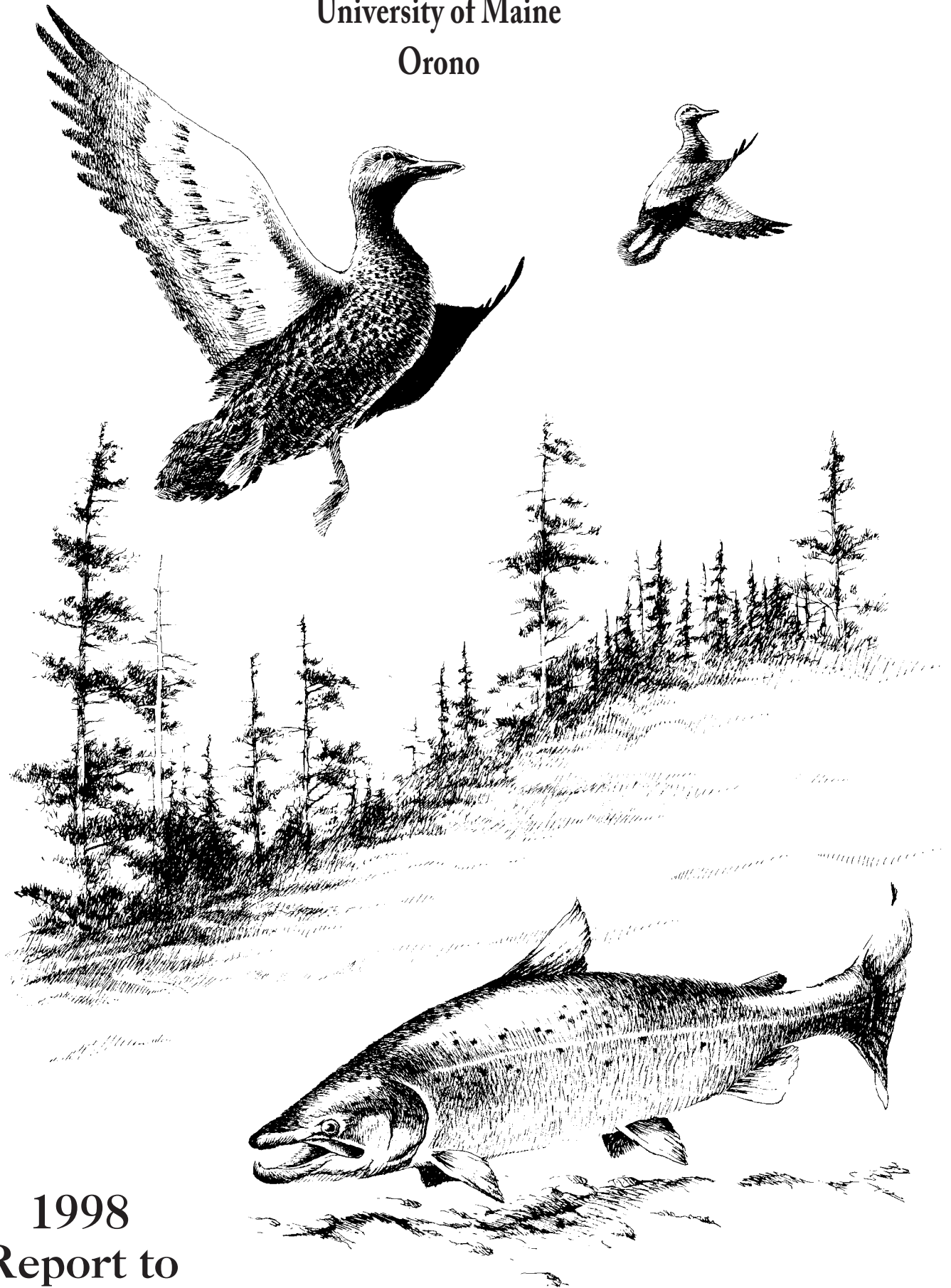


MAINE COOPERATIVE FISH AND WILDLIFE RESEARCH UNIT

University of Maine

Orono



1998
Report to
Cooperators

—Mark McCollough '86

MAINE COOPERATIVE FISH AND WILDLIFE RESEARCH UNIT

5755 Nutting Hall, Room 210*
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COOPERATORS

UNIVERSITY OF MAINE

MAINE DEPARTMENT OF INLAND FISHERIES AND WILDLIFE

BIOLOGICAL RESOURCES DIVISION, U.S. GEOLOGICAL SURVEY

WILDLIFE MANAGEMENT INSTITUTE

October 1997 - September 1998

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

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

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

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PERSONNEL AND COOPERATORS

COORDINATING COMMITTEE

Maine Department of Inland Fisheries and Wildlife
Lee Perry, Commissioner

University of Maine

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

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John R. Moring, Assistant Unit Leader for Fisheries, Professor of Zoology
Susan Anderson, Unit and USGS-LSC Administrative Assistant - Fisheries
Nora Ackley - Unit Administrative Assistant - Wildlife Ecology
Shirley Moulton, Secretary - Wildlife Ecology

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

James R. Gilbert, Chairperson, Department of Wildlife Ecology, College of Natural Sciences,
Forestry, and Agriculture, and Professor of Wildlife Ecology
T. Malcolm Shick, Chairperson, Department of Biological Sciences, College of Natural Sciences, and
Professor of Zoology
William E. Glanz, Associate Professor of Zoology and Cooperating Associate Professor of Wildlife
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Lee 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

Name	Degree Candidacy	Support
John G. Bartlett	Ph.D.	NBS
John R. Burgess	M.S.	NBS
Steven P. Campbell	Ph.D.	McIntire-Stennis
Bradley W. Compton	M.S.	U of M, MDIFW, McIntire-Stennis, USFWS
Lia R. Daniels	M.S.	MDMR
Danielle DiMauro	M.S.	McIntire-Stennis
Sarah E. Dooling	M.S.	McIntire-Stennis
Mustapha El Hamzaoui	Ph.D.	USAID/USDA
Richard T. Finlayson	M.S.	NBS, USFWS, EPA
Carol R. Foss	Ph.D.	USFS, USFWS, SEFP
Angela K. Fuller	M.S.	MDC
Merry Gallagher	M.S.	U of M, MDIFW
Andrew T. Gilbert	M.S.	Hatch
Anne D. Guerry	M.S.	U of M
Nikolina Guldager	M.S.	NMFS
Mitschka J. Hartley	Ph.D.	McIntire-Stennis
Brian J. Hearn	Ph.D.	Canadian Forest Service
Thomas A. Hoffman	M.S.	MDIFW
Christopher L. Hoving	M.S.	NCASI, USFWS, MDIFW, WCS
Catherine M. Johnson	Ph.D.	USGS BRD, U of M
Jon B. Lé	M.S.	NPS
Nathan G. Leaman	M.S.	MDMR
Angela C. Matz	Ph.D.	ANP
Craig R. McLaughlin	Ph.D.	Personal Funding

Laura M. Monti	M.S.	HWRF
Dawn L. Nelson	Ph.D.	HWRF
Stephanie L. Painton	M.S.	MOHF, MCFWRU
David C. Payer	Ph.D.	MDIFW, CFRU, U of M, NCASI
Anne M. Perillo	M.S.	USFWS, USFS, MDIFW
Regina M. Purtell	M.W.C.	Personal Funding
Teresa M. Sauer	Ph.D.	U of M
James W. Schneider	Ph.D.	McIntire-Stennis
Sandra M. Schaefer	M.S.	BRD/GAP, MCFWRU
Ashley M. Smith	M.S.	NBS
Shelley Spohr	M.S.	NWTF, WF, UM, CDEP
James Stahlnecker	M.S.	MDMR
Jennifer A. Stone	M.S.	NPS
Marcia L. B. Summers	M.S.	U of M
Hannah M. Webber	M.S.	NPS
Amy S. Williams	M.S.	NMFS, NBS
Heather L. Ziel	M.S.	U of M

DISSERTATIONS AND THESES COMPLETED THIS PERIOD

Student	Degree Candidacy	Support
Richard T. Finlayson	M.S.	NBS, USFWS, EPA
Merry Gallagher	M.S.	U of M, MDIFW
Catherine M. Johnson	Ph.D.	USGS BRD, U of M.
Craig R. McLaughlin	Ph.D.	Personal Funding
Angela C. Matz	Ph.D.	ANP
Laura M. Monti	M.S.	HWRF
Hannah M. Webber	M.S.	NPS

PERSONNEL NOTES

CATHY JOHNSON received her Ph.D. in Wildlife Ecology and she and **TIM JONES** are employed at the University of Minnesota's Natural Resources Research Institute in Duluth, Minnesota. **RANDY BOONE** completed his job as a Research Associate with the Maine CFWRU and is now working as a GIS specialist at the Natural Resource Ecology Laboratory, Colorado State University, Fort Collins. **ANGELA MATZ** received her Ph.D. in Wildlife Ecology and has been working at the Manomet Bird Observatory in Massachusetts. She will be starting a new job with the U.S. Fish and Wildlife Service in Fairbanks, Alaska in the spring. **LAURA MONTI** received her M.S. degree and is now working on her Ph.D. at the University of Maryland.

MERRY GALLAGHER received her M.S. degree in Zoology and is continuing on to work on her Ph.D. at the University of Maine. **HANNAH WEBBER** received her M.S. degree in Zoology and is currently working with Terry Haines on a contaminant assessment program. **RICHARD FINLAYSON** received his M.S. degree in Zoology and is doing research for Sawyer Environmental.

COLLABORATING AGENCIES AND ORGANIZATIONS

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
 Connecticut Department of Environmental Protection -
 Wildlife Division - CDW
 Cooper Ornithological Society - COS
 Holt Woodlands Research Foundation - HWRF
 James River Corporation - JRC
 Maine Association of Wetland Scientists - MAWS
 Maine Bureau of Public Lands - MBPL
 Maine Department of Conservation - MDC
 Maine Department of Environmental Protection - MDEP
 Maine Department of Inland Fisheries and Wildlife - MDIFW
 Maine 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
 National Council of the Paper Industry for Air and Stream Quality Improvement - NCASI
 National Science Foundation - NSF
 National Wild Turkey Federation -
 Connecticut Chapter - CC NWTF
 New Hampshire Fish & Game Department - NHFG
 New Hampshire Department of Resources and Economic Development -
 Division of Forests and Lands - NHDFL
 Penobscot Valley Conservation Association - PVCA
 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
 Cooperative Forestry Research Unit - CFRU
 Department of Forest Management - DFM
 Department of Wildlife Ecology - DWE
 Forest Ecosystem Research Program - FERP
 Maine Image Analysis Lab - MIAL
 McIntire-Stennis - MS
 Maine Agricultural and Forest Experiment Station - MAFES
 U.S. Department of Agriculture - USDA
 Forest Service - USFS
 U.S. Department of Commerce
 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
Lake Umbagog National Wildlife Refuge - LUNWR
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
Wildlife Forever - WF

ENDANGERED AND THREATENED SPECIES:

ORGANOCHLORINE CONTAMINANTS AND BALD EAGLES *Haliaeetus leucocephalus* IN MAINE: INVESTIGATIONS AT THREE ECOLOGICAL SCALES

Investigator: A. C. Matz

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

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

Objectives:

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

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

PROJECT STATUS: All requirements for the Ph.D. degree (in Wildlife Ecology) were completed in May 1998. The abstract follows:

Maine bald eagles have relatively high organochlorine contaminant concentrations, in spite of few industrial sources within the state. I investigated possible causes or sources at the ecosystem level, and effects on the population and individuals. Biomagnification was investigated by comparing trophic status and contaminant concentrations. There were no significant differences between nestling whole blood DDE concentrations from freshwater and marine habitats (which are trophically elevated compared to freshwater), but total PCBs were higher in marine habitats. There were no significant relationships between DDE or total PCBs and trophic status as indexed by stable isotope ratios ($\delta^{15}\text{N}$), within marine nestlings. Potential point sources in a six-bay area of coastal Maine were indicated by local differences in contaminant concentrations in biota from Frenchman Bay and adjacent Gouldsboro Bay. Atmospheric deposition also is a potential

source, since Maine eagles have similar DDE and PCB concentrations to other North American eagle populations from industrially polluted areas, and Maine is subject to other atmospherically deposited pollutants.

At the population level, productivity (fledglings per occupied territory) is lower in Maine than other populations, and below recovery goals. There was no significant relationship between DDE or PCB concentrations and mean annual number of fledglings per occupied territory for eight watersheds within Maine, but contaminant concentrations found in Maine eagles have been associated with decreased productivity elsewhere. Additionally, there were significant relationships between productivity and spring weather variables. At the individual level, no significant relationships between blood parasite levels and contaminants were found; overall parasite levels in Maine eaglets were low. Few significant relationships were found between contaminants and sex-specific circulating estradiol and testosterone. This analysis is preliminary, however, as sexing methods were not completely accurate.

In conclusion, few effects of high DDE and PCB contaminant concentrations on individuals were apparent. However, concentrations were associated with decreased population productivity, as was spring weather. Maine eagles were useful as indicators of ecosystem chemical contamination, indicating potential point sources, but atmospheric deposition and biomagnification may contribute to the overall high organochlorine contaminant concentrations within Maine eagles.

WINTER ECOLOGY OF HARLEQUIN DUCKS IN MAINE

Investigator: G. H. Mittelhauser

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

Cooperators/ Maine Outdoor Heritage Fund
Project National Park Service -
Support: 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: One year of field work has been completed and additional field work is ongoing. Data analysis is beginning.

FUTURE PLANS: A Master of Science thesis is expected by May 1999.

FISHERIES RESOURCES:

DISTRIBUTION AND STATUS OF REDFIN PICKEREL (*Esox americanus americanus*) IN CENTRAL AND SOUTHERN MAINE

Investigator: M. Gallagher

Advisors: J. R. Moring, Chairperson
L. J. Kling
J. G. Trial
F. W. Kircheis

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

Objective: Determine the status of grass and/or redbfin pickerel in the state and to establish a biological data base for chain pickerel.

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

PROJECT STATUS: The project is completed and a Master of Science degree was awarded in August 1998. The abstract follows:

Fish collections in Maine from the 1890s and the 1970s contained specimens identified as *Esox americanus*. Because the subspecific forms comprising this species, the redbfin pickerel (*E. a. americanus*) and the grass pickerel (*E. a. vermiculatus*), are difficult to differentiate and have vastly different geographic distributions, identification of these collections was questioned. Ecological similarities between *E. americanus* and *E. niger*, the chain pickerel, raised concern regarding natural hybridization. Therefore, allozyme electrophoresis and morphological distinctions were combined to accurately identify pickerel found in Maine. Pickerel from nine Maine locations were compared to known samples of chain, redbfin and grass pickerels. Redfin pickerel were confirmed for one Maine location, no evidence of hybridization with chain pickerel was found, and some historical collections were misidentified. The ratio of snout length/opercular length was the most reliable morphological characteristic for field identifications. Redfin pickerel have a ratio of < 1.0, whereas chain and grass pickerel exceed 1.0.

Maine redbfin pickerel had a maximum age of four years and were 116 mm in total length (TL). Age

1+ and 2+ fish averaged 80.11 and 94.6 mm TL. Maine redbfin pickerel consumed a diverse diet of invertebrates, with prey size increasing with fish size. Successful spawning was confirmed in early May for the Maine redbfin pickerel population. Aquarium-housed larval redbfin pickerel grew to an average size of 49.5 mm TL (range of 44 - 55 mm) in three months. Due to restricted habitat size and documentation of only one population, it is recommended that redbfin pickerel be considered for listing as a threatened or endangered species within the state of Maine.

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 1981, and work has also 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: Experiments with movements of juvenile grubbies and shorthorn sculpins are ongoing.

FUTURE PLANS: Work dealing with intertidal movements of sculpins will continue in 1999, along with experiments on Atlantic seasnail feeding and ecological studies of fishes and sand shrimp. Additional manuscripts are being prepared on community dynamics.

POPULATION DYNAMICS OF SEA-RUN ALEWIVES

Investigator: J. F. Stahlnecker, III

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

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

Objective: To understand the interactions and between stocking rates and the resultant numbers of juvenile and adult 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 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: Field work has been completed, with data analysis underway.

FUTURE PLANS: The investigator is enrolled on a part-time status, but is conducting the additional work in cooperation with the Department of Marine Resources. A Master of Science thesis is expected by December 1999.

FOOD HABITS OF AMERICAN EELS IN FRESH WATER

Investigator: L. R. Daniels

Advisors: J. R. Moring, Chairperson
J. D. McCleave
A.D. Huryn
F.W. Kircheis

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

Objective: Investigate aspects of the life history of the American eel, especially aspects of feeding in yellow eels.

SCOPE: Maine supports abundant populations of American eel, but there has been a rapid increase in harvest of the elver stage in recent years. Elvers ascend local rivers, taking up residence for many years in lakes and rivers, before migrating back to the sea as silver eels in fall months. There has always been a pot fishery on yellow eels and a fall fishery on silver eels, but this accelerated fishery on the elver stage means that the populations are being harvested at three stages during the life cycle. As a result, this project examines one component of the freshwater stage--the summer feeding by eels with additional information collected on the fall migration of adult silver eels--the abiotic and biotic factors triggering such migration.

PROJECT STATUS: Field work has been completed and laboratory analyses of stomach contents is near completion.

FUTURE PLANS: A thesis will be written in fall, 1998. A Master of Science thesis is expected in early 1999.

FISHERIES RESOURCES OF ACADIA NATIONAL PARK

Investigators: J. B. L 
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 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 will be studied for the native brook trout. This project will include investigations by two separate investigators over two field seasons, 1998 and 1999, studying different life history characteristics.

PROJECT STATUS: Field inventories of approximately half of the Park's waters have been completed. Work on the first brook trout study--instream movements--was completed in fall 1998. Brook trout spawning locations were observed in fall 1998 as planning begins for new work in 1999.

FUTURE PLANS: One Master of Science thesis is expected by August 1999, another in August 2000. A final report on fish inventories is expected in August 2000, and a draft report of previous data on fishes will be completed in November 1998.

LENGTH/WEIGHT VARIATIONS AND MERCURY LEVELS IN AMERICAN EELS IN FRESH WATER

Investigator: N. G. Leaman

Advisors: J. R. Moring, Co-advisor
T. A. Haines, Co-advisor
J. D. McCleave

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

Objective: To conduct research on aspects of the freshwater residence of American eels in Maine. Mercury content of eels will be measured in conjunction with other collections with life history objectives.

PROJECT STATUS: Eel samples have been collected from three rivers in Maine that differ in watershed

characteristics. All samples have been digested and mercury analysis of digestates is in progress. Selected eels have been processed for stable nitrogen isotope analysis to assess food chain position, and isotope analysis has been completed.

FUTURE PLANS: Mercury analysis of eel digestates will be completed within six months. A Master of Science thesis will be completed within one year.

COMPETITION BETWEEN SPLAKE AND LANDLOCKED SALMON

Investigator: T. A. Hoffman

Advisors: J. R. Moring, Chairperson
J. G. Trial
D. P. Chivers
F. W. Kircheis

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

Objective: To determine if competition for food exists between landlocked salmon and stocked splake (brook trout x lake trout).

SCOPE: Splake--a hatchery-produced hybrid--are being used with wider frequency in Maine waters. These fishes grow rapidly and tolerate marginal water conditions. However, there is concern that such introductions may adversely affect populations of landlocked salmon--especially if splake and salmon compete for the same foods. This project examines food habits of splake and salmon in three Maine lakes in different seasons.

PROJECT STATUS: Field work from winter-fall 1998 is nearly completed. In late fall 1998, the project status will be reviewed to determine whether additional sampling will be necessary in spring and/or early summer 1999.

FUTURE PLANS: Additional field work may occur in 1999. A Master of Science thesis is expected in December 1999.

HABITAT RESOURCES:

FACTORS AFFECTING FOOD CHAIN UPTAKE OF MERCURY IN A RIVERINE ECOSYSTEM HIGHLY CONTAMINATED BY INDUSTRIAL DISCHARGE

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

Advisors: T. A. Haines, Chairperson
L. E. Katz
J. R. Moring
S. A. Norton

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

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

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

PROJECT STATUS: Project is complete. An M.S. thesis has been completed, a final report has been submitted to EPA, and a journal article submitted for publication.

All requirements for the M.S. degree (in Zoology) were completed in August 1998. The abstract follows:

Food chain uptake of mercury was investigated at the Nyanza Superfund Site, Sudbury River, central Massachusetts, where predatory fish have elevated levels of mercury. I examined the relative importance of site-specific factors affecting mercury bioavailability versus background inorganic mercury concentrations in sediments. Prey items of largemouth bass (*Micropterus salmoides*) were collected from a reservoir and a flowing stretch in the upstream (reference) area and in the downstream (contaminated) area. Forage fish collected were bluegill (*Lepomis macrochirus*), pumpkinseed (*L. gibbosus*), and yellow perch (*Perca flavescens*). Crayfish species collected were *Orconectes immunis*, *O. obscurus*, and *O. virilis*. Dragonfly families collected were Aeshnidae, Corduliidae, Gomphidae, Libellulidae, and Macromiidae. Animals were collected in the spring, summer, and fall. Whole bodies were analyzed for methylmercury (MeHg), and total mercury (Σ Hg) by cold vapor atomic fluorescence detection.

Forage fish mercury concentrations ranged from 161.75 to 1074.53 ng/g for MeHg and 131.59 to 944.20 ng/g for Σ Hg. Crayfish mercury concentrations ranged from 98.34 to 488.24 ng/g for MeHg and 84.17 to 392.20 ng/g for Σ Hg. Mercury concentrations in dragonfly larvae ranged from 58.54 to 1064.91 ng/g for MeHg and 89.54 to 784.37 ng/g for Σ Hg.

Prey items generally had higher mean MeHg and Σ Hg concentrations in the contaminated reservoir (Reservoir 2) than at the reference sites and at the contaminated flowing site. These differences between sites were minor, however, compared to differences in Sediment concentrations of inorganic mercury. Seasonal differences were significant ($p \leq 0.05$) only in forage fish, with spring concentrations higher than in summer or fall. Differences between taxa of each prey item were significant only between dragonfly families, with concentrations lowest in Gomphidae and Libellulidae, and highest in Macromiidae. The majority of Σ Hg for all prey items was in the methyl form and did not differ significantly, regardless of season, taxon, and site: means were 98.9% for dragonfly larvae, 117.7% crayfish, and 87.1% for forage fish.

The results of this study suggest that habitat-specific environmental factors that control the rate of conversion of inorganic mercury to MeHg influence mercury concentrations in fish to an equal, or greater,

extent than does the background load of inorganic mercury in sediments.

EFFECTS OF METHYLMERCURY ON THE PREDATOR AVOIDANCE BEHAVIOR OF A FRESHWATER FORAGE FISH, GOLDEN SHINER (*Notemigonus crysoleucas*)

Investigators:

J. R. Burgess
H. M. Webber

Advisors:

T. A. Haines, Chairperson
J. H. Dearborn
J. R. Moring
W. E. Glanz
R. J. Van Beneden

**Cooperators/
Project
Support:**

USGS Biological Resources Division -
Leetown Science Center
National Park Service

Objectives:

- 1) Characterize the extent of mercury contamination in fish and piscivorous wildlife species in Acadia National Park (ANP) and Cape Cod National Seashore (CCNS), and assess the environmental factors controlling mercury bioavailability to aquatic organisms.
- 2) Demonstrate food chain transfer of mercury, and determine geochemical and biological factors that regulate bioavailability of mercury in order to predict fish and species at risk from mercury contamination.
- 3) Determine historical trends in mercury deposition to aquatic environments at ANP and CCNS.
- 4) Develop a precipitation chemistry monitoring program at ANP to assess long-term changes in mercury deposition.

SCOPE: High concentrations of mercury have been found in fish and wildlife in areas that are remote from industrial pollution. Thousands of lakes have health advisories against human consumption of fish because of the threat of mercury poisoning, and these levels are an even greater threat to wildlife. Previous research identified high levels of mercury in fish from northern Maine lakes. Bald eagle nestlings in the same area contain very high levels of mercury in feathers, up to 33 ppm. Analysis of the distribution of lakes in Maine containing fish with high levels of mercury indicates that geological or industrial point sources are not the likely sources of mercury contamination. Deposition from the atmosphere has been implicated as a major source of mercury in lakes. There is considerable evidence that pre-industrial atmospheric deposition of mercury was substantially lower (by a factor of three or more) than present deposition. Coal-fired electric power plants and municipal solid waste incinerators are reported to be the two most important anthropogenic sources for airborne mercury. The Clean Air Act Amendments of 1990 Title III classified mercury as a hazardous air pollutant, and provides for the regulation of industrial mercury emissions if damage to natural resources from atmospheric emissions can be demonstrated. The mercury content of rain and snow in Maine ranges 5-16 ng/L, which is similar to that in other regions where fish are contaminated with mercury. Although the environmental factors that control bioavailability of mercury to fish are poorly understood at present, fish mercury content seems to be highest in lakes that are softwater (low in dissolved ions and in acid-neutralizing capacity) and slightly acidic ($\text{pH} < 7$) - conditions that are common in ANP and CCNS lakes.

PROJECT STATUS: Project is complete. Two M.S. theses have been completed, and a final report submitted to the National Park Service.

All requirements for the M.S. degree (in Zoology) were completed in May 1998. The abstract follows:

To determine the behavioral effects of low dose exposure to monomethylmercury (CH_3Hg^+), we fed 120 golden shiners (*Notemigonus crysoleucas*) CH_3Hg^+ -spiked diets and then assessed their reaction to the simulated threat of aerial predation. The fish were fed a diet spiked with either 10, 445, or 904 ng Hg (as CH_3Hg^+)/g diet for 90 days. The high mercury diet fish had an average whole body mercury concentration of 518 ng Hg/g (wet weight) and had a hyperactive response to the simulated aerial predator (a model of a kingfisher, *Megaceryle alcyon*) when compared to the control or low mercury diet fish. The high mercury fish had a greater vertical dispersal (20.03 cm compared to 5.87 cm and 7.98 cm, for control and low diet fish, respectively), took longer to settle (23.89 seconds versus 8.02 and 8.98 seconds), and were less compact upon settling (331.4 cm^2 compared to 118.5 and 178.92 cm^2). Hyperactive prey fish are likely to call attention to themselves and tire easily, therefore increasing their susceptibility to predation. The results of this study suggest that environmentally relevant concentrations of mercury may alter fish behavior in a way that would increase predation and therefore accentuate mercury bioaccumulation up the food chain.

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/ Holt Woodlands Research Foundation
Project McIntire-Stennis
Support: 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 (> 10.2 cm DBH) and intensive inventories of tree regeneration, (all trees are being individually numbered and, on 12 tracts, mapped); (2) a complete description of the

vascular plant vegetation using the relevé technique; (3) an inventory of all breeding bird territories; (4) transect surveys of nonbreeding birds; (5) small mammal trapping; (6) salamander quadrat counts; (7) observations of reproductive efforts (flowering and fruiting) for 13 herb and shrub species; (8) estimates of seed and fruit production; (9) general surveys of canopy insect abundance; and (10) meteorological observations. These data, largely population estimates, are integrated by area units (usually 0.25 ha blocks) and analyzed to portray the forests' community structure. After five years of gathering baseline data, in 1987 we began managing the experimental area with three objectives: (1) increase wood production; (2) increase wildlife diversity and abundance; and (3) maintain the forest's aesthetic value. By continuing to monitor populations and processes, we can attain the second objective. Over the course of 20 years, we will begin to understand how the community changes seasonally and from year to year; this is the essence of the third objective.

PROJECT STATUS: In 1997, tasks 3, 4, 5, 6, 8, 9, and 10 as outlined above, were completed. Short-term work on vegetation in gaps dominated the 1998 field season.

FUTURE PLANS: The 1999 field season will replicate the 1995 field season with additional work on snags and forest gap dynamics and their effects on forest understory plants.

WILDLIFE COMMUNITIES OF VERNAL POOLS IN SOUTHERN MAINE

Investigator: A. M. Perillo

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

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

Objectives:

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

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

breed. Therefore, local populations of state-threatened turtles and many amphibian species could be severely limited or extirpated by loss of vernal pools. The information collected in this study will provide a basis for consideration of additional protection initiatives for small wetlands in Maine.

PROJECT STATUS: Forty-five vernal pools were selected for study in York County, Maine. Field work was completed during April-September 1994 and 1995. Data collection included counting amphibian egg masses, trapping larval amphibians and aquatic invertebrates, surveying to determine the presence and abundance of reptiles, amphibians and other vertebrate species using the pools, and conducting aural surveys of breeding frogs and toads using the pools. Other data collected included water temperature, depth, pH, and conductivity, pool shrinkage and hydroperiod, pool flora, vegetation type, structure and percent cover for all vegetation growing within or overhanging pools, and average tree height and forest type of area surrounding pools. Invertebrate samples were sorted, identified, and counted during 1995 and 1996. Additional fieldwork was conducted during the winter of 1997 to gather data on solar input for all pools. Analysis was conducted in spring 1997, and a preliminary report of research results was prepared.

FUTURE PLANS: A final thesis is in preparation.

REPRODUCTION OF AMPHIBIANS IN ANTHROPOGENIC AND NATURAL TEMPORARY POOLS IN INDUSTRIAL FORESTS

Investigator: D. DiMauro

Advisors: M. L. Hunter, Jr., Chairperson
W. E. Glanz
M. A. McCullough
A. J. K. Calhoun

**Cooperators/
Project
Support** University of Maine -
Department of Wildlife Ecology
McIntire-Stennis
Penobscot Valley Conservation Association
Maine Association of Wetlands Scientists
James River Timber Corporation

Objectives:

- 1) Evaluate the reproductive success of amphibians breeding in natural and anthropogenic temporary pools in industrial forests.
- 2) Evaluate the landscape-scale use of temporary pools by breeding amphibians in industrial forests.
- 3) Characterize the features of temporary pools which best predict amphibian reproductive effort and success.

SCOPE: Temporary pools are unique habitats filled by meltwater, rain, or runoff, and characterized by annual drying and the lack of permanent inlets or outlets. Because of their ephemeral nature, temporary pools are unsuitable habitats for fish, and thus are particularly hospitable for amphibian species with vulnerable larvae incapable of withstanding intense predation pressure. In the Northeast, species such as the wood frog (*Rana sylvatica*), spotted salamander (*Ambystoma maculatum*), and blue-spotted salamander (*A. laterale*), rely heavily on productive, fishless water bodies for reproduction.

Several amphibian species deposit eggs in pools which form in roadside ditches and machinery ruts in industrial forests, but no studies have quantified the reproductive success of animals breeding in anthropogenic

pools of this type. The availability of such pools may or may not benefit amphibian populations. Successful reproduction in additional pools could mitigate the loss of breeding habitats damaged in the course of harvesting operations or road construction, but unsuccessful reproduction might suggest that anthropogenic pools function as ecological traps. To better understand these interactions, I am studying populations of amphibians breeding in temporary pools located in industrial forests. This study focuses on the relationships between amphibian reproduction and a set of environmental factors which may differ between anthropogenic and natural pools.

PROJECT STATUS: In the 1996 and 1997 field seasons, I identified 53 temporary pools containing amphibian egg-masses. I counted and measured the wood frog and spotted salamander egg-masses in each pool, monitored pool depth, periodically measured tadpoles, and recorded dates on which pools dried. In addition, I trapped, counted, and weighed recently-metamorphosed wood frogs and spotted salamanders at pools which persisted until juvenile emergence. I also conducted survey transects to determine the distribution of pools across the landscape, and evaluated the surrounding cover types and microhabitat conditions of study pools. Preliminary data analysis occurred in winter/spring 1997.

FUTURE PLANS: The thesis is being written.

THREATS TO BIODIVERSITY

Investigator: J. G. Bartlett

Advisors: R. J. O'Connor, Chairperson
D. M. Mageean
M. K. Beard-Tisdale
M. L. Hunter, Jr.
G. L. Jacobson

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

Objectives:

- 1) Compile selected databases of information about anthropogenic stressors of biodiversity.
- 2) Develop methods of quantifying the impacts of stressors on biodiversity.

SCOPE: The influence of anthropogenic stressors on biodiversity is well-known but their effects at large spatial scales have rarely being quantified. This project extends the use of classification and regression free methods (CART) to the analysis of data sets derived from environmental and demographic sources for the conterminous United States. The environmental data include remotely sensed land cover class information and metrics computed to reflect concepts used in landscape ecology. Additionally, data on climate, elevation, and land ownership have been combined with nine variables extracted from the files of the Bureau of the Census; these variables been chosen to characterize the spectrum of general population impacts on the natural environment. These data have been used to generate 5 environmental models: 1) a model of the distribution of the human population in relation to climate and land cover, 2) a model allowing recognition of when a change in scale is necessary to accommodate processes influencing the distribution of population, 3) a model distinguishing two distinct patterns of population settlement across the conterminous United States and showing that one particular pattern, termed beta settlement, selectively impacts particularly fragile ecosystems on barrier islands, coastal dunes, and desert edges, 4) a model of bird species richness in terms of land cover

classes and in terms of agricultural activity, in both cases with additional information from climate and elevation data, and 5) a model characterizing the joint occurrence of environmental constraints on ecosystem process, biodiversity, and anthropogenic impacts.

PROJECT STATUS: A doctoral thesis is currently scheduled for completion in December 1998. Several papers have been submitted to appropriate outlets.

DEVELOPMENT AND TESTING A HABITAT MAP FOR MAINE

Investigator: J. A. Hepinstall

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

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

Objectives:

- 1) Classify satellite images and create a habitat map of Maine at a 1:100,000 scale.
- 2) Evaluate map classification accuracy with a minimum of 80% correct for major habitat types.
- 3) Prepare final report and publications.

SCOPE: As biodiversity is decreasing and many wildlife species and their habitats are becoming threatened, we need more comprehensive information for conservation efforts. A major requirement for conservation is a reliable statewide habitat map to provide a base for predicting distribution of wildlife species. Ground investigation is time consuming, expensive, and inefficient for large area surveys. Satellite images have advantages for statewide habitat mapping. This research uses aerial videography and satellite imagery to map habitat types for Maine.

PROJECT STATUS: Landsat-Thematic Mapper (TM) imagery acquired in summer 1991 and fall 1993 were obtained from a variety of government agencies and private sources. Portions of eight TM scenes at each date were required to cover the entire state of Maine (16 scenes total). All scenes have been geometrically corrected and co-registered. Clouds, shadows, water, and urban areas were stratified out from these scenes to be processed separately. Aerial videography transects covering 7,100 km were collected in the spring and fall 1994. Systematic samples at one minute intervals along each flight line were interpreted to provide training sites for supervised classification and locations for accuracy assessment of the final habitat map. Classification of all scenes, both supervised and unsupervised, has been completed. Residential and urban areas were delineated through a combination of GIS rules using the transportation network from Digital Line Graphs and unsupervised classification. National Wetlands Inventory (NWI) wetland polygons were used to delineate wetlands in most of the state. For the several areas of Maine without digital NWI maps, supervised classification was used to delineate wetlands.

FUTURE PLANS: The habitat and land cover was completed and tested. A chapter based on this research was written for the final contract report on Maine Gap Analysis, and a detailed publication on this work is being

written for publication as a Maine Forest and Agricultural Experiment Station Technical Report.

MAINE GAP ANALYSIS

Investigators:

W. B. Krohn
R. B. Boone
S. A. Sader
J. A. Hepinstall
S. M. Schaefer
S. L. Panton

Cooperators/

USGS Biological Resources Division

Project

University of Maine -

Support:

Department of Wildlife Ecology
Maine Image Analysis Laboratory
Maine Department of Inland Fisheries and Wildlife
Maine Department of Conservation
Maine Office of Geographic Information Systems

Objectives:

- 1) Develop detailed range maps for terrestrial (i.e., non-fish) vertebrate species in Maine, using literature and expert review.
- 2) Create matrices depicting habitat relationships for the terrestrial vertebrate species breeding in Maine.
- 3) Develop spatially-explicit, statewide predictions of how likely species are to occur in habitats.
- 4) Develop species richness predictions by vertebrate classes and all terrestrial vertebrates, and compare these distributions to the locations of conservation lands in Maine.
- 5) Prepare the final report for Maine Gap Analysis and provide results to cooperators.

SCOPE: Recovering endangered vertebrate populations can be expensive, disruptive to the species and to society, and may not succeed. The recognition that ensuring that the more common species remain common is an efficient conservation strategy that spawned Gap Analysis. In Gap Analysis, the distributions of species are predicted, then compared to the patterns of conservation lands in a region. To conduct Gap Analysis for Maine, we require predicted distributions of the non-fish vertebrate species that breed in inland Maine.

PROJECT STATUS: We have identified 270 terrestrial vertebrates that regularly breed in inland Maine. For each of these species, we have defined ranges based upon literature, expert review, personal communications, and personal experiences. For birds, these ranges were assessed by comparing them to patterns from smoothed U.S. Fish and Wildlife Service Breeding Bird Survey data, and judged to depict reasonably well the distribution of species. The ranges of amphibians and reptiles were refined using atlas information from the region, and will be used in a book describing the herpetofauna of Maine. The ranges of all vertebrates were also provided to colleagues producing a volume describing the animals of New England. To quantify species-habitat associations, a matrix containing 48 habitats was constructed for each species. In each matrix breeding and feeding habitat was assigned a score from 0 to 4, representing how frequently the habitats are used by species. Several data layers were used during species occurrence modeling and Gap Analysis overlays. These include layers describing habitats, conservation lands (including ownership and management status), hydrography (including stream order), wetlands, elevation, watershed boundaries, road networks, and political boundaries. The predicted distributions of all 270 species were made and related to land ownership and

management. All other analyses required by the Gap Analysis Program (GAP) were completed, and a drafted final report was written (see below for details).

FUTURE PLANS: The final contract report for Maine Gap Analysis (ME-GAP) has been drafted in three volumes. After review and revision, the final ME-GAP report, along with detailed documentation of all data bases, will be submitted to national GAP.

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 thinning 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. Invertebrates are currently being identified to varying degrees, depending upon the availability of published keys and help from expert taxonomists.

FUTURE PLANS: All invertebrates will be taken to the level of class, many to family, and some to species. 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.

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:** Gap Analysis Program -
USGS Biological Resources Division
Maine Cooperative Fish and Wildlife Research Unit
University of Maine -
Department of Wildlife Ecology

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 avians 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 by GAP) and commission error (percentage of species not reported on an area that are predicted by GAP) 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. Another question that arises in assessing the accuracy of the vertebrate predictions is, what data layer used in making the prediction is causing the 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: The literature review has been completed and a research proposal has been drafted.

FUTURE PLANS: Once the proposal is reviewed and approved by committee members, creation of the data layers and analysis and will begin.

A GEOGRAPHIC INFORMATION SYSTEM ANALYSIS OF CONSERVATION AREAS IN MAINE

Investigator: S. L. Panton

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, at both statewide and regional scales, how similar the abiotic and biotic factors are on conservation areas versus non-conservation areas.
- 2) Determine the representativeness of natural variation captured by primary ownership (i.e., federal, state, private) on conservation areas versus non-conservation areas at state and regional scales.
- 3) Determine the representativeness of natural variation captured by the relative degree of management for biodiversity maintenance (i.e., management categories 1 through 4, from strictest to no biodiversity protection) on conservation areas versus non-conservation areas at state and regional scales.

SCOPE: While the State of Maine continues to purchase conservation lands, 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 biodiversity, and uncoordinated and unplanned decisions may seriously compromise progress toward that goal.

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. Maine was divided into biophysical regions using a Geographic Information System (GIS) and cluster analyses. Based on five abiotic (elevation, slope, heat accumulation, snowfall, total precipitation) and two biotic (number of species of woody plants and terrestrial vertebrates) variables, five biophysical regions were delineated. Non-conservation and conservation areas will be compared to determine whether or not current conservation areas have captured Maine's natural variability. Comparisons will be on a grid basis, and will include comparisons of conservation areas by land ownership and management status. The study has been divided into three separate analyses. A statewide analysis will be done at 1.86 km² resolution. Approximately 20 variables will be analyzed, including topography, climate, soils, hydrology, habitat, and non-fish vertebrates. Then an analysis by biophysical region will be conducted using most of the same variables as the statewide analysis at a 94.6 m² resolution. Consideration is also being given to a coastal analysis at 94.6 m² resolution.

FUTURE PLANS: A research proposal has been written and submitted to the graduate committee. Analyses will start once the proposal has approved.

EFFECTS OF LANDSCAPE PATTERN ON AMPHIBIAN SPECIES ASSEMBLAGES IN AN AGRICULTURALLY-FRAGMENTED LANDSCAPE

Investigator: A. D. Guerry

Advisors: M. L. Hunter, Chairperson
R. J. O'Connor
D. J. Harrison
A. J. K. Calhoun

Cooperators/ McIntire-Stennis
Project National Science Foundation
Support: Maine Association of Wetlands Scientists

- Objectives:*
- 1) Document the distribution (and in some cases relative abundance) of breeding amphibians in ponds in a variety of landscapes that represent predominantly agricultural landscapes, predominantly forested landscapes, and patchy combinations of the two.
 - 2) Determine whether or not connectivity of habitat-patches mediates the effects of habitat loss by looking at a number of different "landscapes" (1 km circles centered on breeding ponds) with the same areas of natural habitat but different spatial arrangements of habitat-patches with respect to the ponds.
 - 3) Locate potential thresholds at which the amount of agriculture surrounding a pond prohibits particular species from using breeding pools.

SCOPE: One of the themes of landscape ecology is that the landscape mosaic surrounding a patch is often more important to patch function than characteristics within the patch. This study tests this paradigm in a particular case. The landscape pattern in Aroostook County provides a valuable opportunity to test theoretical models of habitat fragmentation. Isolated woodlots of various sizes are embedded in a matrix of agricultural fields, primarily planted with potatoes. This is a fairly simple landscape that may approximate the pixel-based binary landscapes used to model fragmentation. In this fragmented landscape, an inhospitable agricultural matrix separates many ponds from the surrounding uplands. For many amphibians, agricultural practices can limit the use of preferred breeding habitat because migration from woodland hibernacula to breeding ponds in spring must be across a matrix with very little protection from the drying effects of wind and sunlight. Juvenile dispersal, immigration, and re-colonization can also be limited in a fragmented landscape such as Aroostook County.

PROJECT STATUS: 74 ponds were chosen for study in April and May 1998 using National Wetland Inventory (NWI) maps, land-cover maps created by the Maine GAP project, and field checks. All ponds were classified by the NWI as palustrine unconsolidated bottom or palustrine emergent vegetation, are large enough to appear on the NWI map (approximately 0.1 hectares), and smaller than one half hectare. They were chosen to fill 3 classes (0-33%, 34-66%, 67-100%) indicating the amount of agriculture in the 1 km landscape surrounding the pond, quantified within a Geographic Information System (GIS).

Surveys were conducted throughout the breeding-season to look for adults, egg masses, and larvae. Anurans were also detected using night surveys to detect the presence of calling males; protocols from the North American Amphibian Monitoring Program (NAAMP) were used. Local-scale habitat components such as water chemistry, pond vegetation, and the presence or absence of fish were recorded for each pond. Small-scale landscape variables such as corridors, active or abandoned agricultural fields, and proximity to forest were also documented both in the field and from aerial photographs. Large-scale landscape variables such as

wetland density and arrangement of forest patches will be retrieved from the GIS.

From the first year's data, it appears that the anurans are quite ubiquitous and distributed across the study-site without respect to landscape pattern. The less vagile caudates, (salamanders and newts), however, display a pattern of occupancy that reflects the amount of forest surrounding the breeding pond.

WILDLIFE RESOURCES - MIGRATORY BIRDS:

SPATIAL AND TEMPORAL CONSIDERATIONS FOR IDENTIFYING IMPORTANT SEABIRD NESTING HABITATS IN MAINE

Investigator: C. M. Johnson

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

*Cooperators/
Project
Support:* USGS Biological Resources Division
U.S. Fish and Wildlife Service
University of Maine -
Department of Wildlife Ecology
Maine Department of Inland Fisheries and Wildlife
Maine Department of Marine Resources
Maine Geological Survey

Objectives:

- 1) Develop a database detailing historical surveys of Maine's seabird nesting islands, and measure current use of selected islands by three species of breeding seabirds.
- 2) Compare current use and nest density data for seabirds with historical patterns of island use to assess the temporal stability of breeding sites.
- 3) Evaluate environmental, interspecific, and anthropogenic factors affecting the distribution of breeding seabirds in Maine and develop habitat models.
- 4) Examine temporal and spatial patterns in island use by several seabird species and identify important habitats, or mosaics of habitat types, for long-term conservation of selected seabirds.

SCOPE: The Maine coastline encompasses several thousand islands and ledges; however, only a small percentage of these are used by nesting seabirds. While several studies have looked at nest site habitat selection along the Maine coast on individual islands, there is a paucity of information regarding landscape-level habitat selection. We are developing a spatial database of landscape-level environmental factors and potential anthropogenic stressors associated with individual islands in mid-coastal Maine. These data will be used, in conjunction with historic seabird surveys, to examine the temporal and spatial patterns of seabird colonies and their use of insular and aquatic habitats in coastal Maine.

As part of this study, we will assess annual (1993-97) variability and long-term temporal patterns of island use for selected seabird species, using survey data collected periodically over the past 80 years. Habitat models will be developed in order to determine the importance of various environmental, social and anthropogenic factors in determining site use. Finally, patterns of occupancy will be examined at both local

and regional scales to assess the overall value of particular islands, island groupings, and surrounding habitats to Maine's colonial seabirds.

PROJECT STATUS: All requirements for the Ph.D. degree (in Wildlife Ecology) were completed in May 1998. The abstract follows:

I conducted weekly censuses of island in Penobscot Bay, Maine and used aerial photographs to determine peak annual nest count dates for Double-crested Cormorants, Herring Gulls and Great Black-backed Gulls. These data also were used to determine the potential effect of survey timing on the ability to detect long-term trends in the abundance of these species. The number of cormorant nests in the study peaked in mid-June, while Great Black-backed and Herring Gulls peaked in late May and early June, respectively. A 10-year monitoring program using annual surveys conducted between May 23rd and June 23rd or biennial surveys conducted from June 2nd - 17th would have an 80% probability of detecting annual changes of $\pm 5\%$ for all three species.

Logistic regression was used to develop habitat models for Double-crested Cormorants, Common Eiders, Herring Gulls, Great Black-backed Gulls, and Black Guillemots. All final species' models exhibited relatively good fit ($p^2 > 0.56$) and were robust to new data, accurately predicting occupancy on over 80% of islands in test data sets. Distance to the mainland or large (> 50 ha) islands, the availability of low vegetative cover, and surrounding aquatic habitat variables recurred as important predictive factors in island occupancy models for most of the species considered.

I examined the relationship between potential foraging habitat for Double-crested Cormorants (i.e., water depths ≤ 20 m within 4 or 8 km of a colony) and colony size to assess the possibility that competition for food during the breeding season could be a limiting factor for the cormorant population in coastal Maine. Hinterland size (i.e., potential foraging habitat closer to a given colony than any other active colony) was significantly related to colony size for 1994 ($r = .539$, $P < .001$), 1995 ($r = .313$, $P = .020$), and 1997 ($r = .313$, $P = .025$), but not 1996 ($r = .249$, $P = .070$). This relationship also held true using historical census data from 1984 ($r = .424$, $P = .001$), 1977 ($r = .473$, $P < .001$), and 1972 ($r = .362$, $P = .020$). An analysis of long-term census data suggests that the availability of suitable nesting islands also could be a limiting factor for this coastal population. The long-term spatial and temporal patterns of island use and colony size found in this study emphasize the dynamic and interrelated nature of cormorant colonies. Long-term conservation efforts for these and other seabirds need to focus on groups of suitable islands and associated aquatic habitat in addition to individual, high-quality nesting sites.

SITE FIDELITY OF SONGBIRDS IN SELECTIVELY HARVESTED AND UNHARVESTED MIXED WOODS

Investigator: M. J. Hartley

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

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

American Wildlife Research Foundation

- Objectives:*
- 1) To describe changes in breeding bird communities on sites that are experimentally harvested (with selection silviculture) and unharvested.
 - 2) To determine if selective timber harvesting affects site fidelity of Ovenbirds and Hermit Thrushes, as estimated by:
 - a) annual return rates,
 - 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 at the Penobscot Experimental Forest (PEF). These 10 ha stands are grouped into three replicates of "triplets" (three plots) that are treated with light selection cutting (1% annual harvest, with many retention trees), moderate selection cutting (2% annual harvest, with some retention trees), or no cutting (i.e., control). These three replicates are all within one 1400 ha mixed-wood forest that is managed for long-term ecosystem research. My role in the FERP is to study how these treatments affect one aspect of biodiversity in the forest: breeding bird communities. If selective timber harvesting causes migratory songbirds to be displaced from their territories of previous years, then harvesting would negatively affect breeding productivity.

PROJECT STATUS: I have captured and banded approximately 300 birds each summer from 1995-1998, over 150 of which were individually colormarked. The first FERP triplet was harvested in the winter of 1995, so the summer of 1996 (the first year of return data) resulted in returns to 2 treated and 7 untreated sites. The second triplet was harvested the following winter (1996/97), so 1997 yielded return data for 4 of 9 sites, including two sites that were harvested two years earlier. By the final field season (summer 1998) all 6 (of 9) sites were harvested, and data collection was finished. Preliminary return rates for Ovenbirds ($n=150$) have consistently been just below 30% per year, whereas Hermit Thrushes ($n=150$) are more variable, with return rates ranging from 25-50%. Territory mapping data have shown very few changes in songbird communities due to harvest activities. Year to year variations in bird densities, e.g., due to changes in predator abundance, are much stronger than differences among treatments and controls.

FUTURE PLANS: Statistical analyses have begun during fall of 1998, including return rates to harvested versus unharvested areas, distances between territories of successive years, and return rate decay functions one, two, and three years after harvest. These data will yield valuable information on post-disturbance breeding dispersal of adult Ovenbirds, Hermit Thrushes, and possibly other Neotropical migrant songbirds. Also, I am examining the relationship between red squirrel population dynamics and regional songbird recruitment, which seem to be directly related.

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

Investigator: C. R. Foss

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

Cooperators/ University of Maine
Project Switzer Environmental Fellowship Program
Support: McIntire-Stennis
 U.S. Fish 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 1998-99 academic year.

PHYLOGEOGRAPHY AND MATING SYSTEM OF AMERICAN WOODCOCK (*Scolopax minor*)

<i>Investigator:</i>	H. L. Ziel
<i>Advisors:</i>	J. M. Rhymer (Chairperson) D. G. McAuley C. R. Maher
<i>Cooperators/ Project</i>	U.S. Geological Survey - Patuxent Wildlife Research Center
<i>Support:</i>	University of Maine - Department of Wildlife Ecology

SCOPE: The continental population of American woodcock (*Scolopax minor*) has declined over the last 30 years. As a result, there has been renewed interest in studying aspects of woodcock biology. Recent advances in genetic techniques have made new methods available for studies in ecology and population biology. Molecular techniques will be used to examine two aspects of woodcock biology. Banding data used to trace migration routes of birds from different regions have determined that there is a split between birds from the eastern and western portions of the species' range. Phylogeographic patterns of woodcock will be studied using mitochondrial DNA (mtDNA) to determine if genetic variation exists among populations. The mating system of woodcock is complex and unusual, and controversy still exists over what type of mating system they have. DNA fingerprinting techniques will be used to study paternity and the mating system of woodcock.

PROJECT STATUS: To determine phylogeographic structure of American Woodcock, sequences from the control region of mtDNA will be examined and compared among birds from different geographic regions. We obtained woodcock wings from each state and province where woodcock are hunted from U.S. Fish and Wildlife Service and the Canadian Wildlife Service. I have extracted DNA from either feathers or wing tissue. Primers developed for Ruddy Turnstones (*Arenaria interpres*) have been used initially for sequencing. DNA sequences will be aligned using the Clustal method in the Sequence Navigator (ABI) program and compared among individuals within and among populations throughout the species' range. I have completed one field season on the study of the mating system. In late March we located displaying woodcock on two roads in eastern Maine in Hancock County on land owned by Champion International Corporation. Using mist

nets, we caught and marked dominant male woodcock with one USFWS band as well as individual combinations of reflective color bands. We observed marked males from blinds during their display periods, at dawn and dusk. We recorded the following behaviors: number and frequency of display flights, duration of each display flight, number of "peents" each display period on ground, and any interactions with other males or females. When the males were caught and banded, we collected blood samples as well. After females nested and chicks hatched, trained bird dogs located females and broods in the areas surrounding the males' display sites. Females and chicks were caught with hand nets, and small blood samples taken. I have extracted DNA from the blood samples, and DNA fingerprinting using single locus minisatellite probes will be used to identify each individual and assign paternity.

FUTURE PLANS: The second field season will begin in late March 1999. Preliminary analysis of data from the first field season will be completed this winter. Genetic analysis to determine phylogeographic structure and paternity will be continuing throughout 1998 and 1999.

WILDLIFE RESOURCES - OTHER THAN MIGRATORY BIRDS:

MODELING EFFECTS OF FOOD AND HARVESTS ON FEMALE BLACK BEAR POPULATIONS

Investigator: C. R. McLaughlin

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

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

Objectives:

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

SCOPE: Survival and reproductive data from 1982-1996 have been analyzed, and a predictive computer model has been constructed, with most sensitivity testing completed. The model is individual-based, and of expanded Leslie-matrix design. It contains 25 year classes and 6 reproductive categories. Within a simulation year, each bear is assigned to a reproductive category according to age, prior reproductive history, and probabilities of cub production and litter survival. Density-dependent reduction in survival and environmental stochasticity can be accommodated. A strong nutritional relationship with reproductive success, and reduction of subadult survival following food stress are included, allowing study of the influence of fluctuating food planes on population dynamics. The model's annual cycle includes three periods: denning, spring-summer, and fall. Annual survival is the product of survival during each period; cub production is generated at the start of the denning period. Hunting survival can be specified as year class specific survival probabilities, or as year class specific harvests.

Female bear densities have been estimated from plots of telemetry locations for each of 3 study areas

at 3 points in time: 1985, 1989, and 1995. These estimates are being used to validate model performance.

PROJECT STATUS: All requirements for the Ph.D. (in Wildlife Ecology) were completed in May 1998. The abstract follows:

Black bears (*Ursus americanus*) are an economically important big game species in Maine. Nuts of the American beech (*Fagus grandifolia*) are their primary fall food in northern Maine. Beechnut production varies annually, with alternate-year crop failures. The future of this food supply is uncertain, as disease and trends in timber harvest may reduce number of nut-producing beech trees.

I constructed an individual-based, Leslie matrix-based population model using data from 15-year telemetry studies of female bears on three dissimilar sites. I used the model to investigate relationships between variable food supplies and growth of female black bear populations, and to understand the effects of harvests on them. Litter production was the most variable life history parameter associated with beechnut abundance in northern Maine, where most females synchronized their 2- year reproductive schedules and reproduced following abundant mast. Females on the remaining study areas maintained high litter production regardless of beechnut abundance.

I validated the model by comparing projections based on vital rates from two study areas to telemetry-based density indices. I assessed sensitivity of population growth to individual life history parameters by varying their values and observing changes in population growth (r). Population growth was most sensitive to litter production (proportion of breeders producing cubs), and moderately sensitive to adult survival. It was less sensitive to age of first reproduction, litter size, and cub, yearling, and subadult survival.

Synchronous reproduction reduced population growth rate slightly from high litter production. Low litter production severely reduced growth rate, suggesting that loss of beech in northern Maine would cause a drastic decline in the potential growth rate of regional female bear populations.

I examined effects of harvests on population growth by setting litter production to High, Moderate, Alternating High-Low, and Low in turn, and incrementally increasing hunting mortality. Populations with the highest vital rates recorded in Maine sustained 15% hunting mortality; those with alternate-year litter production schedules sustained 10% mortality. Populations with low litter production could not sustain 5% mortality. Litter production, age of first reproduction, and adult mortality should be monitored to assess the nutritional planes, trends, and harvest potential of female black bear populations.

REDBACK SALAMANDER (*Plethodon cinereus*) HABITAT PREFERENCES IN A MAINE OAK-PINE FOREST

Investigator: L. M. Monti

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

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

Objectives:

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

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

PROJECT STATUS: All requirements for the degree of Master of Science (in Wildlife Ecology) were completed in August 1997. An abstract of the thesis follows:

The redback salamander, *Plethodon cinereus*, is one of the most abundant vertebrates in eastern North American forests, with densities often exceeding 1 per m². Given its numbers and sensitivity to habitat conditions, it may be useful as a bioindicator of environmental degradation. Prior to using redbacks in this way, their habitat preferences in a variety of locations should be assessed, and an effective method of monitoring their density should be developed.

At the Holt Research Forest (HRF) in Arrowsic, ME, 60 redback salamander census sites were established in 1988. Each station consists of six 10x25 cm cedar shingles under which redbacks retreat to avoid desiccation. The stations are checked for salamanders every other week from May through September. With data from 1989 through 1995, I used multiple regression to correlate spatial patterns of salamander abundance with characteristics of the vegetation and soil around the stations. I also performed experiments in 1996 to address relationships between salamander abundance and coarse woody debris, O horizon pH and moisture, and overstory cover.

I found that the relationships between these habitat variables and redback numbers were not clear cut. Short-term changes in moisture conditions do not appear as important as the average yearly precipitation in influencing density patterns. The pH of the O horizon at the HRF was generally at or below the purported chronically lethal level for these species, yet HRF salamanders seemed as sensitive to acidity as those from a forest with more basic soils. Gaps in the canopy correlate with areas of low redback density; however, related variables such as O-horizon depth may be driving the relationship. Although the initial multivariate model suggested a negative relationship between coarse woody debris and redback density, subsequent experiments failed to substantiate this. In sum, redback densities do not reflect easily quantifiable habitat variables.

I also addressed the efficacy of the censusing methodology used at the HRF. I evaluated the effects of natural cover objects near the stations, social interactions between redbacks, and methodological variables (such as shingle age and placement) on salamander use of the shingles. I established new stations to determine if the animals at the stations were drawn from natural cover objects and the relative quality of natural versus artificial cover.

This method was relatively unaffected by territorial behavior, age of shingles, and presence of natural cover objects. However, the length of time the shingles had been in place, the depth of the shingles, and seasonal changes in salamander abundance could create biases in station counts. Despite these drawbacks, I concluded that the use of artificial cover is superior to two other censusing techniques, transect walks and quadrat searches, for long-term monitoring of redback population densities.

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

- Investigator:* D. C. Payer
- Advisors:* D. J. Harrison, Chairperson
K. D. Elowe
J. R. Gilbert
W. B. Krohn
R. J. Seymour
- Cooperators/* Maine Department of Inland Fisheries and Wildlife
Project Federal Aid in Wildlife Restoration Project W-82-R-II-368
Support: University of Maine -
Cooperative Forestry Research Unit
Department of Wildlife Ecology
National Council of the Paper Industry for Air and Stream Improvement
Maine Forest Service
McIntire-Stennis
Baxter State Park
Great Northern Paper Company, Bowater, Inc.
- Objectives:*
- 1) Document and compare seasonal habitat selection and population characteristics (i.e. home range size, inter- and intra-sexual home range overlap, home-range fidelity across seasons and years, density, age and sex structure, survival and percent females lactating) by martens in an untrapped forest reserve, an untrapped industrial forest, and a trapped industrial forest.
 - 2) Compare microsite characteristics between areas receiving high, low or no use-intensity by resident, non-juvenile martens in an industrial forest with trapping closure and a forest reserve.

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

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

PROJECT STATUS: We radiocollared 48 (21 F, 27 M), 55 (22 F, 33 M), 76 (28 F, 48 M) and 51 (18 F, 33 M) martens on the three study sites in 1994, 1995, 1996 and 1997, respectively. Approximately 12,000 relocations were obtained via ground and aerial telemetry through 30 April 1998. In 1995 we sampled microhabitat features in 360 randomly placed plots in areas receiving high, low or no marten use-intensity within the industrial forest. The protocol was repeated in 1996 on 288 plots in areas receiving high and low use within the forest reserve.

We are currently analyzing habitat-selection data at three spatial scales. To investigate patterns of habitat use in relation to microsite characteristics, we constructed parsimonious multivariate models that predict use intensity of an area by marten as a function of a subset of overstory, understory, and downed woody debris features. In the industrial forest, areas receiving marten use were distinguished from unused areas primarily by characteristics related to stand maturity. Specifically, used areas had taller trees, greater snag volumes and higher live-tree basal areas than unused areas that were regenerating following clearcutting 10-20 years previously. Areas receiving high use were further characterized by higher deciduous basal areas than low-use areas. These marten-habitat relationships were consistent with habitat associations of preferred small mammal prey species, as described in a companion study. Thus, marten appeared to be selecting habitat to maximize access to prey. Based on our results, we recommend retention of $\geq 10 \text{ m}^3$ snags/ha in harvested areas to provide vertical structure and a source of downed woody debris. Further, we conclude that the threshold for the stage of development at which regenerating forest becomes habitat for resident, adult marten is $18 \text{ m}^2/\text{ha}$ basal area of live trees with mean height of 9 m. Our results suggest that forestry practices that preserve characteristics of stand maturity in harvested stands (e.g., partial harvesting and snag retention) will benefit marten. We urge that additional research be conducted on effects of partial harvesting of forests on habitat quality for marten.

In contrast to the industrial forest, we detected few differences between areas receiving high versus low use by marten in the forest reserve. Factors other than the habitat characteristics we studied (e.g., intraspecific competition, access to mates, prey abundance) may influence choice of microsites by marten in areas where nearly all of the forested stands include mature trees, and where human harvesting has little influence on marten demographics.

Preliminary results of landscape-level and stand-level habitat selection by marten during the leaf-on season in the industrial forest indicate that, within mature ($> 9 \text{ m}$ mean tree height) closed canopy ($> 50\%$ canopy closure) forests, deciduous, coniferous, and mixed forest types were selected equally. At the level of the landscape, mature forest stands may have been selected over immature (6-9 m mean tree height) and young ($< 6 \text{ m}$ mean tree height) stands, although there was some site variability. During both leaf-on and leaf-off seasons, marten in the industrial forest township closed to trapping ($n=63$ marten during leaf-on and 21 marten during leaf-off) demonstrated stand-scale selection; i.e., young forest stands were avoided relative to mature and immature stands. In the industrial forest township open to trapping, no stand-scale selection was evident; habitats within home ranges of resident, adult marten ($n=37$ marten during leaf-on and 11 marten during leaf-off) were used in proportion to availability.

In the forest reserve, resident, adult marten did not demonstrate stand-scale selection during the leaf-on ($n=49$ marten) or leaf-off ($n=7$ marten) seasons; habitat types within home ranges (i.e., mature, closed canopy deciduous, coniferous and mixed forest stands, and stands regenerating following severe spruce-budworm defoliation 10-20 years previously) were used in proportion to availability. Further, landscape-scale selection was not evident here during the leaf-on season.

We are currently investigating habitat selection in relation to marten age (yearling, 1-2 years old, > 2 years old) and reproductive status (females only, lactating versus nonlactating). We are also analyzing marten demographics on the three study sites.

FUTURE PLANS: This work will be submitted as a Ph.D. dissertation in spring 1999. Several manuscripts are in preparation and will be submitted for publication in peer-reviewed journals.

PREY SELECTION BY HARBOR SEALS IN THE GULF OF MAINE SINK GILLNET FISHERY

Investigator: A. S. Williams

Advisors: J. R. Gilbert, Chairperson
F. A. Servello
R. S. Steneck
D. Palka

Cooperators/ National Marine Fisheries Service
Project National Biological Service
Support: University of Maine -
Department of Wildlife Ecology

Objectives:

- 1) Evaluate the diets of harbor seals caught in fishing nets.
- 2) Determine seasonal and spatial prey abundance and availability.
- 3) Estimate prey selection by harbor seals on commercial fish species.

SCOPE: The harbor seal (*Phoca vitulina*) is often accused of having negative effects on fishery yields in the northwestern Atlantic Ocean by preying on fish, damaging fish quality and tearing nets. Populations of seals in the Gulf of Maine have increased over the past twenty years. Potential loss of commercial fish to seals is a growing concern in the multispecies groundfish sink gillnet fishery. There is insufficient knowledge of the foraging ecology of seals to evaluate the effects of seal predation on the abundance of commercial fish stocks.

I will quantify the diets of harbor seals that were accidentally killed in gillnets. I will compare the food habits data, spatially and temporally, with quantities of available prey species and prey size.

PROJECT STATUS: Sample collection of whole animals and stomachs from seals killed in the commercial sink gillnet fishery has been completed through August 1997. Eighty-six stomachs have been analyzed. The ages of the seals have been estimated by counting the growth layer groups in the cementum of thin, stained sections of canine teeth. A Northeast Seal Working Group has been created to coordinate seal research projects requiring biological samples. Data on abiotic and biotic factors such as water temperature, depth, and prey abundance from the seal collection sites have been obtained and archived in Oracle tables.

FUTURE PLANS: Field work, lab analysis, and data archiving have been completed. Thesis completion is anticipated by May 1999.

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/ National Wild Turkey Federation -
Project Connecticut Chapter
Support: Wildlife Forever
 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 has been completed and data analysis is proceeding. Thesis completion is anticipated by December 1998.

NUTRITIONAL AND PHYSIOLOGICAL EFFECTS OF PLANT SECONDARY METABOLITES CONSUMED BY WHITE-TAILED DEER DURING WINTER

Investigator: J. W. Schneider

Advisors: F. A. Servello, Chairperson
 W. B. Krohn
 J. M. Rhymer
 B. J. Cole
 M. R. Stokes

Cooperators/ McIntire-Stennis

*Project
Support:*

- Objectives:*
- 1) Determine the effects of plant secondary metabolites in forages of white-tailed deer on foraging energetics and detoxification costs.
 - 2) Evaluate the effectiveness of urine indices for predicting diet quality and nutritional status for white-tailed deer consuming natural forage diets.
 - 3) Determine the interspecific variation of plant secondary metabolite levels in common forages consumed by white-tailed deer during winter.
 - 4) Determine the metabolic and energetic responses of deer to increasing concentrations of selected phenolic and terpenes compounds.

SCOPE: Research on foraging ecology of vertebrate herbivores has recently focused on the influence of plant secondary metabolites because of the effect these compounds have on forage selection and nutritional value. It has been suggested that forage selection by ruminants may be determined in part by the rate of detoxification or elimination of plant defensive chemicals, but there is little data on energetic costs of detoxification in deer. During winter in northern regions, white-tailed deer are exposed to diets which vary in types and concentrations of plant secondary metabolites. The primary goal of this study is to understand the metabolic and energetic costs of ingested phenolic and terpene compounds in winter diets of white-tailed deer in Maine. Experiments will be conducted using captive white-tailed deer fed natural forage diets and commercial pelleted diets formulated with specific secondary metabolites. Secondary goals of this study are to evaluate the use of detoxification metabolites as indices of diet quality and to evaluate several existing urinalysis methods for evaluating the nutritional status of deer during winter.

PROJECT STATUS: A series of digestion trials with captive deer fed diets of natural winter forages were completed in February-March 1996 to 1) test the use of glucuronic acid in urine as an index of diet quality, 2) evaluate detoxification costs, and 3) evaluate urea nitrogen and potassium (as ratios to creatinine) in urine as indexes of nutritional status. Glucuronic acid excretion was elevated on conifer diets and greatest on a balsam fir diet suggesting that this metabolite has potential as an indicator of diet composition and quality. Urea nitrogen:creatinine ratio was not affected by the potential biases of diet composition and food intake level. Potassium:creatinine ratio was a poor indicator of food intake.

FUTURE PLANS: Analysis of energetic costs of detoxification is in progress. Additional experimental work on this project has been terminated with the resignation of JWS to take a position at Pennsylvania State University.

INFLUENCE OF PARTIAL HARVESTING ON AMERICAN MARTEN AND THEIR PRIMARY PREY

<i>Investigator:</i>	A. K. Fuller
<i>Advisors:</i>	D. J. Harrison, Chairperson W. J. Jakubas J. M. Rhymer R. S. Seymour
<i>Cooperators/ Project Support:</i>	Maine Cooperative Forestry Research Unit Maine Department of Inland Fisheries and Wildlife Maine Agricultural and Forest Experiment Station

- Objectives:**
- 1) Compare changes in use of the landscape by marten before and after partial harvesting.
 - 2) Document stand-scale patterns of habitat selection by marten whose home ranges have been influenced by partial harvesting and compare to patterns of habitat selection of marten in areas without partial harvesting.
 - 3) Estimate small mammal and snowshoe hare densities in partially harvested stands and compare with mature and regenerating forest stands.
 - 4) Document and compare overstory, understory, and coarse woody debris characteristics among partially harvested stands and mature forest stands.

SCOPE: Habitat loss has been cited as a major cause of extinction of American marten (*Martes americana*) from parts of its original range. Forest harvesting practices in Maine are evolving to include increased reliance on partial harvesting (residual basal area > 6.9 m²/ha) and reduced reliance on clearcutting (residual basal area < 6.9 m²/ha). The influence of partial harvesting on marten habitat selection at the stand scale has been studied little, and the influence of partial harvesting on marten in a landscape matrix where extensive areas of regenerating clearcuts occur is speculative. Thus, we will investigate the responses of marten at the sub-stand, stand-, and landscape-scales to predict the influences of large-scale partial harvesting on marten habitat quality, and to evaluate current forest management objectives for marten.

Choice of forest stands by marten is also associated with food abundance, and it has been suggested that marten populations are proximally food regulated. We will compare small mammal densities in partially harvested stands to mature and regenerating forest stands and relate densities to microhabitat features, including coarse woody debris. Small mammals were live-trapped in 1997 and 1998 on 20 trapping grids in 6 forest types (n = 7 partial harvest, 7 mature mixedwood, 2 mature hardwood, 2 mature softwood, and 2 regenerating clearcut). Microhabitat features were measured at the trapping grids and will be used to evaluate the influence of stand and microsite variables on the abundance of small mammals. During a companion study in 1995, microhabitat features were measured on the trap grids for small mammals located in mature (n=11) and regenerating (n=2) forest stands.

PROJECT STATUS: We have had 19 marten (10M, 9F) whose home ranges comprise >20% partially harvested stands. Telemetry locations have been obtained year-round from ground and aircraft. Small mammal trapping was conducted in partially harvested and mature stands and resulted in 1,326 captures of 601 individuals [63% red-backed voles (*Clethrionomys gapperi*), 24% deer mice (*Peromyscus maniculatus*), 13% shrews (*Sorex cinereus* and *Blarina brevicauda*)] during 7,595 trap-nights in 1997 and 758 captures of 400 individuals [49% red-backed voles, 32% shrews, 15% deer mice, and 4% jumping mice (*Napaeozapus insignis*)] during 7,589 trap-nights in 1998. Microsite characteristics were sampled at 112 locations distributed across 7 grids used to census small mammals. Grids were located in forest stands that were partially harvested during 1992-1995. Snowshoe hare pellets were counted in Spring of 1998 on 5 m x 30 cm transects on the innermost 12 trapping stations within each grid used to census small mammals.

FUTURE PLANS: We will continue to collect telemetry locations on radiocollared animals through winter 1999. Project completion is scheduled for August 1999.

POPULATION AND HABITAT ECOLOGY OF BLACK TERNS IN MAINE

Investigator: F. A. Servello

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

Northern Maine National Wildlife Refuge Complex

Objectives:

- 1) Determine the annual local survival of breeding adult and nestling black terns (*Chlidonias niger*) for the Maine population, site fidelity to individual wetlands, and recruitment rates for major colonies.
- 2) Determine the relative effects of demographic parameters on population rates of change for black terns using demographic models and ultimately conduct a population viability analysis of the Maine population to evaluate extinction risk.
- 3) Determine and evaluate the quality of potential breeding habitat on a statewide basis.
- 4) Determine relationships among chick growth rates, food habits and chick provisioning rates by adults as a basis for assessing habitat quality.

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 <75 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's objectives address two primary conservation issues for black terns in Maine. Objectives 1 and 2 will provide information to assess the vulnerability of the existing population to extinction and its potential for future population growth. Objectives 3 and 4 will provide information to evaluate habitat as a limiting factor for black terns in Maine, the importance of habitat protection, and the potential for range expansion in the state.

PROJECT STATUS: The second year of field work has been completed and included banding of adults and nestlings, determination of nesting success in all colonies and fledging rate in selected colonies, and studies of food habits and provisioning rates. We also conducted pilot studies to develop protocols for studies of chick growth rates in nest enclosures. We have banded a total of 78 adults with metal and color bands for resighting individuals and have banded 101 nestlings in the 6 major colonies. We have estimated fledging rate and measured food habits and provisioning rates in 2-3 colonies per year by observing groups of nests from elevated tower blinds. We found that terns adapted readily to nest enclosures and preliminary chick growth studies were successful; however, precautions have to be taken to minimize potential for predation on chicks. Development of a black tern population model for sensitivity analyses of population parameters is in progress.

FUTURE PLANS: In 1999 we plan to expand banding, fledging rate, and foraging studies to all breeding colonies in Maine. A graduate student will begin work on assessing potential habitat in the state and on developing an observational technique based on a provisioning rate-chick growth rate relationship that will allow extensive monitoring of chick productivity in colonies on an annual basis with minimal disturbance to terns.

SPATIAL AND TEMPORAL PATTERNS OF HAUL-OUT USE BY BREEDING HARBOR SEALS

Investigator: N. Guldager

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

*Cooperators/
Project
Support:* National Marine Fisheries Service
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 affects 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 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 will also 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: Aerial surveys were completed in June 1997. The five years of census data have been geo-referenced using a Geographic Information System (GIS). Environmental variables were calculated by use of a GIS as of October 1998. Field data on haul-out numbers, tidal phase, time of day and weather conditions were collected in the Muscle Ridges in May and June of 1998.

FUTURE PLANS: Spatial and temporal analysis of aerial counts and environmental variables will be completed as of January 1999. Analysis of field data on the affect of tidal phase, time of day and weather conditions on haul-out numbers will be completed by February 1999. Project completion is scheduled for April 1999.

HABITAT USE AND NESTING SUCCESS OF THE WOOD TURTLE (*Clemmys insculpta*) IN WESTERN MAINE

- Investigator:* B. W. Compton
- Advisors:* J. M. Rhymer, Chairperson
M. A. McCollough
D. J. Harrison
A. D. Huryn
- Cooperators/Project Support:* Maine Department of Inland Fisheries and Wildlife
Central Maine Power
U. S. Fish and Wildlife Service -
Partnerships for Wildlife
Maine Outdoor Heritage Fund
McIntire-Stennis
University of Maine -
Department of Wildlife Ecology
- Objectives:*
- 1) Determine whether water releases from a dam upriver from the study site are reducing nesting success.
 - 2) Build and test a thermal model of nesting success (thermal regime is a hypothesized major limiting factor on nest survival in western Maine and a possible determinant of northern range limit). Predict northern range limit from thermal nesting success, and compare this with known distribution.
 - 3) Test effectiveness of Maine's Shoreland Zoning Ordinance at protecting wood turtle habitat; suggest size of vernal pool buffer zones needed to protect wood turtles.
 - 4) Test for nest site, hibernaculum, and home range fidelity over years.
 - 5) Model habitat selection at three scales: landscape, cover class, and microhabitat.

SCOPE: Wood turtle populations appear to be declining throughout their range. The wood turtle is listed in 13 of the 17 states in its range and is protected in the four Canadian provinces where it occurs. Wood turtle populations are threatened by habitat destruction and fragmentation, high populations of nest predators such as raccoons and skunks, road kills, and collection of adults for the pet trade. The wood turtle shares with most turtle species a life history strategy of low nest and juvenile survival, late maturity, and high adult survival that leaves it vulnerable to increases in adult mortality. The slow growth potential of turtle populations (population doubling times have been estimated in the thousands of years for some species) suggests that a strategy for conserving turtles must be especially proactive.

Wood turtle habitat use and population dynamics have not been well-studied, especially in New England. Preliminary work has shown that western Maine wood turtles use habitat differently from other populations that have been studied, and that constraints on nesting success differ. Wood turtles in the study population tend to move much greater distances and to use areas such as bogs where they are not found elsewhere in their range. Nesting success appears to be limited by the short, cool summers of western Maine, rather than by nest predators.

This project continues a radio-telemetry study of a population of wood turtles in western Maine initiated by Central Maine Power in 1994. Our goal is to obtain information that will be useful for conservation of wood turtles in Maine. We will model egg development based upon nest temperatures, and test this model with data collected from nests in the field as well in the laboratory. Habitat use will be modeled at three spatial scales, based upon habitat sampling at turtle locations and random locations.

PROJECT STATUS: Two field seasons have been completed. We tracked 36 radio-tagged wood turtles from June through August, 1997, and 37 from May through September, 1998. In 1997, we found and monitored 11 nests; none of these hatched, apparently because of low temperatures. Of the 15 nests found in 1998, 4 nests produced 23 hatchlings in the field, and 7 nests produced 41 hatchlings in incubators in the laboratory. We collected both field and laboratory temperature data for all nests.

We located 36 animals 1-2 times per week in 1997 (for a total of 962 locations), and 37 animals 1-3 times weekly in 1998 (1,298 locations). We sampled habitat at each location in 1997. In 1998, more detailed habitat data were sampled at each turtle location, as well as at random locations.

FUTURE PLANS: Data are currently being entered and analyzed. Project will be completed by December 1999.

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

SCIENTIFIC PUBLICATIONS

- BOOBAR, L.R., P.J. SPANGLER, K.E. GIBBS, J.R. LONGCORE, and K.M. HOPKINS. 1998. Predaceous diving beetles in Maine: Faunal list and keys to subfamilies. Northeastern Naturalist 5(1):1-20.
- COLE, M.B., and J.R. MORING. 1997. Potential error with in-situ surveys of smallmouth bass, *Micropterus dolomieu*, as determined by radio-telemetry. Fisheries Research 31:269-273.
- COLE, M.B., and J.R. MORING. 1997. Relation of adult size to movements and distribution of smallmouth bass in a central Maine lake. Transactions of the American Fisheries Society 126(5):815-821.
- BOONE, R.B. 1997. Modeling the climate of Maine for use in broad-scale ecological analyses. Northeastern Naturalist 4(4):213-230.
- DEMAYNADIER, P. and M.L. HUNTER, JR. 1998. Effects of silvicultural edges on the distribution and abundance of amphibians in Maine. Conservation Biology 12(2):340-352.
- DIEFENBACH, D.R., T.C. McCALL, G.A. PAQUETTE, T.P. HODGMAN, and R.B. OWEN, JR. 1996. A test of a habitat use model for American black ducks. Northeast Wildlife 53:35-44.
- DITCHKOFF, S.S., and F.A. SERVELLO. 1998. Litterfall: an overlooked food source for wintering white-tailed deer. Journal of Wildlife Management 62:250-255.
- FROST, H.C., and W.B. KROHN. 1997. Factors affecting the reproductive success of captive female fishers. Pages 100-109 in G. Proulx, H.N. Bryant, and P.M. Woodard (eds.) Martes: taxonomy, ecology, techniques and management. Provincial Museum of Alberta, Edmonton, Alberta, Canada. 474pp.
- HARTLEY, M., and M.L. HUNTER, JR. 1998. A meta-analysis of forest cover, edge effects and artificial nest predation rates. Conservation Biology 12(2):465-469.
- HEPINSTALL, J.A., and S.A. SADER. 1997. Using bayesian statistics, thematic mapper satellite imagery and breeding bird survey data to model bird species probability of occurrence in Maine. Photogrammetric Engineering and Remote Sensing 63(10):1231-1237.
- HUNTER, M.L., JR., and J. JAROS-SU. 1997. Insects, entomologists, and the conservation of biodiversity. Northeastern Naturalist 4(3):153-158.
- HUNTER, M.L., JR., and A.S. WHITE. 1997. Ecological thresholds and the definition of old-growth forest stands. Natural Areas Journal 17(4):292-296.
- KIRCHEIS, F.W., J.G. TRIAL, and T.A. HOFFMAN. 1997. Length conversion for lacustrine populations of Arctic charr, *Salvelinus alpinus*. Nordic Journal of Freshwater Research 73:24-27.

- KROHN, W.B., J. ZIELINSKI, and R.B. BOONE. 1997. Relations among fishers, snow, and martens in California: Results from small-scale spatial comparisons. Pages 211-232 in G. Proulx, H. N. Bryant, and P.M. Woodard (eds.) *Martes: taxonomy, ecology, techniques, and management*. Provincial Museum of Alberta, Edmonton, Alberta, Canada. 474pp.
- McCALL, T.C., T.P. HODGMAN, D.R. DIEFENBACH, and R.B. OWEN, JR. 1996. Beaver populations and their relation to wetland habitat and breeding waterfowl in Maine. *Wetlands* 16:163-172.
- McCLEAVE, J.D., P.J. BRICKLEY, K.M. O'BRIEN, D.A. KISTNER, M.W. WONG, M. GALLAGHER, and S.M. WATSON. 1998. Do leptocephali of the European eel swim to reach continental waters? Status of the question. *Journal of the Marine Biological Association of the United Kingdom* 78:285-306.
- PHILLIPS, D.M., D.J. HARRISON, and D.C. PAYER. 1998. Seasonal changes in home-range area and fidelity of martens. *Journal of Mammalogy* 79:180-190.
- SADER, S.A., C. REINING, T. SAVER, and C. SOZA. 1997. Human migration and agricultural expansion: an impending threat to the Maya Biosphere Reserve. *Journal of Forestry* 95(12):27-30.
- VICKERY, P.D., M.L. HUNTER, JR., and S.M. MELVIN. 1997. Effect of habitat area on the distribution of grassland birds in Maine and New England. Pages 137-152 in P. D. Vickery and P. W. Dunwiddie (eds.) *Grasslands of northeastern North America*. Massachusetts Audubon Society, Lincoln, MA. 297pp.
- WHITMAN, A.A., M.L. HUNTER, JR., and J.W. WITHAM. 1998. Age distribution of ramets of a forest herb, Wild Sarsaparilla, *Aralia nudicaulis* (Araliaceae). *Canadian Field-Naturalist* 112(1):37-44.

TECHNICAL AND SEMI-TECHNICAL PUBLICATIONS

- BARTLETT, R. I., J. A. HEPINSTALL, and W. B. KROHN. 1997. Maine wildlife habitats identified from spring versus fall aerial videography (Abstract). Page 135 in Ostrofsky and Krohn (1997).
- BOONE, R. B., and W. B. KROHN. 1997. Species occurrence: what, why, and where? Pages 3-6 in E.S. Brackney and M. D. Jennings (eds.) *Gap Analysis - Bulletin No. 6, Gap Analysis Program, U.S. Geological Survey - Biological Resources Division, Moscow, Idaho*. 68pp.
- BOONE, R. B., and W. B. KROHN. 1997. Forest birds and woody plants: broad-scale habitat relations in the north Maine woods (Abstract). Page 144 in Ostrofsky and Krohn (1997).
- GIBBS, J., M.L. HUNTER, JR., and E. STERLING. 1998. Problem-solving in conservation biology and wildlife management: Exercises for class, field, and laboratory. Blackwell Science, Malden, MA. 215pp.
- HIGGINS, J., A.F. O'CONNELL, JR., and F.A. SERVELLO. 1998. Survey of flying squirrels and their association with vegetative communities on Mount Desert Island (Acadia National Park), Maine. Final Report to the National Park Service. 18pp.
- KROHN, W., and S. SADER. 1997. Maine (a progress report on Maine Gap Analysis). Pages 44-45 in E.S. Brackney and M. D. Jennings (eds.) *Gap Analysis - Bulletin No. 6, Gap Analysis Program, U.S. Geological Survey - Biological Resources Division, Moscow, Idaho*. 68pp.

- KROHN, W. B., and R. B. BOONE. 1997. Biodiversity and the north Maine woods - what's all the fuss? (Abstract). Page 1 in Ostrofsky and Krohn (1997).
- MAGEEAN, D.M., and J.G. BARTLETT. 1998. Humans and hexagons: using population data to address the problem of human dimensions of environmental change. Pages 193-205 in S. Morain (ed.) GIS Solutions in Natural Resource Management: balancing the technical-political equation. Onward Press, Santa Fe, NM.
- MORING, J.R., O. VAN DEN ENDE, and K.S. HOCKETT. 1998. Predation on Atlantic salmon smolts in New England rivers. Pages 127-139 in S. Mc Cormick and D. MacKinlay (eds.) Smolt physiology, ecology, and behavior. Proceedings of the International Congress on the Biology of Fish.
- MORING, J.R. 1997. Lewis and Clark's trout. Persimmon Hill 25(4):28-30.
- O'CONNOR, R.J., P.R.H. NEVILLE, and T.B. BENNETT. 1998. Indicators of resources and landscapes. Pages 165-181 in S. Morain (ed.) GIS Solutions in Natural Resource Management: balancing the technical-political equation. Onward Press, Santa Fe, NM.
- OSTROFSKY, W., and W.B. KROHN (eds.). 1997. Our forest's place in the world: New England and Atlantic Canada's forests. Proceedings of a joint meeting of the New England Society of American Foresters, Maine Chapter of The Wildlife Society, and Northeastern Forest Pest Council. Maine Agricultural and Forestry Experiment Station, Miscellaneous Report No.738 (SAF Publication No. 98-01). University of Maine, Orono. 146pp.
- PAYER, D.C., and D.J. HARRISON. 1998. Effects of forest structure on spatial distribution of American marten. Final contract report submitted to National Council of the Paper Industry for Air and Stream Improvement (NCASI). 48pp.

THESES AND DISSERTATIONS

- FINLAYSON, R.T. 1998. Factors affecting food chain uptake of mercury in a riverine ecosystem highly contaminated by industrial discharge. M.S. Thesis, University of Maine, Orono, Maine. 68pp.
- GALLAGHER, M. 1998. Distribution and status of redbfin pickerel (*Esox americanus americanus*) in central and southern Maine. M.S. Thesis, University of Maine, Orono, Maine. 56pp.
- JOHNSON, C.M. 1998. Spatial and temporal considerations for identifying important seabird nesting habitats in Maine. Ph.D. Dissertation, University of Maine, Orono, Maine. 131pp.
- MATZ, A.C. 1998. Organochlorine contaminants and Bald Eagles (*Haliaeetus leucocephalus*) in Maine: investigations at three ecological scales. Ph.D. Dissertation, University of Maine, Orono, Maine. 120pp.
- McLAUGHLIN, C.R. 1998. Modeling effects of food and harvests on female black bear populations. Ph.D. Dissertation, University of Maine, Orono, Maine. 263pp.
- MONTI, L.M. 1997. Redback salamander (*Plethodon cinereus*) habitat preferences in a Maine oak-pine forest. M.S. Thesis, University of Maine, Orono, Maine. 53pp.

WEBBER, H.M. 1998. Effects of methylmercury on the predator avoidance behavior of a freshwater forage fish, golden shiner (*Notemigonus crysoleucas*). M.S. Thesis, University of Maine, Orono, Maine. 63pp.

PROFESSIONAL TALKS PRESENTED

BOONE, R.B. "Issues of predicting vertebrate species distributions." U.S. Chapter of the International Association of Landscape Ecologists, East Lansing, MI. March 18, 1998.

BOONE, R.B., and W.B. KROHN. "Evidence of a transition zone in birds." Maine Bird Conference, Bates College, Lewiston, ME. May 2, 1998.

DANIELS, L.R. "Food habits of American eels in lakes of Maine." Northeast Fish and Wildlife Conference, Camp Hill, PA. May 6, 1998.

DEMAYNADIER, P., and M.L. HUNTER, JR. "Forest canopy closure and dispersal by pool-breeding amphibians in Maine." National Conference of the Society for the Study of Amphibians and Reptiles, University of Guelph, Canada. June 18-21, 1998.

DIMAURO, D., and M.L. HUNTER, JR. "Reproduction of amphibians in natural and anthropogenic pools in industrial forests." Poster presentation at conference entitled Our Hidden Wetlands: Vernal Pools in Connecticut, given by the Connecticut Department of Environmental Protection/Yale School of Forestry, Middletown, CT. November 15, 1997.

FULLER, A.K., and D.J. HARRISON. "Use of partially harvested stands by American marten: A preliminary analysis." Poster presented at Euro-American Mammal Congress, Santiago de Compostela, Spain. July 23, 1998.

GARMAN, G.C., and J.R. MORING. "Immediate and long-term changes in a boreal river macroinvertebrate community following watershed deforestation and recovery." Annual Meeting of the Ecological Society of America, Baltimore, MD. August 3, 1998.

GILBERT, J.R. "Status of attempts to estimate population trends of walrus." Symposium on Surveys, Status and Trends of Marine Mammal Populations, Seattle, WA. February 25-27, 1998.

GILBERT, J.R. Chaired a meeting of the Atlantic Scientific Review Group for Marine Mammal Protection Act, Sarasota, FL. May 20-22, 1998.

HARTLEY, M. "Forestry in Sweden: shifting paradigms." Forest Ecology Seminar Series, University of Maine, Orono. January 30, 1998.

HARRISON, D.J. "Habitat ecology of American marten: specialist or generalist?" Invited presentation in symposium entitled Mustelids in a Modern World, Euro-American Mammal Congress, Santiago de Compostela, Spain. July 23, 1998.

HUNTER, M.L., JR. "Maintaining forest biodiversity." University of British Columbia, Vancouver, BC. October 22, 1997.

HUNTER, M.L., JR. "Maintaining biodiversity in forest ecosystems." Danum Valley Conservation Center, Sabah, Malaysia. March 10, 1998.

- HUNTER, M.L., JR. Chaired a session entitled "Natural disturbance regimes as models for managing ecosystems" at a meeting of the Society for Conservation Biology, Sydney, Australia. July 14, 1998.
- KROHN, W.B. "Biodiversity and the north Maine woods - what's all the fuss?" Slide presentation to the Department of Wildlife Ecology's seminar series, University of Maine, Orono. November 24, 1997.
- KROHN, W.B., and J.R. MORING. "What's going on at the Maine Cooperative Fish and Wildlife Research Unit?" Presentations to the U.S. Geological Survey's state office in Augusta, ME. December 22, 1997.
- KROHN, W.B., and R.B. BOONE. "Spatially explicit landscape analyses: two examples from Maine Gap Analysis." Slide presentation to the Maine Chapter of the Wildlife Society, Augusta, ME. February 3, 1998.
- KROHN, W.B., and R.B. BOONE. "A quantitative approach to setting land conservation priorities at various scales." Invited slide presentation to the Maine State Planning Office, Augusta, ME. May 5, 1998.
- KROHN, W.B., J.A. HEPINSTALL, and R.B. BOONE. "Alternative approaches to landscape analyses of southern Maine." Hosted a workshop for the Maine Department of Inland Fisheries and Wildlife, University of Maine, Orono. March 13, 1998.
- MORING, J.R. "A century of fish culture: the culture of smelt (*Osmeridae*)." Aquaculture '98, Las Vegas, NV. February 17, 1998.
- MORING, J.R. "Early fisheries investigations and the decline of Atlantic salmon." Department of Biological Sciences, University of Massachusetts-Boston, Boston, MA. March 23, 1998.
- MORING, J.R. "The Maine Atlantic Salmon Plan: obstacles and opportunities." 1998 Maine Water Conference, Augusta, ME. April 16, 1998.
- MORING, J.R. "Connecticut River fisheries: the past and the future." Annual Meeting of the American Fisheries Society, Hartford, CT. August 24, 1998.
- MORING, J.R., O. VAN DEN ENDE, and K.S. HOCKETT. "Predation on Atlantic salmon smolts in New England waters." International Congress on the Biology of Fish, Towson, MD. July 29, 1998.
- O'CONNOR, R.J. "A prototype national ecological risk assessment." Presentation to USEPA Office of Pesticide Programs staff, Washington, DC. October 15, 1997.
- O'CONNOR, R.J. "A national risk assessment using Breeding Bird Survey data." University of New Brunswick, Department of Forestry and Environmental Science, Fredericton, NB. October 24, 1997.
- O'CONNOR, R.J. Organized a workshop on exploratory multivariate statistics in ecology, University of New Brunswick, Department of Forestry and Environmental Science, Fredericton, NB. October 25-26, 1997.
- O'CONNOR, R.J., and C. HAHN. "Scaling of host and environmental patchiness in the distribution of Brown-headed Cowbirds." Poster presented at the symposium "Research and Management of the Brownheaded Cowbird in Western and Eastern Landscapes," Research Working Group of Partners in Flight, Sacramento, CA. October 23-25, 1997.

O'CONNOR, R.J., J.G. BARTLETT, and D.M. MAGEEAN. "Indexing the human dimensions of global environmental change." Poster and presentation GCTE-LUCC Open Science Conference on The Earth's Changing Land, Barcelona, Spain. March 14-18, 1998.

O'CONNOR, R.J., D.M. MAGEEAN, and J.G. BARTLETT. "Indexing the human dimensions of global environmental change." Presentation to the Eastern U.S. Forest Modeling and Analysis Workshop, Raleigh, NC. May 13-15, 1998.

O'CONNOR, R.J. "Hierarchical models of human-environment relations." Presentation to the Biodiversity Research Meeting, USEPA Environmental Research Laboratory, Corvallis, OR. May 27-28, 1998.

SCHAEFER, S.M. "A new approach to testing predicted vertebrate occurrences from Gap Analysis." Presentation to the Northeast Wildlife Graduate Student Conference, University of New Brunswick, Fredericton, New Brunswick, Canada. March 6-8, 1998.

PUBLIC TALKS PRESENTED

BOONE, R.B. "Correlates of vertebrate richness in Maine." Guest lecture to WLE 200, Ecology class, University of Maine, Orono. December 3, 1997.

BOONE, R.B. "An assessment of vertebrate diversity in Maine." Guest lecture to WLE 650, Wildlife Habitat class, University of Maine, Orono. December 8, 1997.

COMPTON, B.W., and M.A. MCCOLLOUGH. Interview with Maine Sunday Telegram for an article on wood turtles in Maine. March 15, 1998.

COMPTON, B.W., J.M. RHYMER, and M.A. MCCOLLOUGH. Interview with Habitat: Journal of the Maine Audubon Society for an article on wood turtle research in Maine. Summer 1998.

DANIELS, L.R. "Feeding by American eels." Graduate Student Colloquium series, Department of Biological Sciences, University of Maine, Orono, ME. November 7, 1997.

DANIELS, L.R. Presented several science talks for middle school girls as part of the University of Maine's Raising Aspirations Program, Orono, ME. March 4, 1998.

GALLAGHER, M. "Designing a test for anesthetic use and healing ability in American eel." Graduate Student Colloquium series, Department of Biological Sciences, University of Maine, Orono, ME. October 10, 1997.

GILBERT, J.R. Interview with Hartford Courant on the topic of seals, Hartford, CT. January 6, 1998.

GILBERT, J.R. Interviewed by the Boston Globe regarding seals in New England. April 22, 1998.

GILBERT, J.R. "Wildlife ecology." Talk given at Future Farmers of America State Convention. May 15, 1998.

GILBERT, J.R. Guest speaker at University of Maine Wildlife Society meeting, Orono. September 23, 1998.

HARRISON, D.J. Interviewed for article in fall 1997 issue of Maine Perspective magazine on wolf-habitat research project.

HARRISON, D.J. Interviewed by Boston Globe regarding wolf research for newspaper article. October 15, 1997.

HARRISON, D.J. Interviewed by National Geographic Science Magazine for article on urban coyotes. October 15, 1997.

HARRISON, D.J. "An assessment of potential habitat for eastern timber wolves in the northeastern United States." Presentation at meeting of eastern wolf experts, Sherbrook, Quebec. October 23, 1997.

HARRISON, D.J. "Policy and ecological issues influencing wolf recovery in eastern North America." Presentation to ecology class, University of Maine, Orono. December 8, 1997.

HARRISON, D.J. Attended meeting as advisor to The Nature Conservancy regarding landscape-level planning for wildlife habitat. January 21, 1998.

HARRISON, D.J. Interviewed for article on coyotes that appeared in February 1998 issue of the Maine Times.

HARRISON, D.J. and A.K. FULLER. "Status of ongoing studies of American marten." Presentation to Maine Trappers Association, Augusta, ME. March 27, 1998.

HARRISON, D.J. and D.C. PAYER. "Substand-level habitat use by American marten: recommendations for foresters." Presentation to Advisory Committee, Cooperative Forestry Research Unit, Orono, ME. April 29, 1998.

HARRISON, D.J. "Habitat and population status of wolves, lynx, and cougar in Maine." Presentation at seminar series sponsored by Maine Audubon, Falmouth, ME. April 29, 1998.

HARRISON, D.J. "A short summary of results from ongoing studies of American marten in Maine." Newfoundland Marten Recovery Team, Grand Falls-Windsor, Newfoundland, Canada. May 13, 1998.

HARRISON, D.J. "Adaptions of animals to their environment." Presentation to first-grade class, McGraw School, Hampden, ME. June 8, 1998.

HARRISON, D.J. Interview with Providence Journal on coyote behavior and ecology. August 31, 1998.

HARRISON, D.J. Interview with Wall Street Journal on coyote behavior and ecology. August 31, 1998.

HARRISON, D.J. Presented 2 guest lectures on survival analysis in Evaluation of Wildlife Populations class. September 17 and 19, 1998.

HARRISON, D.J. Interviewed by Portland Press Herald for article on wolf recovery issues in Maine. September 13, 1998.

HARRISON, D.J. Interviewed by Bangor Daily News on issues related to proposed listing of lynx as a threatened species by the U.S. Fish and Wildlife Service. September 15, 1998.

HARRISON, D.J. "Potential habitat for eastern timber wolves in Maine." Eastern Wolf Recovery Meeting, Pinkham Notch, NH. September 29, 1998.

HUNTER, M.L., JR. "Biodiversity: What is it? Why do we care about it?" Slide show presentation sponsored by Support for Science Students Program, University of Maine, Orono. April 6, 1998.

- HUNTER, M.L., JR. "A naturalist in Borneo." Guest lecture to Student Chapter of The Wildlife Society, University of Maine, Orono. April 21, 1998.
- KROHN, W.B. "A preliminary gap analysis of Maine: conservation and policy implications." Post-banquet slide presentation at annual meeting of the Maine Chapter of The Nature Conservancy, Northeast Harbor, ME. October 4, 1997.
- LÊ, J.B. "Brook trout movements." Graduate Student Colloquium series, Department of Biological Sciences, University of Maine, Bar Harbor, ME. May 27, 1998.
- LEAMAN, N. "The relationship between age, sex and river to the total mercury concentrations in the whole body and fillet of the American eel, *Anguilla rostrata*." Graduate Student Colloquium series, Department of Biological Sciences, Orono, ME. June 15, 1998.
- MORING, J.R. Interviewed by the Hartford Courant for an article on the Connecticut River. August 25, 1998.
- MORING, J.R., and J.B. LÊ. Interviewed by the Bar Harbor Times for an article on fish studies at Acadia National Park. June 6, 1998.
- O'CONNOR, R.J. Panelist: "Silent Spring at 35." University of Maine. November 19, 1997.
- O'CONNOR, R.J. Interviewed for Conservation Science and Society by WERU, Blue Hill, ME Community Radio. May 28, 1998.
- O'CONNOR, R.J. Member, NSF Workshop on Biodiversity Observatories. Blandy Farm and Arboretum, Boyce, VA. September 9-12, 1998.
- PAYER, D.C. "Influence of microsite characteristics on patterns of habitat occupancy by American marten." Presentation at seminar series sponsored by the Department of Wildlife Ecology, University of Maine. November 3, 1997.
- PAYER, D.C. "Structural differences between forests regenerating following spruce-budworm infestations and clearcutting, with implications for American marten." Presentation at seminar series sponsored by the Department of Wildlife Ecology, University of Maine. November 3, 1997.
- PAYER, D.C. "Marten research and management in Maine." Talk presented to Aroostook Chapter of Maine Trapper's Association. April 14, 1998.
- WITHAM, J.W. "Fifteen years of bird population studies at Holt Research Forest." Presented to Stanton Bird Club, Auburn, ME. April 6, 1998.

AWARDS, HONORS, AND APPOINTMENTS

- DANIELS, L.R. Received the Horace Bond Graduate Fisheries Scholarship from the Penobscot County Conservation Association. Fall 1997.
- HARRISON, D.J. Served as scientific advisor to marten demographics study conducted by Western Newfoundland Model Forest and Canadian Forest Service.

MORING, J.R. Appointed a voting member of the Technical Advisory Committee for the Maine Atlantic Salmon signatories. Also serves as Chair of the Research Working Group for the Committee.

MORING, J.R. President of the Fisheries History Section of the American Fisheries Society, and co-editor of the section's Newsletter.

MORING, J.R. Member of the Governing Board of the American Fisheries Society and appointed chair/member of three standing committees.

O'CONNOR, R.J. Member USEPA's ECOFRAM Working Group on probabilistic risk assessment methods for pesticide effects.

O'CONNOR, R.J. Member Partners in Flight Landbird Monitoring Strategy Working Group.

