

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

5755 Nutting Hall  
University of Maine  
Orono, Maine 04469-5755

**UNIT COOPERATORS \***

UNIVERSITY OF MAINE

MAINE DEPARTMENT OF INLAND FISHERIES AND WILDLIFE

BIOLOGICAL RESOURCES DIVISION, U.S. GEOLOGICAL SURVEY

WILDLIFE MANAGEMENT INSTITUTE

October 2000 - September 2001

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

This report details the research objectives, procedures, and findings of numerous investigators. Since data contained may be preliminary and inconclusive, permission to reproduce or publish any of the contents of this report in any way is withheld pending specific authorization from the Unit Leader and Chair, Department of Wildlife Ecology.

---

\*The Unit's Fisheries Program is located in 313 Murray Hall and is within the Department of Biological Sciences, College of Natural Sciences, Forestry, and Agriculture; the Unit's Wildlife Program is located in 210 Nutting Hall and is co-located with the Department of Wildlife Ecology, College of Natural Sciences, Forestry, and Agriculture.

## TABLE OF CONTENTS

	Page
PERSONNEL AND COOPERATORS .....	iv
Coordinating Committee .....	iv
Unit Personnel .....	v
Graduate Students.....	vi
Dissertations and Theses Completed.....	vi
Personnel Notes.....	vii
Collaborating Agencies & Organizations.....	vii
PROJECT REPORTS .....	1
ENDANGERED AND THREATENED SPECIES	
The Foraging and Habitat Ecology of Black Tern in Maine.....	1
Winter Ecology of Harlequin Ducks in Maine .....	2
Population Ecology of Black Terns in Maine.....	3
FISHERIES RESOURCES	
Fisheries Resources of Acadia National Park.....	4
Population Studies of Maine Intertidal Fishes .....	5
Population Dynamics of Sea-Run Alewives.....	5
Movements of American Eels in Freshwater Lakes .....	6
Relationships Between Stream Geomorphology and Fish Community Structure .....	7
Intertidal Communities Associated with Rockweed ( <i>Ascophyllum nodosum</i> ).....	8
Alternative Population Estimation Techniques for and Habitat Densities of Atlantic Salmon.....	8
HABITAT RESOURCES	
Historical Occurrence and Habitat Ecology of Canada lynx ( <i>Lynx canadensis</i> ) in eastern North America .....	9
Exploring Grassroots Efforts to Monitor Wildlife.....	10

A Long-term Forest Ecosystem Study.....	11
Bark Invertebrates of White Pine and Red Oak Snags in a Southern Maine Forest.....	12
Representational Analyses of Conservation Areas in Maine.....	13
Investigations of the Accuracy Tests of Predicted Vertebrate Occurrences from Gap Analysis.....	14
Documentation of Savannah River Marsh Conversion and Modification of Spatial Vegetation Succession Model.....	15
Literature Synthesis of Effects of Forest Management Practices on Riparian and In-stream Animal Biota of New England.....	16
Riparian Buffer Widths and Amphibian Communities in Western Maine: Experimental and Retrospective Approaches.....	17
Habitat Assessment Support to the Maine Department of Inland Fisheries and Wildlife.....	18
Simulating Wetland-Landscape Fire Disturbance and Succession to Demonstrate Potential for Changes in Amphibian Presence/Absence.....	19
Vegetation and Invertebrate Response to Impoundment Management at Moosehorn National Wildlife Refuge.....	20
 WILDLIFE RESOURCES - MIGRATORY BIRDS	
Site Fidelity of Songbirds in Selectively Harvested and Unharvested Mixed Woods.....	21
Development and Application of Observation-based Techniques for Assessing Forest Songbird Nesting Success.....	22
Direct Effects of Group Selection Harvest Gaps on the Bird Community of an Oak-pine Forest.....	23
Philopatry and Dispersal of Black Legged Kittiwakes ( <i>Rissa tridactyla</i> ) in Prince William Sound, Alaska.....	24
 WILDLIFE RESOURCES - OTHER THAN MIGRATORY BIRDS	
Effects of an Increasing Harbor Seal Population on Changes in Sites Used for Popping.....	25
Factors Affecting Nesting Success of the Eastern Wild Turkey in Connecticut: Nest Attentiveness, Vegetative Cover, and Landscape Characteristics.....	27
Bat and Small Mammal Habitat Relationships in the Industrial Forests of Northern Maine.....	27
A Retrospective of Pre-commercial Thinning on Snowshoe Hares and Small Rodents.....	28

Interactions Between Harbor Seals and Finfish Aquaculture in Maine .....	30
Harbor Seal and Gray Seal Behavior on a Shared Haul-out Site (Mount Desert Rock) in the Gulf of Maine .....	30
Conservation Genetics of the Penobscot Meadow Vole.....	31
Conservation Genetics of Wood Turtles.....	32
Effects of Habitat Characteristics and Nesting Behavior on Nest Predation of Black Terns.....	33
Effects of Artificial Canopy Gaps and Downed Woody Material on Amphibians in the Acadian Forest of Maine.....	34
DOI Amphibian Research and Monitoring Initiative (ARMI): Effects of Landscape Heterogeneity and Environmental Stressors on Palustrine and Lotic Amphibian Populations In Acadia National Park .....	35
Marten as a Tool for Landscape-Scale Habitat Planning in Northern Maine .....	36
Factors Affecting Habitat Selection and Population Performance of American Marten ( <i>Martes americana atrata</i> ) in Newfoundland .....	37
An Annotated Bibliography of Historic References to Selected Maine Wildlife 1614-1930.....	39
Influence Of Forest Practices On Stand- And Sub-Stand Scale Habitat Selection Of Lynx In Northern Maine .....	40
PUBLICATIONS, THESES AND DISSERTATIONS, PROFESSIONAL AND PUBLIC TALKS GIVEN, AND AWARDS .....	41

## **PERSONNEL AND COOPERATORS**

### **COORDINATING COMMITTEE**

Maine Department of Inland Fisheries and Wildlife  
Lee Perry, Commissioner

University of Maine  
James R. Gilbert, Chairperson, Department of Wildlife Ecology, College of Natural Sciences,  
Forestry, and Agriculture  
Christopher S. Campbell, Chairperson, Department of Biological Sciences, College of Natural Sciences  
Forestry, and Agriculture

USGS Biological Resources Division  
Michael W. Tome, Supervisor, Cooperative Research Units

Wildlife Management Institute  
Scot J. Williamson, Northeastern Representative

### **UNIT PERSONNEL**

## Unit Staff:

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

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

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

## Maine Department of Inland Fisheries and Wildlife:

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

**GRADUATE STUDENTS**

<b>Name</b>	<b>Degree Candidacy</b>	<b>Support</b>
Sarah C. Billig	M.S.	MCCS, NSFA, PCTC
Pamela Bryer	M.S.	NPS- ANP
Steven P. Campbell	Ph.D.	HWRF, U of M
Rebecca Chalmers	M.S.	USGS-BRD, U of M, NPS

Sharon Fleming	M.S.	MASC, NMFS
Carol R. Foss	Ph.D.	U of M, USFWS, SEFP, MCS, USFS
Angela K. Fuller	Ph.D.	MDC
Emily W. Gaenzle	M.S.	MDIFW, U of M
Merry Gallagher	Ph.D.	MDMR, MDIFW, U of M
Amy Gullo	M.S.	U of M, NPS
Mitschka J. Hartley	Ph.D.	U of M, MDIFW, USDA, USFS, COS, AWRP
Brian J. Hearn	Ph.D.	U of M, NRC-CFS, NDFRA-WD, WNMF, CPP, AC
Tara Y. Henrichon	M.S.	USGS-BRD, U of M
Jessica A. Homyack	M.S.	MCFRU, NCASI, USFWS
Shannon B. Kearney	M.S.	U of M, FWS, FPL, MDIFW
Jennifer M. Lowry	M.S.	U of M, MDIFW, MOHF, PCCA
Marcy Lucas	M.S.	NMFS, U of M, MDMR
Jon McCloskey	Ph.D.	FCSC, USFWS, USGS, U of M
Joanna L. Murray	M.S.	MDIFW, MOHF, FWS, U of M, MCS
Dawn L. Nelson	Ph.D.	HWRF, U of M
Stephanie L. Orndorff	M.S.	USGS-BRD, MCFWRU, U of M, MOHF
Dustin W. Perkins	Ph.D.	U of M, MCS, MCCS, CFRU, PCTC, IP, MP
Steven C. Renner	M.S.	COA, U of M
Teresa M. Sauer	M.S.	FWS, U of M
Sandra M. Schaefer	M.S.	GAP, USGS- BRD, MCFWRU, U of M
Shelley Spohr	M.S.	NWTF, WF, UM, CDEP
James Stahlnecker	M.S.	MDMR, MDIFW
Carol A. Strojny	M.S.	USDA, USFS, U of M
Dale A. Tyson	M.S.	U of M, USFWS

## DISSERTATIONS AND THESES COMPLETED THIS PERIOD

<b>Student</b>	<b>Degree Candidacy</b>	<b>Support</b>
Andrew T. Gilbert	M.S.	MDIFW, USFWS, McIntire-Stennis
Nikolina Guldager	M.S.	NMFS, MAFES, U of M
Christopher L. Hoving	M.S.	WCS, UM, MCFWRU, MDIFW, NCASI, USFWS
Glen H. Mittelhauser	M.S.	MOHF, NPS, MDIFW
Regina M. Purtell	M.W.C.	EMCI, PCCA
James Stahlnecker	M.S.	MDMR

## PERSONNEL NOTES

**ANDREW GILBERT** received his M.S. degree in Wildlife and is employed by the USGS at the Patuxent Wildlife Research Center in Maryland. **JAMES STAHLNECKER** received his M.S. degree in Zoology and is a regional fisheries biologist with the Maine Department of Inland Fisheries and Wildlife in Sidney, Maine. **MERRY GALLAGHER**, Ph.D. candidate in Zoology, was appointed a fisheries research biologist with the Maine Department of Inland Fisheries and Wildlife in Bangor. **NIKOLINA GULDAGER** received her M.S. degree in Wildlife and is employed by the National Park Service in Fairbanks, Alaska. **CHRISTOPHER HOVING** received his M.S. degree in Wildlife and is an associate scientist working with The Maine Cooperative Fish and Wildlife Research Unit. **REGINA PURTELL** received her M.W.C. degree and is a sanctuary director with the Massachusetts Audubon Society in South Dartmouth, Massachusetts.

**COLLABORATING AGENCIES AND ORGANIZATIONS**

Abitibi Consolidated - AC  
American Wildlife Research Foundation - AWRF  
Audubon Society of New Hampshire - ASNH  
Baldwin Foundation - BF  
Baxter State Park - BSP  
Boise Cascade - BC  
Bowater-Great Northern Paper, Inc. - BGNP  
Central Maine Power - CMP  
College of the Atlantic - COA  
Connecticut Department of Environmental Protection -  
Wildlife Division - CDW  
Cooper Ornithological Society - COS  
Corner Brook Pulp & Paper - CPP  
Eastern Maine Conservation Initiative - EMCI  
Fort James Corporation - FJC  
FPL Energy - FPL  
Holt Woodlands Research Foundation - HWRF  
International Paper - IP  
Maine Association of Wetland Scientists - MAWS  
Maine Atlantic Salmon Commission - MASC  
Maine Bureau of Public Lands - MBPL  
Maine Chapter of the Nature Conservancy  
Maine Department of Conservation - MDC  
Maine Department of Environmental Protection - MDEP  
Maine Department of Inland Fisheries and Wildlife - MDIFW  
Maine Department of Marine Resources - MDMR  
Maine Forest Service - MFS  
Maine Geological Survey - MGS  
Maine Office of Geographic Information Systems - MOGIS  
Maine Outdoor Heritage Fund - MOHF  
Manomet Center for Conservation Sciences - MCCA  
Mead Paper - MP  
National Council of the Paper Industry for Air and Stream Quality Improvement - NCASI  
National Science Foundation - NSF  
National Wild Turkey Federation -  
Connecticut Chapter - CCNWTF  
Natural Resources Canada – Canadian Forest Service –NRC-CFS  
New Hampshire Fish & Game Department - NHFG  
New Hampshire Department of Resources and Economic Development -  
Division of Forests and Lands – NHDFL  
Newfoundland Department of Forest Resources and Agrifoods – Wildlife Division - NDFRA  
Penobscot County Conservation Association - PCCA  
Penobscot Valley Conservation Association - PVCA  
Plum Creek Timber Company - PCTC  
Seven Islands Land Company - SILC

Switzer Environmental Fellowship Program - SEFP  
University of Maine - U of M  
    Association of Graduate Students - AGS  
    College of Natural Sciences, Forestry, and Agriculture – NSFA  
    Sea Grant Program - SGP  
        Cooperative Forestry Research Unit - CFRU  
        Department of Forest Management – DFM  
        Department of Wildlife Ecology - DWE  
        Forest Ecosystem Science - FES  
        Maine Image Analysis Lab - MIAL  
        McIntire-Stennis - MCS  
    Maine Agricultural and Forest Experiment Station - MAFES  
U.S. Department of Agriculture - USDA  
    Forest Service – USFS  
    National Research Initiative Competitive Grants Program - NRICGP  
U.S. Department of Commerce - USDC  
    National Marine Fisheries Service - NMFS  
U.S. Environmental Protection Agency - EPA  
U.S. Department of the Interior - USDI  
    U.S. Fish and Wildlife Service - FWS  
        Gulf of Maine Project - GMP  
        Neotropical Migratory Bird Program - NMBP  
        Northern Maine National Wildlife Refuge Complex - NMNWRC  
        Partnerships for Wildlife - PW  
        Petit Manan National Wildlife Refuge - PMNWR  
    National Biological Service - NBS  
USGS Biological Resources Division - BRD  
    Cooperative Park Studies Unit - CPSU  
    Gap Analysis Program - GAP  
    Leetown Science Center - LSC  
    Maine Cooperative Fish and Wildlife Research Unit - MCFWRU  
    National Park Service - NPS  
        Acadia National Park - ANP  
Wagner Forest Management, Ltd. - WFM  
Western Newfoundland Model Forest - WNMF  
Wildlife Forever - WF

**ENDANGERED AND THREATENED SPECIES:**

THE FORAGING AND HABITAT ECOLOGY OF  
BLACK TERNS IN MAINE

*Investigator:* A. T. Gilbert

*Advisors:* F. A. Servello, Chairperson  
J. M. Rhymer  
A. J. K. Calhoun  
M. A. McCollough

*Cooperators/  
Project  
Support:* University of Maine -  
Department of Wildlife Ecology  
Maine Department of Inland Fisheries and Wildlife  
Maine Outdoor Heritage Fund  
U.S. Fish and Wildlife Service  
Northern Maine National Wildlife Refuge Complex

*Objectives:*

- 1) Determine effects of long-term weather patterns on black tern nest loss and insect abundance in tern colonies in Maine.
- 2) Determine relationships between black tern chick growth and food provisioning.
  - a) determine if black tern productivity is food limited in Maine.
  - b) develop a less invasive method for monitoring black tern chick growth and survival.
- 3) Identify wetlands suitable for black tern nesting in Maine.

*SCOPE:* Black terns, a state-listed endangered species in Maine, breed at 7-9 inland emergent wetlands. Limited or poor quality habitat in Maine may contribute to reduced productivity and survival, ultimately leading to its rare status in the state. Reproductive success in black terns may be limited by adverse weather, food-limited growth of chicks, the lack of suitable breeding habitat, and predation. I am addressing the first three as part of a long-term population study of black terns in Maine. This information will be used to develop conservation measures to enhance productivity of black terns in Maine.

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

The population of black terns in Maine is low and several aspects of this species' foraging and habitat ecology may limit population growth and recovery. Expansion of the population may be limited by the amount and distribution of suitable habitat, diet (fish vs. insects) and food abundance may limit chick growth and ultimately fledging rates, and flooding events may reduce nesting success. The major objectives were to (1) examine factors that affect chick growth and food delivery rates and determine the adequacy of diets for growth, (2) identify suitable habitat in Maine, and (3) quantify effects of precipitation and water level dynamics on nest success.

I compared growth rates of chicks in 1999-2000 in Maine to rates in other studies, determined the influence of colony and year on growth rates and used an energetics model to determine the sensitivity of growth rates to feeding parameters. I also recorded food habits and determined the factors affecting food delivery rates. To determine potential wetland habitat, I used Geographic Information System analysis of National Wetlands Inventory data from Maine based the following criteria: wetlands >5 ha, >1 ha open water, and semipermanent emergent wetland present. I ranked wetlands based on total area, total and maximum semipermanent wetland area, and landscape-scale wetland area and density. To assess the effects of flooding, I determined the probability of

occurrence for three levels (low, moderate, and catastrophic) of nest losses associated with flooding and based on events that occurred in Maine during 1997-1999. Probabilities were calculated from historical stream gauge and precipitation data (1960-1999).

Growth rates of black tern chicks in Maine ( $\xi = 4.46$  g/d) were comparable to estimates from other studies (range 4.18-5.18 g/d) and varied with hatch order and brood, but not year or colony. Third-hatched chicks grew most slowly ( $\xi = 4.15$  g/d) but at greater rates than one reported estimate (3.32 g/d) for starved chicks. Patterns of food deliveries were complex and varied among colonies, years, and age of broods. Also the ratio of fish to insects in the diet ranged from 3.4-13.3, and total delivery rate varied widely (9.1-23.7 items/brood-hr), but there was no evidence that growth rates differed among feeding strategies. Weight change in chicks was best predicted by delivery rates of large fish, large and small insect and by temperature; however, modeling indicated that growth rates may be most sensitive to rates of large insect delivery. My results indicate that diet type did not influence growth rates of chicks at the observed rates of delivery, and overall there was no evidence that food resources limited fledging rates in black terns in Maine.

I identified 730 wetlands in Maine as potential colony sites for black terns. Suitable wetlands ranged in size from 5-30,864 ha ( $\xi = 425$  ha) and had 0.04-228 ha of semipermanent wetland area. However, only 51 sites were classified as high potential sites (>20 ha of semipermanent wetland) The availability of suitable wetlands does not appear to be limiting the population of black terns in Maine, but these sites should be ground surveyed because wetland data may be out-dated or too coarse-grained.

Low-level flooding events were predicted 70% of all years, but have a low cumulative potential for loss (16), whereas moderate flooding occurred half as often (38%) but have a much greater cumulative potential for loss (51). Catastrophic events occurred rarely (5%) and have a low cumulative potential (12). At other colonies with less dynamic water levels, nest losses from precipitation are likely to be similar but reduced proportionately. Moderate flooding events have the greatest potential to affect long-term nesting success of black terns because of their frequency and high rates of nest loss, whereas low-level events occurred frequently, but result in few nests lost and catastrophic events could cause colony-wide nest loss, but occurred rarely.

## WINTER ECOLOGY OF HARLEQUIN DUCKS IN MAINE

*Investigator:* G. H. Mittelhauser

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

*Cooperators/  
Project  
Support:* Maine Outdoor Heritage Fund  
National Park Service - Acadia National Park  
Maine Department of Inland Fisheries and Wildlife  
U.S. Fish and Wildlife Service -  
Petit Manan National Wildlife Refuge  
Gulf of Maine Project  
University of Maine

*Objectives:*

- 1) Compile and analyze current and historic population data for harlequin ducks in Maine to determine population size, distribution, and trends.
- 2) Identify significant wintering areas and determine essential characteristics of wintering habitat in Maine; compare habitat use to time of year, flock size and composition, and environmental conditions.
- 3) Determine activity budgets for harlequins at Isle au Haut relative to day length, time of day, tide cycle, environmental conditions, and habitat.

*SCOPE:* The number of harlequin ducks (*Histrionicus histrionicus*) in eastern North America is estimated at 1,500

individuals and counts show population declines have occurred, and may be ongoing. More than 50% of this eastern North American population is concentrated at a small number of traditional wintering areas on the coast of Maine. Little is known about the winter ecology and population of harlequin ducks in Maine at these concentration areas. This project will address harlequin duck population size, distribution, trends, and movements in Maine, assess habitat at concentration areas, and determine activity budgets.

*PROJECT STATUS:* All requirements for the degree of Master of Science (in Zoology) were completed in December 2000. An abstract of the thesis follows:

Harlequin ducks wintering in eastern North America numbered fewer than 1,000 individuals in the 1980s and were declining at some sites. In 1990, the population was protected from hunting and listed as endangered by The Committee on the Status of Endangered Wildlife in Canada. Little is known about the winter ecology of this endangered population. I conducted winter surveys of harlequin ducks in Maine from 1988-99 and reviewed records in eastern North America to summarize their numbers and distribution, and estimate population trends. I estimate approximately 1,800 birds wintered in eastern North America in the late 1990s. Although this estimate is more than twice the number estimated in the 1980s, additional survey data likely account for much of this increase. Numbers in Atlantic Canada and Maine, which account for ~75% of the wintering population, suggest a recovery in numbers since 1991, coinciding with closure to hunting. At wintering location south of Maine, numbers have increased since 1970.

The largest concentration of harlequin ducks in eastern North America occurs in outer Jericho Bay, Maine where ~1,000 birds winter. Here, I examined habitat use, behavior and diving, and local survival of wintering harlequin ducks. Logistic regression was used to identify habitat variables that are important in discriminating among high and low densities of birds. Higher densities of birds were observed along shorelines exposed to greater wave action, with intertidal substrate consisting of predominantly granite ledge, having higher densities of amphipods and lower densities of chink shells, and having extensive *Mastocarpus* beds with little *Chondrus*. Results from feeding behavior analysis suggest harlequin ducks spent the majority of the diurnal period (73%) feeding. Feeding bouts (20 min) were longer than non-feeding bouts (6 min). The duration of feeding bouts did not differ among months, but the duration of non-feeding bouts increased with increasing photoperiod length. The mean dive duration (26 s), pause duration (16 s) and dive pause ratio (1.9:1) did not differ between males and females, but first-winter males submerged longer and paused longer on the surface than adult males, perhaps related to the feeding inefficiency of younger birds. Harlequin ducks may have little flexibility in adjusting their winter activity budgets to their environments, especially during prolonged bouts of severe weather. I refined a technique for capturing ducks using decoys and mist nets over floating platforms. A total of 225 harlequin ducks was captured during 16 days of trapping. Females had greater local survival rates than males for both the summer and winter intervals, although these differences do not have strong support. The roles of increased male emigration (possibly permanent) on local winter survival rates remains unclear.

My analyses provide some evidence of the beginning of recovery in the population of harlequin ducks wintering in eastern North America since the closure of hunting in 1990; however, they remain concentrated at few sites. Given the small numbers, limited distribution, and vulnerability of harlequin ducks in eastern North America, they should remain under full protection in the foreseeable future.

---

## POPULATION ECOLOGY OF BLACK TERNS IN MAINE

<i>Investigator:</i>	F. A. Servello
<i>Cooperators/ Project Support:</i>	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 FPL Energy

- Objectives:*
- 1) Determine the annual local survival of breeding adult black terns (*Chlidonias niger*) in Maine, site fidelity to individual wetlands, and movement rates among wetlands.
  - 2) Determine breeding success at black tern colonies and factors influencing rates of nest and chick losses.
  - 3) Determine the relative effects of demographic parameters on population rates of change for Black terns using demographic models, and use stochastic modeling to evaluate extinction risk and management strategies.

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

*PROJECT STATUS:* The fifth year of field work has been completed. We have banded a total of 163 adult terns with USFWS metal bands and color bands and we are now recapturing/resighting a significant number of banded terns annually. Estimation of survival and movement rates are in progress. Nest success has been measured in 6-7 colonies and fledging success has been measured in 2-6 colonies each year. 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:* Field work on these objectives is planned for years 2000-2003.

---

## **FISHERIES RESOURCES:**

### FISHERIES RESOURCES OF ACADIA NATIONAL PARK

- Investigators:*
- P. Bryer
  - R. M. Purtell
  - S. Hayhurst
  - A. Jordaan
  - J. B. Lê
  - J. A. Stone
- Advisors:*
- J. R. Moring, Chairperson
  - J. G. Trial
  - D. P. Chivers
  - A. D. Huryn
- Cooperators/  
Project  
Support:*
- National Park Service - Acadia National Park
- Objective:*
- To inventory fish species and their associated habitat in lakes and brooks and estuaries

and tidepools of Acadia National Park, especially concentrating on life history aspects of brook trout.

*SCOPE:* There are no comprehensive inventories of fish species found in Acadia National Park. This project attempts to describe the species, location, relative abundance, native or non-native status, habitat associations, and associated abiotic parameters. For the students' theses, several life history parameters were studied for the native brook trout. This project included investigations by two separate freshwater investigators over two field seasons, 1998 and 1999, studying different life history characteristics.

*PROJECT STATUS:* All work with freshwater field inventories of the Park's waters has been completed. The first year of inventories of tidepool and estuarine fishes has been completed. Work on marine inventories will continue in 2002.

*FUTURE PLANS:* The final report on the freshwater fish inventories was submitted in September 2001.

## POPULATION STUDIES OF MAINE INTERTIDAL FISHES

*Investigator:* J. R. Moring

*Cooperators/  
Project  
Support:* University of Maine

*Objectives:*

- 1) Identify environmental conditions associated with arrival and departure of fishes in the intertidal zone.
- 2) Identify and quantify algal and food associations of intertidal fishes.
- 3) Study movement patterns of Maine tidepool fishes.

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

Surveys since 1979 have identified 23 species of tidepool fishes in Maine. The movements of the rock gunnel have been examined in marking studies, and algal associations and food habits of lumpfish and Atlantic seasnails have been quantified. Three study pools on Schoodic Peninsula have been studied since 1979, and work also has involved the first description of rock gunnels as the first intermediate host of the digenean fluke, *Cryptocotyle lingua* and seasonal habitat changes of tidepool fishes and sand shrimp.

*PROJECT STATUS:* Papers are being prepared on distribution of sand shrimp and tidepools as refugia.

*FUTURE PLANS:* Additional manuscripts are being prepared on community dynamics and intertidal movement patterns.

## POPULATION DYNAMICS OF SEA-RUN ALEWIVES

*Investigator:* J. F. Stahlnecker, III

*Advisors:* J. R. Moring, Chairperson  
J. D. McCleave  
J. G. Trial

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

*Objective:* To understand the interactions and between stocking rates and the resultant numbers of juvenile alewives in Maine ponds.

*SCOPE:* The Maine State Legislature has instructed the Department of Marine Resources to restore sea-run alewives to their original range in Maine. To do this requires information on stocking rates appropriate for producing adequate numbers of juvenile and adult alewives. Some data from a restricted number of ponds are available, but a wider range of stocking rates is necessary to identify the appropriate stocking rates for the future.

*PROJECT STATUS:* All requirements for a M. S. degree in Zoology were met in December 2000. The abstract follows:

Restoration programs for anadromous alewives in several Maine river drainages are based on trapping of adult alewives in lower river reaches and stocking the captured spawners in historic lentic spawning and nursery habitat farther upstream. Previous studies explored juvenile alewife production at certain adult escapement densities. However, no work has been done at the 15-alewives-per-lake-surface-hectare stocking rate currently used in the alewife trucking program.

This study examined the production of juvenile alewives in lakes stocked at 15 alewives per hectare and 30 alewives per hectare. The primary study waters were 288-ha Pattee Pond and 70-ha Nehumkeag Pond, both eutrophic lakes. Additional data were collected from 136-ha, mesotrophic Lake George, at 15 alewives per hectare. A pilot study to determine the plausibility of using weirs on the study lake outlet streams to count juvenile alewife emigrants was conducted in 1996 at Pattee Pond stream, the outlet of Pattee Pond, which was stocked with 15 alewives per hectare. Based on the success of this preliminary study, weirs were placed on Pattee Pond and Nehumkeag Pond outlet streams in both 1997 and 1998. Stocking rates varied, with Pattee Pond receiving alewives per hectare in 1997 and 30 alewives per hectare in 1998. Nehumkeag Pond received 30 alewives per hectare in 1997 and 15 alewives per hectare in 1998.

Juvenile alewife production in Pattee Pond was 1,177,148, and 165 juveniles per hectare in 1991, 1992, and 1993. Juvenile production in Lake George varied from 3,126 to 10,030 per hectare over three years when stocked with 15 adult alewives per hectare.

Juvenile production responded positively to an increase in adult alewife stocking density in Pattee Pond, although the increase was not proportional to the increase in the stocking rate. The elevated stocking rate at Pattee Pond produced a 27% increase in emigrating juveniles from 1996 (at 15 per hectare) to 1997 (at 30 per hectare).

Growth of juvenile alewives suffered as a result of increased stocking density and increased intraspecific competition. The growth rate of juveniles was much lower at the higher stocking density, in Pattee Pond in 1997, compared to both 1996 and 1998 at the lower stocking density, suggesting intraspecific competition for limited food resources.

The time of juvenile alewife emigration was examined in relation to stream water temperature and stream level (a surrogate for discharge). Water temperature seemed to play a minimal role, but juvenile alewife movement was strongly influenced by stream level, as measured by staff gauges located on the weirs. Peaks in juvenile movement out of both ponds in 1998 closely followed peaks in stream discharge. The magnitude, timing, and duration of juvenile emigration was strongly influenced by flow in the outlet stream.

## MOVEMENTS OF AMERICAN EELS IN FRESHWATER LAKES

*Investigator:* M. Gallagher  
*Advisors:* J. R. Moring, Chairperson  
 J. G. Trial  
 A. D. Huryn

J. D. McCleave  
 F. W. Kircheis  
 W. E. Glanz

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

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

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

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

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

## RELATIONSHIPS BETWEEN STREAM GEOMORPHOLOGY AND FISH COMMUNITY STRUCTURE

*Investigator:* E. Gaenzle

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

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

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

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

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

*FUTURE PLANS:* A Master of Science thesis is expected to be completed in May 2002.

## INTERTIDAL FISH COMMUNITIES ASSOCIATED WITH ROCKWEED, *Ascophyllum nodosum*

*Investigator:* A. Gullo

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

*Cooperators/  
Project  
Support:* University of Maine  
National Park Service

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

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

*PROJECT STATUS:* All field work now has been completed, including inventories of fish species associated with rockweed and the effects of various cutting regimes on the resultant fish communities. Fishes were collected with unique retention sampling nets and invertebrates associated with rockweed were assessed as an indication of prey availability.

*FUTURE PLANS:* A Master of Science thesis is expected in May 2002.

---

## ALTERNATIVE POPULATION ESTIMATION TECHNIQUES FOR AND HABITAT DENSITIES OF ATLANTIC SALMON

*Investigator:* S. L. Fleming

*Advisors:* J. R. Moring, Co-Chairperson  
J. R. Trial, Co-Chairperson  
J. F. Kocik

*Cooperators/  
Project  
Support:* Maine Atlantic Salmon Commission  
National Marine Fisheries Service

*Objective:* (1) To test several alternative techniques for estimating population numbers of juvenile Atlantic salmon in 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 rivers in Maine have now been placed on the Endangered Species List. The common method of assessing stream populations of juvenile salmon has been to conduct surveys using backpack electrofishing units, a method that can add some mortality—however limited. This project examines a matrix of river conditions and several alternative forms of enumeration, such as day vs. night snorkeling, overhead/streambank

observation, and night scope observation. In addition, locations of fishes at the time of snorkel observations will be flagged and analyzed in terms of density distribution.

*PROJECT STATUS:* Preliminary field work began in summer 2001 to develop working methods that were tested on the Narraguagus River in fall 2001. Most field work will occur in 2002.

*FUTURE PLANS:* A detailed project proposal will be developed over 2001-2002 and field work will be completed in summer-fall 2002. A Master of Science thesis is expected to be completed in May 2003.

## **HABITAT RESOURCES:**

### HISTORICAL OCCURRENCE AND HABITAT ECOLOGY OF CANADA LYNX (*Lynx canadensis*) IN EASTERN NORTH AMERICA

*Investigator:* C. L. Hoving

*Advisors:* W. B. Krohn, Co-Chairperson  
D. J. Harrison, Co-Chairperson  
M. K. Beard  
W. J. Jakubas

*Cooperators/  
Project  
Support:* University of Maine –  
Department of Wildlife Ecology  
Maine Cooperative Fish and Wildlife Research Unit  
Maine Department of Inland Fisheries and Wildlife  
National Council of the Paper Industry for Air and Stream  
Improvement, Inc.  
U.S. Fish and Wildlife Service

*Objectives:*

- 1) Document the current and historical distribution of lynx in Maine, 1833-1999, and discuss reasons for historic shifts in abundance and distribution.
- 2) Develop and test a predictive habitat model for lynx for the northeastern U. S. and eastern Canada
- 3) Develop a model of snowshoe hare (*Lepus americanus*) habitat relations at the scale of the state of Maine.
- 4) Develop and test a predictive habitat model for lynx at the scale of the state of Maine.

*SCOPE:* The U.S. Fish and Wildlife Service published their intent to list the Canada lynx under the federal Endangered Species Act in March 2000. The state of Maine is one of the few states in which lynx occur; however, knowledge of the ecology of lynx in eastern North America is limited. The ecological processes that determine lynx habitat occur at many temporal and spatial scales. Therefore a multi-scale approach to lynx habitat modeling is necessary.

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

The contiguous USA population of Canada lynx (*Lynx canadensis*) has been listed as threatened under the federal Endangered Species Act. Past literature and policy decisions have frequently inferred that forest management degrades habitat for lynx in the southern part of their range, but the specific effects of different forms of forest management, as well as potential impacts of climate change on lynx in the eastern USA and Canada have not been

investigated. Further, the historic distribution and current status of lynx in Maine has been unclear, and was challenged during the listing process in 1998 by the state agency responsible for lynx management in Maine.

The past and present occurrence and distribution of lynx in Maine was documented by searching museum records, periodicals, books, and newspapers for evidence that lynx occurred historically in Maine. Recent records were available from track surveys by the Maine Department of Inland Fisheries and Wildlife (MDIFW) and interviews conducted by the U. S. Fish and Wildlife Service. Based on 118 records of 509 lynx, this species has been distributed throughout much of Maine, 1833-1999. Records of 39 kittens representing a minimum of 21 litters suggest that a breeding population has existed in Maine. The spatial distribution of Canada lynx observations contracted in the late-1800s through early-1900s, and many biologists and respected naturalists noted a decline in lynx abundance that coincided with a range expansion by bobcats (*L. rufus*) circa 1900.

Studies of lynx have concentrated on stand-scale habitat associations, however, broad-scale associations are also important. Biologists from the northeastern USA and Canada provided spatially-explicit data on 1,150 lynx, 1985-1999. Snowfall, road density, bobcat harvest, deciduous forest, and coniferous forest at random locations were compared to lynx observations using logistic regression. Models were compared using Akaike's Information Criterion (AIC). A model incorporating snowfall and deciduous forest had a low (good) AIC and best predicted a reserved dataset of 278 points (CCR = 0.94). Lynx were predicted to occur on the Gaspé, northern Maine, northern New Brunswick, and Cape Breton Island. Climate warming could potentially constrict future lynx distributions in northeastern North America.

Winter track surveys were conducted by the MDIFW, 1994-1999. One kilometer transect segments where snowshoe hares (*Lepus americanus*) were abundant were compared to segments where hares were absent using logistic regression. Models changed through time as hare densities changed. Hares were positively associated with late regeneration and forested wetlands, and negatively associated with recent clearcuts and partial harvests.

Lynx presence or absence on track surveys from northwestern Maine were compared using logistic regression. Within northwestern Maine, lynx were positively associated with late regeneration, and negatively associated with forested wetlands, recent clearcuts and partial harvests within an area of 100 km<sup>2</sup>. Lynx in Maine were more closely associated with young forest than mature forest; over-mature forest was functionally absent from the landscape. In conclusion, in eastern North America lynx habitat consists of areas of deep snow (> 268 cm) with relatively little deciduous forest; within deep snow areas in northwestern Maine, lynx are most likely to occur in complexes of regenerating forest, where snowshoe hare are likely to be abundant.

## EXPLORING GRASSROOTS EFFORTS TO MONITOR WILDLIFE

*Investigator:* R. Purtell

*Advisors:* M. L. Hunter, Jr.  
R. J. O'Connor  
D. M. Mageean

*Cooperators/  
Project  
Support:* Eastern Maine Conservation Initiative  
Penobscot County Conservation Association  
University of Maine -  
Department of Wildlife Ecology

*Objectives:*

- 1) Determine the mission, monitoring proficiency, expert input, and infrastructure of grassroots wildlife monitoring groups in Maine.
- 2) Describe dominant trends, variables, and implications of these four facets of grassroots monitoring efforts.
- 3) Synthesize a description of the current and potential value that grassroots monitoring programs have to wildlife conservation.
- 4) Present a profile of grassroots wildlife-monitoring groups, and an inventory of such groups in Maine.

*SCOPE:* Conservation biologists extol the virtues of community-based conservation strategies that incorporate

local people, leaders, and institutions. Research into the roles that local people play in conservation has focused on projects initiated by government agencies, environmental organizations, and industry. Little attention has been given to truly grassroots approaches: those that begin with citizens in a community, evolve in response to local interests, and carry potential for effective and lasting biological conservation. This project examines grassroots groups that monitor wildlife to explore current and potential values such groups might have for wildlife conservation.

Using written questionnaires and in-depth interviews of approximately 25 coordinators, I explored the 1) mission, 2) monitoring proficiency, 3) expert input, and 4) infrastructure of grassroots groups. Following analysis, I described dominant trends, variables, and implications of these four facets of grassroots monitoring efforts. Given the relative paucity of research into citizen-based conservation activities, my research should help address the current gap in knowledge, create an awareness of grassroots resources available to biologists, generate hypotheses for subsequent investigation, and hopefully inspire others to pursue research on the human dimension of wildlife conservation.

*PROJECT STATUS:* Questionnaires and interviews were completed in January 2000. Taped interviews were transcribed into text files. The project has been completed.

*FUTURE PLANS:* All requirements for the degree of Master of Science (non-thesis) were completed in August 2001.

## A LONG-TERM FOREST ECOSYSTEM STUDY

*Investigators:*

M. L. Hunter, Jr.  
A. J. Kimball  
A. S. White  
J. W. Witham  
S. E. Gerken  
H. Tedford

*Cooperators/  
Project  
Support:*

Holt Woodlands Research Foundation  
McIntire-Stennis  
Maine Outdoor Heritage Funds  
Baldwin Foundation

*Objectives:*

- 1) Describe the structure of the plant and animal communities in an oak-pine forest ecosystem.
- 2) Investigate the effect of woodlot management on community structure.
- 3) Document phenological, interannual, and long-term changes in community structure.

*SCOPE:* Thousands of people own woodlots, and they control a resource that is not currently being adequately managed despite a growing demand for forest products. To many landowners, perhaps most, economic return from timber extraction is secondary to considerations such as recreation, aesthetics, and wildlife. In the absence of management advice, these people often choose not to manage their land at all. Thus, there is a great need for information on how to manage small woodlots, particularly in ways that maintain or enhance wildlife and similar values.

This study is being conducted for 20 years on a 120 ha, red oak-white pine woodlot in Arrowsic, Maine, called the Holt Forest. We have selected a 40 ha tract and divided it into forty 1-ha blocks with 20 ha serving as a control area and 20 ha as an experimental area.

Our primary objective is to describe the structure of the plant and animal community. We are undertaking (1) a 100% inventory of trees (>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) transect surveys of nonbreeding birds; (5) small mammal trapping; (6) salamander quadrat counts; (7) observations of reproductive efforts (flowering and fruiting) for 13 herb and shrub species; (8) estimates of seed and fruit production; (9) general surveys of canopy insect abundance; and (10) meteorological observations. These data, largely population estimates, are integrated by area units (usually 0.25 ha blocks) and analyzed to portray the forests' community structure. After five years of gathering baseline data, in 1987 we began managing the experimental area with three objectives: (1) increase wood production; (2) increase wildlife diversity and abundance; and (3) maintain the forest's aesthetic value. By continuing to monitor populations and processes, we can attain the second objective. Over the course of 20 years, we will begin to understand how the community changes seasonally and from year to year; this is the essence of the third objective.

*PROJECT STATUS:* In 2001, tasks 3, 4, 5, 6, 8, 9, and 10, as outlined above, were completed.

*FUTURE PLANS:* The 2002 field season will replicate the 2001 field season with additional work on plants and trees.

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

*Investigator:* D. L. Nelson

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

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

*Objectives:*

- 1) Document the invertebrates on and within the bark of standing dead pines and oaks in the Holt Research Forest.
- 2) Relate variability in abundance and taxa composition of these invertebrates to characteristics of the snags and their local environment.
- 3) Document the characteristics and availability of snags within the Holt Research Forest from 1984 to 1996.

*SCOPE:* Dead wood is an important component of many forest ecosystems. Trees in various stages of decay contribute structural diversity to forests, serve as long-term nutrient sources and sinks, reduce erosion, contribute to soil development and enrichment, influence seedling establishment, provide habitat for mammals, birds, amphibians, reptiles, invertebrates, plants, and fungi, and retain moisture through times of drought. Of all organisms that use decaying wood, invertebrates compose possibly the largest and most diverse group. Invertebrates also play essential roles in the process of wood decomposition. Even so, comparatively little is known about the ecology of most wood-loving invertebrates.

Current forest management practices often discriminate against dead trees, which are reduced through thinnings and short rotations, eliminated as both fire and safety hazards, and destroyed to prevent the spread of timber pests and diseases. These practices may alter the size, species composition, and recruitment rate of dead trees, affect patterns of decay and nutrient cycling, and cause ecosystem simplification. The implications of such practices on forest ecosystems are just beginning to be investigated.

This study is designed to address issues relating to invertebrate and dead tree conservation. I wish to

quantitatively explore the links between snag condition and the community attributes of bark invertebrates. I also wish to explore the dynamics of snag production and decay. This knowledge could be important for the wise management of forest resources.

*PROJECT STATUS:* Invertebrate samples were collected from logs, snags, and live oaks and pines throughout the summer of 1997 and identified to varying degrees, depending upon the availability of published keys and help from expert taxonomists.

*FUTURE PLANS:* A final thesis is in preparation. In addition, the timber inventories conducted in 1984, 1988, and 1996 will be used to examine the numbers and kinds of snags available in the forest, and the rate of snag production and fall.

## REPRESENTATIONAL ANALYSES OF CONSERVATION AREAS IN MAINE

*Investigator:* S. L. Orndorff

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

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

*Objectives:*

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

*SCOPE:* While the State of Maine continues to purchase conservation areas, no scientific analysis has been done to determine the role of existing conservation areas in conserving the state's natural heritage. A set of conservation areas that is as representative as possible of Maine's natural diversity has the greatest chance of conserving the biodiversity, and uncoordinated and unplanned decisions may seriously compromise progress toward that goal. Thus, the purpose of this study is to assess how well the conservation areas in Maine are representing the natural diversity of the state.

*PROJECT STATUS:* The conservation areas in Maine are incorporated into a digital database (scale = 1:100,000), which will be analyzed to determine whether or not the current conservation areas are representative of Maine's natural variability. This analysis will be separated into three chapters. In the first chapter, twelve variables (10 abiotic and 2 biotic) will be analyzed on conservation areas versus non-conservation areas using a Geographic Information System (GIS) at a 1.86 x 1.86 km resolution. Maine was divided into biophysical regions using GIS and cluster analyses and for this analysis were modified into five roughly equal-sized regions. The representativeness of the variables will be compared for the five regions in the state. In the second chapter, a similar analysis will be

conducted on the most under-represented region at a 94.6 x 94.6-m resolution. Similar variables will be analyzed (5 abiotic and 2 biotic) along with a threat and opportunity variable, road density. The areas identified as under-represented by this analysis will represent important areas for conservation acquisition, assuming the State of Maine's goal is to have a sample of conservation areas that fully represents the natural diversity in the state. The third chapter will assess the contribution of State Wildlife Management Areas (WMAs) and Federal National Wildlife Refuges (NWRs) to conservation in Maine. In addition to determining the extent to which Maine's terrestrial vertebrates are represented on these lands, representative analyses of major environmental variables such as elevation, slope, mean temperature, and snowfall also will be done.

*FUTURE PLANS:* All analyses are completed and the thesis is being written.

---

## INVESTIGATIONS OF THE ACCURACY TESTS OF PREDICTED VERTEBRATE OCCURRENCES FROM GAP ANALYSIS

- Investigator:* S. M. Schaefer
- Advisors:* W. B. Krohn, Chairperson  
D. J. Harrison  
S. A. Sader  
R. B. Boone (*ad hoc* member)
- Cooperators/  
Project  
Support:* U. S. Geological Survey, Biological Resources Division - Gap Analysis Program  
Maine Cooperative Fish and Wildlife Research Unit  
Department of Wildlife Ecology, University of Maine
- Objectives:*
- 1) Determine if there is a relationship between the percent of errors reported and the type of test data available (long-term versus short-term field inventory), the size of test site, and definition of what constitutes a breeding species.
  - 2) Determine if the commission errors reported for avian's from ME-GAP relate to *a priori* measures of ease of inventory termed Likelihood Of Occurrence Ranks.
  - 3) Partition out the potential sources of error (i.e., range limits, habitat map, habitat model) in the predicted avian occurrences using the Breeding Bird Survey as the standard of comparison.

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

*PROJECT STATUS:* Data analyses have been completed for the three objectives. The report for the three objectives has been reviewed by the committee and accepted for publication in "Predicting species occurrences: issues of scale and accuracy."

*FUTURE PLANS:* All data analyses have been completed and the thesis is being written.

---

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

- Investigator:* T. Y. Henrichon
- Advisors:* C. S. Loftin, Chairperson  
M. K. Beard-Tisdale  
S. A. Sader  
R. J. O'Connor
- Cooperators/  
Project Support:* U.S. Geological Survey, Biological Resources Division  
Department of Wildlife Ecology, University of Maine
- 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 (1990 and 1997) to document landscape-level marsh conversion.
  - 3) Assess the accuracy of marsh conversion predictions made in 1990 by Pearlstine et al., and modify their vegetation succession model to reflect changes in marsh composition that have actually occurred.

*SCOPE:* The Savannah National Wildlife Refuge (NWR) is responsible for management and protection of the freshwater and brackish marshes occurring within its borders, which are also adjacent to the Savannah River harbor. During the past several decades several 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 modify the succession model where predictions of change are in error.

*PROJECT STATUS:* SPOT satellite imagery was programmed and received for July 2000, October 2000 and April 2001. Landsat satellite imagery has been received for May 1993 and October 1994. An area including the Savannah National Wildlife Refuge and adjacent Savannah River has been subset from each of these images. All imagery has been geometrically corrected and registered to the 1990 vegetation map of the same area so that comparisons can be made. The imagery has been classified and vegetation associations are currently being assigned to the classified imagery. Early results indicate that a conversion from intermediate to freshwater marsh has occurred, suggesting that proposed harbor deepening could prevent further return of the marsh to a freshwater condition, and also may cause a reversion to intermediate and brackish condition. Approximately 800 digital aerial photographs of the area were captured during October 2000. These images will be used to assist in accuracy assessment of the completed vegetation maps. Ground truthing data gathered during June 2000 and October 2000 were used as training sites for satellite image classification. Vegetation and salinity transect data collected during these trips will be used to refine the vegetation succession model.

*FUTURE PLANS:* Final vegetation maps and change detection will be completed by December 2001. Model analysis and updating will be conducted January through April 2002, and the Master of Science thesis will be completed by August 2002.

---

## LITERATURE SYNTHESIS OF EFFECTS OF FOREST MANAGEMENT PRACTICES ON RIPARIAN AND IN-STREAM ANIMAL BIOTA OF NEW ENGLAND

*Investigators:* C. S. Loftin  
M. S. Bank  
J. M. Hagan  
D. Seigel

*Cooperators/  
Project Support:* Cooperative Forestry Research Unit, University of Maine  
U. S. Geological Survey, Biological Resources Division  
Department of Wildlife Ecology, University of Maine  
Manomet Center for Conservation Sciences

*Objectives:*

- 1) Survey published literature (1967-2000) on effects of forest management on riparian and in-stream animal biota of New England.
- 2) Develop digital database of retrieved citations.
- 3) Summarize published literature and provide recommendations for future directions of research examining riparian forest management effects on riparian biota in New England.

*SCOPE:* Regional research has addressed effects of forest management on in-stream water quality in northeastern North America; however, few of these studies have concurrently monitored potential effects on the in-stream and riparian biota. Although studies in northwestern North America have examined effects of forest practices on aquatic biota, and others have noted the diversity and abundance of riparian biota and effectiveness of buffer guidelines in riparian habitat protection, these results have not been summarized in a comprehensive literature review that could aid in identifying in-stream and riparian communities and species potentially affected by forest management in New England. This makes design and application of harvest management alternatives in the northeast unlikely, if potential forest harvest effects on riparian and in-stream biota can not be anticipated. This database and literature synthesis will summarize what is known about forest harvest practice effects on in-stream and riparian biota in northeastern North America and complement the synthesis by Kahl (1996) that reviews effects of forest management practices on water quality in Maine. Potential effects of water quality degradation on in-stream and riparian biota also will be addressed. The product of this objective will be a summary and digital citation database.

*PROJECT STATUS:* To determine the extent of published research conducted in northeastern North America that examines the responses of wildlife (birds, mammals, amphibians, invertebrates, fish, reptiles) to riparian forest harvest, we searched 18 online databases with approximately 20 combinations of the following search words: riparian, forest, wildlife, invertebrates, stream, birds, amphibians, mammals, reptiles, biodiversity, buffer, management, insect, policy, exotic, hyporeos, groundwater, watershed, aquatic. The searches included literature published during 1967-June 2000, although not all databases indexed publications from the entire interval. Reference lists published in approximately 20 recent riparian ecology books also were compiled. Several thousand citations were reviewed, and databases were developed in EndNote citation management software. We retrieved few citations (78) of publications addressing effects of specific forest harvest manipulations on New England riparian wildlife. Most of the riparian biota research in this region has examined bird responses to riparian forest manipulations (primarily buffer width), whereas reptiles and amphibians are the least represented of the surveyed taxonomic groups. Few studies address specific forest manipulations; most are general discussions of streamside forest disturbance. Birds have received more study of effects of changes in buffer widths, whereas studies of invertebrates concentrate on streamside, clear-cutting effects. The review has been summarized in a Cooperative Forestry Research Note and final report, and the citation database (complete citations and abstracts) is available as an EndNote library.

---

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

*Investigator:* D. W. Perkins

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

*Cooperators/  
 Project  
 Support:* University of Maine  
 NcIntire-Stennis  
 Manomet Center for Conservation Science  
 Department of Wildlife Ecology, University of Maine  
 Cooperative Forestry Research Unit, University of Maine  
 Plum Creek  
 International Paper  
 Mead Paper  
 7 Islands (Pingree Heirs)

*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 will consist 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 will be one year of pre-treatment data (2001) and two years of post-treatment data (2002-03). For the retrospective approach eight streams will be selected that have been harvested in the last 4-10 years. Four streams will have a 23 m buffer with clearcut adjacent to the buffer strip. Four streams will have a 200 m partially harvested unit. For both approaches, pitfall traps and drift fences are being used to capture terrestrial species. We are conducting in-stream linear transect surveys turning over suitable rocks for stream salamanders. During the 2001 season we collected pre-treatment data on 15 experimental streams. We also collected data on 3 more retrospective streams. Between 2000 and 2001 we have data on 6 retrospective streams. In 2001 during 86,923 trapnights we captured 2212 amphibians of 10 different species. During aquatic surveys we caught an additional 485 amphibians of 4 species.

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

streams in managed forests.

---

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

<i>Investigators:</i>	H. L. Rustigian W. B. Krohn
<i>Advisory Committee:</i>	G. M. Stadler E. A. Dumont G. J. Matula, Jr. R. L. Dressler
<i>Cooperators/ Project Support:</i>	Maine Department of Inland Fisheries and Wildlife (MDIFW) Maine Cooperative Fish and Wildlife Research Unit University of Maine - Department of Wildlife Ecology Maine Outdoor Heritage Fund
<i>Objectives:</i>	<ol style="list-style-type: none"> <li>1) Develop and apply a GIS-based approach to automate the evaluation of MDIFW-identified and delineated inland waterfowl and wading bird habitats (WWH) in organized towns utilizing MDIFW WWH evaluation criteria.</li> <li>2) Develop and apply a GIS-based approach to automate the delineation and evaluation of inland waterfowl and wading bird habitats statewide utilizing MDIFW WWH delineation procedures and evaluation criteria.</li> <li>3) Use Maine Gap Analysis (ME-GAP) data to assess the relationship between MDIFW and automated ratings and predicted occurrences of wetland associated non-fish vertebrate species.</li> <li>4) Determine feasibility of using existing MDIFW waterfowl and wading bird occurrence data to statistically assess the relationship between MDIFW WWH ratings and waterfowl and wading bird diversity and abundance and to refine MDIFW WWH rating criteria.</li> </ol>

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

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

*PROJECT STATUS:* Coordinating meetings were held between project investigators and the advisory committee on the following dates: 12/1/00, 3/14/01, 5/30/01, 6/20/01, and 7/25/01. The MDIFW WWH evaluation procedure has been successfully automated with a GIS and yielded results comparable to MDIFW manual evaluation. Linear relationships were found between both automated and manual WWH ratings and ME-GAP predicted waterfowl and wading bird species, but the relationship was stronger for the automated system. When the analysis was broadened to include all wetland associated non-fish vertebrate species similar relationships were found, suggesting that though this program focuses only on wading birds and waterfowl, benefits of these conservation measures extends to a broader community of non-fish vertebrate wildlife. The MDIFW WWH delineation process has been automated successfully and WWHs have been delineated statewide. We are currently in the process of evaluating WWHs in the new statewide coverage.

*FUTURE PLANS:* After the above results are fully documented, existing MDIFW waterfowl and wading bird survey data will be used to determine the feasibility of statistically assessing the performance of the WWH ratings system by comparing bird diversity and abundance to wetland attributes. Final report and relevant GIS layers will be prepared for MDIFW and manuscript completed for journal submission. Project completion is scheduled for July 2001.

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

*Investigator:* J. McCloskey

*Advisors:* C. S. Loftin  
L. Smith  
S. Sader

*Cooperators/  
Project  
Support:* Florida Caribbean Science Center  
United States Fish and Wildlife Service  
United States Geological Survey  
University of Maine – Department of Wildlife Ecology

*Objectives:*

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

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

*PROJECT STATUS:* SPOT satellite data was received for May 2001 and a preliminary, unsupervised vegetation

classification has been completed. Digital aerial photographs were also received and will be used for training and accuracy assessment of a supervised vegetation classification of the SPOT imagery.

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

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

*Investigators:* D. A. Tyson

*Advisors:* C. S. Loftin, Chairperson  
J. Longcore  
F. Drummond

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

*Objectives:*

- 1) Develop impoundment vegetation maps using ground surveys and ArcView GIS software, to compare to previously documented vegetation distributions.
- 2) Collect invertebrates from different wetland vegetation types and compare to previously documented species composition of selected Moosehorn impoundments.
- 3) Assess past and present hydrological data to characterize impoundment hydrology and relate to vegetation and invertebrate history.

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

*PROJECT STATUS:* Vegetation and invertebrate surveys began during summer 2001. Of the 20 wetlands selected for mapping, 12 have been completed. Invertebrates in one wetland were sampled from emergent and floating-leaved vegetation; invertebrates will be sorted during fall 2001 and spring 2002. Water level and precipitation data analyses are underway.

*FUTURE PLANS:* The remaining vegetation maps will be updated and invertebrate sampling will be completed in the 20 wetlands during summer 2002. Invertebrate specimens will be identified to order. Updated maps will be digitized and scanned into ArcView, and then compared with previously created maps to document vegetation change.

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

### SITE FIDELITY OF SONGBIRDS IN SELECTIVELY HARVESTED

## AND UNHARVESTED MIXED WOODS

- Investigator:* M. J. Hartley
- Advisors:* M. L. Hunter  
R. J. O' Connor  
A. S. White  
W. B. Halteman  
W. E. Glanz
- Cooperators/  
Project  
Support:* University of Maine -  
Forest Ecosystem Research Program  
Department of Wildlife Ecology  
Maine Department of Inland Fisheries and Wildlife  
USDA Forest Service  
Cooper Ornithological Society  
American Wildlife Research Foundation
- Objectives:*
- 1) Describe changes in breeding bird communities on sites that are experimentally harvested (with selection silviculture), as compared to unharvested stands.
  - 2) Determine if selective timber harvesting affects site fidelity of Ovenbirds and Hermit Thrushes, as estimated by: (a) annual return rates, and (b) distance between territories of successive years.

*SCOPE:* Forests are dynamic ecosystems that may only be understood through long-term research projects that focus on many different aspects of structure, function, and biota within and between stands. The Forest Ecosystem Research Program (FERP) was formed to address such long-term research issues. The FERP has established nine long-term research sites (10 ha each) at the Penobscot Experimental Forest (PEF). These nine stands are grouped into three replicates of "triplets" (three plots) that are treated with light selection cutting (10% harvest, with many retention trees), moderate selection cutting (20% harvest, with some retention trees), or no cutting (i.e., control). These three replicates are all within one 1400 ha mixed-wood forest. My role in the FERP is to study how these treatments affect one aspect of biodiversity in the forest: breeding bird communities. Timber harvesting may change songbird species composition or territory densities for some species. Even if the community is similar after harvesting, a reduction in the rate that migratory songbirds reoccupy territories of previous years would indicate that logging has a detrimental effect on breeding productivity.

*PROJECT STATUS:* I surveyed songbird territories and marked individuals on all FERP research sites during the summer of 1995, before any site had been harvested. The first triplet was harvested during the following winter. Field work continued for three subsequent summers, ending after summer 1998; the last triplets had been harvested in previous winter (i.e., 1997-98). Using 100 mistnets and averaging 4,000 net-hours per summer, I captured and banded approximately 300 birds each summer from 1995-1998; nearly half the birds were individually colormarked. Return rates varied during the three sampling periods, being much higher in one year for both species. Preliminary return rates for Ovenbirds ( $n = 111$ ) have consistently averaged 60% per year, whereas Hermit Thrushes ( $n = 143$ ) average 70%. These estimates are higher than those reported in the literature, probably because many investigators fail to include recapture probability in survival estimates. Territory mapping data have shown very few changes in songbird communities due to harvest activities. Year-to-year variations in bird densities were much stronger than differences between treatments and controls. There is evidence that these fluctuations may have been driven largely by predator (i.e., red squirrel) population dynamics during the study.

*FUTURE PLANS:* Statistical analyses began in 1999 and should be finished during 2001.

---

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

- Investigator:* C. R. Foss
- Advisors:* M. L. Hunter, Jr., Chairperson  
W. A. Halteman  
W. B. Krohn  
R. J. O'Connor  
R. S. Seymour
- Cooperators/  
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. This work was presented at a symposium, "Contemporary Research on the Effects of Forest Management on Bird Populations," during the Annual Conference of The Wildlife Society in Snowmass Village, Colorado, in September 1997, and have been submitted for publication with the symposium proceedings in the Wildlife Society Bulletin in early 1998.

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

## DIRECT EFFECTS OF GROUP SELECTION HARVEST GAPS ON THE BIRD COMMUNITY OF AN OAK-PINE FOREST

*Investigator:* S. P. Campbell

*Advisors:* M. L. Hunter, Chairperson  
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

*Objectives:*

- 1) Characterize the habitat use of breeding birds in the harvested and unharvested forest areas by examining forest canopy gap usage and avoidance.
- 2) Determine if territory placement changes in response to harvesting.
- 3) Investigate possible changes in pairing success.

*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 clearcutting 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 (18 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 ten 1-ha blocks were partially cut with a group-selection timber harvest. The other half of the forest was left as an unharvested control. Data collection after the harvest has continued and results to date indicate that, in terms of abundance, some bird species (e.g., Black-throated Green Warbler, Ovenbird) have responded negatively to the gaps, some (e.g., Eastern Wood-Pewee, Common Yellowthroat, White-throated Sparrow) have responded positively, but the majority of the species have shown little to no effect.

My research will provide a closer examination of the effects of group selection created gaps on the bird community. In other words, I will look for effects beyond simple changes in abundance, which can be a misleading indicator of habitat quality, and focus on the more direct effects of the gaps. Specifically, I will be looking for effects of gaps on habitat use, territory placement, and pairing success.

*PROJECT STATUS:* I have completed my third field season during which I mist-netted and banded 58 birds (62 captures), 26 of which I also colorbanded. The three species comprising most of the captures were Ovenbird (35%), Hermit Thrush (31%), and Veery (10%). I recaptured 16 (19%) of the birds that I colorbanded in previous years.

I recorded 229 locations of birds by resighting colorbanded birds in individually marked and mapped trees within the forest. I also determined pairing success of 19 pairs of Ovenbirds.

More detailed analyses of these data are underway.

## PHILOPATRY AND DISPERSAL OF BLACK LEGGED KITTIWAKES (*Rissa tridactyla*) IN PRINCE WILLIAM SOUND, ALASKA

*Investigator:* T. M. Sauer

*Advisors:* J. R. Gilbert, Chairperson  
W. E. Glanz  
F. A. Servello

*Cooperators/  
Project  
Support:* U.S. Fish and Wildlife Service -  
Migratory Bird Management  
University of Maine -  
Department of Wildlife Ecology

*Objectives:*

- 1) Determine philopatry and dispersal by cohort.
- 2) Determine differences within and between cohorts of philopatric fledglings and evaluate movement patterns.
- 3) Estimate demographic parameters including juvenile and adult local survival rates, age of first breeding and resighting probabilities.
- 4) Evaluate the factors of colony size, colony growth, productivity, distance from, and direction to natal colony in explaining the observed pattern of dispersal.
- 5) Quantify the error associated with local survival rate calculations.

*SCOPE:* Most information on Black legged Kittiwakes is based on data obtained from colonies in the Atlantic which may not be applicable to birds breeding in the Pacific Ocean. Preliminary data suggest that life history strategies are geographically different. Prince William Sound, Alaska, contains 27 Black-Legged Kittiwake colonies. Data have been collected annually by the U.S. Fish and Wildlife Service on the number of nests and chicks at all colonies. Additionally, an intensive banding of chicks and resighting effort of adults has been done at

the Shoup Bay colony since 1988 and 1991. Resighting efforts at all other colonies will allow natal dispersal of birds from the Shoup Bay colony to be estimated.

*PROJECT STATUS:* The data base of resighting information, banding information, nest locations, and plot information was completed in December 1999. Field seasons to collect dispersal information were completed in 1997 and 1998 (additional information was collected in 1999). All requirements for the M.S. degree in Wildlife Ecology will be completed by Spring 2002.

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

### **EFFECTS OF AN INCREASING HARBOR SEAL POPULATION ON CHANGES IN SITES USED FOR PUPPING**

*Investigator:* N. Guldager

*Advisors:* J. R. Gilbert, Chairperson  
W. B. Krohn  
J. T. Kelley

*Cooperators/  
Project  
Support:* National Marine Fisheries Service  
Maine Forest and Agriculture Experiment Station  
University of Maine-  
Department of Wildlife Ecology

*Objectives:*

- 1) Evaluate spatial and temporal patterns of haul-out use by breeding harbor seals.
- 2) Examine the effects of time of year, tidal phase, time of day, and weather conditions on haul-out use by breeding harbor seals.

*SCOPE:* The harbor seal (*Phoca vitulina*) is the most common pinniped that is found off the Maine coast. In late May and early June, harbor seals come inshore to have their pups on the many islands and intertidal ledges that scatter the coastline. Easily accessible, undisturbed rocky ledges of gentle slope and vegetative covering are often used. Researchers have found in various different geographic regions that annual timing of pupping, tidal phase, time of day and weather conditions have an effect on the proportion of seals hauled out. It is important to understand the effect of these covariables on haul-out numbers in Maine in order to obtain a precise population estimate from aerial surveys.

Aerial surveys have been conducted for the Maine coast during the pupping period in 1981, 1982, 1986, 1993, and 1997, during which all hauled-out seals and pups were counted within two hours on either side of low tide. These counts represent a minimum population estimate. The average annual rate of increase in the counts since 1981 has been 4.2 percent. Minimum number of seals observed in June 1981 was 10,543 and 30,990 in June of 1997. Estimated pup production has increased from 676 individuals in June 1981 to 5,359 individuals in June of 1997.

I will examine spatial and temporal patterns of haul-out use by mother/pup pairs during the pupping period and potential environmental factors affecting use in Penobscot and Blue Hill Bays, Maine. I also will document breeding phenology and investigate the effects of tide, time of day and weather conditions on haul-out numbers in a smaller area of Penobscot Bay (Muscle Ridges) during the pupping period.

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

Aerial survey data from 1981 to 1997 of an increasing harbor seal (*Phoca vitulina concolor*) population in Penobscot and Blue Hill bays, Maine, were used to evaluate spatial and temporal patterns of use of pupping sites by

mother-pup pairs. Pupping sites refer to haul-out sites where pups were observed during surveys, and are assumed to be used consistently from birth to weaning. Sites with pups were spatially clustered to remove spatial autocorrelation, reduce temporal variability and provide biologically cohesive and independent sample units. Spatial, temporal and habitat analyses were completed for 2 spatial scales: individual sites and clusters of sites.

The temporal and spatial distribution of the population increase was examined for individual sites (individual site scale) and clusters of sites (cluster scale) to predict behavioral and environmental characteristics that may effect pupping site use at different population densities. On the site scale, Taylor Power Law (TPL) and Analysis of Variance (ANOVA) results revealed that numbers of pups at all sites increased at an equal rate providing no strong evidence for aggregation or repulsion behavior. However, increased use of new sites at high densities decreased spatial pattern, implying some degree of spatial limitation. Clusters of sites that were used during all survey years had the highest number of pups and increased steadily with the overall increase, while clusters used less frequently (< all survey years) maintained low numbers of pups and had higher temporal variability.

Logistic and multiple regression were used to relate frequency of pupping site use and numbers of pups per site and cluster to physical characteristics of sites. Initial site selection was for clusters of sites with a high availability of haul-out space, access to close alternative haul-outs, and seclusion from humans (significant variables ( $\alpha = 0.05$ ): area of intertidal zone, number of sites in a cluster, and minimum distance to a site  $\geq 2000$  ha). Individual site use, however, was poorly related to physical site characteristics, and is likely more dependent on unmeasured dynamic characteristics such as wind, direction, surf, tidal phase, human use patterns, harbor seal behavior, and food availability. Physical characteristics of sites are poor to moderate indicators of pup production and distribution on the individual site and cluster scales, respectively.

Spatial autocorrelation in pup counts was incorporated into multiple regression models using trend surface analyses. Spatial autocorrelation accounted for a moderate amount of variation in pup counts ( $r^2 \leq 0.35$ ) on both the individual site and cluster scales. On the individual site scale, this likely represents species aggregation (patchy spatial pattern), while on the cluster scale it likely represents a larger scale spatial gradient across the study area resulting from an unmeasured environmental gradient in resources.

## FACTORS AFFECTING NESTING SUCCESS OF THE EASTERN WILD TURKEY IN CONNECTICUT: NEST ATTENTIVENESS, VEGETATIVE COVER, AND LANDSCAPE CHARACTERISTICS

*Investigator:* S. M. Spohr

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

*Cooperators/  
Project:* National Wild Turkey Federation - Connecticut Chapter  
Wildlife Forever

*Support:* University of Maine - Department of Wildlife Ecology  
Connecticut Department of Environmental Protection - Wildlife Division

*Objectives:*

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

## turkey nests in eastern Connecticut.

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

*PROJECT STATUS:* Fifty-nine wild turkey hens were captured and equipped with radio transmitters in the winters of 1996 and 1997. Hens were monitored daily during the reproductive season to determine timing of incubation and to quantify and identify sources of mortality. A Rustrak recorder was set up near 16 nests to monitor hen activity and attentiveness to her nest. After hatching or abandonment, 48 nests were examined to determine clutch size and hatching success. Vegetative cover was measured in a 10-meter radius around each nest to determine habitat differences between successful and unsuccessful nests. Landscape characteristics (e.g., edge, developed land, agricultural land, patch density) were quantified at several scales using vector-based geographic information systems (ArcInfo and MapInfo) to determine differences between successful and predated nests.

*FUTURE PLANS:* Field work and analysis are complete. Thesis completion is anticipated in November 2001.

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

<i>Investigator:</i>	S. C. Billig
<i>Advisors:</i>	F. A. Servello, Chairperson D. J. Harrison W. E. Glanz J. M. Hagan
<i>Cooperators/ Project Support:</i>	Manomet Center for Conservation Sciences College of Natural Sciences, Forestry, and Agriculture - Department of Wildlife Ecology Plum Creek Timber Company
<i>Objectives:</i>	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 was 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).

*FUTURE PLANS:* Data analyses are completed and thesis writing are in progress. Thesis completion is scheduled for February 2002.

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

*Investigator:* J. A. Homyack

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

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

*Objectives:*

- 1) Quantify and compare overstory, understory, coarse woody debris (CWD), and vertical and horizontal structure between herbicide treated clearcuts, with and without subsequent 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 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. Precommercial thinning (PCT) is a silvicultural technique that decreases stem density and may reduce densities of hare relative to unthinned, regenerating stands. Insufficient information exists on the influence of thinning on habitat of snowshoe hare, small mammals, and other potential prey species for lynx and other forest-dwelling carnivores. Thus, we are currently investigating the temporal effects of PCT on snowshoe hare and small mammals in the industrial forests of northern Maine.

*PROJECT STATUS:* We established 24 small mammal grids on stands treated with PCT from four age classes, zero years since PCT (n=6), five years since PCT (n=6), 10 years since PCT (n=6), and 15 years since PCT (n=6). Thirteen small mammal grids were established on stands with similar site histories, but without subsequent PCT. We trapped mice, voles and shrews on all 37 grids during summer 2000 and summer 2001. Trapping resulted in captures of 343 individual mice and voles in 2000 and 597 mice and voles in 2001. We completed microhabitat analysis of all 37 study areas.

We established 1.6 km of snowshoe hare pellet transect in each of 30 stands for a total of 48 km of transect. A total of 2,520 pellet plots were distributed among 30 stands (n=84). Pellets were cleared during fall of 2000, counted and cleared during May-June 2001, and counted and cleared during September, 2001 as an index to densities during leaf-off and leaf-on seasons. We live-trapped 128 individual snowshoe hares on a subset of stands May-June 2001. We completed stand-level habitat analysis on 7 study areas.

*FUTURE PLANS:* We will compare hare densities, small mammal densities, and structural characteristics of herbicided stands with and without PCT across a temporal gradient. A third field season will occur during spring and summer 2002. We will count hare pellets during May-June 2002 as a second index to winter densities of hare. Further, we will live-trap four additional study areas to calibrate the relationship between pellet densities and hare densities. We will complete stand-level habitat analysis on the remaining 23 stands. Analysis of data will begin in fall 2001 and is expected to continue through 2002.

## INTERACTIONS BETWEEN HARBOR SEALS AND FINFISH AQUACULTURE IN MAINE

*Investigator:* M. Lucas

*Advisors:* J. R. Gilbert, Chairperson  
F. A. Servello  
J. R. Moring

*Cooperators/  
Project  
Support:* National Marine Fisheries Service  
University of Maine 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; and
- 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 predation 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:* Additional funding support is being sought. University and Federal permits are pending.

*FUTURE PLANS:* The proposed research is anticipated to include two field seasons beginning in January of 2001. Data are being collected between the months of January-April 2001 and January-April 2002. Based on conversations with salmon growers and other industry members in Maine, winter is when seal predation is most prevalent at finfish aquaculture facilities. Data analysis and writing of the thesis will be conducted following the field season of 2002.

## 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, Chairperson  
W. E. Glanz  
F. A. Servello  
S. K. Todd

*Cooperators/  
Project  
Support:* College of the Atlantic- Allied Whale  
University of Maine

*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, and
- 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:* Field work was completed in August 2001.

*FUTURE PLANS:* The thesis will be written, presented, and defended by January 2002.

## CONSERVATION GENETICS OF THE PENOBSCOT MEADOW VOLE

*Investigator:* J. M. Lowry

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

*Cooperators/* University of Maine - Department of Wildlife Ecology and  
*Project* Association of Graduate Students  
*Support:* Maine Department of Inland Fisheries & Wildlife  
 Maine Outdoor Heritage Fund  
 Penobscot County Conservation Association

*Objectives:*

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

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

*PROJECT STATUS:* Morphological measurements have been done on all museum specimens of island subspecies from the Smithsonian National Museum of Natural History, American Museum of Natural History, Museum of Comparative Zoology at Harvard and the Canadian Museum of Nature. At least 20 specimens have been collected from each extant island population (Islesboro, North Haven, Isle au Haut) and three mainland populations (Rockport, Northport, Orono). Study skins have been prepared for each individual and skeletal material will be measured and compared to the museum specimens. Genetic data collection of nuclear microsatellite loci and mitochondrial DNA sequences is near completion.

*FUTURE PLANS:* Statistical analyses of morphological and genetic data from extant populations will be completed. An MS thesis will be written and defended by May 2002.

---

## CONSERVATION GENETICS OF WOOD TURTLES (*Clemmys insculpta*)

*Investigator:* J. L. Murray

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

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

*Objectives:*

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

*SCOPE:* Concern has been expressed recently about the conservation of wood turtles (*Clemmys insculpta*), because populations throughout their range in eastern North America are believed to be declining due to habitat loss and illegal collection for the pet trade. In 1993, the wood turtle was added to the CITES II list. In 1995, the U. S. Fish and Wildlife Service was petitioned by RESTORE the Northwoods to list the wood turtle as Threatened on the federal endangered species list. The Maine Department of Inland Fisheries & Wildlife (MDIFW) opposed the petition, because little information was available from which to assess the status of wood turtles in Maine. Because of range-wide declines and concern for the future of the species, MDIFW listed the wood turtle as a species of Special Concern in 1997. Wood turtle habitat is believed to be abundant in Maine, however illegal collecting for the pet trade may pose a significant threat. Since the 1995 petition to list wood turtles, prices in the pet trade have risen considerably. In response to this problem, Maine and other states have adopted laws prohibiting the commercial collection of turtles, however, thousands of wood turtles are still entering the pet trade annually.

This study is an assessment of genetic variation in the wood turtle at two spatial scales. DNA analysis will be used to study phylogeographic variation among wood turtle populations throughout their range in North America, as well as among river drainages within the State of Maine. These data can assist federal and state wildlife law enforcement officials in tracing the origin of animals entering the pet trade. As part of a survey of wood turtle populations in Maine, small blood samples have been taken from individuals in each population for DNA analysis. In addition, blood samples have been collected from wood turtles in MA, WI, MI, PA, MN, WV, Quebec and Ontario and plans are to increase this collection to include NY and VA. These data will provide the first survey of wood turtle populations in Maine, assess dispersal (i.e. levels of genetic differentiation and gene flow among populations, and establish genetic markers to assess rangewide genetic identity and assist in law enforcement issues.

*PROJECT STATUS:* The field survey is complete, with 99 wood turtles sampled throughout Maine. Sampling for genetic analysis focused on four river drainages in different regions of the state: the Androscoggin, Kennebec, Downeast coastal and Aroostook. Blood or skin samples were collected from each turtle and DNA has been extracted from them. Allelic variation at four microsatellite loci has been characterized for all individuals. Ninety wood turtles have been sampled across the geographic range. DNA has been extracted from these samples and genetic analyses will be done in the next year.

*FUTURE PLANS:* Complete laboratory analysis of genetic markers on all samples and analyze the data.

---

## EFFECTS OF HABITAT CHARACTERISTICS AND NESTING BEHAVIOR ON NEST PREDATION OF BLACK TERNS

*Investigators:* S. B. Kearney

*Advisors:* F. A. Servello, Chairperson  
 D. J. Harrison  
 R. Holberton  
 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

Objectives: 1) Determine effects of habitat characteristics and nesting behavior on nest predation.  
2) Determine the disturbance patterns in black tern colonies during the incubation period.  
3) Identify potential predators.  
4) Determine if predation limits chick survival.

*SCOPE:* Nest (egg) predation is commonly reported for black terns, but the factors influencing predation are poorly understood. In Maine, water levels, nest location in wetlands, and nest predation may be interrelated, which has important implications for developing successful management strategies. Nest data from 2 years of field work in 2001-2002 will be combined with 5 previous years of nest surveys in a multivariate analysis of habitat and tern behavior variables that may influence nest predation rates. Habitat and nesting behavior variables will be measured in the field and using aerial photography and GIS. Videography and data loggers will be used to monitor disturbance of colonies and predator activity.

Based on previous research, food resources and provisioning to chicks appears to be excellent in Maine colonies, which suggests that predation may be the primary cause of observed low chick survival. Predator enclosures and chick growth measurements will be used to evaluate factors influencing chick survival.

*PROJECT STATUS:* The first year of field work have been completed. In 2001, nest success and predation losses were documented and GPS and habitat measurements were made for approximately 100 nests in 6 black tern breeding colonies. Nesting terns were monitored in 4 colonies by video-taping and with temperature monitors at nests. A total of 16 predator enclosures were used at 2 colonies to compare fledging rates for unenclosed clusters of nests.

*FUTURE PLANS:* A second year of field work will be conducted in 2002.

## EFFECTS OF ARTIFICIAL CANOPY GAPS AND DOWNED WOODY MATERIAL ON AMPHIBIANS IN THE ACADIAN FOREST OF MAINE

*Investigator:* C. A. Strojny

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

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

Objectives: 1) To study amphibian abundance and attributes within and between natural and artificial canopy gaps.  
2) To study how downed woody material characteristics (size and decay class) affect redback salamander fitness and site selection.  
3) To study the interactions between redback salamanders and insect communities with and without the presence of downed woody material.

*SCOPE:* The forests of Maine are valued both in terms of biodiversity and lumber. A recommended method to manage for both biodiversity and lumber is to mimic natural disturbance. In the Penobscot Experimental Forest north of Bradley, Maine, artificial canopy gaps have been created as part of a long-term research project to better understand the relationships between canopy removal and biodiversity. This project is interdisciplinary, focusing on canopy gap influences on vegetation, insects, and amphibians. Amphibians are often selected to evaluate changes in an environment due to their sensitivity to disturbance. One aspect of the project will be to evaluate effects of partial canopy removal on terrestrial amphibian abundance. Another aspect of the project is to augment our understanding of the role of redback salamanders in forest system processes. Redback salamanders contribute to a large portion of vertebrate biomass in northeastern mixed forest systems. Exploration of the role they have in predation of invertebrates, and the association they have with downed woody material will further elucidate forest system processes.

*PROJECT STATUS:* Natural gaps (n=23) and artificial gaps (n=44) have been identified in nine 10-ha research areas in the Penobscot Experimental Forest. Terrestrial amphibians will be captured using live pitfall traps with drift fences, and then marked with fluorescent elastomer tags. Traps will be monitored from spring until fall of 2002 and 2003. A pilot study was conducted fall of 2001 in three of the research areas. The results will contribute to the development of the sample design.

*FUTURE PLANS:* Over winter of 2001-2002, we will explore methods to meet the second and third objectives of this project.

---

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

- |  |   |
|--|---|
| <i>Investigators:</i>                    | C.S. Loftin<br>R. Jung<br>R. Chalmers (MS student)<br>M. Bank (PhD student)   |
| <i>Cooperators/<br/>Project Support:</i> | U. S. Geological Survey – Biological Resources Division –<br>Patuxent Wildlife Research Center<br>Department of Wildlife Ecology, University of Maine<br>National Park Service, Acadia National Park<br>Maine Cooperative Fish and Wildlife Research Unit   |
| <i>Objectives:</i>                       | <ol style="list-style-type: none"> <li>1) Develop species-habitat models of selected amphibian species in Acadia National Park at various spatial scales</li> <li>2) Identify environmental correlates related to selected amphibian species occurrence and population status in ANP palustrine and riparian wetlands</li> <li>3) Determine the relationship between counts of stream-dwelling salamanders and estimates of population sizes</li> <li>4) Evaluate the relationship between mercury contamination and population performance in two-lined salamanders (<i>Eurycea bislineata</i>) along a spatial and temporal gradient</li> </ol> |

*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. How representative these surveys are of the populations they are intended to monitor is unknown, however. Therefore, we propose to also determine how representative salamander monitoring surveys are of salamander populations in sampled streams. We will use several sampling methods and assess raw salamander counts in relation to estimated population sizes based on removal sampling. 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 also 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. A final 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 salamanders has declined 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 both within and potentially outside of the Park, and develop predictive models of their potential occurrence in the Park based on the documented local- and landscape-scale habitat associations.

*PROJECT STATUS:* During summer 2001, initial stream surveys were conducted to document two-lined salamander occurrence and habitat use. Stream characterizations and searches for salamanders were conducted in 14 streams; not all streams in ANP contained two-lined salamanders. Samples of larval salamanders were collected for analysis of their mercury content. Salamanders collected from burned watersheds contained less mercury than those from the unburned areas. Sample collection will continue during summer 2002 to examine spatial and temporal trends. Surveys for four-toed salamanders were initiated in mid-summer. More than 50 salamanders were located, and several nests were found. Surveys will continue in ANP next year, and may also include wetlands at Moosehorn National Wildlife Refuge. Collection site characteristics will be recorded for use in development of models predicting four-toed salamander presence.

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

*Investigators:*

J. A. Hepinstall  
D. J. Harrison

*Cooperators/  
Project Support:*

University of Maine, Department of Wildlife Ecology  
Maine Department of Inland Fisheries and Wildlife  
Maine Outdoor Heritage Fund  
Maine Chapter of The Nature Conservancy  
Cooperative Forestry Research Unit, University of Maine

*Objectives:*

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

habitat requirements of other forest dependent vertebrates with smaller area requirements than marten.

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

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

We compared five different possible groupings of vegetation types to determine which grouping was best at differentiating between occupied and unoccupied areas using the Kolmogorov-Smirnov test. To determine if marten are responding to landscape configuration, FRAGSTATS software was used to calculate landscape metrics. Eight metrics have been included in our logistic regression models. Fifteen models were selected *a priori* using expert knowledge. We used observed marten home ranges (n = 124 for our model build data set, n = 126 for our model test data set) and simulated unoccupied home ranges (n = 98 for our build data set and n = 41 for our test data set). Models were developed using logistic regression and evaluated using standard measures. We have been able to predict the probability of marten occupancy in potential home range-sized landscapes of 2-5 km<sup>2</sup> with 70-100% accuracy.

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

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

---

## FACTORS AFFECTING HABITAT SELECTION AND POPULATION PERFORMANCE OF AMERICAN MARTEN (*MARTES AMERICANA ATRATA*) IN NEWFOUNDLAND

- Investigator:* B. J. Hearn
- Advisors:* D. J. Harrison (Chairperson)  
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 2 studies 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 my 2 studies 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 focussed 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:* Between June 1995 and August 2000, 168 marten were captured and individually marked; 75 in the PMSA and another 93 on the RIL study site. One hundred and twenty three adult marten provided data on survival and cause-specific mortality and we recorded 36 mortalities of adult marten from various causes. Approximately, 4,500 telemetry locations were recorded for these 168 marten on which to base home range and habitat selection analyses. Field work was completed in August 2000.

*FUTURE PLANS:* Data analysis will begin in January 2002. Initial efforts will involve final screening of all radio telemetry locations, calculation of seasonal and annual home ranges, and preparation of year-specific forest inventory coverages for GIS analysis. Data analysis and thesis writing will be ongoing in 2002.

## AN ANNOTATED BIBLIOGRAPHY OF HISTORIC REFERENCES TO SELECTED MAINE WILDLIFE, 1614 – 1930

*Investigator:* C. L. Hoving

*Advisors:* W. B. Krohn  
R. S. Palmer

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

*Objectives:*

- 1) Document references to the wolf (*Canis lupus*), Canada lynx (*Lynx canadensis*), eastern panther (*Felis concolor*), wolverine (*Gulo gulo*), and woodland caribou (*Rangifer tarandus*) in Maine from 1624 through 1930. Early references to white-tailed deer (*Odocoileus virginianus*) and moose (*Alces alces*) were included as encountered.
- 2) Create an annotated bibliography of references to the above species in both paper and computer database formats.
- 3) Map locations where woodland caribou were observed or harvested to assess the patterns of extirpation and potentially assess historical habitat associations with persistent landscape features, such as bogs and high elevation tundra.

*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:* We currently have in a computerized database 551 references to woodland caribou (397

references), wolves (120 references), Canada lynx (116 references), eastern panther (74 references), and wolverine (35 references). Of the 397 references to caribou, 135 included enough information to be mapped in a GIS. The number of animals observed varied, and the total number of animals observed and mapped was 1,870. Short biographical sketches of 18 important observers, such as John James Audubon and George Bird Grinnell, have also been completed.

*FUTURE PLANS:* By January 2002, we plan to complete the bibliography and analyze the caribou locations with reference to selected, persistent features of the landscape.

---

## 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, Chairperson

*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 opportunistically 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 (63,620 acres PCT 1997-99), 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, but with overstory and understory features related to protection from predation, or coarse woody debris associated with denning sites. 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:* The first winter field season is scheduled for winter 2001-2002.

*FUTURE PLANS:* Field work will be conducted during winters 2001-2002 and 2002-2003, and a final report is scheduled to be completed by 2004.

---

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

SCIENTIFIC PUBLICATIONS

- ALLEN, A. P., and R. J. O'CONNOR. 2000. Interactive effects of land use and other factors on regional bird distributions. Journal of Biogeography, 17:889-900.
- BISSONETTE, J. A., C. S. LOFTIN, D. M. LESLIE, JR., L.A. NORDSTORM, and W. J. FLEMING. 2000. The Cooperative Research Unit program and wildlife education: historic development, future challenges. Wildlife Society Bulletin, 28:534-541.
- ELIAS, S. P., J. D. FRASER, and P. A. BUCKLEY. 2000. Piping plover foraging ecology on New York barrier islands. Journal of Wildlife Management, 64:346-354.
- HIXON, M. A., R. D. BOERSMA, M. L. HUNTER, JR., F. MICHELI, E. A. NORSE, H. P. POSSINGHAM, and P. V. R. SNELGROVE. 2001. Ocean at risk: research priorities in marine conservation biology. Pages 125-154 in M. E. Soule and G. H. Orians, eds. Conservation Biology: Research Priorities for the Next Decade. Island Press, Washington, DC.
- JOHNSON, C. M., and W. B. KROHN. 2001. The importance of survey timing in monitoring seabird populations. Colonial Waterbirds, 24(1):22-33.
- JOYAL, L. A., M. MCCOLLOUGH, and M. L. HUNTER, JR. 2000. Population structure and reproductive ecology of Blanding's turtle (*Emydoidea blandingii*) in Maine, near the northeastern edge of its range. Chelonian Conservation and Biology, 3:580-588.
- LOFTIN, C. S., S. B. AICHER, and W. M. KITCHENS. 2000. Effects of the Suwannee River sill on the hydrology of Okefenokee Swamp: Application of research results in the environmental assessment procedure. Pages 102-110 in S. F. McCool, D. N. Cole, W. T. Borrie, and J. O'Loughlin, eds., Proceedings of the 1999 National Wilderness Research Conference, USDA Forest Service, Ogden, UT. OMRS-P-15-Vol 3.
- LOFTIN, C. S., N. ANSAY, and W. M. KITCHENS. 2001. Development and application of a spatial hydrology model of Okefenokee Swamp, Georgia. Journal of the American Water Resources Association, 37(4):935-956.
- LONGCORE, J., D. MCAULEY, G. HEPP, and J. M. RHYMER. 2000. American Black Duck. In The Birds of North America (A. Poole, ed.). Philadelphia : The Academy of Natural Sciences; Washington, DC; The American Ornithologists' Union. 97 pp.
- MCCRACKEN, K., and M. L. HUNTER. 2001. Spatial and temporal patterns of seed predation on three tree species in an oak-pine forest. Ecography, 24:309-317.
- MONTI, L., M. L. HUNTER, JR., and J. WITHAM. 2000. An evaluation of the artificial cover object (ACO) method for monitoring populations of the redback salamander *Plethodon cinereus*. Journal of Herpetology, 34:624-629.
- MORING, J. R. 1999. (issued in 2001). Cruises of the *Albatross* off San Diego and other parts of southern California, 1889-1916. Marine Fisheries Review, 61 (4):22-30.
- MORING, J. R. 2001. Appearance and possible homing of two species of sculpins in Maine tidepools. Northeastern Naturalist, 8(2): 207-218.

- NOSS, R., and M. L. HUNTER. 2001. From assemblage to community. Conservation Biology, 15:1201-1202.
- O'CONNELL, A. F., JR., F. A. SERVELLO, J. HIGGINS, and W. A. HALTEMAN. 2000. Status and habitat relationships of northern flying squirrels on Mount Desert Island, Maine. Northeastern Naturalist, 8:127-136.
- O'CONNOR, R. J., R. B. OWEN, and J. RHYMER. 2000. Best practices in endangered species recovery planning: lessons for the conservation of Maine's Atlantic salmon. Maine Policy Review, 9(2):72-91.
- PAYER, D.C., and D.J. HARRISON. 2000. Structural differences between forests regenerating following spruce budworm infestation and clearcut harvesting: implications for American marten. Canadian Journal of Forest Research, 30:1965-1972.
- RHYMER, J. M. 2001. Evolution and conservation of Hawaiian anatids. In Symposium on the status, ecology and conservation of the Hawaiian avifauna. Studies in Avian Biology, 22: 61-67.
- SERVELLO, F. A. 2000. Population research priorities for Black Terns developed from modeling analyses. Waterbirds, 23:442-449.
- UDEVITZ, M. S., J. R. GILBERT, and G. A. FEDOSEEV. 2001. Comparison of methods used to estimate numbers of walrus on sea ice. Marine Mammal Science, 17(3): 601-616.

#### TECHNICAL AND SEMI-TECHNICAL PUBLICATIONS

- BANK, M. S., and A. F. O'CONNELL, JR. 2000. Stalking salamanders in Acadia National Park. Natural New England, 1(4): 8-9.
- BANK, M. S. 2001. Review of Jaguar: one man's struggle to establish the world's first jaguar preserve by Alan Rabinowitz. Journal of Wildlife Management, 65(2): 369-370.
- BANK, M. S., T. A. HAINES, and C. S. LOFTIN. 2001. Preliminary estimates of habitat use and mercury content of two-lined salamanders in Acadia National Park, Maine. Abstract, Maine Water Conference, May 3, 2001, Augusta, ME.
- FULLER, A.K., and D.J. HARRISON. 2000. Partial harvesting guidelines for maintenance of marten and their primary prey. CFRU RN 00-03, Research Note, Maine Cooperative Forestry Research Unit, University of Maine. 2 pp.
- GILBERT, J. R. 2001. Seals of the Gulf of Maine. Gulf of Maine News, (Spring 2001): 1-5.
- HEPINSTALL, J.A., and D.J. HARRISON. 2000. Marten as a tool for landscape-scale habitat planning in northern Maine. Pages 39-40 in Cooperative Forestry Research Unit 2000 Annual Report, Maine Agricultural and Forest Experiment Station Miscellaneous Report 424, University of Maine, Orono.
- HOMYACK, J., D.J. HARRISON, and W.B. KROHN. Effect of precommercial thinning on selected wildlife species with special emphasis on snowshoe hare. Pages 41-43 in Cooperative Forestry Research Unit 2000 Annual Report, Maine Agricultural and Forest Experiment Station, Miscellaneous Report 424, University of Maine, Orono.
- HOVING, C.L. 2001. Historical occurrence and habitat ecology of Canada lynx in eastern North America. Thesis, University of Maine, Orono. 200pp. (This document, put into digital form, served as the final contract report to U.S. Fish and Wildlife Service, Maine Department of Inland Fisheries and Wildlife, and National Council for Air and Stream Improvement).
- KROHN, W. B., and J. R. MORING (editors and compilers). 2000 Unit Report to Cooperators. Maine Cooperative Fish and Wildlife Research Unit, University of Maine, Orono, ME. 50 pp.

- LOFTIN, C. S., M. S. BANK, J. HAGAN, and D. SIEGAL. 2000. Wildlife use of forested riparian areas in New England. Abstract for poster presented at the University of Maine Cooperative Forestry Research Unit *Forestry & the Riparian Zone Conference*, October 26, 2000, Orono, ME.
- LOFTIN, C. S., M. S. BANK, J. HAGAN, and D. SIEGAL. 2001. Literature synthesis of the effects of forest management activities on riparian and in-stream biota of New England. University of Maine Cooperative Forestry Research Unit Research Report 01-01 and Maine Agricultural and Forest Experiment Station Miscellaneous Report 425. 78 pp.
- LOFTIN, C. S., and M. S. BANK. 2001. Literature synthesis of the effects of forest management activities on riparian biota of Northeastern North America. CFRU Research Note 01-01:1-4
- MORING, J. R., B. C. LÉ, and J. STONE. 2001. Fish resources of Acadia National Park, Mount Desert Island, ME. Final Report to the National Park Service, Acadia National Park, Bar Harbor, Maine. 92 pp., plus appendices.
- O'CONNOR, R. J. 2000. Letter: "Why Ecology lags behind Biology." *The Scientist* 14[20]: 35, October 16, 2000.
- O'CONNOR, R. J. Letter: "How New England wins research funds." *Boston Sunday Globe*, p. D6, August 19, 2001.
- SERVELLO, F. A., and A. T. GILBERT. 2001. Population and habitat ecology of Black Terns in Maine. Technical Report for the period 1997-2000 to the Maine Outdoor Heritage Fund and Maine Department of Inland Fisheries and Wildlife. 177 pp.

#### THESES AND DISSERTATIONS

- GILBERT, A. T. 2001. Foraging and habitat ecology of Black Terns in Maine. M. S. Thesis, University of Maine, Orono. 135 pp.
- GULDAGER, N. 2001. Effects of an increasing harbor seal population on changes in sites used for pupping. M. S. Thesis, University of Maine, Orono. 83 pp.
- HOVING, C. L. 2001. Historical occurrence and habitat ecology of Canada lynx (*Lynx canadensis*) in eastern North America. M. S. Thesis, University of Maine, Orono. 200 pp.
- MITTELHAUSER, G. H. 2000. The winter ecology of harlequin ducks in coastal Maine. M. S. Thesis, University of Maine, Orono. 131 pp.
- PURTELL, R. M. 2001. Exploring grassroots efforts to monitor wildlife. Master's project seminar, University of Maine, Orono.
- STAHLNECKER, III, J. F. 2000. Production of juvenile alewives (*Alosa pseudoharengus*) at two adult alewife stocking rates in two Maine lakes. M. S. Thesis, University of Maine, Orono. 73 pp.

#### PROFESSIONAL TALKS PRESENTED

- BANK, M. S., T. A. HAINES, and C. S. LOFTIN. "Preliminary estimates of habitat use and mercury content of two-lined salamanders in Acadia National Park, Maine." Presented at the Aquatic Research in Acadia Conference, College of the Atlantic, Bar Harbor, ME, March 26, 2001.

- BANK, M. S., T. A. HAINES, and C. S. LOFTIN. "Preliminary estimates of habitat use and mercury content of two-lined salamanders in Acadia National Park, Maine." Presented at the Maine Chapter of The Wildlife Society, Brewer, ME, April 19, 2001.
- BANK, M. S., T. A. HAINES, and C. S. LOFTIN. "Preliminary estimates of habitat use and mercury content of two-lined salamanders in Acadia National Park, Maine." Presented at the Maine Water Conference, Augusta, ME, May 3, 2001.
- BILLIG, S. C., and F. A. SERVELLO. "Evaluation of two forest management practices recommended for small mammals: buffer strips and retention of woody debris." Presented at the Meeting of the National Council for Air and Stream Improvement, Portsmouth, NH, October 3, 2000.
- BILLIG, S. C. "Research on forest structure-wildlife relationships in western Maine." Field tour for Cooperative Forestry Research Unit, University of Maine. Kibby Township, ME, October 3, 2000.
- BILLIG, S. C., and F. A. SERVELLO. "Evaluation of two forest management practices recommended for small mammals: buffer strips and retention of woody debris." Presented at 8<sup>th</sup> Annual Conference of the Wildlife Society, Reno, NV, September 28, 2001.
- CAMPBELL, S. P., S. L. THOMAS, S. E. HAYHURST, and R. PURTELL. "Scientists as educators: NSF graduate teaching fellows in k-12 education at the University of Maine." Poster presented at the 15<sup>th</sup> Annual meeting of the Society for Conservation Biology, University of Hawaii, Hilo, HI, July 29-August 1, 2001.
- CAMPBELL, S. P. "NSF Graduate teaching fellows in K-12 education at the University of Maine; a program overview." Presented at the 86<sup>th</sup> Annual Meeting of the Ecological Society of America Symposium – Graduate students conduct K-12 outreach: the NSF graduate teaching fellows in K-12 education program, Madison, WI, August 5-10, 2001.
- FULLER, A.K., and D.J. HARRISON. Influence of partial harvests on American marten habitat selection in Maine. Final contract seminar presented to Advisory Committee, Maine Cooperative Forestry Research Unit, Sugarloaf Mountain, ME, October 3, 2000.
- FULLER, A. K. "Effects of forest practices on snowshoe hares and small mammals." Presented at the Maine Cooperative Forestry Research Unit fall field tour, Moosehead Lake, ME, October 4, 2000.
- FULLER, A. K., and D. J. HARRISON. "Partial harvest guidelines for maintenance of marten in Maine." Lecture presented at the "Newfoundland Marten Endangered Species Recovery Team Meeting," St. John's, Newfoundland, January 12, 2001.
- GILBERT, A. T., and F. A. SERVELLO. "Food provisioning and growth of Black Tern chicks in Maine." Presented at the 24<sup>th</sup> Annual Meeting of the Waterbird Society, Plymouth, MA, November 2, 2000.
- HARRISON, D. J. "Distribution, extent and connectivity of potential habitat for wolves in Maine and eastern Canada." Poster presented at the "Carnivores 2000 Conference", Denver, CO, November 12-15, 2000.
- HARRISON, D. J., T. G. CHAPIN, and C. L. HOVING. "Influence of dispersal on social ecology of coyotes: do social pressures or prey size promote pack formation?" Presented at the "Carnivores 2000 Conference", Denver, CO, November 12-15, 2000.
- HARRISON, D. J., and D. C. PAYER. "Influences of trapping mortality on current distribution and population dynamics of marten: a biogeographical and empirical perspective." Workshop presented at the Newfoundland Marten Accidental Trapping and Snaring Workshop, St. John's, Newfoundland, January 12, 2001.

- HARRISON, D. J. "Extent and distribution of wolf habitat in eastern North America and niche characteristics of wolves versus eastern coyotes." Presented at the Wolf Symposium for invited government agencies, university personnel and non-governmental organizations, Burlington, VT, May 16, 2001.
- HARVEY, E. J., J. M. HOEKSTRA, R. J. O'CONNOR, and W. F. FAGAN. "The role of recovery plan revisions in managing endangered species." Conference at the Annual Meeting of the Society for Conservation Biology, Hilo, HI, July 31, 2001.
- HENRICHON, T. Y., and C. S. LOFTIN. "Using RGB-NDVI techniques to examine dynamics of Savannah River marsh vegetation." Poster presented at the Annual Meeting of the Society of Wetland Scientists, Chicago, IL, May 27 – June 1, 2000.
- HEPINSTALL, J. A., D. J. HARRISON, D. C. PAYER, A. K. FULLER, and D. D. KATNIK. "Using marten as an umbrella species for forest management." Presented at the 37<sup>th</sup> Annual North American Moose Conference and Workshop, Sugarloaf, ME, May 14, 2001.
- HEPINSTALL, J. A., D. J. HARRISON, D. C. PAYER, and A. K. FULLER. "Predicting the occurrences of American marten in harvested landscapes." Presented at the Annual Meeting of the Wildlife Society, Reno, NV, September 25-29, 2001.
- HOMYACK, J. A. "Preliminary results of effects of pre-commercial thinning on snowshoe hares and small mammals." Oral presentation presented at Maine Cooperative Forestry Research Unit fall field tour, Moosehead Lake, ME, October 4, 2000.
- HOMYACK, J. A. "Effects of precommercial thinning on snowshoe hares and small mammals in northern Maine." Oral presentation at the 2001 Northeast Wildlife Graduate Conference, University of New Hampshire, Durham, NH, March 2-4, 2001.
- HOVING, C. L., R. A. JOSEPH, and W. B. KROHN. "Historical distribution and reproduction of Canada lynx in Maine." Presented at the 57<sup>th</sup> Northeast Fish and Wildlife Conference, Saratoga Springs, NY, April 22-26, 2001.
- HOVING, C. L., D. J. HARRISON, W. K. KROHN, W. J. JAKUBAS, R. A. JOSEPH, R. LAFOND, and M. O'BRIEN. "A probability model of Canada lynx occurrence in eastern North America." Poster presented at the 57<sup>th</sup> Northeast Fish and Wildlife Conference, Saratoga Springs, NY, April 22-26, 2001.
- HOVING, C. L., D. J. HARRISON, and W. K. KROHN. "Multi-scale habitat relations of Canada lynx in eastern North America." Presented at the 2001 Meeting of the Northeast Fur Technical Committee, Providence, RI, September 13, 2001.
- HOVING, C. L., D. J. HARRISON, and W. B. KROHN. "Habitat relationships of Canada lynx in eastern North America." Presented at the Annual Meeting of the Wildlife Society, Reno, NV, September 24, 2001.
- HOVING, C. L., D. J. HARRISON, W. K. KROHN, W. J. JAKUBAS, R. A. JOSEPH, R. LAFOND, and M. O'BRIEN. "Canada lynx habitat associations in eastern North America." Presented at The Wildlife Society 8<sup>th</sup> Annual Conference, Reno, NV, September 27, 2001.
- HUNTER, M.L., JR., J. WITHAM, and A. WHITE. "Designing coarse-filter methodologies: vegetation vs. soils as predictors of plant species composition." Presented at the Society for Conservation Biology Conference, Hilo, HI, August 1, 2001.
- KEARNEY, S. B., and F. A. SERVELLO. "Black Tern productivity and predation studies." Presented at the Meeting of the Gulf of Maine Seabird Working Group, Bremen, ME, August 6, 2001.

- KROHN, W. B. "Proposed tests for determining factors affecting the distributions of fishers and martens." Presented at the 2001 Meeting of the Northeast Fur Technical Committee, Providence, RI, September 13, 2001.
- LOFTIN, C. S., M. S. BANK, J. HAGAN, and D. SIEGEL. "Wildlife use of forested riparian areas in New England." Poster presented at the University of Maine Cooperative Forestry Research Unit, Forestry & the Riparian Zone Conference, Orono, ME, October 26, 2000.
- LOFTIN, C. S., M. S. BANK, J. HAGAN, and D. SIEGEL. "Wildlife use of forested riparian areas in New England." Poster presented at the University of Maine Cooperative Forestry Research Unit, Forestry & the Riparian Zone Conference, Orono, ME, October 26, 2000.
- LOFTIN, C. S., M. S. BANK, J. HAGAN and D. SIEGEL "Literature synthesis of the effects of forest management activities on riparian and in-stream biota of New England." Final project report oral presentation to University of Maine Cooperative Forestry Research Unit, Orono, ME, January 24, 2001.
- LOFTIN, C. S., M. S. BANK, J. HAGAN and D. SIEGEL "Literature synthesis of the effects of forest management activities on riparian and in-stream biota of New England." Presented at the New England Society of American Foresters 81<sup>st</sup> Annual Winter Meeting, South Portland, ME, March 15, 2001.
- LOFTIN, C. S., M. S. BANK, and R. JUNG. "DOI Amphibian research an monitoring initiative: effect of landscape heterogeneity and environmental stressors on palustrine and lotic amphibian populations in Acadia National Park." Presentation at the Aquatic Research in Acadia Conference, College of the Atlantic, Bar Harbor, ME, March 26, 2001.
- LOFTIN C. S., and W. M. KITCHENS. "The hydrology of Okefenokee Swamp." Invited speaker at the Research in the Suwanee River Basin Conference, Live Oak, FL, April 11-12, 2001.
- LOFTIN, C. S., and M. S. BANK. "Literature synthesis of the effects of forest management activities on riparian and in-stream biota of New England." Poster presented at the Maine Water Conference, Augusta, ME, May 3, 2001.
- LOWRY, J., and J. M. RHYMER. "Conservation genetics of the Penobscot Meadow Vole. Presented at the Northeastern Wildlife Graduate Student Conference, University of New Hampshire, Durham, NH, March 4, 2001.
- MAGEEAN, D.M., J. G. BARTLETT, and R. J. O'CONNOR. "Environmental and legacy constraints to population growth in the desert South-West." Session on: Research on Population and Environment Relations in the United States. Annual Meeting of the Population Association of America, Washington, DC, March 29-31, 2001.
- MATTHEWS, S. "Carbon sequestration and afforestation; biodiversity consequences." Presented at the New England Society of American Foresters 81<sup>st</sup> Annual Winter Meeting, South Portland, ME, March 14-16, 2001.
- MATTHEWS, S. "Linking wildlife and econometric modeling of afforestation for carbon sequestration." Presented at the 2001 Northeast Wildlife Graduate Conference, University of New Hampshire, Durham, NH, March 2-4, 2001.
- MOORS, A. "Birds as indicators of lake quality in New England." International Symposium on the Urban Ecology of Birds and Mammals. Sponsored by GESELLSCHAFT fur WILDKOLOGIE and NATURSHUTZ, Neinover, Germany, November 11-12, 2000.
- MORING, J. R., and G. C. GARMAN. "A 19-year reassessment of a stream aquatic community following logging in the watershed." Presented at the 81<sup>st</sup> Annual Winter Meeting of the Society of American Foresters, New

England Chapter, South Portland, ME, March 15, 2001.

MORING, J. R. "Freshwater fishes of Acadia National Park." Presented at the Aquatic Research in Acadia Conference, Bar Harbor, ME, March 27, 2001.

MORING, J. R., B. C. LE, and J. STONE. "Historical changes in freshwater fish communities at Acadia National Park, Maine." Presented at the 57<sup>th</sup> Annual Northeast Fish and Wildlife Conference, Saratoga Springs, NY, April 25, 2001.

MORING, J. R. "Reassessment of a stream ecosystem 19 years after logging in the watershed." Presented to the meeting of the Fisheries Division, Maine Department of Inland Fisheries and Wildlife, Waterville, ME, May 1, 2001.

MORING, J. R. "Threats to the intertidal zone." Presented at the Nature and Environmental Writers – College and University Educators Conference on Rachel Carson, Boothbay Harbor, ME, June 15, 2001.

MORING, J. R., B. C. LE, and J. STONE. "Historical changes in freshwater fish communities at Acadia National Park, Maine." Presented at the Annual Meeting of the American Fisheries Society, Phoenix, AZ, August 23, 2001.

MORING, J. R. "Communities and ecosystems." Moderated a session at the Annual Meeting of the American Fisheries Society, Phoenix, AZ, August 23, 2001.

O'CONNOR, R. J. "Why ecology lags biology." Invited Departmental Seminar for the Department of Forestry and Natural Resources, Purdue University, West Lafayette, IN, January 30, 2001.

O'CONNOR, R. J. "Population limitation in birds: inland and mainland contracts." Conference presented at the Annual Meeting of the Society for Conservation Biology, Hilo, HI, July 31, 2001.

PURTELL, R. and M. L. HUNTER, JR. "Exploring grassroots efforts to monitor wildlife." Presented at the 8<sup>th</sup> Annual Conference of the Wildlife Society, Reno, NV, September 24-29, 2001.

PURTELL, R., S. P. CAMPBELL, and S. HAYHURST. "Scientists as educators: NSF Graduate Fellows in K-12 education at the University of Maine." Presented at the 8<sup>th</sup> Annual Conference of the Wildlife Society, Reno, NV, September 24-29, 2001.

SERVELO, F. A., and A. T. GILBERT. "Breeding productivity and site fidelity of black terns in Maine." Presented at the Waterbird Society 24<sup>th</sup> Annual Meeting, Plymouth, MA, November 2, 2000.

SERVELO, F. A. "Population ecology of Black Terns in Maine." Presented at the Department of Natural Resources Seminar Series, University of Rhode Island, Kingston, RI, November 17, 2000.

SERVELO, F. A. "Population and habitat research on Black Terns in Maine." Maine Department of Inland Fisheries and Wildlife staff meeting. Bangor, ME, April 19, 2001.

#### PUBLIC TALKS PRESENTED

BANK, M. S. "Distribution and habitat characteristics of guanaco mating areas in southern Chile: coping with a risky environment." Invited lecture at the University of Maine Student Chapter of the Wildlife Society Evening Seminar Series, April 26, 2001.

FULLER, A. K. "Use of radiotelemetry in wildlife research." Invited speaker at "Biology Day," John Bapst High

- School, Craig Brook National Fish Hatchery, Orland, ME, May 23, 2001.
- GILBERT, J. R. "Maine seals." Talk presented at the Maine Audubon's Wildlife Conference, Maine Audubon Society, Falmouth, ME, April 7, 2001.
- HARRISON, D.J. "Fragmentation thresholds for American marten: preliminary results." Presentation to Advisory Committee, Maine Cooperative Forestry Research Unit, Sugarloaf Mountain, Maine, October 3, 2000.
- HARRISON, D. J. "Wolf ecology, habitat potential in Maine and behavior of wolf-hybrids." Presentation to 7<sup>th</sup> grade science and literature classes at the Reeds Brook Middle School, Hampden, ME, November 8, 2000.
- HARRISON, D.J. "Landscape scale habitat requirements and fragmentation thresholds of marten." Lecture at workshop attended by Canada Parks scientists and invited advisors to address habitat needs of endangered marten in western Newfoundland. Gros Morne National Park, Newfoundland, January 9, 2001.
- HARRISON, D. J. "Marten and forestry: conflict or opportunity." Invited lecture presented at J. D. Irving, Limited's 2001 Science Forum, Fredericton, NB, April 3, 2001.
- HARRISON, D. J. "Forestry and forest carnivores: conflict or opportunity." Talk presented at the University of Maine, Department of Wildlife Ecology, Forestry Noontime Seminar Series, April 6, 2001.
- HARRISON, D.J. "An update of lynx and marten issues related to forest management." Presentation to Advisory Committee, Maine Cooperative Forestry Research Unit, Orono, ME, January 25, 2001.
- HARRISON, D. J. "Where can wolves live and are they already here?" Presented at a public forum on eastern wolf restoration, Burlington, VT, May 16, 2001.
- HENRICHON, T. Y. "Vegetation change in the Savannah National Wildlife Refuge." Invited lecture at the Maine Chapter of the Wildlife Society meeting at the Penobscot County Conservation Association, Bangor, ME, April 19, 2001.
- HOVING, C. L. "Historical occurrence and habitat ecology of Canada lynx in eastern North America." Talk presented at the Maine Audubon's Wildlife Conference, Maine Audubon Society, Falmouth, ME, April 7, 2001.
- HOVING, C.L. "Historical occurrence and habitat ecology of Canada lynx in eastern North America." Final thesis seminar presented to Department of Wildlife Ecology, University of Maine, April, 12, 2001.
- HOVING, C.L., D. J. HARRISON, and W. B. KROHN. "Habitat ecology of Canada lynx in eastern North America." Presented to the U. S. Fish and Wildlife Service's Regional Office, Hadley, MA, April 26, 2001.
- LOFTIN, C. S. "Applications of GIS management of public lands." Invited presentation to the Wildlife Habitat Relationships class, Department of Wildlife Ecology, University of Maine, Orono, ME, April 2 and 4, 2001.
- MCCLOSKEY, J. "Age and sex determination and nutritional ecology of wintering common snipe." Wildlife Ecology Departmental Seminar Series, Orono, ME, September 24, 2001.
- MORING, J. R. "Lewis and Clark and other early naturalists of the American West." Presented to the S<sup>3</sup> Undergraduate Science Club, University of Maine, Orono, ME, November 28, 2000.
- MORING, J. R. "Atlantic salmon: the past, present, and future." Presented to the monthly meeting of the Student Chapter of The Wildlife Society, University of Maine, Orono, ME, November 30, 2000.

- MORING, J. R., and M. T. CATFISH. "Fishes of Maine." Presented to the 3<sup>rd</sup> and 4<sup>th</sup> grade class, Stetson Elementary School, Stetson, ME, December 1, 2000.
- O'CONNOR, R. J. "Endangered Species Recovery Planning: results of the SCB/FWS project." Wildlife Ecology Departmental Seminar Series, University of Maine, Orono, ME, October 2, 2000.
- O'CONNOR, R. J. "Using classification and regression tree (CART) models in empirical and theoretical ecology." Department of Mathematics and Statistics "Got Math?" Seminar Series, University of Maine, Orono, ME, November 30, 2000.
- O'CONNOR, R. J. "Why Ecology Lags Biology." Talk presented at the University of Maine, Department of Wildlife Ecology, Forestry Noontime Seminar Series, Orono, ME February 16, 2001.
- O'CONNOR, R. J. "The geography of forest patch-size effects in warblers in the conterminous U.S." Invited lecture at the Department of Biology Seminar, University of New Brunswick, Fredericton, NB, March 16, 2001.
- PERKINS, D. W., and M. L. HUNTER, JR. "Riparian buffer widths and amphibian communities in western Maine: experimental and retrospective approaches." Maine Herpetological Society Newport, ME, April, 21, 2001.
- PERKINS, D. W., and M. L. HUNTER, JR. "Riparian buffer widths and amphibian communities in western Maine: experimental and retrospective approaches." Maine Forest Products Council Media Day, Kibby Township, ME, June 21, 2001.
- PERKINS, D. W. "Grassland Birds of Maine." Downeast Chapter of Maine Audubon Society, Southwest Harbor, ME, September 20, 2001.
- RUSTIGIAN, H. L. "Assessing the potential impacts of alternative landscape designs on amphibian population dynamics." Maine State Chapter of The Wildlife Society, Brewer, ME, April 19, 2001.
- RUSTIGIAN, H. L. "Assessing the potential impacts of alternative landscape designs on amphibian population dynamics." Department of Wildlife Ecology, University of Maine, Orono, ME, September 17, 2001.
- WITHAM, J. "Overview of Holt Research Forest." Paper presented at Maine Project Learning Tree/WILD Training, Winthrop, ME, October 14, 2000.

#### WORKSHOPS

- GALLAGHER, M. "Techniques in fish anesthesia and surgery for the researcher: a workshop for the fisheries professional." Organized and taught for 30 state, private, and university biologists, Orono, ME, November 11, 2000.
- GILBERT, J. R. Western Regional Workshop on USDA-CSREES Competitive Grants Programs, Denver, CO, October 6, 2000.
- GILBERT, J. R. Annual Meeting of Atlantic Scientific Review Group for Federal Research and Management of Marine Mammals, Lajas, Puerto Rico, November 13 – 16, 2000.
- GILBERT, J. R. Gulf of Maine Harbor Porpoise Take Reduction Team meeting, sponsored by NOAA Fisheries. Danvers, MA, December 12-14, 2000.
- HEARN, B. "Annual survival and mortality factors of American marten in Newfoundland." Workshop on

accidental trapping and snaring of endangered Newfoundland marten. St. John's, Newfoundland, Canada, January 11, 2001.

HUNTER, M. L., JR. "Strengthening Africa-U. S. linkages for Conservation Biology." Participated in a workshop, Nairobi, Kenya, September 10-13, 2001.

KROHN, W. B. "Cooperative lynx research at the Maine Cooperative Fish and Wildlife Research Unit and Department of Wildlife Ecology, University of Maine." Presentation to meeting of the Unit Program and U. S. Fish and Wildlife Service, Region 5, at 57<sup>th</sup> Northeast Fish and Wildlife Conference, Saratoga Springs, NY, April 22, 2001.

LUCAS, M. "Interactions between harbor seals and finfish aquaculture in Maine." Workshop presented at the University of New England, Maritime Aquarium, Norwalk, CT, July 24, 2001.

O'CONNOR, R. J. "Pre-plenary Pilot Census of Marine Life Workshop: censussing large pelagic vertebrates in the Gulf of Maine." Workshop presented at the New England Aquarium (Wood's Hole Oceanographic Institution), Boston, MA, March 20, 2001.

O'CONNOR, R. J. "Second Workshop on a Pilot Census of Marine Life in the Gulf of Maine." Workshop at Woods Hole Oceanographic Institute, Woods Hole, MA, May 9-10, 2001.

WITHAM, J. "Managing your woodlot for wildlife birds and small mammals." Workshop at the Maine Agricultural Trade Show, Augusta, ME, January 10, 2001.

WITHAM, J. "Effects of forest management on small mammals and birds." Workshop presented for a course "Working with your woodlot" sponsored by Maine Forest Service and S.W.O.A.M., Augusta, ME, March 14, 2001.

#### AWARDS, HONORS, AND APPOINTMENTS

GULLO, A. Received the 2001 Horace Bond Graduate Fisheries Scholarship from the Penobscot County Conservation Association.

HUNTER, M.L.,JR. Appointed by The Nature Conservancy to a panel that will review all TNC science programs, domestic and international.  
Assumed the office as President of the Society for Conservation Biology.

MORING, J. R. Appointed to the American Fisheries Society's Board of Professional Certification.

O'CONNOR, R. J. Received a 2001 John Simon Guggenheim Memorial Foundation Fellowship.

RHYMER, J. M. Elected as a voting member of the American Ornithologists' Union.