

**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

October 2002 - September 2003

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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Sarah C. Billig	M.S.	MCCS, NSFA, PCTC
Pamela Bryer	M.S.	NPS, U of M, MCFWRU
Steven P. Campbell	Ph.D.	HWRF, U of M, NPS
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Jordan C. Perkins	M.S.	U of M, MOHF, MDIFW, RCNWR, MAS
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Student	Degree Candidacy	Support
Jessica A. Homyack	M.S.	CFRU, NCASI, USFWS, MCFWRU, U of M
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Stephen N. Matthews	M.S.	USFS, U of M
Stephanie L. Orndorff	M.S.	USGS-BRD, MCFWRU, U of M, MOHF

PERSONNEL NOTES

JESSICA HOMYACK received her MS degree in Wildlife Ecology and worked as a seasonal wildlife technician for the USGS-BRD in Minnesota. She is collaborating with Dan Harrison and Bill Krohn on additional snowshoe hare research. **MARY BETH KOLOZSVARY** received her PhD degree in Ecology and Environmental Sciences and is employed at the New York State Museum. **STEPHEN MATTHEWS** received his MS degree in Wildlife Ecology and is exploring employment opportunities. **STEPHANIE ORNDORFF** received her MS degree in Wildlife Ecology and is employed by the Pennsylvania Chapter of The Nature Conservancy.

COLLABORATING AGENCIES AND ORGANIZATIONS

Abitibi Consolidated - AC
 American Museum of Natural History – AMNH
 Aquaculture Research Center - ARC
 Audubon Society of New Hampshire - ASNH
 Boise Cascade - BC
 College of the Atlantic – COA
 Allied Whale - AW
 Corner Brook Pulp & Paper - CPP
 Crown Vantage Inc. - CVI
 Declining Amphibian Population Task Force - DAPTF
 Duke University - DU
 Eastern National Park Research Fund - ENPRF
 Florida Power Light Energy - FPL
 Holt Woodlands Research Foundation - HWRF
 International Paper - IP
 James River Corporation - JRC
 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 Environmental Protection - MDEP
 Maine Department of Inland Fisheries and Wildlife - MDIFW
 Maine Department of Marine Resources - MDMR
 Maine Outdoor Heritage Fund - MOHF
 Manomet Center for Conservation Sciences - MCCS
 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
 Research Fellowship - RF
 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
 Plum Creek Timber Company - PCTC
 Rachel Carson National Wildlife Refuge - RCNWR
 Seven Islands Land Company - SILC
 Switzer Environmental Fellowship Program - SEFP
 The Nature Conservancy - TNC
 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 Ecosystem Science - FES
 Forest Ecosystem Research Program - FERP
 Department of Plant, Soil and Environmental Science - DPSE
 Department of Wildlife Ecology – DWE
 Faculty Research Fund - FRF
 Graduate School - GS
 McIntire-Stennis – MCS
 School of Marine Sciences - SMS
 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
 Endangered Species Fund – ESF
 Lake Umbagog National Wildlife Refuge - LUNWR
 Neotropical Migratory Bird Program - NMBP
 Moosehorn National Wildlife Refuge - MNWR
 Okefenokee National Wildlife Refuge - ONWF
 Partnerships for Wildlife Program - PWP
 Region 5 - R5
 Savannah National Wildlife Refuge - SNWR
 USGS Biological Resources Division - BRD
 Eastern Region State Partnership Program - ERSPP
 Florida Integrated Science Center - FISC
 Gap Analysis Program - GAP
 Maine Cooperative Fish and Wildlife Research Unit – MCFWRU

Maine Water Research Institute – MWRI
National Park Service - NPS
Acadia National Park – ANP
Patuxent Wildlife Research Center - PWRC
State Partnerships Program - SPP
U. S. Environmental Protection Agency - EPA
Wagner Forest Management, Ltd. - WFM
Western Newfoundland Model Forest - WNMF

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 80 breeding pairs distributed among 6-9 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.

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/
Project
Support:* Maine Cooperative Forestry Research Unit
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. Three lynx (1F, 2M) were snowtracked for 32.8 km between 4 January and 1 April 2003 and 45 km of random straight-line transects were sampled within their home ranges. Vegetation was sampled within 380 plots along the lynx trails and within 495 plots along random transects.

FUTURE PLANS: A final report is scheduled to be completed by 2004.

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: Data analysis began in March 2002 and initially focused on application of various home-range estimation models, e.g. Minimum Convex Polygon versus Adaptive Kernel, and development of asymptotic home range curves, i.e., area-observation curves. Subsequently, year-specific home range coverages were estimated for each individual marten with sufficient numbers of relocations to meet our asymptotic home range criteria (N = 91). Year-specific forest inventory coverages were developed using GIS (Arc Info) for each of the two study areas and were subsequently clipped against our estimated home ranges boundaries to calculate landcover composition for

each individual home range. Finally, individual marten locations (ca. 5,200 locations) were intersected with the associated landcover composition coverage to develop a habitat specific relocation database for each individual marten home range. Habitat analysis was initiated in fall 2003 and should be concluded by January 2004.

FUTURE PLANS: Data analysis will continue for the remainder of 2003 and 2004. A companion study, (A. Fuller, Ph.D.) is utilizing the results of the home range and habitat selection analysis to develop a predictive habitat model for Newfoundland marten. This modeling project will be combined with a further project involving the use of satellite imagery and remote-sensing technologies to augment or replace the habitat coverages currently available from the provincial forest inventory.

**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
P. Rawson
A. Huryn
C. S. Loftin

*Cooperators/
Project Support:* Maine Department of Inland Fisheries and Wildlife
Maine Outdoor Heritage Fund
USGS State Partnerships Program
US Fish and Wildlife Service Endangered Species Funds
University of Maine -
Department of Wildlife Ecology
McIntire-Stennis
Graduate Research Assistantship

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 and lab work are complete, with tissue samples from 170 tidewater muckets and 260 yellow lampmussels. Samples were taken throughout the range of both species in Maine, from populations in the Kennebec, St. George and Penobscot River drainages. To assess population genetic structure within Maine, we have genotyped yellow lampmussel and tidewater muckets at 7 and 3 microsatellite loci respectively. For the rangewide taxonomic analysis, we have obtained tissue samples from sites throughout the ranges of both species from Nova Scotia to Georgia, and compared DNA sequences from the mitochondrial ND1 gene.

FUTURE PLANS: Complete data analysis and defend thesis by April 2004.

**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 (M. S. student)
P. Wick (M. S. 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

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.
 - 1) Identify landscape-scale factors indicating suitable mussel and host fish habitat.
 - 2) 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 is underway. Spatial analyses will be conducted during fall 2003-spring 2004.

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. Wetland and landscape-level variables have been 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 and preliminary GIS analyses have 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 coverages were developed in summer 2003, as well as analyses of nocturnal nest attentiveness. The development of logistic regression models to predict nest predation based on habitat, hydrologic, and conspecific variables is in progress.

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: Data collection was completed in August 2003. I monitored a total of 235 nests at four colonies in 2002 and over 300 nests at five colonies in 2003. I documented clutch size, hatchability, and nest success for all nests and determined causes of nest losses. I documented fledgling success and departure from colony sites for color-banded chicks at two colonies in 2003 and 2003, and used data loggers to monitor nocturnal nest attentiveness at three colonies in 2003.

FUTURE PLANS: Analysis of data is in progress. This data will be presented as a M. S. thesis to the Department of Wildlife Ecology in spring 2004.

FISHERIES RESOURCES:

INVENTORY OF INTERTIDAL AND ESTUARINE FISHES OF ACADIA NATIONAL PARK

Investigators:

P. Bryer

A. Jordaan

Supervisor: L. J. Kling

Cooperators/ National Park Service - Acadia National Park
Project Support: University of Maine - School of Marine Sciences
Maine Cooperative Fish and Wildlife Research Unit

Objectives:1) Inventory fish species found in tidepools at locations adjacent to Park lands on Mount Desert Island and Schoodic Peninsula, and

2) Conduct more detailed assessments 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: The field work component of the project has been completed. We are presently entering data into Microsoft Access and Excel for the data inventory and analysis required. We have completed most of the information required in the tidepool section, but have substantial work remaining for the estuarine component.

Five estuaries were sampled during the summer 2002/2003 field season (Bass harbor, Seal cove, Northeast creek, Somes sound, Mosquito cove) with two sampling processes. The first used a grid of minnow traps with onset temperature loggers, which were attached to the traps to get a time series of the temperature change (the freshwater is usually a different temperature than the ocean water). This will allow for some inference of the freshwater-saltwater mixing at the sites. For the second sampling technique dip-nets were used for sampling the shoreline around the estuaries and seine-nets for doing the deeper water. Minnow traps have a reputation or not sampling effectively all species so the multiple techniques were used. In total, 10806 fish were caught over two sampling periods. A total of 3,371 fishes of 14 species were caught in the first sampling period and 7,435 individuals of 7 species were taken in the later sampling period. A subset of the fish caught was also measured.

Additional tidepool data was collected during 2002 in two sites sampled during 2001. The sampling effort around the Schoodic and Seawall sites were expanded to attempt to gain a more fine scale understanding of the

distribution of fish compared to the broader sampling accomplished in 2001.

FUTURE PLANS: We plan to have the project report completed in the month of November. Mr. Jordaan will also be presenting some of the work at a science symposium in Acadia National Park in early November.

INVESTIGATIONS INTO THE CULTURE OF RAINBOW SMELTS

Investigator: M. A. Hachey

Supervisor: L. J. Kling, Chair
M. Gallagher
M. Kinnison

*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
Maine Outdoor Heritage Fund

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 with a historic distribution encompassing the Atlantic coastal drainage from New Jersey to Labrador with a few native landlocked populations occurring within this range (Scott and Crossman 1973). In Maine, native and transplanted, landlocked rainbow smelt populations support important commercial bait and recreational fisheries as well as a forage base for the state's salmonid fisheries. Commercial smelters provide smelt for sportfish anglers to use as live bait, while recreational anglers catch them for food as well.

Rainbow smelt are caught from the time the ice first forms to a climax for the fishery during spawning which concludes during early May. Most smelt are captured with dipnets during the spawning runs at night as they ascend natal streams. This practice has contributed to dramatic population fluctuations and closures of certain inland waters. 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 and modifying them to the Rainbow smelt.

PROJECT STATUS: The first year of grow-out trials began in May 2003. Wild smelts were captured and brought to Aquaculture Research Center for spawning. Spawning was successful with disinfection and fungicidal treatments tested and producing hatching success at 90%. Larvae were fed rotifers, *Branchionus* spp, using two enrichments. Enrichment showed no significant effect on larval smelt growth rate. Larval mortality was very high during this period and further trials during development were unable to continue.

FUTURE PLANS: In the spring of 2004 we will evaluate the use of a smaller strain rotifer *Branchionus* spp. as first food for larval Rainbow smelt. If successful, we will develop an optimal weaning strategy for moving the fry from live food to a commercially prepared larval diet.

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 Cooperative Fish and Wildlife Research Unit
 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. Data analysis is nearly completed and writing of the dissertation has started.

FUTURE PLANS: A Ph.D. dissertation is expected in May 2004.

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 December 2003. A manual detailing methods for conducting juvenile Atlantic salmon surveys using the snorkeling technique will be prepared for the Maine Atlantic Salmon Commission.

HABITAT RESOURCES:

REPRESENTATIONAL ANALYSES OF CONSERVATION LANDS IN MAINE

- Investigator:* S. L. Orndorff
- 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: All requirements for a M. S. degree in Wildlife Ecology were met in December 2002. The abstract follows:

The three studies reported here (i.e., statewide, southern Maine, and state and federal wildlife areas) identify what areas should be conserved to represent the natural diversity of Maine. Geographic Information System (GIS) technology was used to conduct the analyses comparing the distribution of abiotic and biotic variables representing natural diversity on and off conservation lands. In the statewide analysis, 10 environmental variables were compared on and off conservation lands using Arc Grid with a cell resolution of 1.86 x 1.86 km. The areas found to contain variables that were under-represented were combined to identify and map regions with under-represented characteristics. The mean number of under-represented variables for each major biophysical region in Maine was calculated with southern Maine being in greatest need of more conservation lands. The highest degree of under-representation was in low elevation areas and lower portions of large river valleys. When abiotic variables, which are more permanent to the landscape, were weighted higher than biotic, the same results as above were found.

To determine locations of potential new conservation lands in southern Maine, I analyzed the representation

of seven environmental variables on conservation lands in southern Maine with a cell resolution of 94.6 x 94.6 m. Only four variables were substantially under-represented including 401 – 450 m elevation, 4 – 7 degrees of slope, shoreline and mudflats, and early successional and crop cover types. The distance from these highly under-represented areas to areas with high road density was measured and mapped as an indicator of their vulnerability to development.

The contribution of Wildlife Management Areas (WMA's) and National Wildlife Refuges (NWR's) were analyzed to evaluate their contribution to the conservation of Maine's wildlife and natural diversity. Earlier management objectives for these agencies focused on acquisition of game (e.g., waterfowl) and endangered species habitats. Management emphasis has broadened recently to include conservation of ecosystems and all wildlife species, therefore, it is important to assess whether NWR's and WMA's accomplish these new, broader goals. Geographic datasets including topography, vegetation cover, and terrestrial vertebrate richness were compared on and off WMA's and NWR's using ArcGrid with a cell resolution of 94.6 x 94.6 m for each major biophysical region in Maine. Out of 270 terrestrial vertebrate species predicted to occur in Maine, 219 were predicted to occur on WMA's and 223 on NWR's. Wetland and open water vertebrate species, wetland vegetation types, and low elevation areas were over-represented in the state, while more upland vegetation types were under-represented by WMA's and NWR's. These results suggest that WMA's and NWR's should acquire additional mid-elevation and upland areas, assuming a goal of land conservation that is representative of the state's natural diversity.

HYDROPERIOD OF WETLANDS AND REPRODUCTION IN WOOD FROGS (*RANA SYLVATICA*) AND SPOTTED SALAMANDERS (*AMBYSTOMA* *MACULATUM*)

Investigator: M. B. Kolozsary

Advisors: A. J. K. Calhoun, co-advisor
M. L. Hunter, Jr., co-advisor
W. E. Glanz
A. Huryn
R. J. O'Connor

*Cooperators/
Project
Support:* U. S. Geological Survey – Biological Resources Division
Acadia National Park
American Museum of Natural History
Association of Graduate Students
U. S. Fish and Wildlife Service
Moosehorn Wildlife Refuge
University of Maine
Department of Wildlife Ecology
Plant, Soil and Environmental Science

Objective:

- 1) Determine what pool hydroperiod provides the best conditions for successful reproduction of wood frogs and spotted salamanders.
- 2) Examine patterns of egg and larval mortality and density of invertebrate predators across a hydroperiod gradient from seasonal wetlands of short flood duration to permanently flooded sites.

SCOPE: Many species of amphibians rely on wetlands for reproductions, although each species tends to prefer specific types of wetlands. Recent research suggests that hydroperiod is a key factor in dictating reproductive success for any given amphibians species. The differential distribution of breeding amphibians along a gradient of wetland permanence is striking, yet not absolute. Wetlands are complex ecosystems and it remains unclear how wetlands of different permanence differentially confer advantages and disadvantages to the various species of

breeding amphibians.

Conservation efforts in the northeastern United States have begun to focus on the importance of vernal pools as unique habitats for a variety of flora and fauna, including breeding habitat for wood frogs and spotted salamanders. Because of the ephemeral nature of vernal pools, these unique habitats provide a fish-free environment suitable for the successful development of wood frog and spotted salamander larvae. Vernal pools, therefore, are thought to result in greater reproductive success for these species than permanent wetlands. Vernal pools are largely unprotected and loss of these habitats is of great concern to wetlands conservationists. In fact, many vernal pool indicator species are listed as species of special concern in some states. Furthermore, abiotic (e.g., water chemistry, water temperature) and biotic (e.g., resource availability, vegetation structure, competition, predation) factors which shape the differential distribution and success of breeding amphibians along a gradient of permanence have only begun to be revealed.

PROJECT STATUS: All requirements for a Ph.D. degree in Ecology and Environmental Sciences were met in August 2003. The abstract follows:

Many amphibians rely on wetlands for reproduction and the differential distribution of amphibian species along a gradient of wetland permanence is striking, yet not absolute. In recent years, conservationists have become concerned about declines in populations of wood frogs (*Rana sylvatica*) and spotted salamanders (*Ambystoma maculatum*) over much of their range. These species are thought to rely on seasonal wetlands for greatest breeding success, but there is little documentation of their reliance on these or other habitats. My objective was to determine what pool hydroperiod provides the best conditions for successful reproduction of these species. I documented reproductive effort for wood frogs and spotted salamanders in 72 wetlands in Acadia National Park, Maine in 2000 and 2001. In one or both years, I also examined egg and larval mortality patterns and density of invertebrate predators in a subset of 21 of these wetlands that represent a hydrologic gradient from seasonal wetlands of short flood duration to permanently flooded sites. In 2001, I obtained an index of reproductive success at a subset of 15 of the 21 wetlands. My results indicate that wood frogs have greatest reproductive effort and success in seasonal wetlands of short flood duration; however, for spotted salamanders, greatest reproductive effort occurs in some permanently flooded wetlands as well as seasonal wetlands of long flood duration that have sufficient flood duration to allow development of eggs and larvae in at least some years. Mortality of eggs for wood frogs is generally low across the gradient of flood duration and is higher for spotted salamanders. Larval mortality patterns also differ for the two species: wood frogs have higher mortality in wetlands of long flood duration, whereas spotted salamanders have higher mortality in wetlands of short flood duration. Density of invertebrate predators generally increases with increasing flood duration and larval mortality of wood frogs is significantly correlated with density of invertebrate predators, thus indicating that the vulnerability of wood frog larvae to predation may limit their ability to successfully reproduce at sites of long flood duration.

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 2003, tasks 3, 4, 5, 6, 7, 8, and portions of task 1 as outlined above, were completed.

FUTURE PLANS: The 2004 field season will primarily focus on timber inventory with additional work on plants and trees.

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

Investigator: C. S. Loftin
J. McCloskey
W. M. Kitchens (University of Florida)
M. Dusek (M. S. student, University of Florida)

*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: Maps developed from recent satellite imagery and ground surveys of marsh vegetation associations indicate that Savannah National Wildlife Refuge tidal marshes have undergone changes in vegetation distributions since a tide gate was permanently opened in 1991. Landsat thematic mapper and SPOT multispectral imagery captured during 1986, 1987, 1993, 2000, and 2001 was used to map marsh vegetation and characterize vegetation change. Vegetation maps were created from each image using unsupervised classification procedures and compared using principal components analysis and map overlays to identify change types. Results were then compared with predictions of a previously developed model of vegetation response to tide gate removal. Changes in greenness and brightness indicated changes in biomass, vegetation communities, and water level in the study area. Greenness increased most during 1987-1993. An increase in freshwater species occurred by 1993 in nearly 1/3 of the region predicted to be dominated by freshwater vegetation two years following tide gate removal and to nearly 3/4 of the model-predicted distribution by 2001. The freshwater type, which prior to tide gate removal was limited to the upper marsh, now extends nearly throughout Argyle Island. The change since 1993 has been both an expansion of fresh marsh vegetation distributions and an increase in the interspersions of this type with *Zizaniopsis miliacea* and *Scirpus validus*. Shifts in dominance between *S. validus* and *Z. miliacea* and associated freshwater species have occurred within and between years in previously brackish areas since the gate was removed, and the distribution of *Z. miliacea* has increased downriver since tide gate removal. Comparisons of vegetation maps also indicate increased extent of woody vegetation, a changing distribution of *S. validus* and *Spartina spp.*, and fluctuating dominance of *S. validus* in the middle marsh over the 15-year period of study. The southern end of Argyle Island and New Cut approximate the current southward extent of vegetation associations intolerant of salinity >3.0 ppt, a shift southward of nearly 4 km since tide gate removal. Vegetation composition below Argyle Island has changed little in response to tide gate removal, and remains primarily a mixture of *S. validus*, *S. robustus*, and *Spartina alterniflora*. Recent increased marsh salinity due to harbor modifications and drought may be slowing the fresh/intermediate marsh transition, indicating that the affected species may be at the edge of their tolerances and not resilient to additional salinity stress. Continued loss of freshwater/intermediate marsh that has expanded since removal of the tide gate is likely should additional increases in marsh salinity occur.

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/ University of Maine
Project McIntire-Stennis
Support: Manomet Center for Conservation Science
Cooperative Forestry Research Unit, University of Maine
National Fish and Wildlife Foundation

Plum Creek Timber Company
 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) collected. For the experimental study we collected one year of pre-treatment data and two years of post-treatment date from 2001 to 2003. 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. For the retrospective study we collected data on 12 streams from 2000 to 2002. During the four years and the two studies we have captured over 6,5000 amphibians of 12 different species over more than 270,000 trap nights.

FUTURE PLANS: The 2003 field season just finished in September. This study is being 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 and 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.

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
 J. Wilson

*Cooperators/
Project
Support:* USGS-BRD Florida Intergrated Science Center
U. S. Fish and Wildlife Service
Okefenokee National Wildlife Refuge
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 model to simulate spatial and temporal effects of water levels and fire on vegetation composition and structure.
- 4) Develop models to show habitat association of specific amphibians species within the swamp vegetation types.

SCOPE: The Okefenokee National Wildlife Refuge (ONWR) is a mosaic of several wetland communities covering approximately 1700 km². 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. The 2001 vegetation map was compared to the 1990 map to determine from-to changes in vegetation. Amphibian data collected by the Florida Integrated Science Center were used to develop statistical models that show habitat associations of certain amphibian species.

FUTURE PLANS: Development of the vegetation succession model is underway. Models will be developed to simulate vegetation succession given specific fire regimes and water levels.

VEGETATION RESPONSE TO IMPOUNDMENT MANAGEMENT AT MOOSEHORN NATIONAL WILDLIFE REFUGE

Investigators: C. S. Loftin
J. R. Longcore

Assistants: L. Hierl (MPP/MEM student, Duke University)
C. Currier
H. Alcock

Cooperators/ **University of Maine, Department of Wildlife
Ecology – Graduate School**

*Project
Support:* 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
Duke University

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: Digital maps of vegetation occurring in 50 impoundments during 1984-1985 and 2002 were developed using ArcGIS and MapInfo software. Selected spatial statistics to describe vegetation structure in the impoundments were calculated for each map. Water level data collected during 1981-2002 from each impoundment were summarized. Currently we are developing case studies discussing the vegetation changes that were noted in each impoundment and developing recommendations for impoundment management for waterbirds.

FUTURE PLANS: Vegetation change analyses, comparisons to water level data, and a final report will be completed during fall 2003.

THE PRINCIPLES OF TERRESTRIAL VERTEBRATE DISTRIBUTION MODELING

Investigator: V. Bahn

Advisors: W. B. Krohn, Co-Chair
R. J. O'Connor, Co-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 and appropriate techniques to address the issues identified under 2).

SCOPE: This project aims at supplying a review of the current modeling concepts and techniques for terrestrial vertebrate occurrences with the goal of improving current approaches. The scope is to cover the problems in distribution modeling with the highest negative impact and the best chances for improvement. Specific topics being considered include:

- 1) Modeling of Animal – environment relationships by constraints or limiting factors;
- 2) Spatial effects in species occurrences;
- 3) Effects of different levels of population-wise saturation on distribution modeling;
- 4) Distribution dynamics;

- 5) Animal behavior and habitat selection;
- 6) Spatial and temporal scales; and
- 7) Uncertainty.

The two issues identified as most critical and most realistic for improvement were explicit integration of spatial effects and the modeling of animal-environment relationships. The former is concerned with the integration of neighborhood effects into modeling with spatial analysis techniques. The core of the latter issue is that animal distributions are governed by environmental constraints rather than environmental correlation. Traditional modeling techniques such as correlations and regressions are poorly suited to recover such constraint-based patterns and different avenues need to be explored. In addition, two topics were selected for further investigation: scale and distribution dynamics.

PROJECT STATUS: The review of current concepts and techniques for modeling terrestrial vertebrate occurrences and the identification of the most critical steps in modeling the occurrence of terrestrial vertebrates that need improvement have been completed. The topic of spatial effects in distribution modeling was investigated. Significant progress was made on this topic using Breeding Bird Survey (BBS) data and Conditional Autoregressive models. In total, I modeled 29 species with traditional and with spatial regression models. In all cases, the spatial model outperformed the traditional model by, on average, 14%. In addition, the differences in predictions between the two kinds of models was highly regional, meaning that over large parts of the included area the models did not vary much, but in some regions, the differences were very large.

FUTURE PLANS: The autoregressive models will be verified in their performance with reserved data and some of the observed patterns, such as regional differences in models need to be investigated. The next topic for research will be the modeling of animal-environment relationships through constraints. I will use 90th quantile least absolute deviation regressions to model upper edges in abundance vs. environmental factor graphs from BBS survey data. In addition, I will explore the compatibility of regression tree models with the constraints model theory and in how far the different models can retrieve known patterns in simulated data. I will also research the effects of spatial extent and grain on distribution models and will explore techniques that can retrieve critical scales from distribution data and thus guide modelers in their choice of scale and will investigate the impacts of distribution dynamics on the current static modeling paradigm.

ENVIRONMENTAL FACTORS ASSOCIATED WITH UNIQUE LAKE COMMUNITIES IN MAINE

Investigators: E. Schilling (Ph. D. student)
K. DeGoosh (M. S. student)
D. Anderson (Research Associate)

Advisors: For Ph. D. student Emily Schilling: C. S. Loftin, Chair
A. Huryn
K. Webster
P. Vaux
J. Trial

For M. S. student Katie DeGoosh: C. S. Loftin, Co-Chair
K. Webster, Co-Chair
G. Jacobson

Cooperators: Maine Outdoor Heritage Program
Project Maine Department of Inland Fisheries and Wildlife
Support 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 20th 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 20th 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. We will also develop and apply methodologies to document the historic presence or absence of fish in lakes predicted to be fishless but found to contain fish, to confirm model predictions.

PROJECT STATUS:

Invertebrate and fish surveys of fishless-fishfull lake pairs:

During the summers of 2002 and 2003, thirty-seven ponds (18 currently fishless, 6 historically fishless, 12 fishfull) were sampled around the state using various techniques to quantify differences in invertebrate communities between fishless and fishfull lakes. A third sampling season will be conducted in 2004. The study lakes represent two types of fishless lakes. In central and western Maine the lakes are at high elevations and are located high in the watershed; some are on the watershed boundary. Lakes that are located high in the watershed likely have steep outlet streams, thus creating barriers to fish migration. This is the probable cause for fishlessness of this set of lakes. In Downeast

Maine, we sampled a set of kettle lakes that have no outlet or inlet and have a low pH (less than 5.0). The pH of these lakes makes them inhabitable by fish unless they are limed (a practice that has been conducted by MDIFW to make acidic waters habitable by stocked fish). Analysis of samples is currently underway, involving sorting and identifying invertebrates. In addition, GIS analyses are being conducted to describe landscape characteristics for study lakes. The data from the first two field seasons will then be used to build a model to predict the probability of a given lake being fishless. The absence of fish in these ponds will be confirmed in 2004, providing an indication of the accuracy of our predictive model.

Paleolimnological study of fishless-fishfull lake pairs:

Currently, we are researching the biology and ecology of certain indicator species of *Chaoborus* (Diptera), as published research has shown the presence of certain species to indicate fishlessness. *Chaoborus americanus* is a reliable paleolimnological indicator, commonly identified in sediments by their mandibles and other remains. Other indicator species such as *Nonecta* and *Daphnia* are also being considered for use as indicators, and their interactions with *Chaoborus* are also being researched. Preliminary sediment cores have been taken at five lakes in various regions of Maine, testing several types of coring models to determine the most effective sampling methodologies for use in this project. With collaboration from the Maine Department of Environmental Protection and the University of Maine, plans to make a Huang V corer are now being designed.

FUTURE PLANS:

Invertebrate and fish surveys of fishless-fishfull lake pairs:

In the third field season, during summer 2004, a set of un-sampled lakes in each of the regions sampled in 2002 and 2003 will be selected for model testing. Analyses of landscape-scale parameters will be repeated for these lakes, and they will be surveyed for fish and invertebrate presence. In the case that an appropriate invertebrate indicator species was identified during the previous field seasons, this species will be targeted in the 2004 sampling season. The model will be refined based on the results from the 2004 season.

Paleolimnological study of fishless-fishfull lake pairs:

During the summer of 2004, sediment cores from a subset of the lakes sampled in the Invertebrate and Fish Survey will be taken for processing. Samples will be sorted in the lab and specimens will be microscopically identified. The presence or absence of the pre-determined indicator species will determine if in fact a given lake is currently (or was at some point in the past) fishless as predicted by the model.

USING ALGAE TO EVALUATE THE CONDITION OF MAINE'S STREAMS AND RIVERS

Investigators: T. J. Danielson (Ph.D. student)

Advisors: C. S. Loftin, Chair
D. Courtemanch
S. Brawley
F. Drummond
J. Stevenson

Cooperators/

University of Maine, Department of Wildlife

Project Support U.S. Geological Survey, Biological Resources Division
Maine Department of Environmental Protection
U. S. Environmental Protection Agency

Ecology

Objectives: 1) Determine if algal communities in Maine differ with stream type, such as with gradient and geology, and how species composition varies within a stream type

- within and between years.
- 2) Develop analytical tools to evaluate the condition of algal communities across a gradient of conditions ranging from minimally disturbed streams to those that have been highly degraded.
 - 3) Determine the algal communities that are represented by the water quality classification system currently used by the state of Maine in water quality assessments.

SCOPE: The state of Maine Department of Environmental Protection (MDEP) currently evaluates the conditions of Maine's streams, rivers, and wetlands by sampling the communities of aquatic macroinvertebrates at specific locations. This information is used with supporting chemical, physical, and landscape data to determine if streams and rivers are achieving the aquatic life goals assigned to them under the State's water Classification System (e.g., Class A, Class B, Class C). In this project we will develop bioassessment methods that examine stream algal communities and their relationships with water quality conditions.

PROJECT STATUS: Stream algae and water chemistry were sampled during summer 2003 at 35 locations around Maine. These locations are in drainages affected by land uses such as urban, agriculture, and forestry activities. Sample analysis, including algal species identification, are currently underway.

FUTURE PLANS: The sampling program will be repeated during summer 2004 and include additional sites as needed.

CHARACTERISTICS OF THE PRESETTLEMENT FORESTS OF NORTHERN MAINE

Investigators: L. J. Mitchener

Advisors: W. B. Krohn, Co-Chair
A. S. White, Co-Chair
C. V. Cogbill
R. S. Seymour
J. S. Wilson

	<i>Cooperators/</i>	The Nature Conservancy
<i>Project Support</i>	University of Maine Department of Forest Ecosystem Science Maine Cooperative Fish and Wildlife Research Unit	

- Objectives:*
- 1) Determine the frequency distribution and composition of the pre-settlement vegetation along survey lines in northern Maine.
 - 2) Develop and test new methods for predicting vegetation from environmental factors.
 - 3) Document the type, frequency, and severity of disturbance events along the township lines, prior to significant European settlement.
 - 4) Test the likelihood of specific disturbances across the landscape.
 - 5) Develop and test a new method for detecting sample bias in the 19th century Maine Land Office records.

SCOPE: Documenting patterns, and understanding processes affecting vegetation prior to European settlement (i.e., pre-settlement) is important to scientists and land managers. This understanding is especially critical in regions, such as northern New England, where extensive logging, or other anthropogenic disturbance, have removed much of

the original forest cover. Given the lack of original forest cover, the influence of disturbance on the presettlement forest is not easily discernible. The original land surveys of central and northern Maine, which defined and documented the locations of townships (each 6 by 6 mi.), can be used to document forest characteristics prior to extensive European settlement. These land surveys, also known as Maine Land Office (MLO) records, were based on on-the-ground surveys conducted prior to and during early settlement. The MLO records cover much of northern Maine at sub-township level and can be used to reconstruct the forest composition associated disturbance regimes. Data on forest vegetation from these surveys, once entered into a Geographic Information System (GIS), can be statistically related to environmental data from the Maine Office of GIS (Maine OGIS). By mapping the predictions from these species-habitat models, broad-scale presettlement forest conditions can be estimated and visualized. Spatially explicit knowledge of the vegetation composition and the disturbance agents of the presettlement forest can serve as a baseline for both ecological and silvicultural programs.

PROJECT STATUS: We completed of the transcription of the MLO field notes of the survey of townships in northern Maine into the GIS database. The transcription of the witness trees and line segment data resulted in a dataset rich with information, curiosities, and potential. Three types of data were spatially recorded: witness trees at township corners and ever one-mile along township lines, forest vegetative cover along one-mile segments, and natural breaks in vegetative cover based on dominant tree species along township lines. Additional information of surveyors, years of surveys, and the local landscape were also recorded. In addition, overall township descriptions were also recorded.

An historical, introductory, chapter to my dissertation was drafted. The history of the land survey in Maine is addressed. Answers to the questions who, what, when, and where of the actual surveys, not the ecological data they contain, are documented.

A second chapter contains initial analyses of the ecological data consisted of tabulation of the species composition along the survey lines. The data were tabulated for the overall region, and then segmented into the northwest and northeast (due to differences in survey methods). Tabulations of total numbers of witness trees were recorded. Tabulation of the information contained along the survey lines as natural-break segments the forest composition was done in three ways. First, the species composition of each species for each dominance position (1-6, 1 being most abundant, 6 being least abundant) was tabulated as a percent of the total number of surveyed miles. Next, these percents were summed to determine the percentage of presence along the surveys lines for each species. A third tabulation was done by summarizing species assemblages along the survey lines. The percent of miles occupied by each first-dominant listed species was segmented by the second-dominant, and second and third-dominant species, resulting in percentages of the surveys lines that were occupied by specific two and three species assemblages.

A third chapter exploring and interpreting the methodological differences and geographic variation in the vegetation of northern Maine is underway. My objective is two tease apart the two issues of geographic variation and vegetation to determine if the vegetation in northern Maine is homogenous, or if real variation exists. This is complicated by a very distinct spatial pattern of the methodology of the two types of line segment data, with the one-mile breaks being in the northeast and the natural breaks being in the northwest. The interpretation of the spatial pattern of methodology facilitates understanding the usefulness of each of the three data types (witness trees and the two line segments types). Understanding the spatial component and methods used in the land survey of Maine will assist in determining which data type is best suited to answer specific ecological questions.

FUTURE PLANS: Use of Classification and Regression Tree Analysis (CART) to create a statistical model of the presettlement forest is scheduled for early 2004. Project completion is scheduled for late 2004.

WILDLIFE RESOURCES - MIGRATORY BIRDS:

MODELING BIRD SPECIES OCCURRENCE IN CURRENT AND FUTURE LANDSCAPES

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: All requirements for a M. S. degree in Wildlife Ecology were met in March 2003. The abstract follows:

With mounting evidence that global temperatures have increased significantly over the last century and the projections of even greater changes in climate by the end of this century, understanding the potential consequences of these changes on species distributions has become essential. Ecological modeling is a powerful tool for predicting how potential changes in environmental conditions might influence current species distributions. Here I evaluate the potential response of birds to projected climate change by using regression tree analysis to create models of species distribution under current conditions from Breeding Bird Survey (BBS) data and then projecting these models using previously published global change scenarios.

Before I attempted to model species responses to climate change, I selected seventeen bird species to evaluate several considerations that could influence the ability to effectively model species distributions. The first question addressed concerned the spatial resolution of the analysis. General Circulation Model (GCM) data are readily available at a relatively coarse-grain compared to bird species data. There is a large body of literature indicating that the spatial resolution of an analysis can greatly affect the outcome. I, therefore, assessed the consequences of modeling bird species abundance at the 640-km² hexagonal grid (fine-grain) and the county resolution (coarse-grain) in the eastern United States. The results indicated that county resolution models produced good predictions of current bird species abundance patterns. Next, I compared two sets of climate variables to ensure that the climate outputs from GCMs were as effective in modeling bird distributions as climate variables currently used in ecological studies. There were no differences of the overall model goodness of fit between the two sets of species models. The results from these analyses indicated that effective models of bird species abundance at the county resolution could be constructed, provided both climate and landscape variables were present as potential predictors.

Following these evaluations I was able to model current abundance patterns for 152 bird species. These models were then projected onto two GCM scenarios. The projected response of birds under the two GCM scenarios varied greatly among species. Overall, both GCM scenarios projected approximately 49% of the species to decrease markedly and 22% to increase in their eastern United States populations. These results indicate the potential for large shifts in bird distributions in response to global climate change.

The heightened awareness of our Earth's increasing temperature has focused attention on the recent steady increase in greenhouse gases. Planting forests on marginal agricultural land has emerged as a promising proposition to sequester excess carbon dioxide, but none of these afforestation studies have yet examined additional costs or benefits associated with impacts on wildlife populations. By combining information on current forest and farmland bird abundances with the results from simulations of carbon sequestration policies in South Carolina, Maine, and southern Wisconsin, it is possible to quantify the impacts of land use decisions on bird populations. I estimated

losses respectively of 12.2%, 10.8%, and 11.7% in farmland birds and gains of 2.5%, 3.2%, and 21.8% in forest species in South Carolina, Maine, and southern Wisconsin. The results from this analysis reveal the importance of considering the effects of large-scale land use decisions on wildlife.

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.

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/
Project
Support:* Holt Woodland Foundation
University of Maine
Department of Wildlife Ecology
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).

WILDLIFE RESOURCES - OTHER THAN MIGRATORY BIRDS:

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

<i>Investigator:</i>	J. A. Homyack
<i>Advisors:</i>	D. J. Harrison, Co-chair W. B. Krohn, Co-chair F. A. Servello R. S. Seymour
<i>Cooperators/ Project Support:</i>	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: All requirements for a M. S. degree in Wildlife Ecology were met in May 2003. The abstract follows:

The extent of precommercial thinning (PCT) to manipulate stand density in overstocked, regenerating stands and to accelerate growth, yield, and the rate of development of crop trees has been increasing within the Acadian forest of northeastern North America. Although the silvicultural responses of crop trees to thinning are well studied, few studies have evaluated the effects of PCT on forest-dependent wildlife and their habitat. I investigated the effects of PCT and stand succession on snowshoe hares, small mammals, and forest structure on 38 stands (25 treated with PCT, 13 unthinned stands) from 1 to 16 years post-treatment within 7 townships in the commercial forests of northern Maine. Forest stands were clearcut from 1967-1983, treated with an aerial herbicide during 1977-1988, and treatment stands were manually thinned from 1984-1999.

Densities of snowshoe hares were examined by establishing approximately 46 km of pellet transect across 30 stands and live-trapping a subset of 8 stands to determine the relationships between densities of pellets and estimated densities of hares. Densities of hares were linearly related to pellet densities from 0-3 hares/ha ($P < 0.001$). Two similar pellet x hare density regressions developed outside Maine did not perform well ($AIC_c > 10$) and predictions from these regressions underestimated densities of hares. Unthinned stands had approximately 2x greater densities of hares than similar stands treated with PCT across stand age-classes, 2 years of sampling, and during leaf-off (October – May) and leaf-on (June – September) seasons ($P < 0.10$). Although densities of hares were lower in stands treated with PCT, thinned stands still maintained densities greater than stands managed using other silvicultural regimes.

I examined the temporal effects of PCT on small mammals by live-trapping within 37 stands (24 treated with PCT) during June-August 2000 and 2001. Thinning increased [red-backed voles (*Clethrionomys gapperi*), $P = 0.008$; masked shrews (*Sorex cinereus*), $P < 0.001$] or produced no detectable effect [deer mice (*Peromyscus maniculatus*), $P = 0.544$; short-tailed shrews (*Blarina brevicauda*), $P = 0.517$] on the 4 most abundant species of small mammals captured on my study areas; therefore, PCT was compatible with maintaining or enhancing densities of common species of forest-dwelling small mammals in regenerating conifer stands.

Dominant changes in forest structure were described from 1 to 11 years post-treatment between herbicide treated clearcuts with and without PCT, to predict wildlife responses to thinning and stand succession. During summers 2001 and 2002, 29 structural characteristics were quantified across 30 forest stands (17 treated with PCT). Variables with either significant effects of treatment or thinning class were incorporated into a principal components analysis (PCA) to reduce the dimensionality of data. Near-ground cover, overhead cover, and understory structure described approximately 80% of variation between thinned and unthinned stands. Horizontal cover, an overstory to understory contrast, and a gradient of herbaceous vegetation accounted for 75% variation in forest structure among thinning classes of stands. Wildlife associated with dense, early successional habitat, such as snowshoe hares, have been negatively affected by PCT, but thinning could positively influence species that use more mature forest with a more open understory (i.e. red-backed voles).

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 and thesis is in the final states of completion.

FUTURE PLANS: Completion of final thesis.

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 of seals were conducted bi-weekly from January through April in 2001, 2002 and 2003. One seal was captured, tagged and monitored during 2002. Three years of interviews of aquaculture site managers have been completed.

FUTURE PLANS: Data analysis is ongoing. I will be presenting my results at the 15th Biennial Conference of The Society of Marine Mammalogy in North Carolina in December. A graduation date of May 2004 is anticipated.

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. Data analysis is nearly complete. Partial result will be presented in poster format at the Society for Marine Mammalogy Biennial conference in December 2003.

FUTURE PLANS: Project completion is scheduled for May 2004.

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/ USDA National Research Initiative Competitive Grants Program

Project Support: USFS, Penobscot Experimental Forest

University of Maine

..... Department of Forest Ecosystem Science

..... Forest Ecosystem Research Program

..... 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 that utilize upland forests are in constant contact with the forest floor, relying on cool moist conditions for respiration. Harvesting can have a negative effect on amphibian populations by altering forest floor microhabitats. Creating small-scale canopy gaps modeled after natural disturbance patterns may retain adequate habitat structure for amphibians, facilitating the maintenance of amphibian abundance in managed forests. 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 explore relationships between down woody material and redback salamanders in harvest-created gaps and closed-canopy forest.

PROJECT STATUS: In 2002 and 2003, we sampled forest amphibians in 44 harvested gaps, 19 natural gaps, and 36 full-canopy plots using pitfall traps with drift fences. The sampling period lasted from spring through fall. Results from 2002 indicate that harvest-created gaps may have a larger effect on less mobile amphibian species, such as salamanders and red efts, than on more mobile anurans. This trend is not as strong during fall movements. Natural gaps, when compared to captures in nearby closed-canopy sites, appear to have little influence on abundances of amphibian species. Within a canopy gap, there appears to be no distinct pattern in amphibian captures between the north and south aspects.

Logs in both harvest-created gaps and closed-canopy areas were searched for redback salamanders during the summers of 2002 (N = 244) and 2003 (N = 231). In both years, there were proportionally more salamanders under logs in full-canopies than in gaps. Relationships between salamander occurrence and size to log size will be explored.

FUTURE PLANS: Analyses of data will be completed over winter of 2003-2004. The expected date of completion for this project is May 2004.

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 (M. S. student)
M. Bank (Ph. D. 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
T. A. Haines
W. Glanz
R. E. Jung
K. Webster
- Cooperators/
Project Support:* U. S. Geological Survey – Biological Resources Division
Patuxent Wildlife Research Center
University of Maine
Department of Wildlife Ecology
Department of Biological Sciences
National Park Service
Acadia National Park
Maine Cooperative Fish and Wildlife Research Unit
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:

Characterization of four-toed salamander nest sites in Maine:

The second year of field research was completed during April-July 2003. R. Chalmers and technician surveyed brooding four toed salamanders in Acadia National Park and in the additional locations of: Massabessic Experimental Forest, Penobscot Experimental Forest, the University of Maine Forest, and Sunhaze Meadows National Wildlife Refuge. Data were collected to describe vegetation, climate, topology, water chemistry, hydrology and disturbance at nests and at randomly located non-nest points both at wetlands with and wetlands without breeding. 35 wetlands (randomly selected from within the land units) were exhaustively surveyed and 85 four-toed salamander nests were detected in 2003. Multivariate analysis of nests (n=196) and random non-nest points (n=555) is in progress. Manuscripts describing the search methodology and habitat models of four toed salamander nests at local- and landscape-scales are in preparation.

Effects of trophic and watershed complexity on mercury contamination in two-lined salamanders:

Stream salamander removal sampling was completed on 4 streams in ANP during July 2003. Stream salamander abundance counts (# of salamanders categorized by age class/per 100 rocks) and habitat surveys were also completed on 23 streams during July 2003. All mercury analyses and fieldwork have been completed. Data analyses are currently underway and will be completed during early 2004. A literature review on mercury contamination in biota from Acadia has been submitted for publication to a special Acadia National Park issue of *Environmental Monitoring and Assessment*. The final dissertation will be completed during summer 2004.

FUTURE PLANS: Analyses for these projects are underway and expected to be completed during 2004.

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

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

Advisor: R. S. Palmer (deceased)

Cooperators/ **Maine Outdoor Heritage Fund**
Project Support: **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 in 18 months.

EFFECTS OF LOCAL AND LANDSCAPE HETEROGENEITY ON MERCURY LOADINGS IN PALUSTRINE AMPHIBIANS FROM ACADIA NATIONAL PARK, MAINE

Investigators: C. S. Loftin
A. Amirbahman
M. Bank (Ph. D. student)

Cooperators: Declining Amphibian Population Task Force
FY2003 USGS Maine Water Research Institute
University of Maine -
Department of Wildlife Ecology
Department of Civil and Environmental Engineering
Eastern National Park Research

- Objectives:*
- 1) **Quantify concentrations of total and methyl Hg levels in water, sediments, larval green frog (*Rana clamitans*), and larval bullfrogs (*Rana catesbeiana*), from 5 amphibian die-off sites and compare them with total and methyl Hg concentrations of the same species from 5 sites with no known amphibian die-offs**
 - 2) Compare concentrations of total and methyl Hg levels in larval two-lined

salamanders (*Eurycea bislineata*) analyzed from streams within the affected (i.e., die-off) watersheds with streams located in watersheds with no known amphibian die-off sites (using existing total Hg salamander data from 2001 and 2002)

- 3) Analyze relationships among stream, wetland, and selected watershed-scale environmental variables and total and methyl Hg concentrations recorded in sampled biota, including existing chemistry and Hg data from soils, sediments, stream water, fish, and salamanders from Acadia.
- 4) Relate findings from this investigation with disease analysis results from the same frog species from the same sites in ANP (USGS Wildlife Disease Center (Madison, WI))

SCOPE: We are comparing levels of mercury (Hg) contamination previously documented in samples of soils, sediments, stream water, fish, and salamanders collected in Acadia National Park (ANP) to those of newly-collected samples of selected frog species inhabiting Park wetlands, including those where amphibian die-offs have recently been reported. The Hg loadings in amphibians at these sites are unknown and have never been quantified or compared to sites where amphibian die-offs have not occurred. We predict that Hg concentrations in the larvae of the selected frog species from ANP wetlands may be high in comparison to Hg levels in local fish and lotic salamander larvae due to: 1) life history characteristics (i.e., length of larval period), 2) diet, 3) micro-habitat selection patterns, and 4) the strong potential for high rates of methyl Hg production in palustrine environments.

Our approach examines Hg contamination in both the physical environment and biota and across the landscape from headwaters to the receiving surface waters. Hg levels in frog species inhabiting lentic environments in watersheds with different biotic communities, local geomorphology, fire disturbance histories, and land cover types will be analyzed at multiple spatial scales to determine important predictor variables of Hg levels in the selected frog species. Since an extensive spatial database for Hg concentrations in two-lined salamander larvae in ANP has been developed, we have a unique opportunity to evaluate, in a cost effective manner, the relationship between the observed salamander larvae Hg levels from a given stream and the Hg levels in frogs inhabiting the receiving surface waters at lower positions in the watershed.

PROJECT STATUS: During summer 2003 we collected tadpoles from 9 ponds distributed across Acadia National Park. Water and sediment samples were also collected from these ponds. Sample analysis for total and methyl mercury concentrations is currently underway at the University of Maine Environmental Chemistry lab.

FUTURE PLANS: Completion of sample analysis is expected by winter 2003. Comparisons of tadpole mercury concentrations with other available data will be completed by summer 2004.

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

SCIENTIFIC PUBLICATIONS

- CALHOUN, A. and M. L. HUNTER, JR. 2003. Managing ecosystems for amphibian conservation. Pages 228-241 **In** R. Semlitsch, (editors). Amphibian conservation. Smithsonian Institution Press, Washington DC.
- HUNTER, M. L., JR. 2003. A forest reserve system for Maine. Pages 104-106 **In** P. Austin, D. Bennett, and R. Kimber, (editors). On wilderness: voices from Maine. Tilbury House, Gardiner, Maine.
- HUNTER, M. L., JR. 2003. Foreword. Pages xi-xiii **In** C. Groves. Drafting a conservation blueprint. Island Press, Washington, DC. 456 pp.
- PAYER, D. C. and D. J. HARRISON. 2003. Influence of forest structure on habitat use by American marten in an industrial forest. Forest Ecology and Management 179:145-156.
- PERKINS, D. W. and M. L. HUNTER, JR. 2002. Effects of placing sticks in pitfall traps on amphibian and small mammal capture rates. Herpetological Review 33:282-284.
- PERKINS, D. W., P. D. VICKERY, and W. G. SHRIVER. 2003. Spatial dynamics of source-sink habitats: effect on rare grassland birds. Journal of Wildlife Management 67:588-599.
- SCHUMANN M. E., A. S. WHITE, and J. W. WITHAM. 2003. The effects of harvest-created gaps on plant species diversity, composition, and abundance in a Maine oak-pine forest. Forest Ecology and Management. 176: 543-561.
- SWIHART, R. K., T. M. GEHRING, M. B. KOLOZSVARY, and T. E. NUPP. "Responses of "resistant" vertebrates to habitat loss and fragmentation: the importance of niche breadth and range boundaries. Diversity & Distributions 9:1-18.

TECHNICAL AND SEMI-TECHNICAL PUBLICATIONS

- BANK, M. S. C. S. LOFTIN, T. A. HAINES, and R. E. JUNG. 2003. Effects of fire history, trophic dynamics, and watershed complexity on mercury bioaccumulation and biomagnification in two-lined salamanders (*Eurycea bislineata*) from Acadia and Shenandoah National Parks. Final Technical Report for the Declining Amphibian Population Task Force. 4 pp.
- COVERSTONE, N., L. BERG STACK, and J. WITHAM. 2002. Understanding Ruby-Throated Hummingbirds and Enhancing their habitat in Maine. Bulletin # 7152 – Habitats a fact sheet series on Managing Lands for Wildlife, University of Maine Cooperative Extension. 12 pp.
- FULLER, A. K. and D. J. HARRISON. 2002. Influence of forest practices on sub-stand scale habitat selection and movements of Canada lynx. Pages 49-52 **In** Maine Cooperative Forestry Research Unit 2002 Annual Report. Maine Agricultural and Forest Experiment Station Miscellaneous Report 431, Orono, ME.
- FULLER, A. K. and D. J. HARRISON. 2002. Resource partitioning and interspecific competition between coyotes and red foxes on an island during recent colonization by coyotes. Published abstract: Page 83 **In** Proceedings of Carnivores 2002: A Conference on Carnivore Biology and Conservation. Defender's of Wildlife, Washington, DC.

- HEPINSTALL, J. A., D. J. HARRISON, D. C. PAYER, and A. K. FULLER. 2002. Predicting habitat supply for American marten using measures of landscape composition and configuration. Published abstract: Page 93 **In** Proceedings of Carnivores 2002: A Conference on Carnivore Biology and Conservation. Defender's of Wildlife, Washington, DC.
- HEPINSTALL, J. A. and D. J. HARRISON. 2002. Marten as a tool for landscape-scale habitat planning in northern Maine. Pages 53-56 **In** Maine Cooperative Forestry Research Unit 2002 Annual Report. Maine Agricultural and Forest Experiment Station Miscellaneous Report 431, Orono, ME.
- HOMYACK, J. A., D. J. HARRISON, and W. B. KROHN. 2002. Effects of pre-commercial thinning on select wildlife species in northern Maine, with special emphasis on snowshoe hares. Pages 42-48 **In** Maine Cooperative Forestry Research Unit 2002 Annual Report. Maine Agricultural and Forest Experiment Station Miscellaneous Report 431, Orono, ME.
- HOMYACK, J. A., D. J. HARRISON, and W. B. KROHN. 2002. Effects of precommercial thinning on snowshoe hare: implications for Canada lynx. Published abstract: Page 127 **In** Proceedings of Carnivores 2002: A Conference on Carnivore Biology and Conservation. Defender's of Wildlife, Washington, DC.
- HOVING, C., D. J. HARRISON, W. B. KROHN, and W. JAKUBUS. 2002. Canada lynx habitat, forest harvest strategies and regeneration in northern Maine. Published abstract: Page 126 **In** Proceedings of Carnivores 2002: A Conference on Carnivore Biology and Conservation. Defender's of Wildlife, Washington, DC.
- HOVING, C., D. J. HARRISON, W. B. KROHN, R. A. JOSEPH, and M. O'BRIEN. 2002. Climate change and lynx; spatial occurrence models for eastern North America. Published abstract: Page 237 **In** Proceedings of Carnivores 2002: A Conference on Carnivore Biology and Conservation. Defender's of Wildlife, Washington, DC.
- JONES, J., J. PERKINS, J. PIERCE, and J. POWER. 2002 Piping plover and least tern project report. Maine Audubon Society, Falmouth, ME. February 2003.
- KROHN, W. B. 2003. Historic occurrences of fishers and martens in eastern North America: a preliminary evaluation of factors affecting their broad-scale distribution. Published abstract: Pages 170-174 **In** the tenth Annual Conference of The Wildlife Society, Burlington, VT.
- KROHN, W. B., R. L. DRESSLER, and G. M. STADLER. 2003. Successful integration of GAP databases into town planning: the Maine experience. Pages 48-50 **In** GAP Analysis Bulletin No. 11, USGS Biological Resources Division, Moscow, ID. 88 pp.
- LOFTIN, C. S., J. T. MCCLOSKEY, W. M. KITCHENS, and M. DUSEK. 2003. Changes in vegetation distribution in the lower Savannah River tidal marsh following removal of a tidal flap gate. Final report for RWO 41 Savannah River marsh conversion and spatial vegetation succession model assessment. 42 pp.
- O'CONNOR, R. J. 2003. GAP conservation and science goals: rethinking the underlying biology. Pages 2-6 **In** GAP Analysis Bulletin No. 11, USGS Biological Resources Division, Moscow, ID. 88 pp.
- PECKENHAM, J. M., S. J. NELSON, K. B. JOHNSON, J. S. KAHL, M. S. BANK, and C. S. LOFTIN. 2003. Hydrological, chemical, and landscape controls on mercury in streams on Mount Desert Island. Pages 143-152 **In** J. S. Kahl, et al., eds., Establishing paired gauged watersheds at Acadia National Park for long-term research on acidic deposition, nitrogen saturation, forest health, and mercury biogeochemistry (1998-2002). PrimeNet Final Integrated Report, Acadia National Park.
- PERKINS, J. C. and L. BURNELL. 2003. "Crow predation causes problems for least terns and piping plovers."

Piping Plover and Least Tern Newsletter. Maine Audubon Society, Falmouth, ME. Summer 2003.

O'CONNOR, R. J. 2002. GAP conservation and science goals: rethinking the underlying biology. Pages 2-6 In GAP Analysis Bulletin, Number 11. U. S. Geological Survey's Biological Resources Division, Gap Analysis Program, Moscow, ID. 86 pp.

THESES AND DISSERTATIONS

HOMYACK, J. A. 2003. Effects of precommercial thinning on snowshoe hares, small mammals, and forest structure in northern Maine. M. S. Thesis, University of Maine, Orono, ME. 196 pages.

KOLOZSVARY, M. B. 2003. Hydroperiod of wetland and reproduction in wood frogs (*Rana sylvatica*) and spotted salamanders (*Ambystoma maculatum*). Ph. D. Dissertation, University of Maine, Orono, ME. 124 pages.

MATTHEWS, S. N. 2003. Modeling bird species occurrence in current and future landscapes. M. S. Thesis, University of Maine, Orono, ME. 137 pages.

ORNDORFF, S. L. 2002. Representational analyses of conservation lands in Maine. M. S. Thesis, University of Maine, Orono, ME. 121 pages.

PROFESSIONAL TALKS PRESENTED

AZIZ, S., K. DEGOOSH, M. HACHEY, M. KELLY, K. NESS, J. PERKINS, D. ANDERSON, L. BACON, C. BARKER, T. DANIELSON, C. FLANNAGAN, M. GAHL, S. JIN, A. JORDAAN, D. MICHOR, T. MORLEY, A. PIPER, A. OLIVERO, P. VAUX, and K. WEBSTER. "A landscape view of aquatic ecosystems in Maine." Presentation at the Maine Water Conference, Augusta, ME. April 2003.

BAHN, V., R. J. O'CONNOR AND W. B. KROHN. "Model selection for species distribution models incorporating spatial autocorrelation." Presented at the 59th Northeast Fish and Wildlife Conference, Newport, RI. April 13-16, 2003.

BANK, M. S., T. A. HAINES. C. S. LOFTIN, and R. E. JUNG. "Evaluating the use of two-lined salamanders as eco-indicators of mercury loading in headwater stream ecosystems: a regional perspective." Poster presentation at the National Park Service Air Quality Summit 2002 "Responding to Change", Estes Park, CO. October 21-24, 2002.

BANK, M. S., T. A. HAINES. and C. S. LOFTIN. "Evaluating the use of two-lined salamanders as eco-indicators of mercury loading in headwater stream ecosystems." Presentation at the American Fisheries Society-Environmental Protection Agency National Forum on Fish Contamination, Burlington, VT. October 20-22, 2002.

BANK, M. S., C. S. LOFTIN, T. A. HAINES, and R. E. JUNG. "Mercury, salamanders, and streamscapes. Presented at the Department of Environmental Science and Policy 2003 Spring Seminar Series, University of South Florida, Tampa Bay, FL. March 20, 2003.

BANK, M. S., T. A. HAINES. C. S. LOFTIN, and R. E. JUNG. "Evaluating the use of two-lined salamanders as indicators of mercury loading in headwater stream ecosystems in Acadia and Shenandoah National Parks: implications for regional biomonitoring." Presentation at the 2003 George Wright Society Conference, San Diego, CA. April 14-18, 2003.

CHALMERS, R. and C. S. LOFTIN. "Characterizing four-toed salamander nesting habitat." Presentation at the Northeast Biological Graduate Student Conference, University of Prince Edward Island, Canada. February 28 – March 2, 2003.

CAMPBELL, S. P., E. PERRY, M. E. VAYDA, and J. TREDWELL. "Scientists as Educators: The NSF GK-12 program at the University of Maine." Presented at the National Science Foundation GK-12 Program Annual Meeting, Arlington, VA. October 30-31, 2002.

FLEMING, S. and J. TRIAL. "Alternative methods for enumerating juvenile Atlantic Salmon in Maine and studies fo their distribution in riverine habitats." Presented at the 59th Northeast Fish and Wildlife Conference, Newport, RI. April 13-15, 2003.

FULLER, A. K. and D. J. HARRISON. "Resource partitioning and interspecific competition between coyotes and red foxes on an island during recent colonization by coyotes." Presented at Carnivores 2002 Conference, Monterey, CA. November 18, 2002.

HARRISON, D. J. and A. K. FULLER. "Effects of partial harvesting on forest mammals." Presented at a field tour for Cooperative Forestry Research Unit, Northern Maine. October 9, 2002.

HARRISON, D. J. and J. A. HEPINSTALL. "Landscape management for fragmentation-sensitive species." Presented at a field tour for Cooperative Forestry Research Unit, Northern Maine. October 9, 2002.

HARRISON, D. J. and A. K. FULLER. "Substand-scale responses of Canada lynx to habitat and prey: an ongoing study." Presented at Interagency Lynx Biology Team Meeting, Orono, ME. October 22, 2002.

HARRISON, D. J., W. B. KROHN, and C. HOVING. "Broad-scale habitat ecology of Canada lynx in eastern North America." Presented at the Interagency Lynx Biology Team Meeting, Orono, ME. October 22, 2002.

HARRISON, D. J. and J. A. HEPINSTALL. "Modeling habitat supply as a tool for marten conservation." Presented at Newfoundland Marten Habitat Supply Workshop, Grand Fall, Newfoundland. December 3, 2002.

HARRISON, D. J. and J. A. HEPINSTALL. "Predictive modeling and trends in marten occurrence across the landscape of Northern Maine: Marten as a tool for conserving forest biodiversity. Presented at Wildlife Division Meeting, Maine Department of Inland Fisheries and Wildlife, Bangor, ME. December 17, 2003.

HARRISON, D. J. and J. A. HEPINSTALL. "Marten as a tool for landscape-scale habitat planning in northern Maine." Final contract report presentation to Cooperative Forestry Research Unit, Orono, ME. January 29, 2003.

HARRISON, D. J. "Ecological aspects of coyote predation and the potential for effective control of predation via snaring. Presented and panel discussion at winter meeting of Maine Chapter of The Wildlife Society, Augusta, ME. January 30, 2003.

HARRISON, D. J. and J. A. HEPINSTALL. "Using marten as a landscape-scale conservation tool for maintaining diversity of forest-dependent vertebrates." Presentation and workshop conducted for Maine Department of Inland Fisheries and Wildlife Habitat Planning Committee, Bangor, ME. March 10, 2003.

HARRISON, D. J. and J. A. HEPINSTALL. "Marten as a tool for landscape-scale habitat planning and biodiversity conservation." Presented to Recovery Team for the Endangered Newfound Marten, Deer Lake, Newfoundland. April 1, 2003.

HARRISON, D. J. "Predicting responses of snowshoe hares and lynx to alternative forest harvesting scenarios." Presented to Maine Cooperative Forestry Research Unit, Orono, ME. April 17, 2003.

HARRISON, D. J. "Evaluating the umbrella species approach for biodiversity conservation on commercial forestlands in Maine." Presented to Maine Cooperative Forestry Research Unit, Orono, ME. April 17, 2003.

HARRISON, D. J. "Relative densities, habitat selection, and population performance of spruce grouse in clearcut, intensively managed, and "classic" habitat in northern Maine." Presented to Maine Cooperative Forestry Research Unit, Orono, ME. April 17, 2003.

HEARN, B. and D. J. HARRISON. "Home range characteristics of Newfoundland marten." Invited presentation at Newfoundland Marten Habitat Supply Workshop, Grand Falls, Newfoundland. December 3, 2002.

HEATH, S. R., and F. A. SERVELLO. "Predation as a potential limiting factor of black tern chick survival in Maine." Presented at the 59th Northeast Fish and Wildlife Conference, Newport, RI. April 13-15, 2003.

HEPINSTALL, J. A., D. J. HARRISON, D. C. PAYER, and A. K. FULLER. "Predicting habitat supply for American marten using measures of landscape composition and configuration." Poster presented at Eastern Canada-USA (CANUSA) Forest Science Conference, Orono, ME. October 20, 2002.

HEPINSTALL, J. A., D. J. HARRISON, D. C. PAYER, and A. K. FULLER. "Predicting habitat supply for American marten using measures of landscape composition and configuration." Presented at Carnivores 2002 Conference, Monterey, CA. November 19, 2002.

HEPINSTALL, J. A. and D. J. HARRISON. "Predicting habitat supply for American marten using measures of landscape composition and configuration." Presented at Resource Selection Conference, Laramie, WY. January 5-8, 2003.

HEPINSTALL, J. A. and D. J. HARRISON. "Does the umbrella leak?: Biodiversity conservation based on marten habitat." Presented at the 10th Annual Conference of The Wildlife Society, Burlington, VT. September 9, 2003.

HOMYACK, J. A., D. J. HARRISON, and W. B. KROHN. "Precommercial thinning effects on hare habitat." Presented at a field tour of Cooperative Forestry Research Unit, Northern Maine. October 9, 2002.

HOMYACK, J. A., D. J. HARRISON, and W. B. KROHN. "Effects of precommercial thinning of abundance of snowshoe hare in northern Maine." Presented at Eastern Canada-USA (CANUSA) Forest Science Conference, Orono, ME. October 20, 2002.

HOMYACK, J. A., D. J. HARRISON, and W. B. KROHN. "Effects of precommercial thinning on snowshoe hare in northern Maine: implications for Canada lynx." Presented at Interagency Lynx Biology Team Meeting, Orono, ME. October 22, 2002.

HOMYACK, J. A., D. J. HARRISON, and W. B. KROHN. "Effects of precommercial thinning on snowshoe hare; implications for Canada lynx." Presented at Carnivores 2002 Conference, Monterey, CA. November 19, 2002.

HOMYACK, J. A. "Effects of precommercial thinning on snowshoe hares, small mammals, and forest structure in northern Maine." Presented at Department of Wildlife Ecology seminar, University of Maine, Orono, ME. February 27, 2003.

HOMYACK, J. A., D. J. HARRISON, and W. B. KROHN. "Effects of precommercial thinning on snowshoe hares, small mammals, and forest structure in northern Maine." Presented final contract report to Maine Cooperative Forestry Research Unit, Orono, ME. April 17, 2003.

HOVING, C. L., R.A. JOSEPH, and W. B. KROHN. "Historic distribution of Canada lynx in the northeast with special reference to Maine." Presented at the workshop for the Interagency Lynx Biology Team, Orono, ME. October 22, 2002.

HOVING, C., D. J. HARRISON, W. B. KROHN, and W. JAKUBAS. "Canada lynx habitat, forest harvest strategies and regeneration in northern Maine." Presented at Carnivores 2002 Conference, Monterey, CA. November 19, 2002.

HOVING, C., D. J. HARRISON, W. B. KROHN, R. A. JOSEPH, and M. O'BRIEN. "Climate change and lynx: spatial occurrence models for eastern North America." Presented at Carnivores 2002 Conference, Monterey, CA. November 17-20, 2002.

HUNTER, M. L. JR. "Forest ecosystem integrity and overabundant herbivores." Presented at the Pennsylvania Deer management Forum, State College, PA. September 18, 2002.

KROHN, W. B., J. A. HOMYACK, and D. J. HARRISON. "Changes in the Acadian forest: implication for wildlife." Presented at special wildlife session on early successional habitats: a critical problem, 59th Northeast Fish and Wildlife Conference, Newport, RI. April 15, 2003.

KROHN, W. B. "Historic occurrences of fishers and martens in eastern North America: preliminary evaluation of factors affecting their broad-scale distributions." Presented at the Tenth Annual Conference of The Wildlife Society, Burlington, VT. September 6-10, 2003.

LOFTIN, C. S., J. T. MCCLOSKEY, W. M. KITCHENS, and M. L. DUSEK. "Changes in Savannah River tidal marsh vegetation distributions following removal of a tidal flap gate." Presented at the 88th Annual Meeting of the Ecological Society of America, Savannah, GA. August 3-8, 2003.

LOFTIN, C. S. and E. G. SCHILLING. "Environmental factors associated with unique lake communities in Maine." Presentation to the Maine Department of Inland Fisheries and Wildlife-Fisheries Division, Black Bear Inn, Orono, ME. September 3, 2003.

O'CONNOR, R. J. "Habitat and distribution modeling: time for new ideas." Presented at the Department of Fisheries and Wildlife Seminar, Corvallis, OR. October 18, 2002.

O'CONNOR, R. J. "The practice of ecology." Presented at the Colloquium in Life Sciences, Colorado State University, Fort Collins, CO. October 28, 2002.

PERKINS, J. C. and F. A. SERVELLO. "Chick survival and fledgling residency for least terns in Maine." Presented at the Graduate Research Exposition, University of Maine, Orono, ME. August 12, 2003.

PERKINS, J. C. and F. A. SERVELLO. "Chick survival and fledgling residency for least terns in Maine." Presented at the Gulf of Maine Seabird Working Group, Bremen, ME. August 14, 2003.

PERKINS, J. C. and F. A. SERVELLO. "Chick survival and fledgling residency for least terns in Maine." Poster presented at the 59th Northeast Fish and Wildlife Conference, Newport, RI. April 13-15, 2003.

PERKINS, J. C. and F. A. SERVELLO. "Nest success, chick survival, and fledgling residency of least terns in Maine." Poster Presented at 10th Annual Conference of The Wildlife Society, Burlington, VT. September 7, 2003.

RHYMER, J. M. "Hybridization and the inter-cross policy: conservation genetic implications." Presented at the Applied Conservation Genetics Workshop, U S Fish & Wildlife Service, National Conservation Training Center, Shepherdstown, WV. October 28 – November 1, 2002.

RHYMER, J. M., H. L. ZIEL, and D. G. MCAULEY. "Comparison of phylogeographic patterns of American Woodcock and European Woodcock". Presentations at the American ornithologists' Union, Urbana, IL. August 8, 2003.

SCHILLING, E. G., C. S. LOFTIN, and A. D. HURYRN. "Abundance, distribution, and attributes of invertebrate communities of fishless lakes in Maine." Presentation to the Maine State Chapter of The Wildlife Society, Brewer, ME. April 24, 2003.

SERVELLO, F. A., and A. T. GILBERT. "Site fidelity and inter-colonial movements of black terns in Maine." Poster presented at the 59th Northeast Fish and Wildlife Conference, Newport, RI. April 13-15, 2003.

SERVELLO, F. A. "Black Tern Ecology in Maine." Presented at the Annual Meeting of Snow Pond/Messalonskee Lake Association, Oakland, ME. July 11, 2003.

SERVELLO, F. A., A. T. GILBERT, and S. R. HEATH. "Ecology of black tern in Maine." Presented at the 10th Annual Conference of The Wildlife Society, Burlington, VT. September, 7, 2003.

STROJNY C. A. and M. L. HUNTER, JR. "Effects of harvested canopy gaps on forest amphibians." Presented at the Eastern CANUSA Forest Science Conference, Orono, ME. October 19-20, 2002.

STROJNY, C. A. and M. L. HUNTER, JR. "Relative abundance of forest amphibians in canopy gaps and closed forest." Presented at the Northeast Biological Graduate Students Conference, Charlottetown, Prince Edward Island, Canada. February 28 – March 2, 2003.

STROJNY, C. A. and M. L. HUNTER, JR. "Effects of harvested canopy gaps on forest amphibians." Presented at the 59th annual Northeast Fish and Wildlife Conference, Newport, RI. April 13-16, 2003.

STROJNY, C. A. and M. L. HUNTER, JR. "Effects of harvested canopy gaps on forest amphibians." Presented at the graduate Research EXPO 2003, University of Maine, Orono, ME. April 21-22, 2003.

STROJNY, C. A. and M. L. HUNTER, JR. "Effects of harvested canopy gaps on forest amphibians." Presented at the 17th Annual Meeting for the Society of Conservation Biology, Duluth, MN. June 28-July 2, 2003.

WITHAM, J. "Wildlife ecology for your woodlot." Presented at the Forestry camp at the Tanglewood 4H and Learning Center. October 2, 2002.

WITHAM, J. "Canopy gaps and tree growth: a spatial perspective." Presented at the Department of Forest Ecosystem Science Seminar, University of Maine, Orono, ME. October 11, 2002.

WITHAM, J. "What's green and growing and covering Maine?" Presented at the Georgetown Central School. October 22, 2002.

PUBLIC TALKS PRESENTED

BAHN, V. "A strategic approach to the modeling of terrestrial vertebrate distributions." PhD proposal seminar presented Orono, ME. November 5, 2002.

BLOMQUIST, S. "Population ecology of Columbia spotted frogs." Presented at the Wildlife Ecology Seminar, Orono, ME. September 22, 2003.

FULLER, A. K. "Use of radiotelemetry in wildlife research." Presented at Biology Day, John Bapst High School, at the Craig Brook Fish Hatchery, East Orland, ME. May 28, 2003.

GILBERT, R. J. Lecture on walrus in Marine Mammal class given at University of Massachusetts, Boston, MA. November 4, 2002.

GILBERT, R. J. "Harbor Seals (*Phoca vitulina*): Maine's sacred cow?" Presented at the Wildlife Ecology Seminar, Orono, ME. March 24, 2003.

KROHN, W. B. "Changes in the Acadian Forest: implications for wildlife." Presented at the Wildlife Ecology Seminar, Orono, ME. April 7, 2003.

LOFTIN, C. S. "Landscape modeling with GIS." Invited presentation to Landscape Limnology class, University of Maine, Orono, ME. March 6, 2003.

MCCOLLOUGH, M. and J. C. PERKINS. "Least tern and piping plover ecology and conservation." Presented at a school teach field trip. Higgins Beach, Scarborough, ME. July 16, 2003.

O'CONNOR, R. J. "The practice of ecology." Presented at the Wildlife Ecology Seminar, Orono, ME. November 4, 2002.

PERKINS, J. C. and F. A. SERVELLO. "Factors affecting least tern productivity in Maine." Presented at Greater Portland Naturalists' Forum at Maine Audubon Society, Gilsland Farm Environmental Center, Falmouth, ME. May 19, 2003.

PIERCE, J. and J. C. PERKINS. "The piping plovers." Presented at the Maine Audubon Society field trip. Higgins Beach, Scarborough, ME. June 28, 2003.

QUEHEILLALT, D. M. "Vertebrate use of riparian restoration site along the central coast of California: implications for future restoration and monitoring efforts." Presented at the Wildlife Ecology Seminar, Orono, ME. January 27, 2003.

WORKSHOPS

HARRISON, D. J. and J. A. HEPINSTALL. "Using marten as a landscape-scale conservation tool for maintaining diversity of forest-dependent vertebrates." Presented at a workshop conducted for the Maine Department of Inland Fisheries and Wildlife Habitat Planning Committee, Bangor, ME. March 10, 2003.

HEARN, B. J. and D. J. HARRISON. "Home range characteristics of Newfoundland marten." Presented at Newfoundland Marten Habitat Supply Workshop, Grand Falls, Newfoundland. December 3, 2003.

RHYMER, J. M. "Hybridization and the "Inter-cross Policy": Conservation genetics implications". Presented at the Applied Conservation Genetics Workshop, U.S. Fish & Wildlife Service, Shepherdstown, WV. October 30, 2002.

SERVELLO, F. A. Session moderator for the Wildlife Ecology session at the Eastern CANUSA Forest Science Conference, Orono, ME. October 19-20, 2002.

AWARDS, HONORS, AND APPOINTMENTS

O'CONNOR, R. J. Elected to be a member of American Institute of Biological Societies Working Group on Infrastructure for Biology at Regional and Continental Scales. September 2002 – 2003.

PERKINS, J. C. and F. A. SERVELLO. Awarded 2nd place poster in Biological Sciences by the Graduate Research Exposition Hosted by the University of Maine Association of Graduate Students. The poster was entitled "Chick survival and fledgling residency for least terns in Maine." April 21, 2003.