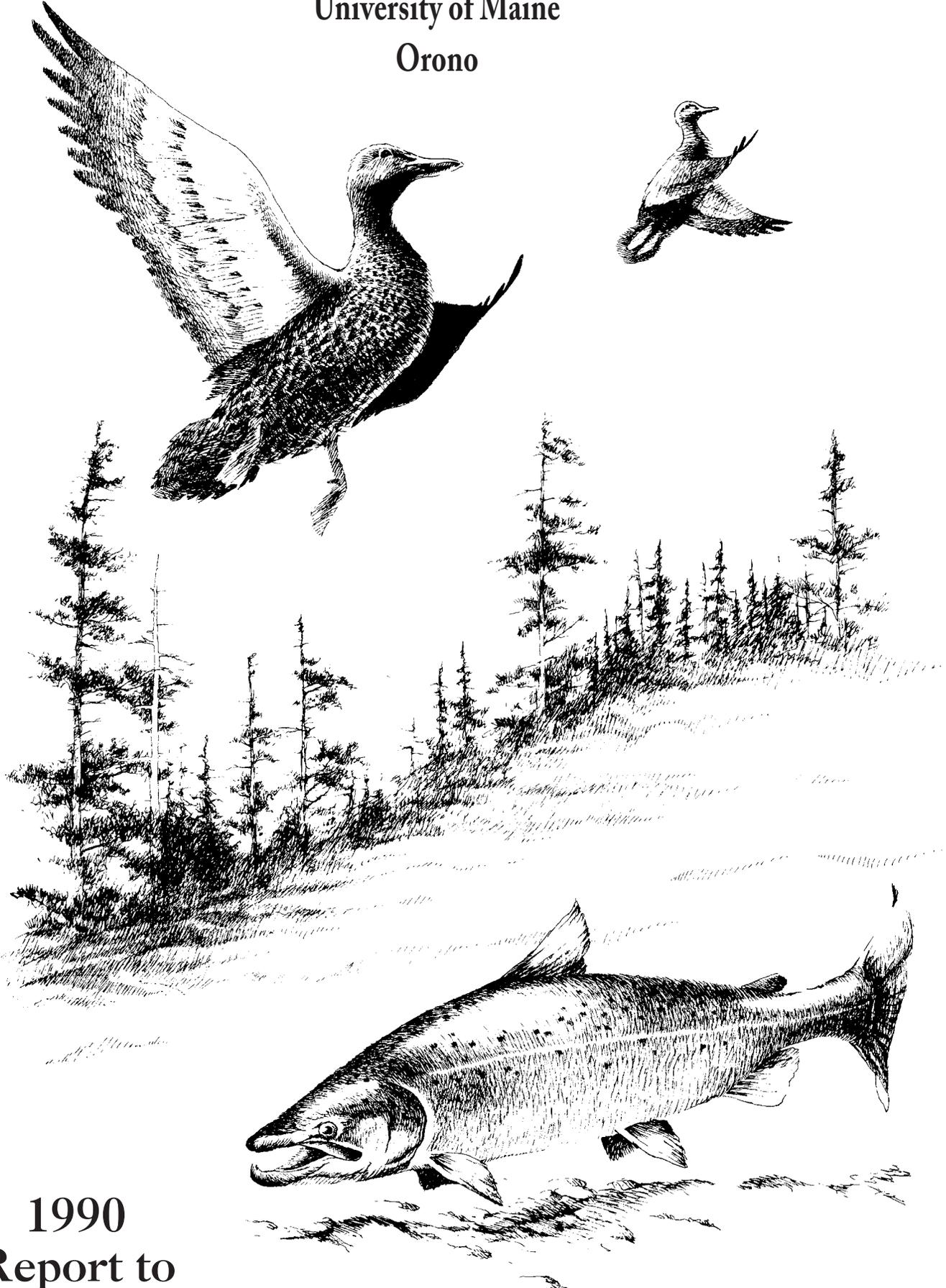


MAINE COOPERATIVE FISH AND WILDLIFE RESEARCH UNIT

University of Maine

Orono



1990 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 1989 - September 1990



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.**

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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
John F. Organ, Federal Assistance, Region 5

Wildlife Management Institute
Laurence R. Jahn, President

UNIT PERSONNEL

Unit Staff:

William B. Krohn, Unit Leader, Associate Professor of Wildlife and Zoology
John R. Moring, Assistant Leader for Fisheries, Associate Professor of Zoology
Brad Griffith, Assistant Leader for Wildlife, Assistant Professor of Wildlife
Kathryn G. Hallett, Unit Secretary - Fisheries
Maxine L. Horne, Unit Administrative Assistant - Wildlife
Shirley Moulton, Secretary - Wildlife
MaryEllen Chilelli - Assistant Scientist, 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
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Kevin J. Boyle, Assistant Professor, Department of Agriculture and Resource Economics, and
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Daniel J. Harrison, Assistant Professor of Wildlife
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Ruth W. Perry, Technician, Zoology

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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
Beverly A. Agler	M.S.	Personal Funding
Herbert C. Frost	Ph.D.	MDIFW, MCFWRU
Brian A. Bogaczyk	M.S.	USFWS-WO, MCFWRU
Randall P. Boone	M.S.	CPM
Holly Devaul	M.S.	U of M, MCFWRU, MDIFW, HMSA
Mustapha El Hamzaoui	M.S.	USAID/USDA
William E. Eschholz	M.S.	CFRU, MCFWRU
P. Brian Gray	M.S.	McIntire-Stennis
William M. Giuliano	Ph.D.	McIntire-Stennis, MDIFW
Richard A. Hartley	M.S.	MDIFW
Susan Hills	Ph.D.	USFWS-AFWRC
Sarah Hooper	M.S.	McIntire-Stennis
Malcolm T. Jones	Ph.D.	CPM
Donald Katnick	M.S.	McIntire-Stennis
Daniel H. Kusnierz	Ph.D.	DWRS, NBDNRE
T. Bruce Lauber	M.S.	CPM
Thomas C. McCall	Ph.D.	Hatch, McIntire-Stennis
Karen McCracken	Ph.D.	U of M
Daniel B. McKinley	M.S.	USFS - WMNF and GMNF
Craig R. McLaughlin	Ph.D.	Personal Funding
Deborah A. Moreau	M.S.	USFWS-NEAFL
Enama T. Mugangu	Ph.D.	AFGRAD, Rockefeller Foundation
Ramona Muller-El Hamzaoui	M.W.C.	Intl. Programs Office, CASS Project
Thomas F. Paragi	M.S.	MDIFW, MCFWRU
Stanislas J. Pauwels	Ph.D.	USFWS, U of M
Cynthia M. Perry	M.S.	USFWS, U of M, PCCA, MCFWRU, ASF
Kevin S. Raymond	M.S.	CFRU, MCFWRU
Mary M. Robbins	Ph.D.	USFWS
Gregory P. Romig	M.S.	USFS - WMNF and GMNF
Jill M. Ryan	M.S.	USFWS, U of M
Tamia Rudnicki	M.S.	McIntire-Stennis
Midori Saeki	M.S.	NPS
Richard E. Sayers, Jr.	Ph.D.	MDIFW, U of M, MCFWRU, PCCA, MDMR
Robert L. Schooley	M.S.	U of M, MDIFW

Todd R. Smith	M.S.	USFWS
Sarah S. Stockwell	Ph.D.	Personal Funding
Johannes Subijanto	M.S.	MUCIA
Marcia Summers	M.S.	Personal Funding (Grad. School Assistantship)
W. Matthew Vander Haegen	Ph.D.	U of M, USFWS (NEC, MNWR), PCCA, HWR, TBF
Agnes Vanderpool	M.S.	USFWS - NEAFL
Eleta J. Vaughan	M.S.	U of M
Sharri A. Venno	M.W.C.	Personal Funding
Christopher Vera	M.S.	Resource Conserv. Serv., Inc., Scott Paper Company
Peter D. Vickery	M.S.	NC, MAS, MPCB, MAAS, CB
Andrew A. Whitman	M.S.	U of M
Lois Winter	M.W.C.	NPS

GRADUATE STUDENTS: DISSERTATIONS/THESES COMPLETED THIS PERIOD

Name	Degree Candidacy	Support
Brian A. Bogaczyk	M.S.	USFWS-WO, MCFWRU
Holly Devaul	M.S.	U of M, MCFWRU, MDIFW, HMSA
Richard A. Hartley	M.S.	MDIFW
Enama T. Mugangu	Ph.D.	AFGRAD, Rockefeller Foundation
Thomas F. Paragi	M.S.	MDIFW; MCFWRU
Stanislas J. Pauwels	Ph.D.	USFWS, U of M
Cynthia M. Perry	M.S.	USFWS, U of M, PCCA, MCFWRU, ASF
Gregory P. Romig	M.S.	USFS - WMNF and GMNF
Richard E. Sayers, Jr.	Ph.D.	MDIFW, U of M, MCFWRU, PCCA, MDMR
Robert L. Schooley	M.S.	U of M, MDIFW
Sharri A. Venno	M.W.C.	Personal Funding
Peter D. Vickery	M.S.	NC, MAS, MPCB, MAAS, CB
Lois Winter	M.W.C.	NPS

PERSONNEL NOTES

The following wildlife students received their degrees at either the December, May, or August graduations: **BRIAN BOGACZYK, M.S.** Brian obtained a position with Woodland Services in Moose Lake, MN. **HOLLY DEVAUL, M.S.** Holly is now working as a Scientific Technician for the Department of Wildlife at the University of Maine. **THOMAS PARAGI, M.S.** Tom was appointed to a Wildlife Biologist position with the U.S. Fish and Wildlife Service in Galena, Alaska. **ENAMA MUGANGU, Ph.D.** Mugangu returned to his university position in Zaire. **ROBERT SCHOOLEY, M.S.** Bob is working for the Department of Biology at Colorado State University. **SHARRI VENNO, M.W.C.** Sharri is working for Land and Water Associates and her M.W.C. report will be published by the University of Maine's Agricultural Experiment Station as a guide to be used by Maine communities on their natural resources projects. **PETER VICKERY, M.S.** Peter is continuing on for his Ph.D. as well as working full time. **LOIS WINTER, M.W.C.** Lois was appointed a Park Ranger (Interpretation) at Mammoth Cave National Park, Kentucky.

The past year saw quite a few changes in the fisheries portion of the Unit. **BONNIE G. WOOD** was named the new Chairperson, Department of Zoology, College of Sciences in July 1990. Several students graduated and obtained employment or continued their education. **STAN PAUWELS** accepted a position with Exxon in New Jersey, **RICH HARTLEY** was employed by ENSR Consulting Company in

Massachusetts, **RICH SAYERS** took a position with Normandeau Associates in New Hampshire, **CINDY PERRY** was hired by the U.S. Fish and Wildlife Service in New Hampshire, **DAN MC KINLEY** now works for the U.S. Forest Service in Vermont, and **GREG ROMIG** has begun a D.Sc. program at the University of North Dakota.

Other Personnel Happenings:

DR. CATHERINE ELLIOTT met January 8-10 with educators at the Vermont Institute of Natural Science to learn about their programs with Environmental Learning for the Future (ELF) and Waste Away. She also attended a Recycling Program at Montpelier High School.

DR. JAMES GILBERT traveled to Kharvarsk, USSR for research planning meetings with Soviet scientists concerning the Walrus Research Project (USA-USSR).

DR. DANIEL HARRISON was requested by the Tanzania Government and the U.S. Fish and Wildlife Service to travel to Lake Manyara National Park, Tanzania to develop a conservation education and resource management strategy for the Park.

DR. WILLIAM KROHN was asked to review the ongoing fisher and marten studies being done by Sierra Pacific Industries in Redding, California.

DR. RAY OWEN, JR. coordinated the Ecology Training Program for the B.S.A. Maine High Adventure Program in June, a herbicide field trip for the Maine Chapter of The Wildlife Society in July, and a wetlands workshop for the Maine Chapter of The Wildlife Society in August.

COLLABORATING AGENCIES AND ORGANIZATIONS

American Cyanamid Company - CPM
 Atlantic Salmon Federation - ASF
 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
 Georgia-Pacific Corporation - GPC
 Hawk Mountain Sanctuary Association - HMSA
 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 - MDMR
 Maine Land Use Regulation Commission - MLURC
 Maine Pesticides Control Board - MPCB
 Massachusetts Audubon Society - MAAS
 Midwest University Consortium for International Activities - MUCIA
 Mobay Corporation - CPM
 National Geographic Society - NGS
 National Rifle Association - NRA

National Wildlife Federation - NWFD
Nature Conservancy - NC
 Maine Chapter - NC-MC
 NE Regional Office - NC-NE
New Brunswick Department of Natural Resources and Energy - NBDNRE
Northeast Fur Resources Technical Committee - NFRTC
North American Wildlife Foundation -
 Delta Waterfowl & Wetland Research Station - DWRS
Penobscot County Conservation Association - PCCA
Resource Conservation Services, Inc. - RCS
Resources for the Future - RFF
Rhone Poulenc - CPM
Rockefeller Foundation - RF
Scott Paper Company - SP
Taylor's Bait Farms, Inc. - TBF
University of Maine - U of M
 Association of Graduate Students - AGS
 College of Sciences - CS
 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 - ARE
 Graduate School
U.S. Dept. of Agriculture - USDA/USAID
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 Laboratory - NAFL
 Office of Information Transfer - OIT
 Patuxent Wildlife Research Center - PWRC
 Region 5, Federal Assistance - R-5/FA
 Washington Office - WO
U.S. Forest Service - USFS
 White Mountain National Forest - WMNF
 Green Mountain National Forest - GMNF
U.S. National Park Service - NPS
 Acadia National Park - ANP
 Boston Regional Office - BRO

PROJECT REPORTS

ENDANGERED AND THREATENED SPECIES:

ANALYSIS OF FACTORS AFFECTING POPULATION VIABILITY OF BIRDS

Investigators: M. Chilelli
B. Griffith

*Cooperators/
Project
Support:* U.S. Fish and Wildlife Service -
Region 8, Office of Research 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, area use patterns, 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 (e.g., long lived, late reproducing birds) 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.

PROJECT STATUS: To evaluate the PVA procedure, we are comparing estimates of success rates predicted by PVA simulations to the documented fates of wildlife translocations in North America, New Zealand, and Australia (Griffith et al. 1989. *Science* 245:477-480.). Model inputs were chosen to replicate life history values appropriate for threatened, endangered, or sensitive bird species that are late breeders with small clutches in "excellent" habitat.

From preliminary simulations, 3 points are suggested: 1) the definition of extinction (e.g., 0 or 1 animal remaining; finite rate of increase < 1 over the simulation horizon) has a strong influence on estimated probability of population persistence; 2) any management activity that improves first year survival (or reduces dispersal of newly released animals) will improve the probabilities of success for a translocation ($P < 0.05$); and 3) PVA may not give accurate estimates of population persistence if situation specific phenomena, such as reduced initial survival of translocated birds, are not acknowledged.

FUTURE PLANS: We will evaluate other types of organisms (e.g., short lived, early reproducing birds and game mammals) and different definitions of population persistence. Additional work needs to be conducted on the interaction between definition of extinction and the length of simulations.

Our assessment of current modeling approaches applied in PVA (e.g., age truncation, distribution of vital rates (i.e., normal vs. binomial), correlation in survival rates among different age classes) will identify the potential influence these factors have on predicting population persistence.

Our literature review of field survival and fecundity rates for birds with various life history strategies is continuing and will be used to address additional objectives of our research.

FINBACK WHALE PHOTOGRAPHIC IDENTIFICATION METHODOLOGY IN THE WESTERN NORTH ATLANTIC

- Investigator:** B. A. Agler
- Advisors:** J.F. Gilbert, Chairperson
B. Griffith
W.E. Glanz
- 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: Photographic databases of finback whales were assembled and cataloged. A series of photographs designed to test the consistency of observers in identifying photographs as matching photographs in the collection being photographs of new whales was compiled and distributed to experienced and inexperienced observers. Observers completed the matching procedure and scores were tabulated.

FUTURE PLANS: Data analysis will continue and a draft thesis is expected to be completed in January 1991.

FISHERIES RESOURCES:

IMPACTS OF STOCKING SEA-RUN ATLANTIC SALMON ON NATIVE POPULATIONS OF BROOK TROUT

- Investigator:** R.E. Sayers, Jr.
- Advisors:** J.R. Moring, Chairperson
W.A. Halteman
W.E. Glanz
J.R. Gilbert
J.D. McCleave
- Cooperators/
Project
Support:** Maine Department of Inland Fish and Wildlife
Maine Cooperative Fish and Wildlife Research Unit
Maine Atlantic Sea-Run Salmon Commission
Atlantic Salmon Federation

Objective: Document impacts of stocking sea-run Atlantic salmon on native populations of brook trout through measurements of habitat selection and population structure and numbers.

SCOPE: Because salmon restoration is an active and successful program in Maine waters, documented evidence of competition and/or displacement is needed by management agencies. Building on work by former graduate student, Pat Bley, this study examined different species interactions over a two-year period. The design looked at trout and/or salmon on four brooks near Kingsbury, Maine. Each brook had a natural or artificial barrier preventing fish from downstream from affecting trout populations in upstream areas.

One brook served as a project control, with brook trout populations studied below and above the barrier. The second brook received an introduction of salmon in the downstream section in the second year with the upstream serving as a control. The third brook received an introduction of salmon in the lower section in the first year, with the salmon removed for the second year and the upstream trout population as a control. The fourth brook had two natural barriers. The downstream section contained native populations of brook trout and landlocked salmon. The middle section received an introduction of sea-run salmon in both years, and the upstream section, with native brook trout, served as a control.

Fish population estimates were made at regular intervals in each year, using a three pass removal technique. Habitat selection was determined, using backpack electrofishers to identify locations of trout and salmon. Bottom substrate, water velocity, and depth of location were measured and related to age and species of fish.

PROJECT STATUS: The project has been completed and an abstract of the Ph.D dissertation follows:

The extent of inter-specific competition for habitat between brook trout, *Salvelinus fontinalis*, and Atlantic salmon, *Salmo salar*, and the extent of inter-annual, intra-annual, and inter-stream variability in habitat use patterns of both species was assessed in four streams near Kingsbury, Maine. Upstream and downstream stations, separated by barriers to upstream fish movement, were established on Bear, Bottle, and Perry brooks, and upstream, middle, and downstream stations were established on Bigelow Brook. Upstream stations contained only native brook trout. Young-of-the-year (YOY) Atlantic salmon were stocked in the downstream station of Bottle Brook and the middle station of Bigelow Brook in 1987 and the downstream station of Bear Brook and the middle station of Bigelow Brook in 1988. Landlocked Atlantic salmon occur naturally in the lower station of Bigelow Brook. Habitat use patterns of native brook trout and stocked Atlantic salmon were monitored monthly during the spring, summer, and early autumn of 1987 and 1988 and population size was estimated during late summer in each station. There was extensive overlap between the habitat use patterns of juvenile Atlantic salmon and brook trout but there was little direct evidence of inter-specific competition for habitat. The presence of Atlantic salmon appeared to cause brook trout to move to deeper, slower-flowing holding positions, but these changes did not result in reduced fitness of brook trout. Density of YOY brook trout was low during 1987 but increased sharply in 1988. The inter-annual variation in habitat use patterns of brook trout, combined with the changes in brook trout density, suggest that intra-specific competition for habitat may be at least as important as inter-specific competition. The habitat use patterns of YOY Atlantic salmon showed considerable variation among the streams. Patterns of intra-annual variation indicated that Atlantic salmon move to deeper, faster flowing holding positions with increasing age. There were no appreciable differences in the habitat use patterns of landlocked and sea-run Atlantic salmon yearlings and there was no apparent inter-annual variation in the habitat use patterns of yearling Atlantic salmon.

USE OF HABITATS BY ATLANTIC SALMON AND TROUT ON NATIONAL FORESTS IN NEW HAMPSHIRE AND VERMONT

Investigator: G.P. Romig

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

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

Objective: To determine microhabitat preferences of Atlantic salmon and compare microhabitat preferences of brook, brown, and rainbow trout.

SCOPE: The U.S. Forest Service has management authority for habitat in the National Forests. In order to improve habitat that is important for juvenile Atlantic salmon, accurate microhabitat measurements must be compiled. Because Atlantic salmon are stocked in waters already home to populations of brook, brown, and/or rainbow trout, competition for habitat is a real possibility, and one that needs to be documented.

PROJECT STATUS: The project has been completed. An abstract of the Master of Science thesis follows:

In recent years, several million Atlantic salmon fry have been introduced into streams of the Green Mountain National Forest in Vermont and the White Mountain National Forest in New Hampshire. Most of these streams already support natural populations of other salmonid species. This study was designed to examine habitat use and selection by juvenile salmonids in streams within the Green and White Mountain National Forests. Atlantic salmon (*Salmo salar*, $n = 362$), brown trout (*S. trutta*, $n = 14$), brook trout (*Salvelinus fontinalis*, $n = 369$), and rainbow trout (*Oncorhynchus mykiss*, $n = 86$) were observed in study sections of four streams. In Vermont, sites were located on the West Branch of the White River and Utley Brook. The New Hampshire sites were on the Mad and Baker rivers. Snorkeling observations were made at each site, in June, July, August, and October of 1989. Habitat variables measured included habitat type, depth, substrate type, cover use, and water velocities.

Variation in microhabitat parameters by season and by site was analyzed using two-way analysis of variance, and it was found that site-to-site variation was greater than seasonal variation. There was considerable overlap in water depth and velocity use for all species and age classes. Where available, cover use was higher for trout than for salmon, and such use increased with age for each species. Habitat selection tables were compiled and it was found that age 1+ salmonids, especially brook trout, occupied shallow areas of low velocity in late spring, but moved to deeper, swifter areas in late summer. In general, age 1+ salmon selected run habitats (> 30 cm deep, swift), while age 1+ and 2+ brook trout were found mainly in pools, particularly those associated with cover (94% were observed using cover in Utley Brook in August).

Potential competition for stream positions and cover between Atlantic salmon and brook trout was examined. A section of Utley Brook was blocked off, and both species were removed. Each species was replaced, separately and in combination, in order to compare allopatric and sympatric habitat use. The study failed to provide obvious evidence for competition between the species.

DELAYED MORTALITY OF BLACK BASSES FOLLOWING TOURNAMENTS

- Investigator:* R.A. Hartley
- Advisors:* J.R. Moring, Chairperson
P.W. Reno
W.E. Glanz
- Cooperators/
Project* Maine Department of Inland Fisheries and Wildlife
Penobscot County Conservation Association
- Support:*
- Objective:*
- (1) To document tournament mortality and delayed mortality in basses following tournaments.
 - (2) To document changes in dissolved oxygen in holding tanks of boats during tournaments.

SCOPE: Bass populations are abundant throughout Maine, and interest in bass angling has increased dramatically. Well over 150 tournaments are now scheduled on Maine lakes and ponds annually. Though most bass are released alive following tournaments, studies in other states, particularly in the South, have indicated that delayed mortality can be high. As Maine tournaments occur in cooler climates, with both smallmouth and largemouth bass, studies are needed to document such potential mortality. Any deaths that occur are likely due to the effects of handling and stress. This study examined tournament-induced and delayed mortality of black basses and measured dissolved oxygen conditions in boat livewells during actual tournament conditions.

PROJECT STATUS: The project has been completed and an abstract of the Master of Science thesis follows:

Nine bass tournaments were monitored to determine initial and delayed mortality of fish. Initial mortalities are defined as those that are judged dead by tournament officials at the weigh-in, whereas delayed mortalities are those which occur during a 48-hour holding period immediately following the tournament. Livewells in boats of selected contestants were also monitored for dissolved oxygen content and temperature to evaluate conditions during actual and simulated tournaments. Three lakes in Maine were selected to determine if geographic locations had any influence on mortalities. Age, weight, length, and species of the fish were also analyzed to determine if these factors influenced mortality rates. Tournaments were monitored during June, July and September/October 1989 to evaluate the effects of season on mortality. For each tournament monitored, 50 fish were held for 48 hours in 1 m³ nylon mesh cages in close proximity to the weigh-in area, and dissolved oxygen and temperature in livewells were monitored at 15 minute intervals. In tournaments, initial mortalities ranged from 0 to 14.6%, and delayed mortalities ranged from 0 to 6%. The highest mortalities were associated with the highest temperatures. Dissolved oxygen levels dropped from above 8.0 ppm to 3.4 ppm when basses were introduced to boat livewells, indicating potentially stressful conditions for fish prior to handling at the end of each tournament day. Overall mortality rate may be a function of the handling time associated with the tournament. Mortalities were lowest in tournaments that minimized both the number of steps and the time elapsed between the removal of a bass from the livewell and its subsequent release into the lake. Location of the tournament was a significant factor in mortalities. The age of the mortalities was not significantly different from that of the surviving fish, while length and weight were significant. Size of the tournament, species, and season also were significant. Either species is four times more likely to die in a large tournament than in a small tournament, smallmouth bass are three times more likely to die than largemouth bass, and the probability that either species will survive a tournament is higher in the fall than in the spring or summer.

EVALUATION TECHNIQUES FOR DISTINGUISHING STOCKS OF ATLANTIC SALMON

Investigator: C.M. Perry

Advisors: J.R. Moring, Chairperson
S.J. Hunter
W.B. Krohn

**Cooperators/
Project** U.S. Fish and Wildlife Service -
National Fishery Research and Development Lab., Wellsboro, PA

Support: Penobscot County Conservation Association
University of Maine

Objective: Describe the impacts of varying levels of pH on the survival, growth, development, and calcium levels of several strains and brood stocks of Atlantic salmon.

SCOPE: The acidification of lakes, rivers and streams in eastern North America, with its impending loss of species diversity, has become a major concern to conservationists. Since the passage of the Anadromous Fish Conservation Act (PL 89-304) in 1965, major efforts are underway to restore and enhance the U.S. populations of Atlantic salmon within its endemic range. However, obstructions to upstream movement such as dams, highly developed commercial fishing leading to overharvesting, pollution, and acidification of home waters have affected these efforts.

The U.S. Fish and Wildlife Service's Research and Development Laboratory in Wellsboro, Pennsylvania, has been charged with determining the effect of acidification on Atlantic salmon. Work on the tolerance of some salmonids to acid waters has shown species differences. Investigations of low pH tolerance on various strains of salmonids species have been inconclusive.

In this project, six sources of Atlantic salmon taken from various sites in the northeast were reared and tested. Four sources were of sea-run origin and two were from landlocked populations. One-half of each source was raised one to two pH units lower than its counterparts for six months. One sea-run source and one landlocked source continued to be reared at a lower pH until smoltification. At various life stages from yolk sac through smolt, these fish were subjected to various low levels of pH.

Lower lethal limits of EC_{50} 's were calculated along with photographic, histological, and physiological (whole body and blood serum chemistry) analyses at each life stage for each source.

This information should prove useful in (1) determining which life stage of each strain is most sensitive, thereby alerting biologists to the increased need for protection; (2) choosing a strain whose overall survival may be improved by its tolerance of lower pH levels during various periods of their lives and using these strains to enhance present populations; and (3) by describing the ionic changes (Na^+ , K^+ , Ca) taking place in these fish during pH exposure (static test and long-term rearing), a more complete explanation of the low pH effect may come to light.

PROJECT STATUS: The project has been completed and an abstract of the Master of Science thesis follows:

The occurrence of acid precipitation and the resulting acidification of freshwater is a threat to Atlantic salmon, *Salmo salar*, populations in North America. This study was undertaken to determine the effects of low pH exposure from hatch through the smolt stage in Atlantic salmon taken from five locations in New England. Eggs of sea-run origin were obtained from the Tunison Laboratory of Fish Nutrition, Cortland, New York; Berkshire National Fish Hatchery, Great Barrington, Massachusetts; Craig Brook National Fish Hatchery, East Orland, Maine; and Green Lake National Fish Hatchery, Ellsworth, Maine. Eggs of landlocked origin were obtained from Grand Lake Stream Fish Hatchery, Grand Lake Stream, Maine. Measurements were made on Atlantic salmon reared at pH 7.0 and 5.2 from hatch to 199, 270, or

440 days. Differences in length and weight were considered significant whenever $P < 0.05$. Length and weight were smaller in Atlantic salmon that were continuously exposed to low pH ($P < 0.05$) compared to control groups. Length and weight in neutral pH water varied among fish from the different sources. Fish from the Green Lake, Craig Brook, and Berkshire sources were not different in their lengths over time. Tunison and landlocked Atlantic salmon were not different from one another but were different from the other three sources. At pH 5.2, there were no differences in length between fish from any of the five sources. The Cortland salmon were different from the other four sources in respect to their weight over time at neutral pH. At pH 5.2, no differences were found between any of the five sources. Therefore, no source of Atlantic salmon tested under long-term acidification is longer or weighs more than another.

Cation concentrations of whole Atlantic salmon reared at pH 7.0 or pH 5.2 from hatch to 199, 270 or 440 days were compared. Whole-body concentrations of sodium and magnesium (ug/g body weight) did not change with age, source, or pH regime. Potassium concentrations increased with age for all source and pH regimes. The whole-body concentration of calcium declined with age for all sources and rearing combinations, although the low pH group maintained slightly higher calcium levels than the neutral pH group. Calculating whole-body options on a dry-weight or wet-weight basis produces the same results. Stronger conclusions regarding the linear relationship of neutral and low pH would be elucidated in future experiments with several low pH values.

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

Investigator: A.M. Vanderpool

Advisors: J.R. Moring, Chairperson
W.E. Glanz
I. Kornfield
J.D. McCleave

*Cooperators/
Project
Support:* U.S. Fish and Wildlife Service -NAFL

Objective: To document the extent of 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 release to the lower Penobscot River, and establishes a monitoring program to trap smolts. The first two years of work will involve radio tracking and evaluation of smolt traps. The second two years will refine techniques for trapping smolts and will evaluate the sources of mortality.

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 was 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 counting unit was obtained from the NFRDL laboratory of the U.S. Fish and Wildlife Service and was tested with Atlantic salmon at Craig Brook NFH. This unit will be used with three self-release ponds at the West Enfield facility, along the Penobscot River, to track migration times of 45,000 stocked smolts. New, smaller tags, to be used externally, were purchased for use with one-year-old smolts in Spring 1991. In addition, radio tags will be tracked by airplane in Spring 1991. The tags and receivers were tested in summer 1990, and the use of aerial fly-overs will allow investigators the opportunity to maximize contact data points and to release larger numbers of smolts at a time. The purpose will be to describe migration routes in the river. A Master of Science thesis is expected in summer 1991.

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

*Cooperators/
Project
Support:* U.S. Fish and Wildlife Service - NAFL

Objective:

- 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. 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. A model will be developed during winter 1990-91, and will be tested in summer-fall 1991. Expected date of graduation (M.S.) is May 1992.

EVALUATION OF THREE TYPES OF ARTIFICIAL REEF MATERIALS IN FRESHWATER

Investigators: J.R. Moring
P.H. Nicholson

*Cooperators/
Project
Support:* Hirundo Wildlife Trust

Objective: To determine the suitability of three types of artificial reef materials as attractants for species of freshwater fishes and macroinvertebrates.

SCOPE: Three types of artificial reef materials are being evaluated at Lac D'Or, Hirundo Wildlife Refuge: brush bundles, automobile tires, and cinder blocks. Three transects in the pond each contain the three types of structures, and a fourth transect serves as a control, without artificial structures. Weekly dives are being made along each transect, with the number, species, and size of all associated fish noted. In addition, night dives examine the fish community with and without artificial structures under different light conditions.

PROJECT STATUS: Sampling began prior to the introduction of the first structures in June 1990, and continued into October 1990. Artificial reefs will remain in place over the winter and will be evaluated in early summer 1991. A Final Report on the 1990 data will be prepared in December 1990, and the results of these investigations will be presented to the Maine Department of Inland Fisheries and Wildlife and at an upcoming International Artificial Reefs meeting in 1991.

ECONOMIC IMPACTS OF AN IMPROVED SPORTFISHERY ON THE LOWER KENNEBEC RIVER WATERSHED

Investigator: V.A. Trefts

Advisors: K.J. Boyle, Chairperson
S.D. Reiling
J.R. Moring

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

Objective: To conduct an economic survey and analysis of potential scenarios for improving the sportfishery of the lower Kennebec River as it relates to the Edwards Dam.

SCOPE: Edwards Dam, on the Kennebec River in Augusta, provides an impassable barrier to the upstream migration of anadromous fishes, such as Atlantic salmon, striped bass, rainbow smelt, and American shad. This blockage, along with polluted waters, eliminated most such runs of fishes in the Kennebec River by the mid-nineteenth century. The water quality of the river has now improved to a point where these fishes can survive and runs are starting to be restored. However, passage is still blocked at Edwards Dam. The dam is due for relicensing soon and the potential for improving the sportfishery on the river needs to be assessed. An economic survey will be conducted that will address several possible scenarios involving increased fisheries management practices, removal of the dam, provision for fish passage, or combinations of the three.

PROJECT STATUS: Preliminary biological surveys and assessments have been made and an economic assessment procedure is being developed. A progress report was submitted that outlined the overall biological assessment of the sportfishery. Survey information has been returned from anglers and a follow-up telephone survey addressed the reasons for individuals not returning survey booklets. Data have been initially summarized, and computer analysis and summation is progressing. A final report will be prepared in 1991. The student investigator has switched to a non-thesis option.

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/
Project
Support:* U.S. Forest Service -
White Mountain National Forest, Laconia, NH
Green Mountain National Forest, Rutland, VT
- Objective:*
- (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 is 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. The investigator has taken a position with the U.S. Forest Service and has completed a draft of a thesis. The thesis is expected to be completed in January 1991.

POPULATION STUDIES OF MAINE INTERTIDAL FISHES

- Investigator:* J.R. Moring
- Cooperators/
Project
Support:* National Geographic Society
The Nature Conservancy
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 22 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 lumpfish and shorthorn sculpins will continue into 1991. Experiments with plankton tows in intertidal areas will relate to the function of tidepools as refugia. Additional work with rock gunnels and artificial habitat are planned for summer 1991. A paper was presented at the Larval Fish Conference in Beaufort, NC, and a seminar was presented at SUNY-Syracuse. Two manuscripts were completed.

HABITAT RESOURCES:

HABITAT SELECTION BY THE AFRICAN BUFFALO IN VIRUNGA NATIONAL PARK, ZAIRE

Investigator: E. T. Mugangu

Advisors: J. R. Gilbert, Co-chairperson
M. L. Hunter, Jr., Co-chairperson
W. E. Glanz
G. L. Jacobson, Jr.
J. A. Sherburne

**Cooperators/
Project
Support:** Institut Zaïrois pour la Conservation de la
Nature, Département de l'Enseignement Supérieur
de la République du Zaïre, University of Maine,
African Graduate Fellowship Program,
United States Agency for International
Development, Rockefeller Foundation

Objectives:

- (1) Estimate densities of African buffalo (*Syncerus caffer*) in Virunga National Park.
- (2) Assess habitat selection by buffalo.
- (3) Test whether buffalo select habitats which maximize energy or protein intake and simultaneously minimize competition and predation risks.

SCOPE: Mechanisms that determine habitat selection in large ungulates are poorly understood. To date, only models that relate large mammals to single factors such as food and structure of the environment have been shown to determine habitat selection. However, it is likely that animals respond to a complex array of biotic and abiotic factors in their environment when they select their habitat. This study endeavors to test

the hypothesis that buffalo select habitats that best enhance their fitness by optimizing food intake while minimizing competitive inhibitions and predation risks. In addition, since the loss of suitable habitats for large mammals in Africa is threatening their existence, the results of this study will have practical implications for the management of buffalo in Virunga and around the parkland.

PROJECT STATUS: The project is completed and an abstract of the doctoral dissertation follows:

Habitat selection by the African buffalo (*Syncerus caffer* Sparrman) was studied in Virunga National Park, Zaïre between 1984 and 1989. Habitat use was determined from line transect sampling of buffalo groups in five different habitats (mudflat steppes, upland steppes, bushy steppes, woodland savannas, and forests) during dry and wet seasons. Availability of each habitat was determined from aerial photographs. Factors, including food, water, predation risks, etc., presumed to affect buffalo habitat selection were evaluated by comparing their means at random (control plots) and buffalo-selected sites. Fiber constituents and protein levels of forages were determined by micro-Kjeldahl and fractionate methods. Predation risks per habitat type were estimated from buffalo skull counts along strip transects. Other habitat characteristics such as height and cover of grasses and distance to nearest water holes were measured at buffalo and random sites. It was found that buffalo selected mudflat steppes during the dry and wet seasons due to adequate levels of protein that *Cynodon dactylon* and *Panicum repens* offered year round, their proximity to water sources, and their low predation risks. Buffalo avoided forested habitats in both seasons, presumably because the risk of predation was greater than expected there. There was a seasonal shift in buffalo use of upland steppes, bushy steppes, and woodland savannas. Buffalo selected bushy steppes and woodland savannas during the dry season because of the palatable green patches they offered, particularly *Cyperus laevigatus* in the bushy steppes, predation risks that were lower than average and opportunity for shade. During the wet seasons, buffalo used bushy steppes and woodland savannas in proportion to their availability, but they selected the upland steppes. Buffalo selection of the upland steppes, despite their having the highest predation risks, remains unexplained as protein levels were satisfactory in all the habitats during the wet seasons. It was suggested that other factors, not documented in this study, such as competition and mineral composition of forages, were driving buffalo's choice of upland steppes in the wet seasons. It was concluded that buffalo select their habitat by optimizing the inter-relationships between food, predation risks, and opportunity for water and shade.

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/
Project
Support:** The Switzer Foundation
Maine Dept. of Inland Fisheries and Wildlife
The Nature Conservancy, Maine Chapter

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, and 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: A Master's thesis was completed in May 1990; the abstract follows:

This thesis explores two aspects of the breeding biology of grassland birds in southern Maine. In the first chapter, I found a significant relationship ($P < 0.01$) between nest predation and striped skunk (*Mephitis mephitis*) invertebrate foraging effort. The relationship between nest predation and vegetation physiognomy was analyzed on three spatial scales, but no strong correlation was found at any level. These results suggest that skunk nest predation at this site was incidental rather than targeted towards bird nests.

In the second chapter, I developed a new method of measuring reproductive success. This method is comprehensive, time-efficient, and nondisruptive of nests. This reproductive index was then used to distinguish birds with known high reproductive success with birds of known low success. Vegetative cover parameters from birds with known high reproductive success were compared to vegetative parameters for low success birds, and were also compared to vegetation from territories developed by conventional "spot-mapping." In high success territories, 17 vegetation features were significantly different ($P < 0.01$) from non-territory vegetation, whereas for "spot-mapped" territories only 8 cover parameters were different and in low success territories just one. This index was then used to test Van Horne's contention (1983) that density can be a misleading measure of habitat quality. None of the three sparrow species in this study showed a clear correlation between high territory density and high reproductive success, thus supporting Van Horne's thesis. More than sixty blueberry barrens were surveyed in 1990 to determine species composition, abundance, and habitat requirements at these sites. This data and previous work will be used to produce a Ph.D. dissertation.

FUTURE PLANS: Data will be analyzed and the dissertation should be complete by December 1992.

INTEGRATING WILDLIFE HABITAT INTO LOCAL PLANNING: A HANDBOOK FOR MAINE COMMUNITIES

Investigator: S. A. Venno

Advisors: R. B. Owen, Jr., Co-chairperson
W. B. Krohn, Co-chairperson
K. J. Boyle

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

- Objectives:**
- 1) Identify and discuss Federal and state laws related to conservation of wildlife habitats at the local level.
 - 2) Suggest guidelines whereby towns set their own objectives and identify protection strategies consistent with existing laws and local needs.
 - 3) Identify and discuss options and tools available to towns for protecting wildlife habitats.

SCOPE: Growth management has become a statewide issue as development pressures spread from southern and coastal Maine to inland lakes and mountains. This has created concern about the impact of this growth on natural resources, including wildlife. A number of changes in Maine's land-use laws reflect this concern. Specifically, the state legislature has passed a law requiring municipalities to adopt comprehensive plans and ordinances by 1996. General guidelines adopted by the state as planning goals for towns include protection of essential (T/E species) and significant (species of special concern) wildlife habitats. Although a wealth of information exists about wildlife, their habitats, and various land-use protection strategies, there is a need for a synthesis of this information in a form easily accessible to towns and adaptable to the local planning process.

PROJECT STATUS: All requirements for the degree of Master of Wildlife Conservation were completed in May 1990. An abstract of the report follows:

This handbook was written in response to the growing need to locally conserve wildlife habitat in Maine. New land-use and planning legislation resulting from increased development pressure requires towns to plan for wildlife habitat. The process of integrating habitat conservation into local land-use planning described in the handbook combines an ecosystem approach with protection of rare, endangered, game, and other species.

Justifications for local habitat conservation include the recreational, economic, ecological, and other values of wildlife; the legal mandates for protecting wildlife (especially the Federal Endangered Species and Clean Water acts, and State of Maine Endangered Species, Natural Resources Protection, Shoreland Zoning acts, and Subdivision and Site Location of Development laws); and the multiple benefits to be gained from maintaining habitats such as protecting soil and water quality, farm and forest lands, and recreational and educational opportunities. The concepts of biological diversity and wildlife habitats are discussed to provide towns with a basis for understanding habitat conservation. The conservation strategy consists of the following recommendations: discourage the fragmentation of relatively large parcels of undeveloped land, conserve a mosaic of different habitats, and ensure habitats are connected by travel corridors.

There are 5 major steps in planning for wildlife habitats at the local level: (1) assemble an advisory committee of local hunters, anglers, and conservationists with knowledge of local habitats; (2) establish a policy and set goals to provide foundation and direction for municipal planning; (3) identify and map sites supporting rare and endangered species and natural communities, aquatic habitats, wetlands, riparian habitats, abandoned farmlands, and oak and beech stands; (4) analyze the vulnerability of these habitats; and (5) apply a variety of regulatory and nonregulatory tools to conserve habitats.

Neighboring towns should coordinate plans as most habitats cross town borders. A detailed example showing maps of various habitats, and the composite result is presented and discussed as well as alternative conservation tools.

ECONOMIC EVALUATION OF CONSUMPTIVE AND NONCONSUMPTIVE USES OF MAINE'S FISH AND WILDLIFE RESOURCES

Investigators:

K.J. Boyle, Asst. Professor
S.D. Reiling, Assoc. Professor
M. Tiesl, Asst. Scientist
M.L. Phillips, Research Assistant

**Cooperators/
Project
Support:** University of Maine -
Department of Agricultural and Resource Economics
Maine Legislative Commission to Study the Impact of Game
and Nongame Species on Maine's Economy
Maine Department of Inland Fisheries and Wildlife
Maine Department of Marine Resources
Maine Cooperative Fish and Wildlife Research Unit

Objectives:

- 1) Estimate monetary values, use rates, and expenditures associated with the recreational use of selected species and groups of species of Maine's fish and wildlife resources. This will be done using data from surveys that are developed and administered as part of the study.
- 2) Identify consumptive and nonconsumptive users' motivations for participating in fisheries and wildlife-related activities as part of the survey effort.
- 3) Evaluate improved consumptive and/or nonconsumptive use opportunities for selected species where possible.
- 4) Partition the results of objectives (1), (2), and (3) by resident and nonresident strata where possible.
- 5) Conduct an economic analysis of trapping within Maine.
- 6) Analyze funding mechanisms for fish and wildlife management in other states and evaluate the potential usefulness of these structures for Maine.

SCOPE: Management of Maine's fish and wildlife resources has reached a significant crossroad. Increasing use, both consumptive and nonconsumptive, and changing habitat conditions make it necessary to take a serious look at the status of Maine's fish and wildlife populations and the characteristics of users of these resources. As part of this effort, the Maine Legislature established the "Commission to Study the Impact of Game and Nongame Species on Maine's Economy" (Public Law 349, Section 38, 1987). The Commission contracted the University of Maine to study the characteristics and preferences of Maine residents and nonresidents who use the state's fish and wildlife resources.

PROJECT STATUS: Data collection is complete and analysis of this data is ongoing. A final report of selected results will be submitted to the Maine Legislature in December 1990. A comprehensive final report will be submitted to the Maine Department of Inland Fisheries and Wildlife and the Maine Department of Marine Resources in February 1991.

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 1989, tasks 3, 4, 5, 6, 7, 8, 9, and 10 as outlined above, were completed, and a new study investigating predation on bird nests in tree fall gaps, ledge openings, and patchcuts were continued.

FUTURE PLANS: The 1991 field season will replicate the 1990 field season.

EFFECTS OF ACID PRECIPITATION ON DISTRIBUTION OF FISHES IN LAKES OF THE NORTHEASTERN UNITED STATES

Investigators:

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Cooperators/ U.S. Fish and Wildlife Service -
Project National Fisheries Contaminant Research Center, Columbia, MO
Support: National Fisheries Research Center - Leetown

Objective: Analyze levels of acidity and related water chemistry in waters of northern New England and their potential influence on distribution of fishes.

SCOPE: Acid precipitation is of particular concern in New England and elsewhere, given the negative impacts of such acidity on fishes and other aquatic life. Specific sampling sites have been established to monitor water quality and fish populations.

A survey was conducted of 226 headwater lakes and low order streams in the six New England states. Acidic surface water (pH < 5) occurred in every state, with 8% of the waters severely acidified, and 29% with pH levels < 6. It was found that a substantial portion of the headwater lakes and low water streams in New England are vulnerable to acidification. As a result, a long-term monitoring program (LTM) was established at a site in Maine in October 1982. Water quality is monitored on a regular basis, and fish populations are sampled once each year at the time of the fall overturn. Intensive studies of stream fishes, a sub-project, are designed to measure specific changes in fishes at different life stages, particularly eggs and alevins, in six streams. In addition, new projects are addressing the role of aluminum in stream ecosystems, and additional impacts of acid deposition to streams.

PROJECT STATUS: Two projects are currently underway, with extensive field work in the 1990 season. One project was completed, and the abstract of the Doctor of Philosophy dissertation follows:

Atlantic salmon eggs were planted in three acid-sensitive streams (pH 5.1-6.7; mean exchangeable Al < 40 ug/l) and their survival and development monitored over a period of eight months. Egg survival to hatching ranged from 30 to 60%. The average fry emergence ranged from 4.9 to 6.1% in the three streams but varied greatly among redds and streams (from 0.3 to 12.0%). Variables related to acidification did not explain the high embryo and alevin mortality.

Atlantic salmon parr were held for 24 days in flow-through channels supplied with streamwater dosed with acid (mean pH 5.36) and acid plus Al (mean pH 5.25, mean exchangeable Al 160 ug/l). Mortality increased at a faster rate than control and was similar for nine days in both treatments after pH dropped below 6.0. This indicated that death initially resulted primarily from acid toxicity. After 10 days of exposure, mortality in the acid-plus-Al channel increased slowly above that in the acid channel. However, Al had less of an overall toxic effect than acid throughout the experiment. In general, parr in the three channels gained weight regardless of treatment, but weight gain was less in the fish exposed to acid or acid plus Al. On the last four days of the experiment, control fish lost weight and exposed fish gained weight continuously. The concentrations of whole-body ions in the fry from the treatment channels were not sensitive indicators of stress at pH < 6.0 and > 5.0, but Na⁺ decreased to below control values on the last two days of exposure when conditions became extreme. Aluminum toxicity may have been reduced because of binding with fluoride present in the stream water.

Atlantic salmon smolts were held for 25 days in flow-through channels supplied with streamwater enriched with acid (mean pH 4.95) and acid plus Al (mean pH 4.85; mean exchangeable Al 100 ug/l). The concentration of plasma Cl was a sensitive indicator of stress and decreased significantly below control values after three days of exposure in both treatments. Exposure to acid plus Al did not cause a response in plasma Cl that was significantly different from that of exposure to acid alone. Smolts in the treatment channels started dying continuously only after 21 days of exposure. For the next two days, cumulative mortality increased to 5% in both channels. For the last three days, it increased more rapidly in the smolts exposed to acid plus Al and reached 39% on the last day. Mortality on the last day in this channel did not result from loss of plasma Cl alone. Aluminum was not toxic to smolts until the last three days of exposure. Before that time, high concentrations of fluoride in the streamwater may have bound to exchangeable Al and made it less toxic. At the end of the experiment, Al was probably the main toxic factor accounting for the differences in mortality between treatments.

Gills from the Atlantic salmon smolts exposed in the channels were analyzed by light and scanning electron microscopy (SEM) to describe structural damage and morphological and numerical changes in chloride and mucous cells after 8 and 24 days of exposure. No structural damage was observed with SEM in the gills from smolts held in either acid or acid plus Al. SEM revealed a substantial increase in the number of primary lamellae mucous cells in both treatments and on both sampling dates, but could not be used to quantify chloride cells because they were difficult to locate. Light microscopy and stereology confirmed the proliferation of mucous cells that was observed with SEM. Light microscopy and stereology also showed that exposure to acid resulted in a significant proliferation of chloride cells in both primary and secondary lamellae. Such proliferation was not observed in gills from smolts exposed to acid plus Al, indicating that in the presence of Al, this response did not occur. The proliferation of chloride cells in smolts exposed to acid did not result in plasma Cl levels that were significantly higher than those found in the smolts exposed to acid plus Al, suggesting that the added chloride cells may have been immature or nonfunctional.

MANAGEMENT OF RIPARIAN FORESTS FOR WILDLIFE

Investigator: S. T. Hooper

Advisors: R. J. O'Connor, Co-Chairperson
S. M. Melvin, Co-Chairperson
H. S. Crawford
D. J. Harrison

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

Objectives:

- 1) Assess wildlife use of forested riparian zones in Maine for consideration in land-use planning.
- 2) Determine if the extent to which wildlife uses riparian zones is associated with specific habitat types, vegetation parameters, or just the presence of the stream.

SCOPE: The importance of understanding wildlife use of riparian zones in Maine stems from development and logging along riverine systems. The potential disturbance and destruction of these riparian habitats and their associated wildlife is an issue land-use planners must consider in setting buffer zones along streams. The project investigated the information available as to wildlife use of such areas and gathered new field data in support of the overall objectives.

PROJECT STATUS: Field work in summer of 1990 was directed to obtaining a third season's data as to bird responses to the presence of riparian edge. Field work in summer 1989 had indicated that there were significant differences in the value of buffer zones for birds breeding in floodplain forests as compared to more upland sites. The 1989 transects were therefore re-run in selected sites, and additional floodplain sites were surveyed in 1990 to confirm the differential response. Vegetation measurements were taken on sites surveyed for the first time in 1990, to allow control for possible confounding effects from vegetation patchiness. The results confirmed the value of buffer zones in floodplain areas, thereby increasing the confidence that can be attached to the conclusions derived from the 1989 data.

A series of experiments were conducted to investigate the effect on census efficiency of the noise from rivers of different size. Background noise could potentially drown out territorial song in some or all species, thus introducing a spurious patterning of distribution along transects perpendicular to the river.

Field trials with bird song recordings indicated that this effect was present for some species but was too slight to have interfered with the field surveys.

The data obtained over the previous 3 years were extensively analyzed in the course of the summer, in preparation for the submission of an M.S. thesis in fall 1990 and subsequent publication of the bird work.

FUTURE PLANS: It is not intended to continue further work on this project. Three considerations led to this decision. First, the comprehensive bibliographic search for information on riparian correlates of wildlife distribution in eastern forests conducted as part of the survey showed that little of the previous work frequently cited in support of a positive effect of buffer zones on wildlife actually supports such conclusions: data were either anecdotal or were inadequate for the statistical analysis conducted. Second, a review of data available other than for birds showed that viable information as to the value of buffer zones would be obtained only from radio tracking, and that methods such as pellet counting would not yield data sufficiently rigorous to justify buffer zone protection. Thirdly, the use of radio tracking on a scale adequate to address the buffer zone question would require resources beyond those available for the project.

FRUGIVORY AND SEED DISPERSAL IN OAK-PINE FOREST

Investigator: A. A. Whitman

Advisors: M. L. Hunter, Chairperson
C. Campbell
W. E. Glanz

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

Objectives:

- (1) Determine fruit production and phenology in oak-pine forest.
- (2) Determine if small mammals are important frugivores for fruit producing plants.
- (3) Compare the quality of seed dispersal by birds to that of foxes.

SCOPE: Seed dispersal and frugivory by wildlife are poorly understood in the temperate zone. Food habits of opportunistic frugivores such as birds, canids, and mustelids are commonly studied. This approach fails to determine the significance of this plant-animal interaction to the animal or the plant involved. More detailed studies have considered the importance of fruit to animals from an energetic stand point, but the importance of frugivores to plants as seed dispersers is poorly understood. To better understand the importance of frugivores to plants, this study 1) determines the availability of fruit and its removal, and 2) investigates the dispersal of one species, wild sarsaparilla (*Aralia nudicaulis*) by birds and foxes (*Vulpes vulpes*).

PROJECT STATUS: Fruit production is highly variable among sites and years in oak-pine forest. Twenty-nine species of fruiting plants were present, but only 13 fruited in the four years of the study. Fruit production peaks in early August, though the main fruiting period runs from July to September. *Maianthemum canadense*, *Cornus canadensis*, *Aralia nudicaulis*, and *Vaccinium angustifolium* were by far the most dominant fruit. Of these four species, *A. nudicaulis* is most quickly removed, *M. canadense* the least. Birds apparently eat fruits of all four species. Foxes remove much fruit of *A. nudicaulis* and some fruit of *V. angustifolium*. Small mammals remove about 50% of *M. canadense* and *C. canadensis* fruit, but little of *V. angustifolium*, and none of *A. nudicaulis*.

Detailed experiments on *A. nudicaulis* revealed that birds and foxes differ in quality of dispersal in several ways. Foxes remove up to 30% of *Aralia* fruit and thrushes (*Catharus sp.*) remove the rest. Seeds passed through birds germinated more frequently (9%) than seeds passed through foxes (2%) ($P < 0.05$). Although its dispersal by foxes and thrushes might result in different dispersal distances, dispersal distance did not affect post-dispersal seed predation by small mammals ($P > 0.209$). Seeds in clumps of 300 (comparable to clumps dispersed by foxes) had less predation than seeds in clumps of 1 or 4 (comparable to clumps dispersed by birds) ($P < 0.05$). Ninety-five percent of wild seedling recruitment is from fox-dispersed seeds in game trails. Seed germination was lowest in gaps (1%), which was different from other sites, but similar among other sites: forest (10%), along trails (3.6%), and under *A. nudicaulis* plants (3.6%) ($P < 0.05$). Foxes appear to disperse seeds to better sites and at densities which had less predation.

FUTURE PLANS: Field work has been completed, and thesis work will be completed fall 1990.

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: Pulp and paper mill sludge contain a range of organic matter, nitrogen, phosphorus, and lime which may improve soil structure and enhance forest regeneration. Landspreading pulp and paper mill sludge also reduces the need for landfill space. However, landspreading sludge may affect wildlife populations through habitat modification. There have been few studies investigating effects of landspreading pulp and paper mill sludge on sites representative of those chosen for landspreading in Maine. This study is designed to determine the effects of landspreading these materials in regenerating forestlands on wildlife populations.

PROJECT STATUS: Eight 60-70 acre study sites were selected in western Maine, based on vegetative composition and structure, forest management history, and soils type in July-August 1989.

Pre-treatment population and habitat studies were completed in summer 1990. Breeding birds were sampled by spot-mapping, small mammals by snap and pitfall trapping, amphibians and surface invertebrates by pitfall, foliage invertebrates by sweep netting, and earthworms by excavation. Forty vegetation plots per study site were also sampled.

Application of the pulp and paper mill sludge on the 4 treatment sites is in progress.

FUTURE PLANS: Post-treatment population and habitat studies will be done in spring-summer 1991 and 1992 in treatment and control sites.

**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
H. S. Crawford
B. Griffith

**Cooperators/
Project
Support:** McIntire-Stennis

Objectives:

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

SCOPE: Mature spruce-fir forest stands are critical habitat for white-tailed deer (*Odocoileus virginianus*) in Maine. The high value of timber on these sites and the desire to salvage trees damaged by spruce budworm not only creates a strong demand to utilize timber, but provides an opportunity for integrated management of timber resources and deer winter habitat. However, the relative importance of shelter and foraging habitat in wintering areas is poorly understood, as is the relative value of timber harvesting methods. Assessing the value of timber harvest relative to deer nutrition requires an understanding of the interactions of forage quality and quantity and its relationship to deer requirements and nutritional limitations. The purpose of this project is to determine limitations of deer for using poor quality winter diets and to use this information in an assessment of forage production and diet quality in wintering areas.

PROJECT STATUS: In March 1990, 11 forage species were collected to examine interspecific variation in forage quality. In addition, 6 of these forage species were collected in or near deer wintering areas to examine intraspecific variations due to shading, plant form, browsing, and stem size. Nine white-tailed deer fawns have been hand-reared at the University of Maine Captive Research Facility for use in digestion trials.

FUTURE PLANS: Nutritional analyses of forages are being conducted. A series of digestion trials will begin in January 1991. Natural winter diets spanning a range of digestible energy content will be fed to determine the relationship between diet DE content and DE intake.

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

Investigator: C. A. Elliott

*Cooperators/
Project
Support:* International Paper Company
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 should 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
Support:* University of Maine
Maine Image Analysis Laboratory
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 marten 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 1985 Landsat TM image will be used to identify habitat types. This classification will be part of a GIS, which also includes roads, hydrography, 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: Satellite imagery has been obtained from Georgia Pacific Corp. through the Maine Image Analysis Laboratory; initial processing has begun. Digital line graph files of roads and hydrography in the area also were obtained from the Maine Image Analysis Laboratory. Their format has been corrected and loaded into PC-ARC/INFO. These files have been cleaned and their topology built.

FUTURE PLANS: Imagery will be georectified, classified, and ground-checked. Some digitizing and editing will be performed on the roads and hydrography files. Analysis of harvest, access, and habitat data will be performed in 1991. The potential for expanding the project with a multi-year approach using change detection analysis will be examined.

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

Investigator: T. C. Rudnický

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 field work has been completed. Several clearcuts increased in size between field seasons and new censusing plots were added. Thirty-four cuts were censused this year compared with 45 from last year, however the number of plots were similar (180 plots in 1990; 198 plots in 1989). Preliminary analyses of bird censusing data shows similar patterns to that of last year. White-throated sparrows, common yellowthroats, and chestnut-sided warblers remain the most common species in all clearcuts sampled and the top eight species (those that occurred in >40% of all plots sampled) revealed similar rankings. Total numbers of species appeared to have decreased from 64 last year to 54 in 1990. Analysis of 1989 data revealed no significant relationship between rare species (birds counted ≤ 2 times during the field season) and clearcut size. Species richness is greater in large clearcuts (>70-ha, mean=29) than in small clearcuts (<5-ha, mean=9). However, the average species richness per plot did not differ significantly between cuts of different sizes (eg. 2-ha, mean=8; 107-ha, mean=9).

Nest predation experiments were run in June and July and eggs remained exposed for 14 days with a check on day 7. In July, shrub and tree nests were set out along the clearcut/forest edge and in the forest interior in addition to ground nests. The predation results are similar to the previous year with clearcuts experiencing less predation than forest sites. Combined results show depredation rates of 5.7% in clearcuts and 18.7% in forest sites. Nests placed 1-2 m high in shrubs experienced a higher rate of predation along the edge (55%, 42 nests) than in the forest (29%, 42 nests). The results for ground nests were not significant (edge-29%; forest-21%). The ground nest transects show no distance to edge effect.

FUTURE PLANS: Analysis of data will continue. Thesis completion is targeted for early 1991.

A RETROSPECTIVE STUDY OF AGRICULTURAL BIRD POPULATIONS IN NORTH AMERICA

Investigators: R. J. O'Connor
R. J. Boone
M. T. Jones
T. B. Lauber

Cooperators/ American Cyanamid Company
Project DuPont Corporation
Support: FMC Corporation
Mobay Corporation
Rhône Poulenc
U.S. Fish and Wildlife Service
National Ecology Research Center, Ft. Collins, CO.

Objective: To examine the data available on bird population trends within the contiguous United States and relate these to changes in agricultural practice and pesticide usage.

SCOPE: Agricultural land occupies approximately 45% of the contiguous United States. A variety of agricultural practices are known to impact bird populations but have received little attention in the U.S. This project examines the major data sets on bird population trends - principally the USFWS/Canadian Wildlife Service-sponsored Breeding Bird Survey conducted annually since 1965 and the National Audubon's Christmas Bird Counts, conducted annually since 1900. Agricultural data has been obtained from the Bureau of Commerce's periodic Census of Agriculture and from the Agricultural Statistics Service's annual reports. Pesticide usage data has been obtained from Resources for the Future's (Washington, DC) Pesticide Usage Data Bank. Analysis has been confined to post-1960. The work is being done collaboratively with the

Laboratory of Ornithology, Cornell University, which holds additional information in the form of the North American Nest Record Card scheme.

PROJECT STATUS: The project began in July 1989 and most of the data banks have been assembled into database format at UMaine. Programs have been written to handle the data and methods to analyze the relationships between the various variables in these large-scale data bases are being developed.

FUTURE PLANS: Methods of statistical analysis are being prepared and will be applied to the data.

ANALYSIS OF EFFECTS OF FARM CONSERVATION RESERVE PROGRAM ON BIRD POPULATIONS

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 Farm 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: The work is being done in partial fulfillment of the requirements for an M.S. degree. The CRP sign-up tapes have been obtained and preliminary analysis to establish the geography of CRP enrollments and their relationship to regular agricultural statistics has been conducted.

FUTURE PLANS: Statistical techniques for the analysis of these data are being developed and appropriate computer programs written. When complete, these will be applied to the data to identify patterns of change correlated with the CRP activities.

WILDLIFE RESOURCES - MIGRATORY BIRDS:

USE OF THE AREA OCCUPIED METHOD TO SURVEY WOODLAND HAWKS IN MAINE

Investigator: H. Devaul

Advisors: W. B. Krohn, Chairperson
W. E. Glanz
R. J. O'Connor

**Cooperators/
Project
Support:** Maine Department of Inland Fisheries and Wildlife -
Endangered and Non-game Wildlife Grants Program
Maine Cooperative Fish and Wildlife Research Unit
Hawk Mountain Sanctuary Association

Objectives:

- (1) Estimate the proportion of area occupied by woodland hawk species in comparable blocks of land representing different land use in Maine.
- (2) Provide field data from northern and central Maine for a comparison with previous and concurrent studies in other eastern and midwestern locations.
- (3) Evaluate the usefulness of the survey technique using computer simulations.

SCOPE: The status of breeding birds of prey in Maine is not well-known. Although the *Atlas of Breeding Birds of Maine*, 1978-1983 was recently compiled (P. Adamus, Maine Dept. Inland Fisheries and Wildlife, 1987), and falconers have knowledge of local populations, a systematic survey had not been conducted prior to 1987. This project was initiated to field-test the "Area Occupied" method (Geissler and Fuller 1987, pp. 533-538 in Proc. 1986 Sect. Survey Research Meth., Amer. Stat. Assoc.) of analyzing survey data from areas representative of land use in Maine. Intensive commercial harvesting occurs over a large portion of northern Maine, and land-use is gradually intensifying in southcentral Maine, modifying potential breeding habitats. Raptors characteristically have large home ranges, are easily disturbed at the nest site, and often return to the same nest or tract of land year after year. Land-use practices and disturbance by humans influence the suitability of an area. It is important to know how various land uses, particularly forest management, affect the species composition of breeding birds of prey before large areas are so modified as

to become unsuitable. A survey technique which produces reliable results is necessary to obtain this information and to provide baseline data for future monitoring. The Area Occupied (AO) method is designed for use with rare or uncommon species and has been used with success in other eastern and midwestern locations.

PROJECT STATUS: All requirements for the degree of Master of Science (in Wildlife Management) were completed in May 1990. An abstract of the thesis follows:

This project examined the relationship between communities of breeding woodland hawks and forest management practices in 3 areas in central Maine, and evaluated the sensitivity of an index of species abundance (area occupied; Geissler and Fuller 1987) using computer simulations.

Surveys for breeding woodland hawks were conducted in 3 areas of contrasting land-use in Maine (unharvested, woodlot/agriculture, and commercial harvest). Forty stops in each of the unharvested and commercial harvest areas were visited for 100 minutes 10-11 times in 1987 (440 and 430 observation periods, respectively), and 52 stops in the woodlot/agricultural area were visited 13-14 times in 1988 (720 observation periods). Of the 8 hawk species potentially present, 4 (broad-winged (*Buteo platypterus*), red-tailed (*B. jamaicensis*), red-shouldered (*B. lineatus*), and sharp-shinned (*Accipiter striatus*) hawk) were observed in the unharvested area; 5 (broad-winged, red-tailed and sharp-shinned hawk, American kestrel (*Falco sparverius*), and northern harrier (*Circus cyaneus*) were observed in the commercially harvested area, and all 8 (broad-winged, red-tailed, red-shouldered, sharp-shinned, and Cooper's hawk (*A. cooperii*), northern goshawk (*A. gentilis*), American kestrel, and northern harrier) occurred in the woodlot/agricultural area. *Buteos* were seen frequently enough to estimate the proportion of area occupied by each species. Although not statistically significant ($P > 0.05$), the abundance of *Buteo* spp. relative to land-use paralleled the pattern suggested by the literature. Specially, median estimates of proportion of area occupied by broad-winged hawks and red-shouldered hawks decreased with greater intensity of land-use, while red-tailed hawks were most widespread in the commercially harvested area.

Computer simulations were used to evaluate the reliability (i.e., precision and accuracy) of the area occupied technique in a range of conditions. I determined the effect of actual area occupied, probability of detection (P), and number of repetitions of a survey (number of visits) on the estimates of area occupied. A total of 336 combinations of the 3 parameters were used to generate sighting data, which was then analyzed by Geissler and Fuller's (1987) method. Results indicated that the technique produces imprecise results (i.e., wide confidence intervals) when P is low (<20%) and the species occupies < 25% of the area surveyed. Increasing the number of visits reduces the minimum probability of detection necessary to obtain the best possible estimate, but does not improve the precision of the estimate. Estimates of P for woodland hawks in Maine (this study), New York (Johnson 1989), and Indiana (Iverson 1987) ranged from 6-41%, with a median of 16%. Maximum possible sample size depends on length of breeding season, and is restricted by the survey protocol as to time of day and weather conditions. In Maine, 10-15 visits is the likely maximum. Simulation results indicate that when $P = 16\%$ and 10-15 visits are made, estimates would likely be biased, and confidence intervals would be >50% of the area occupied estimate, making it difficult to detect differences in actual area occupied. Suggestions for refinement of the method are given.

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
Support:** Maine Department of Inland Fisheries and Wildlife
Signal Fuels, Inc.
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.

ENERGETIC ASPECTS OF WOODCOCK HABITAT USE DURING THE BREEDING SEASON AT THE MOOSEHORN NATIONAL WILDLIFE REFUGE

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/
Project
Support:* University of Maine
Maine Cooperative Fish and Wildlife Research Unit
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 and compare vegetation and food availability at hardwood and softwood sites used by woodcock.
- (2) Examine micro-climate regimes and activity budgets of woodcock in different cover types.
- (3) Document spring food habits.
- (4) Use the above results to develop a spring energetics model.

SCOPE: The Atlantic population of the American woodcock is declining, and available data suggest that habitat loss is the primary cause. To reverse this decline, habitat protection and improvement programs based on sound biological data must be developed and implemented. Although a number of habitat models have been developed for woodcock on the breeding grounds, basic assumptions in these models remain untested.

The Moosehorn National Wildlife Refuge (NWR) has a substantial population of breeding woodcock, and timber management on the refuge has created a variety of cover types available to northern-breeding woodcock. In 1986, Patuxent Wildlife Research Center and Moosehorn NWR began a four-year study to examine woodcock survival, productivity, and habitat use on the refuge. The large sample of birds that will be radioed during this study also provides an opportunity to examine spring habitat use from an energetic perspective. Results from several recent studies indicate that spring is a critical period for woodcock populations, yet the relationship between cover type, micro-climate, and woodcock activity has not been examined.

In 1987, the Maine CFWRU and Moosehorn NWR initiated a companion study to examine energetic considerations, including micro-habitats and activity budgets, influencing habitat use by woodcock on the breeding grounds. This study will examine micro-habitat use and activity budgets of, and micro-climate effects on, woodcock during early spring through early summer. These data, combined with energetic studies on captive birds and supplemented by population data collected concurrently by the Patuxent/Moosehorn study, will provide a basis for modeling woodcock energy requirements during spring and their relationships to habitat use.

PROJECT STATUS: The third and final field season has been completed. A total of 2970 hours of activity data and 1008 hours of concurrent microclimate data were collected on 13 radio-tagged females. Earthworm densities were monitored at sites used by radio-tagged woodcock and at reference transects. Eggs were

collected from radio-tagged woodcock for analysis of energy content. Twenty woodcock were collected for analysis of energy reserves and early spring food habits. Metabolic trials with captive-reared woodcock were completed and values obtained for standard metabolic rate, lower critical temperature, apparent metabolizable energy, and costs of activity and thermoregulation. Two papers were prepared for presentation at the 8th Woodcock Symposium, to be held at Purdue University, Lafayette, Indiana, 29 October - 2 November 1990.

FUTURE PLANS: Data analysis and dissertation preparation are underway. Chapter 1 has been drafted and is being reviewed; 2 more chapters are planned. Target date for project completion is May 1991.

FALL SURVIVAL AND RELATIVE PRODUCTIVITY OF AMERICAN BLACK DUCKS

Investigator: Charles G. Kitchens

Advisors: Jerry R. Longcore (Field Advisor)
(Graduate committee to be established)

**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.

SCOPE: Nearly 70 hatching-year (HY), female black ducks will be equipped with transmitters in late August-early September and tracked until they migrate to determine how important refuge impoundments are during day and night and before and after hunting season commences.

PROJECT STATUS: Logistical and financial planning have been completed and field work will begin in mid-August 1990.

A STUDY OF ECOLOGICAL VARIABLES, AND MANAGEMENT APPROACHES TO ENHANCE WATERFOWL USE OF THREE PEATLANDS AT PETTIT MANAN NATIONAL WILDLIFE REFUGE

Investigator: M. El Hamzaoui

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

**Cooperators/
Project
Support:** U. S. Department of Agriculture, USAID

- Objectives:**
- 1) Determine and map vegetation communities of three peatlands at Petit Manan NWR, including the ratio of vegetation and water interspersion.
 - 2) Compare vegetation changes using aerial photographs in each peatland between 1974 and 1990.
 - 3) Document and recommend management techniques to improve waterfowl habitat within each peatland without encroaching on the ecological uniqueness of these ecosystems.

SCOPE: Peatlands constitute an important habitat for wildlife species, particularly waterfowl. Evidently, changes in vegetation succession and water quality within peatlands can have profound effects on habitat quality and therefore its use by wildlife. The interspersion of water and vegetation has been suggested to be the major feature influencing waterfowl abundance and diversity.

Apparently, two of the three peatlands at Petit Manan NWR do not constitute suitable habitats for black ducks or other wildlife species. Management practices based on flooding the existing vegetation within the two peatlands have been initiated to restore the habitat for wildlife, particularly black ducks.

The refuge is in the process of collecting information regarding wildlife, their habitats and vegetation changes. This study seeks to provide baseline data regarding vegetation changes between 1974 and 1990 as well as other environmental factors operating in this ecosystem. Finally, management practices which can be implemented in order to enhance the black duck population without harming the uniqueness of such environment will be documented.

PROJECT STATUS: Field work was initiated in June 1990. Vegetation communities were mapped from aerial photographs and ground truthing. Transects were established in different habitat types.

FUTURE PLANS: Further field work is planned for the summer of 1991 to gather more data on vegetation composition, water quality and habitat use by black ducks and other wildlife species. Data analysis will begin after the second field season.

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 Department of Natural Resources and Energy

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

- 5) Determine if eye color can be used to determine age of female 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. This 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: The first of two field seasons has been completed. Hens began nesting in mid-June as the water levels receded. Approximately 130-160 scaup nested. Habitat characteristics, including soil moisture, vegetative cover and height, and distance to water, edge and larid colony were measured at 100 nests and 120 random sites. Fifteen hens were captured at night using dip nets and nest traps. Eye color and weight were determined and leg bands were attached prior to release. Recorders were placed at 7 nests to monitor incubation behavior. 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, 8 juveniles were collected to identify foods consumed.

FUTURE PLANS: Similar data collection will continue in 1991. In addition food items will be analyzed to determine energy and protein content.

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

Investigator: J. P. Spruce

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

**Cooperators/
Project** U.S. Fish and Wildlife -
Patuxent Wildlife Research Center

Support: University of Maine -
Department of Forest Management

- Objectives:**
- 1) Apply computer-aided processing of satellite data to quantify the extent of habitat types for wintering neotropical migrants in two Belize study sites.
 - 2) Develop a habitat classification approach suitable for large scale, regional applications done 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 Thematic Mapper satellite data has been processed for two study sites in southern Belize to produce habitat type maps, geo-referenced to the UTM map projection. A standard habitat classification scheme and color table has been developed and applied to each classification. Assorted maps and air photos 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 the interpretation of air photos and maps. Additional air photos are being obtained from the British Royal Air Force to aid classification accuracy assessment. Spruce spent a week in January 1990 with U.S. Fish and Wildlife Service co-investigators in Belize to field check habitat classification image and locate representative areas to field sample for bird identification and banding.

FUTURE PLANS: A progress report to the U.S. Fish and Wildlife Service was submitted September 30, 1990. The project will probably be expanded to include a third field site in northwestern Belize to allow field sampling of habitats in the subtropical moist forest. Spot satellite data will probably be acquired for the new site. U.S. Fish and Wildlife Service co-investigators will estimate bird use of habitat for all Belize study sites after the 1990-91 field season.

WILDLIFE RESOURCES - OTHER THAN MIGRATORY BIRDS:

REPRODUCTIVE BIOLOGY OF FEMALE FISHERS IN SOUTHCENTRAL MAINE

- Investigator:** T. F. Paragi
- Field Assistants:** S. K. Crowley
T. P. Hodgman
E. A. Pfalzer
M. L. B. Summers
- Advisors:** W. B. Krohn, Chairperson
J. R. Gilbert
W. A. Halteman
D. J. Harrison
K. D. Elowe, Ex-Officio
- Cooperators/
Project Support:** Maine Department of Inland Fisheries and Wildlife
Maine Cooperative Fish and Wildlife Research Unit
- Objectives:**
- (1) Estimate the proportion of females giving birth and average number of young produced per successful female.
 - (2) Develop and evaluate indices to reproduction and recruitment.
 - (3) Examine denning and postweaning biology of fisher families from spring to early fall.

PROJECT STATUS: All requirements for the degree of Master of Science (in Wildlife Management) were completed in August 1990. An abstract of the thesis follows:

The reproductive biology of 12 radio-collared female fishers (*Martes pennanti*) ≥ 2 -yrs-old (adult) was studied from February 1984 to December 1989 in a 600 km² study area in southcentral Maine. Twelve adult females were monitored, 7 for ≥ 1 year, for 25 fisher-seasons (season = March-June). Estimated

whelping dates ($n = 12$ litters) were 3 March-1 April (median = 21 March, interquartile range = 14-29 March). Use of natal dens typically began during mid-late March and ended during early June. Kits generally stayed within the mother's home range until being trapped in November (1 male) or dispersing in January (2 females). Intensive monitoring during 1988-89 caused females to move kits more often than during 1986-87, but no kits were abandoned.

All natal dens occurred in tree cavities ($n = 33$). Hardwoods composed 94% of the dens examined, 1986-89, with aspens (*Populus* spp.) accounting for 52% of all den trees.

Annual rate of natal denning by adult females averaged 60% (range 0-100%). Five litters in natal dens averaged 2.0-2.2 kits per female, 1988-89. Survival rate of kits from ca. 6 weeks until late October was a minimum of 0.6. Estimated rate of fall recruitment was 0.7-1.3 kits per female, substantially less than ovulation rate (3.0 ova per female ≥ 1 yr).

Proportion of adult females with placental scars (75%, $n = 20$ fisher carcasses from central Maine, 1988-89) more closely corresponded to annual denning rates (60%) than did occurrence of blastocysts in carcasses of females ≥ 1 -yr-old (85%, $n = 41$), suggesting that implantation rate is less than ovulation or fertilization rates. Teats on female fishers that suckled young ($n = 7$) were larger than those on a female that had not suckled young, suggesting that the proportion of adults with enlarged teats could be an annual index to the proportion of females raising young.

Average annual survival rate was 0.69 (95% CL; 0.54,0.88) for females ≥ 1 yr and 0.19 (0.08,0.47) for juveniles of both sexes. Average annual fall recruitment needed to maintain the population (2.1 kits per female) was greater than the observed rate (0.7-1.3), suggesting a population decline. Annual estimates of population increment were < 1.0 except when annual survival of females ≥ 1 yr was 1.0 in 1986. Catch per unit effort for September-October livetrapping (1985-89) and catch rates of successful trappers (1977-88) were consistent with the estimated population decline. The fisher harvest in southcentral Maine should be reduced to allow population recovery.

A SURVEY OF METASTRONGYLID PARASITES IN MAINE CERVIDS

Investigator: B. A. Bogaczyk

Advisors: W. B. Krohn, Co-Chairperson
H. C. Gibbs, Co-Chairperson
R. L. Dressler
M. A. McCollough

**Cooperators/
Project** U.S. Fish and Wildlife Service -
Washington Office

Support: Maine Department of Inland Fisheries and Wildlife
Marine Caribou Transplant Corporation
Maine Cooperative Fish and Wildlife Research Unit

Objectives:

- 1) Determine if woodland caribou held at the University of Maine harbor *Elaphostrongylus cervi* or other metastrongylid parasites.
- 2) Determine if the nematode muscleworm, *Parelaphostrongylus andersoni*, is present in Maine's white-tailed deer.
- 3) Assess the state-wide prevalence of the nematode brainworm, *P. tenuis*, in Maine's white-tailed deer.

PROJECT STATUS: All requirements for the degree of Master of Science (in Wildlife Management) were completed in August 1990. An abstract of the thesis follows:

Five species of metastrongyloid (Nematoda) parasites are known to infect cervids of North America.

These parasites can be lethal in aberrant cervid hosts and thus are of concern. The purpose of this study was to investigate the occurrence and distribution of three of these parasites (*Elaphostrongylus cervi*, *Parelaphostrongylus andersoni*, and *P. tenuis* that potentially infect Maine cervids.

E. cervi, known to occur in caribou (*Rangifer tarandus*) of northcentral Newfoundland, causes neurologic disease in caribou, moose (*Alces alces*) and possibly white-tailed deer (*Odocoileus virginianus*). Twenty-two woodland caribou brought to Maine from southeastern Newfoundland for a reintroduction attempt in December 1986, and their progeny were tested repeatedly for infection by *E. cervi* by examining feces for first-stage larvae (L₁s). Baermann analyses failed to reveal metastrongyloid L₁s in caribou held at the University of Maine.

Heads from 679 deer collected throughout Maine from November 1988 through November 1989 were examined for *P. tenuis*. Deer age ($P < 0.001$) and interaction of age and collection year ($P < 0.001$) were associated with percentage of deer infected (i.e., prevalence). Prevalence increased with age and was greater in fawns during 1988 (66%, $n = 87$) than 1989 (23%, $n = 73$, $P < 0.001$). Prevalence did not vary by year in older (≥ 1 yr old) animals (85%, $n = 519$). The number of worms per infected deer (i.e., intensity) increased with deer age ($P = 0.032$), averaging 2.5 (SD = 2.8, $n = 72$) in fawns versus 3.9 (SD = 3.1, $n = 379$) in deer ≥ 1 yr old. Deer density was not associated with prevalence ($P < 0.05$) or intensity ($P < 0.50$) of infection. L₁s were not always found in infected deer. Prevalence in heads and fecal samples from 42 deer were 73% and 44%, respectively; reasons for the discrepancy are discussed. No differences in prevalence ($P = 0.27$), intensity, or geographic distribution of *P. tenuis* were evident when data were compared to a *P. tenuis* survey done in Maine from 1968-1970.

Backstrap muscles from 42 Maine white-tailed deer were examined for the nematode parasite *P. andersoni*. No adult worms were found. Calculation of a prevalence rate based on the Poisson approximation of a binomial distribution indicated that the true rate could have been between 0.0 and 11.9% (99% C.I.). Given that prevalence documented elsewhere ranged from 21-77%, I conclude that *P. andersoni* probably does not occur in deer from central Maine.

A female moose calf, displaying tameness indicative of infection by *P. tenuis*, was euthanized and four adult *P. tenuis* were found in the cranium. Baermann analysis of feces revealed first-stage larvae indistinguishable from *P. tenuis* (4.4 larvae / g feces). I suggest the parasite completed its life cycle in aberrant host, but completion of the life cycle in moose is not widespread in Maine (McCollough and Pollard, Univ. of Maine, In prep.).

Further research of metastrongyloids should be directed toward understanding their transmission biology and the ecological factors affecting it. Additionally, methods are needed to identify first-stage larvae, such as DNA fingerprinting, and determine exposure of cervid hosts to metastrongyloids by developing serologic tests.

HABITAT USE, FALL MOVEMENT, AND DENNING ECOLOGY OF FEMALE BLACK BEARS IN MAINE

<i>Investigator:</i>	R. L. Schooley
<i>Advisors:</i>	W. B. Krohn, Co-chairperson G. J. Matula, Jr., Co-chairperson W. E. Glanz
<i>Cooperators/ Project Support:</i>	Maine Department of Inland Fisheries and Wildlife McIntire-Stennis
<i>Objectives:</i>	(1) Compare habitat use, fall movements, and denning among female black bears from 3 dissimilar study areas in Maine.

- (2) Determine what characteristics of tolerant hardwood stands in northern Maine are correlated with use by female bears during the fall.

PROJECT STATUS: All requirements for the degree of Master of Science (in Wildlife Management) were completed in August 1990. An abstract of the thesis follows:

I studied habitat use, fall movements, and denning ecology of female black bears (*Ursus americanus*) on 3 study areas in Maine with different topography, forest composition, and land use. I primarily analyzed data from 88 females radiotracked from 1986-88 by the Maine Department of Inland Fisheries and Wildlife.

Tests with 27 stationary radio collars indicated pilots exhibited observer bias when classifying habitat from aircraft, so I excluded several habitat variables from analyses and used broader forest types. Observer bias can be reduced by minimizing number of observers, establishing quantitative criteria for all variables, designing effective field sheets, and standardizing observers' estimates with control sites.

In Spectacle Pond study area, bears used hardwood stands more than expected during fall when beechnuts (*Fagus grandifolia*) were abundant (1986 and 1988); bears used softwoods near riparian areas more than expected when beechnuts were scarce (1987). In Stacyville study area, bears also were located in hardwoods less during fall in 1987, but evidently shifted use near agricultural fields instead of riparian areas. In Bradford study area, beech was less common, habitat was more diverse, and habitat use by bears during fall did not vary annually. Bears used hardwoods, softwoods, and bogs as expected. In all 3 areas, bears rarely were located in open forests.

The mean maximum distance that bears traveled away from summer ranges during fall did not differ among years (1986-88) within study areas. Fall movements were greater for bears in Stacyville ($n = 19$ bear-years, median = 7.3 km) than Spectacle Pond ($n = 52$, median = 1.3 km) and Bradford ($n = 28$, median = 0.9 km). Differences in fall movements among study areas reflected distribution of available food. During 1986 and 1988, bears in Stacyville typically moved long distances (>7.2 km) to areas where northern hardwoods were common.

Ninety-three percent of winter dens ($n = 90$ bear-years) were within or near (≤ 1.0 km) summer ranges. In all 3 study areas, ground dens under windfall trees were used most often, there were no differences between natal and non-natal dens, and suitable den sites were abundant. Most bears entered dens during October or November and emerged during April (range of den period: 134-197 days). In Spectacle Pond and Stacyville, mean dates of den entry for bears were about 1 month later in 1986 and 1988 than 1987. Data suggest this 2-year pattern in den entry occurred for at least 11 years. Den entry dates for bears in Bradford were more consistent among years. Weather patterns did not explain annual variation in den entry dates, and I suggest timing of den entry reflected variation in food availability. Pregnant bears tended to enter dens earlier than other females and I hypothesize that pregnant females den after reaching a weight necessary to reproduce. Mean dates of den emergence did not differ among reproductive classes, and emergence was most related to timing of snow melt.

Spatial and temporal patterns in habitat use, fall movements, and timing of den entry indicated beechnuts were an important resource for bears. Northern hardwood stands should be managed to retain mast-producing beech trees.

POPULATION DYNAMICS OF PACIFIC WALRUSES

Investigator: S. Hills

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

**Cooperators/
Project
Support:** U.S. Fish and Wildlife Service -
Alaska Fish and Wildlife Research Center, Anchorage, AK.

- 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: Fifteen adult male walruses in Bristol Bay, Alaska, were fitted with radio transmitters in May and June, 1990. Nine had both satellite and conventional VHF transmitters; six had VHF transmitters only. Although previous versions of the satellite transmitter worked for only a few weeks, seven of nine functioned 3-4 months, one was shed 2 months after attachment, and the saltwater switch on one never worked properly. The last satellite tag stopped transmitting on JD 320 (16 November) although data continue to be received intermittently. Observers at Round Island (Alaska Dept. Fish and Game) and Cape Pierce (USFWS, Region 7) monitored the haulouts daily for 121 and 154 days, respectively. The coast of Bristol Bay from Port Moller to Chagvan Bay was flown seven times through the end of September, and the north portion of the Bay was surveyed three more times in October and November.

A paper on chemical immobilization of Pacific walruses is ready for internal FWS review before being submitted to the Journal of Wildlife Diseases. The note on the preliminary mtDNA analysis done in 1988 has been accepted with revisions by Marine Mammal Science.

FUTURE PLANS: Data analysis is continuing in anticipation of a dissertation and manuscripts being completed in the spring of 1991.

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/ Maine Department of Inland Fisheries and Wildlife
Project
Support:

- 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: Initial analysis of accumulated population data is complete, producing population parameter values required by the model. Construction of the computer model has begun, employing QuickBasic.

FUTURE PLANS: The computer model will be constructed utilizing data from the Spectacle Pond area in northern Maine. Initial model structure will be a simple Leslie matrix design, using existing estimates of survival and reproduction. Dynamic-modeling concepts will be incorporated subject to favorable evaluation early in the modeling process.

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 analysis 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.

HOME RANGE CHARACTERISTICS AND HABITAT USE OF PINE MARTEN

- Investigator:** D. Katnik
- Advisors:** D. J. Harrison, Chairperson
B. Griffith
G. L. Jacobson
K. D. Elowe, Ex-Officio
S. A. Arthur, Ex-Officio
- Field Assistants:** T. P. Hodgman
S. S. Sherburne
G. Hayes
T. F. Foster
K. McGinley
J. P. Sincage
- Cooperators/
Project Support:** McIntire-Stennis
Maine Department of Inland Fisheries and Wildlife
Department of Wildlife, University of Maine
- Objectives:**
- 1) Document seasonal, age-specific, and sexual differences in home range size and core area use by pine marten.
 - 2) Assess extent of spatial and temporal home range overlap among marten as influenced by sex, age, and season.
 - 3) Determine influence of cover type, crown closure, average tree height, distance to edge, and shape and size of habitat blocks on marten habitat selection.

SCOPE: Trapping and timber harvesting are potential factors influencing marten populations throughout northern Maine. This furbearer is highly sought by trappers because marten are easy to capture and their pelts are valuable relative to most other furbearers. Extensive clearcuts are replacing mature softwood stands, while expanding road networks are increasing human access to previously remote areas and potentially unexploited marten populations.

Unfortunately, a lack of information on home range size, home range overlap, and habitat use of marten is preventing reliable estimation of population levels and carrying capacity. The goal of this study is to provide information that can be used by management agencies to set acceptable harvest levels and to predict the effects of alternative land-use practices.

PROJECT STATUS: Thirty-five (16M, 19F) marten were radio-collared from May 1989 through October 1989, and 3 (2M, 1F) marten were ear-tagged. Over 700 relocations were obtained by ground and aerial telemetry. Twenty-one marten (12M, 9F) were harvested by trappers.

Twenty-six (14M, 12F) additional marten were radio-collared from May 1990 through September 1990. No animals marked in 1989 were recaptured. Over 1,000 relocations have been obtained by ground and aerial telemetry.

FUTURE PLANS: Twelve (6M, 6F) additional animals will be radio-collared in October 1990. Daily relocations will be obtained through December 1990. Spatial and habitat analyses will be conducted from January through June 1991. The expected date for thesis completion is August 1991.

OCCURRENCE, DISTRIBUTION, AND SPATIAL INTERACTIONS AMONG MAMMALIAN CARNIVORES IN ACADIA NATIONAL PARK

Investigators: D. J. Harrison
L. Winter

**Cooperators/
Project
Support:** U.S. National Park Service -
Acadia National Park, Bar Harbor, ME
Regional Office, Boston, MA.
University of Maine -
Department of Wildlife

Objectives:

- 1) Determine the presence or absence and distribution, where appropriate, of breeding of coyotes, red foxes, bobcats, and fishers.
- 2) Document habitat use and food habits of coyotes and red foxes.
- 3) Assess the influence of coyotes on spatial distributions and densities of red foxes.
- 4) Provide baseline data for future assessments of terrestrial mammals in Acadia National Park.

SCOPE: Acadia National Park on Mount Desert Island (MDI) provides habitat for mammalian predators including coyotes (*Canis latrans*), red foxes (*Vulpes vulpes*), bobcats (*Felis rufus*), and fishers (*Martes pennanti*). Basic information regarding the occurrence and distribution of these species is lacking. All four predators share a common, finite resource base, resulting in potential for interspecific competition. Major prey species of each of the four predators consist of mammalian herbivores.

The recent establishment of coyotes on MDI may result in changes in populations of red foxes, snowshoe hares (*Lepus americanus*), and white-tailed deer (*Odocoileus virginianus*), and may decrease the potential for bobcat and fisher populations to expand on the island. Changes in the predator community may also result in behavioral changes that may necessitate management action. Limited potential for coyote to disperse from MDI, in combination with high deer densities, may lead to the establishment of atypical group sizes and compositions.

The broad-based ecological study includes snow track surveys, scent-post surveys, vocalization surveys, live-trapping and radio telemetry, habitat comparisons, and food habitat analyses. This study is being conducted concurrently with a study assessing the effects of snowshoe hare and white-tailed deer on plant succession in Acadia. Together, these studies will provide complementary information on the mammalian community and its influence on natural systems in Acadia National Park.

PROJECT STATUS: Field work was completed on 31 July 1990. Overall, 12 coyotes and 14 red foxes were radio-tracked and more than 2,000 radio locations were obtained. One hundred km of snow tracking transects, 100 howl survey stations, and 402 scent-post stations were surveyed to assess the distribution of mammalian predators in Acadia National Park. Feces from coyotes ($n = 171$) and red foxes ($n = 110$) were collected and analyzed for percent occurrence of prey remains.

FUTURE PLANS: Habitat analyses are being completed during fall 1990. A final project report will be completed and submitted to the National Park Service by 31 December 1990.

INFLUENCE OF BROWSING BY WHITE-TAILED DEER AND SNOWSHOE HARE ON VEGETATION AT ACADIA NATIONAL PARK

- Investigator:** M. Saeki
- Advisors:** D. J. Harrison, Chairperson
F. A. Servello
W. E. Glanz
G. L. Jacobson
- Cooperators/
Project
Support:** U.S. National Park Service -
Acadia National Park, Bar Harbor, ME
Regional Office, Boston, MA.
University of Maine -
Department of Wildlife
- Objectives:**
- 1) Quantify browse availability in different habitat types in Acadia National Park.
 - 2) Quantify browsing intensity of white-tailed deer and snowshoe hare among different habitat types and plant species.
 - 3) Compare browse availability among burned and unburned areas.
 - 4) Characterize succession as influenced by fire and the browsing habits of deer and hare.
 - 5) Assess and compare nutritional condition of deer among different habitats.

SCOPE: White-tailed deer and snowshoe hare are the major herbivores at Acadia National Park (ANP). This park totals approximately 16,000 ha on Mt. Desert Island (MDI) and Isle au Haut (IH). In 1947, a wildfire burned 6,880 ha on the east side of MDI, whereas most of the west side and IH were unburned. Following the fire, populations of these herbivores increased substantially in the burned areas. This study assessed the influence of browsing by these herbivores on post-fire succession in ANP.

Browse availability-utilization for white-tailed deer (Baird 1966, McLaughlin 1968, Gilbert and Harrison 1982) and for snowshoe hare (Gilbert and Harrison 1982, Final report, Contact CX1600-8-0045, USDI, Natl. Park Serv., North Atlantic Reg.) and for snowshoe hare (Gilbert and Harrison *op cit* has been previously studied at ANP. This project serves as a follow-up study of browsing by white-tailed deer and snowshoe hare. Vegetation was surveyed along permanent transects and within permanent exclosures to estimate utilization and availability. Population levels of herbivores were assessed by relative abundance of tracks and pellets along survey lines. Nutritional condition of the deer was assessed by fecal nitrogen levels during late winter.

PROJECT STATUS: Approximately 100 km of permanent transects were established for winter track surveys and vegetation plots. Snow-tracking surveys were completed during the winters of 1988, 1989, and 1990. Two hundred fifteen vegetation plots (2 m x 25 m) on MDI and 17 plots on IH were surveyed during summer 1989. Surveys included stem counts, twig counts, and diameter at the point of browsing for selected browse species. Biomass browsed was estimated for key browse species using regression analyses obtained from clipped twigs. Deer and hare fecal pellet groups were also counted within all plots.

Vegetation inventory on four exclosures on MDI and two exclosures on IH was completed during summer 1988. Two control plots were also inventoried for each exclosure. An exclosure was constructed within active beaver habitat on MDI, and a baseline vegetation inventory was completed on this site and on two adjacent control plots during summer 1989.

Fecal groups of deer were collected on MDI ($n = 1170$) and on IH ($n = 360$) during late winter 1990. Fecal crude protein (percent dry matter of nitrogen x 6.25) levels were analyzed and compared

among areas with different fire history and browsing intensities.

Browsing intensity of deer and hare probably decreased since the last surveys in 1980. The results of vegetation surveys and fecal nitrogen analyses suggest that the deer population at ANP is below nutritional carrying capacity.

FUTURE PLANS: The thesis and final project report will be completed by December 1990.

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 density of beaver on a trapped area and an area recently closed to trapping.
- (2) Compare the number of wetlands and surface area of water on both areas.
- (3) Compare the quality of vegetation to waterfowl on both areas.
- (4) Compare the annual density of breeding pairs of selected waterfowl species between both areas.

SCOPE: The black duck population has declined steadily since 1950, and overharvest is thought to be the primary factor. Therefore, since 1981 the annual harvest in Maine has been reduced 60%. Once the population increases, habitat may likely be a limiting factor.

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 area will be closed to beaver trapping for 3 years beginning in 1989, whereas another area will remain open to trapping. The 150 km² untrapped area corresponds to the location of 3 previous waterfowl graduate studies conducted during the past 30 years. This area consists of the townships of Dixmont, Jackson, Monroe, and Newburgh in Waldo County, Maine. The trapped area consists of the township of Montville.

PROJECT STATUS: The second field season has been completed. In October 1988-90, counts of beaver caches on both areas were made from fixed-wing aircraft and from the ground to determine the number of active lodges. On the untrapped area the number of active lodges has increased from 18 in 1988, to 21 in 1989, and 28 in 1990. Whereas, the number of active colonies on the trapped area has declined from 29 in 1988, to 19 in 1989, and 18 in 1990. Two hundred twenty beaver were live-trapped and tagged with colored ear tags to determine the average number of beaver per lodge and dispersal. On the trapped area, trappers were interviewed to determine the harvest of beaver in 1989-90 and to collect teeth for aging. Trappers harvested 43% of the beaver population in 1989 and 47% in 1990.

Each May, the number and sizes of wetlands and the types of vegetation associated with each wetland were determined using aerial photos. From July-September 1989-90, each of the 200 wetlands was visited to verify the accuracy of the data obtained from the photos. Each spring and summer the condition of beaver dams and water levels were recorded at every wetland. Presently, many inactive wetlands have been recolonized on the untrapped area, and there are a few new wetlands <1 ha. In contrast, there is little change in wetlands on the trapped area.

From April-May 1989-90, breeding-pair counts of selected waterfowl species were compared on each area using counts from a helicopter and observers on the ground. To date, no trend in waterfowl numbers has been noted on either area. In conclusion, a 1-year closure of beaver trapping caused an increase in the average number of beaver per lodge but few new colonies or wetlands. The second year of closure produced more colonies and an increase in recolonization of inactive wetlands. No change in waterfowl densities has been observed.

FUTURE PLANS: In 1990 and 1991 the collection of data will be replicated. The anticipated date of completion is May 31, 1992.

ANALYSIS OF RIVER OTTER HARVEST AND REPRODUCTIVE DATA IN THE NORTHEASTERN U.S., 1970-88

Investigators: M. Chilelli
B. Griffith
D. J. Harrison

**Cooperators/
Project
Support:** U. S. Fish and Wildlife Service -
Region 5 Federal Aid
Northeast Fur Resources Technical Committee

Objectives: 1) Evaluate existing river otter data from the northeastern U.S.
2) Develop a region-wide protocol for the subsequent collection of river otter biological and harvest data.

SCOPE: With the CITES listing of the river otter, the U. S. Fish and Wildlife Service (USFWS) is required to ascertain that harvest strategies in individual states are not detrimentally affecting the species prior to issuing export permits. Because the USFWS relies on recommendations from individual states regarding their harvest strategies, it is essential to Federal and state management agencies that the soundness of the data used to reach these decisions be evaluated.

PROJECT STATUS: Analysis of river otter harvest and reproductive data has been completed. Based on 176 tooth aging samples from 7 states, there was no directional bias in age determination when estimates from states and an independent observer were compared. Use of radiographs improved the consistency of age determination as juveniles or older compared to aging by cementum annuli alone. Season of harvest did not affect aging consistency.

For the period 1970-88, there was an increasing yearly trend in number of otters harvested in Connecticut, Maine, New Hampshire, New York, and Vermont (Conn., N.H., N.Y., and Vt.: weighted mean $r_t = 0.828$, $P < 0.002$; Me.: $r_t = 0.472$, $P = 0.041$). States showing no significant yearly trend in otter harvests during this period included Delaware, Maryland, Massachusetts, New Jersey, and Rhode Island ($P > 0.384$). Otter harvests were positively correlated with beaver harvests in Connecticut, Maine, Maryland, New Hampshire, and New York (weighted mean $r_t = 0.725$, $P < 0.02$); there was no correlation in New Jersey and Vermont ($P \geq 0.610$). Prior to the 1984-85 trapping season in Massachusetts, otter harvests were correlated with beaver harvests ($r_t = 0.667$, $P = 0.071$). However, from the 1984-85 season to present, the overlap of the otter and beaver seasons were reduced to approximately 1 month and the correlation between the reported harvests of these 2 furbearers was not significant ($P = 0.505$).

Based on the analysis of sex- and age-ratios in relation to exploitation season patterns, it appears that females constitute a lower proportion of the harvest during spring only seasons ($P < 0.001$). The percentage of juveniles in the male and female harvest of river otters was related to aging technique (females: $G = 55.08$, 2 df, $P < 0.001$; males: $G = 36.97$, 2 df, $P < 0.001$), aging lab (females: $G = 44.84$, 4 df, $P < 0.001$; males: $G = 44.57$, 4 df, $P < 0.001$), and age reader (females: $G = 8.03$, 1 df, $P = 0.005$; males: $G = 41.69$, 1 df, $P < 0.001$). Aging techniques need to be standardized to make comparisons of age distribution among states reflect biology and management and not technique differences.

There were >600 records of adult female otters with reproductive data from 7 states (Conn., Mass., Me., N.H., N.J., N.Y., and Vt.). However, analyses of temporal and spatial patterns in fecundity indices (i.e., corpora lutea, blastocyst, placental scar, and embryo counts) were limited due to scarcity of reproductive data for each index by state.

Results of the analysis were presented at the 1990 Northeast Fish and Wildlife Conference and the 1990 meeting of the Northeast Fur Resources Technical Committee.

FUTURE PLANS: The final report will be completed by April 1991.

EVALUATION OF PLACENTAL SCARS TO MONITOR FISHER REPRODUCTION

Investigator: H. C. Frost

Advisors: W. B. Krohn, Chairperson
(Graduate committee to be established)

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

Support:

- Objectives:*
- 1) Test validity of counting hemorrhage sites in female reproductive tracts (assumed to be placental scars) to determine:
 - a) the percent of adult females giving birth, and
 - b) the mean number of young per successful female.
 - 2) Determine annual and geographic variation in the reproduction (i.e., corpora lutea, placental scars, and blastocysts) of Maine fishers, and investigate possible causes of reproductive variation.

SCOPE: It has been assumed that placental scar counts underestimate the number of females which give birth and that corpora lutea counts equate to the number of young born. Recent field work in Maine refutes these two assumptions and suggests that counts of placental scars more closely reflect observed parturition

rates and spring recruitment. To test the field data, female fishers will be live-trapped and brought into captivity at the University of Maine. Using ultrasound techniques and laparotomies, the actual number of young born will be compared to the number of placental scars present after birth. Placental scars will be observed throughout the year to monitor regression of hemorrhage sites. In addition, data on seasonal hormonal concentrations, time and rate of implantation, and gestation period will be verified.

Carcass collections will be initiated to determine: a) juveniles to adult ratios, b) percent of females which gave birth based on the absence or presence of placental scars, and c) number of young per pregnant female based on corpora lutea, blastocysts, and placental scars. Special attention will be given to analyzing time/space comparison to test for the effect of snow (depth, softness, and duration) and population density on reproduction. Possibly, captive animals will also be used to see if physiological measures of body conditions can be validated and related to reproductive success.

PROJECT STATUS: Twenty-two cages with nest boxes have been constructed and put in place at the University of Maine's Ungulate Research Facility. Five weeks of trapping before the general trapping season by project personnel yielded 3 juvenile female fishers. Three cooperating trappers have been hired to activity trap throughout the general season. All females captured will be brought into captivity. In the event of more captures than available cages, juveniles will be radio-collared and released and monitored throughout the year and recaptured next season. Food is being collected from road killed deer and moose, and presently there is enough on hand to last 4 months. Procedures are currently being worked out and times being set with cooperating veterinarians when ultrasound and laparotomies will be performed. Development of detailed study protocols has been initiated.

FUTURE PLANS: The study plan will be reviewed by a committee and completed. Monitoring of placental scars throughout the year will be initiated. Carcass collection will be initiated next trapping season with emphasis on obtaining carcasses from northern and southern portions of the state to assess the effect of environmental variation on reproduction.

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- POTTER, D.M., K.J. BOYLE, and S.D. REILING. 1990. Highlights from the 1989 Survey of Maine Turkey Hunters. Department of Agricultural and Resource Economics, Staff Paper Series in Resource Economics, ARE 413, University of Maine.
- SADER, S.A., and J.P. SPRUCE. 1990. Application of satellite data to quantify habitat of wintering neotropical migrants in Belize. Maine Cooperative Fish and Wildlife Research Unit RWO #19, Annual Report. 21pp.
- SERVELLO, F.A. (contributing author). 1989. In S. Atwater and J. Schnell, eds. *The Wildlife Series: Ruffed Grouse*. Stackpole Books, Harrisburg. 370pp.
- TEISL, M.F., K.J. BOYLE, and S.D. REILING. 1990. Highlights from the Survey of Hunters Holding a 1988 Maine Hunting License. Department of Agricultural and Resource Economics, Staff Paper Series in Resource Economics, ARE 424, University of Maine.
- VICKERY, P. 1990. Requiem for the wood thrush: are Maine's forest birds declining. *Habitat* 6:19-25.

THESES AND DISSERTATIONS

- BOGACZYK, B.A. 1990. A survey of metastrongyloid parasites in Maine cervids. Master of Science thesis, University of Maine, Orono. 60pp + 27pp supplement.
- DEVAUL, H. 1990. A theoretical and empirical evaluation of a method of estimating area occupied for breeding woodland hawks in Maine. Master of Science thesis, University of Maine, Orono. 59pp.
- MUGANGU, E.T. 1990. Habitat selection by the African buffalo in Virunga National Park, Zaire. Ph.D. Dissertation, University of Maine, Orono. 74pp.
- HARTLEY, R.A. 1990. Survival of tournament-caught largemouth (*Micropterus salmoides*) and smallmouth (*M. dolomieu*) bass in three Maine lakes. Master of Science thesis, University of Maine, Orono. 75pp.
- PARAGI, T.F. 1990. Reproductive biology of female fishers in southcentral Maine. Master of Science thesis, University of Maine, Orono. 107pp.
- PAUWELS, S.J. 1990. Effects of chronic exposure to acid and aluminum on ion regulation and gill ultrastructure in smolts of the Atlantic salmon (*Salmo salar*). Ph.D. Dissertation, University of Maine, Orono. 171pp.

- PERRY, C.M. 1990. Chronic effects of low pH on length, weight, and whole-body composition of captive Atlantic salmon (*Salmo salar*) in New England. Master of Science thesis, University of Maine, Orono. 46pp.
- ROMIG, G.P. 1990. Habitat use and selection by juvenile salmonids in New Hampshire and Vermont streams. Master of Science thesis, University of Maine, Orono. 80pp.
- SAYERS, R.E., JR. 1990. Habitat use patterns of native brook trout and stocked salmon: inter-specific competition and salmon restoration. Ph.D. dissertation, University of Maine, Orono. 125pp.
- SCHOOLEY, R.L. 1990. Habitat use, fall movements, and denning ecology of black bears in Maine. Master of Science thesis, University of Maine, Orono. 115pp.
- VENNO, S.A. 1990. Integrating wildlife habitat into local planning: a handbook for Maine communities. Master of Wildlife Conservation report, University of Maine, Orono. 78pp.
- VICKERY, P.D. 1990. Aspects of the breeding biology of grassland birds in southern Maine. Master of Science thesis, University of Maine, Orono. 61pp.
- WINTER, L.A. 1990. Home range size and spatial relationships of coyotes and red foxes in Acadia National Park, Mount Desert Island, Maine. Master of Wildlife Conservation report, University of Maine, Orono. 74pp.

PROFESSIONAL TALKS PRESENTED

- ARTHUR, S. M., T. F. PARAGI, and W. B. KROHN. June 1990. "Dispersal of juvenile fishers in Maine." American Society of Mammalogists, Frostburg, MD.
- BOGACZYK, B., and W.B. KROHN. April 1990. "Increasing moose populations in relation to brainworm: a review of hypotheses." 46th annual Northeast Fish and Wildlife Conference, Nashua, NH.
- CHILELLI, M., and B. GRIFFITH. April 1990. "Analysis of river otter harvest and reproductive data in northeastern U.S." 46th annual Northeast Fish and Wildlife Conference, Nashua, NH.
- CHILELLI, M., G. LAVIGNE, W. KROHN, and J. GILBERT. April 1990. "Using antler beam diameters from yearling white-tailed deer bucks as an index to carrying capacity in Maine. 46th annual Northeast Fish and Wildlife Conference, Nashua, NH.
- CHILELLI, M. September 1990. "Analysis of river otter harvest and reproductive data in northeastern U.S, 1970-88: an update." Talk presented to the Northeast Fur Resources Technical Committee, Alleghany State Park, New York.
- CROWLEY, S., W.B. KROHN, and T.F. PARAGI. April 1990. "A comparison of fisher recruitment indices." Paper presented at 46th annual Northeast Fish and Wildlife Conference, Nashua, NH.
- DEVAUL, H., and W.B. KROHN. April 1990. "Use of the area occupied method to survey breeding woodland hawks in Maine." Maine Bird Conference, Farmington, ME.

- ELLIOTT, C. April 1990. "Songbird use of forest-clearcut edges in northcentral Maine." Maine Bird Conference, Farmington, ME.
- GRIFFITH, B. August 1990. "Assessing population viability of birds." National Meeting of Cooperative Fish and Wildlife Research Units, Raleigh, NC.
- GRIFFITH, B., and J.M. SCOTT. April 1990. "Translocation as a species conservation tool." Society for Ecological Restoration - Symposium: Recovery and Restoration of Endangered Species, Chicago, IL.
- HARRISON, D.J., J.A. HARRISON, and M. O'DONOGHUE. June 1990. "Predispersal movements of coyote pups in eastern Maine." 70th annual meeting of the American Society of Mammalogists, Frostburg, MD.
- HARTLEY, R.A. August 1990. "Delayed mortality of largemouth and smallmouth bass following tournaments." Annual Meeting of the American Fisheries Society, Pittsburgh, PA.
- HARTLEY, R.A. April 1990. "Delayed mortality of largemouth and smallmouth basses following tournaments." 46th Northeast Fish and Wildlife Conference, Nashua, NH.
- HOOPER, S. April 1990. "Wildlife and riparian zones in Maine: a review." Atlantic Society of Fish and Wildlife Biologists Spring Workshop: Management of the Riparian Zone, Mount Allison Univ., Sackville, NB.
- HUNTER, M.L., JR. "Spatial and temporal perspectives on forest bird conservation." Talk given to Maine Bird Conference, University of Maine, Farmington, April 14, 1990.
- HUNTER, M.L., JR. "Implications of conservation biology for wildlife management in Maine." Talk given to Maine Chapter of The Wildlife Society, Brewer, ME., April 27, 1990.
- HUNTER, M.L., JR., and P. YONZON. "Altitudinal distributions of birds, mammals, forest, parks, and people in Nepal." Talk presented at the meeting of the Society for Conservation Biology, Gainesville, FL, June 19, 1990.
- HUNTER, M.L., JR. "Forest diversity in time and space." Talk presented to USDA Forest Service, Clemson University, Clemson, SC, September 20, 1990.
- HUNTER, M.L., JR. "Lessons from paleoecology for maintaining biological diversity." Talk given to Department of Forestry, University of New Hampshire, Durham, October 19, 1989.
- KATNIK, D. February 1990. "Home range characteristics of pine marten." Northeast Wildlife Graduate Student Conference, Acadia University, Wolfville, NS.
- KROHN, W. B. May 1990. "Results of recent fisher research in Maine." Northeast Fisher Workshop. Concord, NH.
- MCCALL, T.C. February 1990. "Relationship between beaver management and waterfowl in south-central Maine." Black Duck Symposium, Saint John, NB.
- MCLAUGHLIN, C.R., and H.L. SMITH. April 1990. "Baiting black bears: hunting techniques and management issues." 10th Eastern Black Bear Workshop, Bismarck, AR.

- MCLAUGHLIN, C.R., K.D. ELOWE, and M.A. CARON. April 1990. "Status of Maine's black bear research and management." 10th Eastern Black Bear Workshop, Bismarck, AR.
- MORING, J.R., K.I. GUSTAFSON-GREENWOOD, and C. MACKENZIE. August 1990. "Intragravel stages and territorial behavior of newly-emerged Atlantic salmon: a review of recent studies in Maine." Annual Meeting of the American Fisheries Society, Pittsburgh, PA.
- MORING, J.R., and S.W. MORING. May 1990. "Short-term retention and translocation of larval lumpfish (*Cyclopterus lumpus*) in tidepools." 14th Larval Fish Conference, Beaufort, NC.
- MORING, J.R. August 1990. "Delayed mortality of black basses following tournaments." National Meeting of Cooperative Fish and Wildlife Research Units, Raleigh, NC.
- MUGANGU, E.T. "Habitat selection by the African buffalo in Virunga National Park, Zaire." Talk given to professional researchers at Texas A&M University Agricultural Research Center, Uvalde, TX., December 8, 1989.
- O'CONNOR, R.J. December 1989. "Population dynamics and migrancy status in North American birds." Ecology and Conservation of Neotropical Migrant Landbirds Symposium sponsored by Manomet Bird Observatory, Manomet, MA.
- O'CONNOR, R.J. April 1990. "Longterm population studies in birds." British Ornithologists Union Conference, Aberdeen, Scotland.
- O'CONNOR, R.J. June 1990. "Ubiquity, abundance, and nest habitat diversity in bird populations." American Ornithologists Union/Cooper Ornithological Society joint annual meeting, Los Angeles, CA.
- O'CONNOR, R.J. July 1990. "Population patterns and process parameters - issues in integrating monitoring and models." Conference entitled "Population ecology and wildlife toxicology of agricultural pesticide use: a modeling initiative for avian species," Kiawah Island, SC.
- OWEN, R.B., JR., C.T. TODD, and M.A. MC COLLOUGH. April 1990. "Nesting history and population status of Maine's bald eagles. 46th Northeast Wildlife Conference, Nashua, NH.
- OWEN, R.B., JR. October 1989. "Ecology and management of bald eagles in Maine", "Biopolitics", and "Black duck management - where do we go from here." Distinguished Lecturer Series, Virginia Polytechnical Institute and State University, Blacksburg, VA.
- OWEN, R.B., JR. April 1990. "Population status and management of Maine's bald eagles." 46th Northeast Wildlife Conference, Nashua, NH.
- OWEN, R.B., JR. April 1990. "A history of ornithological studies in the wildlife program at the University of Maine." Maine Bird Conference, Farmington, ME.
- PAUWELS, S.J. April 1990. "Morphological changes in gill chloride cells from gills of Atlantic salmon smolts exposed to acid and Al-enriched streamwater." 46th Northeast Fish and Wildlife Conference, Nashua, NH.
- PERRY, C.M. April 1990. "Chronic effects of reduced pH on growth and elemental composition of Atlantic salmon (*Salmo salar*)." 46th Northeast Fish and Wildlife Conference, Nashua, NH.

- POWELL, G.V.N., J.H. RAPPOLE AND S.A. SADER. December 1989. "Nearctic migrant use of lowland Atlantic habitats in Costa Rica: a test of remote sensing for identification of habitat." Ecology and Conservation of Neotropical Migrants Workshop, Woods Hole, MA.
- ROMIG, G.P. April 1990. "Habitat selection in juvenile salmonids in New England streams." 46th Northeast Fish and Wildlife Conference, Nashua, NH.
- RUDNICKY, T. February 1990. "The effects of clearcut size on bird species richness and nest predation rates in eastern Maine." Northeast Wildlife Graduate Student Conference, Acadia University, Wolfville, NS.
- SADER, S.A., G.V.N. POWELL AND J.H. RAPPOLE. March 1990. "Migratory bird habitat change estimated through remote sensing techniques." American Congress for Surveying and Mapping and American Society for Photogrammetry and Remote Sensing Annual Convention, Denver, CO.
- SAEKI, M. February 1990. "Influence of browsing by white-tailed deer and snowshoe hare on vegetation in Acadia National Park." Northeast Wildlife Graduate Student Conference, Acadia University, Wolfville, NS.
- SAEKI, M., and D. HARRISON. August 1990. "Influence of browsing by white-tailed deer and snowshoe hare on vegetation at Acadia National Park, Maine, U.S.A." International Symposium on Wildlife Conservation, INTECOL 90, Tsukuba-Yokohama, Japan.
- VICKERY, P., M.L. HUNTER, JR., and J.V. WELLS. June 1990. "A new comprehensive measure of reproduction relationship of habitat quality in three *Emberizine* sparrows." Annual meeting of the Wilson Ornithological Society, Wheaton College, Newton, MA.
- VICKERY, P. June 1990. "Is increased territorial density associated with higher levels of breeding success?" Annual meeting of the Wilson Ornithological Society, Wheaton College, Newton, MA.
- VICKERY, P. April 1990. "Contributions of the amateur to ornithology and science: values and constraints." Maine Bird Conference, Farmington, ME.
- VICKERY, P., M.L. HUNTER, JR., and J.V. WELLS. April 1990. "The effect of territorial density on the reproduction success of three *Emberizine* sparrows." Maine Bird Conference, Farmington, ME.
- VICKERY, P. October 1989. "Neotropical migrants and tropical diversity." Neotropical Ecology course, Maine Audubon Society.
- VICKERY, P. November 1989. "The role of neotropical migrants in tropical systems." Symposium on Latin America, University of Southern Maine, Portland.
- WHITMAN, A. February 1990. "Seed dispersal of wild sarsaparilla, *Aralia nudicaulis*, by wildlife." Paper presented at Northeast Wildlife Graduate Student Conference, Acadia University, Wolfville, NS.
- WHITMAN, A. August 1990. "Are foxes better seed dispersers than birds?" (Poster) 75th meeting of the Ecological Society of America, Snowbird, UT.
- WITHAM, J. April 1990. "Population trends of neotropical migrant landbirds in northern coastal New England: a case study." Maine Bird Conference, Farmington, ME.

WITHAM, J., and M.L. HUNTER, JR. December 1989. "Population trends of neotropical migrant landbirds in northern coastal New England." Ecology and Conservation of Neotropical Migrant Landbirds Symposium, Manomet Bird Observatory, Manomet, MA.

PUBLIC TALKS PRESENTED

DEVAUL, H. "A theoretical and empirical evaluation of a method of estimating area occupied for breeding woodland hawks in Maine." Public seminar given at the University of Maine, Orono, February 27, 1990.

DEVAUL, H. "Hawks in Maine." Talk given to Ernst Mayer Community Housing for Elderly, February 1, 1990.

DEVAUL, H. "Field identification of raptors." Talk given to WLM 250 summer camp, University of Maine, Orono, May 18, 1990.

ELLIOTT, C.A. "Managing forests for wildlife." Talk given to Woodlot Volunteers in Hancock County, ME, October 17, 1989.

ELLIOTT, C.A. Introduction to wildlife ecology and management." Talk given at "A Forester's Guide to Managing Wildlife Habitats in Maine - A Workshop for Foresters," October 26, 1989.

ELLIOTT, C.A. "Careers in wildlife biology and management." Talk given at the Connors-Emerson Schools Career Day, Bar Harbor, ME, May 8, 1990.

ELLIOTT, C.A. "Managing wildlife in your backyard and woodlot." Talk given to the Surry Garden Club, Surry, ME, November 8, 1989.

ELLIOTT, C.A. "Backyards and woodlands: How to attract more wildlife to your land." Talk given at the 52nd annual Maine Sportsmans Show, Orono, March 10, 1990.

ELLIOTT, C.A. "Managing forested land for wildlife." Talk given at Woodland Dollars and Sense: a New England workshop for forest land owners, April 5, 1990.

ELLIOTT, C.A. "Living the wildlife." Talk given to girls in Grades 6-8 at the conference Expanding Your Horizons, March 6, 1990.

ELLIOTT, C.A. "Bats in the belfry." Talk given to the Brewer Middle School, Brewer, ME., February 2, 1990.

ELLIOTT, C.A. "Forest and wildlife management." Talk given to forestry faculty, University of New Brunswick, Fredericton, January 25, 1990.

ELLIOTT, C.A. "Forest and wildlife management." Talk given to foresters with Valley Forests Products, Saint Anne Pulp and Paper Company, Millville, NB, January 25, 1990.

ELLIOTT, C.A. "A survey of animal damage and its control in Maine." Talk given at Who's Eating Whom, a workshop on agriculture damage by wildlife, Auburn, ME, May 9, 1990.

ELLIOTT, C.A. "A survey of animal damage and its control in Maine." Talk given at Who's Eating Whom, a workshop on agriculture damage by wildlife, Houlton, ME, May 10, 1990.

- ELLIOTT, C.A. "A survey of animal damage and its control in Maine." Talk given at Who's Eating Whom, a workshop on agriculture damage by wildlife, Bangor, ME, May 7, 1990.
- ELLIOTT, C.A. "Managing your woodlands for wildlife." Talk and field trip for the Forest Products Marketing and Management Association, Dover-Foxcroft Chapter of the Small Woodlot Owners Association of Maine, July 15, 1990.
- ELLIOTT, C.A. "Managing your woodlands for wildlife." Talk and field trip at the Yankee Woodlot Forestry Camp, Tanglewood 4-H Camp, Lincolnville Beach, ME, September 19, 1990.
- ELLIOTT, C.A. "Backyards and woodlands: How to attract more wildlife to your land." Talk given to the Dixmont Women in Extension, Dixmont, ME, June 21, 1990.
- ENAMA, M.T. "A study of buffalo and wildlife in Zaire." Talk given to members of the Student Chapter of The Wildlife Society, University of Maine, Orono, January 31, 1990.
- GIULIANO, W. "Pine marten research in Maine." Talk presented to Maine Trappers Association, Dixmont, ME, September 9, 1990.
- GRIFFITH, B. "Stochastic influences on population viability." Professional development lecture given at annual meeting of Maine Chapter, The Wildlife Society, March 26, 1990, Brewer, ME.
- HARRISON, D.J. "Coyote control strategies." 15-minute radio show for Canadian Broadcasting Network taped January 26, 1990.
- HARRISON, D.J. "Ecology and inter-specific relationships among Maine predators." Talk given to Dept. of Biology, Suffolk University, Boston, MA.
- HARRISON, D.J. "Careers in wildlife management." Talk given to Brewer High School Science Club, November 15, 1989.
- HARRISON, D.J. "Ecology and inter-specific relationships among Maine predators." Talk given to S. C. Friedman Field Lab, Dennysville, ME.
- HARRISON, D.J. "The controversial coyote in Maine." Segment filmed for MPBN's "Woods and Waters" program on coyotes, August 1989. Aired January 18 and 20, 1990.
- HARRISON, D.J. Participated in filming segment on coyote research in Acadia National Park as part of coyote documentary for National Geographic - Discovery Television Series, September 1989. To be aired in fall of 1990.
- HARRISON, D.J. "Spatial dynamics and inter-specific relationships among Maine predators." Talk presented to wildlife students and faculty at Unity College, Unity, ME, September 22, 1989.
- HARRISON, D.J. "Ecology of coyotes in Maine" - research results in a popularized version. Talk given on WDEA radio show, "Coastal Conservation." Aired November 24 and November 26, 1989.
- HARTLEY, R.A. "Delayed mortality of black basses following fishing tournaments." Talk presented to southern Maine bass clubs, Portland, April 14, 1990.
- HARTLEY, R.A. "Delayed mortality of black basses following fishing tournaments." Seminar presented as part of the Wildlife Department Seminar Series, University of Maine, Orono, March 20, 1990.

- HARTLEY, R.A. "Delayed mortality of black basses following fishing tournaments." Talk presented to meeting of Fisheries and Hatcheries Division, Maine Department of Inland Fisheries and Wildlife, Bangor, March 14, 1990.
- HARTLEY, R.A. "Delayed mortality of black basses following fishing tournaments." Seminar presented as part of Zoology Department Faculty/Graduate Student Colloquium, University of Maine, Orono, February 23, 1990.
- HARTLEY, R.A. "Delayed mortality of black basses following fishing tournaments." Talk presented to the Veazie Bass Club, Veazie, February 25, 1990.
- HARTLEY, R.A. "Delayed mortality in basses following tournaments." Talk presented to Maine bass clubs at State Bass Lottery, Augusta, January 9, 1990.
- HUNTER, M.L., JR. "Careers in environmental education." Talk given at Environmental Careers Conference, Boston, MA., October 21, 1989.
- HUNTER, M.L., JR. "A global approach to assuring the survival of people and other living things" and "What you can do to help the environment." Talks presented at the Southeast World Affairs Institute, Black Mountain, NC, July 29-30, 1990.
- KROHN, W.B. 1990. "Results of recent fisher research in Maine." (slide presentation given to furbearer biologists from northeastern USA and New Brunswick, Canada). Northeast Fisher Workshop, Concord, N.H. May 22, 1990.
- KROHN, W.B. "Recent findings from Maine fisher research." Slide presentation to the Board of Directors. Maine Trappers Association, Waterville, Maine. July 15, 1990.
- KROHN, W.B. "Ecology of eastern fishers." Slide presentation given to university, state, and federal personnel at Sierra Pacific Forest Industries, Redding, California, September 24-29, 1990.
- KROHN, W.B. "Ecology of the fisher in Maine." Slide presentation to Veazie Salmon Club, Veazie, Maine. March 20, 1990.
- KROHN, W.B. "Mission and organization of the U.S. Fish and Wildlife Service." Lecture given to Wildlife Policy class. University of Maine, Orono. March 1, 1990.
- KROHN, W.B. "Biology and status of Maine's eider ducks." (Slide presentation to Freshman Wildlife Seminar). University of Maine, Orono. October 4, 1989.
- KROHN, W.B. "Ecology of fishers in northern New England." Slide presentation given to the School of Natural Resources, University of Vermont, Burlington, October 25, 1990.
- KROHN, W.B. "Woodcock population and habitat trends." (Slide presentation to Forest Wildlife Management class). University of Maine, Orono. December 11, 1989.
- KROHN, W. B. "Overview of ongoing research at the Maine Cooperative Fish and Wildlife Research Unit." Talk to the management and research biologists of the Maine Dept. of Inland Fisheries and Wildlife, Rockland, Maine. December 12, 1989.
- MORING, J.R. "Ecology of rocky intertidal fishes." Seminar presented at the State University of New York - College of Environmental Sciences and Forestry, Syracuse, NY, April 24, 1990.

- MORING, J.R. "Restoration of Atlantic salmon." Talk presented to the Orono - Old Town Kiwanis Club, Orono, April 20, 1990.
- MORING, J.R. "Studies of intragravel and juvenile stages of Atlantic salmon." Talk presented to the Veazie Salmon Club, Veazie, Maine, February 22, 1990.
- MORING, J.R. "Restoration of Atlantic salmon and studies of intragravel and juvenile stages." Seminar presented at the State University of New York - College of Environmental Sciences and Forestry, Syracuse, NY, April 23, 1990.
- SAYERS, R.E., JR. "Great Lakes fisheries." Guest lecture presented to the Fishery Biology class, University of Maine, Orono, October 16, 1989.
- MORING, J.R. "Fishes of wetlands." Guest lecture presented to the Wetlands and Aquatic Biology class, University of Maine, Orono, September 12, 1990.
- MORING, J.R. "Smelt culture." Seminar presented at the State University of New York - College of Environmental Sciences and Forestry, Syracuse, NY, April 24, 1990.
- MORING, J.R. "Restoration of Atlantic salmon and studies of intragravel and juvenile stages." Seminar presented as part of the Wildlife Department Seminar Series, University of Maine, Orono, September 18, 1990.
- MORING, J.R. Presented summary of Unit bass studies in 1989 to a meeting of the Fisheries and Hatcheries Division, Maine Department of Inland Fisheries and Wildlife, Augusta, December 18, 1989.
- MORING, J.R. "Salmon and trout aquaculture." Guest lecture presented to the Aquatic Food Webs class, University of Maine, Orono, December 12, 1989.
- MORING, J.R. "Salmon and trout aquaculture." Guest lecture presented to the Aquaculture class, University of Maine, Orono, October 27, 1989.
- O'CONNOR, R.J. "Population ecology and migrancy in birds." Talk presented at Dept. of Biology Program in Ecology and Evolutionary Biology, Princeton University, Princeton, NJ, October 6, 1989.
- O'CONNOR, R.J. "Homage to St. Patrick or why there are so few bird species in Ireland." Talk presented to Department of Biological Sciences, SUNY, Albany, NY, November 30, 1989.
- O'CONNOR, R.J. "Population ecology of migrant and resident birds." Talk presented to Department of Biological Sciences, SUNY, Albany, NY, December 1, 1989.
- OWEN, R.B., JR. "Management of national parks in Africa." Talk presented to Orono Women's Group, Orono, ME, April 18, 1990.
- OWEN, R. B., JR., and W. B. KROHN, W. B. "An overview of avian research conducted by the Wildlife Program, University of Maine. (Invited slide presentation to professional biologists and avid birders). Maine Bird Conference. Farmington, ME. April 14, 1990.
- OWEN, R.B., JR. "Management of national parks in Africa." Talk presented to United Methodist Homemakers, Orono, ME, May 14, 1990.

- OWEN, R.B., JR. "Ecology of Maine bald eagles." Talk presented at Eastern Maine Sportsman's Show, Orono, ME, March 9 and March 10, 1990.
- OWEN, R.B., JR. "Wildlife management in East African parks." Talk presented to Orono Women's Association, Orono, ME, April 2, 1990.
- SCHOOLEY, R.L. "Habitat requirements for black bears: Management implications. Talk given to students enrolled in WLM 430, University of Maine, Orono, December 11, 1989.
- SUMMERS, M. "Wildlife in the forest: everything is somebody's food, every place is somebody's home." Talk presented to Winnie-the-Pooh Preschool, Bangor, ME, May 1, 1990.
- VANDERPOOL, A.M. "Radio tracking of salmon smolts." Talk presented to the Eddington Salmon Club, Eddington, ME, April 4, 1990.
- VICKERY, P. "Nondisruptive measures of reproductive success as applied to habitat quality and breeding success of 3 sparrows." Seminar presented to Department of Wildlife, University of Maine, Orono, February 27, 1990.
- WINTER, L. "Coyotes: adaptable, beautiful, and controversial." Talk given at the Pretty Marsh Community Center, Pretty Marsh, ME, June 16, 1990.
- WINTER, L. "Coyotes: adaptable, beautiful, and controversial." Talk given to Downeast Audubon Society at the Wendell Gilley Museum, Southwest Harbor, ME, June 21, 1990.
- WITHAM, J. "Managing for wildlife." Talk given to mid-coast chapter of SWOAM on tour of Holt Research Forest, Arrowsic, ME, April 28, 1990.

AWARDS HONORS, AND APPOINTMENTS

- DEVAUL, H. November 1989. Panelist in "Women in Science," College of the Atlantic, Bar Harbor, ME.
- DEVAUL, H. December 1989. Received George Dow Award from Maine Agricultural Experiment Station.
- GRIFFITH, B. May, 1990. National Wildlife Federation, 1990 Environmental Publication Award for "Translocation as a species conservation tool: status and strategy." *Science* 245:477-480.
- GRIFFITH, B. April 1990. Elected Treasurer of Northeast Section, The Wildlife Society.
- HARTLEY, R.A. October, 1989. Horace Bond Scholarship for Fisheries from the Penobscot County Conservation Association.
- HUNTER, M.L., JR. Appointed consultant to the White House Task Force on the Spotted Owl.
- HUNTER, M.L., JR. June 1990. Chaired "Strategic issues," a session at the meeting of the Society for Conservation Biology, Gainesville, FL.
- HUNTER, M.L., JR. October 1989. Achievement Award from Center for Environmental Interns, Boston, Massachusetts.

- MCLAUGHLIN, C.R.** Elected member of the International Association for Bear Research and Management Council, 1989-1992.
- MORING, J.R.** November 1989. Special Achievement Award from the U.S. Fish and Wildlife Service.
- MORING, J.R.** Graduate Coordinator for the Zoology Department, University of Maine.
- MORING, J.R.** President of the Northeastern Division of the American Fisheries Society and served on the Executive Committee of the American Fisheries Society and the American Fisheries Society Professional Certification Board of Appeals.
- O'CONNOR, R.J.** July 1990. Member of Steering Committee and of the Synthesis Subcommittee for the Population Ecology and Wildlife Toxicology of Agricultural Pesticide Use: A Modeling Initiative for Avian Species Conference, Kiawah Island, SC.
- O'CONNOR, R.J.** December 1989. Chaired "Population trends and distribution changes", a session of the Ecology and Conservation of Neotropical Migrant Landbirds Symposium sponsored by Manomet Bird Observatory, Manomet, MA.
- OWEN, R.B., JR.** March 1990. Judge for Maine Waterfowl Stamp Contest, Augusta, ME.
- OWEN, R.B., JR.** March 1990. Appointed by Maine's Bureau of Forestry to Technical Committee to draft Maine's new Forest Practices Law.
- OWEN, R.B., JR.** October 1989. Distinguished Lecturer, Virginia Polytechnical Institute and State University, Blacksburg, VA.
- OWEN, R.B., JR.** September 1990. Member of CSRS review team for the Forestry, Wildlife, Fisheries Program, Louisiana State University, Baton Rouge, LA.
- OWEN, R.B., JR.** June 1990. Appointed member of Nature Conservancy review team to determine research needs and management on Great Duck Island.
- PAUWELS, S.J.** April 1990. Roger Reed Best Student Paper Award at the Northeast Fish and Wildlife Conference.
- VICKERY, P.** September 1990. Appointed Counselor, Association of Field Ornithologists, Publisher - Journal of Field Ornithology.
- VICKERY, P.** Selected as 1990 Switzer Environmental Fellow and recipient of Switzer Environmental Leadership Grant for travel to ICBP and IOC meetings in New Zealand.
- WHITMAN, A.** December 1989. Received George Dow Award from Maine Agricultural Experiment Station.

