in the PEF peaked in 1995 and crashed in 1996, while bird densities decreased from 1995 to 1996, then increased sharply from 1996 to 1997. Breeding Bird Survey data showed that this same pattern of avian population decline and increase from 1995-1997 was evident at much larger scales.

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

*Investigator:* C. R. Foss

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

*Cooperators/  
Project  
Support:* University of Maine  
Switzer Environmental Fellowship Program  
McIntire-Stennis  
U.S. Fish and Wildlife Service -  
Lake Umbagog National Wildlife Refuge  
Neotropical Migratory Bird Program  
USDA Forest Service  
N.H. Fish and Game Department  
Maine Department of Inland Fisheries and Wildlife  
N.H. Department of Resources and Economic Development  
Division of Forests and Lands

Boise Cascade  
Mead Corporation  
James River Corporation  
Crown Vantage, Inc.  
Maine Bureau of Public Lands  
Seven Islands Land Company  
Wagner Forest Management, Ltd.  
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 between 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, which provides 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.

*PROJECT STATUS:* Pilot field work during May-August 1994 involved surveys on 12 20-ha plots in northern New Hampshire, 4 each in managed hardwoods, spruce-fir forest, and regenerating clearcuts. 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 led to the evolution of two techniques, behavior mapping for intensive surveys of rectangular study plots, and fledgling surveys for use in combination with point counts on linear transects.

The study of effects of partial cutting in spruce-fir forests began in 1995 on 11 20-ha plots in managed spruce-fir forests of the Androscoggin headwaters area of northern New Hampshire and western Maine. Treatments ranged from no cutting in the past 60 years through commercial thinning to progressively heavier partial cuts, conducted during the past 5-7 years. Field work conducted during May-August 1995 and 1996 involved behavior mapping of all birds encountered on the 11 plots. Vegetation surveys, including prism point sampling and collection of relevé data in each of 80 50x50 m-cells on each of the 11 plots, were completed during September-November 1996. Behavior mapping continued in 1997 on 6 of the 11 plots that spanned the range of silvicultural treatments. Comparisons of behavior mapping with nest-searching and monitoring were conducted on 10-ha subsets of 3 of the 11 plots in 1996, and of behavior mapping with constant-effort mist netting were conducted by a collaborator on a plot elsewhere in Maine in 1995 and 1996.

*FUTURE PLANS:* Preparation of papers is the priority for the next academic year.

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THE LONG-TERM EFFECTS OF A SELECTIVE TIMBER HARVEST ON THE BIRD  
COMMUNITY OF AN OAK-PINE FOREST IN MAINE

*Investigator:* S. P. Campbell

*Advisors:* M. L. Hunter, Chair  
R. J. O'Connor  
J. M. Rhymer  
A. S. White  
W. B. Halteman

*Cooperators/* Holt Woodland Foundation  
*Project* University of Maine, Department of Wildlife Ecology  
*Support:* NSF GK-12 Teaching Fellowship

*Objectives:*

- 1) Examine changes in bird abundance in response to harvest-created gaps.
- 2) Examine shifts in habitat use in response to harvest-created gaps.
- 3) Compare local trends in bird abundance to regional trends.
- 4) Investigate temporal and spatial stochasticity of habitat use.

*SCOPE:* Population declines in many species of Neotropical migrant birds have largely been attributed to the destruction and degradation of forest on their tropical wintering grounds as well as on their temperate breeding grounds. These findings have in turn drawn considerable attention to current forest management practices in both tropical and temperate regions. Much of this attention has been given to the effects of clear-cutting and fragmentation; however, few studies have examined the effects of small harvest-created openings or gaps in a forest.

One such study that is examining the effects of small harvest-created gaps on the forest bird community is being conducted at the Holt Research Forest in Arrowsic, Maine. The Holt Research Forest is the location of a long-term (20 years to date) oak-pine forest ecosystem study that was established with the broad goals of monitoring long-term changes in the forest's plant and animal community and documenting the effects of forest management practices on these communities. It was established in 1983 and after five years of baseline data collection on the entire 40-ha study area, one half of the area was harvested such that 10 1-ha blocks were partially cut with a group-selection timber harvest. The other half of the forest was left as an unharvested control. Since the timber harvest in 1987-1988, data collection has continued. This effort has resulted in long-term databases reflecting the effects of harvest-created gaps on the forest and its associated communities. In particular, the resident scientist (J. Witham) has compiled an extensive database on the bird community by spotmapping all species encountered in 16 visits to the study area during each breeding season.

Using this long-term data set, I plan to examine various aspects of the effects of harvest-created gaps on the bird community. Specifically, I will be examining changes in abundance and habitat use in response to the creation of the gaps. In addition, I will compare the long-term population trends of birds at the Holt Forest to those trends occurring on a regional scale. Finally, I plan to investigate the degree of temporal and spatial stochasticity of habitat use, i.e., I will analyze the long-term data on habitat use to see if the same areas of the forest are repeatedly preferred or if territory placement is random.

*PROJECT STATUS:* Preliminary analysis of the data show that there are 38 species of breeding birds abundant enough for analysis; of these only six showed a significant response to the timber harvest. The abundances of Ovenbird and Black-throated Green Warbler decreased in the harvested areas, while those of White-throated Sparrow, Common Yellowthroat, and Eastern Wood-Pewee increased in these areas. Notably, the Winter Wren which was previously absent from the forest appeared in the harvested areas immediately following the harvest, apparently in response to remnant slash piles; its abundance has since declined to pre-harvest levels.

I am currently looking at the data in greater detail to more fully explore the effects of the group-selection harvest on the bird community (Objectives 1 and 2). These results will be incorporated into the analyses of the long-term trends in population size (Objective 3) and habitat use (Objective 4).

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## REDISTRIBUTION OF BIRD SPECIES IN THE EASTERN UNITED STATES FOLLOWING CLIMATE CHANGE SCENARIOS

*Investigator:* S. N. Matthews

*Advisors:* R. J. O'Connor, Chair  
D. J. Harrison  
G. L. Jacobson

*Cooperators/  
Project  
Support:* USDA Forest Service  
University of Maine, Department of Wildlife Ecology

*Objectives:* 1) Determine the distribution of selected birds relative to climate and vegetation.  
2) Estimate changes in distributions of selected bird species given different climate change scenarios.

*SCOPE:* With mounting evidence that global temperatures are increasing at faster rates than previous episodes of climate change, understanding the potential consequences of global climate change on species distributions is essential. Birds have frequently been advocated as excellent candidates with which to investigate likely responses by biota, given the known climate sensitivity of the taxon in conjunction with extensive data on species distributions.

*PROJECT STATUS:* The potential response of 157 bird species, in the eastern United States, to projected climate change has been modeled by use of regression trees, using climate variables and USDA Forest Service's Forest Inventory Analysis data on tree species abundance. Since tree distributions will themselves change under the climate change scenarios, the Iverson and Prasad Atlas of future tree distributions was used to address this component. Models of each bird species' current occurrence in each county in the conterminous U. S. east of the 100<sup>th</sup> meridian were produced. These models, based on 8 climate, 4 elevation, and 80 individual tree species abundance variable, specified where the species is currently found as a function of its current climate and forest environment. These models ranged in total  $r^2$  from 35.5 to 91.0% with a mean  $r^2 = 71.5\%$ , and the classification accuracy of the species distributions averaged 76.6%. Under the two GCM scenarios (CCC and Hadley), the population sizes and ranges of 133 species are projected to change significantly, about two-thirds of them negatively. These results suggest that under these two scenarios of global climate change, the potential consequences to bird species in eastern United States would be substantial. In a distinct sub-project an econometric land use model was used to develop a prototype assessment of bird species changes if "carbon sink" subsidies were used to promote afforestation on farmland as a means of mitigating greenhouse gases. Results from the prototype assessment for three states, published in 2002, showed that there would be a net loss of avian diversity.

*FUTURE PLANS:* An M. S. thesis based on this work is being prepared. In addition, we intend to produce an atlas of projected population and range changes under climate change scenarios, as a companion volume to the atlas of tree distribution changes already produced by Iverson and Prasad. The econometrics is scheduled to receive continuing funding to incorporate forest fragmentation effects and then to extend the analysis nationally.

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## **WILDLIFE RESOURCES - OTHER THAN MIGRATORY BIRDS:**

### **SYSTEMATICS OF NORTHEASTERN MEADOW VOLE (*Microtus pennsylvanicus*) SUBSPECIES, WITH EMPHASIS ON THE ISLAND ENDEMIC (*M. p. shattucki*, Howe 1901) IN PENOBSCOT BAY, MAINE**

*Investigator:* J. M. Lowry

*Advisors:* J. M. Rhymer, Chair  
W. E. Glanz  
F. A. Servello

*Cooperators/  
Project* University of Maine - Department of Wildlife Ecology and  
Association of Graduate Students

*Support:* Maine Department of Inland Fisheries & Wildlife  
Maine Outdoor Heritage Fund  
Penobscot County Conservation Association

- Objectives:*
- 1) Do detailed morphological and genetic analyses of island and nearby mainland populations of meadow voles (*M. pennsylvanicus*) in Penobscot Bay area, with a focus on the status of the unique Maine subspecies, the Penobscot meadow vole (*M. p. shattucki*).
  - 2) Reanalyze morphological characteristics of island subspecies of meadow voles in the northeastern U. S. and eastern Canada, from specimens in museum collections, as a baseline for comparison to extant populations of the Penobscot meadow vole in Maine.

*SCOPE:* The Penobscot meadow vole (*Microtus pennsylvanicus shattucki*) is an insular subspecies inhabiting Islesboro, North Haven, and TumbleDown Dick Island in Penobscot Bay, Maine. It is one of a suite of island meadow vole subspecies that have been described from southern New England through Canada. The Penobscot meadow vole is one of the few endemic (sub) species in Maine and was originally listed as a Federal Species of Concern (when this designation was still used), because of its apparent limited distribution. Subspecific status of these populations was primarily based on univariate analysis of a few morphological variables comparing island and mainland populations. I am studying island populations of *M. pennsylvanicus* in the Gulf of Maine: in particular, those of Islesboro and North Haven, the type localities of *M. p. shattucki*, plus Isle au Haut, and comparing them to three mainland populations in Rockland, Northport and Orono. The islands of coastal Maine have been separated from the mainland for 11,500 years, which may have been sufficient time for differentiation of *M. p. shattucki* from the nominant species. On the other hand, meadow voles have extraordinary dispersal capabilities, so continuous gene flow is possible from the mainland to near island populations. I will quantify the morphological and genetic variation among extant island and mainland populations to determine whether there is sufficient evidence for a distinct subspecies in Maine.

*PROJECT STATUS:* All requirements for the Masters degree in Wildlife Ecology were completed in May 2002. The abstract follows:

The Penobscot meadow vole (*Microtus pennsylvanicus shattucki*) (PMV) is an insular subspecies of meadow vole (*M. pennsylvanicus*) inhabiting the islands of North Haven, Islesboro, and Tumbledown Dick in Penobscot Bay, Maine. It is one in a suite of island meadow vole subspecies which has been described from southern New England through eastern Canada. The subspecific recognition of *M. p. shattucki*, along with the others in this group, was solely based on a univariate analysis of a few morphological characters, which has fostered debate about the validity of the subspecies. Despite this uncertainty, the taxonomy is widely applied and conservation issues have been raised: *M. p. shattucki* was listed as a Species of Special Concern in the state of Maine when that listing was in use. The U. S. Fish and Wildlife Service did not propose *M. p. shattucki* for listing at the federal level because of lack of information on the subspecies. Concern about losing unique island taxa such as the PMV is warranted because another subspecies in this group, *M. p. nesophilus*, which was found on Gull Island, NY has already gone extinct.

To clarify the taxonomic status of *M. p. shattucki* for conservation purposes, I used multivariate discriminant function analysis (DFA) to examine historical and recent morphological differences in 14 cranial and three external characters. Historical differentiation was quantified through DFA of museum specimens. To study recent morphological differentiation, extant populations were sampled from the type localities of *M. p. shattucki* (Islesboro and North Haven), as well as populations of *M. p. pennsylvanicus* on another island in Penobscot Bay (Isle au Haut), the closest mainland coastal populations to Islesboro and North Haven (Northport and Rockport, respectively), and an inland mainland site, Orono. To further clarify distinctiveness of *M. p. shattucki*, genetic differentiation of extant populations was investigated by genotyping seven microsatellite loci and doing a phylogenetic analysis of the mitochondrial DNA control region.

*M. p. shattucki* is morphologically and genetically distinct from the mainland nominant populations of *M. p. pennsylvanicus*. Museum specimens were classified correctly at a 90% rate, while extant specimens had an 80% correct classification rate. Overall, *M. p. shattucki* individuals are larger in cranial and external morphology than mainland *M. p. pennsylvanicus*. Mitochondrial DNA analysis indicated that *M. p. shattucki* formed a monophyletic lineage. Microsatellite analysis supported this result with the highest genetic distances being between *M. p. shattucki* and populations of *M. p. pennsylvanicus*. All populations of meadow voles appeared to have high levels of

inbreeding, heterozygote deficiency and departure from Hardy-Weinberg equilibrium. This is most likely due to the social structure of meadow vole populations and/or non-amplifying (null) alleles that contribute to high estimates of homozygosity.

The morphological and genetic data in this study support the subspecific status of *M. p. shattucki*. In terms of uniqueness, or exchangeability (whether an individual of one population can be placed in the second population), *M. p. shattucki* is historically and recently distinct both morphologically and genetically and while this evidence is suggestive of *M. p. shattucki* as an Evolutionary Significant Unit (ESU), additional study of *M. p. shattucki* is warranted before this conclusion can be made. The naming of a population as an ESU has possible political ramifications that need to be considered in conjunction with the biological data.

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## VARIABLES INFLUENCING NEST SUCCESS OF EASTERN WILD TURKEYS IN CONNECTICUT: NESTING HABITAT, HOME RANGE-SCALE FRAGMENTATION, AND NEST ATTENTIVENESS

*Investigator:* S. M. Spohr

*Advisors:* F. A. Servello, Co-chair  
D. J. Harrison, Co-chair  
J. R. Longcore  
J. M. Ringo

*Cooperators/  
Project* National Wild Turkey Federation - Connecticut Chapter  
Wildlife Forever  
*Support:* University of Maine - Department of Wildlife Ecology  
Connecticut Department of Environmental Protection - Wildlife Division

*Objectives:*

- 1) Determine if nest success is influenced by attentiveness of hen turkeys.
- 2) Examine the effects of landscape characteristics on success and rates of predation on nests of wild turkeys in eastern Connecticut.
- 3) Determine the relationship between vegetative cover and the fate of turkey nests in eastern Connecticut.

*SCOPE:* In northern and midwestern regions of the U.S., winter mortality has been reported as one of the most important variables affecting eastern wild turkey (*Meleagris gallopavo silvestris*) populations. However, previous studies have concluded that winter mortality may not influence turkey populations in southern New England. Instead, annual population fluctuations of turkeys in New England are thought to result from variable reproductive success. Thus, nest success appears to be the most important demographic variable influencing annual population change of turkeys in this region. High annual variation in nest success is common, but the relative importance of environmental and behavioral factors that may affect nest success is not known. Our objectives are to determine the relative effects of nest attentiveness, cover, weather, and landscape characteristics on nest success of wild turkeys in Connecticut.

*PROJECT STATUS:* All requirements for the Masters degree in Wildlife Ecology were completed in December 2001. The abstract follows:

Nest success is the most important demographic parameter influencing rates of population change of eastern wild turkeys (*Meleagris gallopavo silvestris*) and many variables operating at multiple spatial and temporal scales may influence whether a nest is successful. Most studies of nest success and survival of turkeys have occurred in forested or agricultural landscapes; variables influencing nest success have not been studied in suburban landscapes. My objectives were to: 1) quantify survival and reproductive parameters of eastern wild turkey hens in the suburban environment of southeastern Connecticut and compare results to studies conducted in other northeastern states; 2) determine which within patch- and within home range-scale variables were most important in determining the success of turkey nests; and 3) quantify nest attentiveness of hens.

Fifty-nine hens were equipped with back-pack transmitters during 1996 and 1997. Survival rate of hens

during the reproductive period (0.60) and success rate of nests (0.35) were lower in Connecticut than rates reported in most neighboring states. Predation during the reproductive period appeared to be greater on my study sites than on more forested study sites elsewhere in the eastern U. S., possible due to increased densities of nest predators in suburban environments.

Landscape and cover variables were measured at 38 nests (14 successful, 16 destroyed by predators, 8 abandoned). Multiple linear regression modeling was used to determine relationships between home range-scale fragmentation and cover variables and the number of days each nest survived, and logistic regression modeling was used to compare home range-scale fragmentation and cover characteristics of successful and destroyed nest. The most parsimonious logistic regression model included number of trees and height of ground vegetation as significant descriptor variables. Variables that significantly influenced duration of nest success were number of trees within 10 m of the nest, number of nonwoody stems per 10 m<sup>2</sup>, and amount of forest within 225 m of nests. These variables probably had indirect influences on wild turkey nest success by influencing detection and encounter rates of predators.

Attentiveness data were obtained for 15 nesting hens. Mean values of attentiveness variables did not differ between hens of successful and destroyed nests; however, small sample sizes resulted in high probability of type II error. Hens whose nests were destroyed were more likely to leave nest from 1200-1459 hr and successful birds were more likely to leave nests from 1500-2100 hr. Although it is reported that turkeys have 2 distinct daily periods of intense feeding activity – mid-morning and mid-afternoon, I found that 1200-1459 hr was the most frequent time for hens to leave their nests.

Predation may be the proximate factor influencing nest success of turkey hens, but the ultimate cause may be habitat related. Despite the ability of hens to decrease the probability of nest predation by placing nests in forested areas with dense herbaceous or woody understories, fragmentation may have contributed to higher predator densities and subsequent nest predation in this suburban landscape. Thus, long-term studies will be necessary to determine whether incremental increases in forest fragmentation will decrease productivity of turkeys in increasingly suburban environments.

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## BAT AND SMALL MAMMAL HABITAT RELATIONSHIPS IN THE INDUSTRIAL FORESTS OF NORTHERN MAINE

*Investigator:* S. C. Billig

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

*Cooperators/  
Project  
Support:* Manomet Center for Conservation Sciences  
College of Natural Sciences, Forestry, and Agriculture -  
Department of Wildlife Ecology  
Plum Creek Timber Company

*Objectives:*

- 1) Determine relationship between coarse woody debris and small mammal abundance.
- 2) Determine if upland buffer straps between clearcuts retain pre-harvest species assemblages of small mammals.
- 3) Determine effects of forest and upland buffer edges on bat activity.

*SCOPE:* A difficulty in designing forested landscapes that maintain existing biological diversity in northern Maine is our poor understanding of how many species relate to managed forest habitats. The goal of this project is to better understand the relationships of small mammals, including bats, to habitat features in industrial forests of northern Maine. It has been hypothesized that small mammal abundance is related to coarse woody debris, but this hypothesis is relatively untested in the northeast. There is also little research on the value of buffer straps for retaining small mammal species in clearcut landscapes. I will examine microhabitat factors in relation to small mammal abundance and occurrence, with special emphasis on the importance of coarse woody debris and determining if separation

zones, clearcuts, and continuous forest habitats maintain different species assemblages of small mammal.

Overall, little is known about bats in northern New England except from research in New Hampshire, which indicates that bats need mature forests and linear edges, such as roads, for travel pathways. I will examine bat activity in relation to forest edge habitat in a heavily harvested area.

This project is being conducted in conjunction with the Shifting Mosaic Project, a forest research and management project of the Manomet Center for Conservation Sciences.

*PROJECT STATUS:* Both years of fieldwork have been completed. Small mammals were trapped on 45 sites for the study of coarse woody debris. Trapping grids were centered on permanent forest structure sampling plots established by Manomet Center for Conservation Sciences. Data on microhabitat and forest structure were related to small mammal occurrence and abundance. Small mammals were trapped in harvested buffers (n = 25), unharvested buffers (n = 5), clearcuts (n = 25), and continuous forest (n = 25), to evaluate species assemblages and habitat structure measurements were made on each site. Bat activity was surveyed using broadband ultrasonic bat detectors. Bat activity data were collected from clearcut-forest edges (n = 10), clearcut-buffer edges (n = 10), and clearcut center points (n = 10). Data analyses are complete.

*FUTURE PLANS:* Thesis completion is in progress.

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## A RETROSPECTIVE OF PRE-COMMERCIAL THINNING ON SNOWSHOE HARES AND SMALL RODENTS

*Investigator:* J. A. Homyack

*Advisors:* D. J. Harrison, Co-chair  
W. B. Krohn, Co-chair  
F. A. Servello  
R. S. Seymour

*Cooperators/  
Project  
Support:* Maine Cooperative Forestry Research Unit  
National Council of the Paper Industry for Air and Stream  
Improvement (NCASI)  
U.S. Fish and Wildlife Service – Region 5  
Maine Cooperative Fish and Wildlife Research Unit  
University of Maine, Department of Wildlife Ecology

*Objectives:*

- 1) Quantify and compare overstory, understory, coarse woody debris (CWD), and vertical and horizontal structure between herbicide treated clearcuts, with and without subsequent pre-commercial thinning (PCT) across a temporal gradient.
- 2) Document stand-level effects of PCT on densities of snowshoe hare and small mammals across a temporal gradient, and relate to changes in vegetation associated with thinning.
- 3) Use existing data on forest structure and snowshoe hare densities from other forest types and silvicultural treatments in Maine to develop a predictive relationship of hare density in relation to overstory, understory, CWD, and structural variables.

*SCOPE:* In March 2000, the U. S. Fish and Wildlife Service listed the Canada lynx (*Lynx canadensis*) as a threatened species under the Endangered Species Act (ESA). Although Maine, a state where forestry is a significant part of the economy, has the only verified population of resident lynx in the northeastern United States, the relationships between lynx habitat and forestry practices are not understood. Lynx are specialized predators of snowshoe hare (*Lepus americanus*). Hare density is positively and exponentially associated with stands with high densities of conifer saplings, and at a statewide scale, large areas of regenerating conifer stands is a habitat variable

that predicts occurrences of lynx in Maine. Thus, extensive areas of regenerating forest may promote persistence of a population of lynx in the northeast. PCT is a silvicultural technique that decreases stem density and may reduce densities of hare relative to unthinned, regenerating stands. Insufficient information exists on the influence of thinning on habitat of snowshoe hare, small mammals, and other potential prey species for lynx and other forest-dwelling carnivores. Thus, we are currently investigating the temporal effects of PCT on snowshoe hare and small mammals in the industrial forests of northern Maine.

*PROJECT STATUS:* We established 24 small mammal grids on stands treated with PCT from four age classes, one year since PCT (n=6), six years since PCT (n=6), 11 years since PCT (n=6), and 16 years since PCT (n=6). Thirteen small mammal grids were established on stands with similar site histories, but without subsequent PCT. We trapped mice, voles and shrews on all 37 grids during summer 2000 and summer 2001. Trapping resulted in captures of 343 individual mice and voles in 2000 and 597 mice and voles in 2001. We completed microhabitat analysis of all 37 study areas.

We established 1.6 km of snowshoe hare pellet transect in each of 30 stands for a total of 48 km of transect. Nearly 2,500 pellet plots were distributed among 30 stands (n=84). Pellets were cleared during fall of 2000, counted and cleared during May-June 2001, September 2001, May-June 2002, and September –October 2002 as an index to densities during leaf-off (October – April) and leaf-on (May – September) seasons. We live-trapped 128 hares (69 M, 59F) 308 times in 2001 and 114 (64M, 49F, 1 unknown) 464 times in 2002 on a subset of stands. We completed stand-level habitat measurements on all 30 sites.

Stands treated with PCT supported greater number of red-backed voles (*Clethrionomys gapperi*) and shrews, and number of deer mice (*Peromyscus maniculatus*) were greater in older stands. This work and previous studies conducted in Maine indicate that the numbers of small mammals increase with stand age and that densities fluctuate between years. Snowshoe hare pellet densities were approximately 2 times greater in control stands than stands treated with PCT during leaf-off season and nearly 2.5 times greater during leaf-on season. Although regenerating clearcuts treated with PCT supported lower densities of snowshoe hare relative to unthinned-control stands, the magnitudes of these differences were less than those reported for alternative forest practices, such as partial harvesting.

*FUTURE PLANS:* Analysis of data will continue through 2002 and expected date of completion for the project is May 2003.

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## INTERACTIONS BETWEEN HARBOR SEALS AND FINFISH AQUACULTURE IN MAINE

*Investigator:* M. Nelson

*Advisors:* J. R. Gilbert, Chair  
F. A. Servello  
K. J. Boyle

*Cooperators/  
Project Support:* National Marine Fisheries Service  
University of Maine –  
Department of Wildlife Ecology  
Sea Grant Program  
Maine Department of Marine Resources

*Objectives:*

- 1) To document the frequency and pattern of harbor seal predation at Maine fish farms in Maine.
- 2) To determine if this frequency and pattern is related to the number of harbor seals at nearby haul-outs.
- 3) To determine if repeat attacks at a site are the result of the same seals or different seals.

*SCOPE:* The methods I intend to employ to satisfy each of the above objectives include: conducting personal

interviews with site managers, reviewing available logs of predations events (i.e., from insurance companies) and personal observations; conducting aerial surveys of harbor seal locations and abundance within a 20 km 'swimming distance' of marine fish-farms; capturing harbor seals at finfish aquaculture facilities and haul-outs within 20 km distance and fitting said individuals with radio tags for the purpose of monitoring movements and documenting presence at finfish sites.

*PROJECT STATUS:* Aerial surveys to count seals were conducted bi-weekly from January through May in 2001 and 2002. One seal was captured, tagged and monitored. Two years of interviews of aquaculture site managers have been completed.

*FUTURE PLANS:* Capturing and tagging operations will resume this January. An additional season of aerial surveys of seals will be completed by June 1. A third year of interviews is planned for summer, 2003.

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## HARBOR SEAL AND GRAY SEAL BEHAVIOR ON A SHARED HAUL-OUT SITE (MOUNT DESERT ROCK) IN THE GULF OF MAINE

*Investigator:* S. C. Renner

*Advisors:* J. R. Gilbert, Chair  
W. E. Glanz  
F. A. Servello  
S. K. Todd

*Cooperators/  
Project  
Support:* University of Maine Agricultural and Forest Experiment Station  
College of the Atlantic - Allied Whale  
University of Maine – Department of Wildlife Ecology

*Objectives:*

- 1) Compare behavior patterns of harbor seals and gray seals on Mount Desert Rock, including aggressive encounters, resting, and non-resting behaviors as a function of tide cycle, species composition on the haul-out ledge, and animal density.
- 2) Determine environmental factors (tide, time of day, sea-state, or cloud cover) that influence haul-out patterns for both species of seals.
- 3) Evaluate differences in haul-out site characteristics between ledges used primarily by gray seals and those used by harbor seals.

*SCOPE:* The number of gray seals (*Halichoerus grypus*) in the Gulf of Maine has been increasing for more than 20 years. Substantial data exist that quantify overlap of food resources for gray seals and harbor seals (*Phoca vitulina*), but few researchers have observed both species on common haul-out sites. Hauling-out serves several important functions for most phocids including rest between foraging forays (thus fat storage), predator avoidance, and molting. This project will address inter- and intra-specific interactions that may affect haul-out duration, location, and function.

*PROJECT STATUS:* Fieldwork was completed in August 2001. Videotapes were reviewed and field data entered over this past year. Data analysis is underway.

*FUTURE PLANS:* Project completion is scheduled for June 2003.

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## CONSERVATION GENETICS OF WOOD TURTLES *Glyptemys insculpta* (LeConte, 1829)

*Investigator:* J. L. Murray

*Advisors:* J. M. Rhymer, Chair  
J. R. Gilbert  
M. A. McCollough  
P. Rawson

*Cooperators/  
Project  
Support:* Maine Department of Inland Fisheries and Wildlife  
Maine Outdoor Heritage Fund  
U. S. Fish & Wildlife Service – Partnerships for Wildlife  
University of Maine- Faculty Research Fund and  
Department of Wildlife Ecology  
McIntire-Stennis

*Objectives:* 1) Analyze genetic variation among wood turtle populations in Maine.  
2) Study phylogeography of wood turtles across their North American range.  
3) Determine if genetic markers can be used in law enforcement in illegal collection cases.

*SCOPE:* The wood turtle, recently renamed *Glyptemys insculpta*, is a semi-aquatic, northern freshwater turtle that is declining throughout its geographic range. Declines are attributed to habitat degradation and/or fragmentation, as well as illegal collection for the pet trade. It is listed as Endangered, Threatened, or of Special Concern in different states and Canadian provinces. The wood turtle was added to the CITES II list in 1993. RESTORE: The North Woods and six other co-sponsors petitioned the U.S. Fish and Wildlife Services to list the wood turtle as federally threatened, but the petition was declined due to a lack of scientific data. MDIFW listed the wood turtle as a Species of Special Concern in Maine in 1997. Although it has been suggested that Maine harbors some of the largest remaining populations of wood turtles, the threat of illegal collection persists, despite laws that prohibit collection for commercial use.

This study will investigate genetic variation of wood turtles at two spatial scales: a broad-scale phylogeographic survey across their geographic range, and a fine scale study of genetic variation of populations among river drainages within the state of Maine. Samples have been collected from populations in Minnesota, Wisconsin, Ontario, Quebec, Massachusetts and Virginia, as well as from four major river drainages in geographically isolated regions of Maine.

*PROJECT STATUS:* Analysis of genetic variation using eight polymorphic microsatellite loci indicates that there is significant differentiation among most populations of wood turtles in Maine. Analysis of phylogeographic structure is in progress, but preliminary results indicate that there are significant broad-scale differences among populations from Minnesota, Virginia, and Maine.

*FUTURE PLANS:* Data analyses and thesis preparation will be completed.

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## EFFECTS OF HARVESTED CANOPY GAPS AND DOWN WOODY MATERIAL ON AMPHIBIANS IN THE ACADIAN FOREST OF MAINE

*Investigator:* C. A. Strojny

*Advisor:* M. L. Hunter, Jr., Chair

*Cooperators/  
Project Support:* USDA National Research Initiative Competitive Grants Program  
USFS, Penobscot Experimental Forest  
University of Maine - Department of Forest Ecology, Forest Ecosystem Research Program  
University of Maine, Department of Wildlife Ecology

*Objectives:* 1) To compare relative abundance of forest amphibians among harvested and

- natural canopy gaps and contiguous, closed-canopy forest.
- 2) To compare relative abundance of forest amphibians *within* harvested and natural canopy gaps to determine if gap aspect influences distribution.
  - 3) To determine how redback salamander (*Plethodon cinereus*) distribution and body size are affected by down woody material size under both open and closed canopy conditions.

**SCOPE:** Amphibians, a significant component of forest systems, are often studied in forest ecology and management projects due to characteristics that render them sensitive to disturbance. Amphibians are in constant contact with the forest floor, relying on cool moist habitat for respiration, and thus harvesting can have a negative impact on amphibian populations by altering forest floor microhabitats. However, harvests that leave structure, such as down woody material and standing trees, may reduce negative effects of canopy removal on amphibian populations. In the Penobscot Experimental Forest of central Maine, canopy gaps have been created as part of a long-term research project to better understand the ecological effects of canopy removal. One aspect of the project will be to evaluate effects of partial canopy removal on forest amphibian abundance. Another aspect of the project is to augment our understanding of the relationship between down woody material and redback salamanders in the forest mosaic.

**PROJECT STATUS:** We sampled forest amphibians in 44 harvested gaps, 19 natural gaps, and 36 full-canopy plots using pitfall traps with drift fences. Each sample plot (harvested gap, natural gap, full-canopy) had a pitfall array located 5 m south of the plot center, at center, and 5 m north of the center. Captures from these pitfall arrays were pooled to compare relative amphibian abundance among treatments. Seven natural gaps and 23 harvested gaps had pitfall arrays positioned every 5 m along the entire north-south transect of the gap to study gap aspect.

Nine-hundred and fifty amphibians were captured between 10 May and 26 July 2002 of the first field season. Three of the 4 species reported to be sensitive to canopy removal, the redback salamander, wood frog (*Rana sylvatica*), and blue-spotted salamander (*Ambystoma laterale*) only accounted for 12.3% of all captures. The fourth sensitive species, spotted salamanders (*A. maculatum*), green frogs (*Rana clamitans*), and eastern newts (*Notophthalmus viridescens*) accounted for 21%, 33.2%, and 21.4%, respectively, of all captures. Initial results comparing captures per 100 trap nights for each species indicate that amphibians in gaps are active in numbers similar to those of nearby full-canopy sites. However, when captures of management-sensitive species are pooled, there is an indication that more captures occur in full canopy plots. Also, there appears to be no distinct pattern in amphibian captures between the north and south aspects within gaps, except for a slight trend of more management-sensitive species being captured in the southern aspect of gaps.

During the summer of 2002, we searched under logs both in gaps and full canopy areas for redback salamanders. There were proportionally more salamanders under logs in full-canopies (22 salamanders for 124 logs) than in gaps (11 salamanders of 131 logs). No relation was found between log size and salamander size.

**FUTURE PLANS:** Further sampling during the fall of 2002 and spring and fall of 2003 may clarify possible underlying trends for objectives 1 and 2 that were not detected thus far. To address objective 3, we plan to adjust our sampling protocol during 2003 in order to increase our sample size of logs with salamanders.

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## DOI AMPHIBIAN RESEARCH AND MONITORING INITIATIVE (ARMI): EFFECTS OF LANDSCAPE HETEROGENEITY AND ENVIRONMENTAL STRESSORS ON PALUSTRINE AND LOTIC AMPHIBIAN POPULATIONS IN ACADIA NATIONAL PARK

**Investigators:** C.S. Loftin  
R. Chalmers (MS student)  
M. Bank (PhD student)

**Advisors:** for R. Chalmers: C. S. Loftin, Chair

W. B. Halteman  
J. Longcore  
R. E. Jung

for M. Bank: C. S. Loftin, Co-chair  
A. Huryn, Co-chair  
T. A. Haines  
W. Glanz  
A. Huryn  
R. E. Jung

*Cooperators/  
Project Support:* U. S. Geological Survey – Biological Resources Division –  
Patuxent Wildlife Research Center  
Department of Wildlife Ecology, University of Maine  
National Park Service, Acadia National Park  
Maine Cooperative Fish and Wildlife Research Unit  
Department of Biological Sciences, University of Maine  
Eastern National Park Research Fund  
Declining amphibian Task Force

*Objectives:*

- 1) Develop species-habitat models of selected amphibian species in Acadia National Park at various spatial scales.
- 2) Identify environmental correlates related to selected amphibian species occurrence and population status in ANP palustrine and riparian wetlands.
- 3) Determine the relationship between counts of stream-dwelling salamanders and estimates of population sizes.
- 4) Evaluate the relationship between mercury contamination and population performance in two-lined salamanders (*Eurycea bislineata*) along a spatial and temporal gradient.

*SCOPE:* Worldwide amphibian declines and increased reports of amphibian malformations have prompted the United States Department of Interior (DOI) to initiate an Amphibian Research and Monitoring Initiative (ARMI). Regional ARMI programs are planned throughout the United States. Acadia National Park (ANP) is serving as a long-term intensive amphibian monitoring index site. This proposed research includes defining relationships of stream-dwelling salamanders and cross-scale habitat composition (within-stream to watershed-scale), with the intent of using salamander population counts and trends as indicators of park stream conditions. Although mercury contamination in lotic ecosystems in the Park is well-documented and is a result of non-point atmospheric deposition, levels in streamside salamanders are unknown. This study will provide insights into mercury bioaccumulation levels in stream-side salamanders, how they contribute to mercury cycling and transfer in both lotic and terrestrial food webs, and the potential for a decline of stream-dwelling biota with increasing mercury contamination. Another aspect of this research includes a survey of four-toed salamanders, a species of concern in Maine, Massachusetts, and Vermont. The distribution of four-toed salamander has decreased throughout its range due to wetland loss associated with land clearing and development. This species may require mature hardwood or conifer forests and fishless wetland breeding sites, making it vulnerable to habitat disturbance. Our objective is to document the distribution and habitat associations of this species within ANP, and develop predictive models of their potential occurrence in the Park based on the documented local- and landscape-scale habitat associations.

*PROJECT STATUS:* Stream surveys to document two-lined salamander occurrence and habitat use were completed. Stream characterizations and searches for salamanders were conducted in 36 streams; not all streams in ANP contained two-lined salamanders. Samples of larval salamanders were collected for analysis of their mercury content. Salamanders collected from burned watersheds contained less mercury than those from the unburned areas. We also collected salamanders from Shenandoah National Park, VA, to compare mercury levels with those from ANP. Surveys for four-toed salamanders continued in late spring. More than 100 nests were located in 16 surveyed

wetlands. Development of models predicting four-toed salamander presence is underway. Model prediction accuracy will be assessed using survey data collected during 2003.

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## MARTEN AS A TOOL FOR LANDSCAPE-SCALE HABITAT PLANNING IN NORTHERN MAINE

*Investigators:* J. A. Hepinstall  
D. J. Harrison

*Cooperators/  
Project Support:* University of Maine, Department of Wildlife Ecology  
Maine Department of Inland Fisheries and Wildlife  
Maine Outdoor Heritage Fund  
Maine Chapter of The Nature Conservancy  
Cooperative Forestry Research Unit, University of Maine

- Objectives:*
- 1) To develop and evaluate habitat models that will reliably predict the distribution of habitat for marten in the Telos (T4 R11 WELS and T5R11 WELS) and Baxter State Park study areas using field data gathered over 11 years and vector databases on vegetation type, age, and structure.
  - 2) To modify the models from Objective 1 to be able to predict marten habitat across the marten's range in Maine. Implicit in this objective will be an evaluation of whether the predicted habitat available will be sufficient to achieve the objective population sizes resulting from MDIFW's species assessment process.
  - 3) To develop a spatially-explicit, long-term habitat projection for northern Maine using marten as an area-sensitive umbrella species, while also incorporating habitat requirements of other forest dependent vertebrates with smaller area requirements than marten.

*SCOPE:* Marten are the most area-sensitive, forest specialized mammal inhabiting forest landscapes in northern Maine. They require large areas of relatively intact forest, are sensitive to forest fragmentation (Chapin et al. 1998); however, marten in Maine use a variety of forest types greater than 20 feet in height within their territories (Payer 1999). Thus, this species is an ideal "umbrella species" to use for evaluating landscape effects of forest harvesting and can be used as a coarse filter to assist in long-term forest planning at the scale of townships or larger landscapes.

*PROJECT STATUS:* This project has completed the process of developing and evaluating models designed to predict marten habitat in the Telos and Baxter State Park study areas (Objective 1). We used marten home range data gathered previously in the industrial forest (n = 150) and Baxter State Park (n = 100) from 1989 to 1998. Because we knew what areas marten occupied and what areas were not occupied, we combined used versus unused areas to analyze habitat thresholds for marten at the scale of the forest landscape. To do this we developed a method to populate the unused areas with simulated marten home ranges. These ranges were designed to simulate the approximate size and shape of observed home ranges for male and female marten. The marten home range data from previous studies in the industrial forest was paired with these simulated home ranges to: 1) estimate thresholds of forest types (e.g., mature closed canopy forest, young forest) that will accurately predict the presence or absence of marten (i.e., habitat currencies); and 2) build the database required to model marten occurrence.

We compared five different possible groupings of vegetation types to determine which grouping was best at differentiating between occupied and unoccupied areas using the Kolmogorov-Smirnov test. To determine if marten are responding to landscape configuration, FRAGSTATS software was used to calculate landscape metrics. Eight metrics have been included in our logistic regression models. Fifteen models were selected *a priori* using expert knowledge. We used observed marten home ranges (n = 124 for our model build data set, n = 126 for our model test data set) and simulated unoccupied home ranges (n = 98 for our build data set and n = 41 for our test data set).

Models were developed using logistic regression and evaluated using standard measures. We have been able to predict the probability of marten occupancy in potential home range-sized landscapes of 2-5 km<sup>2</sup> with 70-100% accuracy.

We are currently adapting the models developed for Objective 1 to run on raster-based vegetation maps and satellite imagery available for Maine. We have statewide data for vegetation and land cover for 1993 developed for the Maine Gap Analysis Project, as well as unclassified satellite imagery from 1991, 1993, and 2000, and additional study area imagery for 1995, 1997, and 1998. The year-specific satellite imagery has been paired as closely as possible with the year-specific marten home ranges. Landscape metrics have been calculated for the same home ranges and simulated unoccupied home ranges using the raster-derived habitat data. These data currently are being used to generate the same logistic regression models as done for Objective 1. Once this is complete, model output will be calibrated to the 1993 vegetation map for Maine. Once this calibration is complete, we will predict marten habitat across their range in Maine.

*FUTURE PLANS:* Work on the final objective of this project, to develop a spatially explicit projection of marten habitat for northern Maine and incorporate the habitat requirements of other forest dependent vertebrates with smaller area requirements than marten, began in December 2001. This project will develop several products that will complement and enhance the landscape habitat planning and urban sprawl initiatives of the Maine Department of Inland Fisheries and Wildlife (MDIFW) and the State Planning Office, and will provide opportunities to integrate volunteer habitat planning across the diverse ownerships and management objectives in northern, western, and eastern Maine. In addition to map products, it is hoped that we will have the time and funding to complete a more dynamic, spatially-explicit decision support system based on the results from Objective 3. Final products will be completed and delivered by summer 2002.

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## FACTORS AFFECTING HABITAT SELECTION AND POPULATION PERFORMANCE OF AMERICAN MARTEN (*Martes americana atrata*) IN NEWFOUNDLAND

*Investigator:* B. J. Hearn

*Advisors:* D. J. Harrison, Chair  
M. L. Hunter, Jr.  
W. B. Krohn  
R. J. O'Connor  
A. S. White

*Cooperators/  
Project  
Support:* University of Maine, Department of Wildlife Ecology  
Natural Resources Canada - Canadian Forest Service  
Newfoundland Department of Forest Resources and Agrifoods -  
Wildlife Division  
Western Newfoundland Model Forest  
Corner Brook Pulp and Paper  
Abitibi Consolidated

*Objectives:*

- 1) Document the population characteristics of Newfoundland marten on two study areas, one area open to trapping and snaring and the other closed, representing a range of forest management and natural habitat conditions;
- 2) Determine scale-specific (i.e., seasonal and annual stand- and landscape-level) habitat selection of marten across the range of habitat conditions present within the two study areas; and
- 3) Examine home-range area and habitat composition in relation to the proposed explanations of why Newfoundland marten are restricted in distribution in the

province to primarily old-growth forests.

**SCOPE:** The Newfoundland marten (*Martes americana atrata*) is one of only 14 terrestrial mammals endemic to the island of Newfoundland. Since the early 1900s, the Newfoundland marten has declined both in numbers and distribution; excessive trapping, in combination with habitat loss due to logging and fire, are suggested as the major factors contributing to the early decline. In 1934, commercial trapping for marten was closed on the island. However, despite this protection, marten populations continued to decline. Trapping for marten remains closed but some number of marten are taken each year in traps and snares set for other furbearers and snowshoe hares (*Lepus americanus*). In 1973, the Pine Marten Study Area (PMSA), was established in southwestern Newfoundland, and is generally considered to contain the last viable marten population on the Island. The area is closed to all land-based trapping and snaring. The PMSA was created as a refuge from which marten would disperse to reoccupy their historical range. In 1985, the Newfoundland marten was federally classified by the Committee On The Status of Endangered Wildlife In Canada (COSEWIC) as Threatened. In 1996, the status was uplisted to Endangered.

Earlier work on Newfoundland marten was conducted within the PMSA and focused on the effects of timber harvesting on “old growth” habitat and explaining the underlying association of Newfoundland marten with old growth forests, i.e., 81+ year-old balsam fir (*Abies balsamea*). In general, these studies concluded that loss of old growth habitat through clearcut logging was limiting the distribution and recovery of marten in Newfoundland. More recent work, looking at forest structure and prey densities in forest of various ages, suggested that marten in Newfoundland are restricted to mature and overmature balsam fir due to the depauperate prey base, i.e., lack of prey in younger stands. An alternative suggestion is that marten in Newfoundland are restricted in distribution due to issues of habitat security, that is, marten attempting to occupy second-growth stands are subjected to increased mortality due to incidental snaring and trapping.

In 1995, a 5-year cooperative project to determine the basic population characteristics of Newfoundland marten, particularly in relation to old-growth habitat within the PMSA, was initiated. Field work began in June 1995 and in May 1996, the project was expanded with the addition of a second study area. This second area, outside the PMSA, was centred near Red Indian Lake in south-central Newfoundland and had what was believed to be a newly established marten population. The underlying assumption was that, due to past forest harvesting (hence habitat conditions that appeared dissimilar to the PMSA), the RIL study area had a recently established, low-density marten population, and that the area represented a habitat sink for marten. The goal of the project is to evaluate these competing explanations for the historical decline and current restriction of the distribution of marten in Newfoundland. Further, following the analysis of factors influencing habitat selection and restriction, we hope to develop forest and wildlife management recommendations for the conservation and management of Newfoundland marten.

**PROJECT STATUS:** One hundred and sixty eight marten were captured and individually marked between June 1995 and August 2000; 75 in the PMSA and another 93 on the RIL study site. Approximately, 5,200 telemetry locations were recorded for these 168 marten or use in home range and habitat selection analyses. Data analysis began in March 2002 with initial work focusing on editing and finalizing the database of all marten location, calculation of home ranges characteristics, and preparation of the underlying landcover (habitat) GIS coverages. Preparation of the habitat coverages for each study area included a reinterpretation of the existing aerial photography to better define all areas currently classified as unmerchantable, low-volume softwood (ca. 25% of total area) with respect to stand height, density, canopy closure, and spatial arrangement; completed in October 2002.

**FUTURE PLANS:** Data analysis will continue for the remainder of 2002 and 2003. A companion study, which will utilize the results of the home range and habitat selection analysis of this project, will begin in 2002. This new initiative will evaluate threshold responses of Newfoundland marten to human-induced landscape change, and develop a predictive model of marten occurrence based on landscape characteristics (A. Fuller, Ph.D. Thesis). Finally, a third project is underway to develop an island-wide habitat (GIS) coverage required for application of the predictive model. This final project involves the use of satellite imagery and remote-sensing technologies to augment or replace the habitat coverages currently available from the provincial forest inventory.

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EXCERPTS FROM EARLY WRITINGS ON SELECTED SPECIES  
OF MAINE WILDLIFE, 1614 – 1930

*Investigators:* C. L. Hoving  
W. B. Krohn

*Advisor:* R. S. Palmer

*Cooperators/  
Project Support:* Maine Outdoor Heritage Fund  
Maine Cooperative Fish and Wildlife Research Unit  
University of Maine, Department of Wildlife Ecology

*Objectives:*

- 1) Document references to the wolf (*Canis lupus*), Canada lynx (*Lynx canadensis*), eastern panther (*Felis concolor*), wolverine (*Gulo gulo*), and woodland caribou (*Rangifer tarandus*) in Maine from 1624 through 1930. Include the early references to white-tailed deer (*Odocoileus virginianus*) and moose (*Alces alces*) as encountered.
- 2) Discuss the strengths and weaknesses (i.e., limitations) of using occurrence data from the above references, and publish excerpts from references to the above species (in both paper and computer database formats).

*SCOPE:* The above species have been cited as having occurred in Maine historically, and their historical occurrence has been used to justify the use of the species as flagship species, indicator species, or in efforts for reintroduction. Therefore, we sought to provide references to the presence and absence of these species when noted in the historic literature. This work is of interest to multiple agencies and organizations. By assembling these data, we hope to avoid duplicating effort and to provide a common information base from which to discuss management and research issues.

*PROJECT STATUS:* Excerpts from historic literature pertaining to woodland caribou (397 excerpts), wolves (120 excerpts) Canada lynx (116 excerpts), eastern panther (74 excerpts), and wolverine (35 excerpts) have been gathered into a computer database, and are in the process of being edited and published in book form. These references have been put into a historical context with a chronology of significant occurrences in Maine natural history and biographical sketches of 20 important observers.

*FUTURE PLANS:* The research and compilation of this project have been completed. Editing is ongoing, with publication via the University of Maine Press anticipated.

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CONSERVATION GENETICS OF THE YELLOW LAMPMUSSEL (*Lampsils cariosa*) AND  
THE TIDEWATER MUCKET (*Leptodea ochracea*)

*Investigator:* M. W. Kelly

*Advisors:* J. M. Rhymer, Chair  
F. A. Servello  
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A. Huryn  
C. S. Loftin

*Cooperators/*

*Project Support:* Maine Department of Inland Fisheries and Wildlife  
Maine Outdoor Heritage Fund

U.S.G.S. State Partnerships Program  
U.S. Fish and Wildlife Service Endangered Species Funds  
University of Maine -  
Department of Wildlife Ecology  
McIntire-Stennis

- Objectives:*
- 1) Analyze population genetic structure for tidewater mucket and yellow lampmussel within and among river drainages in Maine.
  - 2) Assess species taxonomy on a range-wide basis.

*SCOPE:* Freshwater mussels make up the most endangered taxon in the U.S., with 70% of species listed as endangered, threatened, or of special concern. Declines in freshwater mussels are linked to habitat degradation from pollution and modifications to waterways, and to introductions of exotic species, such as the zebra mussel. In Maine, the Yellow Lampmussel (*Lampsils cariosa*) and tidewater mucket (*Leptodea ochracea*) are state-listed as threatened. Both species are also declining throughout their range.

This study is an assessment of genetic variation in the tidewater mucket and yellow lampmussel on two spatial scales. DNA analysis will be used to study phylogeographic variation across the geographic range of each species as well as among and within river drainages in Maine. Understanding patterns of genetic differentiation among populations of freshwater mussels in Maine will provide a rationale for determining whether their metapopulation should be managed as one or several distinct conservable units. On a national level, taxonomic clarification is critical to the conservation of both species.

*PROJECT STATUS:* The field survey is complete, with tissue samples from 170 tidewater muckets and 260 yellow lampmussel. Samples were taken throughout the range of both species in Maine from populations in the Kennebec, St. George, and Penobscot River drainages. DNA extraction and laboratory analyses are underway.

*FUTURE PLANS:* Laboratory analyses of genetic markers on all samples is underway and data analysis will follow.

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

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BANK, M. S., T. A. HAINES, C. S. LOFTIN, AND R. E. JUNG. "Relative density and mercury contamination of two-lined salamanders from Acadia National Park, Maine." Presented at the 58<sup>th</sup> Annual Northeast Fish and Wildlife Conference, Portland, ME. April 2002.

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HARRISON, D. J., and J. A. HEPINSTALL. "Habitat supply planning for American marten in Maine and Newfoundland." Seminar presented to Canadian Forest Service and Newfoundland Provincial Scientists, Cornerbrook, Newfoundland, August 26, 2001.

HARRISON, D. J. "Marten habitat supply assessment." Presentation at meeting of Maine Cooperative Forestry Research Unit Advisory Committee, Millinocket, Maine, October 17, 2001.

HARRISON, D.J. "Habitat potential for wolves and niche overlap with eastern coyotes in eastern North America." Presentation at Eastern Wolf Workshop, Dixville Notch, New Hampshire, October 19, 2001.

HARRISON, D.J., and J. A. HEPINSTALL. "A workshop on approaches to evaluate habitat requirements and to inventory habitat supply for endangered marten in Newfoundland." Workshop presented to Canadian Forest Service Scientists, Newfoundland Government Scientists, and Western Newfoundland Model Forest Scientists, Cornerbrook, Newfoundland, January 9, 2002.

HARRISON, D.J. "Forestry and forest carnivores: conflict or opportunity." Talk presented to Student Chapter of The Wildlife Society, Orono, Maine, February 7, 2002.

HARRISON, D.J. "Forestry and forest carnivores: conflict or opportunity." Department of Biology Seminar Series, Colby College, Waterville, Maine, March 8, 2002.

HARRISON, D.J., C. L. HOVING, A. K. FULLER, and W.B. KROHN. "A summary of research needs for lynx in eastern North America: what do we know, what are we researching, and what is left?" Presentation at Northern Appalachians Lynx Science Workshop, Portland, Maine, April 24, 2002.

HARRISON, D.J. "Landscape considerations for conserving habitat for wolves, American marten, and lynx in the White and Green Mountain National Forests." Presentation at Species Viability Workshop, U.S. Forest Service, Manchester, New Hampshire, May 22, 2002.

HARTLEY, M. J., M. BURGER, and J. BEYEA. "Effect of harvest intensity on northern hardwood forest birds: comparing watchlist species and ecological habitat groups in NY." Presented at the 58<sup>th</sup> Annual Northeast Fish and Wildlife Conference, Portland, ME. April 21-24, 2002.

HARTLEY, M. J. "Forest management effects on watch-list birds and bird habitat groups in New York Hardwood Forests." Presented at the Department of Wildlife Ecology Seminar series, Orono, ME. January 28, 2002.

HENRICHON, T. Y. and C. S. LOFTIN. "GIS and remote sensing methods to monitor wetland change." Poster presented at the Northeast Fish and Wildlife Conference, Portland, ME. April 21- 24, 2002.

HENRICHON, T. Y. and C. S. LOFTIN. "Documentation of Savannah River marsh conversion and modification of a spatial vegetation succession model." Presented at the Annual meeting of the American Water Resources Association, New Orleans, LA. May 2002.

HENRICHON, T. Y. and C. S. LOFTIN. "Determining long-term extent of marsh type conversion, using satellite imagery, digital aerial photography, and GIS." Presented at the Annual meeting of the Society of Wetland Scientists, Lake Placid, NY. June 2002.

- HEPINSTALL, J. A., D. J. HARRISON, D. C. PAYER and A. K. FULLER. "Habitat supply modeling for American marten in the managed forests of northern Maine." Poster presented at the Northeast Fish and Wildlife Conference, Portland, ME. April 21- 24, 2002.
- HEPINSTALL, J. A., D. J. HARRISON, D.C. PAYER, and A. K. FULLER. "Can marten serve as an umbrella species for forest management in northern Maine?" Paper presented at the 17<sup>th</sup> annual symposium of the International Association for Landscape Ecology – United States Regional Association (US-IALE), Lincoln, NE. April 23-27 2002.
- HEPINSTALL, J. A. and D. J. HARRISON. "Applications of Field Research to Forest Landscape Planning: A Case Study Using American Marten in Maine." Paper presented at *Beyond the Data: Integrating Research Findings into Forest Management Planning and Operations*, Moncton, New Brunswick, Canada. May 3-4, 2002.
- HOMYACK, J. A., D. J. HARRISON, and W. B. KROHN. "Update on the effects of precommercial thinning on snowshoe hare and small mammals in northern Maine." Field tour and presentation to Advisory Committee, Maine Cooperative Forestry Research Unit, Millinocket, Maine, October 17, 2001.
- HOMYACK, J. A., D. J. HARRISON, and W. B. KROHN. "Effects of precommercial thinning on small mammals in northern Maine." Presented at the Northeast Fish and Wildlife Conference, Portland, ME. April 23, 2002.
- HOMYACK J. A., HARRISON, D. J. and W. B. KROHN. "Preliminary results of the effects of precommercial thinning on snowshoe hare." Poster presented at the Northeast Fish and Wildlife Conference, Portland, ME. April 21- 24, 2002.
- HOMYACK, J. A., D. J. HARRISON, and W. B. KROHN. "Effects of precommercial thinning on snowshoe hare in northern Maine." Abstract and presentation at the annual meeting of The Wildlife Society, Bismarck, ND. September 27, 2002.
- HOVING, C. L., D. J. HARRISON, W. B. KROHN, and W. J. JAKUBAS. "Canada lynx habitat, forest harvest strategies and regeneration in northern Maine." Presented at the Northeast Fish and Wildlife Conference, Portland, ME. April 24, 2002.
- HOVING, C. L., R. A. JOSEPH, and W. B. KROHN. "Historical distribution of Canada lynx (*Lynx Canadensis*) in Maine and the Northeast, 1833-1999." The Northeast Natural History Conference. Albany, NY. April 25, 2002.
- HUNTER, M. L. JR. "Spatial and temporal perspectives on forest ecosystem management." Presented at the USDA Forest Service, Litchfield, SC. October 22, 2001.
- HUNTER, M. L. JR. "Coarse filters and ecologically functional populations." Presented at the Wildlife Conservation Society, White Oak's Plantation, FL. November 3, 2001.
- HUNTER, M. L. JR. "Lessons from nature: using ecosystem processes as models for managing natural resources." Presented at the first MacConnell Lecture in Natural Resources Conservation, University of Massachusetts Amherst, MA. May 2, 2002.
- HUNTER, M. L. JR. "Biodiversity in forest planning and management: Science status and needs." Keynote address to the National Committee on Science and Sustainable Forestry Conference, Portland Oregon. June 20, 2002.

- HUNTER, M. L. JR. "Global research priorities for conservation science." Invited presentation to the Trustees of the Christensen Foundation, New York City, NY. June 24, 2002.
- HUNTER, M. L. JR. "Forest ecosystem integrity and overabundant herbivores." Presented at the Pennsylvania Deer Management Forum, State College, PA. September 18, 2002.
- KOLOZSVARY, M. B., A. J. K. CALHOUN, and M. L. HUNTER, JR. 2002. "Wetland duration and reproductive effort and success of wood frogs (*Rana sylvatica*) and spotted salamanders (*Ambystoma maculatum*)."  
Presented at the 58<sup>th</sup> Annual Northeast Fish and Wildlife Conference, Portland, ME. April 21-24, 2002.
- KOLOZSVARY, M. B., A. J. K. CALHOUN, and M. L. HUNTER, JR. 2002. "Is conservation of temporary wetland important for wood frogs and spotted salamanders?" Presented at the joint meeting of Ichthyologists and Herpetologists. July 3-8, 2002.
- KOLOZSVARY, M. B., A. J. K. CALHOUN, and M. L. HUNTER, JR. 2002. "Constraints of wetland duration on reproduction in wood frogs and spotted salamanders." Presented at the 16<sup>th</sup> Annual Meeting of the Society for Conservation Biology, Canterbury, England. July 14-19, 2002.
- KROHN, W. B. "Current research activities of the Maine Cooperative Fish and Wildlife Research Unit." Presented at the Annual meeting of the Wildlife Division, Maine Department of Inland Fisheries and Wildlife, Bangor, ME. October 23, 2001.
- LOFTIN, C. S. "Workshop on opportunities for women working in the field of Wildlife Ecology." Presented at the Expanding your Horizons Conference, University of Maine, Orono, ME. March 2002.
- LOWRY, J. M. and J. M. RHYMER. "Conservation status of the Penobscot meadow vole, *Microtus pennsylvanicus shattucki*." Poster presented at the Northeast Fish and Wildlife Conference, Portland, ME. April 21- 24, 2002.
- MCCLOSKEY, J. and C. S. LOFTIN. "Using image differencing and post-classification comparison to monitor vegetation succession in the Okefenokee Swamp, Georgia." Presented at the Annual meeting of the Society of Wetland Scientists, Lake Placid, NY. June 2002.
- O'CONNOR, R. J., D. M. MAGEEAN, and J. G. BARTLETT. "Structure and scale identification in population – environment models." Presented at the 2001 Open Meeting of the International Human Dimensions Program: Symposium "Population – Environment Studies: Space and Time Dimensions," Rio de Janeiro, Brazil. October 8, 2001.
- O'CONNOR, R. J. "Beyond population effects: spatio-temporal processes in populations and pesticides." Presented at the Invitational science symposium Pesticide effects on birds: beyond the tip of the iceberg, organized by American Bird Conservancy at the Patuxent Wildlife Research Center in Laurel, MD. October 12-20, 2001.
- O'CONNOR, R. J. "Agricultural regimes and the conservation of farmland biodiversity." Presented at the International Symposium on Managing Biodiversity in Agricultural Ecosystems, co-organized by United Nations University, Secretariat of the Convention on Biological Diversity, and the International Plant Genetic Resource Institute, Montreal, Canada. November 8-10, 2001.
- PERKINS, D. W. and P. D. VICKERY. "Population viability analysis of an endangered passerine: Florida Grasshopper Sparrow." Presented to the U. S. Fish and Wildlife Service, South Florida Ecological Field Office, Vero Beach, FL. November 28, 2001.

- PERKINS, D. W. and M. L. HUNTER, JR. "Riparian buffer widths and amphibian communities in Western Maine." Presented at the annual meeting for Northeast Wildlife Graduate Student Conference, University of New Brunswick, Fredericton, New Brunswick, Canada. March 2, 2002.
- PERKINS, J. C. and F. A. SERVELLO. "Research on least terns in Maine." Gulf of Maine Seabird Working Group, Bremen, ME. August 12, 2002.
- RUSTIGIAN, H. L. and W. B. KROHN. "GIS based evaluation system for waterfowl and wading bird habitats in Maine." Presented at the Maine Department of Inland Fisheries and Wildlife Meeting of Regional Biologists, Bangor, ME. January 30, 2002.
- RUSTIGIAN, H. L. and W. B. KROHN. "GIS-based evaluation systems for waterfowl and wading bird habitats in Maine." Abstract and poster presented at the Northeast Fish and Wildlife Conference, Portland, ME. April 21- 24, 2002.
- SCHAEFER, S. M., W. B. KROHN, and R. J. O'CONNOR. "A new approach for testing the accuracy of vertebrate occurrence predictions." Abstract and presentation at the twelfth Annual National Gap Analysis Program Meeting, Shepherdstown, WV. August 4, 2002.
- SCHILLING, E. G., and J. R. MORING. "Relationships between geomorphology and fish community structure in Maine." Poster presented at the Northeast Fish and Wildlife Conference, Portland, ME. April 21-24 (a modification of this poster also presented at the 16<sup>th</sup> annual meeting for the Society for Conservation Biology, Canterbury, England. July 2002).
- SERVELLO, F. A. and S. C. BILLIG. "Evaluation of two forest management practices recommended for small mammals: buffer strips and retention of woody debris. Presented at the Stakeholder council Meeting, Shipting Mosaic Project, November 29, 2001.
- SERVELLO, F. A., A. T. GILBERT, and S. B. KEARNEY. "Breeding productivity and site fidelity of black terns in Maine, 1997-2001." Presented at the 58<sup>th</sup> Annual Northeast Fish and Wildlife Conference. April 22-24, 2002.
- SPOHR, S., D.J. HARRISON, and F.A. SERVELLO. "Effects of landscape and cover characteristics on nest success of eastern wild turkeys in southeastern Connecticut." Paper presented at the Northeast Fish and Wildlife Conference, Portland, Maine, April 23, 2002.
- STROJNY, C. "Effects of artificial canopy gaps and downed woody material on forest amphibians in Maine." Presented at the Northeastern Wildlife Graduate Student Conference, Fredericton, New Brunswick, Canada. March 2, 2002.
- WEBB, N., F. A. SERVELLO, C. MCLAUGHLIN, and W. JAKUBAS. "Characteristics of beechnut producing hardwood stands by black bears in Maine." Undergraduate research presentation at the State House Hall of Flags, Augusta, ME. April 4, 2002.

#### PUBLIC TALKS PRESENTED

- BAHN, V. "Big trees, big money, little bird – the case of the Marbled Murrelet in the old-growth temperate rainforests of Clayoquot Sound, British Columbia." Presented at the Wildlife Ecology Seminar Series, Orono, ME. September 9, 2002.
- FULLER, A. K. "Multi-scalar responses of forest carnivores to habitat and spatial pattern: case studies with Canada

- lynx and American marten.” Dissertation proposal seminar, Orono, ME. September 19, 2002.
- GILBERT, J. R. “Seals and Salmon in Maine.” Presented at the Project SHARE meeting. August 14, 2002.
- HARTLEY, M. J. “Forest management effects on watch-list birds and bird habitat groups in New York hardwood forests.” Presented at the Wildlife Ecology Seminar Series, Orono, ME. January 28, 2002.
- HEPINSTALL, J. A. and D. J. HARRISON, and W. B. KROHN. “Spatially explicit wildlife habitat modeling; case studies from Maine.” Presented at the Wildlife Ecology Seminar Series, Orono, ME. April 8, 2002.
- HEPINSTALL, J. A. “Predicting the effects of landscape configuration and change on wildlife habitat using spatially explicit models.” Ecology Seminary Series, University of Washington, Seattle, WA. January 10, 2002.
- HOMYACK, J. A., D. J. HARRISON, and W. B. KROHN. “Effects of intensive forest management on small mammals and snowshoe hare in northern Maine.” Presented at the Spring 2002 Evening Seminar Series of the University of Maine Student Chapter of the Wildlife Society, Orono, ME. April 14, 2002.
- HOVING, C. L., D. J. HARRISON, and W. B. KROHN. “Canada lynx habitat in eastern North America.” Presented at the Alice Steward Lecture Series, Maine Center for the Arts, Orono, ME. October 31, 2001.
- KROHN, W. B. Interviewed, along with Dr. P. MacDougall of the UM Maine Folklife Center, on the radio program “Maine Outdoors” (103.9 FM). Topics discussed included Manly Hardy, Fannie H. Eckstorm, and the early Maine game laws. March 24, 2002.
- RHYMER, J. M. “Phylogeography and avian conservation genetics: two case histories.” Presented at the Wildlife Ecology Seminar Series, Orono, ME. March 25, 2002.

## WORKSHOPS

- HUNTER, M. L. Facilitated a meeting of the chief scientists of the World Wildlife Fund, The Nature Conservancy, Conservation International, and the Wildlife Conservation Society in which they began a process of cooperation in setting global priorities in New York City, NY. April 18-19, 2002.
- GILBERT, J. R. Panel member at the Northeast Consortium Review Panel for project development proposals, Portsmouth, NH. July 15, 2002.
- LOFTIN, C. S. Session organizer and chair, GIS Applications in Hydrology, Maine Water Conference, Augusta, ME. May 9, 2002.
- LOFTIN, C. S. Session organizer and chair, Employment Opportunities in the Natural Resources, 58<sup>th</sup> Annual Northeast Fish and Wildlife Conference, Portland, ME. April 21-24, 2002.
- O’CONNOR, R. J. Biotech Branches Out: A look at the opportunities and impacts of forest biotechnology. A conference sponsored by Pew Initiative on Food and Biotechnology, Society of American Foresters, and Ecological Society of America, Atlanta, GA. December 4-5, 2001.
- WITHAM, J. Organized and presented “Introduction to Forest Ecology”, the first workshop in a continuing series entitled “Sustainable Forests for Midcoast Maine.” April 20, 2002.

WITHAM, J. Organized and presented “Biodiversity – Knowing Your Forest”, a workshop in the continuing series entitled “Sustainable Forests for Midcoast Maine.” September 28, 2002.

#### AWARDS, HONORS, AND APPOINTMENTS

KROHN, W. B. Presented with a Leadership Award by the Unit Program of the U. S. Geological Survey’s Biological Resources Division. This is one of three such awards presented annually across the nation. February 2002.

KROHN, W. B. The Maine Cooperative Fish and Wildlife Research Unit was one of nine organizations that received the Maine Governor’s Teamwork Award for developing and implementing “Beginning with Habitat.” Currently, over 70 towns are using the information generated by this program in the comprehensive plans. Information created from the Maine Gap Analysis Project is a major part of the information that the towns are incorporating into their open space plans. September 2002.

SCHILLING, E. G. Awarded the Best Student Poster by the Northeast Division of the American Fisheries Society at the Northeast Fish and Wildlife Conference. The poster was entitled “Relationships between geomorphology and fish community structure in Maine.” April 2002.