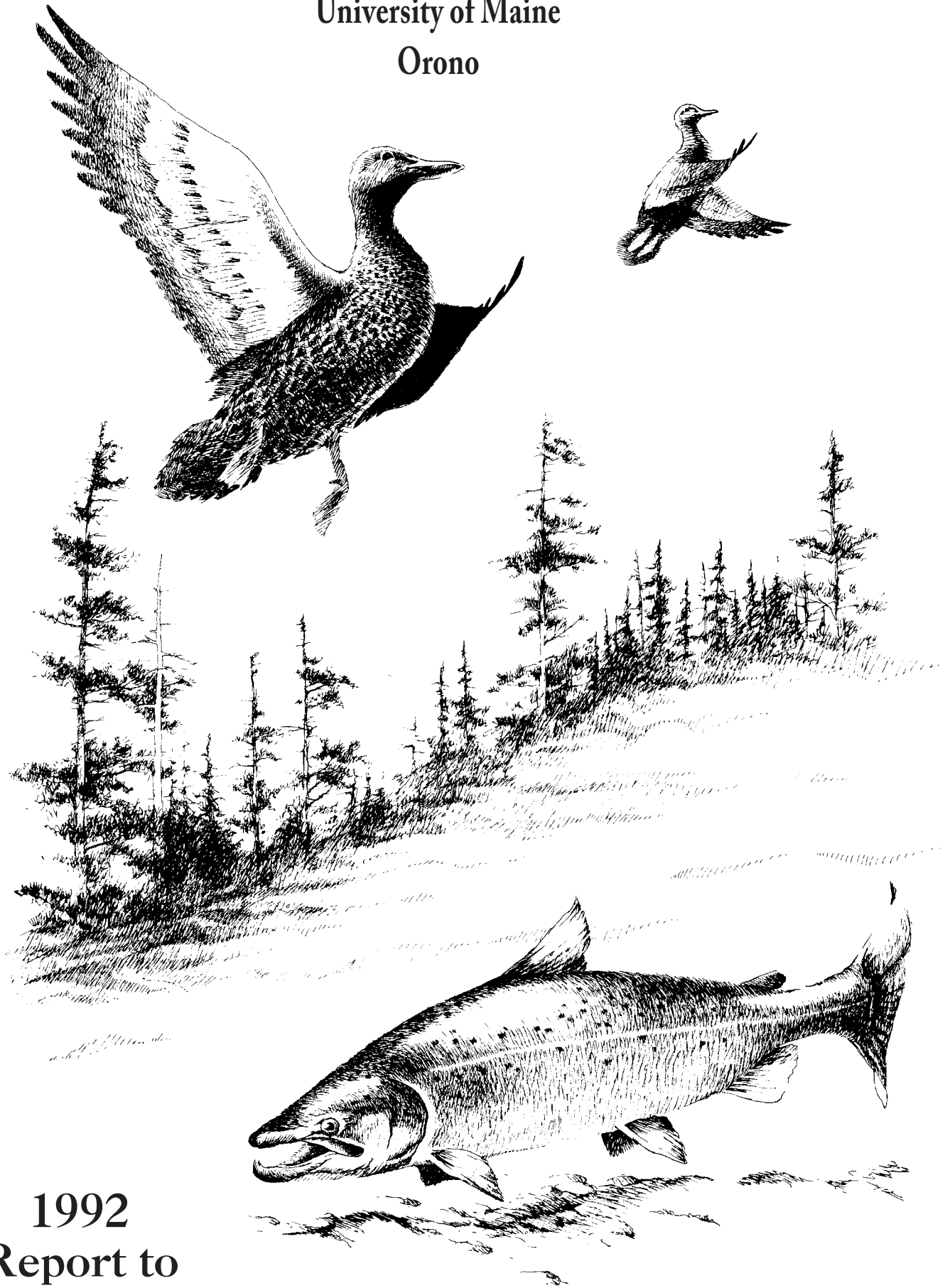


# MAINE COOPERATIVE FISH AND WILDLIFE RESEARCH UNIT

University of Maine

Orono



1992  
Report to  
Cooperators

—Mark McCollough '86

## MAINE COOPERATIVE FISH AND WILDLIFE RESEARCH UNIT

240 Nutting Hall\*  
University of Maine  
Orono, Maine 04469



### COOPERATORS

UNIVERSITY OF MAINE



DEPARTMENT OF INLAND FISHERIES AND WILDLIFE

FISH AND WILDLIFE SERVICE, U.S. DEPARTMENT OF THE INTERIOR

WILDLIFE MANAGEMENT INSTITUTE



October 1991 - September 1992



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 Murray Hall and is part of the Department of Zoology, College of Sciences; the Unit's Wildlife Program is located in Nutting Hall and is part of the Department of Wildlife, College of Forest Resources.



## TABLE OF CONTENTS

	Page
<b>PERSONNEL AND COOPERATORS</b> .....	iv
Coordinating Committee .....	iv
Unit Personnel .....	iv
Graduate Students .....	v
Dissertations and Theses Completed .....	vi
Personnel Notes .....	vi
Collaborating Agencies & Organizations .....	vii
 <b>PROJECT REPORTS</b> .....	 1
 <b>ENDANGERED AND THREATENED SPECIES</b>	
Finback Whale Photographic Identification Methodology in the Western North Atlantic .....	1
Analysis of Factors Affecting Population Viability of Birds .....	2
Analysis of Factors Affecting Population Viability and Reintroduction Attempts for Fisher and Other Mammals in Acadia National Park .....	3
Contaminant Burdens and Reproductive Rates of Bald Eagles Breeding in Maine .....	4
 <b>FISHERIES RESOURCES</b>	
Comparison of Two Stream Habitat Assessment Techniques in the White and Green Mountain National Forests .....	5
Population Studies of Maine Intertidal Fishes .....	6
Movements and Spawning Success of Displaced Largemouth Bass .....	6
Downstream Mortality of Atlantic Salmon Smolts in the Penobscot River, Maine .....	7
Upstream Migration of Atlantic Salmon in the Penobscot River .....	8
Refinement and Testing of the Habitat Suitability Index Model for Atlantic Salmon .....	8
Fish Predators of Atlantic Salmon in the Penobscot River .....	9

Susceptibility of Atlantic Salmon Smolts to Predation by Double-crested Cormorants . . . . .	10
Daily and Seasonal Movement of Smallmouth Bass . . . . .	10
Growth, Survival and Performance of Stocked and Wild Brook Trout in Lakes with Heavy Competition . . . . .	11

## HABITAT RESOURCES

Construction of a Database Used in Analyses of Bird Populations and Agriculture, With a Study of Density Dependence . . . . .	11
Birds and the Conservation Reserve Program: A Retrospective Study . . . . .	13
The Effects of Clearcut Size on Bird Species Richness and Nest Predation Rates in Northeastern Maine . . . . .	14
Comprehensive Multiple-Use Management Strategy for Future Research and Management of Moroccan Coastal Wetlands . . . . .	15
The Nesting Ecology and Habitat Requirements of Blueberry Barren Avifauna . . . . .	16
A Long-Term Forest Ecosystem Study . . . . .	17
Effects of Heavy Metals on Fishes and Eagles of the Northeastern United States . . . . .	18
Frugivory and Seed Dispersal of Fleshy Fruiting Plants in an Oak-Pine Forest . . . . .	19
Effects of Landspredding Pulp and Paper Mill Sludge in Regenerating Forestland on Wildlife Populations . . . . .	21
Effects of Digestible Energy Content of Winter Forages on White-tailed Deer Nutritional Ecology: Implications for Forage-based Carrying Capacity in Deer Wintering Areas . . . . .	21
Effects of Glyphosate Application on Winter Clearcut Use by Moose in Northern Maine . . . . .	22
Effects of Glyphosate on Winter Nutritional Ecology of Moose in Maine . . . . .	23
Effectiveness of Planned Skips for Maintaining Wildlife Habitat in Herbicide-treated Clearcuts in Maine . . . . .	24
Quantifying the Relationship of Forest Management to Maine's Marten Harvest with a Geographic Information System . . . . .	24
Seed Predation by Small Mammals on Three Tree Species in Southern Maine . . . . .	25
Forest Fragmentation and Barriers to Wildlife Dispersal . . . . .	26
New England Biodiversity Project (EMAP) . . . . .	27

Application of Satellite Data to Quantify Neotropical Habitat for Migrant Land Birds Wintering in Belize . . . . .	29
An Analysis of Biodiversity in New England: GIS Assessment of Terrestrial Vertebrate Diversity in Maine . . . . .	29

#### WILDLIFE RESOURCES - MIGRATORY BIRDS

Bioenergetics of American Woodcock During the Breeding Season on Moosehorn National Wildlife Refuge, Maine . . . . .	31
Birds of Maine's Peatlands . . . . .	32
Birds as an Index of Biotic Integrity of Lakes in New England . . . . .	33
Habitat Use by Black Ducks and Mallards on Missisquoi National Wildlife Refuge . . . . .	34
Breeding Ecology of Greater Scaup in the Saint John River Valley, New Brunswick . . . . .	35
Ecology of the Double-crested Cormorant in the Penobscot River Ecosystem with Emphasis on Smolt Predation . . . . .	36
Avian Bioindicator Dynamics . . . . .	37

#### WILDLIFE RESOURCES - OTHER THAN MIGRATORY BIRDS

Spatial Use, Territoriality, and Summer-Autumn Selection of Habitat in an Intensively Harvested Population of Martens on Commercial Forestland in Maine . . . . .	38
Population Dynamics of Pacific Walruses . . . . .	39
1990 Walrus Population Estimate . . . . .	40
Population Ecology of Female Black Bears in Maine . . . . .	41
A Survey of Bear Hunters in Maine: Hunting Effort, and Success Rates, and Attitudes About Bear Hunting Policies . . . . .	42
Survival and Sustainability of a Heavily Harvested Marten Population . . . . .	43
Relationship of Beaver Management and Waterfowl Production in Southcentral Maine . . . . .	44
Reproductive Biology of Captive Fishers . . . . .	45
Ecology of Spruce Grouse in Acadia National Park and on Mount Desert Island . . . . .	47
White-tailed Deer Mortality, Population Dynamics, Movements, and Spatial Interactions with Coyotes in Acadia National Park, Maine . . . . .	47
Spatial Relationships and Dispersal Characteristics in an Unexploited American Marten Population . . . . .	48

Population Status and Habitat Use of Blanding's and Spotted Turtles in Southwestern Maine .....	49
--	----

PUBLICATIONS, THESES AND DISSERTATIONS, PROFESSIONAL AND PUBLIC TALKS GIVEN, AND AWARDS .....	51
--	----

## PERSONNEL AND COOPERATORS

### COORDINATING COMMITTEE

Maine Department of Inland Fisheries and Wildlife  
William J. Vail, Commissioner

University of Maine

Ray B. Owen, Jr., Chairperson, Department of Wildlife, College of Forest Resources  
Bonnie G. Wood, Chairperson, Department of Zoology, College of Sciences

U.S. Fish and Wildlife Service

W. Reid Goforth, Supervisor, Cooperative Fish and Wildlife Research Units Center,  
Washington Office  
John F. Organ, Federal Assistance, Region 5

Wildlife Management Institute

Rollin D. Sparrowe, President

### UNIT PERSONNEL

Unit Staff:

William B. Krohn, Unit Leader, Professor of Wildlife and Cooperating Professor of Zoology  
John R. Moring, Assistant Unit Leader for Fisheries, Professor of Zoology  
MaryEllen Chilelli - Assistant Scientist, Wildlife  
Susan Anderson, Administrative Assistant - Unit and USFWS-NFCRC  
Maxine L. Horne, Unit Administrative Assistant - Wildlife  
Shirley Moulton, Secretary - Wildlife

Associated Faculty and Staff, Departments of Wildlife and Zoology:

Ray B. Owen, Jr., Chairperson, Department of Wildlife, College of Forest Resources, and Professor  
of Wildlife  
Bonnie G. Wood, Chairperson, Department of Zoology, College of Sciences, and Professor of  
Zoology  
James R. Gilbert, Professor of Wildlife  
William E. Glanz, Associate Professor of Zoology and Cooperating Associate Professor of Wildlife  
Kevin J. Boyle, Associate Professor, Department of Agriculture and Resource Economics, and  
Cooperating Associate Professor of Wildlife  
Daniel J. Harrison, Assistant Professor of Wildlife  
Malcolm L. Hunter, Jr., Professor of Wildlife  
Allen O'Connell, Faculty Associate and Leader, Cooperative National Park Unit  
Raymond J. O'Connor, Professor of Wildlife  
Frederick A. Servello, Assistant Professor of Wildlife  
Jerry R. Longcore, Faculty Associate, Wildlife, and Research Wildlife Biologist, USFWS  
James A. Sherburne, Director, International Programs and Professor of Wildlife

Terry A. Haines, Professor of Zoology and Fishery Research Biologist, USFWS  
 Ruth W. Perry, Technician, Zoology  
 Elizabeth Moore, Research Assistant, Wildlife  
 Jack Witham, Assistant Scientist, Wildlife  
 Thomas Hodgman, Research Associate, Wildlife

**Maine Department of Inland Fisheries and Wildlife:**

William J. Vail, Commissioner  
 Norman E. Trask, Deputy Commissioner  
 Frederick B. Hurley, Jr., Director, Bureau of Resource Management  
 Gary Donovan, Director, Wildlife Division  
 Peter Bourque, Director, Fisheries and Hatcheries Division  
 George J. Matula, Jr., Supervisor, Wildlife Resource Assessment Group  
 Kendall Warner, Supervisor, Fisheries Research and Management Section

**GRADUATE STUDENTS**

Name	Degree Candidacy	Support
Cathryn Abbott	M.S.	USFWS
Beverly A. Agler	M.S.	Personal Funding
Bradley Blackwell	Ph.D.	MCFWRU, USFWS
Randall B. Boone	Ph.D.	MCFWRU, USFWS
Merrie Cartwright	M.S.	MDIFW
Theodore Chapin	M.S.	McIntire-Stennis
Michael Cole	M.S.	MDIFW
Phillip de Maynadier	Ph.D.	McIntire-Stennis
Stephen Ditchkoff	M.S.	McIntire-Stennis
Mustapha El Hamzaoui	M.W.C.	USAID/USDA
William E. Eschholz	M.S.	CFRU, MCFWRU
Herbert C. Frost	Ph.D.	MDIFW, MCFWRU
Brian Gray	M.S.	McIntire-Stennis
Stephen Glass	Ph.D.	ANP
Christopher Hartleb	Ph.D.	MDIFW
Susan Hills	Ph.D.	USFWS-AFWRC
Karen Hockett	M.S.	USFWS
Malcolm T. Jones	Ph.D.	CPM
Lisa Joyal	M.S.	U of M
Donald Katnik	M.S.	McIntire-Stennis
Charles Kitchens	M.S.	USFWS
Daniel H. Kusnierz	M.S.	DWRS, NBDNRE
T. Bruce Lauber	M.S.	CPM
Laurance Lisle	M.W.C.	Personal Funding
Thomas C. McCall	M.S.	Hatch, McIntire-Stennis
Karen McCracken	Ph.D.	U of M
Daniel McKinley	M.S.	USFS
Craig R. McLaughlin	Ph.D.	Personal Funding
Amanda Moors	M.S.	EPA
Deborah Moreau	M.S.	USFWS
Ramona Muller-El Hamzaoui	M.W.C.	Intl. Programs Office, CASS Project



Sara Oyler	M.S.	EPA
David Phillips	M.S.	U of M
Michael W. Powell	M.S.	U of M
Kevin S. Raymond	M.S.	CFRU, MCFWRU
Tamia Rudnický	M.S.	McIntire-Stennis, Personal Funding
Steven L. Shepard	M.S.	BHE
Craig P. Stafford	M.S.	U of M
Sarah S. Stockwell	Ph.D.	Personal Funding
Marcia Summers	M.S.	Personal Funding (Grad. School Assistantship)
Oliver van den Ende	M.S.	USFWS-NEAFL
W. Matthew Vander Haegen	Ph.D.	U of M, USFWS (NEC, MNWR), PCCA, HWR, TBF
Agnes M. Vanderpool	M.S.	USFWS
Christopher Vera	M.S.	RCS, SCP
Peter D. Vickery	Ph.D.	NC, MAS, MPCB, MAAS, CB
Linda Welch	M.S.	USFWS
Scott Whitcomb	M.S.	NPS
Andrew A. Whitman	M.S.	U of M

#### DISSERTATIONS AND THESES COMPLETED THIS PERIOD

Student	Degree Candidacy	Support
Beverly A. Agler	M.S.	Personal Funding
Randall P. Boone	M.S.	CPM
Mustapha El Hamzaoui	M.W.C.	USAID/USDA
Donald Katnik	M.S.	McIntire-Stennis
T. Bruce Lauber	M.S.	CPM
Tamia Rudnický	M.S.	McIntire-Stennis, Personal Funding
W. Matthew Vander Haegen	Ph.D.	MCFWRU, USFWS

#### PERSONNEL NOTES

**BEVERLY AGLER** received her M.S. degree and is continuing her teaching position at the College of the Atlantic. **RANDALL BOONE** received his M.S. in Wildlife and has begun his Ph.D. on a new GIS project under Dr. Krohn. **MUSTAPHA EL HAMZAOU** graduated with a M.W.C. degree and has begun his Ph.D. program in Parks and Recreation in the Department of Forest Management. **DONALD KATNIK** completed his M.S. program and is now working for the Wyoming Game and Fish Department. **BRUCE LAUBER** is registered at Cornell University and is working on his Ph.D. **TAMIA RUDNICKY** has moved to Leverett, Massachusetts where her husband has obtained a position. **MATTHEW VANDER HAEGEN** is working as a wildlife biologist for the U.S. Forest Service after receiving his Ph.D. He is stationed in Orono, Maine and working on the ecology of neotropical migrants. Two new graduate research assistants were admitted in September. They are **STEPHEN DITCHKOFF** and **THEODORE CHAPIN**. In April at the College of Forest Resources Honors Banquet, **MAXINE HORNE** received a "Special Recognition Certificate." She has completed 45 years of dedicated service to both the Maine CFWRU and the Department of Wildlife as their Administrative Assistant.

## COLLABORATING AGENCIES AND ORGANIZATIONS

American Cyanamid Company - CPM  
 Atlantic Salmon Federation - ASF  
 Bangor Hydro-Electric - BHE  
 Bowater-Great Northern Paper, Inc. - GNP  
 Champion International Corporation - CI  
 CIBA-Geigy Corporation - CPM  
 Coastal Blueberry, Inc. - CB  
 Cooperative Forestry Research Unit, College of Forest Resources, Univ. Maine - CFRU  
 Cornell University, Laboratory of Ornithology - CULO  
 Dupont Corporation - CPM  
 FMC Corporation - CPM  
 Hirundo Wildlife Refuge - HWR  
 Holt Woodlands Research Foundation - HWRF  
 International Paper Company - IPC  
 Kennebec Log Driving Company - KLDC  
 Maine Atlantic Sea-Run Commission - MASRC  
 Maine Audubon Society - MAS  
 Maine Department of Conservation - MDC  
 Maine Department of Environmental Protection - MDEP  
 Maine Department of Inland Fisheries and Wildlife - MDIFW  
 Maine Department of Marine Resources  
 Maine Pesticides Control Board - MPCB  
 Massachusetts Audubon Society - MAAS  
 Mobay Corporation - CPM  
 National Wildlife Federation - NWFD  
 Nature Conservancy - NC  
     Maine Chapter - NC-MC  
     NE Regional Office  
 New Brunswick Department of Natural Resources and Energy - NBDNRE  
 North American Wildlife Foundation -  
     Delta Waterfowl & Wetland Research Station - DWRS  
 Penobscot County Conservation Association - PCCA  
 Resource Conservation Services - RCS  
 Scott Paper Company - SP  
 Taylor's Bait Farms, Inc. - TBF  
 The Nature Conservancy, Maine Chapter - MCTNC  
 University of Maine - U of M  
     Association of Graduate Students - AGS  
     College of Arts and Sciences - CAS  
         Zoology Department - ZD  
     College of Forest Resources - CFR  
         Hatch Act Funds - HAF  
         McIntire-Stennis - MS  
     College of Applied Sciences and Agriculture  
         Department of Agricultural Resource Economics  
         Graduate School  
 U.S. Dept. of Agriculture - USDA/USAID  
 U.S. Environmental Protection Agency - EPA

**U.S. Fish and Wildlife Service - FWS**

**Alaska Fish and Wildlife Research Center - AFWRC**

**Alaska Regional Office - ARO**

**Moosehorn National Wildlife Refuge - MNWR**

**National Ecology Center - NEC**

**National Fisheries Contaminant Research Center - NFCRC**

**National Fishery Research and Development Lab - NFRDL**

**Northeast Anadromous Fisheries Research Laboratory - NAFRL**

**Office of Information Transfer - OIT**

**Patuxent Wildlife Research Center - PWRC**

**Region 5, Federal Assistance - R-5, FA**

**Region 5, Fish and Wildlife Enhancement - R-5, FWE**

**Washington Office - WO**

**U.S. Forest Service - USFS**

**Green Mountain National Forest**

**White Mountain National Forest**

**U.S. National Park Service - NPS**

**Acadia National Park**

**Boston Regional Office**

## PROJECT REPORTS

### ENDANGERED AND THREATENED SPECIES:

#### FINBACK WHALE PHOTOGRAPHIC IDENTIFICATION METHODOLOGY IN THE WESTERN NORTH ATLANTIC

*Investigators:* B. A. Agler  
J. R. Gilbert

*Advisors:* J. R. Gilbert, Chairperson  
W. A. Halteman  
W. E. Glanz  
W. B. Krohn

*Cooperators/  
Project  
Support* Personal Funding  
College of the Atlantic  
Allied Whale Watch

*Objectives:*

- 1) Describe and develop techniques to identify individual finback whales photographically.
- 2) Compile a catalog using the three major collections of photographs of finback whales from the Gulf of Maine.
- 3) Test the validity of matching photographs of finback whales.

**SCOPE:** Currently neither the numbers, stock affinity, nor population differences in different parts of the Atlantic are known for the finback whale *Balaenoptera physalis*. This project attempts to evaluate methods for identifying individual finback whales as a first step toward obtaining a reliable mark-resighting estimate of population size.

**PROJECT STATUS:** All requirements for the degree of Master of Science (in Wildlife Management) were completed in August 1992. An abstract of the thesis follows:

This thesis examines the uses and value of photographic identification of individual fin whales (*Balaenoptera physalis*) based on data from the North Atlantic Fin Whales Catalogue. Individual fin whales within the Gulf of Maine were identified using the shape of the pigment pattern, dorsal fin and acquired scars. Photographs of 537 individual fin whales were contributed by eight organizations. Some 58% of the fin whales in the Catalogue were resighted within the same field season, and 39% were sighted during more than one field season. A total of 107 (20%) individuals were resighted in more than one of the six regions within the Gulf of Maine. Of these, only 30 (6%) were sighted in both the northern and southern Gulf of Maine. These photo-identification data from the Gulf of Maine were evaluated for usefulness in estimating the population parameters of fin whales.

The ability of observers to compare sets of photographs and use them to identify individual fin whales varied significantly among the four experience levels examined. The distinctiveness of markings found on an animal and the quality of the photographs affected an observer's score. The ability to identify individual fin whales from a variety of photographic media was evaluated for five experienced observers. Five types of responses, including three types of errors, were defined and discussed. To correct for these errors, a revised version of the Petersen capture-recapture estimator was developed.

The revised Petersen capture-recapture estimator was used to adjust for errors made photographically identifying fin whales. These corrected estimates were compared with the results of the Petersen estimate and Bailey's binomial model. The Petersen estimate and Bailey's binomial model both

greatly overestimated population size when resighting rates were  $< 120$  individuals (60% of the second sample) and underestimated population size when resighting rates were  $> 175$  (88%) individuals. The use of the corrected estimates is recommended when resighting rates are  $< 120$  (60%) individuals.

I examined the type, location, causes and longevity of scars ( $n = 803$ ) on 218 fine whales seen for  $> 1$  year to determine their reliability as cues for photo-identification studies. Linear scars were the most common scar type (found on 157 whales; 72%), while circular scars were second (111 whales; 51%). Scars occurred significantly more often on the back of a whale (70%). New scars appeared on 101 (46%) whales, and 199 (15%) scars disappeared from 75 (34%) whales. Scars appeared, then disappeared on 6 (3%) whales, while scars faded slowly on 79 (36%). The sources of scarring on fin whales included ropes (55; 25%), boats (34; 16%) and lampreys (25; 11%). Mean minimum longevity of scars was 3.32 years; mean maximum longevity was 4.54 years. Marks caused by parasitic copepods, *Penella* spp., disappeared quickly (1.20-3.40) years; propeller scars lasted longest (5.26-6.03 years). Overall, scars help confirm the identity of an individual, but should be used in conjunction with other natural markings for identification of an individual.

## ANALYSIS OF FACTORS AFFECTING POPULATION VIABILITY OF BIRDS

*Investigators:* M. Chilelli  
J. R. Gilbert  
B. Griffith  
W. B. Krohn

*Cooperators/* U.S. Fish and Wildlife Service -  
*Project* Region 8, Office of Research Support, WO  
*Support:*

*Objectives:*

- 1) Assess the utility of computerized population viability analysis (PVA) in predicting the fate of small populations of wildlife species.
- 2) Use PVA to rank types of species by their susceptibility to extinction based on life history strategy, population size, and environmental variation.

**SCOPE:** PVA only assigns a *probability* of extinction under a specified schedule of vital rates and temporal variation. Because extinction and persistence are both possible, the fate of a single species or single endangered population can neither validate nor reject PVA predictions. Thus, although the PVA process appears reasonable, it is difficult to assess how meaningful the predictions are on a situation specific basis.

To assess the utility of PVA, we will conduct PVA for generalized types of organisms that include several species. PVA predictions can then be compared to the actual fates of a number of small populations of a particular type of organism. If PVA provides reasonable estimates of the actual proportion of populations that become extinct, then validity of the modeling process will be supported. If PVA fails to predict the proportional fates of actual populations, the analyses may identify types of critical input data necessary to improve the accuracy of future PVA.

After identifying the conditions under which a PVA is effective, we will use stochastic simulation modeling to evaluate extinction probabilities of birds by life history strata.

**PROJECT STATUS:** A final report is being prepared and will consist of 3 sections:

- 1) Assessing the success of translocations of wild turkeys, sharp-tailed grouse, and bighorn sheep by comparing simulation and actual translocation based models. We used 3 simulation models (RAMASage, GAPPS, and TRANSLOC) to predict potential success of translocations.

- 2) **TRANSLOC:** simulating the fate of translocations. This computer model, written in FORTRAN, was developed for this project to simulate the dynamics of small populations of birds (wild or translocated).
- 3) Analysis of factors affecting population viability of birds. Three bird strata have been selected, depicting various life history strategies. Stratum 1 consists of birds that are late breeders ( $\geq 5$  years), long-lived (15-40 years), monogamous, with low productivity ( $\bar{x}$  fledglings/pair  $\leq 2.0$ ). Stratum 2 consists of birds that first breed at year 1 and are monogamous. Strata 3 consists of birds that first breed at year 1 and are polygamous breeders. Simulations have been conducted, covering a range of vital rates, variances on those rates, and founder population sizes. Species groups will be ranked according to susceptibility to extinction.

**FUTURE PLANS:** This report will be submitted in November 1992 to U.S. Fish and Wildlife Service, Region 8, Cooperative Research Units Center.

---

## ANALYSIS OF FACTORS AFFECTING POPULATION VIABILITY AND REINTRODUCTION ATTEMPTS FOR FISHER AND OTHER MAMMALS IN ACADIA NATIONAL PARK

**Investigators:** J. R. Gilbert  
M. Chilelli  
A. O'Connell  
B. Griffith  
W. B. Krohn

**Cooperators/** U.S. National Park Service -  
**Project** Acadia National Park, Bar Harbor, ME  
**Support:** Regional Office, Boston, ME  
U.S. Fish and Wildlife Service -  
Region 8, Office of Research Support, WO

**Objective:** Estimate the risk of extinction for small free-ranging or reintroduced populations of mammals across a range of reproductive strategies, home range sizes, and area use patterns.

**SCOPE:** Escalating habitat fragmentation suggests that native wildlife populations will become increasingly restricted to disjunct habitats in the future. The role of National Parks in providing relatively unexploited habitat patches will increase. Habitat patches will contain smaller populations of wildlife species than large contiguous areas of habitat, and these reduced populations will be more susceptible to extinction due to stochastic events. Addition of suitable habitat area to parks may be impossible. Therefore, effective evaluation of the ability of National Parks to sustain viable populations of wildlife species requires 2 analyses. First, estimates of extinction probabilities for small populations of various species are needed; and, second, estimates of success rates of reintroduction programs used for restoration after local extinction are necessary.

**PROJECT STATUS:** Data on reproductive strategy, home range size, area use patterns, and survival and fecundity rates have been compiled from >650 references to field studies of population dynamics in mammals. Three strata were selected (with representative species) that are of special management concern to Acadia National Park (fisher, black bear, bog lemming).

**FUTURE PLANS:** The risk of extinction (e.g., 50% probability extinction in 50 years) will be estimated for each of the 3 representative species "confined" to a range of habitat fragment sizes. Various enhancement strategies (e.g., introductions) will also be simulated for each stratum. Populations will be simulated using TRANSLOC (an on-site developed simulation program). Based on these simulations, species groups will be ranked according to the potential for Acadia National Park to retain viable populations. The final report will be completed September 1993.

## CONTAMINANT BURDENS AND REPRODUCTIVE RATES OF BALD EAGLES BREEDING IN MAINE

- Investigator:** L. J. Welch
- Advisors:** W. B. Krohn, Co-chairperson  
R. B. Owen, Jr. Co-chairperson  
T. A. Haines  
K. C. Carr, Ex-officio  
C. S. Todd, Ex-officio
- Cooperators/  
Project** U.S. Fish and Wildlife Service  
Maine Cooperative Fish and Wildlife Research Unit
- Support:** Maine Department of Inland Fisheries and Wildlife
- Objectives:**
- 1) Determine the production level of all known pairs of bald eagles breeding in Maine.
  - 2) Evaluate relationships of contaminant residues in blood samples from nesting bald eagles with regional variations in eagle productivity, variable trophic status of the adults, and contaminant residues in prey from that area.
  - 3) Determine correlations between mercury residues in feathers and prey items to blood levels of mercury in nestlings. Levels will be compared to individual nest site and regional productivity.
  - 4) Identify the occurrence and residue levels of environmental contaminants in unhatched bald eagle eggs.
  - 5) Determine the current deviation of eggshell thickness from the "precontaminant" era standard.
  - 6) Determine correlations among contaminant residue levels in tissue samples obtained from eagle carcasses to time of exposure (age of the bird) and regional variations in productivity.

**SCOPE:** In 1978, the bald eagle was classified as an endangered species in Maine and 42 of the other contiguous states, and threatened in the Remaining 5 states. At that time environmental contaminants were shown to be adversely effecting many of the eagle populations. Currently, Maine bald eagles have reproductive rates 15-40% lower than all other North American populations, and it is believed that contaminants may still be responsible. Past studies of Maine's eagle population have found uniquely high levels of contaminants in unhatched eggs.

This study includes all known pairs of bald eagles in Maine. Aerial surveys are conducted to determine site occupancy and nesting status. Nonviable eggs and nestling blood and feather samples will be collected and analyzed from all possible sites.

**PROJECT STATUS:** The second and final field season has been completed and a total of 129 nest sites have

been visited. Collections included 158 blood samples from 107 productive nests, and 12 nonviable eggs. A total of 161 eaglets were banded. Breast feathers were collected from the eaglets and prey items were collected from in and around each nest site. Fish and water samples were collected from 6 lakes to look at variability in mercury levels.

Blood, egg, and feather samples from the 1991 field season have been analyzed. Prey remains have been identified for both the 1991 and 1992 seasons. Reproductive histories and production levels have been determined for all territories sampled.

**FUTURE PLANS:** Blood and eggs samples from the 1992 field season will be analyzed by USFWS Patuxent Analytical Control Facility. Feather, fish, and water samples will be analyzed by the USFWS Field Station at the University of Maine. Target date for project completion is August 1993.

## **FISHERIES RESOURCES:**

### **COMPARISON OF TWO STREAM HABITAT ASSESSMENT TECHNIQUES IN THE WHITE AND GREEN MOUNTAIN NATIONAL FORESTS**

**Investigator:** D. B. McKinley

**Advisors:** J. R. Moring, Chairperson  
W. B. Krohn  
J. D. McCleave

**Cooperators/** U.S. Forest Service -  
**Project** Green Mountain National Forest, Rutland, VT  
**Support:** White Mountain National Forest, Laconia, NH

**Objectives:**

- (1) Determine what level of sampling segments provides usable estimates compared to current procedures of sampling entire streams.
- (2) Measure habitat shifts by juvenile Atlantic salmon following changes in fish densities.

**SCOPE:** Habitat surveys are an integral part of the fisheries management program on the U.S. National Forests (NF). These surveys are used to quantify existing habitat conditions, identify limiting factors, prescribe enhancement measures (where feasible), and integrate fish habitat management concerns with other proposed land uses (timber, recreations, etc.). This information may be used to develop prescriptions at both the NF level and project planning levels. The focus of the fisheries programs in the White and Green Mountain NF is Atlantic salmon restoration. At present, knowledge of existing habitat capability of most forest streams for this species is fairly general in nature and, in many instances, is unknown. There is a need to determine this capability, along with the identification of opportunities to enhance limiting conditions, where feasible. Therefore, there is a need for intensive habitat surveys on most of the streams on both National Forests. The technical subcommittees for both the Merrimack and Connecticut River Atlantic salmon restoration programs have recommended a methodology to be utilized by the Forest Service for these surveys. This methodology is based on one developed in Maine and cost estimates range from \$466 to \$621 per kilometer (\$750-\$1,000 per mile). Alternative ways to improve habitat survey efficiency need to be explored, especially in light of limited funding for the entire program. One approach which needs to be investigated is the use of representative reaches, whereby the habitat data collected within sample sections of these reaches are assumed to be representative of the entire reach. If this approach is feasible, a larger amount of stream miles could be surveyed for the same amount of money.



**PROJECT STATUS:** All field work has been completed. A Final Report was issued in January 1990. The investigator has taken a position with the U.S. Forest Service and successfully defended his M.S. thesis in January 1991.

**FUTURE PLANS:** We are awaiting the submission of the final thesis copy.

## POPULATION STUDIES OF MAINE INTERTIDAL FISHES

**Investigator:** J. R. Moring

**Cooperators/  
Project  
Support:** University of Maine

**Objectives:**

- 1) Identify environmental conditions associated with arrival and departure of fishes in the intertidal zone.
- 2) Identify and quantify algal and food associations of intertidal fishes.
- 3) Develop a species checklist of Maine tidepool fishes.

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

Surveys since 1979 have identified 23 species of tidepool fishes in Maine. The movements of the rock gunnel have been examined in marking studies, and algal associations and food habits of lumpfish and Atlantic seasnails have been quantified. Three study pools on Schoodic Peninsula have been studied since 1981, and work has also involved the first description of rock gunnels as the first intermediate host of the digenean fluke, *Cryptocotyle lingua*.

**PROJECT STATUS:** Experiments with movements of juvenile grubbies, shorthorn sculpins, and lumpfish are ongoing. New funding has allowed us to examine in detail the fish communities of two coastal tidepools. In addition, several papers have been submitted in 1992 and two seminars were presented.

**FUTURE PLANS:** Work dealing with intertidal movements of sculpins will continue in 1993, along with experiments on Atlantic seasnail feeding and innovative fish marking techniques. At least two papers are planned for presentation. Additional manuscripts are being prepared.

## MOVEMENTS AND SPAWNING SUCCESS OF DISPLACED LARGEMOUTH BASS

**Investigator:** M. A. Cartwright

**Advisor:** J. R. Moring, Chairperson  
**Cooperators/** W. E. Glanz  
J. G. Trial

**Project** Maine Department of Inland Fisheries and Wildlife  
**Support:** Penobscot County Conservation Association

*Objective:* To measure movements and document homing behavior of displaced largemouth bass in two lakes.

*SCOPE:* Little is known of the movement patterns of largemouth bass in boreal environments. In particular, it is not known whether displaced bass are able to return to original points of capture or, if so, how quickly they are able to return. In addition, the angling season is open during the spawning season for bass. There is evidence for smallmouth bass that, when the adult is removed from the nest and eggs or fry are unprotected, mortality can be extremely high. There are no studies concerning largemouth bass, particularly in boreal waters. Radio tags will be placed on captured largemouth bass to determine movements during spawning times and non-spawning times in two lakes, Webber Pond and Cobbosseecontee Lake.

*PROJECT STATUS:* All field work has been completed and data analysis is underway. There appears to be a difference in homing success (return to the point of initial capture) between the spawning season and mid-summer (non-spawning), between the large and the small lake, and between fish displaced immediately after capture and fish held in a boat livewell prior to displacement.

*FUTURE PLANS:* Data analysis and writing will continue in fall and winter. M.S. thesis completion is expected by May 1993.

## DOWNSTREAM MORTALITY OF ATLANTIC SALMON SMOLTS IN THE PENOBSCOT RIVER, MAINE

*Investigator:* A. M. Vanderpool

*Advisors:* J. R. Moring, Chairperson  
W. E. Glanz  
I. L. Kornfield  
J. D. McCleave  
J. G. Trial

*Cooperators/  
Project  
Support:* U.S. Fish and Wildlife Service - NAFRL  
Association of Graduate Students  
Atlantic Salmon Federation

*Objective:* To document the timing, routes, and mortality in downstream migrating smolts of Atlantic salmon in the Penobscot River, Maine.

*SCOPE:* The Atlantic salmon restoration program has high natural visibility and priority. Yet, returns to United States rivers have been quite low, averaging only 0.6% from smolt to returning adult in the Penobscot River, Maine, and only 0.2 to 0.3% in the Merrimack and Connecticut rivers of southern New England. This excessive mortality can occur during the downstream passage of smolts in the river, in the estuary, and on the high seas. Of these, the downstream portion may be the least difficult to assess. This project tracks radio-tagged smolts from their upstream release site to the lower Penobscot River.

*PROJECT STATUS:* Initial field work in Spring 1990 encountered numerous technical problems with radio tracking and fish counting equipment, yet seven fish were tagged; five were monitored. Speeds of migrating smolts were rapid and quickly outdistanced tracking boats, though one salmon was followed 10 km downstream. Salmon migration data were obtained, though the validity of numbers is unknown because of problems with fish counters. Salmon smolts reared in 1990 were of sufficient lengths for internal tags, but

of insufficient weight. Most tagged salmon had to be, of necessity, two-year-old smolts.

A new videotape counting unit was borrowed from the Atlantic Sea-Run Salmon Commission and was used with one of the self-release ponds at the West Enfield facility, along the Penobscot River, to track migration times of stocked smolts in 1991. New, smaller tags, externally attached, were used with one-year-old smolts in Spring 1991, and tracked by airplane. Movements were rapid in April, but minimal in May. Some fish were tracked around dams, but most contacts ceased prior to fish reaching the lower river, either due to battery failure or predation. Four papers and one seminar were presented. The investigator has taken a position with the West Virginia University Cooperative Extension. The M.S. thesis was defended in March 1992.

**FUTURE PLANS:** We are awaiting the submission of a final thesis copy.

---

## UPSTREAM MIGRATION OF ATLANTIC SALMON IN THE PENOBSCOT RIVER

**Investigator:** S. L. Shepard

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

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

**Objective:** To document and correlate environmental factors influencing upstream movements of Atlantic salmon.

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

**PROJECT STATUS:** Salmon have been tagged and monitored in 1990, 1991, and 1992. Analysis of data is underway.

**FUTURE PLANS:** An M.S. thesis is expected in December 1993.

---

## REFINEMENT AND TESTING OF THE HABITAT SUITABILITY INDEX MODEL FOR ATLANTIC SALMON

**Investigator:** D. A. Moreau

**Advisors:** J. R. Moring, Chairperson  
D. L. Parrish  
J. G. Trial  
H. B. Dowse

*Cooperators/* U.S. Fish and Wildlife Service - NAFRL  
*Project* Penobscot County Conservation Association  
*Support:* New England Salmon Association

*Objectives:*

- 1) To incorporate low-flow data into the existing Atlantic salmon Habitat Suitability Index (HSI) model.
- 2) To measure habitat parameters for adult cover, and test a model.

**SCOPE:** Habitat Suitability Index models are commonly used for evaluating habitat capacity to support various species of animals and to use in conjunction with mitigation projects and environmental assessments. The current model for Atlantic salmon is non-functional because several aspects of habitat need to be included and tested. This project incorporates existing low-flow habitat information and measures and tests habitat data for adult holding areas.

**PROJECT STATUS:** Data on adult holding areas were collected from observations of Atlantic salmon on the Dennys River, near Dennysville, Maine during summer 1990. Because of the relatively low numbers of salmon entering the smaller rivers in Maine, additional measurements of salmon were made in streams in New Brunswick in August 1990, and during May-October 1991. All field work has been completed and the model has been developed. Thesis writing is underway, and the investigator has taken a position with the Vermont Cooperative Fish and Wildlife Research Unit.

**FUTURE PLANS:** M.S. thesis completion is expected in December 1992.

## FISH PREDATORS OF ATLANTIC SALMON IN THE PENOBSCOT RIVER

*Investigator:* O. van den Ende

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

*Cooperators/* U. S. Fish and Wildlife Service - NAFRL  
*Project* Maine Atlantic Sea-Run Salmon Commission  
*Support:*

*Objective:* To document the source and extent of predation on juvenile Atlantic salmon by freshwater fishes in the Penobscot River.

**SCOPE:** Several species of freshwater fishes, particularly chain pickerel, smallmouth bass, and fallfish, are known to prey on juvenile Atlantic salmon. Survival of Atlantic salmon from smolts to returning adults averages 0.6%, or less, in the Penobscot River. Part of this mortality is likely due to predation by freshwater fishes, either on juveniles or on smolts on their downstream migration. This project documents the extent and source of this predation by fishes in the Penobscot River.

**PROJECT STATUS:** Spring 1992 collection of chain pickerel and smallmouth bass was hampered by abnormally cold water temperatures that kept predators inactive during the period of smolt migration. Nevertheless, feeding of smolts by pickerel was documented to mid-June.

**FUTURE PLANS:** A series of laboratory experiments is planned for fall 1992 that will examine the role of water temperature on consumption rate of smolts by bass and pickerel. If needed, additional examinations of

predator stomach contents will be conducted in spring 1993. M.S. thesis completion is expected in May or August 1993.

---

### SUSCEPTIBILITY OF ATLANTIC SALMON SMOLTS TO PREDATION BY DOUBLE-CRESTED CORMORANTS

*Investigator:* K. S. Hockett

*Advisor:* J. R. Moring, Chairperson  
W. B. Dowse  
W. E. Glanz

*Cooperators/  
Project  
Support:* U.S. Fish and Wildlife Service -  
WO, Federal Aid

*Objectives:*

- 1) To document the response availability of salmon smolts to potential avian predation.
- 2) To test the retention of the learned response by hatchery-cultivated Atlantic salmon.

**SCOPE:** Double-crested cormorants are known predators of Atlantic salmon smolts. Survival of Atlantic salmon from smolts to returning adults averages 0.6%, or less, in the Penobscot River, and part of this mortality may be due to predation by aquatic birds during the downstream migration. This project documents the susceptibility of smolts to in-river predation by cormorants and other bird predators and whether the avoidance response is lost in the continued absence of cover.

**PROJECT STATUS:** Laboratory experiments are underway and will continue until winter 1992-93. Atlantic salmon fry were obtained from Craig Brook National Fish Hatchery and are being held in experimental tanks at the University of Maine.

**FUTURE PLANS:** M.S. thesis completion is expected by May 1993.

---

### DAILY AND SEASONAL MOVEMENTS OF SMALLMOUTH BASS

*Investigator:* M. B. Cole

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

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

*Objectives:*

- 1) To follow daily and seasonal movements of smallmouth bass in several lakes.
- 2) To examine the role of larger bass found in deep waters.

**SCOPE:** It is believed that a segment of the smallmouth bass population in lakes may be included in population surveys or may be utilizing habitat managed for other species. The project involves radio tracking smallmouth bass in Branch Lake and Green Lake to examine daily and seasonal patterns at the time of spawning, during summer, and in the fall.

**PROJECT STATUS:** The project has just started. Field work is planned for 1993, with M.S. thesis completion expected in May 1994.

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

**Investigator:** C. F. Hartleb

**Advisors:** J. R. Moring, Chairperson  
J. H. Dearborn  
K. E. Gibbs  
W. H. Howell  
One member to be named

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

**Objective:** To compare growth, survival, and angler return of stocked spring yearling brook trout and wild brook trout in waters with heavy competition and waters with limited competition.

**SCOPE:** The State of Maine currently stocks yearling brook trout in bodies of water where angling demand is high, but where competition from other species (smallmouth bass, yellow perch, white perch, suckers, chain pickerel) may make such use cost-ineffective. There are no data on survival or performance of such stocked fish in these marginal waters, but this policy is relatively common in southern and central Maine. The study involves a sampling program in several lakes to analyze growth of brook trout and food habits of trout and competing species over 2 seasons.

**PROJECT STATUS:** This project is just beginning and will continue until 1995. A Ph.D. dissertation is expected in May 1995.

## **HABITAT RESOURCES:**

### CONSTRUCTION OF A DATABASE USED IN ANALYSES OF BIRD POPULATIONS AND AGRICULTURE, WITH A STUDY OF DENSITY DEPENDENCE

**Investigator:** R. B. Boone

**Advisors:** R. J. O'Connor, Chairperson  
J. R. Gilbert  
J. A. Wilson

*Cooperators/* American Cyanamid Company  
*Project* CIBA-GEIGY Corporation  
*Support:* DuPont Corporation  
 FMC Corporation  
 Mobay Corporation  
 Rhone Poulenc

*Objective:* To design and implement a database for use in research investigating the relation between agricultural practices and birds, and to determine if population regulation in birds is associated with life history variables or pesticide use.

*SCOPE:* A research program was begun to investigate the effect of farming on birds within the contiguous United States. Avian and agricultural data are available from several sources, but the data are stored in an unusable form. To be used effectively, the data must be incorporated into a well-designed database. The methods used in database design are described. Two additional goals were to determine if population regulation in birds is altered by pesticide use, and if regulation in bird populations is associated with life history variables.

*PROJECT STATUS:* All requirements for the degree of Master of Science (in Wildlife Management) were completed in December 1991. An abstract of the thesis follows:

Methods used to design and construct the Birds and Agriculture Database are described, and an example of database design is presented using the U.S. Breeding Bird Survey data set. When users receive data sets from suppliers, the data sets are typically in a form that is inefficient to store or access on a computer. Normalization methods are described that yield a database that stores information efficiently and allows data to be accessed quickly. Detailed descriptions of the data sets in the database are provided in the appendices. The appendices provide examples of queries that may be used by researchers to query the Birds and Agriculture Database.

Changes in the frequency of density dependence due to pesticide use, and the correlation of density dependence and r- and K- selection, were determined for 102 bird species associated with agriculture. Evidence exists that density dependence in bird populations is most closely associated with food supply, and that as food supply decreases, the frequency of density dependence increases. Because pesticides can reduce the food supply for insectivorous and herbivorous bird species, I hypothesized that species in areas of high insecticide and high herbicide use more frequently would exhibit density dependence than species in low insecticide and low herbicide areas. In addition, I tested whether or not correlates of r- and K-selection were related to the frequency of density dependence. Theoretically, species that are r-selected have density independent mortality, whereas K-selected species have density dependent mortality. Population regulations were determined for U.S. populations of 102 species of birds, and compared against the life-history variables representing the correlates that have been predicted to be associated with r- and K-selection.

No important relation was determined between large-scale pesticide use and the frequency of density dependence in the birds tested. This may be because food supply is not related closely to density dependence in birds, food may be super-abundant, or the methods used may have been inadequate to identify differences.

Of the 10 life-history variables that were correlates of r- and K-selection, and were tested against the frequency of density dependence, six were significantly correlated (i.e., correlates of development, variability in climate, body size, and range). The variables were correlated with density dependence in the direction predicted by r- and K-selection theory.

---

## BIRDS AND THE CONSERVATION RESERVE PROGRAM: A RETROSPECTIVE STUDY

**Investigator:** T. B. Lauber

**Advisors:** R. J. O'Connor, Chairperson  
K. J. Boyle  
J. L. Gilbert

**Cooperators/  
Project  
Support:** University of Maine  
U.S. Fish and Wildlife Service -  
National Ecology Research Center, Ft. Collins, CO.

**Objectives:**

- 1) Integrate the Conservation Research Program contract data obtained from ASCS for the first nine sign-up periods with the existing University of Maine databanks on bird numbers and national agricultural practices. Identify regions where the CRP data indicate spatially cohesive patterns of change in agriculture that might impact bird populations. Identify the species potentially affected by means of literature searches and cooperation with an existing study project in the Wildlife Department.
- 2) Within these regions, systematically investigate population trends in selected species, using a "before" and "after" approach within regions homogenous with respect to agricultural practice and bird populations at risk. Control for concomitant changes in national populations of birds or in national trends in agricultural practice by reference to the data from the parallel retrospective study. Combine the evidence from temporal, spatial, and species-based evidence to provide *prima facie* evidence of CRP impacts (beneficial and detrimental) on bird populations and to identify areas for potential field-based research.
- 3) Perform more detailed analyses suggested by the synthesis of Objective 2 to determine more fully the need for, and scope of, future field-based research and to resolve, as far as possible, questions raised by FWS Project Officer in the light of the synthesis.

**SCOPE:** The Conservation Reserve Program, enacted as part of the 1985 Food Security Act, provides for financial assistance to farmers abandoning the cultivation of highly erodible soils in favor of land-use practices designed to minimize or eliminate soil erosion. Farmers entering the program may obtain 10-year contracts for land enrolled in the program. Land retired in this way is restricted to approved conservation practices. Contracts first took effect in 1986 and some 33 million acres were enrolled in the first 9 sign-up periods of the program.

Since as much as 25% of the cropland in given counties can be retired under the CRP, changes in land use are of a scale that can have an impact on wildlife associated with agricultural land. This project supplements the investigation into these issues by the National Ecology Research Center by conducting a retrospective analysis of bird population data in relation to statistics on the changes brought about on CRP land. The intention is to document the nature of the spatial and temporal changes in the populations directly resulting from the CRP program.

**PROJECT STATUS:** All requirements for the degree of Master of Science (in Wildlife Management) were completed in December 1991. An abstract of the thesis follows:

I conducted a retrospective study to investigate the effects of the U.S. Department of Agriculture's Conservation Reserve Program (CRP) on bird populations. The CRP pays farmers to convert cropland to



permanent vegetative cover under long-term contracts and is primarily intended to control crop production and reduce soil erosion. Many species of birds, however, could be affected by the changes in nesting habitat and available food sources as land in agricultural areas is retired.

I conducted my work using data from several computerized data sets. Bird population data were obtained from the U.S. Fish and Wildlife Service's Breeding Bird Survey. Statistics on agricultural land use were obtained from the U.S. Department of Agriculture. Weather and climatic data were derived from statistics kept by the National Climatic Data Center. These data sets provided county-level estimates of density for species of birds and of numerous variables, including the CRP, which could influence the distribution of these species.

Some 102 species associated with agriculture were selected *a priori* for study. I tested for spatial correlations of these species' distributions with the CRP and other variables using decision tree methodology. This method allowed the detection of non-linear effects and interactions of variables in a straightforward manner. These analyses not only indicated which variables were correlated with species' distributions, but also identified locations where such correlations existed. Some 31 of the 102 species were spatially correlated with the CRP, although all of these correlations could be at least partially attributed to confounding variables.

A consistent geographical pattern of association with the CRP was detected for 12 of the 31 species. For the 10 of 12 species for which sample sizes were sufficient, I tested for population responses after the introduction of the CRP. Four species, Western Meadowlark ( $P = 0.004$ ), Ring-necked Pheasant ( $P = 0.084$ ), Brown-headed Cowbird ( $P = 0.099$ ), and Northern Bobwhite ( $P = 0.139$ ) showed evidence of positive population responses after the introduction of the CRP.

## THE EFFECTS OF CLEARCUT SIZE ON BIRD SPECIES RICHNESS AND NEST PREDATION RATES IN NORTHEASTERN MAINE

*Investigator:* T. C. Rudnicky

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

*Cooperators/  
Project  
Support:* McIntire - Stennis

*Objectives:*

- (1) Determine how the size and vegetation of clearcuts affect species richness and structure of the bird community.
- (2) Determine how the size and vegetation of clearcuts and distance to edge affect predation rates on eggs of ground-nesting and shrub-nesting birds.

**SCOPE:** The size of a habitat patch can greatly influence the number of species present. While many studies have examined bird communities in forest fragments of different sizes, little information is available on the distribution and diversity of birds in clearcuts of different size. Thus, information gathered in this study will aid in the understanding of species area requirements of early successional birds and will complement research designed to facilitate wildlife management in dynamic forest landscapes.

To understand bird-habitat relationships it is important to study reproductive success in different habitats. Placement of the nest (ground or arboreal), its distance from an edge, amount of cover, and size of surrounding habitat contribute to nesting success. Most nest predation studies have examined predation rates along edges and in forests. However, this predation study looks at predation rates in clearcuts as well as forests and edges. Although the results can only be used as an index to real nest predation, they will be

comparable to other artificial nest studies and will lend insight into the predation pressures experienced by ground and shrub nesting birds.

**PROJECT STATUS:** All requirements for the degree of Master of Science (in Wildlife Management) were completed in December 1991. An abstract of the thesis follows:

The effects of clearcut size on bird species richness and nest predation rates in a forest-dominated landscape were examined. Forty-five clearcuts, ranging in size from 2 to 112 ha and in age from 3 to 10 years post-cut were selected as study sites in eastern Maine. At least 10% of each clearcut was censused using 1-16 fixed radius (50 m) circular plots in May and June of 1989 and 1990. Species richness increased with clearcut size but the number of species present per plot did not differ significantly over the size range of cuts. There was some evidence of increased richness up to 20 ha. Of the 15 most common species in both years, 10 (1989) and 12 (1990) increased in abundance between 2 and 20 ha, beyond which no preference for clearcut size was found. Additionally, bird species locations throughout clearcuts were largely independent of distance from the forest edge.

Predation pressure on ground-nesting birds was estimated by placing artificial nests containing quail eggs every 15 m on transects perpendicular to the clearcut/forest edge. Nests were exposed for 7 days in early July 1989 and for 14 days each in June and July 1990. Artificial shrub nests (1-2 m above ground) were placed along the forest edge and in the forest interior in July 1990. Predation rates were significantly higher for forest nests than for clearcut nests. Neither size of the clearcut nor forest tract size exhibited a consistent relationship with predation intensity. Distance to edge had no apparent effect on predation of ground nests. However, the predation rate of edge shrub nests was significantly higher than for edge ground nests and forest interior ground and shrub nests. Analyses of data from vegetation surrounding nests re that cover was negatively correlated with predation rates in forests, and positively correlated in clearcuts.

## COMPREHENSIVE MULTIPLE-USE MANAGEMENT STRATEGY FOR FUTURE RESEARCH AND MANAGEMENT OF MOROCCAN COASTAL WETLANDS

**Investigator:** M. El Hamzaoui

**Advisors:** J. A. Sherburne, Chairperson  
R. B. Owen, Jr.  
J. B. Diamond  
J. B. Longcore

**Cooperators/  
Project  
Support:** USAID

**Objectives:**

- 1) Document the existing data base for five of Morocco's most ecologically important coastal wetland sites.
- 2) Determine future research needs.
- 3) Develop a comprehensive management strategy including systematic, continued monitoring of wildlife and human uses, and social acceptable, technically feasible management options.

**PROJECT STATUS:** All requirements for the degree of Master of Wildlife Conservation were completed in December 1991. An abstract of the report follows:

The complex geological history of Morocco has resulted in the remarkable diversity of landscapes and ecosystems that occur there. Morocco, which lies at the southwestern corner of the western Palaearctic

and forms the northwest corner of Africa contains avifauna that originates in two faunal zones (Blondel and Blondel 1964). Wetlands are a prominent feature of the Moroccan Atlantic coast. The most important are the Merja-Zerga, Sidi-Bourhaba, Khnifiss lagoon, and Souss-Massa estuaries. They are of extraordinary importance as wintering, molting, feeding and roosting sites for great numbers of waders and waterfowl moving between their breeding grounds in northern Europe and wintering areas in tropical west Africa.

The study briefly reviews the present status of and constraints to the management of Morocco's protected areas. The conservation of coastal wetlands is still not advanced in Morocco and the likely causes of this are discussed. The lack of an effective legal status and an institutional responsibility, the economic climate, lack of education and information, lack of trained personnel, and inadequate support by the State Administration of Eaux et Forêts (responsible for the administration of national resources) and the regional governments have a negative effect on protected areas. The need for a new government authority called "the National Council of Natural Reserves and National Parks" with full responsibility for the management of protected areas is emphasized.

A brief review is given of wintering waders and waterfowl populations, based on inconsistent counts by observers over a 30-year period. Five main coastal wetlands sites that are in urgent need of protection from the threat of irreparable damage inflicted by various unmanaged uses (Appendix A) are discussed in detail.

A comprehensive multiple-use management strategy is designed to address the current situation of wetland losses and to promote the development of a sound and modern management structure that would help local communities to protect remaining habitats for wildlife. The strategy is to maintain the overall biological and physical importance of coastal wetlands, while ensuring the sustainable and multiple use of wetland resources. The strategy emphasizes the use of existing resources for the development and implementation of management decisions.

Six components constitute the comprehensive strategy: 1) scientific aspects (including resource and use inventory); 2) training programs; 3) education and interpretation; 4) financial support; 5) national and international cooperation network; and 6) community participation.

To respond to the urgent need for rapid assessment of physical, biological and human use for each site, a procedure to collect data is designed. Because limited funds are available for management and maintenance of all wetlands, a site scheme is described to evaluate and to establish a priority for protection of each wetland site.

The comprehensive strategy stresses the need to involve local communities in forming and implementing the management actions. A rearrangement of the existing inefficient legislation is stressed in the management strategy. While waiting for the necessary legislative changes, however, other reasonable actions that can be implemented are discussed.

---

## THE NESTING ECOLOGY AND HABITAT REQUIREMENTS OF BLUEBERRY BARREN AVIFAUNA

*Investigator:* P. D. Vickery

*Advisors:* M. L. Hunter, Jr., Chairperson  
W. E. Glanz  
G. L. Jacobson  
R. J. O'Connor  
N. T. Wheelwright  
A. S. White

*Cooperators/* The Switzer Foundation  
*Project* Maine Chapter of The Nature Conservancy  
*Support:* Maine Department of Inland Fisheries and Wildlife

- Objectives:**
- 1) Identify the species composition and relative abundance of birds found nesting on blueberry barrens throughout Maine.
  - 2) Identify the vegetational requirements of birds nesting on blueberry barrens.
  - 3) Determine the impact of habitat alteration on the avian community on these barrens.

**SCOPE:** Though blueberry barrens comprise a relatively small part of Maine's total acreage, these areas form a special ecosystem with a distinctive breeding avifauna. At least five species that breed primarily in this habitat are noted by the Maine Department of Inland Fisheries and Wildlife as Endangered or in need of some level of protection or monitoring. Bird-life has coexisted with blueberry management for many decades, but recent introduction of herbicides on blueberry barrens has significantly altered vegetation and appears to have a detrimental effect on some species nesting in this ecosystem.

The Kennebunk Plains, an extensive sandplain grassland in southern Maine, was formerly managed for commercial blueberry production but has recently been purchased by the State of Maine as habitat for rare and endangered species. The unique breeding bird community found there has been studied for seven years. Species breeding at this site include: upland sandpiper, horned lark, bobolink, eastern meadowlark, vesper sparrow, savannah sparrow, and grasshopper sparrow. The latter species is a rare nesting bird throughout New England and is experiencing significant, long-term declines throughout its range.

**PROJECT STATUS:** For the past nine years I have examined the process of avian habitat occupancy on a dry grassland in southern Maine. To learn which habitat features are most important to these birds, I have measured bird densities and vegetation on eight large plots (8-24 ha.) that have been manipulated by fire and herbicide treatments. Not surprisingly, each species occupies slightly different microhabitats described in a unique set of habitat variables. For example, breeding densities of Grasshopper Sparrows (*Ammodramus* *savannarum*), Savannah Sparrow (*Passerculus* *sandwichensis*), Bobolink (*Dolichonyx* *orizivorus*), and Eastern Meadowlark (*Sturnella* *magna*), all declined significantly in lots that were sprayed with herbicide. Graminoid, forb, and shrub cover in these herbicide-treated plots were significantly lower than control plots.

To learn if each species' particularly habitat requirements, as identified in our primary research site in Kennebunk, reflects a broader pattern of habitat use and occupancy, I have sampled bird populations and vegetation at 100 blueberry barrens and dry grasslands throughout Maine. These data will be analyzed and compared to the results of the Kennebunk research.

**FUTURE PLANS:** Data will be analyzed and dissertation should be complete by early 1993.

## A LONG-TERM FOREST ECOSYSTEM STUDY

**Investigators:**

M. L. Hunter, Jr.  
A. J. Kimball  
A. S. White  
J. W. Witham

**Cooperators/  
Project  
Support:**

Holt Woodlands Research Foundation  
McIntire-Stennis

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

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

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

Our primary objective is to describe the structure of the plant and animal community. We are undertaking (1) a 100% inventory of trees (> 10cm 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 1992, tasks 3, 4, 5, 6, 7, 8, 9, and 10 as outlined above, were completed, and a study investigating the structure of tree fall gaps, ledge openings, and patchcuts and how they influence predation on bird nests was continued.

**FUTURE PLANS:** The 1993 field season will replicate the 1992 field season with additional work on forest gap dynamics and their effects on forest understory plants.

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

**Investigators:**

C. C. Abbott  
T. A. Haines  
R. W. Perry  
M. W. Powell  
C. P. Stafford

**Advisors:**

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

**Cooperators/  
Project  
Support:**

U.S. Fish and Wildlife Service -  
National Fisheries Contaminant Research Center -  
Columbia, MO  
National Fisheries Research Center - Leetown

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

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

**PROJECT STATUS:** The general objectives of this study are to determine the importance of atmospheric input of mercury on mercury content of fish, and the effects of within-stream processing of inorganic mercury to methyl mercury. Specifically, the total, acid-labile, and methyl mercury content of stream water, sediments, and benthic invertebrates will be measured periodically to assess the seasonal and stream chemistry influence on availability of methyl mercury to fish. Models will be used to assess the importance of diet versus direct uptake of mercury. The working hypothesis is that stream temperature, acidity, and dissolved organic carbon (DOC) content influence either the chemical or microbiological methylation of mercury, or the uptake of methyl mercury by biota, and that the diet is the major route of uptake.

**FUTURE PLANS:** Three projects are currently underway, two of them just starting. One thesis is expected in May 1993, two others in May 1994.

## FRUGIVORY AND SEED DISPERSAL OF FLESHY FRUITING PLANTS IN AN OAK-PINE FOREST

**Investigator:** A. A. Whitman

**Advisors:** M. L. Hunter, Chairperson  
A. White  
W. E. Glanz

**Cooperators/** Holt Woodlands Research Foundation  
**Project** University of Maine  
**Support:** Association of Graduate Students  
Sigma Xi

**Objectives:**

- 1) Determine fruit production and phenology in oak-pine forest.
- 2) Determine dispersal strategies of fleshy fruiting plants in an oak-pine forest.
- 3) Compare the quality of seed dispersal by birds to that of foxes.

**SCOPE:** In the northern temperate forests, little is known about biomass of fleshy fruiting plants, their phenology, or the relative importance frugivore-plant interactions to the plants or animals. This study 1) determined patterns in annual fruit biomass, reproduction, phenology, and fruit characteristics of fleshy fruiting plants, and 2) investigated the dispersal ecology wild sarsaparilla (*Aralia nudicaulis*) by birds and foxes.

### PROJECT STATUS:

(1) Ages and growth of *A. nudicaulis* ramets were measured to determine factors affecting its vegetative reproduction. Soil conditions, forest structure and composition of each site, and large disturbances (e.g., harvest gaps > 100m<sup>2</sup>) affect ramet age structure, recruitment, and growth more than subtle and temporally varying factors such as tree fall gaps, canopy defoliation, climate, and growth of overstory trees.

(2) Spatial and temporal variation in fruit biomass was measured to determine which environmental factors most affected fruit production. Logging affected total fruit production and fruit production of individual species (especially shrub species) by reducing canopy cover and increasing light. Weather may have affected fruit production; weather in the year of peak production was warmer during the flowering season and more moist in the growing season than other years. Unlike in other studies, herb species contributed more to total fruit biomass in intact forest than shrub species. Total fruit biomass was similar to other northern forests but less than southern forests.

(3) I measured fruiting phenology from July to October 1987. Richness of plant species in fruit peaked once in late August but fruit biomass peaked twice, in late July and mid-September. Abundance of major avian frugivores was correlated with richness of species in fruit and fruit removal rates of 14 species. Fruiting plants probably compete for dispersers as fruit removal rates were less when fruit biomass was high. Small mammals were seed dispersers and predators, thus were not a consistent selective force on phenology. Phenology peaks were earlier and narrower than more southern sites, probably because of climate differences. Climate may limit the beginning of the fruiting period by determining flowering patterns and ending of the fruiting period by damaging and lowering fruit quality and likelihood of dispersal success. Fruiting times were strongly associated with plant family. Patterns of fruiting phenology in northern temperate forest may most strongly reflect constraints imposed by physiology, growing season weather, and phylogeny and only weakly reflect the results of selective forces imposed by disperser abundance and competition.

(4) Using fruit characteristics and fruit use data, three types of disperser syndromes emerged to define three endpoints of a disperser gradient triad. At one endpoint, species were dispersed by bird/large, carnivorous mammals and were predominantly woody species that are most common in openings, fruit early, offer a high reward by producing large fruits with a high percentage of fruit pulp, have moderate to high dispersal rates, and were limited to three families. Species dispersed by birds/small mammals were a second endpoint and were predominantly forest herbs that yield a moderate reward by producing fruits with a moderate percent mass of fruit pulp, and had low removal rates. Species dispersed primarily by birds were a third endpoint, fruit later, and offer a small reward by producing small fruits with a low proportion of fruit mass and large seeds. This paradigm recognizes the implicit role of phylogeny in determining seed dispersers, fruit phenology and characters.

(5) Experiments with *A. nudicaulis* revealed that birds and foxes (*Vulpes vulpes*) differed in quality of dispersal in several ways. Foxes remove up to 30% of *A. nudicaulis* fruit and birds (probably thrushes, *Catharus* sp.) remove the rest. Seedlings were most common along trails, where seeds were probably deposited by foxes, and rare in forest. Seed predation was greater in patches of fruiting *A. nudicaulis* and forest than along trails, and not influenced by canopy gaps. Seed predation was density dependent but not consistently positive or negative across years. Seeds at low densities were less likely to be detected but more likely to all be eaten than seeds at high densities. Seeds passed through American robins were more likely to germinate than seeds passed through foxes. Seed germination and seedling survival was lower in gaps than intact forest, and was slightly greater along trails than other forest sites and in patches of *A. nudicaulis*. Foxes may be better dispersers than birds because they deposit seeds along trails where germination and seedling survival is greater, possibly because competition is less, soil moisture and light levels are greater than in sites to which birds disperse seeds.

**FUTURE PLANS:** Field work has been completed and thesis work will be completed by December 1992.

## EFFECTS OF LANDSPREADING PULP AND PAPER MILL SLUDGE IN REGENERATING FORESTLAND ON WILDLIFE POPULATIONS

- Investigator:* C. J. Vera
- Advisors:* F. A. Servello, Chairperson  
W. E. Glanz  
R. J. O'Connor
- Cooperators/  
Project  
Support:* Resource Conservation Services, Inc.  
Scott Paper Company
- Objectives:*
- 1) Determine the effects of landspreading pulp and paper mill sludge on the density, diversity, and species composition of breeding birds.
  - 2) Determine the effects of landspreading pulp and paper mill sludge on the relative abundance, diversity, and species composition of small mammals and amphibians.
  - 3) Determine the effects of landspreading pulp and paper mill sludge on invertebrate abundance and vegetative species composition and structure and examine the relationships of these effects with breeding bird, small mammal, and amphibian population changes.

**SCOPE:** The U.S. pulp and paper industry produces nearly 4 million dry tons of sludge per year. Approximately 70% of this sludge is currently landfilled. However, environmental concerns and government regulation of landfilling have stimulated interest in alternative sludge management practices.

Land application is an alternative which currently accounts for 8% of sludge produced. Pulp and paper mill sludge contain a range of organic matter, nitrogen, phosphorus, and lime which may improve soil structure and enhance forest regeneration. However, sludges applied to forestlands may affect wildlife populations through habitat modification and possibly through direct toxic effects. There have been few studies on the effects of landspreading pulp and paper mill sludge on forest sites representative of those used in Maine. This study will determine the effects of landspreading sludge in regenerating forestlands on wildlife populations.

**PROJECT STATUS:** Estimates of breeding bird, small mammal, and invertebrate densities and measurements of wildlife habitat characteristics were made on 8 study sites in northern Maine during spring-summer 1992. Four sites had received treatments of sludge 2 years earlier and four sites served as controls.

**FUTURE PLANS:** Final analyses of this 3-year study will be completed in 1992.

## EFFECTS OF DIGESTIBLE ENERGY CONTENT OF WINTER FORAGES ON WHITE-TAILED DEER NUTRITIONAL ECOLOGY: IMPLICATIONS FOR FORAGE-BASED CARRYING CAPACITY IN DEER WINTERING AREAS

- Investigator:* P. B. Gray
- Advisors:* F. A. Servello, Chairperson  
B. A. Barton  
R. L. Dressler



*Cooperators/  
Project  
Support:* McIntire-Stennis

*Objectives:*

- 1) To determine relationships between dietary digestible energy content and digestible energy and nitrogen intake for white-tailed deer fed winter diets.
- 2) To determine interspecific and intraspecific variation in the nutritional quality of winter forages.

**SCOPE:** Mature spruce-fir forest stands are critical winter habitat for white-tailed deer (*Odocoileus virginianus*) in Maine. The high value of timber on these sites provides an opportunity to integrate the management of timber resources and deer wintering habitat. However, the relative value of timber harvesting methods for improving shelter and foraging habitat for deer in wintering areas is poorly understood. Assessing the value of timber harvest relative to deer nutrition requires an understanding of forage quantity and quality variation in wintering areas and its relationship to deer nutritional limitations. The purpose of this project is to assess diet quality in wintering areas and to determine limitations of deer for using poor quality winter diets.

**PROJECT STATUS:** Digestion trials using 9 white-tailed deer were conducted at the University of Maine Captive Wildlife Research Facility during the winter of 1991. Deer were fed winter browse diets spanning a range of digestible energy intake. Samples of 6 forage species were collected within a deer wintering area to examine intraspecific variation in quality due to shading, plan form, browsing, and stem size. Thirteen forage species were collected to examine interspecific variation in forage quality during winter. Laboratory analyses are complete and data analyses are in progress.

**FUTURE PLANS:** Complete thesis.

## EFFECTS OF GLYPHOSATE APPLICATION ON WINTER CLEARCUT USE BY MOOSE IN NORTHERN MAINE

*Investigator:* W. E. Eschholz

*Advisors:* F. A. Servello, Co-chairperson  
W. B. Krohn, Co-chairperson  
J. R. Gilbert  
R. D. Briggs

*Cooperators/  
Project  
Support:* Maine Cooperative Forestry Research Unit  
Maine Cooperative Fish and Wildlife Research Unit  
University of Maine

*Objectives:*

- (1) Determine if intensity of clearcut use by moose differs between glyphosate treated and untreated stands 1-2 years post-treatment and 7-10 years post-treatment.
- (2) Determine the effects of landscape scale habitat characteristics on moose habitat use in glyphosate treated and untreated stands.
- (3) Determine the effects of browse availability and stand characteristics on moose use of glyphosate treated and untreated stands.

- (4) Evaluate the validity of using tracks/ha, track aggregates/ha, and track aggregate size from aerial surveys to estimate intensity of use by moose in clearcuts.

**SCOPE:** Early seral forest communities created by clearcutting provide large quantities of hardwood browse for moose. Herbicides are applied to clearcuts in Maine to suppress hardwood vegetation and hasten growth of coniferous trees. Use of herbicides in forest management is a subject of public concern because of uncertain effects on moose habitat. Glyphosate, trade name Roundup, is the most commonly used herbicide for conifer release in Maine.

**PROJECT STATUS:** Twelve 20 to 80 ha regenerating clearcuts scheduled for glyphosate treatment were selected as study sites for study of 1-2 year post-treatment effects. Nineteen older sites (14 treatment and 5 control) were selected for study of 7-10 year post-treatment effects. Pre-treatment aerial and ground surveys of moose and moose tracks were completed in winter 1991. In summer 1991 6 short term sites were treated with glyphosate. Ground surveys were performed in winter of 1992 and analysis of track counts and habitat characteristics is in progress.

**FUTURE PLANS:** Moose habitat use surveys will be conducted on all sites in winter 1992-93. Browse availability and stand characteristic data for all sites will be available from other concurrent studies on these sites.

---

## EFFECTS OF GLYPHOSATE ON WINTER NUTRITIONAL ECOLOGY OF MOOSE IN MAINE

**Investigator:** K. S. Raymond

**Advisors:** F. A. Servello, Chairperson  
W. B. Krohn  
J. R. Gilbert  
R. D. Briggs  
M. L. McCormack

**Cooperators/  
Project  
Support:** Maine Cooperative Forestry Research Unit  
Maine Cooperative Fish and Wildlife Research Unit  
University of Maine.

**Objectives:**

- 1) To determine effects of glyphosate on winter browse and digestible energy availability for moose at 1-2 and 7-10 years post-treatment.
- 2) To determine effects of glyphosate on winter browse utilization and diet quality for moose at 1-2 and 7-10 years post-treatment.

**SCOPE:** The herbicide glyphosate is used extensively in forest management to control hardwoods and promote softwood regeneration. Moose feed primarily on hardwoods in winter and must maintain a high food intake to compensate for the low energy content of winter browses and meet increased energy requirements. Glyphosate may significantly affect food intake and diet quality for moose. However, the effects of glyphosate on moose nutrition may vary as the stand regenerates from treatments.

**PROJECT STATUS:** The project is in its third and final year. First-year post-treatment data on browse availability and utilization were collected for 12 clearcuts during January-March 1992. Data were also collected on 11 clearcuts that were 71-0 years post-treatment or similar in age but untreated. Nutritional

analyses of browse samples collected during the vegetation sampling were conducted during April-September 1992.

**FUTURE PLANS:** Nutritional analyses will be completed in fall 1992. Post-treatment field studies of browse availability and utilization and laboratory studies of browse quality will be conducted in 1993. Project completion is expected in fall 1993.

## EFFECTIVENESS OF PLANNED SKIPS FOR MAINTAINING WILDLIFE HABITAT IN HERBICIDE-TREATED CLEARCUTS IN MAINE

*Investigator:* C. A. Elliott

*Cooperators/  
Project  
Support:* International Paper Company  
Maine Cooperative Forestry Research Unit  
University of Maine

*Objectives:*

- 1) Assess the effectiveness of planned skips in maintaining the diversity of the flora and fauna in herbicide-treated clearcuts.
- 2) Assess the effectiveness of pilot-created planned skips versus ground-marked planned skips.

**SCOPE:** Recent studies suggest that the use of herbicides to control hardwood species on clearcuts in Maine reduce habitat quality, population, size, and species diversity of small mammals and birds for at least three years after treatment. Such treatments may also reduce food and cover for species such as deer and moose during the initial years following treatment, although the long-term effects may be the opposite. It has been suggested that incorporating planned skip areas into a spraying program could mitigate some of these effects by maintaining small patches of habitat for rodents and birds, and providing food and cover for larger mammals. Such skips would be larger than accidental skips to provide blocks of cover and travel ways for wildlife. However, little is known about the effectiveness of skips of different sizes and dimensions.

**PROJECT STATUS:** Two study areas are being used, each with a treatment block containing a planned skip and a control block with no planned skips. Planned skips are approximately 100 m by 200 m (2 ha). Spot-mapping of songbirds was conducted in June on plots of 150 to 200 m by 250 m. Small mammals were trapped for four nights in July on a 7x9 grid of traps 10 m apart. Two snap traps were located at each grid point, and a pitfall trap was located at every third grid point. Small mammal trapping will be repeated in October. During winter, track counts of deer and moose will be conducted to determine if planned skips are used more or less than other portions of the cuts.

**FUTURE PLANS:** Data analysis is underway, and a report will be prepared as a basis for determining future study.

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

*Investigator:* T. P. Hodgman

*Cooperators/  
Project* University of Maine  
Maine Image Analysis Laboratory

**Support:** Maine Department of Inland Fisheries and Wildlife

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

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

**PROJECT STATUS:** Processing of satellite imagery is complete. Coverages have been generated from roads data for approximately 2/3 of the study area. Most primary and some secondary roads data are in coverages for the remaining 1/3. All spatial data have been clipped to coincide with the boundaries of the study area.

**FUTURE PLANS:** Completing the road database for the remaining third of the area is the next step. Maps and/or photos for these lands still need to be acquired and roads must be digitized. The spatial database will be completed by late 1992. Analysis of harvest, access, and habitat data will be performed in early 1993.

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

**Investigator:** K. E. McCracken

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

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

**Objectives:**

- 1) Estimate rates of removal of seeds of three species of trees by small mammals in five habitat types.
- 2) Compare relative rates of removal by "small" rodents (mice and voles) to "large" rodents (chipmunks and squirrels).
- 3) Investigate effects of lunar cycle on the foraging behavior of small nocturnal animals.
- 4) Investigate other correlates of seed predation (i.e., seed size, seed preference, time of day).

**SCOPE:** Small rodents are extremely efficient seed predators. Consequently, they may influence plant succession, including regeneration of trees. The response of small mammals to both natural and human-created openings in the forest canopy, and their effect on survival of tree seeds within these openings, has been little studied. This project will examine possible correlates of seed predation intensity in an oak-pine forest in southern Maine.

**PROJECT STATUS:** Wire cages were designed, each consisting of three sections, one which excluded all small mammals, one which excluded "large" small mammals, and one which allowed access by all small mammals. Eight replicates were placed in each of five habitat types (ledge, tree-fall, and small harvest gaps, matched by size; large harvest gaps, and forest), and removal rates of red maple (*Acer rubrum*) seeds were monitored for two 21-day periods, one beginning in mid-June, and one in mid-July. Removal rates of northern red oak (*Quercus rubra*) and white pine (*Pinus strobus*) seeds were similarly monitored during mid-October.

To test whether small mammals shift their foraging microhabitat to sites with more cover as ambient lighting increases, removal rates of red maple seeds were monitored in large harvest gaps and in mature forest, during full and new-moon periods. Each site had one petri dish with seeds placed under shrub cover, and one dish three meters away in the open.

In late August, small mammal abundance at experimental sites was quantified by four nights of trapping.

In 1992, the above experiments were repeated. Additionally, samples of all three species of seeds are being collected to estimate average annual biomass. I am also estimating rates of nocturnal versus diurnal seed predation of all three species of seeds. Other aspects of seed predation to be investigated include effects of: 1) acorn size, and 2) preference of seed predators for oak or pine seeds, on rates of seed removal.

**FUTURE PLANS:** The final field season will be in 1993. Data analysis continues, incorporating ten years of data on seedfall and small mammal abundance at the Holt Forest.

## FOREST FRAGMENTATION AND BARRIERS TO WILDLIFE DISPERSAL

**Investigator:** P. de Maynadier

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

**Cooperators/  
Project  
Support:** Maine Agricultural Experiment Station  
McIntire-Stennis

**Objectives:**

- 1) Investigate the influence of forest-clearcut edges on the habitat use of resident and dispersing amphibians and small mammals.
- 2) Determine the importance of logging roads as a potential barrier to the movements of amphibians and small mammals.
- 3) Evaluate the importance of edge contrast and cover to habitat use of dispersing and resident juvenile and adult amphibians.

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

The degree to which human disturbance in a forested landscape serves as a barrier to dispersal is poorly understood with work having been conducted mainly on birds and mammals, two highly vagile taxa. In order to better understand the importance of barriers as isolating mechanisms, this study will quantify amphibian and small mammal response to Maine's forest roads and clear-cuts.

**PROJECT STATUS:** Drift-fences were built perpendicular to two upland forest-clearcut edges during the spring of 1992 and captures were monitored continuously through early October. The technique was effective at capturing a large abundance and richness (15 species) of dispersing and resident amphibians. Preliminary analysis reveals a general decline in richness and abundance across the gradient from forest to clearcut habitat. Species-specific responses included generalists (American toad) and forest specialists (wood frog), however no species was found to specialize on the clearcut habitat.

In the spring of 1992 paired drift-fences were placed adjacent to a logging road edge and in the forest interior serving as treatment and controls, respectively. This design allowed for tests of potential barrier effects the road might have on amphibian and small mammal movements. Analysis is incomplete but the road does not appear to filter movement attempts.

Finally, a technique for culturing wood frog and American toad larvae was developed and a methodology for releasing and measuring the dispersal of juvenile anurans was tested in a continuous forest setting. The technique may be used to test the effect of habitat barriers to dispersal in the 1993 field season.

**FUTURE PLANS:** Additional site replicates for the forest edge work will be located during the fall and winter of 1992 with an attempt to locate high contrast edges to compare with the lower contrast mature clearcut edges currently under study. Pine boards serving as artificial refugia will be placed in the forest litter along the drift-fence transects as a complementary means for monitoring the response of salamanders to the forest-clearcut edge. Wood frog and American toad larvae will be raised during the spring of 1993 for release adjacent to forest or powerline edges to monitor their choice of dispersal habitat.

---

## NEW ENGLAND BIODIVERSITY PROJECT (EMAP)

**Investigators:** R. J. O'Connor  
M. L. Hunter Jr.  
R. B. Owen, Jr.  
S. A. Sader  
A. A. Whitman  
H. Devaul

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

**Objective:** The primary objective of the project is to relate extant data on bird distribution in New England to landscape characterization of the region. The final product will make recommendations to the EPA on how best to utilize this information within the framework of the national EMAP project.

**SCOPE:** The U.S. Environmental Protection Agency is currently developing a nation-wide monitoring program known as EMAP (Environmental Monitoring and Assessment Program). This project evaluates extant bird and habitat data in order to make recommendations for bird and habitat monitoring protocols for use in the EMAP program.

**PROJECT STATUS:** This project has three objectives: (1) to evaluate current bird monitoring schemes and determine their usefulness and potential biases; (2) to compare extant and new habitat data and determine the relative usefulness of different methods of monitoring bird habitats; (3) to determine whether guilds of bird species are useful in designing monitoring schemes.

Two studies investigated whether the BBS monitors bird populations in a relatively unbiased manner. In the first study, time-limited bird censuses were conducted by searching for birds in 0.0625 sq. mile blocks away from roads ("checkplots") and the trends were compared to bird data from adjacent USFWS Breeding Bird Survey routes (BBS). Uncommon bird species and forest interior bird species were more frequently detected by the checkplot method than the BBS but the edge, wetland, and agricultural species were more frequently detected by BBS, the latter largely because checkplots were deliberately located away from roads. However, the checkplot method was discarded because it took more than 60 minutes to record 75% of the bird species per checkplot.

In a second study, 29 EPA hexagons (64 km<sup>2</sup> each) were surveyed for birds using 20 five-minute, limited area point counts per hexagon. Hexagons were selected to cover the range of the principal eco-regions in New England. Within each hexagon, census points were placed so as to census a variety of habitats yet be representative. Habitat data were also gathered at each census location. Analysis of the bird data is in progress but an initial analysis of the habitat data revealed that three forest types and hayfields dominated over 50% of the census points and that hayfields and mixed forest were disproportionately recorded along roads and away from roads, respectively.

The second component of the project compared extant and new habitat data to determine the usefulness of each in monitoring bird habitats. All sources of habitat data were sampled near or on BBS routes and came from three sources: USGS land use / land cover data ("LUDA") from the mid-1970s (54 BBS routes), point habitat data previously determined by EPA staff from aerial photography data ("EPIC") of the mid-1980s (same 54 BBS routes), and percent cover habitat data from each BBS bird census point ("BBS habitat") collected by this project in 1991 (73 BBS routes). All three methods were moderately comparable in the habitats that they indicated. However, dominant habitats indicated BBS habitat data better matched LUDA and EPIC data at all scales than vice versa. Moreover, bird abundance was better correlated with BBS habitat data than with LUDA and EPIC data. Thus, our BBS habitat protocol appears to better measure bird habitats than LUDA and EPIC data. The last phase of this component includes comparing bird population and habitat changes from the late 1960s to the mid-1980s.

The third component of this investigation was to determine the usefulness of a guild approach to monitoring bird population and their habitats. We adapted algorithms used in pattern recognition in robotics to classify species on the basis of the similarity of their attributes. These algorithms were used to group species on the basis of their habitat use and yielded more successful groupings (as judged by two expert field ornithologists) than did alternative conventional clustering programs. The new approach has many advantages over traditional methods, both in removing subjectivity and in handling a variety of attribute data structures. A preliminary guild classification was developed based on an analysis of life history data using the new algorithms.

**FUTURE PLANS:** An analysis of bird population and habitat changes from the 1960s to the 1980s will be completed by November. Work is currently underway finishing analyses in progress and report writing culminating in a final report in December 1992.

---

## APPLICATION OF SATELLITE DATA TO QUANTIFY NEOTROPICAL HABITAT FOR MIGRANT LAND BIRDS WINTERING IN BELIZE

*Investigator:* J. P. Spruce

*Advisors:* S. A. Sader, Chairperson  
M. K. Beard-Tisdale  
T. B. Brann  
M. L. Hunter, Jr.

*Cooperators/  
Project  
Support:* U.S. Fish and Wildlife -  
Patuxent Wildlife Research Center  
University of Maine -  
Department of Forest Management

*Objectives:*

- 1) Apply computer-aided processing of satellite data to map and monitor neotropical habitat availability for avian migrants wintering in Central American study sites.
- 2) Develop a habitat classification approach suitable for regional applications on an operational basis.

**SCOPE:** Human-induced habitat change is occurring throughout the tropics, and the impact of land use change on migratory land birds is believed to be significant yet difficult to quantify. Evaluation of habitat availability and use by migratory birds wintering in the neotropics is being done using data from satellite remote sensing and field surveys of bird habitat use. This two-staged approach allows a method to estimate regional trends in bird/habitat associations, and is less expensive to apply regionally, compared to ground-based methods.

**PROJECT STATUS:** Landsat TM satellite data have been acquired for study sites in southern Mexico (Veracruz and Campeche) and southeast Guatemala. Habitat availability and change detection maps have been produced for the Veracruz Mexico study site. Maps and aerial photographs have been acquired to aid in habitat classification and analysis. Habitat classifications are being modified on the basis of knowledge gained from field visits and interpretation of air photos, maps and statistical measures of satellite data multi-spectral characteristics. Sader spent a week in March 1992 to field check habitat classification maps of the Veracruz site. Spruce's thesis on the Belize work is near completion now that habitat map accuracy assessment is done. An annual report to the U.S. Fish and Wildlife Service was submitted in October 1992.

**FUTURE PLANS:** The project will focus on quantifying habitat availability and migrant habitat use at the Guatemala study site, which consists of forest and agricultural habitats in the tropical wet life zone. U.S. Fish and Wildlife Service co-investigators will complete a final report on Belize survey of habitat availability and avian migrant habitat use during fiscal 1993.

---

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

*Investigator:* R. B. Boone



- Advisors:** W. B. Krohn, Chairperson  
M. K. Beard-Tisdale  
M. L. Hunter, Jr.  
G. L. Jacobson, Jr.  
M. A. McCollough  
R. J. O'Connor
- Cooperators/  
Project  
Support:** U.S. Fish and Wildlife Service  
University of Maine  
Maine Department of Inland Fisheries and Wildlife  
Maine Department of Conservation  
Champion International Corporation  
Bowater-Great Northern Paper, Inc.
- Objectives:**
- 1) Develop detailed range maps of non-fish vertebrate species in Maine, using literature on species-habitat relations, and expert review.
  - 2) Create species richness maps for various groups of species (e.g., neotropical migrant birds), and compare them to areas managed for natural vegetation, to identify gaps in biodiversity protection.
  - 3) Correlate species richness distributions with woody plant distribution, climatic variables, and geomorphology, to characterize factors determining the distribution of Maine terrestrial vertebrates.

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

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

**PROJECT STATUS:** Since the beginning of the project, in February of this year, much of our effort has been put to laying a foundation for later stages of the research. We conferred with Gap Analysis personnel in western states, to become familiar with their techniques. I completed an introductory course in ARC/INFO, conducted by Environmental Systems Research Institute. A computer (486/50 Mhz Tri-Lan) has been purchased, and we have acquired access to a RISC 6000 workstation. We cooperated in setting-up the Habitat Relations GIS Laboratory at the Department of Wildlife, University of Maine.

We have begun to compile a library of geographic information for Maine. Currently in the library are, at 1:100,000 scale, coverages describing: hydrology, transportation networks, bedrock, and aquifers. Other coverages we have acquired for the state include: land use / land cover, federal and state ownership, biophysical regions, and political boundaries. All geographic data will be maintained using standards set by the state GIS Office, Maine Department of Conservation.

Landsat Thematic Mapper (TM) scenes for Maine were jointly purchased with the Maine Department of Conservation. The scenes, all from 1991, have been forwarded to the University of Massachusetts for checking and use. The appearance of vegetation polygon types on TM scenes will vary across New England, so we must provide the interpreters at the University of Massachusetts field-checked maps to use in training themselves to recognize Maine habitats. We have acquired 24 field-checked maps for state Wildlife Management Areas, primarily in southern and central Maine. Large-scale maps produced by timber-industry land owners will be used to characterize upland habitats in eastern, northern, and western Maine. We have agreements with two large land holders. The National Wetland Inventory (NWI) maps for Maine have been received and organized. We have received information to use in ordering National Aerial Photography Program color infrared photographs. Ultimately, we will have about 60 areas with ground-truthed cover maps (with some digital), NWI maps, and color infrared photographs. Some portion (likely two-thirds) will be sent to Massachusetts to train interpreters, and the remainder will be used by them at a later date, to verify the classification.

The Vermont Cooperative Fish and Wildlife Research Unit will produce the initial species-habitat associations and range maps for New England vertebrates. We have provided them with county-level Breeding Bird Survey (BBS) counts to assist in this effort. We will also forward to them further BBS data, and breeding bird atlas data for those states that we have. We have spoke with those compiling the Natural Heritage database in Maine, and are planning to add to the database vertebrate information that is back-logged.

Considerable literature is available discussing vertebrate species-habitat relations in Maine. We are collecting and organizing both published and unpublished (e.g., thesis) manuscripts to use in refining species-habitat relationships. We have also obtained survey data for locations of waterbird colonies, and are exploring the use of harvest data and atlas data in defining species ranges.

**FUTURE PLANS:** Assemble information on the distribution and habitat use of terrestrial vertebrates, and have this information reviewed by species experts. Provide cover maps to the University of Massachusetts, and assist in updating the conservation lands database.

---

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

### **BIOENERGETICS OF AMERICAN WOODCOCK DURING THE BREEDING SEASON ON MOOSEHORN NATIONAL WILDLIFE REFUGE, MAINE**

*Investigator:* W. M. VanderHaegen

*Advisors:* W. B. Krohn, Co-chairperson  
R. B. Owen, Jr., Co-chairperson  
F. A. Servello  
W. E. Glanz  
A. S. White

*Cooperators/* University of Maine  
*Project* Maine Cooperative Fish and Wildlife Research Unit  
*Support:* U.S. Fish and Wildlife Service -  
National Ecology Center, Fort Collins, CO.  
Moosehorn National Wildlife Refuge, Calais, ME.  
Penobscot County Conservation Association  
Hirundo Wildlife Refuge  
Taylor's Bait Farms

- Objectives:**
- 1) Determine basic metabolic parameters for woodcock using captive-reared birds in the laboratory.
  - 2) Measure microclimate regimes and activity budgets of woodcock on the Refuge.
  - 3) Measure body composition and nutrient stores of woodcock during key periods of the breeding cycle.
  - 4) Document spring food habits.
  - 5) Develop a spring energetics model and assess energetic constraints on breeding female woodcock.

**PROJECT STATUS:** All requirements for the Ph.D. degree (in Wildlife) were completed in May 1992. The abstract follows:

Bioenergetics of female American woodcock (*Scolopax minor*) was studied from 1987-1989 at Moosehorn National Wildlife Refuge, Maine. A model of daily energy expenditure was developed from laboratory-derived data on metabolic rates; from data on activity and microclimates collected in the field; and from body component analysis of collected birds.

Energy demands incurred by female woodcock on the breeding grounds were highest during the Pre-nesting (60.3 kcal/day) and Laying (89.1 kcal/day) periods. Availability of food (earthworms [*Lumbricidae*]) is normally sufficient during these periods, but shortages such as the one caused by persistent soil frost in spring of 1989 can delay nesting and affect productivity. Female woodcock feed throughout the diel period prior to incubation, obtaining nutrients for reproductive tissues and to store fat for use during incubation. Incubating females spend only 8% of the day active and used endogenous reserves to supplement energy derived by feeding, losing about 75% of their body fat over incubation. In March and April 1989, energy intake was too low to initiate egg production as nesting did not occur until the frost melted and earthworm availability returned to normal, 3-4 weeks later than the typical nesting date in Maine.

Woodcock chicks are not homeothermic until 15-20 days old, and there is an inverse relationship between air temperature and brooding requirements. At air temperatures typical of the brood period, a drop in mean air temperature of 5°C can result in a 40% decrease in time spent active, with a concomitant loss of foraging time. Rainfall also increases the brooding requirements of chicks, reducing by 30% the time spent active by chicks < 10 days old. Reduced foraging time lowers both energy intake by the female and her ability to feed the chicks.

Lack of snow cover and freezing temperatures influence the depth of soil frost and can reduce both food availability in spring and woodcock productivity. In addition, weather during the brood period and condition of the female at the end of incubation play important roles in determining the number of offspring produced. Thus, habitat management should strive to provide high earthworm biomass in a variety of suitable feeding sites to ameliorate the effects of weather.

---

## BIRDS OF MAINE'S PEATLANDS

**Investigator:** S. S. Stockwell

**Advisors:** M. L. Hunter, Jr., Chairperson  
R. B. Davis  
W. E. Glanz  
J. R. Longcore

**Cooperators/Project** Maine Department of Inland Fisheries and Wildlife  
Signal Fuels, Inc.

**Support:** Maine Chapter of The Nature Conservancy  
Maine Land Use Regulation Commission

# Maine Department of Environmental Protection

## *Objectives:*

- 1) Identify those species of birds that inhabit Maine's peatlands.
- 2) Quantify the abundances of each species relative to peatland vegetation and hydrology.
- 3) Determine whether large, commercially valuable peatlands differ in their "value" to wildlife from smaller, non-commercially valuable peatlands.
- 4) Determine which of five environmental factors (foliage height diversity, area of peatland, peatland-foliage height diversity, type of peatland, and peatland vegetation diversity) are important in influencing bird species composition, bird species richness, and bird density in peatlands.

**SCOPE:** Peatlands are one of the last remaining undisturbed ecosystems in the Northeast. Thus, the state of Maine has an unusual opportunity to develop a comprehensive plan for conserving Maine's peatlands. However, before this project was initiated, no surveys of the wildlife in Maine's peatlands had been conducted. Before issuing mining permits or establishing peatland preserves, the state needs to know what bird species depend on peatlands for their continued survival, if any, and whether certain species are restricted to particular types or sizes of peatlands.

This study relates the abundances and distributions of birds in eight Maine peatlands to peatland vegetation, size, and geomorphology.

**PROJECT STATUS:** Birds were censused in eight Maine peatlands of varying types and sizes during May and June of 1984. Eight distinct vegetation types occurred in the peatlands. A variable-width transect method was used to census birds and estimate densities from a modified Emlen method and the Fourier Series Estimator in program TRANSECT.

During the two-year study, 104 bird species were identified. Bird species richness ranged from 48 to 81 per peatland and from 46 to 76 per vegetation type. Overall bird density ranged from 4 to 11 birds per ha in each peatland, and from 3 to 19 birds per ha in each vegetation type. Densities of each species in each peatland and vegetation type were highly variable, and most species were abundant in only a few types of vegetation. Densities ranged from 1 to 160 birds per 40 ha, with the common yellowthroat being the most abundant species in 5 of 8 peatlands and 4 of 8 vegetation types.

Foliage height diversity (FHD, vertical heterogeneity of vegetation) was the best predictor of bird species composition (BSC), bird species richness (BSR), bird species diversity (BSD), and bird density (BD) in eight types of peatland vegetation. As foliage height diversity increased, bird species composition changed, species richness increased, species diversity increased, and density increased.

Neither type nor size of a peatland affected species composition, richness, diversity, or bird density in a predictable pattern. Bird species richness in eight peatlands was best related to the interacting variables of peatland-FHD and PVD. Thus, horizontal heterogeneity of vegetation seems to be as, or more, important than vertical vegetation structure in influencing BSR and BD in peatlands. The high number of species recorded in peatlands relative to other habitats lends support to the hypothesis that patchiness, rather than foliage height diversity, is most important in influencing bird diversity.

**FUTURE PLANS:** Revise and complete thesis.

## BIRDS AS AN INDEX OF BIOTIC INTEGRITY OF LAKES IN NEW ENGLAND

*Investigator:*

A. Moors

*Advisors:* R. B. Owen, Jr., Co-chairperson  
R. J. O'Connor, Co-chairperson  
J. R. Moring

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

*Objectives:*

- 1) Examine the possibility of using birds as an index of biotic integrity on selected lakes in New England.
- 2) Examine bird distribution in relation to shoreline habitat.
- 3) Identify disturbance factors related to reduced bird species richness or altered species composition on degraded lakes.

**SCOPE:** Birds can be excellent bioindicators, as demonstrated by eggshell thinning in relation to pesticide contamination. Research on avian bioindicators of water quality has previously focused on waterfowl. How water quality affects the total bird community (terrestrial and aquatic species) is poorly known. Because both water quality and bird presence are related to the vegetation surrounding a water body, the avifauna may provide an economic way of monitoring its health. This project investigates whether censusing the local bird communities can provide sufficiently accurate and precise assessment of the quality of individual lakes to allow their use as response indicators within the U.S. EPA's Environmental Monitoring and Assessment Program (EMAP).

**PROJECT STATUS:** Two seasons of fieldwork have been completed. During the first field season, 20 lakes chosen by EMAP staff to reflect environmental gradients across New England were surveyed between June 1 and July 3, 1991 for bird and habitat distribution. Two indicators that identified degraded lakes were developed from the 1991 data. One indicator is based on species richness, the second is based on the guild structure of the community.

These indicators are currently being tested on the data from 52 randomly chosen lakes surveyed during June 1992. These 52 lakes were located in New England, New York, and New Jersey.

**FUTURE PLANS:** Data analysis may be extended to include consideration of data on water chemistry, macrobenthos, and related limnological characteristics gathered in the summer of 1992 by EMAP Surface Waters personnel. M.S. thesis completion is expected in May 1992. Indicator development and refinement is anticipated to continue through at least a third year. If so, approximately 60-70 lakes will be surveyed in June 1993.

---

## HABITAT USE BY BLACK DUCKS AND MALLARDS ON MISSISQUOI NATIONAL WILDLIFE REFUGE

*Investigator:* C. G. Kitchens

*Advisors:* J. R. Longcore, Co-chairperson  
R. B. Owen, Jr., Co-chairperson  
Committee being developed

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

**Objective:** To evaluate the use/importance of managed wetlands by radio-marked black ducks at Missisquoi National Wildlife Refuge during hunting and non-hunting periods by use of radio-marked black ducks and mallards.

**SCOPE:** During the fall staging periods of 1990 and 1991, samples of hatching-year female (n=35-40) and male (n=35-40) black ducks and hatching-year female mallards (n=40) were radio-marked to determine the importance of refuge wetlands during pre-hunting and hunting periods.

**PROJECT STATUS:** During October 1991 through September 1992 work progressed as scheduled. The second field season was completed on December 15, 1991. Detailed maps were prepared and an electronic planimeter was used to determine availability of habitat types in the study area. Data (5,341 locations during the two years) on habitat use obtained by telemetry were entered in D-Base files, examined for errors, and analyzed to compare use between sexes, species, and among months, habitat types and hunting and non-hunting periods. The graduate student completed the statistics/SAS course at the University of Vermont. Data analyses of bird movement are continuing and completion of the thesis is expected by December 30, 1992.

## BREEDING ECOLOGY OF GREATER SCAUP IN THE SAINT JOHN RIVER VALLEY, NEW BRUNSWICK

**Investigator:** D. H. Kusnierz

**Advisors:** R. B. Owen, Jr., Chairperson  
W. B. Krohn  
W. E. Glanz  
F. P. Kehoe, Ex-Officio

**Cooperators/  
Project  
Support:** North American Wildlife Foundation -  
Delta Waterfowl and Wetlands Research Station  
New Brunswick Dept of Natural Resources and Energy

**Objectives:**

- 1) Determine the effects of nest markers on nesting success of Greater scaup.
- 2) Identify habitat characteristics of nest sites selected by female Greater scaup.
- 3) Document incubation rhythms of Greater scaup nesting among colonial larids.
- 4) Determine food habits and habitat use of juvenile Greater scaup.

**SCOPE:** U. S. Fish and Wildlife Service surveys indicate that scaup breeding populations are at an all-time low, yet the breeding biology of Greater scaup in North America still remains unstudied. The vast majority (75%) of nesting occurs in remote areas of Alaska; however, an island nesting colony was discovered in 1984 within a traditional spring-fall staging area of the Saint John River, New Brunswick, Canada. This broad-base study attempts to determine what requirements are necessary to successfully establish a breeding colony of Greater scaup. The study will provide the first in-depth insight into the nest site habitat selection, incubation behavior, and juvenile feeding ecology and habitat use of Greater scaup in North America.

**PROJECT STATUS:** All data have been collected. Habitat characteristics, including soil moisture, vegetative cover, species and height, and distance to water, edge of cover were measured at 167 nests and 246 random sites. The same variables were measured four times in 1991 at 25 nest sites from the previous

year. These measurements will be used to follow temporal changes in habitat at nests and backdate characteristics to time of nest initiation. Behavior during incubation was monitored at 12 nests. Observations were made from a blind to examine scaup-gull interactions when broods dispersed from the islands. Surveys from fixed wing aircraft and boats were conducted to identify habitats used by broods. Habitats were sampled to quantify physical characteristics including water depth, foods available and vegetation types. In addition, 18 juveniles were collected to identify foods consumed. Food items were analyzed to determine energy and protein content.

Data analysis is nearly complete and thesis preparation is underway. The first two chapters have been drafted and two more are planned.

**FUTURE PLANS:** Complete and revise thesis. Anticipated date of completion is December 1992.

---

## ECOLOGY OF THE DOUBLE-CRESTED CORMORANT IN THE PENOBSCOT RIVER ECOSYSTEM WITH EMPHASIS ON SMOLT PREDATION

**Investigator:** B. F. Blackwell

**Advisors:** W. B. Krohn, Chair  
R. B. Owen  
J. R. Gilbert  
J. R. Moring  
F. A. Servello

**Cooperators/  
Project** U. S. Fish and Wildlife Service -  
WO, Federal Aid  
**Support:** Maine Department of Inland Fisheries and Wildlife  
Maine Atlantic Sea-Run Salmon Commission

**Objectives:**

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

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

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

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

**PROJECT STATUS:** The 1992 field season provided information on cormorant movements, locations of roosting and feeding areas, and the logistics of surveying, capturing, and radio-tagging these birds. Birds returned to the Penobscot River area between the second and third weeks of April. Between April and July 69 birds were collected for food habits analyses and 102 regurgitant samples from nestlings were collected. Six night roosts were located along the Penobscot River and censused on a 10 day interval. An aerial census was conducted that included the Mattawamkeag River from Haynesville to Mattawamkeag, the Piscataquis River from Dover Foxcroft to Howland, the Penobscot River from West Enfield to Verona Island and Penobscot Bay to the southern tip of Islesboro Island. Flights began on April 27 and continued on a 10 day interval until August 20. The aerial census along the river peaked during the first week of May, and it appears that early spring depredation on Atlantic salmon smolts is caused by breeding adults, prior to the arrival of subadults. A total of 132 cormorants were captured and banded.

**FUTURE PLANS:** The second field season will begin in April 1993. Special emphasis will be placed on estimating cormorant days of predation relative to specific river segments and dams, collecting stomach samples from feeding cormorants, and documenting movements of radio-tagged cormorants during the smolt migration. Aerial and roost surveys will provide a means of measuring predation pressure along the Penobscot River. When combined with data on the foraging behavior of radio-tagged cormorants, this will allow the determination of features contributing to cormorant selection of foraging sites as well as the magnitude of the depredation.

## AVIAN BIOINDICATOR DYNAMICS

**Investigator:** S. J. Oyler

**Advisors:** R. J. O'Connor, Chairperson  
M. L. Hunter, Jr.  
W. E. Glanz

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

**Objectives:**

- 1) Evaluate the applicability of the Taylor Power Law concept to the North American avifauna.
- 2) Map bird diversity and develop indices of biodiversity and community structure to land use patterns on the basis of Major Land Resource Area (MLRS) classification.
- (3) Examine the effects of short-term change in land use on bioindicators.
- (4) Determine the relative effects of yearly variation in weather conditions and agricultural changes on bioindicators.

**SCOPE:** EPA's Environmental Monitoring and Assessment Program (EMAP) assumes changes in the abundance of bioindicators correspond directly to changes in environmental condition such as landscape pattern, habitat structure, or land use practices. Thus, any fluctuation in biodiversity or other environmental indicator is assumed by EPA to be caused by some change in environmental condition. Because intrinsic



dynamical variability in biodiversity and ecological indicator values may not be small compared to the changes brought about by alterations in the environment, this investigation examines how bird diversity and ecological indicators are affected by underlying pattern of dynamics in bird abundance. These patterns are being determined both from empirical data from national bird and land use databases already collated in the Wildlife Department and from theoretical models of population processes. These underlying patterns of variation in bird abundance will be related to land-use patterns within the coterminous United States to aid the future interpretation of EMAP results.

**PROJECT STATUS:** The applicability of Taylor Power Law was evaluated for the distribution of bird species within the coterminous United States. This analysis confirmed that the variance of each species' abundance varied predictably over space and time as predicted by Taylor Power Law. Computer simulations were used to determine the probabilities of observing certain combinations of Taylor Power Law parameters, thus providing a theoretical basis for the assessment of the patterns present in the empirical data.

**FUTURE PLANS:** Existing theories about the distribution of bird species are being currently reviewed in an attempt to synthesize unified theory in the light of our empirical investigations. Target date for project completion in December 1993.

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

### **SPATIAL USE, TERRITORIALITY, AND SUMMER-AUTUMN SELECTION OF HABITAT IN AN INTENSIVELY HARVESTED POPULATION OF MARTENS ON COMMERCIAL FORESTLAND IN MAINE**

**Investigator:** D. D. Katnik

**Advisors:** D. J. Harrison, Chairperson  
W. B. Krohn  
G. L. Jacobson  
K. D. Elowe, Ex-Officio  
S. A. Arthur, Ex-Officio

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

- Objectives:**
- 1) To document age, sex-specific, and seasonal differences in size of home ranges of martens.
  - 2) To document the extent of spatial and temporal overlap of home ranges of non-juvenile martens within and between sexes.
  - 3) To assess the influence of home ranges of non-juvenile, resident martens on relocations of juvenile martens.
  - 4) To assess the influence of cover type, canopy closure, average tree height, distance to and density of forest edge, and distance to and density of roads on use of habitat by martens within home ranges and location of home ranges of martens within the study area.

**PROJECT STATUS:** All requirements for the degree of Master of Science (in Wildlife Management) were completed in May 1992. An abstract of the thesis follows:

Despite the economic and ecological importance of martens (*Martes americana*), social organization of marten populations has not been well documented. I examined age-specific, seasonal, and sex-specific differences in size and location of marten home-ranges, and spatial and temporal overlap of ranges within and between sexes.

Previous researchers concluded that martens select for mature conifer-dominated forest, but did not consider the effect of intrasexual territoriality on habitat availability, or the variation in selection among martens. I compared habitat selection between sexes, and assessed habitat use in home ranges and in core areas relative to availability within the study area (i.e., landscape-level selection), and at relocations relative to availability within home ranges (i.e., stand-level selection). I also examined the influence of road density, and of the proximity to roads and forest edges on spatial use of habitat.

I radiotracked 28 resident non-juvenile ( $\geq 1$  yr) martens (14 M, 14 F), and 22 juvenile martens (12 M, 10 F) from May 1989-April 1991. Minimum distance between relocations (MINDIST), and radius of relocations (RADIUS) did not differ within sexes between adults and yearlings, or seasonally, from May-October. Home ranges did not change location during kit dependency (May-July), or during breeding season (July-August). Perhaps females with dependent young foraged more intensively, rather than over a larger area. Minimum convex polygon home-ranges (May-October) were larger for males (5.45 km<sup>2</sup>,  $P < 0.01$ ); males also had greater energetic needs related to body weight than did females.

Martens were territorial within, but not between sexes. The proportion of a marten's home range exclusive of conspecifics of the same sex was 97.0% for males, and 87.7% for females; compared with 59.6% (males), and 16.6% (females) for areas of the range exclusive of the opposite sex. Number of relocations in exclusive areas of home ranges did not differ from expected for either sex. Age, weight, and range size of males was not related with access to females. Removal of resident adult males, and immigration of younger males from nearby untrapped areas may have precluded an age-related social hierarchy among males. Social organization in this marten population was similar to other mustelids, despite a rapid and almost complete annual turnover of residents due to trapping.

Martens selected habitat at the landscape-level. I did not observe selection at the stand-level, perhaps because of random error from using 0.1-km<sup>2</sup> circles to assess stand-level use. Mixedwood stands were selected over pure conifer or pure deciduous stands. Conifer habitats in this study were unique; most uncut stands were located on wet sites, and previously harvested stands were even-aged with little understory. Physical characteristics of stands (e.g., vertical diversity) may be more important than species composition to martens. Habitat use did not differ between males and females.

The proportion of roads in male ranges did not differ from expected, whereas the proportion in female ranges was less than expected. Distance to roads was less than expected for both sexes. Distance to forest edge was greater than expected for relocations in forested habitats, and less than expected in nonforested habitats.

Region-wide management of forested lands, through a long-term plan for the size, shape, distribution, and frequency of clearcutting, is needed to ensure both viable populations of martens and the economic viability of the wood-products industry. The potential effects of the Maine Forest Practices Act on marten habitat may be considerable, and warrants further study.

## POPULATION DYNAMICS OF PACIFIC WALRUSES

*Investigators:* S. Hills  
J. R. Gilbert

*Advisors:* J. R. Gilbert  
W. E. Glanz  
W. A. Halteman  
M. L. Hunter, Jr.  
W. B. Krohn

*Cooperators/  
Project  
Support:* U.S. Fish and Wildlife Service -  
R-8, AFWRC

- Objectives:*
- 1) Techniques development and evaluation:
    - a) Adapt existing satellite telemetry technology to walrus, including packaging, sensors, and attachment procedures.
    - b) Develop immobilization techniques for walrus on pack ice.
  - 2) Determine the effect of behavioral patterns of walruses (herd composition, distribution, movements, and behavior) on the existing population estimates.
  - 3) Determine the distribution and movements of walruses relative to pack ice distribution, bathymetry, and other environmental parameters.
  - 4) Evaluate the past censuses of walruses in relation to the distribution information collected on objectives 2 and 3.

*SCOPE:* Existing walrus population estimates fail to account for herd composition, movement, distribution, and behavioral patterns. Sampling effort is shared by the U.S. and the U.S.S.R., and population estimates are attempted once every five years. Sampling effort currently lacks coordination and design and, therefore, lacks credibility; results are limited to determining overall population trend. Adaptation and implementation of available satellite telemetry techniques to walrus will potentially address the majority of the problems associated with current estimates, and thus help to provide a more reliable data base for management.

*PROJECT STATUS:* The analysis of the satellite telemetry data was completed over the summer and a draft of the dissertation submitted to committee. The dissertation "The effects of temporal and spatial variability on population assessment of Pacific walruses: is comprised of five chapters. The first two address methods of immobilization of walruses and evaluation of the satellite transmitters attached to walruses. The terrestrial haulout behavior of walruses in Bristol Bay is described in chapter three. The relation of autumn distribution of walruses in the Chukchi Sea to habitat parameters is evaluated in the fourth chapter. The final chapter evaluates the evidence for trends in the walrus population.

*FUTURE PLANS:* The dissertation will be finished in November and papers submitted to refereed journals.

## 1990 WALRUS POPULATION ESTIMATE

*Investigator:* J. R. Gilbert

*Cooperators/  
Project  
Support:* U.S. Fish and Wildlife Service -  
Region 7, Anchorage, Alaska  
VNIRO, Moscow, USSR  
TINRO, Magadan, USSR

*Objective:* To estimate the size of the Pacific Walrus population in the Bering and Chukchi seas.

*SCOPE:* Every five years the U.S. and U.S.S.R. have cooperated in censusing the Pacific walruses in the waters between Alaska and the Chukotka Peninsula. With increased cooperation possible, this census was planned and executed using common methodology and coordinated field efforts.

**PROJECT STATUS:** Soviet and American scientists cooperated in a coordinated aerial survey of walrus in the Bering and Chukchi seas in the fall of 1990. Three U.S. scientists were observers on a Soviet aircraft operating from the Chukotka Coast, four scientists flew from Barrow, Alaska.

In March 1991, the Soviet and American participants convened in Anchorage, Alaska to analyze the survey data and write a preliminary report. A manuscript which reports the results of the survey has been written and is being prepared for review and publication.

In early September 1990, walrus were counted on coastal and island haulouts in the Bering and Chukchi seas using aerial photography or visual counts from aircraft. In late September, walrus were counted on the sea ice and in the waters of the Chukchi Sea. With cooperation between the governments and the scientists of the United States and the former Soviet Union, coordinated surveys with a common methodology were possible for the first time.

We estimated a total visible population of 201,038 walrus and were not able to account for those under the water. Of those observed, fewer were found in the pack ice than in previous surveys, and a majority were on Wrangel Island. This difference in distribution between land and ice habitats is likely due to the extreme minimum ice coverage in the Chukchi Sea.

## POPULATION ECOLOGY OF FEMALE BLACK BEARS IN MAINE

**Investigator:** C. R. McLaughlin

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

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

**Objectives:**

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

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

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

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

These relationships will be investigated using a computer model based upon parameter estimates from field data. The model should improve prediction of population responses to management actions and habitat changes. It may also enhance MDIFW's ability to monitor the State's bear population. Model construction and testing will include extensive sensitivity analysis, which should provide insight into the type of data needed, and required precision in data collections for reliable monitoring of population parameters.

The model should also become a vehicle for developing and testing statewide population monitoring techniques. Observed changes in population status of bears living within MDIFW study areas will provide a basis for evaluating harvest-related monitoring techniques. The model could be used to further test the sensitivity of new monitoring techniques over a wide range of population conditions.

**PROJECT STATUS:** Survival analysis has been completed, and analysis of reproductive data is underway, paralleling model development. Several preliminary computer models have been constructed in QuickBasic. Each succeeding model included additional components; the current model describes the life history of female bears in considerable detail. The model is a Leslie matrix design, and accommodates variation in survival during 2 periods (pre-hunting season and hunting season), fluctuating age of first reproduction, and variation in frequency of various-sized litters, litter sex ratios, and litter production. Density dependent survival of subadults is assumed to be the principal factor regulating population growth in the absence of harvest.

**FUTURE PLANS:** Sensitivity analysis will evaluate changes in model output with changing parameter values, and indicate needed precision of input data. This analysis will utilize large numbers of simulation runs with progressive alterations of parameter values. Comparisons of simulation results should identify and quantify the model's sensitivity to variation in parameter values. Additional complexity (i.e., stochastic effects and behavioral influences) will be incorporated into the model structure, with progressive sensitivity analysis as appropriate.

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

---

### A SURVEY OF BEAR HUNTERS IN MAINE: HUNTING EFFORT AND SUCCESS RATES, AND ATTITUDES ABOUT BEAR HUNTING POLICIES

**Investigator:** R. M. Muller

**Advisors:** J. A. Sherburne, Co-Chairperson  
K. J. Boyle, Co-Chairperson  
J. R. Gilbert

**Cooperators/  
Project  
Support:** Maine Department of Inland Fisheries and Wildlife (MDIFW)  
Office of International Programs

**Objectives:**

- 1) Design a survey to address the following issues:
  - a) Bear hunting effort and success rates by hunting method and WMU.
  - b) Bear hunter attitudes about past and current bear hunting policies.
  - c) Hunter interest and effort in providing input on bear hunting issues to MDIFW.
- 2) Evaluate hunter attitudes about past and current bear hunting policies, and interest and effort in providing input on bear hunting issues to MDIFW.

**SCOPE:** Black bear hunting as a controlled and regulated hunt in Maine began in the 1930s. Since 1931 the bear harvest season has fluctuated widely from year-long seasons from 1942-1965, to a five month

season, to a split season between the spring and the fall months, to the current three month season, which is restricted by law.

Throughout this time, most of the data concerning the status of the bear population in the state of Maine have been gathered via harvest data. Very little data have actually been collected on the numbers of hunters pursuing bear, their hunting effort, and their success rates. This past year, 1990, was the first year that a special bear hunting permit was required in order to better evaluate bear hunting effort and success rates in the state of Maine.

MDIFW is interested in the preparation of a bear hunter survey which can be administered on a yearly basis in order to provide them with accurate information concerning hunting effort and success rates by various hunting methods and in the different Wildlife Management Units.

**PROJECT STATUS:** A mail survey for bear hunters has been designed and administered to 500 resident hunters and 500 non-resident hunters. Currently, survey data are being analyzed.

## SURVIVAL AND SUSTAINABILITY OF A HEAVILY HARVESTED MARTEN POPULATION

**Investigators:** D. J. Harrison  
T. P. Hodgman  
D. D. Katnik

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

**Objectives:**

- 1) To document and compare age/sex specific survival rates of martens in a heavily trapped area.
- 2) To compare vulnerability of martens to trapping by age/sex class.
- 3) To evaluate sustainable harvests of martens in relation to observed mortality.

**SCOPE:** Pine marten (*Martes americana*) populations are particularly vulnerable to overharvesting because of the species' low reproductive rate, high pelt price relative to other furbearers, and ease of capture. Further, a recent decline in pelt prices of other furbearers has directed additional trapping pressure towards martens. In 1973, the trapping season on martens in Maine was reopened after nearly 40 years of closure. Following reinstatement, the harvest has increased in Wildlife Management Unit #2 (WMU 2), the majority of marten range in Maine, from < 150 martens in 1973 to nearly 6,000 martens in 1985. Recently, however, the annual harvest has decreased; < 2,000 martens were harvested in WMU 2 during 1991. To better understand the population ecology of this furbearer, we initiated a project in Townships 4 & 5 Range 11 to examine the survival of martens in an intensively trapped area. Our goal is to identify factors which significantly affect survival of martens and to propose management recommendations to ensure the sustainability of marten populations in Maine.

**PROJECT STATUS:** We estimated age and sex-specific survival from May 1989 - March 1992 for 38 female (26 adults, 12 juveniles) and 36 male (24 adults, 12 juveniles) martens. Most mortalities observed during 7,134 radio-days were human-caused. Span (1 May-15 December) survival rates were significantly different between adult ( $\geq 1$  year) males and adult females. Daily survival rates of adults were significantly lower during the first 14 days of the trapping season than during the remaining 4-5 weeks. Survival through the first 14 days of the trapping season was highest for adult females, followed by adult males, juvenile (< 1 year) females, and juvenile males. Vulnerability of adult females to trapping was lower than all other

age/sex classes. However, we observed no significant differences between any other age/sex classes.

Sex-specific adult survival rates were calculated for the post-trapping interval (16 December-April 30) from multiples (i.e., 0X, 1X, 2X, 4X, 8X) of MLE daily mortality rates observed during the pre-trapping interval (1 May-31 October). Annual MLE survival rates, calculated as the product of all interval rates, differed little among these scenarios for either adult males or adult females.

Estimates of population change and survival of juvenile females both indicate the population is not sustaining itself. Further, we simulated the affect of longer trapping seasons on survival of this population. With mortalities concentrated in the early portion of the trapping season, extending the length of the season had little added negative affect. Immigration from adjacent refugia appear critical to the viability of martens on our study area.

**FUTURE PLANS:** Analyses are complete and a final project manuscript is in preparation.

## RELATIONSHIP OF BEAVER MANAGEMENT AND WATERFOWL PRODUCTION IN SOUTHCENTRAL MAINE

**Investigator:** T. C. McCall

**Advisors:** R. B. Owen, Jr., Chairperson  
D. J. Harrison  
W. B. Krohn  
W. A. Halteman  
J. R. Longcore  
P. O. Corr, Ex-Officio  
K. D. Elowe, Ex-Officio

**Cooperators/  
Project  
Support:** McIntire-Stennis  
Hirundo Wildlife Trust  
Maine Cooperative Fish and Wildlife Research Unit  
Maine Department of Inland Fisheries and Wildlife  
Maine Trappers Association  
National Rifle Association  
Penobscot County Conservation Association

**Objectives:**

- 1) Determine the yearly response of the density of beaver on an area open to recreational beaver trapping and an area recently closed to trapping.
- 2) Compare the number of wetlands and surface area of water on both areas.
- 3) Compare the area of lifeforms of habitat for waterfowl on both areas.
- 4) Compare the annual response in the density of breeding pairs of selected waterfowl species on both areas.

**SCOPE:** Beaver are one of the primary agents influencing wetland creation and dynamics in North America. Furthermore, beaver flowages have been recognized for years as high quality habitat for waterfowl and many other wildlife species. However, it is unclear how beaver trapping influences beaver densities, wetland dynamics, and waterfowl densities. This study is designed to provide data for better management of beaver to (1) ensure maximum waterfowl and other wildlife habitat, (2) ensure a sustainable beaver harvest, (3) minimize impact of beaver damage, and (4) maximize aesthetic enjoyment of wildlife for the public.

One 111 km<sup>2</sup> area in south-central Maine was closed to beaver trapping for 4 years beginning in 1989, whereas a similar area remained open to trapping.

**PROJECT STATUS:** The fourth field season has been completed. Each October from 1988-91, the density of active beaver colonies was determined on both areas from fixed-wing aircraft. On the trapped area, trappers were interviewed annually to determine the harvest of beaver. Each May the number and sizes of wetlands and the lifeforms of habitat associated with each of the 270 wetlands was determined using aerial photos. From July-September 1989-91 each wetland was visited to verify the accuracy of the data obtained from the photos. Each wetlands was visited in the spring and summer to record the condition of the beaver dam and the water level. From April-May 1989-92, ground counts of breeding pairs of selected waterfowl species were compared on each area.

The density of active beaver colonies on the untrapped area increased dramatically from 0.15-0.25/km<sup>2</sup> (17-28, 65%) from 1988-91. However, on the trapped area the density of colonies declined slightly from 0.20-0.17/km<sup>2</sup> (22-19, 14%). Harvest of beaver on the trapped area declined from 39-18 (54%) from 1989-92. Thirteen of 22 colonies (59%) were trapped in 1989, 39% in 1990, 22% in 1991, and 37% in 1992. Five hundred beaver were live-trapped and tagged to determine population dynamics and dispersal of beaver.

The number of wetlands on the untrapped area increased from 120-132 (10%) from 1989-91, and on the trapped area fewer wetlands were added (92-97, 5%). Total surface area of water on the untrapped area increased greatly (48%) but remained stable on the trapped area. Moreover, on the untrapped area there was a striking increase in area of flooded lifeforms: open water (24%), herbaceous vegetation (36%), ericaceous vegetation (233%), alder and willow (140%), and timber (67%). The only lifeform to decline was floating-leaved vegetation (3%). Whereas, on the trapped area alder and willow increased 8%, timber declined 4%, and other lifeforms changes <3%.

Number of pairs of all species of waterfowl on the untrapped area increased in density: black ducks (27.0-31.5/100 km<sup>2</sup>, 17%), Canada geese (3.6-9.0/100 km<sup>2</sup>, 25%), mallards (7.5-13.5/100 km<sup>2</sup>, 80%), and wood ducks (29.7-33.8/100 km<sup>2</sup>, 14%). On the other hand, on the trapped area the density of pairs either declined as in black ducks (29.3-23.4/100 km<sup>2</sup>, 20%) or increased less than on the untrapped area as in Canada geese (8.1-10.8/100 km<sup>2</sup>, 33%) and mallards (11.5-13.5/100 km<sup>2</sup>, 17%), except for hooded mergansers that increased 7.5-13.0/100 km<sup>2</sup> (73%) and wood ducks that increased 18.0-27.0/100 km<sup>2</sup> (50%).

Our controlled study demonstrates that given a closure of beaver trapping in a heavily trapped area where the beaver population is below its potential, beaver can rapidly expand into suitable habitat and create and reflood wetlands. Furthermore, most species of waterfowl will increase in density in response to the greater quantity and quality of wetlands.

**FUTURE PLANS:** In the fall of 1992 the number of beaver colonies will be determined; and in the winter of 1993 the harvest of beaver will be monitored, thus completing the fieldwork. The anticipated date of completion is May 31, 1993.

## REPRODUCTIVE BIOLOGY OF CAPTIVE FISHERS

**Investigator:** H. C. Frost

**Advisors:** W. B. Krohn, Chairperson  
D. J. Harrison  
C. R. Wallace  
H. C. Gibbs  
K. D. Elowe

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



- Objectives:*
- 1) Determine if placental scars are a reliable index for estimating fisher recruitment from trapper caught animals.
  - 2) Document male and female reproductive cycles by: A) monitoring levels of reproductive hormones; B) documenting the estrous cycle and implantation dates of females and; C) monitoring testes size, sperm viability, and baculum development in males.
  - 3) Document growth and development of embryos and kits in captivity.

*SCOPE:* Most of the information on fisher reproduction came from fur farms before 1930. Between 1950 and 1970 several investigators studied fisher reproduction, primarily from data collected from carcasses of trapper caught animals. Common reproductive indices for fisher are counts of corpora lutea, blastocysts, and placental scars. Recently, the state of Maine has undertaken an extensive effort to document the reproductive biology of fishers both from wild animals using radio-telemetry and from studying wild fishers brought into captivity. Data from the telemetry studies indicate that counts of corpora lutea and blastocysts over estimate the number of females that give birth and the number of young born. However, the proportion of adult females with placental scars was similar to the proportion of females denning and raising young in the wild. The use of placental scars has been questioned because of the reliability of observing them on the uterus and determining how long they are visible. The validity of using placental scars as a recruitment index will be investigated. In addition, the male and female reproductive cycles will be documented along with the growth and development of embryos and young born in captivity.

*PROJECT STATUS:* Twenty-two cages and nest boxes were constructed during the fall of 1990 and put in place at the University of Maine's Animal Research Facility. Thirty-two fishers, 28 females and 4 males, have been captured and brought into captivity. Twelve (5 in 1991 and 7 in 1992) of the 28 females have given birth to 35 young. Through releases, escapes, and deaths, 23 fishers remain in captivity. More releases are planned before the end of the year, to make room for newly trapped animals.

Ultrasound readings were taken at weekly intervals on all pregnant females from the last week of January 1992 until birth in March 1992. Dates of blastocyst implantation were identified and development of the embryos was monitored. Weight and body measurements were taken on the kits from birth until they were released in November. Behavioral observations were done from the time the kits began leaving the nest box until the litters were separated. Blood was taken from all adults at weekly intervals between January and June, and levels of testosterone and progesterone are currently being determined by radioimmunoassay. Vaginal smears and vulva measurements were also taken weekly to determine when estrus occurs and how long it lasts. Teste measurements and electroejaculations were done to determine when males become sexually active and how long this period persists. Laparotomies were done on all animals that gave birth to count placental scars and compare them with the number of known births. Only 1 placental scar has been seen out of 35 known births from 12 females.

*FUTURE PLANS:* Placental scars are known to occur in fishers harvested by trapper in November and December. However, placental scars in the live captive fishers have not been seen. Trappers will be hired to capture 10 additional females and 2 adult males during the 1992 trapping season. Laparotomies will be done on all females that are judged to have given birth the previous year. This will allow comparisons between females that are pregnant (wild caught) and those that are not pregnant (captive from previous year). Hormone profiles will continue to be monitored. Vaginal smears, vulva and testes measurements, and electroejaculations will be done throughout the breeding season on all animals so adult, yearling, and juvenile reproductive cycles can be compared. All animals will be released in June 1993 and data analysis will begin. The final report should be finished by December 1993.

---

## ECOLOGY OF SPRUCE GROUSE IN ACADIA NATIONAL PARK AND ON MOUNT DESERT ISLAND

*Investigator:* S. D. Whitcomb

*Advisors:* F. A. Servello  
D. J. Harrison  
A. F. O'Connell  
W. E. Glanz

*Cooperators/  
Project  
Support:* National Park Service -  
Acadia National Park

- Objectives:*
- (1) Identify potential habitat patches occupied by breeding spruce grouse in Acadia National Park and on Mount Desert Island.
  - (2) Determine the minimum breeding population of spruce grouse in Acadia National Park and on Mount Desert Island.
  - (3) Determine habitat types selected by dispersing juvenile spruce grouse, and describe dispersal movements.

**SCOPE:** Spruce grouse were believed to be extirpated on Mount Desert Island in the late 1800s but a breeding population currently exists. However, little is known about the population or its long term viability. Spruce grouse breeding habitat is predominantly lowland conifer cover. This cover type has a highly fragmented distribution on the island and occupies only 26% of the island's area. Therefore, the potential breeding habitat for spruce grouse is limited, and dispersal of juveniles between widely separated patches of breeding habitat may be important for maintaining a viable population.

**PROJECT STATUS:** Areas of potential habitat have been identified from cover maps and preliminary surveys of spruce grouse occurrence and habitat availability have been completed. A census of breeding spruce grouse was completed in spring 1992. Female spruce grouse were fitted with radio transmitters and monitored during nesting and brood rearing. In August juvenile spruce grouse were radio tagged to study habitat selection during dispersal.

**FUTURE PLANS:** A second census of spruce grouse will be conducted in April-May 1993. Female spruce grouse will be monitored during nesting and brooding to determine productivity.

## WHITE-TAILED DEER MORTALITY, POPULATION DYNAMICS, MOVEMENTS, AND SPATIAL INTERACTIONS WITH COYOTES IN ACADIA NATIONAL PARK, MAINE

*Investigator:* S. L. Glass

*Advisors:* D. J. Harrison  
A. F. O'Connell  
J. R. Gilbert  
K. D. Elowe

W. E. Glanz

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

- Objectives:*
- 1) Estimate cause-specific mortality rates for radio-collared female white-tailed deer on Mount Desert Island.
  - 2) Assess patterns of spatial overlap among coyote and white-tailed deer social groups to determine whether coyotes influence available habitat for deer in Acadia National Park.
  - 3) Using mortality rates estimated via objective #1 and a stochastic simulation model, to assess the effect of various causes of mortality on population dynamics of deer in Acadia National Park.
  - 4) Compare social structure of coyote family groups on Mount Desert Island with mainland coyotes in eastern Maine.
  - 5) To determine the extent of shared use of private lands and park lands by deer inhabiting Mount Desert Island.

**SCOPE:** Deer populations in many eastern National Parks have been increasing to the extent that vegetation and species composition are showing significant negative effects. Acadia National Park (ANP) is an exception; since 1968 no evidence of widespread overbrowsing has been documented. Recent studies suggest that deer populations have declined in ANP since 1980.

Coyotes colonized Mount Desert Island (MDI) in the early 1980s and are a potentially significant predator on deer in ANP. Preliminary food habits studies suggest that the use of deer by coyotes is high relative to mainland areas. In addition to direct predation, spatial interactions between coyotes and deer may potentially affect deer populations.

We plan to investigate cause-specific mortality of deer, assess patterns of movement and spatial overlap between coyotes and deer, examine the social structure of coyotes on MDI, and develop a stochastic simulation model for deer in ANP.

**PROJECT STATUS:** Field work was initiated in August 1991. Twenty-two coyotes (13 females, 9 males) from 7 different family groups have been captured and equipped with transmitters. From January-June, 1992, 10 adult does and 8 fawns (4 females, 4 males) were equipped with transmitters. Relocations have been obtained 1-3 times per week. Mortality sources documented for deer on MDI have been coyotes, domestic dogs, and vehicles.

**FUTURE PLANS:** Coyote trapping will proceed through November 1992 with the intent of capturing 5-7 additional coyotes. Deer trapping and darting will be conducted from December-April. Relocations will be obtained 1-3 times per week for deer and coyotes. Coyote and deer trapping will continue during 1993 and 1994.

---

## SPATIAL RELATIONSHIPS AND DISPERSAL CHARACTERISTICS IN AN UNEXPLOITED AMERICAN MARTEN POPULATION

*Investigator:* D. M. Phillips

*Advisors:* D. J. Harrison, Chairperson  
W. B. Krohn  
K. D. Elowe  
W. A. Halteman

*Cooperators/* McIntire-Stennis  
*Project* Maine Department of Inland Fisheries and Wildlife  
*Support:* Baxter State Park

*Objectives:*

- 1) Compare spatial relationships in an unexploited marten population to a recently studied population in an area characterized by extensive timber harvesting and intensive trapping.
- 2) Document the extent of seasonal and annual home range fidelity of martens.
- 3) Document and compare sex-specific characteristics of dispersal in an unexploited marten population.

*SCOPE:* Despite the ecological and economic importance of martens, and the steadily increasing harvest in Maine, reports on home range size, seasonal and annual home range fidelity, and degree of overlap are fragmented and often inconsistent. Most marten research has been conducted in areas subject to trapping pressure and/or timber harvesting, and an assessment of marten spatial relationships in an unexploited marten population is needed.

Knowledge of marten dispersal characteristics is an essential ingredient of sound management decisions; however, reports on timing, directionality, distance and duration of dispersal is largely anecdotal. A large scale biotelemetry study of these factors is justified due to the contradictory and incomplete information available, and the fact that marten dispersal characteristics remain unknown.

My goals are to document spatial relationships (i.e., home range size, seasonal and annual home range shift, spatial and temporal overlap) of martens in a 50km<sup>2</sup> area of Baxter State Park, and compare them with the results of a recently completed study of an adjacent population in an area characterized by extensive timber harvesting and intensive trapping. I will document dispersal characteristics of martens, evaluate their relationship with Maine's current harvest restrictions, and assess the role of the park in maintaining marten populations in adjacent areas where trapping and forest harvesting occur.

*PROJECT STATUS:* Since October 1990, 65 martens have been equipped with radio-collars in the Baxter study area. Over 2,500 relocations were obtained by livetrapping, ground and aerial telemetry, and walk-in observations. Sufficient data are available for 34 martens (17m,17f) to document and compare spatial characteristics. Twenty-one martens (7m,14f) will be used in the analysis of dispersal.

*FUTURE PLANS:* Ground and aerial monitoring of radio-collared martens will continue until May 1993. The expected date of project completion is May 1994.

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

*Investigator:* L. A. Joyal

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

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

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

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

*PROJECT STATUS:* A nine square kilometer area containing the largest known population of each species was selected as an intensive study site. Radiotransmitters were put on eight female spotted turtles, five female Blanding's turtles, and two male Blanding's turtles. These turtles were located every two to three days during the summer and they are still being monitored periodically. Individual wetlands were visited repeatedly throughout the summer to visually survey for turtles and to measure habitat variables. Eleven total nests were located in June and they are now being monitored for emerging hatchlings.

*FUTURE PLANS:* Field work will be repeated during the spring and summer of 1993.

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

**SCIENTIFIC PUBLICATIONS**

- BOGACZYK, B.A. 1992. A search for Parelaphostrongylus andersoni in white-tailed deer from Maine. J. of Wildlife Diseases 28:311-312.
- BOWMAN, T.D., and P.W. BROWN. 1992. Site fidelity of male black ducks to a molting area in Labrador. Journal of Field Ornithology 63:32-34.
- DUBUC, L.J., R.B. OWEN, JR., W.B. KROHN, and C.J. SCHELL. 1991. Foods and distribution of river otters on Mount Desert Island, Maine. Trans. Northeast Section of The Wildlife Society 48:104-112.
- GIBBS, J. 1991. Spatial relationships between nesting colonies and foraging areas of great blue herons. Auk 108:764-770.
- GUSTAFSON-GREENWOOD, K.I., and J.R. MORING. 1991. Gravel compaction and permeabilities in redds of Atlantic salmon *Salmo salar* L. Aquaculture and Fisheries Management 22: 537-540.
- HARRISON, D.J., A.F. O'CONNELL, JR., and J.A. SUBIJANTO. 1991. Seasonal food habits of a recently established insular coyote population. Abstracts of the 2nd National Park Service Conference on Science and Natural Research Management, North Atlantic Region, p. 159.
- HARRISON, D.J., J. HARRISON, and M. O'DONOGHUE. 1991. Predispersal movements of coyote (Canis latrans) pups in eastern Maine. Journal of Mammalogy 72:756-763.
- HARRISON, D.J. 1992. Social ecology of coyotes in northeastern North America: relationships to dispersal, food resources, and human exploitation. Pages 53-72 in Ecology and management of the eastern coyotes, ed. A. Boer. Fredericton: New Ireland Press.
- HARRISON, D.J. 1992. Dispersal characteristics of juvenile coyotes in Maine. Journal of Wildlife Management 56:128-138.
- HARRISON, D.J., and N.E. FAMOUS. 1992. Effects of peat harvesting on a large mammalian carnivore: a case study with coyotes (Canis latrans). Pages 77-96 in Peat and peatlands: the resource and its utilization, ed. D. Grubic. Proc. Int. Peat Symp. Duluth, MN.
- HARTLEY, R.A., and J.R. MORING. 1991. Initial and delayed mortality of largemouth and smallmouth basses due to tournaments. USDA Forest Service, Gen. Tech. Rep. RM-207:269-272.
- HUNTER, M.L. 1991. Conservation of amphibians and reptiles in the State of Maine, USA. New Zealand Journal of Zoology 18:345.
- HUNTER, M.L., JR. 1991. Conservation strategies for the giant and red pandas. Trends in Ecology and Evolution 6:379-380.
- HUNTER, M.L., JR. 1991. Bird conservation at a landscape scale: Seeing the world from a bird's eye view. Acta Congressus Internationalis Ornithologici 20:2283-2285.

- HUNTER, M.L., JR. 1992. Paleoeecology, landscape ecology, and conservation of Neotropical migrant passerines in boreal forests. Pages 511-523 in Ecology and conservation of neotropical migrant landbirds, eds. J. Hagan and D. Johnston. Washington, DC: Smithsonian Institution Press.
- HUTCHINSON, A., and M.L. HUNTER. 1992. The status of the timber rattlesnake in Maine. Page 6 in Conservation of the timber rattlesnake in the northeast, ed. T. Tynning. Massachusetts Audubon Society, Lincoln, MA.
- O'CONNELL, A.F., D.J. HARRISON, and J.A. SUBIJANTO. 1992. Variation in coyote (Canis latrans) foraging behavior: influence of island biogeography. Abstracts of the 72nd Meeting of the American Society of Mammalogists: 100.
- O'CONNOR, R.J. 1991. Breeding. Chapter 9, pages 222-255 in The Cambridge Encyclopedia of Ornithology, eds. M. Brooke, and T. Birkhead. Cambridge: Cambridge University Press.
- O'CONNOR, R.J., R.B. BOONE, H. DEVAUL, M.T. JONES, and T.B. LAUBER. 1992. The relative effects of environment and agricultural practices on bird populations in the United States. Program and Abstracts, 77th Annual Meeting of Ecological Society of America: 290.
- O'CONNOR, R.J. 1992. Trends in populations: Introduction. Pages 23-25 in Ecology and conservation of neotropical migrant landbirds, eds. J. Hagan and D. Johnston. Washington, DC: Smithsonian Institution Press.
- O'CONNOR, R.J. 1992. Population variation in relation to migrancy status in some North American birds. Pages 64-74 in Ecology and conservation of neotropical migrant landbirds, eds. J. Hagan and D. Johnston. Washington, DC: Smithsonian Institution Press.
- OWEN, R.B., JR., C.S. TODD, M.A. MCCOLLOUGH, and F.J. GRAMLICH. 1991. Nesting history and population status of Maine's bald eagles. Trans. Northeast Section of The Wildlife Society 48:21-30.
- POWELL, G.V.N., J.H. RAPPOLE, and S.A. SADER. 1992. Nearctic migrant use of lowland Atlantic habitats in Costa Rica: a test of remote sensing for identification of habitat. Pages 287-298 in: Ecology and conservation of neotropical migrant landbirds, eds. J.M. Hagan and D. Johnston. Washington, D.C.: Smithsonian Institution Press.
- SADER, S.A. 1992. Forest change on a landscape scale using landsat imagery: tropical and temperate forest examples. Pages 25-35 in Remote Sensing and Permanent Plot Techniques for World Forest Monitoring, Bangkok, Thailand: International Union of Forest Research Organizations (IUFRO).
- SAEKI, M., and D.J. HARRISON. 1991. Trends in browse use and preference in an unhunted deer and hare population. Abstracts of the 2nd National Park Service Conference on Science and Natural Research Management, North Atlantic Region: 169.
- SAEKI, M., and D.J. HARRISON. 1992. Influence of food availability and fire history on dietary quality of white-tailed deer (Odocoileus virginianus). Abstracts of the 72nd Meeting of the American Society of Mammalogists: 96.
- VICKERY, P. 1991. A regional analysis of endangered, threatened, and special-concern birds in the northeastern United States. Trans. Northeast Section of The Wildlife Society 48:1-10.

- VICKERY, P., M.L. HUNTER, JR., and J. WELLS. 1992. Evidence of incidental predation and its effects on nests of threatened grassland birds. *Oikos* 63:281-288.
- VICKERY, P. 1992. Observation of a band-rumped storm petrel (*Oceanodroma castro*) in inland Maine. *Maine Bird Notes* 5:15.
- WHITMAN, A.A., and P.M. PAYNE. 1991. Age of harbour seals, *Phoca vitulina concolor*, wintering in southern New England. *Canadian Field-Naturalist* 104:579-582.
- WITHAM, J.W. and M.L. HUNTER, Jr. 1992. Population trends of Neotropical migrant landbirds in northern coastal New England. Pages 85-95 in Ecology and conservation of neotropical migrant landbirds, eds. J. Hagan and D. Johnston. Washington, DC: Smithsonian Institution Press.
- YONZON, P., R. JONES, and J. FOX. 1991. Geographic information systems for assessing habitat and estimating populations of red pandas in Langtang National Park, Nepal. *Ambio* 20:285-288.

#### TECHNICAL AND SEMI-TECHNICAL PUBLICATIONS

- AGLER, B.A. 1992. Testing the reliability of photographic identification of individual fin whales (*Balaenoptera physalus*). *Rep. Int. Whal. Commn.* 42:731-737.
- AGLER, B.A., K.A. Robertson, D. DenDanto, S.K. Katona, J.M. Allen, S.E. Forhock, I.E. Seipt, and R.S. Bowman. 1992. The use of photographic identification for studying individual fin whales (*Balaenoptera physalus*) in the Gulf of Maine. *Rep. Int. Whal. Commn.* 42:711-722.
- MORING, J.R. Our specialty: answering questions. *Maine Fish and Wildlife* 14(1):9-11.
- SERVELLO, F.A. 1992. Winter survival strategies. *Small Woodlot Owners Association of Maine Newsletter* 17:5.
- SEYMOUR, R., and M.L. HUNTER, JR. 1992. New forestry in eastern spruce-fir forests: Principles and applications to Maine. *Maine Agricultural Experiment Station Publication* 716.
- VICKERY, P. 1991. Is Victoria's secret secure? - Watching birds on Monhegan Island. *New Monhegan Press*: III:5-6.
- VICKERY, P. 1992. Racer (*Coluber constrictor*). Pp. 125-127 in The Amphibians and Reptiles of Maine, eds. M. L. Hunter, J. Albright, and J. Arbuckle.

#### THESES AND DISSERTATIONS

- AGLER, B.A. 1992. Photographic identification of individual fin whales (*Balaenoptera physalus*) in the Gulf of Maine. Master of Science thesis, University of Maine, Orono. 158pp.
- BOONE, R.B. 1991. Construction of a database used in analyses of bird populations and agriculture, with a study of density dependence. Master of Science thesis, University of Maine, Orono. 280pp.
- EL HAMZAoui, M. 1991. Comprehensive multiple-use management strategy for future research and management of Moroccan coastal wetlands. M.W.C. Report, University of Maine, Orono. 143pp.



- KATNIK, D.D. 1992. Spatial use, territoriality, and summer-autumn selection of habitat in an intensively harvested population of martens on commercial forestland in Maine. Master of Science thesis, University of Maine, Orono. 137pp.
- LAUBER, T.B. 1991. Birds and the Conservation Reserve Program: A retrospective study. Master of Science thesis, University of Maine, Orono. 252pp.
- RUDNICKY, T.C. 1991. The effects of clearcut size on bird species richness and nest predation rates in eastern Maine. Master of Science thesis, University of Maine, Orono. 94pp.
- VANDER HAEGEN, W.M. 1992. Bioenergetics of American woodcock during the breeding season on Moosehorn National Wildlife Refuge, Maine. Ph.D. dissertation, University of Maine, Orono. 103pp.

#### PROFESSIONAL TALKS PRESENTED

- ELLIOTT, C.A. March 1992. "Wildlife corridors: Pathways to Diversity?" Forests of New England: A Conference on Integrating Biodiversity and Land Management, Lowell, MA.
- ELLIOTT, C.A. May 1992. "Managing wildlife habitats in Maine." Workshop for Bowater/Great Northern Paper Inc., Millinocket, ME.
- FROST, H.C. February 1992. "Placental scars as a reproductive index to fisher." Northeast Graduate Wildlife Conference, MacDonald Campus of McGill University, Montreal, Canada.
- GIBBS, J.P., M.L. HUNTER, JR., and S.M. MELVIN. June 1992. "Snag availability and cavity-nesting bird communities in tropical versus temperate forests: a comparison among 10 new world forests." Society for Conservation Biology Conference, Blacksburg, VA.
- GILBERT, J.R., G. FEDOSEEV, D.J. SEAGARS, E. RAZLIVALOV, and A. LACHUGIN. December 1991. Results of the 1990 USSR-US Pacific Walrus Survey. Ninth Biennial Conference on the Biology of Marine Mammals, Chicago, IL.
- HARRISON, D.J. November 1991. "Coyote social organization and relationships to dispersal and food resources: predictions with an unpredictable animal." Eastern Coyote Symposium, Fredericton, NB.
- HARRISON, D.J., and M. SAEKI. November 1991. "Trends in browse utilization and preference in an un hunted deer and hare population." Second National Park Service Conference on Science and Natural Resource Management in the North Atlantic Region, Newport, RI.
- HARRISON, D.J., and M. SAEKI. June 1992. "Influence of food availability and fire history on dietary quality of white-tailed deer (*Odocoileus virginianus*)." 72nd annual meeting of the American Society of Mammalogists, Salt Lake City, UT.
- HUNTER, M.L., JR. October 1991. "Spatial and temporal aspects of managing forests for biological diversity." USDA Forest Service, Clemson University, SC.
- HUNTER, M.L., JR. October 1991. "Managing forests for biological diversity." Ontario Ministry of Natural Resources, Kempville, Ontario.

- HUNTER, M.L., JR. October 1991. "Resource conservation in Nepal." International Environmental Leaders Workshop, Orono, Maine.
- HUNTER, M.L., JR. March 1992. Keynote speaker at Birds in the Boreal Forest Conference. Canadian Wildlife Service, Prince Albert, Saskatchewan.
- HUNTER, M.L., JR. March 1992. "Managing biodiversity in forests at large spatial and temporal scales." Canadian Wildlife Service Conference, Prince Albert, Saskatchewan.
- HUNTER, M.L., JR. April 1992. "Biodiversity: What is it? What can we do about it?" Briefing given to staff of the President's Commission on Environmental Quality, Washington, D.C.
- HUNTER, M.L., JR. June 1992. "A landscape perspective on managing biodiversity." President's Commission on Environmental Quality Workshop on Biodiversity, Washington, D.C.
- HUNTER, M.L., JR., and A. CALHOUN. June 1992. "A triad approach to land use allocation in forests and wetlands." Society for Conservation Biology Conference, Blacksburg, VA.
- HUNTER, M.L., JR., and A. CALHOUN. July 1992. "A triad approach to land use allocation in forests and wetlands." USDA Forest Service Conference on Biodiversity in Managed Landscapes, Sacramento, CA.
- HUNTER, M.L., JR. September 1992. "Spatial and temporal aspects of managing forests for biological diversity." USDA Forest Service, Clemson University, SC.
- KATNIK, D. February 1992. "Habitat use of martens in Maine." Confor '92, University of Maine, Orono.
- KROHN, W.B. October 1991. Organized and sponsored a workshop on "Technical aspects of radio telemetry" given by L. Holz, USDA Denver Wildlife Research Center, University of Maine, Orono.
- LAUBER, B. September 1991. Presented summary of research in progress identifying neotropical migrants with population declines. Meeting of the Northeast Working Group on Neotropical Migrants, Luray, VA.
- MOREAU, D.A., and J.R. MORING. September 1992. "A Habitat Suitability Index Model for holding pools of adult Atlantic salmon." Annual Meeting of the Atlantic International Chapter, American Fisheries Society, St-Gregoire, Quebec.
- MORING, J.R., and P.H. NICHOLSON. November 1991. "Evaluation of three types of artificial habitat for fishes in a freshwater, boreal environment (Maine U.S.A.)." Fifth International Conference on Artificial Habitats for Fisheries, Long Beach, CA.
- MORING, J.R., G.C. GARMAN, and D.M. MULLEN. April 1992. "Effects of logging practices on fishes in streams and techniques for protection: a review of four studies in the United States." International Conference on Rehabilitation of Freshwater Fisheries, Hull, United Kingdom.
- O'CONNELL, A., D.J. HARRISON, D.J., and J. SUBIJANTO. November 1991. "Seasonal food habits of a recently established insular coyote population." Second National Park Service Conference on Science and Natural Resource Management in the North Atlantic Region, Newport, RI.

- O'CONNELL, A., and D.J. HARRISON. June 1992. "Variation in coyote food selection: effects of island biogeography. 72nd annual meeting of American Society of Mammalogists, Salt Lake City, Utah.
- O'CONNOR, R.J. November 1991. "Pattern and process in avian biodiversity." International Symposium on Environmental and Hormonal Approaches to Ornithology. Garhwal University, Srinagar, Garhwal, India.
- O'CONNOR, R.J. November 1991. Chaired a session at nutrition and feeding ecology. International Symposium on Environmental and Hormonal Approaches to Ornithology. Garhwal University, Srinagar, Garhwal, India.
- O'CONNOR, R.J., and A. MOORS. April 1992. "Development of an avian bioindicator of lake quality." USEPA Environmental Monitoring and Assessment Program - Surface Waters Peer Review Panel Workshop, Dallas, TX.
- O'CONNOR, R.J., A. WHITMAN, and M.T. JONES. April 1992. "Population change and habitat distribution in New England birds." New York Natural History Conference II, Landbird populations in the northeastern United States: What are the trends? Albany, NY.
- O'CONNOR, R.J. June 1992. "Birds and agriculture - an international perspective." Plenary address given to 100th Annual Meeting of the American Ornithologists Union, Ames, IA.
- OWEN, R.B. May 1992. "Landscape ecology and its application to management of Maine's wildlife." Conference on Research Initiatives for the Maine Agricultural Experiment Station, University of Maine, Orono.
- RUDNICKY, T.C., and M.L. HUNTER, JR. June 1992. "Reversing the fragmentation paradigm: the effects of clearcut size on bird species richness." Society for Conservation Biology Conference, Blacksburg, VA.
- SADER, S.A. October 1991. "Forest change detection techniques." Presented at NASA-Earth Observation Commercialization Applications Program, Stennis Space Center, MS.
- SADER, S.A. and A. ESTRADA. September 1992. "Forest fragmentation in the Sierra De Los Tuxtlas, Mexico." Poster paper presented at Smithsonian Institution Symposium - Forest remnants in the tropical landscape: benefits and policy implications, Washington, D.C.
- SHEPARD, S.L. March 1992. "Private sector contributions to Atlantic salmon management and restoration, the utility perspective." 1992 Atlantic Salmon Workshop, Rockport, ME.
- SPRUCE, J.P., B. DOWELL, C. ROBBINS, and S.A. SADER. 1992. "Forest to agriculture conversion in southern Belize: implications for migrant land birds." Poster paper presented at Smithsonian Institution Symposium - Forest remnants in the tropical landscape: benefits and policy implications, Washington, D.C.
- VERA, C.J., and F.A. SERVELLO. April 1992. "Effects of landspreading pulp and papermill sludge on Maine forestland on wildlife populations." Paper presented at Northeast Fish and Wildlife Conference, Richmond, VA.

VICKERY, P. October 1991. Organized a program at Switzer Environmental Fellowship Program annual meeting - Proposal to spread sludge, Department of Environmental Protection (mock hearing), Bedford, NH.

VICKERY, P. March 1992. Participated in workshop: Monitoring Populations of Migratory Birds in the Northeast, Lincoln, MA.

VICKERY, P., and M.L. HUNTER, JR. June 1992. "Where are the birds: how much does 'spot-mapping' tell us about habitat quality?" Society for Conservation Biology Conference, VA Tech. Univ., Blacksburg, VA.

#### PUBLIC TALKS PRESENTED

CARTWRIGHT, M.A. "Largemouth bass radio telemetry studies." Seminar presented to the Zoology Department Colloquium Series, University of Maine, September 25, 1992.

ELLIOTT, C.A. "An introduction to Project WILD." Talk given to U.M. College of Education science education students, October 29, 1991.

ELLIOTT, C.A. Conducted Project WILD Workshop for pre-service and in-service teachers, College of Education, University of Maine, November 2, 1991.

ELLIOTT, C.A. Conducted Project WILD Workshop for pre-service and in-service teachers, College of Education, University of Maine, February 4, 1992.

ELLIOTT, C.A. "Managing woodlots for wildlife." Talk given to Maine Chapter National Audubon Society, Dover-Foxcroft, January 16, 1992.

ELLIOTT, C.A. "Woodlots and wildlife management." Talk given at Maine Agricultural Trade Show, Augusta, January 22, 1992.

ELLIOTT, C.A. Conducted Project WILD Workshop for pre-service and in-service teachers, College of Education, University of Maine, February 5, 1992.

ELLIOTT, C.A. Conducted Project WILD Workshop for pre-service and in-service teachers, College of Education, University of Maine, February 6, 1992.

ELLIOTT, C.A. Conducted Project WILD Workshop for pre-service and in-service teachers, College of Education, University of Maine, February 8, 1992.

ELLIOTT, C.A. "Wildlife management in backyards and woodlots." Talk given at 54th Annual Eastern Maine Sportsman's Show, University of Maine, Orono, March 8, 1992.

ELLIOTT, C.A. Conducted Project WILD-Aquatic Workshop for pre-service and in-service teachers, College of Education, University of Maine, April 25, 1992.

ELLIOTT, C.A. "Careers in wildlife." Talk given at Brewer Middle School, Brewer, ME, May 21, 1992.

ELLIOTT, C.A. "An introduction to ecology and wildlife management." Talk given at University of Maine Cooperative Extension Forestry Camp, Tanglewood 4-H Camp, Lincolnville, ME, September 23, 1992.

- ESCHHOLZ, W.F. "Moose ecology in Maine." Presentation to woodlands staff, Great Northern Paper, Millinocket, ME, May 1, 1992.
- GLASS, S. "Coyote and deer research on Mount Desert Island." Talk given to Union River Chapter, Maine Trappers Association, Ellsworth, February 2, 1992.
- GLASS, S. "Coyote and deer research on Mount Desert Island." Talk given to Maintenance Department, Acadia National Park, Bar Harbor, ME, February 26, 1992.
- GLASS, S. "Coyote and deer research on Mount Desert Island." Topic of radio interview conducted by WERU in Blue Hill, ME, March 4, 1992.
- GLASS, S. "Coyote and deer research on Mount Desert Island." Topic of interview with Channel 5 News at Acadia National Park, Bar Harbor, ME, March 26, 1992.
- GLASS, S. "Coyote and deer research on Mount Desert Island." Topic of newspaper interview with the Maine Telegram, Portland, ME, April 27, 1992.
- GLASS, S. "Coyote and deer research on Mount Desert Island." Topic of interview with Channel 7 News, Bangor, ME, May 15, 1992.
- GLASS, S. "Coyote and deer research on Mount Desert Island." Talk given to University of Maine Wildlife Summer Camp, May 15, 1992.
- GLASS, S. "Coyote and deer research on Mount Desert Island." Topic of radio interview with WPBR, May 27, 1992.
- GLASS, S. "Coyote and deer research on Mount Desert Island." Talk given at interpretation staff orientation, Acadia National Park, Bar Harbor, ME, June 25, 1992.
- HARRISON, D.J. "Wildlife diversity in the Bangor Marsh." Talk given to The Bangor Nature Club, Bangor, ME, November 13, 1991.
- HARRISON, D.J. "Ecology of coyotes in Maine." Presentation to Penobscot County Conservation Association, Brewer, ME, December 5, 1991.
- HARRISON, D.J. "Significance of pine martens to future forest practices in Maine." Presentation to Woodlands staff, Great Northern Corp., Millinocket, ME, May 1, 1992.
- HARRISON, D.J. "Pine marten habitat requirements: will the Forest Practices Act safeguard marten habitat?" Presentation to Maine Chapter of The Wildlife Society, Orono, ME, January 23, 1992.
- HARRISON, D.J. "Interactions among timber harvesting, trapping, and pine marten populations in northern Maine." Presentation to Student Chapter of The Wildlife Society, Orono, ME, February 27, 1992.
- HODGMAN, T.P. "Herbivore food habits analysis." Talk and demonstration given to WLM 450, Wildlife Habitat Relationships, University of Maine, Orono, October 21 and 22, 1991.
- HODGMAN, T.P. "Natural history of Maine's wildlife," talk and tour of UM large animal holding facility given to Carmel Area Cub Scouts, University of Maine, Orono, November 25, 1991.

HODGMAN, T.P. "Western rangelands." Talk given to WLM 200, Ecology, University of Maine, Orono, December 2, 1991.

HODGMAN T.P. "Career possibilities in wildlife conservation." Talk given to University of Maine, Student Chapter of The Wildlife Society, University of Maine, Orono, December 4, 1991.

HODGMAN, T.P. "Quantifying the relationship of forest management to Maine's marten harvest with a geographic information system." Talk given to FTY 609, Image Processing, University of Maine, Orono, December 5, 1991.

HODGMAN, T.P. "A wildlife management career." Talk given to science class at Weatherbee Middle School, Hampden, Maine, January 22, 1992.

HODGMAN, T.P. "Summer jobs in wildlife conservation." Talk given to Introduction to Wildlife Resources, University of Maine, Orono, January 29, 1992.

HODGMAN, T.P. "Grazing effects and rangeland conservation." Talk given to WLM 540, Conservation Biology. University of Maine, Orono, March 19, 1992.

HODGMAN, T.P. "Survival and vulnerability of pine martens in northern Maine: outlook for the future." Talk given to Department of Wildlife, University of Maine, Orono.

HUNTER, M.L., JR. "Spatial and temporal aspects of managing forests for biological diversity." Yale University, New Haven, CT, October 14, 1991.

HUNTER, M.L., JR. "Paleoecology and its implications for conservation biology." Yale University, New Haven, CT, October 14, 1991.

HUNTER, M.L., JR. "Spatial and temporal aspects of managing forests for wildlife diversity." Dept. Natural Resources, Univ. of New Hampshire, Durham, NH, October 25, 1991.

HUNTER, M.L., JR. "Natural disturbance regimes as spatial models." Department of Wildlife, University of Maine, Orono, December 4, 1991.

HUNTER, M.L., JR. "Forest ecosystems of the Northeast." Talk given at Northern Forest Lands Study Conference, University of Maine, Orono, January 25, 1992.

HUNTER, M.L., JR. "Natural fire regimes as models for managing boreal forests." Department of Plant Biology and Pathology, University of Maine, Orono, January 30, 1992.

HUNTER, M.L., JR. Testified to Maine State Legislature on reorganization of the state's natural resource agencies, February 28, 1992.

HUNTER, M.L., JR., and R. SEYMOUR. "New forestry." Student Chapter of The Wildlife Society, September 23, 1992.

HUNTER, M.L., JR. "Spatial and temporal aspects of forest management." USDA Forest Service staff, Clemson University, SC, September 25, 1992.

HUNTER, M.L., JR. "A triad approach to land use allocation." Wildlife/Forestry Seminar, University of Maine, Orono, September 11, 1992.

- KATNIK, D. "Spatial use, territoriality, and habitat use of martens in Maine." Talk presented to Central Chapter of Maine Trapper's Association, Palmyra, March 4, 1992.
- KATNIK, D. "Spatial relationships, movements, and habitat selection of martens on commercial forestland in northern Maine." Talk given to Department of Wildlife, Orono, ME, April 8, 1992.
- KATNIK, D. "Habitat selection by martens on commercial forestland in northern Maine." Presentation to Woodlands staff, Great Northern Corporation, Millinocket, ME, May 1, 1992.
- KROHN, W.B. "New England's changing forestlands - effects on early and late successional wildlife". Forest Wildlife Management class, University of Maine, Orono, November 19, 1991.
- KROHN, W.B. "How Refuges and Units can work together." Slide presentation at the FWS' Region 5 Project Leaders' meeting, Stillwater, Maine, January 23, 1992.
- KROHN, W.B. "Mission and structure of the U.S. Fish and Wildlife Service." Talk given to Wildlife Policy Class, University of Maine, Orono, January 30, 1992.
- KROHN, W.B. Presented slide presentation on Maine Gap Analysis to forest industry at a meeting of the Cooperative Forestry Research Unit, University of Maine, Orono, April 28, 1992.
- MOREAU, D.A. "Habitat Suitability Index Models." Guest lecture to the Fishery Biology Laboratory class, University of Maine, November 11, 1991.
- MOREAU, D.A. "Habitat Suitability Index Models for Atlantic salmon." Seminar presented to the Zoology Department Colloquium Series, University of Maine, February 28, 1992.
- MORING, J.R. "Fisheries careers and training." Talk given to Zoology first-year students, University of Maine, December 2, 1991.
- MORING, J.R. "Artificial reefs and habitats." Talk given to meeting of the Fisheries Division, Maine Department of Inland Fisheries and Wildlife, Orono, Maine, December 18, 1991.
- MORING, J.R. "Ecology of tidepool fishes: adaptations to life in the intertidal zone." Talk presented to the Upward Bound Summer Biology Program, University of Maine, July 10, 1992.
- OWEN, R.B., JR. Radio interview on the reauthorization of the Endangered Species Act - UM Public Affairs, April 2, 1992.
- OWEN, R.B., JR. "Trends in wildlife research in the 1990's." Talk presented at Unity College Seminar Series, Unity, Maine, April 3, 1992.
- OWEN, R.B., JR. "Common birds of Maine." Talk given to Katahdin Area Council Boy Scouts, Bangor, Maine, April 8, 1992.
- PHILLIPS, D. "Pine marten research in Baxter State Park, Maine." Talk given to visitors and park staff, Baxter State Park, Maine, July 28, 1992.
- RAYMOND, K.S., W.E. ESCHHOLZ, and F.A. SERVELLO. "Effects of herbicide use on moose ecology in Maine." Presentation to Maine Department of Inland Fisheries and Wildlife staff, Bangor, ME, April 18, 1992.

- SADER, S.A. "Integrated geographic information systems for spatial analysis of wildlife habitat: a teaching approach." Wildlife Seminar, University of Maine, Orono, October 29, 1991.
- SADER, S.A. "Forest change on a landscape scale as sensed by satellite imagery." UM Botany Seminar, University of Maine, Orono, March 26, 1992.
- SADER, S.A. "Tropical deforestation: effects on migratory birds." Talk given to Bangor Nature Club, Bangor, ME, March 11, 1992.
- SADER, S.A. "Tropical deforestation: causes and consequences." Presented at Maine Scholars Day, University of Maine, Orono, May 18, 1992.
- SADER, S.A. "Spatial characteristics of forest fragments and deforestation patterns in Southern Mexico and Guatemala". UM Forestry Seminar, University of Maine, Orono, September 18, 1992.
- SERVELLO, F.A. "Effects of herbicides on wildlife habitat." Talk given to the Penobscot County Conservation Association, Brewer, ME, September 2, 1992.
- SHERBURNE, J.A. "Conservation education methods and approaches in national parks." Talk given to Peace Corps volunteers in Morocco, January 1, 1992.
- SHERBURNE, J.A. "Careers in international conservation." Talk given in first year wildlife major course, University of Maine, Orono, April 8, 1992.
- SHERBURNE, J.A. "International conservation efforts in U.S. private and public sector donor organizations." Talk given in Tropical Forestry class, University of Maine, Orono, April 10, 1992.
- SHERBURNE, J.A. "Wildlife issues and human population demands for natural resources in Africa." Talk given to Milo Garden Club, Milo, ME, April 1992.
- SHERBURNE, J.A. "Value of student exchanges in the development of higher education programs." Talk given at International Student Exchange Program meetings, Budapest, May 4, 1992.
- SHERBURNE, J.A. "Five-step process in the development of conservation education programs in developing countries." Paper and talk presented to Moroccan biologists and Peace Corps volunteers in Morocco, May 11, 1992.
- SHERBURNE, J.A. "Similarities between internationalizing higher education institutions and ecological processes." Talk given at NASULGC International Sectional Meetings, Washington, DC, July 12, 1992.
- SHERBURNE, J.A. "The ethics of U.S. foreign assistance funding in light of weakened domestic programs addressing U.S. socioeconomic issues." Talk given to International Rotary Club, Bangor, July 22, 1992.
- SHERBURNE, J.A. "International program activities at the University of Maine." Talk given to Kiwanis Club, Dover-Foxcroft, September 9, 1992.
- VAN DEN ENDE, O. "Studies of fish predation on Atlantic salmon smolts." Seminar presented to the Zoology Colloquium Series, University of Maine, September 25, 1992.



- VERA, C.J., and F.A. SERVELLO. "Effects of landspreading pulp and paper mill sludge in Maine forestland on wildlife populations." Presentation at Northeast Fish and Wildlife Conference, Richmond, VA, May 5, 1992.
- WHITCOMB, S. "Population ecology of spruce grouse on Mount Desert Island." Talk given to staff of Acadia National Park, Bar Harbor, ME, June 25, 1992.
- WHITCOMB, S. "Population ecology of spruce grouse on Mount Desert Island." Talk given to staff of Maine Department of Inland Fisheries and Wildlife, Bangor, July 14, 1992.
- WHITMAN, A., M.T. JONES, and R.J. O'CONNOR. "Bird species richness in New England: effects of habitat diversity and tree species richness." Poster presentation at New England Society of American Foresters meeting, Lowell, MA., March 11-13, 1992.

#### AWARDS, HONORS, AND APPOINTMENTS

- CARTWRIGHT, M.A. 1992. Received the 1992 Horace Bond Scholarship from the Penobscot County Conservation Association.
- CHILELLI, M., and B. GRIFFITH. May 1991. Awarded Outstanding Wildlife Paper from the Northeast Section of The Wildlife Society for "Assessing the validity of computerized population viability analysis" presented at the 47th Northeast Fish and Wildlife Conference.
- ELLIOTT, C.A. November 1991. As member of Cooperative Extension Task Force on Diversity, received the 1991 Cooperative Extension System Award for Diversity.
- ELLIOTT, C.A. March 1992. Chair of Planning Committee for Expanding Your Horizons in Math and Sciences Conference for Young Women in Grades 7, 8, and 9.
- HARRISON, D.J. 1991. Served as script editor for National Geographic Explorer Series television documentary entitled "Call of the Coyote," aired 12/22/91.
- HUNTER, M.L., JR. 1991. Received appointment to Libra Professorship of Conservation Biology, University of Maine, Orono.
- HUNTER, M.L., JR. 1992. Appointed to the Biodiversity Task Force of the President's Commission on Environmental Quality, Washington, D.C.
- HUNTER, M.L., JR. 1992. Appointed to the Species Survival Commission of the World Conservation Union, Switzerland.
- HUNTER, M.L., JR. 1992. Appointed to Maine Task Force of the New England Plant Conservation Program.
- MORING, J.R. September 1992. Elected as Northeastern Division Representative for the Early Life History Section of the American Fisheries Society.
- O'CONNOR, R.J. August 1992. Served as a judge for the Buell and Braun Student Awards, Ecological Society of America Annual Meeting, Honolulu, Hawaii.

