MAINE COOPERATIVE FISH AND WILDLIFE RESEARCH UNIT

University of Maine

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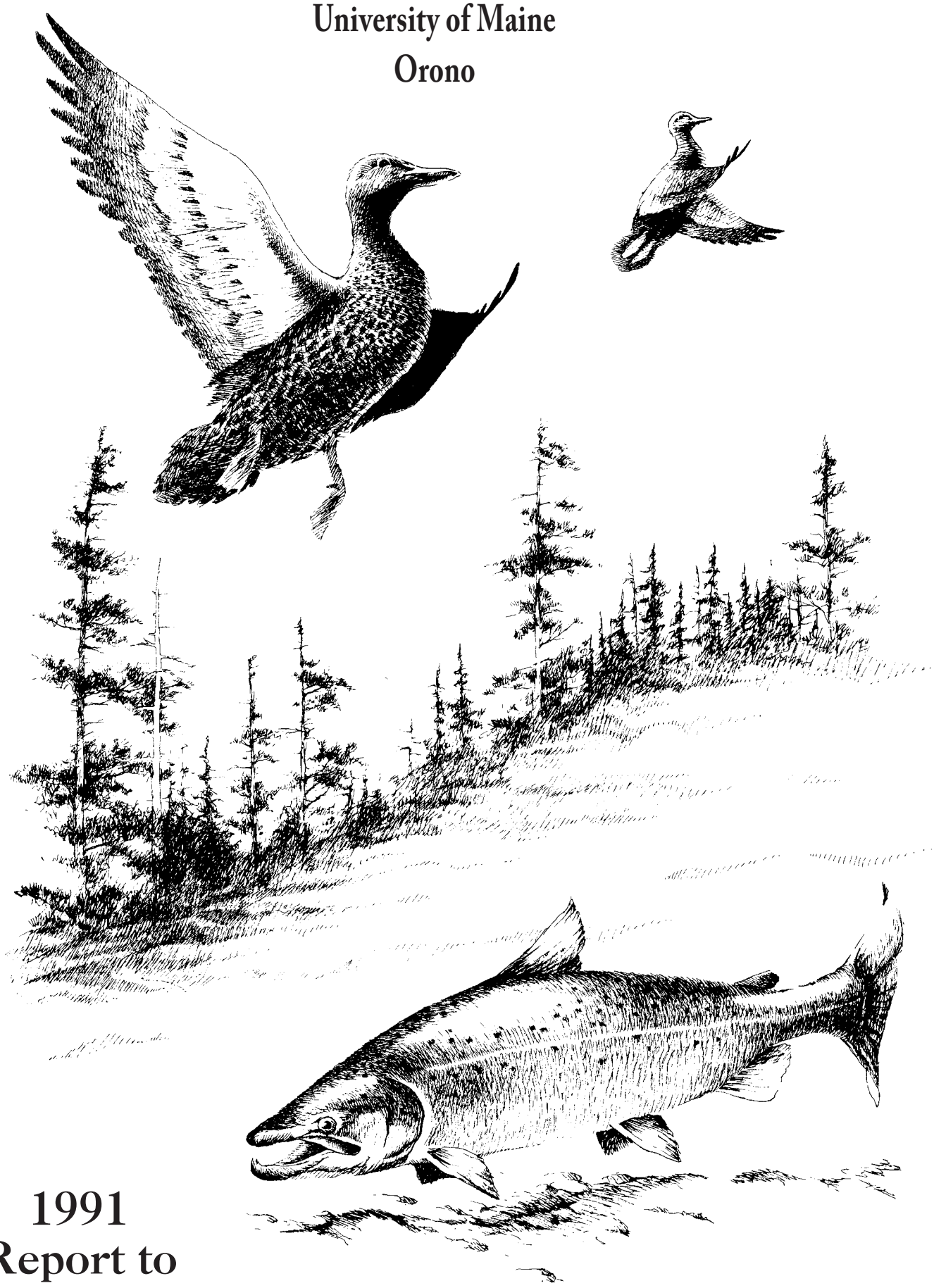

1991 Report to Cooperators

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 1990 - September 1991

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*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
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Bonnie G. Wood, Chairperson, Department of Zoology, College of Sciences

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

Wildlife Management Institute
Rollin D. Sparrowe, President

UNIT PERSONNEL

Unit Staff:

William B. Krohn, Unit Leader, Professor of Wildlife and Cooperating Professor of Zoology
John R. Moring, Assistant Leader for Fisheries, Professor of Zoology
Brad Griffith, Assistant Leader for Wildlife, Assistant Professor of Wildlife
Kathryn G. Hallett, Unit Secretary - Fisheries
Susan Anderson, Administrative Assistant - Unit and USFWS-NFCRC
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
William E. Glanz, Associate Professor of Zoology and Cooperating Associate Professor of Wildlife
Kevin J. Boyle, Associate Professor, Department of Agriculture and Resource Economics, and Cooperating Associate Professor of Wildlife
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Ruth W. Perry, Technician, Zoology
Elizabeth Moore, Research Assistant, Wildlife
Jack Witham, Assistant Scientist, Wildlife
Thomas Hodgman, Research Associate, Wildlife

Maine Department of Inland Fisheries and Wildlife:

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

GRADUATE STUDENTS

Name	Degree Candidacy	Support
Cathryn Abbott	M.S.	USFWS
Beverly A. Agler	M.S.	Personal Funding
Bradley Blackwell	Ph.D.	MCFWRU, USFWS

Randall P. Boone	M.S.	CPM
Merrie Cartwright	M.S.	MDIFW
Phillip de Maynadier	M.S.	McIntire-Stennis
Mustapha El Hamzaoui	M.S.	USAID/USDA
William E. Eschholz	M.S.	CFRU, MCFWRU
Herbert C. Frost	Ph.D.	MDIFW, MCFWRU
Brian Gray	M.S.	McIntire-Stennis
William M. Giuliano	Ph.D.	McIntire-Stennis, MDIFW
Stephen Glass	Ph.D.	ANP
Jaime Haskins	M.S.	Personal Funding
Susan Hills	Ph.D.	USFWS-AFWRC
Karen Hockett	M.S.	USFWS
Leslie Hudson	Ph.D.	UGA
Malcolm T. Jones	Ph.D.	CPM
Donald Katnik	M.S.	McIntire-Stennis
Charles Kitchens	M.S.	USFWS
Daniel H. Kusnierz	Ph.D.	DWRS, NBDNRE
T. Bruce Lauber	M.S.	CPM
Laurance Lisle	M.W.C.	Personal Funding
Thomas C. McCall	Ph.D.	Hatch, McIntire-Stennis
Karen McCracken	Ph.D.	U of M
Craig R. McLaughlin	Ph.D.	Personal Funding
Amanda Moors	M.S.	EPA
Deborah A. Moreau	M.S.	USFWS-NEAFL
Ramona Muller-El Hamzaoui	M.W.C.	Intl. Programs Office, CASS Project
Sara Oyler	M.S.	EPA
Kevin S. Raymond	M.S.	CFRU, MCFWRU
Tamia Rudnicky	M.S.	McIntire-Stennis, Personal Funding
Midori Saeki	M.S.	NPS
Steven L. Shepard	M.S.	Bangor Hydro-Electric
Sarah S. Stockwell	Ph.D.	Personal Funding
Marcia Summers	M.S.	Personal Funding (Grad. School Assistantship)
Oliver van den Ende	M.S.	USFWS-NEAFL
W. Matthew Vander Haegen	Ph.D.	U of M, USFWS (NEC, MNWR), PCCA, HWR, TBF
Agnes M. Vanderpool	M.S.	USFWS - NEAFL
Eleta J. Vaughan	M.S.	U of M
Christopher Vera	M.S.	Resource Conserv. Serv., Scott Paper Company
Peter D. Vickery	M.S.	NC, MAS, MPCB, MAAS, CB
Linda Welch	M.S.	USFWS
Scott Whitcomb	M.S.	ANP
Andrew A. Whitman	M.S.	U of M

DISSERTATIONS AND THESES COMPLETED THIS PERIOD

Student	Degree Candidacy	Support
Sarah T. Hooper	M.S.	McIntire-Stennis
Jill M. Ryan	M.S.	USFWS, U of M
Midori Saeki	M.S.	NPS
Todd R. Smith	M.S.	USFWS
Eleta J. Vaughan	M.S.	U of M

PERSONNEL NOTES

DR. BRAD GRIFFITH transferred to the Service's Alaska Fish and Wildlife Research Center as a Wildlife Biologist. Brad is now working on caribou in the Arctic National Wildlife Refuge.

MARYELLEN CHILELLI is an Assistant Wildlife Scientist and is completing the population viability modelling she and Brad initiated.

The Wildlife students that have graduated recently are: **SARAH HOOPER, M.S.** Sarah is now working for BLM at Lake Havasu, Arizona. **MIDORI SAEKI, M.S.** Midori worked part of the summer on the University's marten project and then flew to Oxford to work on a project that consisted of trapping badgers and wood mice. She will start working toward a D.Ph. at Oxford next spring. **ELETA VAUGHAN, M.S.** Eleta is hiking the length of the Appalachian Trail.

ELIZABETH MOORE was hired as a Research Assistant to work at the Holt Forest.

JILL RYAN received her M.S. in Zoology and took a job with the U.S. Fish and Wildlife Service in Virginia. **TODD SMITH** received his M.S. in Zoology and began work toward his Ph.D. at the University of Rhode Island. **DAN MCKINLEY** defended his M.S. thesis and returned to his job with the U.S. Forest Service in Vermont.

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
Hirundo Wildlife Refuge - HWR
Holt Woodlands Research Foundation - HWRF
International Paper Company - IPC
Kennebec Log Driving Company - KLDC
Maine Atlantic Sea-Run Commission - MASRC
Maine Audubon Society - MAS
Maine Department of Conservation - MDC
Maine Department of Environmental Protection - MDEP
Maine Department of Inland Fisheries and Wildlife - MDIFW
Maine Department of Marine Resources
Maine Pesticides Control Board - MPCB
Massachusetts Audubon Society - MAAS
Mobay Corporation - CPM
National Wildlife Federation - NWFD
Nature Conservancy - NC
    Maine Chapter - NC-MC
    NE Regional Office
New Brunswick Department of Natural Resources and Energy - NBDNRE
North American Wildlife Foundation -
    Delta Waterfowl & Wetland Research Station - DWRS

Penobscot County Conservation Association - PCCA
Scott Paper Company - SP
Taylor's Bait Farms, Inc. - TBF
The Nature Conservancy, Maine Chapter - MCTNC
University of Maine - U of M
    Association of Graduate Students - AGS
    College of Arts and Sciences - CAS
        Zoology Department - ZD
    College of Forest Resources - CFR
        Hatch Act Funds - HAF
        McIntire-Stennis - MS
    College of Applied Sciences and Agriculture
        Department of Agricultural Resource Economics
    Graduate School
U.S. Dept. of Agriculture - USDA/USAID
U.S. Environmental Protection Agency - EPA
U.S. Fish and Wildlife Service - FWS
    Alaska Fish and Wildlife Research Center - AFWRC
    Alaska Regional Office - ARO
    Moosehorn National Wildlife Refuge - MNWR
    National Ecology Center - NEC
    National Fisheries Contaminant Research Center - NFCRC
    National Fishery Research and Development Lab - NFRDL
    Northeast Anadromous Fisheries Research Laboratory - NAFRL
    Office of Information Transfer - OIT
    Patuxent Wildlife Research Center - PWRC
    Region 5, Federal Assistance - R-5, FA
    Region 5, Fish and Wildlife Enhancement - R-5, FWE
    Washington Office - WO
U.S. Forest Service - USFS
    Green Mountain National Forest
    White Mountain National Forest
U.S. National Park Service - NPS
    Acadia National Park
    Boston Regional Office

PROJECT REPORTS

ENDANGERED AND THREATENED SPECIES:

ANALYSIS OF FACTORS AFFECTING POPULATION VIABILITY OF BIRDS

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

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

Objectives:

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

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

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

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

PROJECT STATUS: 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 and game birds that are early breeders, with large clutches, in poor habitat.

From preliminary simulations, 3 points are suggested: 1) the definition of failure (e.g., 0 animals or only 1 sex 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 realistic estimates of population persistence if situation specific phenomena are not acknowledged.

A computer model, TRANSLOC, was developed to simulate the dynamics of small populations of birds (wild or translocated). Previously available simulation models did not incorporate the flexibility needed to adequately assess the validity of computerized population viability analysis in predicting the fates of small populations of wildlife species.

An extensive review of the literature has been completed (737 citations), providing estimates of field survival and fecundity rates for birds. This database will be used to stratify bird species by life history

strategy.

FUTURE PLANS: We will evaluate types of organisms (e.g., short lived, early reproducing birds and game mammals; long lived, late reproducing birds and mammals) using TRANSLOC. We will be looking at the influence of definition of failure (population persistence), reduced survival (and breeding) in year of release, age truncation, distribution curves for S.D. on vital rates (normal, lognormal, binomial), correlation in vital rates among different age/sex classes, and differences in population assessments evaluated at year 10 vs. year 50.

Bird species will be stratified by life history strategy using the completed database. Based on stochastic simulation modeling using TRANSLOC, we will identify population levels and vital rates indicating 50% probability of extinction within 50 years. Species groups will be ranked according to susceptibility to extinction.

The simulation model TRANSLOC will continue to be revised as the need arises. The final report will be completed by September 1992.

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

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

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

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

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

PROJECT STATUS: Our literature review of vital rates for mammals by life history strategy is continuing and will be used to stratify mammals by reproductive strategy, home range size, and area use patterns. Once this database is completed, we will use stochastic simulation modeling to evaluate extinction probabilities. Within strata, the simulations will evaluate the effect of founder population size, means and variances for survival and fecundity, and various population enhancement strategies (e.g., introductions). Special

emphasis will be placed on fisher. Based on these simulations, species groups will be ranked according to the potential for Acadia National Park to retain viable populations.

FINBACK WHALE PHOTOGRAPHIC IDENTIFICATION METHODOLOGY IN THE WESTERN NORTH ATLANTIC

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

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

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

Objectives:

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

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

PROJECT STATUS: 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 1992.

CONTAMINANT BURDENS AND REPRODUCTIVE RATES OF BALD EAGLES BREEDING IN MAINE

Investigator: L. J. Welch

Advisors: W. B. Krohn, Co-chairperson
R. B. Owen, Jr. Co-chairperson
T. A. Haines
K. C. Carr, Ex-officio
C. S. Todd, Ex-officio

Cooperators/ Project Support:
U.S. Fish and Wildlife Service -
R-5, FWE (Concord, NH, and Orono, ME Offices)
Maine Cooperative Fish and Wildlife Research Unit
Maine Department of Inland Fisheries and Wildlife
Maine Department of Marine Resources

Objectives:

1) Determine the production level of all known pairs of bald eagles breeding in Maine.
2) Evaluate relationships of contaminant residues in blood samples from nesting bald eagles with regional variations in eagle productivity, variable trophic status of the adults, and contaminant residues in prey from that area.
3) Determine correlations between mercury residues in feathers and prey items to blood levels of mercury in nestlings. Levels will be compared to individual nest site and regional productivity.
4) Identify the occurrence and residue levels of environmental contaminants in unhatched bald eagle eggs.
5) Determine the current deviation of eggshell thickness from the "pre-contaminant" era standard.
6) Determine correlations among contaminant residue levels in tissue samples obtained from eagle carcasses to time of exposure (age of the bird) and regional variations in productivity.

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

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

PROJECT STATUS: The first field season has been completed with a total of 63 nest sites were visited. Collections included 77 blood samples from 52 productive nests and 7 nonviable eggs. A total of 80 eaglets were banded. Breast feathers were collected from the eaglets and prey items were collected from in and around each nest site.

FUTURE PLANS: Blood and egg samples will be analyzed by USFWS Patuxent Analytical Control Facility. Prey remains will be identified. Field collections will be repeated.

FISHERIES RESOURCES:

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

Investigators:
K. J. Boyle
M. F. Teisl
S. D. Reiling

J. R. Moring

Cooperators/ Project Support: Maine Department of Marine Resources

Objectives:

1. Estimate the economic benefits of improved sport fisheries in the lower Kennebec River watershed with fish passage provided at Edwards Dam in Augusta, Maine.
2. Estimate the economic benefits of improved sport fisheries in the lower Kennebec River watershed with removal of Edwards Dam in Augusta, Maine.

SCOPE: Edwards Dam, on the Kennebec River in Augusta, Maine, 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 and overfishing, eliminated most runs of these 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. Furthermore, a 1987 "Agreement between the State of Maine and the Kennebec Hydro Developers Group" stipulates that fish passage will be provided on the Kennebec and Sebasticook rivers above Edwards Dam in Augusta. Edwards Dam is not part of this agreement, and the dam is due for relicensing. To provide economic data for the relicensing process, a survey of licensed Maine anglers was conducted to address two possible scenarios involving increased fisheries management practices: removal of the dam or provision for fish passage.

PROJECT STATUS: Project is completed. Economic valuation data were collected by administering a mail survey to three independent samples of anglers who held a Maine inland fishing license: 1) resident anglers from communities adjacent to the lower Kennebec River, 2) resident anglers from all other communities within Maine, and 3) nonresident anglers. A total of 810 anglers was randomly selected with each subsample containing 270 anglers. The final response rate to the mail survey was 72 percent for adjacent anglers, 60 percent for nonadjacent anglers and 67 percent for nonresidents. The most important finding is that the economic benefits accruing to sport fishing from removing the dam do not exceed the angling benefits from providing fish passage. The estimated aggregate annual benefit of improving sport fisheries in the lower Kennebec River via increased management and provision of fish passage is $1.49 million per year. The estimate is exactly the same whether fish passage is provided or Edwards Dam is removed. In addition, survey respondents' self-predicted, participation rates for an improved Kennebec River sport fishery are not significantly different according to whether fish passage is provided or the dam is removed. These findings lead us to conclude that provision of fish passage or removal of Edwards Dam each provide exactly the same sport fishing benefits to licensed Maine anglers.

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 were evaluated at Lac D'Or, Hirundo Wildlife Refuge: brush bundles, automobile tires, and cinder blocks. Three transacts in the pond each contained the three types of structures, and a fourth transect served as a control, without artificial structures. Weekly dives were made along each transect, with the number, species, and size of all associated fish noted. In addition, night dives examined 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 November 1990. Artificial reefs remained in place over the winter and were evaluated in June 1991.

Fishes rapidly colonized artificial habitats soon after their introduction and numbers of fishes were significantly higher around artificial reefs than with the control transect. Recesses in cinder blocks were almost always occupied by pumpkin seeds, while shiners associated with the outside of brush bundles and cinder blocks. Numbers of fishes associated with artificial cover were higher at night than during the day.

A Final Report was issued in December 1990, and the results of these investigations will be presented to the Maine Department of Inland Fisheries and Wildlife and at an International Artificial Reefs meeting in November 1991.

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 -
Green Mountain National Forest, Rutland, VT
White Mountain National Forest, Laconia, NH

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

SCOPE: Habitat surveys are an integral part of the fisheries management program on the U.S. National Forests (NF). These surveys are used to quantify existing habitat conditions, identify limiting factors, prescribe enhancement measures (where feasible), and integrate fish habitat management concerns with other proposed land uses (timber, recreations, etc.). This information may be used to develop prescriptions at both the NF level and project planning levels. The focus of the fisheries programs in the White and Green Mountain NF is Atlantic salmon restoration. At present, knowledge of existing habitat capability of most forest streams for this species is fairly general in nature and, in many instances, is unknown. There is a need to determine this capability, along with the identification of opportunities to enhance limiting conditions, where feasible. Therefore, there is a need for intensive habitat surveys on most of the steams 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. A Final Report was issued in January 1990. The investigator has taken a position with the U.S. Forest Service and has successfully defended his thesis. The thesis is expected to be completed in 1991.

FUTURE PLANS: A final thesis is being prepared.

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, *Cryptocotle lingua*.

PROJECT STATUS: Experiments with movements of juvenile grubbies, shorthorn sculpins, and lumpfish are ongoing. In addition, two papers were published in 1991.

FUTURE PLANS: Work dealing with intertidal movements of sculpins will continue in 1991, along with experiments on Atlantic seasnail feeding and innovative fish marking techniques. At least one seminar is scheduled, and several manuscripts are being prepared.

MOVEMENTS AND SPAWNING SUCCESS OF DISPLACED LARGEMOUTH BASS

Investigator: M. A. Cartwright

Advisor: J. R. Moring, Chairperson

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

Objectives:
1) To document fate of eggs and fry of largemouth bass in the absence of the male from the nest.
2) To measure movements and document homing behavior of displaced largemouth bass.

SCOPE: Little is known of the movement patterns of largemouth bass in boreal environments. In particular, it is not known whether displaced bass are able to return to original points of capture or, if so, how quickly they are able to return. In addition, the angling season is open during the spawning season for bass. There is evidence for smallmouth bass that, when the adult is removed from the nest and eggs or fry are unprotected, mortality can be extremely high. There are no studies concerning largemouth bass, particularly in boreal waters. Radio tags will be placed on captured largemouth bass to determine movements. Males will be temporarily removed from nests during the spring spawning period and the fate of offspring will be documented using video cameras.

PROJECT STATUS: The project is just beginning. Field work will begin in 1992. Thesis completion is expected by May 1993.

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

Investigator: A. M. Vanderpool

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

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

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. The first two years of work involved radio tracking and recommendations for smolt traps. The second two years 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 videotape counting unit was borrowed from the Atlantic Sea-run Salmon Commission and was used with one of the self-release ponds at the West Enfield facility, along the Penobscot River, to track migration times of stocked smolts in 1991. New, smaller tags, externally attached, were used with one-year-old smolts in Spring 1991, and tracked by airplane. Movements were rapid in April, but minimal in May. Some fish were tracked around dams, but most contacts ceased prior to fish reaching the lower river, either due to battery failure or predation. Four papers and one seminar were presented.

FUTURE PLANS: All field work has been completed, and a thesis draft has been prepared. The M.S. degree is expected in December 1991.

UPSTREAM MIGRATION OF ATLANTIC SALMON IN THE PENOBSCOT RIVER

Investigator: S. L. Shepard

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

Cooperators/ Project Support: Bangor Hydro-Electric Company

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

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

PROJECT STATUS: Salmon have been tagged and monitored in 1990 and 1991, and additional monitoring is planned.

FUTURE PLANS: Additional tagging of adult salmon is planned for fall 1991. An M.S. thesis is expected in December 1992.

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

Investigator: D. A. Moreau

Advisors: J. R. Moring, Chairperson
D. L. Parrish
J. G. Trial

H. B. Dowse

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

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

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

PROJECT STATUS: Data on adult holding areas were collected from observations of Atlantic salmon on the Dennys River, near Dennysville, Maine during summer 1990. Because of the relatively low numbers of salmon entering the smaller rivers in Maine, additional measurements of salmon were made in streams in New Brunswick in August 1990, and during May-October 1991. A model will be developed and tested in the Ducktrap River in 1991.

FUTURE PLANS: Field work has been completed and the model will be refined during winter 1991-92. Expected date of M.S. completion is March 1992.

FISH PREDATORS OF ATLANTIC SALMON IN THE PENOBSCOT RIVER

Investigator: O. van den Ende

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

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

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

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

PROJECT STATUS: The project is just beginning. Field work will begin in spring 1992. Thesis completion is expected in May 1993.

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

Investigator: K. S. Hockett

Advisor: J. R. Moring, Chairperson
Committee being developed

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

Objectives:

1) To document the availability of salmon smolts to potential predation by cormorants in the Penobscot River.
2) To monitor fish passage routes and timing in the lower Penobscot River, particularly around dams.
3) To record cormorant activity in forebays above dams in relation to feeding.

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

PROJECT STATUS: The project is just beginning. Field work will begin in spring 1992. Thesis completion is expected in May 1993.

HABITAT RESOURCES:

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

Investigators: K. J. Boyle, Assoc. Professor
S. D. Reiling, Assoc. Professor
M. F. Teisl, Asst. Scientist
M. L. Phillips, Graduate 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: Project completed. Total economic values were estimated for consumptive and nonconsumptive uses of Maine's fish and wildlife resources by residents and nonresidents of Maine.

* The total economic value of inland fishing in Maine is at least $300.7 million and does not exceed $494.2 million.

* The total economic value of marine sport fishing in Maine is estimated to be at least $135.4 million and does not exceed $274.5 million. These estimates must be interpreted with caution given difficulties in developing representative samples of resident and nonresident marine, sport anglers.

* The total economic value of hunting in Maine is at least $183 million and does not exceed $291 million.

* A total economic value was not estimated for trapping. The minimum economic impact of resident trapping is at least $1.5 million and does not exceed $3.4 million.

* The minimum total economic value of nonconsumptive uses of Maine's wildlife resources is $55.4 million. Nonconsumptive uses, for the purposes of this report, are defined as any activity where a person enjoys wildlife in its' natural habitat but the creatures are not removed from the wild.

* Given the figures reported above, the total economic value for selected wildlife-related activities in Maine is at least $676.7 million.

Management Recommendations

Selected management recommendations were offered to resource management agencies. These recommendations were designed to enhance the utilization of the fish and wildlife resources of the state, and thereby increase the aggregate economic impact and aggregate surplus values these resources generate in Maine. These recommendations should be considered in the development and modification of fisheries and wildlife management plans.

Inland Fishing

* The Department of Inland Fisheries and Wildlife should work closely with other state agencies to protect the scenic quality of Maine's water bodies. Future development should not detract from scenic quality.

* Efforts to expand fishing effort for warm water fish species should be increased to more fully utilize this valuable resource. This effort should focus on nonresident anglers as they are more inclined to fish for warm-water species and because nonresidents have a larger economic impact on the State's economy.

Marine Fishing

* The Department of Marine Resources should consider the implementation of a recreational marine fishing licenses for Maine.

Hunting

* The Department of Inland Fisheries and Wildlife should publicize key management actions designed to improve the quality of the hunting experience. This program should be designed so that information will reach all current and potential resident and nonresident hunters, not just well organized special interest groups of hunters.

* To the extent possible, the Department of Inland Fisheries and Wildlife should set the deer, moose and bear seasons to minimize the overlap among the three seasons for these species.

* The Department of Inland Fisheries and Wildlife should develop reasonable policies to reduce conflicts among bear hunters who use dogs and bear hunters who do not use dogs.

* The Department of Inland Fisheries and Wildlife should continue to develop management plans to maintain current opportunities of deer hunting in Maine.

* The number of moose hunting permits issued each year should be increased. Biological data should be used to determine the number of permits issued.

Nonconsumptive Uses

* The Department of Inland Fisheries and Wildlife should develop educational materials for distribution to residents interested in learning more about different species of wildlife. Materials, describing opportune times and viewing locations, should also be developed and distributed upon request.

* Management plans should reflect the importance of nonconsumptive uses of deer, bears, and moose. Management actions should be taken to enhance the nonconsumptive use of these species.

All Program Areas

* The Department of Inland Fisheries and Wildlife develop an organized program to increase information and education about the resources it manages. This program should be designed to reach the average Maine resident.

Since the recommendations described above are based on economic data and the preferences of the users of the resources, they must be evaluated in light of biological and ecological information about the resource.

DISTRIBUTION OF SONGBIRDS IN RIPARIAN FORESTS OF CENTRAL MAINE

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.

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

I investigated the relative influences of distance from streams and vegetation structure on distributions of songbirds in riparian forests of Maine in 1989-1990. I surveyed 24 riparian sites in 1989 and 18 sites in 1990, classifying each site as either upland or floodplain riparian forest. Upland forests (21 sites) were well-drained, coniferous or deciduous forests, adjacent to a stream or river, and were similar in vegetation structure to non-riparian forests. Flood plain forests (8 sites) were poorly drained, deciduous forests, often with standing water. At each site, I censused breeding birds and measured 14 vegetation variables along transects at 6 distances from streams: 25 m, 75 m, 125 m, 175 m, 225 m, 275 m. The distributions of songbirds among these 6 distances were compared between upland and floodplain forest types, with the null hypothesis that species richness and numbers of songbirds would not vary with increasing distance from streams (i.e., no "riparian effect").

Patterns of songbird distribution differed between upland and floodplain forests. Species richness showed no strong trends with distance in upland forests. In floodplain forests, species richness decreased from 25 m to 125 m from streams; >125 m from streams, no differences were evident in species richness. I detected similar distribution patterns relative to distance from streams for total individuals in each forest type.

Forty-eight percent of the songbird community occurred within both forest types. All songbird species detected in my study occur in other habitats in central Maine. Interior species dominated in upland forests, while edge species dominated in floodplain forests. Number of individuals of edge species decreased with distance from streams in floodplain forests, but were independent of distance in upland forests. Number of individuals of interior species were independent of distance in both forest types.
Upland forests, dominated by conifers, large trees, and closed canopy, formed abrupt interfaces with streams, and vegetation did not vary with distance from streams. Floodplain forests, dominated by more open canopy, smaller trees, and many deciduous shrubs, provided a transitional habitat, with conifers increasing ≥ 175 m from streams. Songbirds were significantly associated with variations in vegetation among sites and between the 2 forest types.

I detected no riparian effect for species richness or total individuals of songbirds in upland forests of central Maine. This directly contrasts conditions in the southwestern U.S., where the presence of riparian forests significantly increases regional songbird diversity. A riparian effect was evident in floodplain forests in my study; however, the increase in songbirds was primarily generalist species. My study neither adequately addressed reproductive or foraging success of songbirds, nor life requirements of non-passerine

bird species in riparian forests of central Maine.

Using prerecorded bird songs representing 2 song volumes and 4 song patterns, I conducted a test near 4 "loud" streams and 4 "quiet" streams to determined if noise created by streams affected my ability to detect singing male birds at 3 distances: 25 m, 75 m, and 125 m. I heard all songs played at 25 m from quiet streams, and at distances $\geq$75 m from both quiet and loud streams. I heard >95% of songs played at 25 m from loud streams. Results of this test indicated that I probably missed few, if any, birds during my censuses because of stream noise.

DISPERSAL OF ACORNS OF NORTHERN RED OAKS, QUERCUS RUBRA, BY BLUE JAYS, CYANOCITTA CRISTATA, IN CENTRAL MAINE

Investigator: E. J. Vaughan

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

Cooperators/ Project Support: University of Maine
Personal Funding

Objectives:
1) To determine the number of acorns dispersed and the habitat types to which blue jays disperse northern red oak acorns.
2) To determine the rates of overwinter survival and germination of cached acorns.

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

Acorn dispersal by blue jays from a stand of 111 northern red oak trees was studied near Blue Hill, Maine in 1988, a poor acorn crop year, and in 1989, a relatively good acorn production year. Ten times more acorns were produced in 1989 (128,339) than in 1988 (11,792). The proportion of acorns that were viable differed significantly (1.2% in 1988 and 55.2% in 1989). Acorn dispersal was synchronized with acorn production in the stand, which was one month earlier in the poor year (dispersal ended on Oct. 7, 1988 and Nov. 6, 1989).

The overwintering blue jay population was estimated to be 51 to 71 jays. Blue jay dispersal activity was not constant over the dispersal period nor throughout the day. The greatest rate of dispersal activity was near the end of the dispersal period (four days before the end of dispersal in 1988 and one day before in 1989). The greatest hourly dispersal activity occurred approximately three hours after sunrise. Blue jays flew fewer dispersal trips than has been observed in other blue jay dispersal studies (an estimated 23 to 37 trips per jay) and the mean number of acorns dispersed per tree was low (10.8 in 1988 and 15.2 in 1989). Blue jays did not disperse acorns from three trees with larger acorns than those in the stand and may select trees with smaller acorns.

The estimated number of acorns dispersed was similar in both years (1197 in 1988 and 1686 in 1989), but the proportion of the viable crop dispersed significantly differed (90.4% in 1988 and 2.4% in 1989). Dispersed acorns had a greater rate of survival than nondispersed acorns because overwinter survival of nondispersed acorns was low. Few, if any, acorns survived in the stand of 1988, while 1.4% of the viable crop survived until May 1989. A significantly greater number of seedlings few in fields than in forests and first year seedlings in fields had significantly greater height and number of leaves than first year seedlings in forest.

Fourteen percent of acorns dispersed by blue jays were cached in or beside fields in environments that are favorable for oak establishment. Although 82% of dispersed acorns were taken into forest where low light conditions may cause high seedling mortality, blue jays may still favor of oak regeneration by increasing acorn survival overwinter and by placing some seedlings in edge habitat or canopy gaps. Blue jays in Maine clearly have the potential to facilitate oak establishment.

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

Investigator: T. C. Rudnicky

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

Cooperators/ Project Support: McIntire - Stennis

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

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

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

PROJECT STATUS: All field work and analyses have been completed. Thirty-four cuts were censused in 1990 compared with 45 from 1989, however the number of plots were similar (180 plots in 1990; 198 plots in 1989). Analyses of bird censusing data shows similar patterns in both years. White-throated sparrows, common yellowthroats, and chestnut-sided warblers were the most common species in all clearcuts sampled and the top eight species (those that occurred in >40% of all plots sampled) showed similar rankings. Sixty-four species were censused in 1989 and 54 species were censused in 1990. Analysis of data from both years showed no significant relationship between rare species (birds counted ≤ 2 times during the field season) and clearcut size. Species richness increased with clearcut size but the number of species present per plot did not differ significantly over the size range of cuts (eg. 2-ha, mean=8; 107-ha, mean=9). Visual inspection of the data between 2 and 20 ha suggested a positive area effect up to 20 ha, after which cut size did not affect species richness. Bird species locations throughout clearcuts were largely independent of distance from the forest edge.

Nest predation experiments were run in June and July of 1990 and July of 1989. Quail eggs and

nests were exposed for 7 days in 1989 and for 14 days each in June and July 1990. In July 1990 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 were similar for both years with clearcuts experiencing significantly 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 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. Neither size of the clearcut nor forest tract size exhibited a consistent relationship with predation intensity.

FUTURE PLANS: Complete thesis revisions and graduate in December 1991.

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 Chapter of The Nature Conservancy
Maine Department of Inland Fisheries and Wildlife

Objectives:

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

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

The Kennebunk Plains, 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: For the past eight years I have examined the process of avian habitat occupancy on a dry grassland in southern Maine. To learn which habitat features are most important to these birds, I have measured bird densities and vegetation on eight large plots (8-24 ha.) that have been manipulated by fire and

herbicide treatments. Not surprisingly, each species occupies slightly different microhabitats described in a unique set of habitat variables. For example, breeding densities of Grasshopper Sparrows (*Ammodramus savannarum*), Savannah Sparrow (*Passerculus sandwichensis*), Bobolink (*Dolichonyx orizivorus*), and Eastern Meadowlark (*Sturnella magna*), all declined significantly in lots that were sprayed with herbicide. Graminoid, forb, and shrub cover in these herbicide-treated plots were significantly lower than control plots.

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

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

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 1990, tasks 3, 4, 5, 6, 7, 8, 9, and 10 as outlined above, were completed, and a study investigating the structure of tree fall gaps, ledge openings, and patchcuts and how they influence predation on bird nests was continued.

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

EFFECTS OF ACID PRECIPITATION AND HEAVY METALS ON FISHES OF THE NORTHEASTERN UNITED STATES

Investigators:
J. M. Ryan
T. R. Smith
C. C. Abbott
T. A. Haines
R. W. Perry

Advisors:
T. A. Haines, Chairperson (for Ryan, Smith, Abbott)
I. J. Fernandez
J. D. McCleave
S. A. Norton
J. R. Moring

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

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

SCOPE: Acid precipitation and levels of mercury are 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, and a field station is used to monitor mercury impacts on survival and growth of salmonids.

PROJECT STATUS: Two projects were completed during the year, and a new project dealing with mercury impacts, just began.

FUTURE PLANS: Field work for the new project will begin in 1992. The requirements for the degree of Master of Science in Zoology have been completed for two students. The abstracts follow:

Mercury in the Environment and the Implications for Brook Trout (*Savelinus fontinalis*): Fish from acidic and soft waters around the world have been found to have elevated concentrations of mercury in relation to fish from more neutral waters, which is a concern for both humans and wildlife consuming these fish. The role of acidification in mercury biogeochemistry was investigated by use of paired watersheds, one a control, and the other manipulated with ammonium sulfate. Native brook trout (*Salvelinus fontinalis*) were held in cages for six month periods in both watersheds and then analyzed for whole-body mercury content. In addition, mercury was measured in precipitation, soil, soil water, and stream water.

Precipitation mercury concentration (rain: 5.52 $\pm$ 0.30 ng/l total, 0.18 $\pm$ 0.025 ng/l methyl, sleet:

13.38 hg/1 total, 0.13 ng/1 methyl) are within the range generally found for the New England coast (3 to 17 ng/1 total). Soil average total mercury concentrations were found to be higher in the O horizon (0.237 $\pm$ 0.103 μg/g) than the B horizon (0.103 $\pm$ 0.047 μg/g), as were soil water concentrations; O horizon (3.786 $\pm$ ng/1 total, 0.0253 $\pm$ 0.0136 ng/1 methyl) and B horizon (2.03 $\pm$ 2.04 ng/1 total, 0.0203 $\pm$ 0.0119 ng/1 methyl). Mercury concentration did not vary significantly between streams (means: 1.007 $\pm$ 0.902 ng/1 total, 0.0201 $\pm$ 0.029 ng/1 methyl). Fish mercury concentrations did not differ significantly between the streams, or between pretreatment fish (mean: 0.297 $\pm$ 0.147 μg/g) and those harvested in May (mean: 0.291 $\pm$ 0.054 μg/g), but those harvested in November were significantly higher (mean: 1.045 $\pm$ 0.205 μg/g). After the first year of manipulation of the watershed, no difference is seen in mercury concentrations either in the environment or in the fish. However, there appears to be a significant seasonal effect on the mercury concentrations found in the fish held in the streams.

Response of Brook Trout (*Salvelinus fontinalis*) and Atlantic Salmon (*Salmo salar*) Exposed to Low pH With and Without Aluminum: Brook trout (*Salvelinus fontinalis*) are relatively resistant to the combination of increased acidity and an elevated concentration of aluminum, in contrast to Atlantic salmon (*Salmo salar*), which are less tolerant of such conditions. The swimming behavior of brook trout and Atlantic salmon was measured to quantify the responses of the two species to a 30d exposure to pH≈5.6 with and without aluminum (mean conc.=107 μg exchangeable Al/L). Swimming activity in the presence and absence of food was used as the measure of swimming behavior. Growth, mortality, and gill morphology were recorded as additional measures of toxicity. Brook trout and Atlantic salmon were used for the theoretical value of comparing a tolerant versus a sensitive species, and for the information that could be gained on the behavior of two regionally important species. Only the Atlantic salmon exposed to increased acidity and aluminum had significantly decreased growth, and increased mortality. In the acid plus aluminum exposure there was slight morphological damage to brook trout gills and massive damage to Atlantic salmon gills. There was no difference between Atlantic salmon feeding and non-feeding activity. However, both measures of swimming behavior were decreased in Atlantic salmon exposed to acid, only to acid plus aluminum. Brook trout swimming behavior was also affected by exposure to both acid only and acid plus aluminum. Non-feeding and feeding acid-exposed trout were hyperactive relative to the control fish. Non-feeding trout exposed to acid plus aluminum had decreased activity, whereas feeding trout exposed to the same conditions were hyperactive. These results show that a small, chronic decrease in the pH of a stream can alter the behavior of these two fish species, and that brook trout behavior is affected by mild decreases in pH and increases in exchangeable aluminum. These changes in swimming activity have implications for the entire spectrum of fish behaviors, and therefore also for the ecology of brook trout and Atlantic salmon.

FRUGIVORY AND SEED DISPERSAL IN OAK-PINE FOREST

Investigator: A. A. Whitman

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

Cooperators/ Project Support: Holt Woodlands Research Foundation
Association of Graduate Students
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 *Vaccinnium 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 winter 1991.

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

Investigator: C. J. Vera

Advisors: F. A. Servello, Chairperson
W. E. Glanz
R. J. O'Connor

Cooperators/ Project Support: Resource Conservation Services, Inc.
Scott Paper Company

Objectives:

1) Determine the effects of landspreading pulp and paper mill sludge on the density, diversity, and species composition of breeding birds.
2) Determine the effects of landspreading pulp and paper mill sludge on the relative abundance, diversity, and species composition of small mammals and amphibians.

(3) Determine the effects of landspreading pulp and paper mill sludge on invertebrate abundance and vegetative species composition and structure and examine the relationships of these effects with breeding bird, small mammal, and amphibian population changes.

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

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

PROJECT STATUS: Eight 8-10 ha study sites were selected in western Maine, based on vegetative composition and structure, forest management history, and soil type. Pulp and paper mill sludge was applied to the 4 treatment sites in fall 1991.

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
R. L. Dressler

Cooperators/ Project Support: McIntire-Stennis

Objectives:

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

SCOPE: Mature spruce-fir forest stands are critical winter habitat for white-tailed deer (*Odocoileus virginianus*) in Maine. The high value of timber on these sites provides an opportunity to integrate the management of timber resources and deer wintering habitat. However, the relative value of timber harvesting methods for improving shelter and foraging habitat for deer in wintering areas is poorly understood. Assessing the value of timber harvest relative to deer nutrition requires an understanding of

forage quantity and quality variation in wintering areas and its relationship to deer nutritional limitations. The purpose of this project is to assess diet quality in wintering areas and to determine limitations of deer for using poor quality winter diets.

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

FUTURE PLANS: Complete thesis in January 1992.

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

Investigator: W. E. Eschholz

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

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

Objectives:

1) Determine if intensity of clearcut use by moose differs between glyphosate treated and untreated stands 1-2 years post-treatment and 7-10 years post-treatment.
2) Determine the effects of landscape-scale habitat characteristics on moose habitat use in glyphosate treated and untreated stands.
3) Determine the effects of browse availability and stand characteristics on moose use of glyphosate treated and untreated stands.
4) Evaluate the validity of using tracks/ha, track aggregates/ha, and track aggregate size from aerial surveys to estimate intensity of use by moose in clearcuts.

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

PROJECT STATUS: Twelve 20 to 80 ha regenerating clearcuts scheduled for glyphosate treatment were selected for study of 1-2 year post-treatment effects (short-term effects). Sites were paired based on size, surrounding habitat, site characteristics, and harvest dates. Twenty-eight older sites (17 treatment and 11 control) were selected based on size, surrounding habitat, site characteristics, harvest date, and glyphosate treatment date. These will be used for study of 7-10 year post-treatment effects. Pre-treatment aerial and ground surveys of moose and moose tracks were completed in winter 1991. Six aerial surveys were flown

on 6 long-term sites. Ground surveys were performed on subsequent days to evaluate the validity of aerial surveys. In summer 1991, 6 short-term sites (one of each pair) were treated with glyphosate. Preliminary analysis of track counts and stand characteristics is underway.

FUTURE PLANS: Moose habitat use surveys will be conducted on all sites in winter 1991-92 and 1992-93. Browse availability and stand characteristic data for all sites will be available from a concurrent study on these sites.

EFFECTS OF GLYPHOSATE ON WINTER NUTRITIONAL ECOLOGY OF MOOSE IN MAINE

Investigator: K. S. Raymond

Advisors: F. A. Servello, Chairperson
W. B. Krohn
J. R. Gilbert

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

Objectives:

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

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

PROJECT STATUS: Twelve 20 to 80 ha regenerating clearcuts in the Moosehead Lake region were selected in fall 1990 to study 1-2 year post-treatment effects. Clearcuts were selected and paired based on harvest date, site characteristics, location, size, and surrounding cover. Pre-treatment data on availability and utilization of 11 major browse species were collected on these sites during January-March 1991. One site from each pair was subsequently sprayed with glyphosate during August 1991. Nutritional analysis of browse samples collected during the vegetation sampling was conducted during april-September 1991.

To examine effects 7-10 years post-treatment, 17 treated and 11 untreated control sites were selected in summer 1991.

FUTURE PLANS: Nutritional analyses for year 1 of the study will be completed in fall 1991. Post-treatment field studies of browse availability and utilization and laboratory studies of browse quality will be conducted in 1992 and 1993.

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

Investigator: C. A. Elliott

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

Objectives:

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

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

PROJECT STATUS: Two study areas are being used, each with a treatment block containing a planned skip and a control block with no planned skips. Planned skips are approximately 100 m by 200 m (2 ha).

Spot-mapping of songbirds was conducted in June on plots of 150 to 200 m by 250 m. Small mammals were trapped for four nights in July on a 7x9 grid of traps 10 m apart. Two snap traps were located at each grid point, and a pitfall trap was located at every third grid point. Small mammal trapping will be repeated in October. During winter, track counts of deer and moose will be conducted to determine if planned skips are used more or less than other portions of the cuts.

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

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

Investigator: T. P. Hodgman

Cooperators/ Project 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 pine martens (*Martes americana*) has offered some protection from overexploitation. However, continued construction of logging roads has provided marten trappers with access to previously inaccessible areas. Past studies on the effects of trapper access on Maine's marten

harvest did not account for misreporting the location of capture nor the spatial arrangement of habitat types and forest roads. To overcome these limitations, towns will be grouped by geographic region; marten harvest, trapper access, and habitat data will be summarized by these township clusters. Also, a supervised classification of a 1986 Landsat TM image ("leaf on") will be used to identify habitat types. This classification will be part of a GIS, which also includes roads and township borders for approximately 75 townships in northern Maine. After removing the area occupied by unsuitable marten habitat (i.e., water, clearcut, etc.) in each township cluster, comparisons will be made between the harvest of marten and the amount and spatial arrangement of forest roads and habitat types.

PROJECT STATUS: Satellite imagery was georectified and supervised (maximum likelihood classifier) and unsupervised (paralellopiped classifier) classifications were performed. Both classifications were ground-checked and the number of cover classes has been recoded based on limitations revealed during ground-truthing. Image processing is now nearly complete. An improved version of the roads files, in Erdas' DIG format, was obtained from Georgia Pacific Corp. for their timberlands. These data encompass approximately 2/3 of the study area and require only minor editing. A file containing township borders in ARC-INFO format also was obtained. All spatial data have been clipped to coincide with the boundaries of the study area.

FUTURE PLANS: Only minor modifications need to be made to the classified image. Assembling the road database is the next major objective. Landowners will be asked to provide maps and/or photos for their lands inside the study area. This material will be used to edit existing digital road files. Analysis of harvest, access, and habitat data will be performed in 1992.

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

Investigator: K. E. McCracken

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

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

Objectives:
1) Estimate rates of removal of seeds of three species of trees by small mammals in five habitat types.
2) Compare relative rates of removal by "small" rodents (mice and voles) to "large" rodents (chipmunks and squirrels).
3) Investigate effects of lunar cycle on the foraging behavior of small nocturnal animals.

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

forest in southern Maine.

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

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

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

FUTURE PLANS: Removal rates of northern red oak (*Quercus rubra*) and white pine (*Pinus strobus*) seeds will be similarly monitored during mid-October. Data analysis has begun. Similar data collection will continue in 1992.

FOREST FRAGMENTATION AND CARRIERS TO WILDLIFE DISPERSAL

Investigator: P. de Maynadier

Advisors: M. L. Hunter, Jr., Chairperson
Committee being developed

Cooperators/ Project Support: Maine Agricultural Experiment Station
Penobscot Experimental Forest

Objectives:

1) Determine the importance of anthropogenic barriers to the dispersal of amphibian and small mammal populations.
2) Investigate the role of forest corridors of varying quality to amphibians.
3) Evaluate the importance of habitat-barrier contrast gradients to the movement of small mammals.

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

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

PROJECT STATUS: A field methodology for releasing and measuring the dispersal of juvenile wood frogs was developed and tested in two control (continuous forest) and two treatment sites (gravel road barriers) in July and August of 1991. Approximately 5000 wood frog tadpoles were raised for the pilot study. Project

materials for drift-fence construction (four treatments and four replicates) and tadpole farming have been acquired and stored until the 1992 season.

Pilot data from the summer's work indicates that a continuous drift-fence at 50 m diameter is an effective method of monitoring juvenile wood frog dispersal from artificially created forest ponds. Recapture rates ranged from ≈15-40% which should be sufficient to determine the significance of tested barriers. Survival and recapture rates for forest-captured froglets used in our ponds were higher than those for farm-raised froglets. Preliminary analysis of pilot data indicates that even forest roads with low traffic may inhibit the movement of wood frog juveniles. However, it is also clear that experimental site selection is critical since even small differences in micro-topography on either side of a barrier may bias the results (i.e., wood frogs tend to follow drainages).

Methods for live-trapping and measuring small mammals were studied in the Holt Research Forest in early August. In late August two small-mammal trapping grids were established along forest roads and animal movements monitored through mark and recapture. The pilot data will be examined to help determine future sample sizes and grid methodology.

FUTURE PLANS: The plan of study will be formalized and reviewed by a committee. Study sites will be chosen and amphibian eggs will be collected for raising during the winter and early spring, respectively. The first of two full field seasons of data collection will begin in the summer of 1992.

COMPREHENSIVE MANAGEMENT STRATEGY FOR FUTURE RESEARCH AND MANAGEMENT OF MOROCCAN COASTAL WETLANDS

Investigator: M. El Hamzaoui

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

Cooperators/ Project Support: USAID

Objectives:

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

SCOPE: Moroccan coastal wetlands are both extremely valuable and extremely vulnerable natural habitats. They are used extensively by the human populations surrounding the sites, as well as by migratory birds which use the sites for breeding or staging prior to crossing the Sahara Desert. Several of the sites being investigated are RAMSAR Convention sites.

Continued human and wildlife use of these coastal wetland ecosystems will result in more intensive conflicts as environmentalists try to remove these areas from human use and people continue to use the sites in traditional ways.

A comprehensive management strategy is needed to ensure that these coastal wetlands continue to provide for both people and wildlife.

PROJECT STATUS: At present, the comprehensive management strategy is being written.

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/ Project Support:	American Cyanamid Company CIBA-Geigy Corporation DuPont Corporation FMC Corporation Mobay Corporation Rhone 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: Analysis of the data initially available has been completed using data for selected years for 105 species identified as linked to agricultural land in some way. Conventional multiple regression analysis proved inappropriate for the analysis and alternative statistical treatments based on classification and regression tree theory were developed and implemented. Geographic and climatic variables were the dominant factors influencing abundance and distribution, accounting for up to 62% of the variance in species abundance (though generally much lower). Cropping practices were next in importance as explanatory variables. The 25 pesticides tested had little effect on population density, except in special circumstances. The study was also able to document the growing impact of the Farm Conservation Reserve Program on birds, generally promoting their numbers, despite the still early state of the Program (see separate entry).

Copies of the draft report of the project have been deposited with the sponsors and with a Technical Advisory Committee, for their initial review. Two M.S. theses based on the project will be submitted in Fall 1991 semester.

FUTURE PLANS: The study will terminate in December 1991 unless new funding becomes available.

ANALYSIS OF EFFECTS OF 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 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. All research has been completed, and the results are in the process of being written up.

FUTURE PLANS: The final report on this project, in the form of an M.S. thesis, will be completed in

December 1991.

NEW ENGLAND BIODIVERSITY PROJECT (EMAP)

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

Cooperators/ Project Support: U.S Environmental Protection Agency

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

SCOPE: The U.S. Environmental Protection Agency is currently developing a nation-wide monitoring program known as EMAP (Environmental Monitoring and Assessment Program). Our project is a regional sub-contract focussing on monitoring schemes for birds and their associated habitat, evaluating existing data as well as developing and field-testing new protocols for use in the EMAP program.

PROJECT STATUS: A preliminary study of existing datasets including the Breeding Bird Survey (BBS), Christmas Bird Count (CBC), and selected state atlases, was completed in December of 1990. A continuing contract was awarded in May 1991, expanding the fieldwork component of the work to include collecting habitat data along 66 BBS routes in New England, and an investigation of the checkplot survey method and its comparability to the BBS. Analysis of extant datasets continues to explore the utility of the guild concept with respect to indicator species, as well as assessing the utility of the data for EMAP's purposes. A remote-sensing component is planned for 1992, interpreting and ground-truthing air-photo data for selected BBS routes.

FUTURE PLANS: A series of status reports to the EPA are scheduled throughout the duration of the contract, culminating in a final report planned for December 1992.

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

Investigator: J. P. Spruce

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

Cooperators/ U.S. Fish and Wildlife -

Project Support: Patuxent Wildlife Research Center
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: Spot HRV-XS satellite data has been processed for two study sites in northern 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. Pertinent 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 interpretation of air photos, maps and statistical measures of satellite data multi-spectral characteristics. Spruce and Sader spent a week in January 1991 with U.S. Fish and Wildlife co-investigators in Belize to field check habitat classification imagery and locate representative areas to field sample for bird identification and banding. A progress report to the U.S. Fish and Wildlife Service was submitted September 30, 1991.

FUTURE PLANS: The project will be extended to include another field site (probably in southern Campeche, Mexico) to allow field sampling of more dry habitats in the subtropical moist life zone. Landsat TM satellite data will 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 during fiscal 1992.

WILDLIFE RESOURCES - MIGRATORY BIRDS:

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.

BIOENERGETICS OF AMERICAN WOODCOCK DURING THE BREEDING SEASON ON 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 basic metabolic parameters for woodcock using captive-reared birds in the laboratory.
2) Measure microclimate regimes and activity budgets of woodcock on the Refuge.
3) Measure body composition and nutrient stores of woodcock during key periods of the breeding cycle.
4) Document spring food habits.
5) Develop a spring energetics model and assess energetic constraints on breeding female woodcock.

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 microhabitat 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: Two papers were presented at the Eighth Woodcock Symposium, Purdue University, Lafayette, Indiana, 29 October - 2 November 1990. A first draft of the dissertation was written and is being revised prior to Committee review.

FUTURE PLANS: Target date for project completion is December 1991.

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

Investigator: A. Moors

Advisors: R. B. Owen, Jr., Co-chairperson
R. J. O'Connor, Co-chairperson
Committee being developed

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

Objectives:

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

SCOPE: Birds can be excellent bioindicators, as demonstrated by eggshell thinning in relation to pesticide contamination. Research on avian bioindicators of water quality has previously focused on waterfowl. How water quality affects the total bird community (terrestrial and aquatic species) is poorly known. Avifauna may provide an economic way of monitoring the health of a lake. This project attempts to determine if the study of a bird community can allow assessment of the quality of individual lakes as part of the U.S. EPA's Environmental Monitoring and Assessment Program (EMAP).

PROJECT STATUS: The first season's fieldwork has been completed. Twenty lakes chosen by EMAP staff to reflect environmental gradients across New England were surveyed between June 1 and July 3, 1991 for bird and habitat distribution. Data analysis has begun.

FUTURE PLANS: Data analysis will be extended to include consideration of data on water chemistry, macrobenthos, and related limnological characteristics gathered in the summer of 1991 by EMAP Surface Waters personnel. A second field season will begin in June 1992 and may be expanded to include more lakes.

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

Investigator: C. G. Kitchens

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

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

Objective: To evaluate the use/importance of managed wetlands by radio-marked black ducks at Missisquoi National Wildlife Refuge.

SCOPE: During the fall staging periods of 1990 and 1991, a sample of hatching-year female (n=35) and male (n=35) black ducks and hatching-year female (n=40) mallards will be equipped with radio-transmitters to determine the importance of the refuge impoundments to these waterfowl during pre-hunting and hunting periods.

PROJECT STATUS: During the period October 1990 through September 1991, the last half of the first field season and the first month of the second field season were completed. Marked birds were monitored as planned to obtain daily locations and ascertain the numbers of ducks that use the Refuge as a night roost. Current B&W aerial photos were obtained and maps and ground truthing were completed of the designated study area. Daily locations obtained from the first field season were entered into the computer. During August and September of the second field season, ducks were again radio-marked and are being monitored daily and by the early morning scan for roosting birds. The graduate student is now enrolled in a statistics/SAS course at the University of Vermont in addition to conducting field work.

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

Investigator: D. H. Kusnierz

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

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

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.

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

PROJECT STATUS: The final of two field seasons has been completed and data analysis as begun.

Habitat characteristics, including soil moisture, vegetative cover, species and height, and distance to water, edge of cover and larid colony were measured at 167 nests and 246 random sites. The same variables were measured four times in 1991 at 25 nest sites from the previous year. These measurements will be used to follow temporal changes in habitat at nests and backdate characteristics to time of nest initiation. Behavior during incubation was monitored at 12 nests. Observations were made from a blind to examine scaup-gull interactions when broods dispersed from the islands. Surveys from fixed wing aircraft and boats were conducted to identify habitats used by broods. Habitats were sampled to quantify physical characteristics including water depth, foods available, and vegetation types. In addition, 18 juveniles were

collected to identify foods consumed.

FUTURE PLANS: Food items will be analyzed to determine energy and protein content. Analysis of data will continue. The target date for project completion is May 1992.

NEOTROPICAL MIGRANT BIRDS: CRITICAL SPECIES

Investigators: R. J. O'Connor
T. B. Lauber

Cooperators/ Project Support: USDA Forest Service

Objectives:

1) Identify those species of neotropical migrant birds experiencing the most severe population declines in the 13 northeastern United States (Virginia to Maine).
2) Synthesize population analyses of species in this region and prepare status and trends assessment for use by Northeastern Regional Committee of the multi-agency 'Partners in Flight' initiative on neotropical migrant birds.

SCOPE: The 'Partners in Flight' initiative was established to determine the status of populations of neotropical migrant species, to assess the causes of population changes in these species, and to maintain stable populations and restore declining populations. The present project provides technical support in identifying a critical set of species most in need of attention. The results will be used by the Northeastern Regional Committee of the program in planning and implementing regional conservation measures for these species.

PROJECT STATUS: Preliminary population trends of neotropical migrant species within each state in the region have been produced. More complete analyses including confidence intervals on trends and statistical checks on the methods used to calculate the trends are being conducted.

FUTURE PLANS: A final report is planned for December 1991.

BIOENERGETICS AND HABITAT UTILIZATION OF DOUBLE-CRESTED CORMORANTS INHABITING THE LOWER PENOBSCOT RIVER ECOSYSTEM

Investigator: B. F. Blackwell

Advisors: W. B. Krohn, Chairperson
J. R. Moring
Committee being developed

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

Objectives:

1) Define and delineate the double-crested cormorant population in the lower Penobscot River ecosystem, giving special attention to breeding and non-breeding components.
2) Determine the activity patterns and movements of cormorants in this ecosystem with respect to breeding status.
3) Estimate the number of cormorant days of predation relative to breeding status, season, and location.
4) Determine the seasonal energy requirements of cormorants relative to breeding status, and attempt to estimate the magnitude of Atlantic salmon smolts eaten annually by cormorants.

SCOPE: Populations of double-crested cormorants (*Phalacrocorax auritus*) increased in size and distribution during the past 20-30 years across the U.S.A. and southern Canada with the reductions in DDT contamination and Federal protection afforded with the amendment of the Migratory Bird Treaty Act. With this increase has come a growing number of complaints from recreational and commercial fishermen regarding depredation of fish populations by cormorants. The perception of cormorants competing with humans for fish has become acute relative to the multi-million dollar efforts by Federal, state, and private organizations to restore Atlantic salmon (*Salmo salar*) in the Penobscot River.

Although protected, double-crested cormorants are still viewed as a threat to commercial and recreational fisheries, and control measures have been implemented in Maine as recently as 1989. However, control programs can prove to be counterproductive by increasing the proportion of young birds attaining breeding status, and thus increasing the proportion of first year breeders returning to local colonies to nest and reproduce. Further control programs implemented without accurate prediction or quantification of the effects of predation on individual prey species cannot be justified economically.

A practical means of estimating the biomass of organisms removed from oceans by seabirds involves the incorporation of the requirements of a seabird community together with the knowledge of the energy content of the prey species. Estimates or direct measurements of activity-specific energy expenditures, along with detailed food habits studies, have been incorporated into species-specific bioenergetic models to estimate the impacts of seabird predation on communities of prey species. However, energy budgets determined via behavioral observations, even if based upon rates of metabolism determined in the laboratory, can involve substantial errors when extrapolated to include free-ranging animals.

The challenge of obtaining an accurate measure of energy metabolism in a free-ranging animal has been successfully met by technological advancements in the use of doubly-labeled water. This method makes use of isotopic tracers to measure total CO_2 production (a measure of metabolism) in the intact animal. The unique advantage of doubly-labeled water technique is that activity-specific energy expenditures can be measured in a free-ranging animal, thus eliminating much of the guesswork associated with extrapolating energy expenditures from the laboratory to natural conditions.

To this end, this study will estimate daily energy requirements of double-crested cormorants inhabiting the Lower Penobscot River ecosystem, tentatively delineated by Old Town in the north and south to upper Penobscot Bay. Special emphasis will be given to estimating seasonal patterns of prey use and the potential impact of cormorant predation on migrating Atlantic salmon smolts. Information necessary to make these estimates will come from monitoring cormorant numbers, use of the ecosystem, bioenergetic requirements of breeders and nonbreeders, and regurgitant samples from adults and nestlings.

PROJECT STATUS: Discussions have been held with the Maine Department of Inland Fisheries and Wildlife, the Atlantic Sea Run Salmon Commission, and hatchery and research personnel of the U.S. Fish and Wildlife Service. A literature review was done that encompassed seabird energetics, foraging ecology, and the ecology of cormorants and Atlantic salmon. Data on food habits were analyzed and visits made to the study area to assess logistical constraints done. A research protocol is being drafted.

FUTURE PLANS: The research protocol will be done in November 1991. To learn about night-lighting

cormorants, a trip to Mississippi is anticipated in February. Field work will begin in April 1992. The first field season will involve radio-tagging at least 40 individuals to provide information on activity patterns and foraging range. Beginning in April 1993, the number of cormorant days of predation within the study area will be estimated via aerial censuses. Also, field metabolic rates of breeders and nonbreeders will be measured using doubly-labeled water.

WILDLIFE RESOURCES - OTHER THAN MIGRATORY BIRDS:

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

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.

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

I quantified browsing relationships and effects on post-fire succession of white-tailed deer (*Odocoileus virginianus*) and snowshoe hare (*Lepus americanus*) in Acadia National Park (ANP). I conducted surveys of browse availability and utilization on 232 random plots (2 x 25 m) along approximately 100 km of permanent transects, and calculated browse utilization and preference indices for 28 key species. Estimates of browse biomass available and utilized were obtained from twig weight-diameter regression analysis and percent of twigs browsed. Habitat selection of deer and hares was assessed based on snow-track and fecal-pellet group counts. I used fecal crude protein (FCP; % fecal nitrogen x 6.25) to compare dietary quality of deer among habitats with different fire histories, and with a harvested population on the mainland. Six permanent deer exclosures and associated control plots were also inventoried to assess the long-term influences of browsing on plant communities in ANP.

Browse was abundant in relation to the current browsing intensity of deer and hares in ANP. Since 1980, utilization has declined for 17 (61%) of the key browse species for deer and 22 of key species (79%) for hares (Gilbert and Harrison, Final report, Natl. Park Serv., 1982), suggesting that these unharvested herbivore populations have declined. Browse availability and browse utilization of deer on areas burned in

1947 exceeded levels on unburned areas despite successional changes in understory vegetation from birch-aspen towards spruce-fir dominated forests on burned sites.

Fecal crude protein was correlated with browsing intensity and browse availability of preferred species, but not with relative density of deer (i.e., snow-track and fecal group counts). Mean FCP levels in burned areas (10.6%) were greater than levels in residual spruce-fir forests (8.8 - 9.1%) or on the mainland (8.5%). High FCP (10.8%) and low availability and diversity of preferred browse species suggest that seaweeds may be an important winter food for deer on Isle au Haut.

Long-term effects of browsing were most prominent within the shrub height class (0.5 - 2.0 m) and in burned areas. Height class distribution of white cedar (*Thuja occidentalis*) stems reflected different fire histories in cedar dominated habitats.

Based on high dietary quality of deer and lack of widespread overbrowsing by deer or hares, management activities to reduce browsing effects on vegetation are not recommended.

POPULATION DYNAMICS OF PACIFIC WALRUSES

Investigators: S. Hills
J. R. Gilbert

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

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

Objectives:

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

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

PROJECT STATUS: The satellite transmitters deployed in 1990 functioned much better than previous models. The walruses tagged in Bristol Bay moved back and forth between the haulout beaches at Cape Peirce and Round Island. In April and May, 1991, seven satellite transmitters and six VHF transmitters

were put on seven female walruses in the Bering Sea. The transmitters had a new, lighter housing and shorter external antenna than previous models and performed well. Adult female walruses in the spring required larger drug doses than all males or females immobilized in late summer.

Data on terrestrial haulout behavior in Bristol Bay were centralized and analyzed. Additional data were collected at Round Island and Cape Peirce in cooperation with Togiak National Wildlife Refuge and Alaska Department of Fish and Game. Other analyses on the relation between walrus distribution and the environmental factors of water depth, ice concentration, bottom sediment type, bottom sorting type, and water origin were initiated.

Tissue samples collected in 1987 for mitochondrial DNA analysis were analyzed in cooperation with the Greenland Fisheries Research Institute, which contributed Atlantic walrus tissues. Analysis showed that genetic separation between the Atlantic and Pacific walruses is excellent, but that the genotypes of walruses collected in several areas of the Chukchi Sea showed no segregation.

FUTURE PLANS: Chapters of the thesis are being written this fall. Refereed papers and a dissertation are anticipated.

1990 WALRUS POPULATION ESTIMATE

Investigator: J. R. Gilbert

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

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

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

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

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

FUTURE PLANS: In the coming year, all past data from the aerial surveys, including previously unavailable Soviet data, will be re-analyzed with common methodology to evaluate the status of the walrus population.

POPULATION ECOLOGY OF FEMALE BLACK BEARS IN MAINE

Investigator: C. R. McLaughlin

Advisors: R. J. O'Connor, Co-Chairperson
G. J. Matula, Jr., Co-chairperson
W. A. Halteman

D. J. Harrison
W. B. Krohn

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

Objectives:

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

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

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

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

These relationships will be investigated using a computer model based upon parameter estimates from field data. The model should improve prediction of population responses to management actions and habitat changes. It may also enhance MDIFW's ability to monitor the State's bear population. Model construction and testing will include extensive sensitivity analysis, which should provide insight into the type of data needed, and required precision in data collections for reliable monitoring of population parameters. The model should also become a vehicle for developing and testing statewide population monitoring techniques. Observed changes in population status of bears living within MDIFW study areas will provide a basis for evaluating harvest-related monitoring techniques. The model could be used to further test the sensitivity of new monitoring techniques over a wide range of population conditions.

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

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

Sensitivity 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.

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

Investigator: R. M. Muller

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

Cooperators/ Project Support: Maine Department of Inland Fisheries and Wildlife (MDIFW)

Objectives:

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

SCOPE: Black bear hunting as a controlled and regulated hunt in Maine began in the 1930s. Since 1931 the bear harvest season has fluctuated widely from year-long seasons from 1942-1965, to a five month season, to a split season between the spring and the fall months, to the current three month season, which is restricted by law.

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

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

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

SURVIVAL AND SUSTAINABILITY OF A HEAVILY HARVESTED MARTEN POPULATION

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

Cooperators/ University of Maine

Project Support: Maine Agricultural Experiment Station
Maine Department of Inland Fisheries and Wildlife

Objectives:

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

SCOPE: Pine marten (*Martes americana*) populations are particularly vulnerable to overharvesting because of the species' low reproductive rate, high pelt price relative to other furbearers, and ease of capture. Further, a recent decline in pelt prices of other furbearers has directed additional trapping pressure towards martens. In 1973, the trapping season on martens was reopened after nearly 40 years of closure. Since reinstatement, the harvest has steadily increased in Wildlife Management Unit #2 (WMU 2), the majority of marten range in Maine. The harvest increased from < 150 martens in 1973 to nearly 6,000 martens in 1985. Recently, however, the annual harvest has decreased; < 2,000 martens were harvested in WMU 2 during 1990. To better understand the population ecology of this furbearer, we initiated a project in Townships 4 & 5 Range 11 to examine the survival of martens in an intensively trapped area. Our goal is to identify factors which significantly affect survival of martens and to propose management recommendations to ensure the sustainability of marten populations in Maine.

PROJECT STATUS: To date, we have estimated age and sex-specific survival from May 1989 - December 1990 for 30 female (22 adults, 8 juveniles) and 29 male (21 adults, 8 juveniles) martens. Thirty-seven deaths were documented during 5,825 radio-days of observation; most mortalities were human-caused. Span (1 May-15 December) survival rates differed significantly between adult ($\geq$ 1 year) males and adult females. Daily survival rates of adults were significantly lower during the first 14 days of the trapping season than during the remaining 4-5 weeks. Survival through the first 14 days of the trapping season was highest for adult females, followed by adult males, juvenile (< 1 year) females, and juvenile males. Vulnerability of juvenile males to trapping was higher than all other age/sex classes. Vulnerability differed significantly among age-sex groups.

Sex-specific adult survival rates were calculated for the post-trapping interval (16 December-April 30) from MLE daily mortality rates observed during the pre-trapping interval (1 May-31 October), and 2X and 3X the observed pre-trapping rates. Annual MLE survival rates, calculated as the product of all interval rates, differed little among these 3 scenarios for either adult females or adult males.

FUTURE PLANS: We radio-collared 14 additional martens (8M:6F) during September 1991. Aerial monitoring is scheduled through the fall trapping season (December 1991). We will assess whether populations are sustainable based on our observed survival rates and published fecundity rates using a deterministic population model. Final analyses are scheduled for late 1991 and we plan to complete a final project manuscript by early 1992.

SPATIAL USE, TERRITORIALITY, AND HABITAT USE OF MARTENS IN MAINE

Investigator: D. D. Katnik

Field Assistants:
T. P. Hodgman
S. S. Sherburne
G. Hayes
T. F. Foster
K. E. McGinley

J. P. Sincage

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

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

Objectives:

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

SCOPE: A decreasing annual harvest of martens concurrent with a stable or increasing effort of trappers to catch martens may be a result of increasing pressure on populations of martens from trapping. Quantity and quality of marten habitat has declined; harvesting of timber has reduced the quantity of mature, coniferous forest and created networks of roads that have increased access of humans to previously remote areas and unexploited populations of martens.

Unfortunately, management of populations of martens is currently limited because previous information on size of home ranges and territoriality of martens was based on outdated methods of determining movements or on small numbers of martens. Also, research on use of habitat by martens has been limited by amount of effort required to accurately document characteristics of habitat for large areas.

The goal of this project is to document spatial relationships (i.e., size of home ranges and territoriality) and habitat use of martens in commercial forestland open to trapping. The study area, which is owned and managed for timber by Georgia-Pacific Corp., is located in northcentral Maine, west of Baxter State Park. I will use radio-telemetry to monitor movements of martens from May-October and delineate boundaries of home ranges to evaluate spatial relationships. I will use a GIS database to evaluate use of habitat by martens at point relocations and in home ranges in comparison with available habitat.

PROJECT STATUS: Fifty-five martens (29 M, 26 F) were radio-collared and tracked from May 1989-October 1990. Over 1,000 relocations of martens were obtained. I compared size of home range between adult and yearling martens, between male and female martens, and among seasons. No age or seasonal differences in size of home range were detected, but male martens had larger home ranges than did female martens. I compared overlap of home ranges and core areas of non-juvenile martens within and between sexes. Martens were territorial within but not between sexes. Juvenile martens moved independently of home ranges of non-juvenile martens.

FUTURE PLANS: I will use a GIS database provided by Georgia-Pacific Corp. to determine cover type, canopy closure, mean height of trees, distance to and density of forest edge, and distance to and density of roads. I will evaluate use of habitat by martens at the stand-level (i.e., by individuals) by comparing habitat between relocations of martens and randomly-located points. I will evaluate use of habitat by martens at the

landscape-level (i.e., by the population) by comparing habitat between home ranges of martens and the area that was trapped for martens. I expect to complete this project by December 1991.

RELATIONSHIP OF BEAVER MANAGEMENT AND WATERFOWL PRODUCTION IN SOUTHCENTRAL MAINE

Investigator: T. C. McCall

Advisors:
R. B. Owen, Jr., Chairperson
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Cooperators/ Project Support:
McIntire-Stennis
Hirundo Wildlife Trust
Maine Cooperative Fish and Wildlife Research Unit
Maine Department of Inland Fisheries and Wildlife
Maine Trappers Association
National Rifle Association
Penobscot County Conservation Association

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

SCOPE: 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 4 years beginning in 1989, whereas another area will remain open to trapping. The 150 km^2 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 third field season has been completed. Each October from 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 trapped area, trappers were interviewed annually to determine the harvest of beaver and to collect teeth for aging. Each May the number and sizes of wetlands and the types of vegetation associated with each wetland were determined using aerial photos. From July to September 1989-

1991, each of the 270 wetlands was visited to verify the accuracy of the data obtained from the photos. Each wetland was visited in the spring and summer to record the condition of the beaver dam and the water level. From April to May 1989-1991, breeding-pair counts of selected waterfowl species were compared to each area using counts from a helicopter and observers on the ground.

On the untrapped area, the number of active lodges has increased from 18 in 1988 to 21 in 1989 and 28 in 1990, whereas on the trapped area, the number of active colonies has declined from 29 in 1988 to 19 in 1989 and 18 in 1990. Four hundred beaver have been live-trapped and tagged to determine population dynamics and dispersal of beaver. Trappers harvested 43% of the beaver population in 1989, 47% in 1990, and 25% in 1991. Because there were few new dams constructed on the untrapped area during the first year of the closure, there was little increase in the number of wetlands. However, by the third year 5 new wetlands had been constructed by beaver (+5.5 ha surface water), and reconstruction of old dams resulted in the reflooding of 3 wetlands (+6 ha surface water). To date no trend in waterfowl numbers has been noted on either area.

Preliminary results suggest that (1) a 1-year closure of beaver trapping is adequate to increase beaver density, (2) a $\geq$2-year closure is needed to increase the amount of wetland habitat, and (3) a $\geq$3-year closure may be needed to influence densities of waterfowl and other associated wildlife species.

FUTURE PLANS: In 1992 the collection of data will be replicated. The anticipated date of completion is May 31, 1993.

ANALYSIS OF RIVER OTTER HARVEST AND REPRODUCTIVE DATA IN THE NORTHEASTERN U.S.A., 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
Maine Cooperative Fish and Wildlife Research Unit

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 listing in the Convention on International Trade in Endangered Species 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: The final report (48pp.) was submitted to U.S. Fish and Wildlife Service, Region 5 Federal Aid. An abstract of the final report follows:

The Northeast Fur Resources Technical Committee and the U.S. Fish and Wildlife Service (USFWS) Region 5 Federal Aid conceived this study to enhance interstate coordination in furbearer management. The objectives of this study were to examine existing river otter (*Lutra canadensis*) harvest and reproductive data from Region 5 of the USFWS, 1970-89, determine temporal and spatial characteristics of the data, assess utility of the data for ascertaining population trends, and provide guidelines for subsequent data collection and analyses. The river otter can serve as an indicator for other furbearer species

in regard to problems encountered in data analysis and application. Findings from this study may be used by the Office of Scientific Authority (OSA), USFWS, as guidelines for establishing protocol for other furbearers.

States were consistent in assigning otters to 3 age classes (juvenile, subadult, and adult) based on cementum annuli with corresponding radiographs when available. Use of radiographs improved the consistency of aging as juvenile or nonjuvenile compared to aging by cementum annuli alone.

The number of otters harvested increased during 1970-89 in Connecticut, Maine, New Hampshire, New York, and Vermont. Because otters often are incidentally caught in beaver (*Castor canadensis*) sets or opportunistically trapped by beaver trappers, otter harvests were positively correlated with beaver harvests.

Female otters and juveniles of both sexes composed a greater proportion of the harvest in the fall season than in the winter. The percentage of juvenile males and females in the harvest was related to aging technique, preparation lab, and reader. These results emphasize the need for standardizing aging techniques among states to make comparisons of age distribution reflect biology and management and not technique differences.

Productivity (percent females reproductively active, mean litter size) generally is underestimated when based on blastocyst counts. Because corpora lutea only reflect ovulation rates, these counts overestimate successful pregnancy rates. Embryo counts are more appropriate for use in estimating pregnancy rates of otter populations; however, few carcasses are available for fetal examination in state harvest collections. Therefore, states with only a fall otter season need a reliable indicator of pregnancy. Corpora lutea counts provide reliable estimates of litter size for reproductively active females.

Errors in data entry have compromised the integrity of biological data from river otter in northeastern U.S. These errors and the lack of regional standardization in data collection have limited the scope of this analysis. Currently, no method is used to estimate year-to-year changes in otter population levels. Development of catch per unit effort indices is a first step toward tracking population levels and should be a research priority. Catch per unit effort statistics combined with juvenile:nonjuvenile ratios obtained from radiographs would enhance evaluation of regional population status and would be useful for assessing population trend on a regional basis.

REPRODUCTIVE BIOLOGY OF CAPTIVE FISHERS

Investigator: H. C. Frost

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

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

Objectives:

1) Determine if placental scars are a reliable index for estimating fisher recruitment from trapper-caught animals.
2) Determine if freezing and thawing have an effect on the persistence of placental scars in trapper-caught animals.
3) Document male and female reproductive cycle by:
   a) monitoring levels of reproductive hormones,
   b) documenting the estrous cycle and implantation dates of females, and

c) monitoring testes size, sperm viability, and baculum development in males.

4) Document growth and development of embryos and kits in captivity.

SCOPE: Little was known about fisher reproduction before 1930. Most of the early information came from accounts from fur farms. Between 1950 and 1970, several investigators studied fisher reproduction, primarily from data collected from carcasses of trapper-caught animals. Common reproductive indices for fisher are counts of corpora lutea, blastocysts, and placental scars. Recent radio-telemetry of wild fishers in Maine indicates that counts of corpora lutea and blastocysts overestimate the number of females that give birth and the number of young born. However, the proportion of adult females with placental scars is very similar to the proportion of radioed adult females denning and raising young in the wild. The use of placental scars has been questioned because of the reliability of observing them on the uterus, and determining how long they are visible along with the effects of freezing and thawing on placental scar persistence will be investigated. In addition, the male and female reproductive cycles will be documented along with the growth and development of embryos and young born in captivity.

PROJECT STATUS: Twenty-two cages and nest boxes were constructed during the fall of 1990 and put in place at the University of Maine's Animal Research Facility. Seventeen fisher, 13 females and 4 males, were captured and brought into captivity by December 1990. Eight of the 13 females were aged as adults and 5 of those gave birth to 14 young. Seven of the 14 young survived and are currently in captivity. Weights, body measurements, and behavioral developments have been monitored since birth. Blood was taken from all adults at 14-day intervals between January and June and levels of testosterone and progesterone are currently being determined by radio-immunoassay. Testes, vulva, and mammillae measurements were also taken and will be analyzed seasonally relative to reproductive status.

FUTURE PLANS: Trappers will be hired to capture 15 to 20 additional females during the 1991 trapping season. Female carcasses will be collected throughout the trapping season from selected trappers and put under different treatments to determine the effects of freezing and thawing on the persistence of placental scars. Preparations are being made to do laparotomies on all adult females captured in 1990, to determine if placental scar counts are the same as litter size and embryo counts. Blood will again be taken from January to June at 10-day intervals for progesterone and testosterone determination. Ultrasound will be used to determine which females are pregnant and to monitor growth and development of the embryos. After birth, kits will be weighed and measured at 10-day intervals. Behavioral development will be monitored from birth through early fall.

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

Investigator: S. D. Whitcomb

Advisors: F. A. Servello
D. J. Harrison
A. F. O'Connell

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

Objectives:

1) Identify and characterize potential breeding habitat for spruce grouse in Acadia National Park and on Mount Desert Island.

2) Determine the relative value of conifer cover types for spruce grouse during spring and winter.
3) Determine the minimum breeding population of spruce grouse in Acadia National Park and on Mount Desert Island.
4) Determine dispersal characteristics of spruce grouse relative to habitat patch distribution and size.

SCOPE: Spruce grouse were believed to be extirpated on Mount Desert Island in the late 1800's, but a breeding population currently exists. However, little is known about the population or its long-term viability. Spruce grouse breeding habitat is predominantly lowland conifer cover. This cover type has a highly fragmented distribution on the island and occupies only 25% of the island's area. Therefore, the potential breeding habitat for spruce grouse is limited, and dispersal of juveniles between widely separated patches of breeding habitat may be important for maintaining a viable population.

PROJECT STATUS: Areas of potential habitat have been identified from cover maps and preliminary surveys of spruce grouse occurrence and habitat availability have been completed.

FUTURE PLANS: A census of breeding spruce grouse will be conducted in April-May 1992. Spruce grouse will be fitted with radio transmitters in summer and fall 1992 to study dispersal of juveniles and fall-winter habitat use patterns.

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

Investigator: S. L. Glass

Advisors: D. J. Harrison
A. F. O'Connell

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

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

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

Coyotes colonized Mount Desert Island (MDI) in the early 1980's and are a potentially significant

predator on deer in ANP. Preliminary food habits studies suggest that the use of deer by coyotes is high relative to mainland areas. In addition to direct predation, spatial interactions between coyotes and deer may potentially affect deer populations.

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

PROJECT STATUS: Field work was initiated in August 1991. Currently 7 coyotes (6 females, 1 male) have been equipped with transmitters.

FUTURE PLANS: Plans are to equip 5-7 more coyotes with transmitters before winter. Deer trapping will begin in December with the goal of equipping up to 30 deer with transmitters.

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VENNO, S.A. 1991. Integrating wildlife habitat into local planning: a handbook. Maine Agric. Exp. Sta. Publ. 712. 54pp.

THESES AND DISSERTATIONS

HOOPER, S.T. 1990. Distribution of songbirds in riparian forests of central Maine. Master of Science thesis, University of Maine, Orono. 90pp.

RUDNICKY, T.C. 1991. The effects of clearcut size on bird species richness and nest predation rates in northeastern Maine. Master of Science thesis, University of Maine, Orono.

RYAN, J.M. 1991. Mercury in the environment and its impact on fish. Master of Science thesis, University of Maine, Orono. 46pp.

SAEKI, M. 1991. Influence of browsing by white-tailed deer and snowshoe hare on vegetation at Acadia National Park, Maine. Master of Science thesis, University of Maine, Orono. 120pp.

SMITH, T.R. 1991. Response of brook trout (*Salvelinus fontinalis*) and Atlantic salmon (*Salmo salar*) exposed to low pH with and without aluminum. Master of Science thesis, University of Maine, Orono. 50pp.

PROFESSIONAL TALKS PRESENTED

CHILELLI, M., and D.B. GRIFFITH. May 1991. "Assessing the validity of computerized population viability analysis." Northeast Fish and Wildlife Conference, Portland, ME.

DEVAUL, H., R.J. O'CONNOR, and W.B. KROHN. October 1990. "Evaluation of a method of estimating proportion of area occupied for woodland hawks." Annual conference of Raptor Research Foundation, Allentown, PA.

DEVAUL, H. August 1991. "Evaluation of the area occupied method for surveys of woodland hawks." USFWS workshop to discuss standardizing survey methods for woodland hawks, Minnesota Valley National Wildlife Refuge, Minneapolis, MN.

FROST, H.C. June 1991. "Reproductive biology of captive fishers - a proposal." Northeast Fisher Workshop, Durham, NH.

GILBERT, J.R. October 1990. Results of the 1990 US-USSR Walrus Survey. Briefing for Regional Director, U.S. Fish and Wildlife Service, Anchorage. AK.

GILBERT, J.R. October 1990. "Results of the 1990 US-USSR Walrus Survey." Briefing for Law Enforcement, U.S. Fish and Wildlife Service, Anchorage, AK.

GILBERT, J.R. November 1990. "Walruses and the Soviet Union." Wildlife Seminar, University of Maine.

GILBERT, J.R. 1991. Meetings with USSR walrus biologists to analyze results of 1990 walrus surveys, Anchorage, AK.

GIULIANO, W. May 1991. "A preliminary assessment of spatial-temporal relationships in an unexploited pine marten population." International Symposium on the Biology and Management of Martens and Fishers, University of Wyoming, Laramie, WY.

GRAY, P.B., M. SAEKI, R.D. APPLEGATE, W. ESCHHOLZ, D.D. KATNIK, D.H. KUSNIERZ, C. VERA, and F.A. SERVELLO. May 1991. "Nutritional comparison of three seaweed species and common winter forages of white-tailed deer." Poster presented at Northeast Fish and Wildlife Conference, Portland, ME.

HARRISON, D.J., A.F. O'CONNELL, and J.A. SUBIJANTO. May 1991. "Seasonal food habits of a recently established insular population of coyotes." Northeast Fish and Wildlife Conference, Portland, ME.

HARRISON, D.J., T.P. HODGMAN, and D.D. KATNIK. June 1991. "Survival in a heavily harvested marten population, a preliminary assessment." International Symposium on the Biology and Management of Martens and Fishers, University of Wyoming, Laramie, WY.

HARRISON, D.J. June 1991. Chaired the session "Habitat management of martens and fishers," International Symposium on the Biology and Management of Martens and Fishers, Laramie, WY,

HARRISON, D.J. December 1990. "Status, ecology, and inter-specific relationships of mammalian predators in Acadia National Park." Final project seminar presented to U.S. National Park Service, Bar Harbor, ME.

HARRISON, D.J. December 1990. "A summary of results from ongoing research involving coyote-fox spatial interactions, deer-hare browsing relationships, and marten population characteristics in Maine." Seminar presented at annual Wildlife Division meeting, Maine Department of Inland Fisheries and Wildlife, Rockland, ME.

HARRISON, D.J. October 1990. "Status of mammal research in Acadia National Park." Seminar presented to regional management staff, Maine Dept. of Inland Fisheries and Wildlife, Bar Harbor, ME.

HARRISON, D.J., and N.E. FAMOUS. August 1991. "Effects of peat harvesting on a large mammalian carnivore: a case study with coyotes (*Canis latrans*)." International Peat Symposium, Duluth, MN.

HARTLEY, R.A., and J.R. MORING. June 1991. "Initial and delayed mortality of largemouth and smallmouth basses related to tournaments." Warmwater Fisheries Symposium, Scottsdale, AZ.

HUNTER, M.L., JR. December 1990. "Conservation of amphibians and reptiles in Maine, USA." Society for the Study of Amphibians and Reptiles in New Zealand, Whitianga, New Zealand.

HUNTER, M.L., JR. December 1990. Organized and chaired symposium, "Bird conservation at a landscape scale," for the International Ornithological Congress, Christchurch, New Zealand.

HUNTER, M.L., JR. April 1991. "What is an old-growth forest?" Atlantic Society of Fish and Wildlife Biologists, Sackville, New Brunswick.

HUNTER, M.L., JR. May 1991. "Maintaining biological diversity in managed forests." White Mountain National Forest staff, Conway, NH.

HUNTER, M.L., JR. June 1991. "Towards a conceptual definition of old-growth forests." Society for Conservation Biology Conference, Madison, WI.

HUNTER, M.L., JR. July 1991. "Natural disturbance patterns as a model for harvesting in boreal forests." World Congress of Landscape Ecology, Ottawa, Ontario, Canada.

HUNTER, M.L., JR. July 1991. "Forest fragmentation and biodiversity." Vermont Society of American Foresters, Shrewsbury, Vermont, July 26, 1991.

HUNTER, M.L., JR. September 1991. "Maintaining biological diversity in managed forests." USDA Forest Service, Nashville, TN.

HUNTER, M.L., JR. September 1991. "Maintaining biological diversity in managed forests." Society for the Protection of New Hampshire Forests, Concord, NH.

JONES, M.T. June 1991. Presented a review of SYSTAT 5.0 to workshop for groups interested in PC software packages for statistical analyses, held at the Senator Inn and Conference Center, Augusta, ME.

KATNIK, D.D., D.J. HARRISON, and T.P. HODGMAN. May 1991. "Movements and spatial relationships of pine martens in Maine." Northeast Fish and Wildlife Conference, Portland, ME.

KATNIK, D.D., D.J. HARRISON, and T.P. HODGMAN. June 1991. "Movements and spatial relationships of pine martens in Maine." International Symposium on the Biology and Management of Martens and Fishers, University of Wyoming, Laramie, WY.

KROHN, W.B., S.M. ARTHUR, and T.F. PARAGI. June 1991. "Mortality and vulnerability of a heavily trapped fisher population." International Symposium on the Biology and Management of Martens and Fishers, University of Wyoming, Laramie, WY.

KUSNIERZ, D. May 1991. Co-led the wildlife section of 1991 Maine Environthon, East Corinth.

KUSNIERZ, D. June 1991. "Nesting ecology of great scaup." North American Waterfowl Management Plan - Atlantic Research Workshop, Sackville, NB.

KUSNIERZ, D. August 1991. "Radio telemetry in waterfowl studies." Ducks Unlimited Canada - Greenwing Day, Evandale, NB.

MOREAU, D.A. March 1991. "Developing a habitat suitability model characterizing Atlantic salmon holding pools, with emphasis on the selection variables that may determine pool quality." 1991 Atlantic Salmon Workshop, Rockport, ME.

MORING, J.R. May 1991. "Effects of logging practices on trout in streams: A review of four studies in Oregon and Maine." Workshop on Forestry Practices and Trout Management, American Fisheries Society, Deep Creek Lake, MD.

O'CONNOR, R.J. October 1990. "Analysis of bird population monitoring data." Ecological Indicators Symposium, Fort Lauderdale, FL.

O'CONNOR, R.J. October 1990. "Bird populations and agricultural impacts in Britain." Ecological Indicators Symposium, Fort Lauderdale, FL.

O'CONNOR, R.J., and R.B. BOONE. October 1990. "A retrospective study of agricultural bird populations in North America." Ecological Indicators Symposium, Fort Lauderdale, FL.

O'CONNOR, R.J. February 1991. "A retrospective study of bird populations in North America." Paper presented at USEPA Environmental Research Laboratory, Athens, GA.

OWEN, R.B., JR. November 1990. "Earthworm biomass in relation to forest types, soil, and land use." Eighth Woodcock Symposium, Purdue University, Lafayette, IN.

OWEN, R.B., JR. November 1990. Chaired the session "Woodcock Initiatives - What do we know: Where do we go?" at the Eighth Woodcock Symposium, Purdue University, Lafayette, IN.

OWEN, R.B., JR. March 1991. "Wetlands at risk." Alaska Wetlands Forum, University of Alaska-Fairbanks.

PARAGI, T.F., W. B. KROHN, and S.M. ARTHUR. June 1991. "Estimates of fisher recruitment and survival and their management implications." International Symposium on the Biology and Management of Martens and Fishers, University of Wyoming, Laramie, WY.

RYAN, J.M. May 1991. "Mercury in the environmental and implications for fish." Northeast Fish and Wildlife Conference, Portland, ME.

SADER, S.A. August 1991. "GIS analysis of tropical forest change associated with landscape variables." (Poster) Society of American Foresters Annual Convention, San Francisco, CA.

SAEKI, M., and D.J. HARRISON. May 1991. "Trends in browse utilization and preference in an unhunted deer and hare population." Northeast Fish and Wildlife Conference, Portland, ME.

SAEKI, M., and D.J. HARRISON. May 1991. "Influence of browsing by white-tailed deer and snowshoe hares on vegetation at Acadia National Park." Final project seminar presented to U.S. National Park Service, Bar Harbor, ME.

SERVELLO, F.A. April 1991. "Effects of herbicides on wildlife habitats." University of Maine Vegetation Management Workshop, Bangor, ME.

SERVELLO, F. March 1991. "Papermill sludges: disposal options and environmental impacts: effects of landspreading sludges on forestland on wildlife populations." Waste Management Seminars, University of Maine, Orono.

SHEPARD, S. March 1991. "A radio telemetry investigation of ATS smolt migration in the Penobscot River, Maine." 1991 Atlantic Salmon Workshop, Rockport, ME.

SHEPARD, S. March 1991. "A radio telemetry investigation of adult ATS movements in the Penobscot River of Maine." 1991 Atlantic Salmon Workshop, Rockport, ME.

SPRUCE, J.P. and S.A. SADER. August 1991. "Use of Landsat TM reflectance data to quantify migratory bird habitat in southern Belize." (Poster) Society of American Foresters Annual Convention, San Francisco, CA.

VANDER HAEGEN, M., W.B. KROHN, and R.B. OWEN, JR. October 1990. "Care, behavior, and growth of captive American woodcock." Eighth Woodcock Symposium, Purdue University, Lafayette, IN.

VANDER HAEGEN, M., R.B. OWEN, JR., and W.B. KROHN. October 1990. "Effects of weather on earthworm abundance and spring food habits of American woodcock." Eighth Woodcock Symposium, Purdue University, Lafayette, IN.

VANDERPOOL, A.M. March 1991. "A radio telemetry study of the migratory behavior of ATS smolts in the Penobscot River, Maine -- A progress report." 1991 Atlantic Salmon Workshop, Rockport, ME.

VANDERPOOL, A.M. May 1991. "Downstream migratory activity of Atlantic salmon smolts in the Penobscot River, Maine." Northeast Fish and Wildlife Conference, Portland, ME.

VANDERPOOL, A.M. June 1991. "A radio telemetry study of the migratory behavior of Atlantic salmon smolts in the Penobscot River, Maine." Atlantic University Graduate Biology Conference, Saint John, NB.

VANDERPOOL, A.M. September 1991. "A radio telemetry study of the behavior of Atlantic salmon smolts in the Penobscot River, Maine." International Wildlife Telemetry Symposium, Edinburgh, Scotland.

VICKERY, P.D. November 1990. "The history, distribution, and economic impact of professional bird toms in developing countries." Birds and Tourism Symposium, International Council for Bird Preservation, University of Waikato, Hamilton, New Zealand.

VICKERY, P.D., and M.L. HUNTER, JR. December 1990. "Is increased breeding success associated with increased territorial density?" International Ornithological Congress, University of Canterbury, Christchurch, New Zealand.

VICKERY, P.D. March 1991. "New England's endangered and threatened birds." Spring Bird Symposium, Maine Audubon Society, Falmouth, ME.

VICKERY, P.D. May 1991. "A regional and habitat analysis of New England and New York listings of endangered, threatened, and special concern birds." Northeast Fish and Wildlife Conference, Portland, ME.

PUBLIC TALKS PRESENTED

CHILELLI, M. "Careers in wildlife biology." Talk given to students at Weatherbee Middle School Career Day, Hampden, ME, January 16, 1991.

DEVAUL, H. Participated in a panel discussion of career opportunities in science at College of the Atlantic, Bar Harbor, ME, April 20, 1991.

DEVAUL, H. "Field identification of raptors." Talk given to WLM 250, Wildlife Field Survey, University of Maine, Orono, May 14, 1991.

ELLIOTT, C.A. "Songbird use of forest clearcut edges in north-central Maine." Talk given to Stanton Bird Club, Auburn, ME, November 5, 1990.

ELLIOTT, C.A. "An introduction to Project WILD." Talk given to Univ. of Maine, College of Education, CID and pre-service teachers, November 15, 1990.

ELLIOTT, C.A. Presented a workshop entitled "Project WILD" to 29 pre-service teachers at the University of Maine, College of Education, Orono, December 1, 1990.

ELLIOTT, C.A. Presented a workshop entitled "Project WILD" to 8 pre-school and elementary teachers at Stillwater Montessori School, Stillwater, ME, December 8, 1990.

ELLIOTT, C.A. "Careers in wildlife biology." Talk given to students at Weatherbee Middle School Career Day, Hampden, ME, January 16, 1991.

ELLIOTT, C.A. "Winter adaptations of owls and other birds." Talk given at Brooklin Elementary School, Brooklin, ME, January 18, 1991.

ELLIOTT, C.A. "Forest-wildlife management." Talk given to first-year wildlife students at University of Maine Wildlife Department, Orono, February 20, 1991.

ELLIOTT, C.A. "An introduction to Project WILD." Talk given to Univ. of Maine, College of Education, CID and pre-service teachers, February 26 and February 28, 1991.

ELLIOTT, C.A. "Forest-wildlife management: The Maine perspective." Paper presented at Conference on Managing for Wildlife in Nova Scotia Forests, Pictou County, Nova Scotia, March 4, 1991.

ELLIOTT, C.A. Participated in panel discussion on "Forestry, wildlife, and land-use planning." Conference on Managing for wildlife in Nova Scotia forests, Pictou County, Nova Scotia, March 8, 1991.

ELLIOTT, C.A. "How to attract wildlife to your woodlot or backyard." Talk given at Eastern Maine Sportsmen's Show, University of Maine Field House, Orono, March 10, 1991.

ELLIOTT, C.A. "4H earth connections." Talk given to two sessions at 1991 4H Day at the University of Maine, Orono, April 6, 1991.

ELLIOTT, C.A. Presented a workshop entitled "Project WILD - Aquatic" for Pre-service and In-Service Teachers. Univ. of Maine, College of Education, April 20, 1991.

ELLIOTT, C.A. "Bats in Maine." Talk given at Piscataquis County Soil and Water Conservation District UMCE Office, Dover-Foxcroft, ME, April 16, 1991.

ELLIOTT, C.A. "Environmental stewardship: Cooperative Extension in action." Talk given to MEMA/MLA Spring Conference, University of Maine, Orono, May 20, 1991.

ELLIOTT, C.A. "Herbicides and songbirds." Talk given to the Schoodic Chapter of Maine Audubon Society, Calais, ME, June 18, 1991.

ELLIOTT, C.A. Project WILD workshop for in-service and pre-service teachers, Univ. of Maine, College of Education, June 24, 1991.

ELLIOTT, C.A. "An introduction to Project WILD." Univ. of Maine Science in the Classroom summer workshop, Orono, July 24, 1991.

ELLIOTT, C.A. "A forester's guide to managing wildlife habitats in Maine." Workshop presented to Diamond Occidental Forests, Inc., Old Town, ME, August 2, 1991.

ELLIOTT, C.A. "Wildlife ecology, habitat, and management." Field trip and written test given to state winner attending the 1991 National Envirothon, Mapleton, ME, August 11, 1991.

ELLIOTT, C.A. "UMCE -- Action plan for diversity." Talk presentd at the ES-USDA National Diversity Strategic Planning Workshop, Denver, CO, September 5, 1991.

ELLIOTT, C.A. "Wildlife ecology and management." Talk and field session presented at the Yankee Woodlot Forestry Camp, Tanglewood 4-H Camp, Lincolnville, ME, September 18, 1991.

ELLIOTT, C.A. "Coverts project in Maine." A workshop for landowners conducted at Camp Jordan, Ellsworth, ME, September 26-30, 1991.

FROST, H.C. "Population characteristics of black bears in southeastern Utah." Talk given at Unity College, Unity, ME, February 22, 1991.

GILBERT, J.R. "Marine mammals." Talk given at 1991 4H Day at the University of Maine, Orono, April 6, 1991.

GILBERT, J.R. "Walruses and the Soviet Union." Talk to Penobscot County Conservation Association, Brewer, ME, December 4, 1991.

HARRISON, D.J. "Ecology of Maine's newest predator: the eastern coyote." Seminar presented at College of the Atlantic, Bar Harbor, ME, July 10, 1991.

HARRISON, D.J. "Ecology of Maine's newest predator: the eastern coyote." Talk presented to staff and visitors at Baxter State Park, Millinocket, ME, August 7, 1991.

HODGMAN, T.P. "Herbivore food habits analysis." Talk and demonstration given to WLM 450, Wildlife Habitat Relationships, University of Maine, Orono, October 15 and 16, 1990.

HODGMAN, T.P. "Western rangelands." Talk given to WLM 200, Ecology, University of Maine, Orono, December 3, 1990.

HUDSON, L. "Environment and the quality of life: lessons from the Third World." Talk presented at Bangor High School Earth Day, April 25, 1991.

HUNTER, M.L., JR. "A global approach to conservation." Talk given to Lincoln County Historical Society, Wiscasset, ME, March 24, 1991.

HUNTER, M.L., JR. "A conservationist's tour of New Zealand." Talk presented to Maine Audubon Society, Brewer, ME, April 5, 1991.

HUNTER, M.L., JR. "Global conservation." Talk presented to University of Maine, Student Environmental Action Committee, Orono, April 25, 1991.

HUNTER, M.L., JR. "Impacts of biomass fuel management on wildlife." Talk presented to National Audubon Society, New York, NY, May 6, 1991.

HUNTER, M.L., JR. "A global approach to wildlife conservation." Talk given to Maine Audubon Society, Southwest Harbor, ME, July 18, 1991.

HUNTER, M.L., JR. "Land use allocation strategies." Talk given to U.S. Forest Service personnel, Nashville, TN, September 18, 1991.

HUNTER, M.L., JR. "Managing forests for biological diversity." Talk given to U.S. Forest Service personnel, Nashville, TN, September 18, 1991.

HUNTER, M.L., JR. "Clearcutting and the spatial scales of forest management." Talk given to Society for the Protection of New Hampshire Forests, Concord, NH, September 19, 1991.

JONES, M.T. "Uses of Christmas Bird Count data." Talk given to Western Maine Audubon Society, University of Maine at Farmington, April 7, 1991.

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. "Ecology of fishers in northern New England." Talk presented to Vermont Institute of

Natural Science, Woodstock, VT, April 25, 1991.

KUSNIERZ, D. "Managing ecosystems - wetlands and rangelands." Talk given to WLM - Introduction to Conservation Biology, Univ. of Maine, Orono, March 26, 1991.

KUSNIERZ, D. "Wetlands and waterfowl." Talk given at 1991 4H Day at the University of Maine, Orono, April 6, 1991.

MORING, J.R. "Salmonid aquaculture." Guest lecture to the Aquaculture class, University of Maine, Orono, December 13, 1990.

MORING, J.R. "Salmonid aquaculture." Guest lecture to the Introduction to Marine Science class, University of Maine, Orono, april 22, 1991.

O'CONNOR, R.J. "Bird populations and agricultural impacts in Britain." Poster presentation at Ecological Indicators Symposium, October 16-19, 1990.

O'CONNOR, R.J. "A retrospective study of bird populations in North America." Paper presented at USEPA Environmental Research Laboratory, Athens, GA, February 8, 1991.

OWEN, R.B., Jr. "The Odyssey." Talk presented at the annual meeting of Phi Kappa Phi, Orono, ME.

OWEN, R.B., JR. "Ecology of marine birds." Presentation at University of Maine Alumni College, Orono, June 5, 1991.

OWEN, R.B., JR. "Ecology of northern Maine." Presentation to Boy Scouts of America, Maine High Adventure Guide Training Program, Howland, ME, June 6, 1991.

OWEN, R.B., JR. "Wildlife conservation in East Africa." Presentation to the Junior Conservation Camp, Branch Lake, ME, August 13, 1991.

RUDNICKY, T. "Wildlife camouflage." Talk given at 1991 4H Day at the University of Maine, Orono, April 6, 1991.

RYAN, J. "Mercury update in an acid-stressed system." Seminar presented as part of the Zoology Department Faculty/Student Colloquium Series, University of Maine, Orono, October 19, 1990.

SHEPARD, S. "The guys in the black hats: and industry perspective." Seminar presented as part of the Zoology Department Faculty/Student Colloquium Series, University of Maine, Orono, October 15, 1990.

SMITH, T. "Swimming activity of Atlantic salmon and brook trout exposed to acid and aluminum." Seminar presented as part of the Zoology Department Faculty/Student Colloquium Series, University of Maine, Orono, March 1, 1991.

VANDERPOOL, A.M. "Now you see it, now you don't: the perils of radio-telemetry." Seminar presented as part of the Zoology Department Faculty/Student Colloquium Series, University of Maine, Orono, October 4, 1990.

VERA, C. "Predators in Maine." Talk given at 1991 4H Day at the University of Maine, Orono, April 6, 1991.

VICKERY, P. "A naturalist in the Soviet Union." Talk given to Bath Area Citizens, Bath, Maine, March 21, 1991.

VICKERY, P. "Endangered species conservation in wildlife reserves." Talk given Conservation Biology, University of New Hampshire at Kennebunk, ME, May 7, 1991.

AWARDS, HONORS, AND APPOINTMENTS

ELLIOTT, C.A. Elected president of the Maine Chapter of The Wildlife Society, 1992-93.

GILBERT, J.R. Chief U.S. scientist, U.S. delegation to participate in joint US-USSR walrus survey.

HUNTER, M.L., JR. Chaired the session "Identifying Critical Wildlife Habitat" at the Northeast Fish and Wildlife Conference, Portland, ME.

HUNTER, M.L., JR. Appointed to the Species Survival Commission of the World Conservation Union in Switzerland.

HUNTER, M.L., JR. Given endowed chair as Libra Professor of Conservation Biology.

HUNTER, M.L., JR. Judge for the best student paper for Society for Conservation Biology, Madison, WI.

KROHN, W.B. Chaired a poster session at the Northeast Fish and Wildlife Conference, Portland, ME.

KROHN, W.B. Invited to serve on a panel discussing harvest management at the International Symposium on the Biology and Management of Martens and Fishers, University of Wyoming, Laramie, WY.

KROHN, W.B. Promoted to rank of Professor of Wildlife and Cooperating Professor of Zoology, University of Maine, Orono.

LONGCORE, J.R. Honored by U.S. Fish and Wildlife Service as 1990 Unusually Outstanding Employee for unusually outstanding contributions to the Service's mission.

MOREAU, D. Received research grant award, New England Salmon Association.

MOREAU, D. Awarded a grant from the Association of Graduate Students, University of Maine.

MORING, J.R. Special Achievement Award for Research, U.S. Fish and Wildlife Service.

MORING, J.R. Quality Performance Award for Research, U.S. Fish and Wildlife Service.

MORING, J.R. Promoted to rank of Professor of Zoology, University of Maine, Orono.

MORING, J.R. Chaired an anadromous fish session at the Northeast Fish and Wildlife Conference, Portland, ME.

MORING, J.R. Chair of the Nominating Committee, Northeastern Division, American Fisheries Society, and member of the American Fisheries Society's Executive Committee.

O'CONNOR, R.J. Appointed a member of the Advisory Committee for the American Ornithologist Union's reference series The Birds of North America.

O'CONNOR, R.J. Chosen as one of 24 selected attendees from major research groups in the U.S. to participate in "The Visualization Experience," a workshop to help seed the scientific community with expertise in scientific visualization.

VANDERPOOL, A. Received Olin Fellowship, Atlantic Salmon Federation.

VANDERPOOL, A. Received Horace Bond Scholarship, Penobscot County Conservation Association.

VANDERPOOL, A. Received research grant award, New England Salmon Association.

VANDERPOOL, A. Received a Migratory Fish Research Institute travel grant.

VICKERY, P.D. Four-year appointment as Councilor, Association of Field Ornithology.

VICKERY, P.D. Chosen as judge for the 1991 Maine Duck Stamp.

VICKERY, P. Elected chair, Nongame Advisory Committee, Maine Department of Inland Fisheries and Wildlife, 1991-1992.