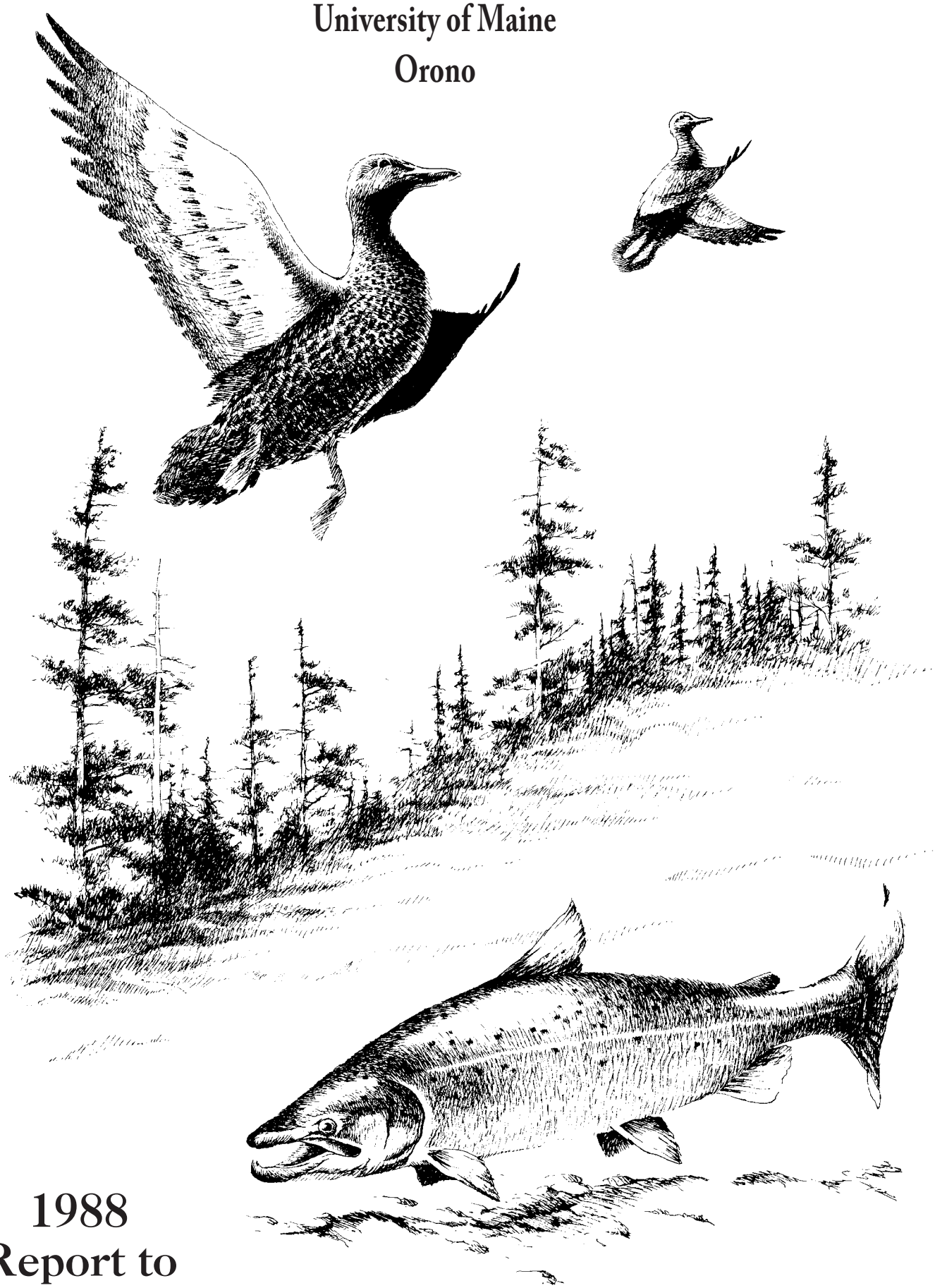
MAINE COOPERATIVE FISH AND WILDLIFE RESEARCH UNIT

University of Maine

Orono



1988 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 1987 - September 1988

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

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*The Unit's Fisheries Program is located in Murray Hall and is part of the Department of Zoology, College of Arts and 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

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College of Forest Resources
Ray B. Owen, Jr., Chairperson, Department of Wildlife
College of Forest Resources
James D. McCleave, Chairperson, Department of Zoology
College of Arts and Sciences

U.S. Fish and Wildlife Service
W. Reid Goforth, Supervisor, Cooperative Fish and Wildlife Research Units Center

Wildlife Management Institute
Laurence R. Jahn, President

UNIT PERSONNEL

Unit Staff
- William B. Krohn, Unit Leader
  Associate Professor of Wildlife and Zoology
- John R. Moring, Assistant Leader for Fisheries
  Associate Professor of Zoology
- Kathryn G. Hallett, Unit Secretary - Fisheries
- Maxine L. Horne, Unit Administrative Assistant - Wildlife
- Shirley Moulton, Secretary - Wildlife
- Stephen M. Arthur - Research Associate

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- Ray B. Owen, Jr., Chairperson, Department of Wildlife
  College of Forest Resources, and Professor of Wildlife
- James D. McCleave, Chairperson, Department of Zoology
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- James R. Gilbert, Associate Professor of Wildlife
- William E. Glanz, Associate Professor of Zoology
  and Cooperating Associate Professor of Wildlife
- Kevin J. Boyle, Assistant Professor, Department of Agriculture
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- Malcolm L. Hunter, Jr., Associate Professor of Wildlife
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- Susan Anderson, Administrative Assistant, USFWS-NFCRC

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 Management Section

GRADUATE STUDENTS

Name	Degree Candidacy	Support
Beverly Agler	M.S.	Personal Funding
Brian Bogaczyk	M.S.	USFWS-WO; MCFWRU
MaryEllen Chilelli	Ph.D	MDIFW; MCFWRU; NRA
Andrea Colnes	M.S.	McIntire-Stennis
Lisa A. DeBruyckere	M.S.	USFWS - Refuge Division
Holly Devaul	M.S.	U of M, MCFWRU, MDIFW
Duane R. Diefenbach	M.S.	Hatch Act
Catherine Frazer	M.S.	USFWS - PWRC
Scott W. Herke	M.S.	MDIFW, MCFWRU, U of M
Susan Hills	Ph.D.	USFWS-AFWRC
Sarah Hooper	M.S.	McIntire-Stennis
Charles M. Jagoe	Ph.D.	USFWS
Susan Livingston	M.S.	MDIFW, USFWS
Thomas McCall	Ph.D.	Hatch; McIntire-Stennis
Daniel B. McKinley	M.S.	USFS - WMNF and GMNF
Craig McLaughlin	Ph.D.	Personal Funding
Leslie H. Mink	M.S.	MDIFW, MCFWRU
Glenn P. Morlock	M.S.	U of M
Enama Mugangu	Ph.D.	AFGRAD
Thomas Paragi	M.S.	MDIFW; MCFWRU
Stanislas J. Pauwels	Ph.D.	USFWS, U of M
Cynthia M. Perry	Ph.D.	USFWS, U of M, PCCA, MCFWRU
Gregory P. Romig	M.S.	USFS - WMNF and GMNF
Midori Saeki	M.S.	NPS
Richard E. Sayers, Jr.	Ph.D.	MDIFW, U of M, MCFWRU, PCCA, ASF
Robert L. Schooley	M.S.	U of M
Lisa A. Shively	M.S.	McIntire-Stennis
Sarah S. Stockwell	Ph.D.	Personal Funding
Johannes Subijanto	M.S.	HIID
Beatrix E. Treiterer	M.S.	MDIFW, NWTF
Joan G. Trial	Ph.D.	USFWS
W. Matthew VanderHaegen	Ph.D.	U of M, USFWS (NEL, MNWA), PCCA, HWR, TBF
Eleta J. Vaughan	M.S.	U of M
Sharri A. Venno	M.S.	Personal Funding
Peter D. Vickery	M.S.	NC; MAS; MPCB; MAAS; CB
Andrew A. Whitman	M.S.	U of M
Lois Winter	M.S.	NPS
Pralad B. Yonzon	Ph.D.	U of M; WWF

Graduate Students: Dissertations/Theses Completed This Period

MaryEllen Chilelli	Ph.D.
Lisa A. DeBruyckere	M.S.
Duane Diefenbach	M.S.
Catherine Frazer	M.S.
Scott W. Herke	M.S.
Charles M. Jagoe	Ph.D.

Susan Livingston	M.S.
Beatrix Treiterer	M.S.

PERSONNEL NOTES

DR. RAY OWEN, JR. is on sabbatical until January 1, 1989, and **DR. JAMES GILBERT** is Acting Chair of the Department.

DR. DONALD SPALINGER left the Wildlife Department in August and accepted a research position at Texas A&M University with their Agricultural Research and Extension Center.

THOMAS HODGMAN (M.S., Washington State, 1988) was hired as a Research Associate for the Wildlife Department replacing **DAN LICHT**, who is now a technician with the U.S. Fish and Wildlife Service at the Northern Wildlife Prairie Research Center.

The following Wildlife graduates received their degrees at either the December, May, or August commencements: **MARYELLEN CHILELLI** completed her Ph.D. program. **LISA DeBRUYCKERE** received her M.S. degree and is a State Game Warden in Missouri. **DUANE DIEFENBACH** obtained his M.S. degree and is now a Ph.D. candidate at the University of Georgia. **CATHERINE FRAZER** completed her M.S. program and in September and is employed by the U.S. Fish and Wildlife Service in California. **SUSAN LIVINGSTON** received her M.S. degree and is working on an eagle project in Wyoming (USFWS). **BEATRIX TREITERER** completed her M.S. program and was married in July.

In Fisheries, **SCOTT HERKE** received his M.S. degree and is now employed by the U.S. Army Corps of Engineers in Massachusetts, and **CHARLES JAGOE** received his Ph.D. and has accepted a post-doctoral position at Rutgers University's Pinelands Field Station in New Jersey.

COLLABORATING AGENCIES AND ORGANIZATIONS

Atlantic Salmon Federation - ASF
Coastal Blueberry, Inc. - CB
Dupont
Hirundo Wildlife Refuge - HWR
Holt Woodlands Research Foundation - HWRF
International Paper Company - IPC
Kennebec Log Driving Company - KLDC
King Mahendra Trust for Nature Conservation
L.L. Bean, Inc. - LLB
Maine Atlantic Sea-Run Commission
Maine Audubon Society - MAS
Maine Department of Conservation - MDC
Maine Department of Environmental Protection - MDEP
Maine Department of Inland Fisheries and Wildlife - MDIFW
Maine Land Use Regulation Commission

Maine Pesticides Control Board - MPCB
Massachusetts Audubon Society - MAAS
National Geographic Society - NGS
National Rifle Association - NRA
National Wild Turkey Federation - NWTF
   Maine Chapter - NWTF-MC
National Wildlife Federation - NWFD
Nature Conservancy - NC
   Maine Chapter - NC-MC
   NE Regional Office
Nepal Department of National Parks and Wildlife
North American Wildlife Foundation -
   Delta Waterfowl & Wetland Research Station - DWRS
Penobscot County Conservation Association - PCCA
Taylor's Bait Farms, Inc. - TBF
Tribhuvan University
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 Life Sciences and Agriculture
      Department of Agricultural Resource Economics
   Graduate School
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
   Office of Information Transfer - OIT
   Patuxent Wildlife Research Center - PWRC
   Selawik National Wildlife Refuge - SNWR
   Washington Office - WO
U.S. Forest Service - USFS
   White Mountain National Forest - WMNF
   Green Mountain National Forest - GMNF
U.S. National Park Service - NPS
   Acadia National Park
   Boston Regional Office
World Wildlife Fund - WWF

NESTING HABITAT MODELS FOR BALD EAGLES IN MAINE

Investigator: S. A. Livingston

Advisors: R. B. Owen, Jr., Co-chairperson
W. B. Krohn, Co-chairperson
W. E. Glanz

Cooperators/ Project Support: Maine Department of Inland Fisheries and Wildlife
U.S. Fish and Wildlife Service - Region 5, Newton Corner, MA.
Maine Cooperative Fish and Wildlife Research Unit

Objectives:

(1) Construct a model that will determine if an area is potential bald eagle nesting habitat.
(2) Test the predictability and stability of the models through cross validation.
(3) Apply models on historically used nests to assess their potential for re-establishment.

Project Status:

All requirements for the degree of Master of Science (in Wildlife Management) were completed in December 1987. An abstract of the thesis follows:

Thirty-nine habitat variables describing human disturbance, prey presence, water bodies, and forest continuity were measured within 500 and 1500 m, respectively, of 82 occupied bald eagle (*Haliaeetus leucocephalus*) nests and 88 random sites in Maine. Discriminant function analysis was applied to nest and random sites within river, lake, marine mainland, and marine island habitat types to derive 4 models. Models were tested using cross validation.

Compared to random sites, bald eagle nests were located on river stretches with a larger basin area, less forest edge and closer to the shore. The lake model indicated that bald eagle nests were positively associated with the number of superdominant trees, and negatively associated with distance to water, area of land disturbed by humans, and area of land that is harvested for timber. Although food related variables did not occur in the model, bald eagles avoided coldwater lakes ($P < 0.05$), lakes with only 1 species of their major warmwater fish prey ($P \leq 0.01$), and selected lakes with all 5 species of warmwater fish prey ($P < 0.01$). The number of diadromous fish species and area of water <6 ft deep during low tide were positively associated with bald eagle nests in marine mainland habitats; the length of roads near nests was a negative variable. Compared to random points, eagles nesting on offshore islands selected sites with larger openings, less forest edge, and a smaller area of combined shallow water and intertidal area. Removal from disturbance seemed to be the key requirement of eagles nesting on marine islands.

The respective models correctly classified 100% of the 26 river sites, 91% of the 57 lake sites, 90% of the 62 marine mainland sites, but only 75% of the 32 marine island sites. Similar classification rates, which never differed by more than 8 percentage points in any model, occurred during cross validation and indicated model validity. Higher misclassification by the marine island model may be due to a difference in the way bald eagles use this more open habitat to obtain prey.

Lake or marine mainland models were applied to 15 historic nests in and around the Kennebec estuary. Thirteen were classified as being potential habitat, and protection should be established at these sites. Remaining historic nest sites should be evaluated. Waters with a diverse prey base should next be targeted for model application. Habitat evaluation via use of these models can help fortify existing eagle concentrations, as well as expand their distribution into peripheral areas.

NEPAL-HIMALAYAS RED PANDA PROJECT

Investigator: P. B. Yonzon

Advisors: M. L. Hunter, Jr., Chairperson
W. E. Glanz
R. B. Owen, Jr.

Cooperators/ Project Support: World Wildlife Fund
Environment and Policy Institute, East-West Center
Department of National Parks and Wildlife Conservation
King Mahendra Trust for Nature Conservation
Tribhuvan University

Objectives:
(1) Develop techniques for assessing the distribution and status of red pandas.
(2) Provide basic information on red panda ecology regarding habitat selection, diet, and social systems.

Scope:

Red pandas (*Ailurus fulgens*), the sole species in an endemic monotypic family of the Himalayas and adjacent ranges, have become rare because of ever-increasing deforestation. Although there have been more than a dozen studies on captive populations of red pandas, little is known about their distribution and status in the wild. Red pandas are a protected species in Nepal and CITES has included them in Appendix II, whereby they are subjected to strict trade regulations to avoid exploitation. Because red pandas are stenotypic, they could serve as an indicator of ecological conditions in those habitats to which they are adapted. In conserving habitats for red panda, it is probable that the life requisites of many species in the community will also be satisfied. Thus, it is likely to be a sensitive index of ecosystem integrity.

A two-year ecological study of red pandas will be carried out in the Langtang National Park, Nepal. The study will emphasize developing methods for studying red pandas, and a broad array of data on habitat selection, movements, diet, and social system will be gathered.

Besides the study on red panda ecology for long-term conservation, a technical training component is also incorporated into this project. A key component of this program is the involvement of Nepali biologists in conservation research. Graduate students from Tribhuvan University will be involved by undertaking related, short-term studies.

Project Status:

Two graduate students from Tribhuvan University participated as assistants and prepared their master's degree theses. Five adult pandas

were captured and radio-collared to monitor their movement, activity, and reproduction.

Pandas range altitudinally from 2,800-3,900 m throughout the year. Resting sites were largely trees, rocky outcrops, and tree hollows, and different tree species were preferred seasonally. Occasionally, pandas moved from tree to tree, avoiding soft snow on the ground. Mortality of cubs was high. The bulk of their diet was ringal bamboo (*Arundinaria sp.*), preference existed between two species of ringal bamboo. From September to November, their altitudinal movements were largely dictated by availability of seasonal fruits.

Future Plans:

Data analysis is underway, and the dissertation will be completed in July 1989.

SURVIVAL OF ATLANTIC SALMON AND STEELHEAD RAINBOW TROUT

Investigators: J. R. Moring
P. W. Bley

Cooperators/
Project Support: U.S. Fish and Wildlife Service - Office of Information Transfer, Ft. Collins, CO.

Objective: Prepare a report summarizing the current published and unpublished information on survival in fresh and salt water of Atlantic salmon and steelhead rainbow trout, for use by the U.S. Fish and Wildlife Service managers and other agencies.

Scope:

The U.S. Fish and Wildlife Service is currently refining several restoration models for Atlantic salmon. To maximize predictive confidence, accurate estimates of such factors as ocean and freshwater survival rates must be included in the model. As steelhead trout are close relatives of sea-run Atlantic salmon, comparative data on survival for this species would be advantageous to use as well. Much of the available data on survival of Atlantic salmon and steelhead trout is unpublished, with limited published papers. A report consolidating this information into one source is needed for managers developing salmon restoration models.

Project Status:

The project is completed and a report "Freshwater and Ocean Survival of Atlantic Salmon and Steelhead: A Synopsis" was issued in July 1988.

ECOLOGY OF NORTHERN PIKE IN MAINE

Investigator: S. W. Herke

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

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

Objective: To provide data on movements, age and growth, and food habits of northern pike in the Belgrade Lakes region of Maine.

Scope:

Northern pike (*Esox lucius*) were illegally introduced to the Belgrade Lakes region of Maine in the late 1970s. Since that time, pike have spread to four lakes and the Kennebec River. There is virtually no information on the species in Maine, and fish managers need accurate information on food habits, movements, age and growth, spawning locations and conditions, and other aspects of the life history. The species is now being actively pursued by anglers, and fish up to 9 kg (20 lbs.) have been taken in increasingly popular ice and open water fisheries. It is important to know if habitat requirements of pike parallel those of chain pickerel (*E. niger*).

The project involved collecting pike and chain pickerel primarily from Great Pond using gill nets, trap nets, and angling. Radio tags were placed on larger pike, and all escocids were tagged with Floy anchor tags. Scales were collected from all pike and pickerel, and the habitat of capture location was documented in terms of depth, water temperature, and vegetation. A selected number of pike and pickerel were examined for food habits. Additional samples of scales, stomachs, and length-weight data were obtained from specimens collected by anglers at derbies and from creel clerks.

Project Status:

The project is completed and all requirements for the degree of Master of Science in Zoology have been met. An abstract of the thesis follows:

Northern pike (*Esox lucius*) were illegally introduced during the mid-1970s into the Belgrade Lakes region of Maine, which already supported a large population of another esocid, the chain pickerel (*E. niger*). Movement patterns, genetics, and food habits of both species were studied in the largest (3,334 ha) lake, Great Pond.

Movement patterns were investigated by mark-and-recapture techniques (Floy anchor tags) as well as by underwater telemetry. The latter required development and evaluation of a new technique for externally attaching large radio transmitters to northern pike; although this technique worked well, some modifications are recommended. The Floy anchor tag results indicated that chain pickerel do not maintain restricted home ranges for long time periods, although two specimens were recaptured at their release sites 118 and 239 days after being tagged. No significant homing ability by chain pickerel was demonstrated. Radio transmitter results indicated that (1) pike are generally sedentary fish which do maintain restricted home ranges (although some specimens did move long distances — 3-10 km), (2) night and day movements of pike are similar, (3) members of a spawning group do not form "localized" populations during the remainder of the year, (4) large (3.2-7.5 kg) pike usually reside in shallow (1-3 m) water, but may also utilize deeper (> 6 m) water, (5) large pike are usually associated with vegetation, (6) the consensus of other research that swimming energy costs are relatively unimportant to pike energy budgets may need re-evaluation, at least for large (> 4 kg) pike, (7) weather patterns have no discernible effects on pike movements, and (8) the optimal temperature range (19-21°C) for growth of northern pike calculated by Casselman (1978) is correct.

Investigation of the genetics of these esocids by protein electrophoresis and mitochondrial DNA digestion demonstrated the existence in Great Pond of natural hybirds produced by matings of female chain pickerel and male northern pike. Substantial genetic divergence ($D = 1.9$; $p > 10.3\%$) between these two esocids was also revealed, indicating that the subgenus, Kenoza, of the chain pickerel may need to be elevated to generic status.

Investigation of the food habits of 62 chain pickerel and 15 northern pike from Great Pond revealed predatory behavior that was similar to what has been reported for these esocids in the literature. (1) Empty stomachs occurred in 29% of chain pickerel and 40% of northern pike. (2) Northern pike were totally piscivorous, while chain pickerel consumed crayfish and dragonfly (Anisoptera) larvae in addition to fishes. No predation on waterfowl or stocked landlocked Atlantic salmon was noted, but other evidence suggests that such predation exists. (3) Chain pickerel preferred spiny-rayed prey; northern pike tended to select soft-rayed forage fishes. Forage supplies in Great Pond are probably of sufficient quality and quantity to support high growth rates of esocids. These two esocids are expected to compete for prey (e.g., Atlantic salmon), and the demise (as a fishery) of the chain pickerel population is a possibility. (4) No substantial diet differences between male and female esocids were found. (5) The optimum size of prey appears to be about 20% and 25% of the length of the predator for northern pike and chain pickerel, respectively.

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 a refuge and nursery. 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 located 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:

Work continued in 1988 on retention of shorthorn sculpins and juvenile lumpfish in tidepools through a series of mark-recapture experiments. Fin regeneration was evident within one month for juvenile lumpfish, and a significant number of individuals remained in tidepools during a 15-day study. Two papers were accepted and a third is being prepared for publication and oral presentation.

Future Plans:

Experiments planned for 1989 include re-examination of an intertidal fish community 20 years after the initial study, and behavioral studies with species of intertidal fishes. Additional publications are being prepared.

EVALUATION TECHNIQUES FOR DISTINGUISHING STOCKS OF ATLANTIC SALMON

Investigator: C. M. Perry

Advisors: J. R. Moring, Chairperson
W. A. Halteman
T. A. Haines
S. J. Hunter
S. Tyler
H. L. Kincaid

Cooperators/ Project Support: U.S. Fish and Wildlife Service - National Fishery Research and Development Laboratory, Wellsboro, PA.
Penobscot County Conservation Association
University of Maine

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

Scope:

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

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

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

Lower lethal limits of EC_{50}'s were calculated along with photographic, histological, and physiological (whole body and blood

serum chemistry) analyses at each life stage for each source.

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

Project Status:

The initial stage of the project has been completed and a Final Report submitted to the National Fishery Research and Development Laboratory in February 1988. New laboratory studies dealing with the role of calcium on toxicity of acidic pH and aluminum to Atlantic salmon will be done through a series of laboratory experiments in Missouri and Maine examining gill and epidermal histopathology. Initial testing began in May 1988.

Future Plans:

Laboratory work will continue into early summer 1989. A Ph.D. dissertation is expected to be completed in fall 1989.

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

Investigator: R. E. Sayers, Jr.

Advisors: J. R. Moring, Chairperson
W. A. Halteman
W. E. Glanz
J. R. Gilbert
J. D. McCleave

Cooperators/ Project Support: Maine Department of Inland Fisheries and Wildlife
Maine Cooperative Fish and Wildlife Research Unit
Maine Atlantic Sea-Run Salmon Commission
Atlantic Salmon Federation

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

Scope:

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

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

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

Project Status:

The project is ongoing. Field work will be completed in October 1988. A paper on project results was presented at the 1988 annual meeting of the Atlantic International Chapter of the American Fisheries Society.

Future Plans:

Data analysis will continue during winter, 1988-89, and a dissertation is scheduled for completion in May 1989.

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

Investigator: D. B. McKinley

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

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

Objective:

(1) Determine what level of sampling stream 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, recreation, 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 NFs 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 habitat conditions, where feasible. Therefore, there is a need for intensive habitat surveys on most of the streams on both National Forests. The technical subcommittees for both the Merrimack and Connecticut River Atlantic salmon restoration programs have recommended a methodology to be utilized by the Forest Service for these surveys. This methodology is based on one developed in Maine and cost estimates range from $466 to $621 per kilometer ($750-$1,000 per mile). Alternative ways to improve habitat survey efficiency need to be explored, especially in light of limited funding for the entire program. One approach which needs to be investigated is the use of representative reaches, whereby the habitat data collected within sample sections of these reaches is assumed to be representative of the entire reach. If this approach is feasible, a larger amount of stream miles could be surveyed for the same amount of money.

Project Status:

Stream measurements and sampling began in June 1988 and were completed in October 1988. Field research for the degree of Master of Science was completed in early October and involved a series of salmon density manipulations on a stream in Vermont and one in New Hampshire. In addition, day/night habitat selection measurements were compiled, and standard study sites were monitored and habitat measured.

Future Plans:

Data analysis will continue in winter, 1988-89, and a final report will be issued to the U.S. Forest Service in 1989. A thesis will be completed by summer 1989.

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

Investigator: G. P. Romig

Advisor: J. R. Moring, Chairperson

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

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

Scope:

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

Project Status:

The project only began in September 1988 with initial funding and the arrival of a new graduate student/investigator.

Future Plans:

Project planning will proceed until spring 1989. Field work will occur from late spring to fall in 1989, centered on 2-3 streams on each of the two National Forests. A thesis is scheduled for completion in May 1990.

BIOLOGY OF WHITE PERCH IN LAKE GEORGE, MAINE

Investigator: L. H. Mink

Advisors: J. R. Moring, Chairperson
W. E. Glanz
M. Gilmartin

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

Objectives:
(1) To describe the age structure and food habits of white perch in Lake George, Maine
(2) To compare the food habits of white perch and sea-run alewives in two ponds in central-coastal Maine to assess possible competition for food resources between the two species.

Scope:

The Maine Legislature has directed the Maine Department of Marine Resources (DMR) to restore sea-run alewives to their former range in Maine. Such restoration has caused concern among other state agencies that alewives may adversely affect gamefishes already established in such waters. A cooperative project is underway between the DMR, MDIFW, and the University to study the fishes and plankton in Lake George for three years prior to the experimental introduction of sea-run alewives, then continue to study the fish community for several years after introduction.

This project concentrates on the pre-introduction status of white perch in Lake George. To compare food habits of white perch and alewives, collections are also being made in two other ponds, Biscay and North, where the two species already co-exist. The results will form part of the pre-introduction component of the overall study.

Project Status:

Field work began in June 1988 in the three ponds, and was completed in October 1988. Fishes have been collected using trapnets, gill nets, seines, and hook-and-line gear. The project is active and analysis will continue.

Future Plans:

Analysis of data in winter, 1988-89, will culminate with the scheduled completion of a thesis in May 1988.

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

Investigators: K. J. Boyle, Co-advisor
S. D. Reiling, Co-advisor
L. Demirelli, Asst. Scientist
M. L. Phillips, Research Assistant
V. A. Trefts, Graduate Research Assistant
E. J. Rudnicki, Jr., 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 Resource
Maine Cooperative Fish and Wildlife Research Unit

Objective:

(1) Estimate monetary values, use rate, and expenditures associated with the use of selected species and groups of species of Maine's recreational fish and wildlife resources. This will be done using data from surveys that are developed and administered as part of the study.
(2) Consumptive and nonconsumptive users' motivations for participating in fisheries and wildlife-related activities will be identified as part of the survey effort.
(3) The surveys will be designed to evaluate improved consumptive and/or nonconsumptive use opportunities for selected species where possible.
(4) The results of objectives (1), (2), and (3) will be disaggregated as to whether respondents are residents or nonresidents in Maine where possible.
(5) An economic analysis of trapping activities within Maine, including trapping itself and the other production aspects of the trapping industry in Maine as hides and animals products are processed and resold, will be conducted.
(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 with 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:

Currently hunters, trappers, anglers, and nonconsumptive users of Maine's fish and wildlife resources are being surveyed by mail to collect the data necessary to do the required analysis.

Future Plans:

The survey work will continue throughout the next year with analyses of the data proceeding concurrently. Interim reports will be provided to the Legislative Commission in December 1988 and December 1989. A final report will be forthcoming in late 1990.

A LONG-TERM FOREST ECOSYSTEM STUDY

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

Cooperators/
Project
Support: Holt Woodlands Research Foundation

Objectives:

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

Scope:

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

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

Our primary objective is to describe the structure of the plant and animal community. We are undertaking (1) a 100% inventory of trees (>10cm DBH) and intensive inventories of tree regeneration, (all trees are being individually numbered and, on 12 ha locations, mapped); (2) a complete description of the vascular plant vegetation using the releve 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) meterological observations. These data, largely population estimates, are integrated by area units (usually 0.25 ha blocks) and analyzed to portray the forest's 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 the winter of 1987-1988, group selection cutting was undertaken on 10 one ha blocks distributed through the managed area in a randomized block design. All the tasks undertaken annually (3-10, as outlined above) were performed plus detailed post-harvest measurements of the vegetation (Tasks 1 and 2).

Future Plans:

In 1989 tasks 3-10 will be continued and analysis of the first five years of data initiated. A new structure was completed on the site that has a large storage and work area on the ground floor and a dry lab, kitchen, two bedrooms, and bathroom upstairs.

THE EFFECT OF BLUEBERRY MANAGEMENT ON THE NESTING ECOLOGY OF BLUEBERRY BARREN AVIFAUNA

Investigator: P. D. Vickery

Advisors: M. L. Hunter, Jr., Chairperson
P. W. Brown
W. E. Glanz
G. L. Jacobson

Cooperators/ Project Support: The Nature Conservancy - Maine Chapter
Northeast Regional Office
Maine Audubon Society
Maine Pesticides Control Board
Massachusetts Audubon Society
Coastal Blueberry, Inc.
Dupont

Objectives:

(1) Identify the species composition and relative abundance of birds found nesting on blueberry barrens in southern Maine.
(2) Identify the vegetational requirements of birds nesting on blueberry barrens.
(3) Determine the impact of blueberry management on the avian community of nesting 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. Bird life has co-existed with blueberry management for many decades. Recent introduction of the herbicide hexazinone (Velpar) on blueberry barrens may alter the vegetation sufficiently to have a detrimental effect on birds nesting in this ecosystem.

The Kennebunk Blueberry Barrens support a small but unique group of breeding birds. These include upland sandpiper, horned lark, bobolink, eastern meadowlark, vesper sparrow, savannah sparrow, and grasshopper sparrow. The latter species is considered a rare nesting bird throughout New England and is experiencing significant, long-term declines throughout its range. The Kennebunk Blueberry Barrens supports the second largest grasshopper sparrow population, some 30 pairs, presently known in New England.

Project Status:

Five years of data have been collected on the breeding population and distribution of grasshopper sparrows. Data on nest predation have been analyzed and a manuscript is near completion. A second manuscript on reproductive success is in preparation.

Future Plans:

Additional data following the distribution and nesting densities of the grassland birds at the Kennebunk Plains will be collected.

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

Investigators: C. M. Jagoe
S. J. Pauwels
C. W. Fay
T. A. Haines
R. W. Perry

Advisors: T. A. Haines, Chairperson (for Jagoe and Pauwels)
J. R. Moring
K. E. Gibbs
M. L. Hunter, Jr.
J. D. McCleave
S. A. Norton
B. D. Sidell
G. L. LaCroix

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

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

Scope:

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

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

Project Status:

The project is ongoing, with some segments completed and other segments beginning. All requirements for the degree of Doctor of

Philosophy have been met by Charles Jagoe. An abstract of the dissertation follows:

Atlantic salmon (Salmo salar) inhabit freshwater during part of their life cycle, and can be exposed to low pH and aluminum concentrations that disturb gill functions such as ion regulation, acid base balance, and gas exchange in fish. Electron microscopy showed that exposure of fry to 75 ug/1 or more inorganic aluminum at pH 5.5 caused hyperplasia and development of apical crypts in chloride cells, which are involved in ion transport. Fusion of primary and secondary lamellae was observed. These effects would interfere with gill function. Abnormalities did not occur when humic acid was present to chelate aluminum, suggesting that only the inorganic form is toxic.

One group of fish was held in water from an acid river, another in the same water treated with limestone, and a third in a river with a higher pH. Morphometric analysis showed that exposure to pH 4.5 to 5.0 caused increased numbers of chloride cells on primary lamellae, but not on secondary lamellae. Numbers of mucous cells were higher in acid exposed fish. Chloride cells in fish exposed to low pH water were larger and rounder than in control fish, suggesting increased ion transport. Liming the water partially prevented these changes.

Morphometric analysis of gills from smolts exposed to low pH and aluminum in artificial channels revealed that fish exposed to pH 5 to 6 without aluminum had more chloride cells on primary and secondary lamellae than controls. Fish exposed to aluminum (exchangeable Al 100 to 400 ug/1) at pH 5 to 6 had more primary lamellar chloride cells than controls, but the number of secondary lamellar chloride cells did not increase. Exposure to aluminum damages chloride cells, and their numbers decrease as these are lost from secondary lamellae.

Gills treated with lanthanum were examined by electron microscopy. Lanthanum tracer did not penetrate between epithelial cells in controls, but cell junctions were permeable to lanthanum in acid stressed fish. No difference was observed between fish exposed to low pH with or without aluminum. Exposure to low pH caused the tight junctions that normally seal gill epithelia to become leaky, allowing plasma ion losses. Histochemical staining of sections from frozen gills demonstrated that chloride cells accumulated aluminum. X-ray microanalysis showed that aluminum was also bound in mucus.

Future Plans:

Toxicology work with Atlantic salmon will continue in 1989 with studies in clear-water streams, to follow previous work on brown-water streams. The ongoing Watershed Project will study trace metal recycling as affected by acid precipitation, particularly lead, mercury, and cadmium. An additional Ph.D. dissertation is expected to be completed in spring or summer 1989.

MANAGEMENT OF RIPARIAN FORESTS FOR WILDLIFE

Investigator: S. T. Hooper

Advisors: R. J. O'Connor, Chairperson
H. S. Crawford
D. J. Harrison

Cooperators/
Project
Support: McIntire-Stennis

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 use riparian zones is associated with specific habitat types, vegetation parameters, or just the presence of the stream.
3) Assess snowshoe hare use of forested riparian zones as movement corridors during dispersal.

Scope:

The importance of understanding wildlife use of riparian zones in Maine stems from development and logging along riverine systems. The potential disturbance or destruction of these riparian habitats and their associated wildlife is an issue land-use planners must consider in setting buffer zones along streams.

Because of the variety of vegetation structure along Maine's streams (compared to the general application of land-use regulations), this study will extensively monitor wildlife use of a broad spectrum of riparian habitats. Research will focus on wildlife that planners consider important in making land-use decisions: breeding birds, game mammals (deer, moose, snowshoe hare), and furbearers. Habitat components will also be evaluated to determine to which vegetation parameters, if any, the wildlife are responding. In addition, snowshoe hare will be monitored through telemetry to assess their use of riparian zones as movement corridors during dispersal.

Field work will consist of breeding bird censusing, pellet counts, vegetation sampling, and snowshoe hare telemetry. Bird species richness and pellet count data will be analyzed in relation to distance from the stream. Vegetation variables will be correlated to wildlife data to test for any associations. Snowshoe hare telemetry will compare movements of hares along streams to movements in the interior of

forests. Furbearer use of riparian zones will be analyzed using data collected by previous investigators. Locations of animals will be analyzed in relation to distance from streams and gross habitat parameters.

Project Status:

During the summer of 1988, data collected in 1987 by a previous student was evaluated and it was concluded that a new research design was needed. A plan of study with a primary emphasis on land-use planning is being developed.

Potential sites for the new study plan were identified by investigating various streams in northern and eastern Maine. Sites will be selected according to the Land Use Regulation Commission's (LURC) guidelines for streams requiring buffer zones.

An in-depth analysis of the vegetation data taken in 1987 has begun to identify any variables associated with bird species abundance. This analysis will be used to develop the methods for measuring vegetation parameters in this study.

Future Plans:

The new research protocol will be finalized by January 1989.

Field work is scheduled for spring and summer of 1989 and 1990. Pellet counts will be taken from mid-April to mid-May (after snow-melt, before leaf-out); breeding bird censuses and vegetation sampling will be conducted from mid-May through June; and snowshoe hare trapping and telemetry will take place from June through August.

Assessment and analysis of furbearer data will begin when data are available from original investigators.

INTEGRATING WILDLIFE RESOURCES INFORMATION INTO LOCAL PLANNING: A HANDBOOK FOR MAINE COMMUNITIES

Investigator: S. A. Venno

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

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

Objectives:

(1) Develop general guidelines for towns to identify and assess significant wildlife habitats.
(2) Suggest guidelines whereby towns set their own objectives and identify protection strategies consistent with existing laws and local needs.
(3) Identify and discuss options and tools available to towns for protecting significant habitats.

Scope:

Growth management has become a statewide issue as development pressures spread from southern and coastal Maine to inland lakes and mountains. This has created concern about the impact of this growth on natural resources, including wildlife. A number of changes in Maine's land use laws reflect this concern. Specifically, the state legislature has passed a law requiring municipalities to adopt comprehensive plans and ordinances by 1996. General guidelines adopted by the state as planning goals for towns include protection of significant wildlife habitat. Although a wealth of information exists about wildlife, their habitats, and various land use protection strategies, there is a need for a synthesis of this information in a form easily accessible to towns and adaptable to the local planning process.

Project Status:

A preliminary outline of the handbook has been completed, and writing of the handbook has begun.

Future Plans:

The thesis, to be done in the form of a handbook, is being developed by research into the literature, consultation with topic experts, and input from towns. Completion of the thesis is expected in December 1989.

FRUGIVORY AND SEED DISPERSAL IN OAK-PINE FOREST

Investigator: A. A. Whitman

Advisors: M. L. Hunter, Chairperson
C. Campbell

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

Objectives:

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

Scope:

Seed dispersal and frugivory by wildlife are poorly understood in the temperate zone. Most studies determine only the foods of opportunistic frugivores such as birds, canids, and mustelids without further consideration. This approach fails to investigate the significance of this plant-animal interaction to either the frugivore or the plants involved. Some biologists are beginning to explore the importance of fruit in maintaining the energetic balance of frugivores. However, the importance of frugivores to plants as seed dispersers is poorly understood. Frugivores can affect seed germination, move seeds so that seed predation is reduced, and move seeds to sites that are good for germination. 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 mammals.

Project Status:

A second field season has been completed. Preliminary analyses of the data indicate that fruit production is highly variable between sites and years. Fruit abundance peaks at the end of July or beginning of August, and quickly declines. For most fruiting species of plants, small mammals were important predators of fruit as they eat both the fruit and the seeds. Dispersal by small mammals is apparently minimal.

Future Plans:

To compare seed dispersal of birds versus mammals, the final field season will determine if dispersal by small mammals is possible for the small seeded, low bush blueberry (*Vaccinium angustifolium*).

FEEDING ECOLOGY OF NORTHERN PINTAILS, AMERICAN WIGEON, AND LONG-BILLED DOWITCHERS AT THE SELAWIK NATIONAL WILDLIFE REFUGE, ALASKA POTENTIAL EFFECTS OF MOSQUITO CONTROL

Investigator: L. A. DeBruyckere

Advisors: P. W. Brown, Chairperson
W. E. Glanz
K. E. Gibbs
J. R. Longcore

Cooperators/ Project Support: U.S. Fish and Wildlife Service - Selawik National Wildlife Refuge, AK
Regional Office, Anchorage AK

Objectives:
(1) Determine the diets of northern pintails, American wigeon, and long-billed dowitchers during the breeding season.
(2) Determine the spatial and temporal distribution of foods consumed by the above species.
(3) Make management recommendations on the use of *Bacillus thuringiensis israelensis* in Alaska based on the food habits of three waterbird species breeding on the tundra.

Project Status:

All requirements for the degree of Master of Science (in Wildlife Management) were completed in May 1988. An abstract of the thesis follows:

Foods of northern pintails, American wigeon, and long-billed dowitchers were determined by collecting birds from May to August in 1985-1986 at Selawik National Wildlife Refuge in northwest Alaska. The proportion of invertebrates in the diets of prelaying (N = 5), laying (N = 11) and postlaying (N = 16) adult female pintails was not different (range of 27.0% - 33.0% aggregate percent, dry weight, $P > 0.05$). Trichopterans and tipulid larvae were important invertebrate foods of prelaying females, whereas trichopterans and gastropods were most abundant in the diets of laying females. Corixids and gastropods were abundant invertebrates in postlaying female pintails. Plant foods accounted for 73.0% of the diet of prelaying females, 67.0% for laying females, and 72.0% for postlaying females. The diets of male and female pintails did not differ ($P > 0.05$). *Carex* spp. was common in the diets of all adult pintails. *Empetrum* spp. was abundant in prelaying and laying females and all males. *Potamogeton* spp., *Hippuris* spp. and *Vaccinium* spp. were abundant in postlaying females. Invertebrates collected in core sediments were similar in abundance and composition to those eaten by adult pintails, but invertebrates collected in sweep samples differed from those in birds. Evidently pintails obtained

invertebrates from the substrate and ingested them in proportion to their abundance.

Ingestion of invertebrates was similar for 12 Class I, 12 Class II, and 3 Class III pintail ducklings ($P > 0.05$). Plant foods accounted for 68.0% of the diet of Class I ducklings, 54.0% of the diet of Class II ducklings, and 69.0% of the diet of Class III ducklings. Ephemeropterans, pelecypods, corixids and trichopterans were abundant invertebrate foods in the diets of pintail ducklings.

Seven prelaying, 3 laying, and 21 postlaying American wigeon females and 24 wigeon males were collected. Prelaying females ate 100.0% plant foods. Laying females consumed more invertebrates (22.0%) by aggregate percent, dry weight than did postlaying females (8.0%) ($P < 0.05$). Dipterans, trichopterans and gastropods were common animal foods of laying females, whereas dipterans, anostracans, hemipterans and tripchopterans were common in postlaying females. Simuliium spp. larvae were abundant in the diet of 1 of 3 laying females. Invertebrates collected in core samples were similar to those in the diets of female wigeon, suggesting that female wigeon fed upon benthic invertebrates proportionally to their abundance.

Equisetum spp. was abundant in the diets of all adult wigeon, and Cicuta spp. and Potamogeton spp. occurred commonly in postlaying females. The algae, Nitella spp., were abundant in males and prelaying females.

Animal foods accounted for 34.0% of the diet for Class I wigeon ducklings ($N = 17$) and 8.0% for Class II ducklings ($N = 12$). Trichopterans, dipterans, and hemipterans were the most important invertebrates of Class I ducklings. Dipterans, trichopterans, and gastropods were the most abundant invertebrates of Class II ducklings. The most common dipterans in the diets of all ducklings were chironomids. Carex spp., Potamogeton spp., Hippuris spp., unidentified vegetation, Equisetum spp., and Sparganium spp. were the most abundant plant foods in the diets of all ducklings.

The proportion of invertebrates in the diets of 8 prelaying, 5 laying, and 4 postlaying long-billed dowitchers was not different (range of 19.0%-41.0% aggregate percent, dry weight, $P > 0.05$). Dipterans, particularly tipulids, were abundant foods. Potentilla spp., Carex spp., and Menyanthes spp. seeds were the most common plant foods in the diets of all birds. Invertebrate abundance and composition in the diet of all birds was similar to that in sweep samples ($P > 0.05$) but different from those in core samples ($P < 0.05$).

Water chemistries were determined for water from 3 wetland basins, 21 large, open tundra wetlands (> 0.1 km^2), 16 small, open tundra wetlands (< 0.1 km^2), and 8 oxbow lakes. All wetlands were circumneutral and contained soft water. Wetlands were moderately eutrophic and relatively uniform. Because of similarities in limnological characteristics among wetland types, water chemistry may

not influence wetland selection by birds on Selawik National Wildlife Refuge.

Greatest numbers of waterfowl were observed and greatest numbers of benthic and nektonic invertebrates were collected from wetlands with wet forb and wet graminoid herbaceous plant communities. Factors influencing wetland use by birds include wetland hydrology, basin morphometry, bird morphology, and availability of invertebrates.

CHANGES IN THE WETLAND HABITATS AND POPULATION OF BREEDING BLACK DUCKS IN SOUTHCENTRAL MAINE

Investigator: D. R. Diefenbach

Advisors: R. B. Owen, Jr., Chairperson
P. O. Corr
W. A. Halteman
W. B. Krohn
J. L. Longcore

Cooperators/ Project Support: College of Forest Resources, Hatch Act Funds
Maine Department of Inland Fisheries and Wildlife
Maine Cooperative Fish and Wildlife Research Unit

Objectives:

(1) Determine the change in number, size, and composition of wetlands since 1980 on the study area in southcentral Maine.
(2) Determine the number of breeding pairs of black ducks and other waterfowl species on the study area.
(3) Develop a mathematical model of the selection of beaver flowages by breeding pairs of black ducks based on physical/chemical/biological characteristics of the habitat.

Project Status:

All requirements for the degree of Master of Science (in Wildlife) were completed in May 1988. An abstract of the thesis follows:

Thesis objectives were to: (1) determine the change between 1977-80 and 1986-87 in the wetland habitats on 151 km^2 in southcentral Maine; (2) determine the change between 1978-80 and 1986-87 in the population of breeding American Black ducks (*Anas rubripes*) and other waterfowl species on the study area; and (3) identify the characteristics of wetland habitats selected by black ducks during the breeding season.

The number of wetlands on the study areas increased from a mean of 119 (range 116-123 wetlands) during 1977-80 to 128 during 1986-87, but the area of surface water decreased 43 ha (22.2%). The area of wetland-types preferred by black ducks declined (deciduous forested wetlands) or remained unchanged (deciduous scrub-shrub and emergent wetlands). The total area of open water, flooded alder (*Alnus rugosa*) and willow (*Salix* spp.), and flooded timber declined (44.4%, 65.3%, and 62.0%, respectively). The total area of aquatic vegetation increased (86.7%), and herbaceous and ericaceous vegetation that was flooded remained unchanged (+0.3% and 14.5%, respectively).

The changes in the vegetation and wetland-types on the study area represented a decline in the quantity and quality of wetland habitats

for waterfowl. The cause of this decline was a 38% decrease in the number of wetlands with beaver (Castor canadensis) between 1977-80 and 1986-87.

Despite the decline in the quantity and quality of wetland habitats, the number of pairs of black ducks, mallards (Anas platyrhynchos), hooded mergansers (Lophodytes cucullatus), and Canada geese (Branta canadensis) increased on the study area. The number of wood duck (Aix sponsa) pairs remained the same, and common mergansers (Mergus merganser) occurred infrequently on the study area. Black ducks may have increased because of restrictive harvest regulations, mallards may have increased on the study area partly because of the availability of their preferred habitat, man-made impoundments, and Canada geese increased as a result of a successful introduction program conducted by the Maine Department of Inland Fisheries and Wildlife (MDIFW). Wood ducks and hooded mergansers have been the focus of a waterfowl nest-box program conducted by the MDIFW and may have responded to those efforts; however, the number of wood ducks seemed to fluctuate on the study area.

Use of a wetland during the breeding season by black ducks was best predicted by the following variables: perimeter of the surface water area (SWPER, in meters), area of flooded timber (SWTIMBER, in square meters), presence or absence of beaver activity (BEAVER; 1 or 0, respectively), and whether a dwelling was visible from the wetland (DWLVIS; 1 or 0, respectively). These variables were combined in the linear-logistic model:

$$0 = \frac{e^{y}}{1+e^{y}}$$

where,

$$y = -1.99 + (2.33X10^{-3})SWPER + (1.70X10^{-4})SWTIMBER + 1.08BEAVER - 0.66DWLVIS,$$

and values of 0>0.41 predicted use by black ducks. The overall correct-classification rate was 79.8%.

THE ECOLOGY OF POST-FLEDGING AMERICAN BLACK DUCKS IN EASTERN MAINE

Investigator: C. Frazer, Graduate Assistant

Advisors: R. B. Owen, Jr., Chairperson
J. R. Longcore
W. B. Krohn
W. A. Halteman

Cooperators/ Project Support: U.S. Fish and Wildlife Service -
Patuxent Wildlife Research Center, Laurel, MD.
Moosehorn National Wildlife Refuge, Calais, ME.

Objectives:

(1) Estimate a survival rate of hatching-year female black ducks during the non-hunting period from mid-August to October 1st and for the period until birds leave Maine.
(2) Determine habitat use, bird movements from the Refuge, and pairing activity during this post-fledging period.
(3) Determine changes in habitat use, if they occur, after hunting season opens October 1st and until birds migrate in late December.

Project Status:

All requirements for the degree of Master of Science (Wildlife Management) were completed in August 1988. An abstract of the thesis follows:

This study was conducted to describe the ecology of juvenile American black ducks (*Anas rubripes*) between the time of fledging and fall migration, a previously unstudied period of the black duck life cycle. Habitat preferences, movements, and social behavior of 97 female and 15 male juvenile black ducks were studied from early September to mid-December 1985-1987 in the vicinity of Moosehorn National Wildlife Refuge (NWR) in eastern Maine and southwestern New Brunswick.

Use of 10 habitat types was compared to their availability, based on the wetland types at 640 random points within a 333.3 km^2 circular area. The most preferred habitat type during both day and night in all years and months was Palustrine Emergent Wetland ($P < 0.05$), while Lacustrine and Estuarine habitats rarely were used. Riverine habitats were used less than their availability ($P < 0.10$) in September, but became preferred habitats ($P < 0.10$) or were used in proportion to their availability ($P > 0.10$) in November, as ice formed on lentic habitats. Ducks used a wider variety of habitat types during the day than at night (X^2 tests, 4-9 df, all $P < 0.002$). Males used more Riverine habitats during the day than did females (X^2 tests, 3-6 df, all $P < 0.011$). The managed impoundments of Moosehorn NWR were the most used wetlands (66%

of diurnal, 90% of nocturnal locations), in particular, the Magurrewock marshes (41% of diurnal, 72% of nocturnal locations). Impoundments dominated by persistent, emergent vegetation were preferred ($P < 0.05$). The used impoundments were larger, with more interspersion of life forms and less flooded timber, than the unused impoundments (Wilcoxon rank-sum tests, all $P < 0.031$). Location of habitats in relation to Magurrewock seemed to be a proximate factor in habitat selection.

Movements were described by estimating Minimum Convex Polygon home ranges and radial movements from the primary roost marsh. Average home range for the entire post-fledging period was 4987 ha ($N = 105$, $SD = 5936$ ha), and the mean farthest distance moved from the roost marsh was 9.90 km ($N = 105$, $SD = 7.28$). Home ranges and distances moved from the roost increased monthly (Kruskal-Wallis tests, 3 df, all $P < 0.001$), but most birds continued using the same few roost areas through the fall. Home ranges were linear. Birds that used >15% Riverine habitat had larger home ranges and longer radial movements from the roost than the birds using >85% Palustrine wetlands (Wilcoxon rank-sum tests, all $P < 0.005$).

The young black ducks associated in small flocks ($\bar{x} = 6.1$. $N = 355$), and often were observed alone (34% of observations). Seven (9.6%) of 73 birds that I observed ≥ 3 times formed weak pair bonds, but no courtship was observed. Paired birds used more forested wetland habitats and more beaver-created wetlands than did unpaired birds (X^2 tests, 4-9 df, all $P < 0.001$).

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 vegetation diversity (PVD, horizontal heterogeneity of vegetation), peatland-FHD (overall FHD), and area. Bird density 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.

<u>Future Plans</u>:

Revise and complete thesis.

SURVEY OF BREEDING WOODLAND HAWKS AS RELATED TO FOREST MANAGEMENT

Investigator: H. Devaul

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

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

Objectives:

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

Scope:

The status of breeding birds of prey in Maine is not well-known. Although an Atlas of Breeding Birds of Maine was recently compiled (Adamus 1987), and falconers have knowledge of local populations, a systematic survey had not been conducted prior to 1987. This project was initiated to field-test the "Area Occupied" method (Geissler and Fuller 1987) of analyzing survey data from areas representing three land uses in Maine (i.e., commercial clear-cuts, unharvested, and woodlot/agriculture). Intensive commercial harvesting occurs over a large portion of northern Maine, and land-use is gradually intensifying in southcentral Maine, modifying potential breeding habitats. Raptors characteristically have large home ranges, are easily disturbed at the nest site, and often return to the same nest or tract of land year after year. Land-use practices and disturbance by humans influence the suitability of an area. It is important to know how various land uses, particularly forest management, affect the species composition of breeding birds of prey before large areas are so modified as to become unsuitable. A survey technique which produces reliable results is necessary to obtain this information and to provide baseline data for future monitoring. The "Area Occupied" method (AO) is designed for use with rare or uncommon species, has been successfully used in other eastern and midwestern locations.

Project Status:

Weekly point-counts were conducted during the breeding season in 3 study areas. In 1987, 2 areas in north-central Maine were surveyed; a commercially-harvested area (Telos) and an adjacent unharvested area (Baxter). In 1988, an area in southcentral Maine was surveyed, representative of mixed agriculture and small woodlot management (Waldo). Of the 8 species potentially present in the areas, 4 species (broad-winged, red-tailed, red-shouldered, and sharp-shinned hawk) were observed in Baxter, 5 species (broad-winged, red-tailed and sharp-shinned hawk, American kestrel, and northern harrier) were observed in Telos, and all 8 species (broad-winged, red-tailed, red-shouldered, sharp-shinned and Cooper's hawk, northern goshawk, American kestrel, and northern harrier) in Waldo.

Estimates of proportion of area occupied (AO) and probability of detection (PD) were obtained using a computer program available from Patuxent Wildlife Research Center in Laurel, MD. These data show a trend in proportion of area occupied (AO) for broad-wings, from a low in Telos (48%), intermediate in Waldo (78%) to a high in Baxter (100%). Red-tailed hawks were observed too infrequently in Waldo to produce an estimate, but occupied an estimated 9% of Baxter and 93% of Telos. Red-shouldered hawks were absent in Telos, observed too infrequently for analysis in Baxter, and occupied an estimated 29% of the Waldo study area. Low PD's were obtained for all species, ranging from 0 for those with insufficient data, to 5% for broad-wings in Baxter and red-tails in Telos, to a high of 23% for American kestrels in Telos. Results for 3 Buteos were as follows:

Species	Baxter	Telos	Waldo
Broad-winged hawk	AO: 1.00 (0.0-1.00)	0.47 (0.0-1.00)	0.78 (0.57-0.99)
	PD: 0.06 (0.0-0.12)	0.07 (0.0-0.15)	0.14 (0.06-0.21)
Red-tailed	AO: 0.09 (0.0-1.00)	0.93 (0.0-1.00)	insufficient data
	PD: 0.10 (0.0-0.56)	0.06 (0.01-0.11)	
Red-shouldered hawk	not observed	insufficient data	AO: 0.29 (0.06-0.53)
			PD: 0.13 (0.03-0.24)

Comparison between species and study areas was difficult due to overlapping confidence intervals at the 95% level. These results indicate that limits to the AO technique exist, despite its intended

application in surveys of rare and uncommon species. Computer simulations to investigate the sensitivity of the technique are now underway.

Future Plans:

The computer simulations will focus on the effects of actual proportion of area occupied, the probability of detection (PD), and the number of repetitions of a survey route on the reliability of the resulting AO estimates. This work will aid in evaluating the future use of the technique in areas where sightings are variable, as well as indicating the degree of sensitivity that can be expected under specific combinations of AO, PD, and number of repetitions.

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

Investigator: W. M. VanderHaegen

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

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

Objectives:

(1) Determine and compare vegetation and food characteristics of hardwood and softwood covers used by woodcock and compare to randomly selected hardwood and softwood sites.
(2) Examine micro-climate regimes and activity budgets of woodcock in different cover types.
(3) Document spring food habits and determine the feasibility of developing a spring condition index.
(4) Use the above results to evaluate existing woodcock spring habitat models.

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 representing those most available to northern-breeding woodcock. In 1986, the Maine Field Station of Patuxent Wildlife Research Center and Moosehorn NWR began a four-year study to examine woodcock survival, productivity, and habitat use on the refuge. This study will provide base line data on population dynamics and macro-habitat use. 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 detail.

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

Project Status:

A second field season has been completed. Additional data on micro-habitat use, diel activity, and microclimate environments were collected from a sample of 15 radio-instrumented females. Twenty woodcock were collected for analysis of energy reserves and early spring food habitats. Fourteen chicks were hatched from eggs collected in the wild; six (3M, 3F) are currently being used in laboratory studies of metabolism and thermoregulation.

Future Plans:

Additional field data will be collected during 1989. Target date for project completion is October 1989.

MODELING THE POPULATION DYNAMICS OF MAINE'S WHITE-TAILED DEER

Investigator: M. Chilelli

Advisors: J. R. Gilbert, Co-chairperson
W. B. Krohn, Co-chairperson
G. J. Matula
M. L. McCormack
W. L. Soule

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

Objectives:

(1) Develop a model that describes the annual fluctuations of white-tailed deer in Maine.
(2) Determine, by applying the model, the influence of various management strategies and nonhunting mortality factors on deer in Maine.

Project Status:

All requirements for the degree of Doctor of Philosophy (in Wildlife) were completed in August 1988. An abstract of the dissertation follows:

A stochastic simulation model, WTDDYNMC, was developed to examine the population dynamics of white-tailed deer (*Odocoileus virginianus*) in Maine. Whereas many population models require users to determine and input mortality and reproductive rates, WTDDYNMC is distinctive in that rates are derived from input variables and those generated within the model. Data from the Maine Department of Inland Fisheries and Wildlife and other available sources were used to derive the initial mortality and birth rate estimates.

The model consists of 3 major compartments (fall, winter, and summer) reflecting major periods of birth and death in the annual cycle of white-tailed deer in Maine. Derived mortality and reproductive rates reflected variations by sex, age, and subcompartment. Annual mortality factors acting on the population include predation (coyote, bobcat, dog), poaching, harvest (firearm, bow), crippling (firearm, bow), road kill, winter starvation, and neonatal mortality.

The model was most sensitive to alterations in firearm harvest net rates and yearlong predation rates. There was moderate sensitivity to changes in winter starvation rates, neonatal rates, and poaching rates. The model was relatively insensitive to population-wide adjustments in crippling rates, reproductive rates, yearlong road kill rates, and bow harvest net rates. Population growth was most responsive to changes in harvest pressure on the female segment of the population, particularly

adult does. Therefore, the reduction in harvest rate associated with a chosen antlerless permit level needs to be determined. Coyotes are a significant natural predator on deer in Maine. The relationship of coyote predation to increasing winter severity and increasing deer density needs to be defined. Condition of the deer herd and quality of the habitat need to be considered in estimating winter starvation losses and reproductive rates.

Survival rates had a greater influence on population growth than did reproductive rates. Estimates of major mortality rates (i.e., firearm harvest, predation, winter starvation) need to be improved via a large-scale telemetry study done in areas of differing firearm harvest rates, deer density, coyote density, and winter severity. Special attention must be given to determining density dependent relationships for mortality and reproductive rates and compensatory-additive relationships between predation and harvest, and winter starvation and predation.

NESTING ECOLOGY AND HABITAT USE OF WILD TURKEYS IN SOUTHCENTRAL MAINE

Investigator: B. E. Treiterer

Advisors: P. W. Brown, Chairperson
G. J. Matula
W. A. Halteman

Cooperators/ Project Support: Maine Department of Inland Fisheries and Wildlife
National Wild Turkey Federation
Maine Chapter of the National Wild Turkey Federation
National Rifle Association
L. L. Bean, Inc.
Maine Cooperative Fish and Wildlife Research Unit

Objectives:

(1) Document nesting chronology, proportion of females nesting, nest site characteristics, and the success of eggs and nests of free-ranging turkeys in southcentral Maine.
(2) Determine the types of nesting and brood habitat used by female turkeys with broods during the breeding season.

Project Status:

All requirements for degree of Master of Science (Wildlife Management) were completed in December 1987. An abstract of the thesis follows:

Survival, productivity, and habitat preferences of 22 female wild turkeys (*Meleagris gallopavo sylvestris*) were studied during 1985-1987 in a recently established population in Waldo County, Maine. The population was estimated at 50-75 birds in March 1987 and has not increased at the rate seen of other newly established populations in the Northeast and Midwest. Mortality rates of juvenile females were higher ($P < 0.05$) during the severe winter of 1987 than the mild winter of 1986; all deaths were due to predation. Eleven females surviving to either the 1986 or 1987 breeding seasons attempted to nest, although no juvenile females survived to breed in 1987. Nesting success was lower ($P < 0.05$) in 1987 (51%) than 1986 (74%), as were clutch sizes and hatching success ($P < 0.05$). Poult survival ($N = 77$) to 10 weeks after hatch was 38% and 25% in 1986 and 1987. Most mortality (43%) occurred during the first 2 weeks after hatch. Natality and recruitment rates of females were lower ($P < 0.05$) in 1987 than 1986. Body weights of turkeys in Maine were lower than those recorded in other northern states. Standing corn, an important food source when snow depths exceed 12 cm, occurs on only 3% of the study area. Acorn-producing oaks (*Quercus* spp.) are found on only 6.7% of the area. Foods such as sensitive fern and persistent fruits also are less available during deep snows.

Females preferred dense understory vegetation (50-75% cover) at nest sites. Shrubs were more common and vegetation and/or slash ground cover was denser ($P < 0.05$) at nest than random sites. Slash provided cover early in incubation when herbaceous cover was not available. During the breeding season old fields, hayfields, cornfields, and hardwood stands were used more than expected based upon availability; softwood stands and mixed forests were used less ($P < 0.05$). Brood rearing areas included both open fields and adjacent hardwood stands with adequate herbaceous ground cover that provided animal and plant foods and cover from predators.

Management plans should include the release of additional adult hens in Waldo County to offset the low survival, natality, and recruitment rates of 1987. The selection of future release sites should consider the availability of fields (hay, corn, and pasture) and hardwood stands.

SYNTHESIS OF THE MAINE PREDATOR STUDIES

Investigators: S. M. Arthur
W. B. Krohn

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

Objective: Develop an annotated bibliography and summary of recent research on Maine's major furbearing predators.

Scope:

From 1974 to 1988, 18 graduate students (13 M.S. and 5 Ph.D.) and several faculty members from the Maine Cooperative Fish and Wildlife Research Unit and the University of Maine conducted a series of studies regarding the ecology of coyotes, red foxes, bobcats, pine martens, fishers, otters, and their prey. This research was reported in 67 theses, journal articles, and other reports. The bibliography contains and abstract of each report and an introductory section summarizing major findings.

Project Status:

The bibliography was completed, submitted to 8 reviewers, revised, and accepted for publication as Maine Agricultural Experiment Station Technical Bulletin 132. The manuscript has been sent to the printers and publication is scheduled for November 1988.

THE MAINE AMPHIBIAN AND REPTILE ATLAS PROJECT (MARAP)

Investigators: M. L. Hunter, Jr.
J. K. Arbuckle
J. J. Albright

Advisors: B. Burgason
S. Davis
A. Ritter

Cooperators/ Project Support: The Nature Conservancy
The Maine Audubon Society
Maine Department of Inland Fisheries and Wildlife

Objectives:

(1) Determine the status and distribution of amphibians and reptiles in Maine, particularly rare species and those that reach their range limit here.
(2) Describe the general ecology (e.g., habitat selection and life history) of Maine's herpetiles.

Scope:

There are approximately 35 species of amphibians and reptiles occurring in Maine, of which 20 probably reach the limit of their range here. One or more species have probably been extirpated from the state, and there may well be species occurring here that have not been previously recorded. There is little knowledge about the status, distribution, and ecology of Maine's herps, and this is the reason MARAP was initiated. Nearly 100 volunteers from around the state have been issued instruction manuals and record cards to report their observations of herps. These cards will be computer encoded and range maps generated.

Project Status:

All species of reptiles and amphibians known to occur in Maine have been reported in the MARAP project with the exception of the timber rattlesnake, a species believed to be extirpated.

Future Plans:

MARAP will be terminated after the 1988 field season and a book "The Amphibians and Reptiles of Maine" will be written.

POPULATION DYNAMICS OF PACIFIC WALRUSES

Investigators: J. R. Gilbert
S. Hills

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

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

Objectives:

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

Scope:

Existing walrus population estimates fail to account for 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 of this international wildlife resource.

Project Status:

Although small adjustments will be made in future radio transmitter packages, most of the technique development has been completed. Satellite-linked transmitters were attached to the tusks of four walruses that were immobilized on the pack ice of the Chukchi Sea in July-August 1988. Data from those transmitters and additional units deployed on male walruses in Bristol Bay, Alaska are currently being analyzed for patterns of movement and behavior in relation to environmental variables. Re-evaluation of previous census data has shown an unexpected relationship of number of walruses seen and the distance into the pack ice from the edge.

Future Plans:

Up to 20 satellite-linked transmitters will be deployed on walruses in May-July 1989. Data from the transmitters will be validated with additional observations from ships or aircraft during tests of alternative survey designs that will be conducted concurrently in preparation for the 1990 joint US-USSR walrus survey. Analysis of data from past surveys and those from the satellite transmitters will continue. Coordination with Soviet scientists for the 1989 and 1990 work has begun, and invitations for cooperative work have been issued by both sides.

HABITAT SUITABILITY FOR VERTEBRATE HERBIVORES IN RELATION TO FOREST STAND CHARACTERISTICS

Investigator: L. Shively

Advisors: D. E. Spalinger, Chairperson
H. S. Crawford
W. E. Glanz

Cooperators/
Project Support: McIntire-Stennis
Northeast Forest Experiment Station

Objectives:

(1) Determine the relationship of winter browse abundance and patchiness to foraging efficiency and net energy intake in white-tailed deer, moose, and caribou.
(2) Determine the effect of bite size on intake rates of snowshoe hare, deer, caribou, and moose.
(3) Compare components of foraging behavior among 4 vertebrate herbivores based on body size and molar surface.
(4) Compare biomass/intake rate predictions developed in pen trials with data obtained in field experiments with tame deer in forest stands.

Scope:

Rising demands on forest resources in Maine, especially mature conifer timber, have instigated the development of regulations for timber harvest in areas critical to wintering white-tailed deer. Current regulations in northern Maine, however, are based on some previous deer yard studies which stressed the shelter component of the habitat. Because timber stands heavy enough to provide shelter cannot also provide adequate food, these regulations may be inadequate for optimum survival and reproduction of deer. In addition, timber operations have greatly affected winter habitat of other forest herbivores including moose and snowshoe hare. Thus, we must understand how structural and nutritional stand characteristics affect the foraging efficiency and energetics of wintering herbivores. Because body size and morphology affect nutritional requirements and energy expenditures of animals, habitat quality can be defined by different mixes of cover and forage patches for snowshoe hare, white-tailed deer, caribou, and moose.

Project Status:

A series of foraging experiments in which browse density and patch size were artificially modified were conducted in January and February 1988 at the ungulate research facility on the Orono campus. Asymptotic relationships between browse density and intake rates for moose calves and deer fawns were obtained. No difference in intake rate was measured for different patch distributions of the same biomass. Bite size correlated highly with intake rate for both species at all biomass levels.

Four litters of snowshoe hare were bottled-raised during May-July 1988. Six snowshoe hare, along with deer, moose, and caribou yearlings, were allowed to forage on maple leaves of different bite sizes, and corresponding intake rates were measured. Body weight correlated strongly with bite size-intake rate regressions.

Data obtained from winter and summer experiments are currently being analyzed for additional trends in foraging behavior induced by forage biomass and body size.

Future Plans:

Pen experiments with tame ungulates and hares will continue from October 1988 through March 1989, focusing on how browse density affects bite size and travel speed. In addition, 4 tame white-tailed deer yearlings will be released into a winter deer yard in Maine for three months. Intake rates and energy expenditures will be measured during foraging bouts. Target date for project completion is August 1989.

REPRODUCTIVE ECOLOGY OF FEMALE FISHER IN SOUTHCENTRAL MAINE

Investigator: T. F. Paragi

Field Assistants: S. M. Arthur
E. A. Pfalzer
M. L. Summers

Advisors: W. B. Krohn, Chairperson
J. R. Gilbert
W. A. Halteman
D. J. Harrison
K. D. Elowe, Ex-Officio

Cooperators/ Project Support: Maine Dept. of Inland Fisheries and Wildlife
Maine Coop. Fish and Wildlife Research Unit

Objectives:

(1) Estimate spring and fall recruitment by using radiotelemetry to document the proportion of females reproducing, the size of litters in the den, and the size of litters prior to fall trapping.
(2) Estimate fall recruitment (juveniles per adult female) by using age- and sex-specific rates of trapping mortality and the age-sex composition of the harvest to reconstruct the preharvest population.
(3) Develop and evaluate indices to reproduction and recruitment independent of telemetry and population reconstruction.
(4) Examine denning ecology and activity patterns of fisher families from spring to early fall.

Scope:

The price of fisher pelts, especially females, has increased over the past 15 years, and today fishers have the most valuable pelt of furbearers in Maine. The Maine Department of Inland Fisheries and Wildlife maintains a uniform trapping season for all furbearers, and conservative management requires careful harvesting of those species most vulnerable to overharvest. The fisher is a keystone species because of its low reproductive rate, relative susceptibility to land trappers, and secretive nature making population assessment difficult.

Wildlife Management Units (WMUs) 4 and 7 in southcentral Maine support the highest trapper densities and WMU 7 the highest harvest density of fishers in Maine. Given good road access throughout this

region, more should be known about the potential impact of the harvest on the fisher population. Preliminary data from a recent study of fisher ecology in this area suggested that parturition rates were substantially lower than pregnancy rates estimated from counts of corpora lutea, the conventional index to reproductive success in fishers. Also, little is known about the litter size, neonatal mortality, and denning habits of wild fishers.

The purpose of this project is to provide the MDIFW with estimates of fall recruitment in a fisher population in 1988 and 1989 so managers can more accurately model population dynamics and the effects of varying harvest regimes. New or improved indices to reproduction and fall recruitment may allow long-term assessment of populations from carcass data. Information on denning habitat and reproductive biology will allow managers to more clearly incorporate fishers into forest management plans.

Project Status:

Six radio-collared fishers (4 females and 2 males) remained in the study area in early 1988 following a recently-completed study of fisher ecology. The investigator arrived in Maine in early February and began livetrapping, primarily for adult female fishers. Two adult male fishers were caught in early March, and one was fitted with a radio collar. All 4 radio-collared females denned in mid-late March. Litters of 3, 2, 1, and 1 were confirmed in mid May by climbing den trees; kits were sexed, weighed, measured, and ear tagged. Family groups were observed after denning by walking in on resting females, and kits were seen on 8 of 49 attempts by mid August. A male kit from a litter of 1 was darted with its mother in mid August and fitted with a breakaway radio collar. The kit was slightly larger that its mother but only 78% of her weight. Both were located several times during August to examine the mother-kit relationship in late summer.

Radio-collared males were located biweekly to confirm survival, and ancillary data on den trees, denning habitat, and resting sites were collected while observing adult females and kits. A stripchart recorder attached to a telemetry receiver was evaluated for monitoring den attendance by collared females; the system holds promise, and 2 additional stripchart recorders were purchased for use in 1989. Work began on developing a technique to consistently identify placental scars from carcasses as an index to litter size at birth.

Future Plans:

Livetrapping will be conducted in September and October 1988 to capture and fit fishers (juveniles and adults of both sexes) with radio collars for estimating mortality during trapping season; to try to capture ear-tagged juveniles for documenting their survival and dispersal; and to try to examine radio-collared females to determine if the sizes of mammillae in fall are a reliable index to reproductive success the previous spring.

A monetary reward will be offered to trappers to ensure the return of ear-tagged and radio-collared fishers. In addition, the heads of all trapped fishers will be collected from most of WMU 7 and the southern towns in WMU 4 to determine the age-sex composition of the harvest in the study region. The first year's recruitment estimates will be calculated and the project reviewed in spring 1989. Livetrapping, primarily for adult females, will start again in February 1989.

A SURVEY OF METASTRONGYLID PARASITES IN MAINE CERVIDS

Investigator: B. A. Bogaczyk

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

Cooperators/ Project Support: U.S. Fish and Wildlife Service - Washington Office
Maine Department of Inland Fisheries and Wildlife
Maine Caribou Transplant Corporation
Maine Cooperative Fish and Wildlife Research Unit

Objectives:

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

Scope:

This study is investigating the occurrence and distribution of three parasite species known or suspected to infect Maine cervids: *E. cervi*, *P. andersoni*, and *P. tenuis*. These three species have spike-tailed larvae indistinguishable from one another, which are shed in cervid feces. Positive identification of these parasites depends upon finding adult worms.

Woodland caribou transported from Newfoundland, Canada to Maine in 1986 for reintroduction may be harboring a nematode roundworm, *E. cervi*, potentially harmful to moose. To prevent accidental introduction of this parasite, all caribou will be tested for the presence of these parasites. Only animals with negative tests will be released.

P. andersoni is a widespread metastrongylid having been documented in white-tailed deer throughout the southeastern United States and elsewhere. However, its presence has not been investigated in Maine. If not found in Maine, and assuming no other metastrongylid parasites in Maine deer other than *P. tenuis*, future *P. tenuis* surveys could be based on recovery of spike-tailed larvae from deer feces.

P. tenuis is benign, though ubiquitous, in Maine deer; but it causes a lethal neurologic disease in moose and caribou. Inexplicably,

Maine's moose population has increased since the 1960s. A mid-1960s survey of P. tenuis showed a statewide incidence rate of 76%. Maine's deer population declined from the 1960s until about 1980. Results of this survey will be compared to data from the 1960s to determine if changes in Maine's P. tenuis distribution and incidence have accompanied the changes in deer density. In addition, these data will provide a baseline in evaluating the reintroduction of woodland caribou in Maine.

Project Status:

The project began in June 1988, and the research protocol has been drafted. Karen Morris, MDIFW biologist and University of Maine graduate students Glenn Morlock and Brian Bogaczyk accompanied Southeast Cooperative Wildlife Disease Study (SCWDS) personnel from the University of Georgia on deer herd health checks from August 15-21 in Maryland and Virginia. SCWDS personnel provided training in necropsy procedures. A network to collect deer carcasses and heads has been established with the Maine Department of Inland Fisheries and Wildlife. In addition, a protocol for testing caribou to detect E. cervi has been developed in cooperation with the Maine Department of Inland Fisheries and Wildlife and the Maine Caribou Transplant Corporation.

Future Plans:

Collection of deer carcasses and heads will start in October 1988 and continue for the duration of the study. Head collection and examination will begin with the deer season in November and will be repeated during November 1989. Necropsy of deer carcasses will continue through April 1990.

Caribou fecal samples will be monitored monthly from 31 January to 31 March, 1989 for E. cervi.

PREVALENCE OF METASTRONGYLID LARVAE AS RELATED TO DENSITIES OF WHITE-TAILED DEER IN MAINE

Investigator: G. P. Morlock

Advisors: W. B. Krohn, Co-chairperson
M. A. McCollough, Co-chairperson
H. C. Gibbs

Cooperators/ Project Support: Maine Department of Inland Fisheries and Wildlife
University of Maine
Caribou Transplant Corporation
Hirundo Wildlife Trust

Objectives:

(1) Determine whether or not the prevalence of Parelaphostrongylus spp.in white-tailed deer in Maine is related to deer density.
(2) Investigate the relationship between the prevalence of Parelaphostrongylus spp. in white-tailed deer and moose population density.
(3) Ascertain if moose in Maine are shedding Parelaphostrongylus spp. larvae and, if so, identify the species.

Scope:

Parelaphostrongylus tenuis, the "meningeal worm" of white-tailed deer, is common throughout much of eastern North America. This parasite, though apparently benign in white-tailed deer, is pathogenic in other members of the cervid family. P. tenuis is the parasite responsible for causing neurologic disease ("moose sickness") in moose. The complexity of the P. tenuis life cycle, involving development of the nematode to the infective third stage within a gastropod intermediate host, has made it difficult to assess those factors most important in regulating the prevalence of the parasite in white-tailed deer. This project tests the hypothesis that the prevalence of Parelaphostrongylus spp. (i.e., P. tenuis and/or the closely related species P. andersoni) in deer is related to deer density.

In recent years two developments have brought into question the current importance of P. tenuis as a pathogen of moose. First, Maine has experienced an increased moose population with an apparent decline in the occurrence of moose sickness. This would appear to contradict the current understanding of the dynamics of P. tenuis in these ungulates. It is commonly believed that high densities of deer and moose can not occur in the same area. Secondly, researchers have reported finding first-stage Parelaphostrongylus spp. larvae in moose feces, suggesting that moose may have developed a tolerance of P. tenuis. This study should help to clarify the present status of P. tenuis in moose.

Project Status:

Deer and moose feces were collected in the course of conducting pellet group surveys to determine deer density. The feces were examined, using a sedimentation technique, for the presence of the spike-tailed larvae characteristic of members of the genus *Parelaphostrongylus*.

Future Plans:

Examination of remaining deer and moose fecal samples continues. Should *Parelaphostrongylus* spp. larvae be found in moose feces, these larvae will be recovered and used to infect fawn white-tailed deer in order to identify the parasite to the species level. The target date for project completion is December 1989.

HOME RANGE AND HABITAT USE OF FEMALE BLACK BEAR IN MAINE

Investigator: R. L. Schooley

Advisors: W. B. Krohn, Co-chairperson
G. J. Matula, Jr., Co-chairperson
W. E. Glanz

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

Objectives:

(1) Compare home range characteristics, movements, and seasonal habitat use between female black bears from 3 dissimilar study areas in Maine.
(2) Determine what characteristics of tolerant hardwood stands in northern Maine are correlated with use by female bears during the fall.

Scope:

Once considered a nuisance species, the black bear is now a desirable big game species in Maine. Harvest levels of black bears have increased steadily in the 1980s, and interest in hunting bears in Maine seems to be at an all-time high. This change in the status of black bears has increased the need to understand the species' spatial organization and habitat requirements.

The predicted trend in the Maine forest industry of increased harvesting of hardwood species could greatly affect the forested habitat available to black bears. Mast-producing hardwood species such as American beech and northern red oak are important sources of fall bear foods. In particular, beechnuts are evidently the primary fall food of bears in northern Maine where alternative food sources such as oaks, agricultural crops, and abandoned apple orchards are limited or nonexistent.

Between 1982 and 1987, the Maine Department of Inland Fisheries and Wildlife placed radiocollars on approximately 120 female bears in 3 study areas that differed in geology, vegetation, land use, and hunting pressure. Collared bears were radiotracked by small fixed-wing airplanes. Data from 65 female bears being monitored in 1988 will also be analyzed.

I will test several hypotheses including (1) annual home range sizes are greatest in the northern study area where food resources are most limited, (2) fall movements out of annual home ranges are most frequent in the northern study area, and (3) use of tolerant hardwood stands by bears in the fall is positively correlated with basal area of American beech within the stand.

Project Status:

To determine the accuracy of the telemetry data, 27 test collars were placed in forested habitat in August 1988. From the ground we recorded the location and surrounding habitat type for each collar. The research pilots then located the test collars and recorded all data normally taken for radiocollared bears. The comparison between ground and air data has been initiated.

All telemetry data from bears monitored between 1982 and 1987 have been entered into computer files. Data from 1988 are currently being coded and entered. Home range calculations have been initiated.

Future Plans:

During the fall of 1988, the characteristics (i.e., species composition, aspect, slope, mast production) of tolerant hardwood stands will be compared between a sample of plots used by bears in the fall and a sample of random plots. A second telemetry test will be completed in October 1988. Home range analysis will continue.

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

Investigator: L. Winter

Advisor: D. J. Harrison, Chairperson

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

Objectives:

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

Scope:

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

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

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

mammalian community and its influence on natural systems in Acadia National Park.

Project Status:

The project began in May 1988. Vocalization surveys have been completed and live-trapping and radio telemetry work was initiated in September 1988.

Future Plans:

The telemetry work will continue and the tracking will start when adequate snow is present. The projected date for project completion is September 1990.

INFLUENCE OF BROWSING BY DEER, HARE, AND BEAVER ON VEGETATION AT ACADIA NATIONAL PARK

Investigator: M. Saeki

Advisor: D. J. Harrison, Chairperson

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 plant species present in the different habitat types in Acadia National Park.
(2) Quantify browsing intensity of white-tailed deer, snowshoe hare, and beaver among differing 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, hare, and beaver.
(5) Provide baseline data for future studies of the relationship of deer, hare, beaver, and vegetation in Acadia National Park.

Scope:

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

Browse availability-utilization for white-tailed deer (Baird 1966, McLaughlin 1968, Gilbert and Harrison 1982) and for snowshoe hare (Gilbert and Harrison 1982) has been previously studied at ANP. This project serves as a follow-up study of browsing by white-tailed deer and snowshoe hare and initiates an assessment of the impact on vegetation by beaver. Vegetation will be surveyed along permanent transects and within permanent exclosures to estimate utilization and availability. Population levels of herbivores will be assessed by relative abundance of tracks and pellets along survey lines.

Project Status:

A snow tracking index of herbivore abundance was initiated in winter 1988. A vegetation inventory on four exclosures on MDI and on two exclosures on AH was completed in summer 1988. Two control plots were also inventoried for each exclosure.

Future Plans:

Snow tracking survey for deer and hare will continue on 100 km of permanent transects. Vegetation and browsing surveys on approximately 200 plots along permanent transect lines will be conducted during the summer of 1989 and 1990. Deer and hare pellet groups will be sampled along the transects as an index of herbivore abundance.

The projected date for project completion is September 1990.

RELATIONSHIP OF BEAVER MANAGEMENT AND WATERFOWL PRODUCTION IN SOUTHCENTRAL MAINE

Investigator: T. C. McCall

Advisor: R. B. Owen, Chairperson

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

Objectives:

(1) Determine the effect of a 3-year beaver trapping closure on beaver and waterfowl abundance and quality and quantity of wetlands.

(2) Test the beaver management model currently used by the Maine Department of Inland Fisheries and Wildlife (MDIFW).

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. Recent data suggest that excessive trapping can have a detrimental effect on the availability and quality of wetlands and their associated wildlife. 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.

The study areas will consist of a treatment and a control area. The treatment area will be closed to beaver trapping for 3 years beginning in 1989, whereas the control area will remain open to trapping. The 150 km^2 treatment area corresponds to the location of 3 previous waterfowl graduate studies conducted during the past 30 years. This area consists of the towns of Dixmont, Jackson, Monroe, and Newburgh in Waldo County, Maine. An area of similar habitat will be chosen as the control.

Project Status:

Meetings were held in August and October with the MDIFW to discuss project objectives and boundaries of study areas. In addition, 80 of the 130 wetlands on the treatment area were visited and discussions held

with trapper groups and wardens. I determined the average number of beaver per lodge on the treatment area by live-trapping 13 beaver from 5 lodges. Colored plastic ear tags were attached to beavers for individual identification. Then, at each lodge where trapping occurred, an evening was spent searching for unmarked animals. The beaver populations of both areas will be determined by multiplying the average number of beaver per lodge by the number of active lodges.

Future Plans:

Until mid-November, beaver will be live-trapped and ear-tagged on the control area. Food cache counts will be conducted to determine the number of active lodges, and aerial photos will be taken to determine the surface area of wetlands. The research proposal will be finished after the fall field work is completed. The anticipated completion date of the project is July 31, 1991.

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

SCIENTIFIC PUBLICATIONS

CATURANO, S., L.S. Glanz, D.C. Smith, L. Tsomides, and J.R. Moring. 1988. Shellfish mariculture: The status of mussel power in Maine. Fisheries, 13(3):18-21.

GIBBS, J.P., S. Woodward, M.L. Hunter, and A.E. Hutchinson. 1988. Comparison of techniques for censusing great blue heron nests. Journal of Field Ornithology, 59(2):130-134.

HALPIN, M.A., and J.A. Bissonette. 1988. Influence of snow depth on prey availability and habitat use by red fox. Canadian Journal of Zoology, 66(3):587-592.

JORDE, D.G., and R.B. Owen, Jr. 1988. The need for noctural activity and energy budgets of waterfowl. Pages 169-180 in Weller, M.W. (ed.). Waterfowl in winter. University of Minnesota Press, Minneapolis. 624pp.

KROHN, W.B., and E.G. Bizeau. 1988. Changes in winter distribution of the Rocky Mountain Canada goose population. Wildlife Society Bulletin, 16(3):272-277.

MacKENZIE, C., and J.R. Moring. 1988. Estimating survival of Atlantic salmon during the intragravel period. North American Journal of Fisheries Management, 8(1):45-49.

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McAULEY, D.G., and J.R. Longcore. 1988. Foods of juvenile ring-necked ducks: relationship to wetland pH. Journal of Wildlife Management, 52(2):177-185.

McCALL, T.C., R.D. Brown, and C.A. DeYoung. 1988. Comparison of mortality of pen-raised and wild white-tailed deer bucks. Wildl. Soc. Bull. 16:(4). In press.

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MUGANGU, E. 1988. Differenciation, morphologique, chez la tortue a' dossiere Kinixys erosa (Schweigger), (Reptilia, Testudines, Testudinidae). Annales Faculte' Scientifique Kisangani, 5:81-91.

PERRY, C.M., and S.B. Smith. 1988. Toxicity of six heterocyclic nitrogen compounds to Daphnia pulex. Bulletin of Environmental Contamination and Toxicology, 41(4):604-608.

SAYERS, R.E., Jr. 1987. Effects of freezing in and out of water on length and weight of Lake Michigan bloaters. North American Journal of Fisheries Management, 7(2):299-301.

SMALL, M., and M.L. Hunter. 1988. Forest fragmentation and avian nest predation in forested landscapes. Oecologia, 76:62-64.

STRONG, P.I.V., and J.A. Bissonette. 1987. Effects of nest-site loss on common loons, Gavia immer. Canadian Field-Naturalist, 101(4):581-583.

VANDERHAEGEN, W.M., W.E. Dodge, and M.W. Sayre. 1988. Factors affecting productivity in a northern wild turkey population. Journal of Wildlife Management 52:127-133.

VICKERY, P.D. 1988. Distribution and population status of harlequin ducks (Histrionicus histrionicus) wintering in eastern North America. Wilson Bulletin, 100(1):119-126.

VICKERY, P.D., D.W. Finch, and P.K. Donahue. 1988. Juvenile Cox's sandpiper (Calidris paramelanotos) in Massachusetts, a first New World occurrence and a hitherto undescribed plumage. American Birds, 41:1366-1369.

TECHNICAL AND SEMI-TECHNICAL PUBLICATIONS

ARTHUR, S.M. 1988. Tracking that elusive ole' fisher. Maine Fish and Wildlife, 30(1):6-9, 21.

BLEY, P.W. 1987. Age, growth, and mortality of juvenile Atlantic salmon in streams: a review. U.S. Fish and Wildlife Service, Biological Report 87(4). 25pp.

BLEY, P.W., and J.R. Moring. 1988. Freshwater and ocean survival of Atlantic salmon and steelhead: a synopsis. U.S. Fish and Wildlife Service, Biological Report 88(9). 22pp.

BLUMTON, A., R.B. Owen, Jr., and W.B. Krohn. 1988. Habitat suitability index models: American eider (breeding). U.S. Fish and Wildlife Service Biological Report 82(10.149). 24pp.

DESGRANGES, J.L., and M.L. Hunter, Jr. 1987. Duckling response to lake acidification. Transactions of the North American Wildlife Natural Resources Conference, 52:636-644.

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HILLS, S. 1988. Cruise promotes international cooperation in walrus research. U.S. Fish and Wildlife News (March-April):19, 22.

HUNTER, M.L., Jr. 1987. Managing forests for spatial heterogeneity to maintain biological diversity. Transactions of the North American Wildlife Natural Resources Conference, 52:60-69.

KROHN, W.B., and J.R. Moring. 1987. The determining factor. Habitat, 4(8):30-33.

LICHT, D.S. 1988. Fisher research trapline. Fur-Fish-Game, 85(5):10-12.

PERRY, C.M. 1987. Atlantic salmon source characterization: low pH tolerance. Final Report to U.S. Fish and Wildlife Service, National Fishery Research and Development Laboratory. 110pp.

THESES AND DISSERTATIONS

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DeBRUYCKERE, L.A. 1988. Feeding ecology of northern pintails, American wigeon, and long-billed dowitchers at the Selawik National Wildlife Refuge, Alaska. M.S. Thesis, University of Maine, Orono. 120pp.

DIEFENBACH, D.R. 1988. Changes in the wetland habitats and population of breeding black ducks in southcentral Maine. M.S. Thesis, University of Maine, Orono. 75pp + supplement.

FRAZER, C. 1988. The ecology of post-fledging American black ducks in eastern Maine. M.S. Thesis, University of Maine, Orono. 90pp.

HERKE, S.W. 1988. Natural hybridization and biology of northern pike (Esox lucius) and chain pickerel (E. niger) in the Belgrade Lakes of Maine. M.S. Thesis, University of Maine, Orono. 98pp.

JAGOE, C.H. 1988. A histological and ultrastructural study of the effects of low pH and aluminum upon the gills of the Atlantic salmon. Ph.D. Dissertation, University of Maine, Orono. 230pp.

LIVINGSTON, S.A. 1987. Nesting habitat models for bald eagles in Maine. M.S. Thesis, University of Maine, Orono. 45pp. + supplement.

TREITERER, B.E. 1987. Nesting ecology and habitat use of wild turkeys in southcentral Maine. M.S. Thesis, University of Maine, Orono. 70pp.

PROFESSIONAL TALKS PRESENTED

AGLER, B.A. May 1988. "Photo-identification of finback whales Balaenoptera physalus in the western North Atlantic." Invited paper presented at the International Whaling Commission's special meeting on Benign Techniques, La Jolla, CA.

ARTHUR, S.M. February 1988. "Behavior and reproductive ecology of fishers in southcentral Maine." Paper presented at 20th Northeast Graduate Wildlife Conference, University of Maine, Orono.

ARTHUR, S.M. June 1988. "Reproductive ecology of fishers in southcentral Maine." Paper presented at the American Society of Mammalogy Meeting, Clemson University, Clemson, SC.

CHILELLI, M. September 1988. "An overview of a model of Maine's white-tailed deer population." Slide presentation at the Northeast Deer Technical Committee Meeting, Gailille, RI.

CORR, P.O., A.E. Hutchinson, and W.B. Krohn. January 1988. "Status of eider ducks in the eastern United States with special reference to coastal Maine." Invited paper at a Workshop on Eider Management, Ste.-Foy, Quebec.

DEVAUL, H. February 1988. "Survey of woodland hawks using the Area Occupied Method." Paper presented at 20th Northeast Graduate Wildlife Conference, University of Maine, Orono.

DEVAUL, H. May 1988. "A review of techniques to survey for woodland hawks in the Northeast." Paper presented to approximately 100 people attending National Wildlife Federation's Raptor Management Symposium and Workshop, Syracuse, NY.

GILBERT, J.R. December 1987. "Longterm studies of ringed seal (Phoca hispida) distribution in Alaska." Abstracts/poster session at Seventh Biennial Conference on the Biology of Marine Mammals, Miami, FL.

HARRISON, D.J. September 1988. "A regional approach for analyzing biological data for river otters." Invited talk to 40 professionals at Northeast Fur Resources Technical Committee Meeting, Quebec City, Quebec.

HARRISON, D.J. September 1988. "A proposal to study the interactions among forest management practices, trapping, and pine marten populations." Talk given to 15 professionals at Northeast Fur Resources Technical Committee Meeting, Quebec City, Quebec.

HILLS, S. December 1987. "New techniques for study of Pacific walruses." Abstracts/poster session of Seventh Biennial Conference on the Biology of Marine Mammals, Miami, FL.

HUNTER, M.L., Jr. February 1988. "A global approach to wildlife conservation." Talk given to 30 members, staff, and guests of the Royal Nepal Academy of Science and Technology, Kathmandu.

HUNTER, M.L., Jr. March 1988. "Managing for biological diversity at a macro and micro scale." Talk given to ca. 50 students and staff of the Wildlife Institute of India, Dehra Dun.

HUNTER, M.L., Jr., G. Jacobson, and W. Thompson. August 1988. "Paleoecology and the coarse-filter approach to maintaining biological diversity." Paper presented to the Society for Conservation Biology meetings, Davis, CA.

KROHN, W.B. September 1987. "Update of projects at the Maine Cooperative Fish and Wildlife Research Unit." Report presented to the Wildlife Division of the Maine Department of Inland Fisheries and Wildlife, Bangor, ME.

KROHN, W.B., and R.B. Owen, Jr. March 1988. "Validation of a habitat suitability model for American eider duck nesting islands." Paper presented at 1988 Northeast Fish and Wildlife Conference, White Sulphur Springs, WV.

LIVINGSTON, S.A., R.B. Owen, Jr., and W.B. Krohn. March 1988. "Nesting habitat models for bald eagles in Maine." Paper presented at 1988 Northeast Fish and Wildlife Conference, White Sulphur Springs, WV.

McKINLEY, D.B. September 1988. "Atlantic salmon restoration in the White Mountain and Green Mountain National Forests from a habitat management perspective." Annual meeting, Atlantic International Chapter, American Fisheries Society, Sargentville, ME.

MINK, L.H. April 1988. "Aquaculture in Cameroon." Seminar as part of the Migratory Fish Research Institute Lecture Series, University of Maine, Orono.

MORING, J.R., M.T. Negus, R.D. McCullough, and S.W. Herke. November 1987. "Large concentrations of submerged pulpwood logs as fish attraction devices in a reservoir." International Conference on Artificial Habitats for Fisheries, Miami, FL.

MORING, J.R. April 1988. "Attraction of juvenile lumpfish (Cyclopterus lumpus) to marine algae in tidepools." 1988 Benthic Ecology Meeting, Portland, ME.

MORING, J.R. April 1988. "Salmon Aquaculture." Seminar presented as part of the Aquaculture Seminar Series, University of Maine, Orono.

MORING, J.R. June 1988. "Marking and tagging intertidal fishes: a review of techniques." Poster paper at International Symposium and Educational Workshop on Fish-Marking Techniques, Seattle, WA.

O'CONNOR, R.J. December 1987. "Avian habitat dynamics." Presented at seminar at National Ecology Center, USFWS, Ft. Collins, CO. 30 professional scientists and academics attended.

O'CONNOR, R.J. December 1987. "Effects of agricultural intensification on bird populations in Britain." Presented at seminar at National Ecology Center, USFWS, Ft. Collins, CO. 30 professional scientists and academics attended.

O'CONNOR, R.J. December 1987. "Ecological aspects of migrancy and residency in birds." Paper presented at Biological Sciences Colloquium, Colorado State University, Ft. Collins, CO. 60 academic faculty and students.

O'CONNOR, R.J. January 1988. "Habitat use and nesting success in migrant birds." Seminar presented to research staff of Manomet Bird Observatory, Manomet, MA. 15 attended.

O'CONNOR, R.J. February 1988. "Ecological aspects of migrancy in birds." Presented at Smithsonian National Zoological Garden, Washington, DC.

O'CONNOR, R.J. April 1988. "The UK's Common Bird Census." Paper presented at U.S. Fish and Wildlife Service Workshop on Analysis of Avian Population Trends, Patuxent Wildlife Research Center, Laurel, MD.

O'CONNOR, R.J. April 1988. "Current thinking on UK bird monitoring." Paper presented at U.S. Fish and Wildlife Service Workshop on Analysis of Avian Population Trends, Patuxent Wildlife Research Center, Laurel, MD.

O'CONNOR, R.J. May 1988. "Ecology of migrant and resident birds in Britain." Research seminar, biological sciences, Dartmouth College, NH. Ca. 30 faculty and graduate students attended.

O'CONNOR, R.J. July 1988. Presentation on "Post-registration and monitoring systems in the U.K." Meeting of Conservation Foundation's Avian Effects Dialogue Group, Washington, D.C. 15 researchers and administrators.

OWEN, R.B., Jr. October 1987. "Black Ducks in Peril." Seminar presented at Unity College, Unity, ME.

PERRY, C.M. May 1988. "The role of calcium and acidity in juvenile Atlantic salmon." Seminar presented to National Fisheries Contaminant Research Center, Columbia, MO.

SAYERS, R.E., Jr. September 1988. "Atlantic salmon/brook trout interactions." Annual meeting, Atlantic International Chapter, American Fisheries Society, Sargentville, ME.

SHIVELY, L.A. February 1988. "Foraging behavior and energetics in relation to habitat suitability for forest ungulates." Paper presented at 20th Northeast Graduate Wildlife Conference, University of Maine, Orono.

VANDERHAEGEN, W.M. January 1988. "Energetic aspects of woodcock habitat use during the breeding season at the Moosehorn National Wildlife Refuge." Northeast Graduate Wildlife Conference, Univ. of Maine, Orono.

YONZON, P., and J.J. Bauer. April 1988. "Conflicting issues of developmental infrastructure." National Conference on Science and Technology, Kathmandu, Nepal.

YONZON, P. July 1988. "Conservation biology of rare mammals in Nepal's protected areas." Paper presented to South Asia Pacific Mammal Meeting, Beijing, China.

PUBLIC TALKS PRESENTED

ARTHUR, S.M. "Fisher ecology." Slide show presented to Palmyra Chapter, Maine Trappers Association, October 7, 1987.

ARTHUR, S.M. "Furbearer management." Lecture presented to wildlife students, University of Maine, Orono, December 7, 1987.

ARTHUR, S.M. "Fisher ecology." Slide show presented to Farmington Chapter, Maine Trappers Association, December 8, 1987.

ARTHUR, S.M. "Fisher ecology." Slide show presented to South Path Chapter, Maine Trappers Association, January 7, 1988.

ARTHUR, S.M. "Fisher ecology." Slide show presented to Belfast Chapter, Maine Trappers Association, March 3, 1988.

ARTHUR, S.M. "Fisher ecology." Slide show presented at Penobscot County Conservation Association Sportsman's Show, March 12 and 13, 1988.

BOGACZYK, B. "Overview of the cervid parasite survey." Talk presented to regional biologists of the Maine Department of Inland Fisheries and Wildlife, Bangor, September 1988. 12 attendees.

DIEFENBACH, D. "Careers in wildlife biology." Talk presented to St. Johnsbury Middle School, St. Johnsbury, VT., November 1987.

ELLIOTT, C.A. "Careers in wildlife." Talk presented to 30 eighth grade 5th Street Middle School students as part of their "Career Day," Bangor, February 1988.

ELLIOTT, C. "Backyards and woodlots: How to attract more wildlife to your land." CES program given at Bangor Sportsman's Show, Orono, March 1988.

ELLIOTT, C. "Backyards and woodlots: How to attract more wildlife to your land." CES program given at USM-Gorham, April 1988.

ELLIOTT, C. "Backyards and woodlots: How to attract more wildlife to your land." CES program given to Washington County VTI, April 1988.

HILLS, S. "Blood and guts in the Arctic." Noontime seminar presented to Alaska Fish and Wildlife Research Center, Anchorage, AK, February 1988.

HILLS, S. "The UM/USFWS/USSR Pacific walrus research project." Talk presented to City Council meeting, Wainwright, AK, June 28, 1988.

KROHN, W.B. "Ecology and management of Canada geese." Slide presentation to freshman wildlife seminar, University of Maine, Orono, September 1987. 45 attendees.

KROHN, W.B. Invited by the Maine Arts Commission to help judge a wildlife art contest; winning paintings were displayed outside the Governor's Office in Augusta, ME, December 1987.

KROHN, W.B. "Structure and function of the U.S. Fish and Wildlife Service," "Migratory bird program of the U.S. Fish and Wildlife Service." Lectures to undergraduate wildlife policy class, University of Maine, Orono, January 1988. 25 attendees.

KROHN, W.B. "Biology and status of Maine's eider ducks." Slide presentation given at the 50th Eastern Maine Sportsman's Show, Orono, ME., March 1988.

KROHN, W.B. "An overview of the Maine Cooperative Fish and Wildlife Research Unit." Talk presented to the Maine Warden School, Orono, May 1988. 15 attendees.

HARRISON, D.J. "Ecology of coyotes and bobcats in eastern Maine." Talk presented to ca. 10 general audience, Edmunds, ME., May 24, 1988.

HERKE, S.W. "Northern pike in the Belgrade Lakes Region." Talk presented at the 50th Eastern Maine Sportsman's Show, Orono, March 1988. 30 attendees.

LIVINGSTON, S. "Ecology of bald eagles." Presentation with Bart the bald eagle to approximately 12 high school students at Hermon High School, November 1987.

MINK, L.H. "Aquaculture in Cameroon." Lecture presented to Fishery Biology class, University of Maine, November 1987. 18 attendees.

MORING, J.R. "Coolwater fish aquaculture." Lecture presented to Aquaculture class, University of Maine, November 1987. 10 attendees.

MORING, J.R. "Effects of logging on streams." Lecture presented to Wildlife Techniques class, University of Maine, December 1987. 50 attendees.

MORING, J.R. "Salmon and trout in Maine." Talk presented at the 50th Eastern Maine Sportsman's Show, Orono, March 1988. 45 attendees.

O'CONNOR, R.J. Evening talk on assessing the influence of agricultural practices on birds in Britain. Presented to Northeast Nongame Technical Committee Meeting, Wiscasset, ME, October 1987.

O'CONNOR, R.J. Participated in BBC Radio 3 program [in the Science Now series] about biological invasions, broadcast January 3, 1988.

SAYERS, R.E., Jr. "The Great Lakes fisheries." Lecture to the Fishery Biology class, University of Maine, November 1987. 18 attendees.

VANDERHAEGEN, W.M. "Ecology of the wild turkey in Massachusetts." Wildlife Seminar Series, Univ. of Maine, Orono, November 1987.

PROFESSIONAL MEETINGS ATTENDED

ARTHUR, S.M. Attended American Society of Mammalogists 68th annual meeting, Clemson, S.C., June 19-23, 1988.

ARTHUR, S.M. Attended 20th annual Northeast Wildlife Graduate Conference, University of Maine, Orono, February 12-14, 1988.

BOGACZYK, B. Participated in a field training session on deer necropsy procedures by personnel from the Southeast Cooperative Wildlife Disease Study, University of Georgia at Athens, August 1988.

CHILELLI, M. Attended the Northeast Deer Techical Committee Meeting, Galille, RI, September 6-9, 1988.

DEVAUL, H. Attended Seventh Biennial Conference on the Biology of Marine Mammals, Miami, FL, December 5-9, 1987.

DEVAUL, H. Attended National Wildlife Federation's Northeast Raptor Management Symposium and Workshop, Syracuse, NY, May 16-18, 1988.

ELLIOTT, C.A. Attended the Southern Region 4-H Wildlife Judging Conference, Paul B. Johnson State Park, Hattiesburg, MS, July 25-29, 1988.

GILBERT, J. Attended Seventh Biennial Conference on Biology of Marine Mammals, Miami, FL, December 5-9, 1987.

HARRISON, D.J. Attended 1988 Northeast Fish and Wildlife Conference, White Sulphur Springs, WV, March 27-30, 1988.

HARRISON, D.J. Attended Systemwide Conference on Undergraduate Education, Rockland, ME, March 25-26, 1988.

HERKE, S.W. Attended the Atlantic Salmon Management Meeting, Portland, ME, October 1987.

HILLS, S. Attended Seventh Biennial Conference on Biology of Marine Mammals, Miami, FL, December 5-9, 1987.

HUNTER, M.L., Jr. Attended the Society for Conservation Biology Meetings, Davis, CA, August 1988.

KROHN, W.B. Attended Workshop on Eider Management, Ste.-Foy, Quebec, January 12-13, 1988.

KROHN, W.B. Attended 45th Northeast Fish and Wildlife Conference, White Sulphur Springs, WV, March 29-30, 1988.

McKINLEY, D.B. Attended the annual meeting, Atlantic International Chapter, American Fisheries Society, Sargentville, ME, September 1988.

MINK, L.H. Attended the annual meeting, Atlantic International Chapter, American Fisheries Society, Sargentville, ME, September 1988.

MORING, J.R. Attended the Atlantic Salmon Management Meeting, Portland, ME, October 1987.

MORING, J.R. Attended the International Conference on Artificial Habitats for Fisheries, Miami, FL, November 1987.

MORING, J.R. Attended the 45th Northeast Fish and Wildlife Conference, White Sulphur Springs, WV, March 29-30, 1988.

MORING, J.R. Attended the Atlantic Salmon Culture Workshop, Rockport, ME, March 1988.

MORING, J.R. Attended the 1988 Benthic Ecology Meeting, Portland, ME, April 1988.

MORING, J.R. Attended the Symposium on Climate, Agriculture, and History, and was a session chairman, Orono, ME, June 1988.

MORING, J.R. Attended the International Symposium and Educational Workshop on Fish-Marking Techniques, Seattle, WA, June 1988.

MORING, J.R. Attended the annual meeting, Atlantic International Chapter, American Fisheries Society, Sargentville, ME, September 1988.

MUGANGU, E. Attended 53rd North American Wildlife and Natural Resources Conference, Louisville, KY, March 19-23, 1988.

O'CONNOR, R.J. Attended Northeast Nongame Technical Committee Meeting, Wiscasset, ME, October 1987.

O'CONNOR, R.J. Attended 53rd North American Wildlife and Natural Resources Conference, Louisville, KY, March 19-23, 1988.

O'CONNOR, R.J. Served as consultant to Workshop on Analysis of Avian Population Trends, Patuxent Wildlife Research Center, Laurel, MD, April 11-12, 1988.

O'CONNOR, R.J. Attended meeting of Conservation Foundation's Avian Effects Dialogue Group, Washington, D.C., July 27, 1988.

PERRY, C.M. Attended the Atlantic Salmon Management Meeting, Portland, ME, October 1987.

PERRY, C.M. Attended the Atlantic Salmon Culture Workshop, Rockport, ME, March 1988.

ROMIG, G.P. Attended the annual meeting, Atlantic International Chapter, American Fisheries Society, Sargentville, ME, September 1988.

SAYERS, R.E., Jr. Attended the Atlantic Salmon Management Meeting, Portland, ME, October 1987.

SAYERS, R.E., Jr. Attended the Atlantic Salmon Culture Workshop, Rockport, ME, March 1988.

SAYERS, R.E., Jr. Attended the annual meeting, Atlantic International Chapter, American Fisheries Society, Sargentville, ME, September 1988.

SCHOOLEY, R.L. Attended Ninth Eastern Black Bear Workshop, Huntsville, Ontario, April 4-7, 1988.

VANDERHAEGEN, W.M. Attended Northeast Graduate Wildlife Conference, Univ. of Maine, Orono, January 1988.

VAUGHAN, E. Attended Tropical Rainforest Conference, New York, NY, October 1987.

WHITMAN, A. Attended American Institute of Biology Sciences Meeting (including Ecological Society of America and Association of Tropical Biology), Columbus, OH, August 1987.

WHITMAN, A. Attended Tropical Rainforest Conference, NY, October 1987.

YONZON, P. Attended the National Conference on Science and Technology, Kathmandu, Nepal, April 1988.

YONZON, P. Attended the South Asia Pacific Mammal Meeting, Beijing, China, July 1988.

AWARDS

DEVAUL, H. Received the Hawk Mountain Sanctuary Association Student Research Award, February 1988.

HERKE, S.W. Appointed by President Dale Lick, University of Maine, to serve on the President's Committee for Campus Reorganization.

KROHN, W.B. Elected President of the Maine Chapter of The Wildlife Society.

MORING, J.R. Elected President of the American Fisheries Society, Northeastern Division. He was also Chairman of the Coordinating Committee for the Migratory Fish Research Institute.

O'CONNOR, R.J. Appointed by President H. T. Rhodes of Cornell University to serve a term on the Administrative Board of Cornell's Laboratory of Ornithology from July 1, 1988.

O'CONNOR, R.J. Elected to be an Elective Member of the American Ornithologists Union "in recognition of your contributions to ornithology" in voting by Fellows and Elective Members of the AOU, announced at the 106th Slated Meeting of the AOU at Fayettevile, Arkansas in August 1988.

PERRY, C.M. Received the Horace Bond Scholarship for Fisheries from the Penobscot County Conservation Association, October 1987.

SAYERS, R.E., Jr. Received a 1988 Olin Fellowship from the Atlantic Salmon Federation.

TRIAL, J.G. Served as President, Atlantic International Chapter, American Fisheries Society.

YONZON, P. Awarded a one-year research fellowship at the East-West Center, Honolulu, Hawaii.