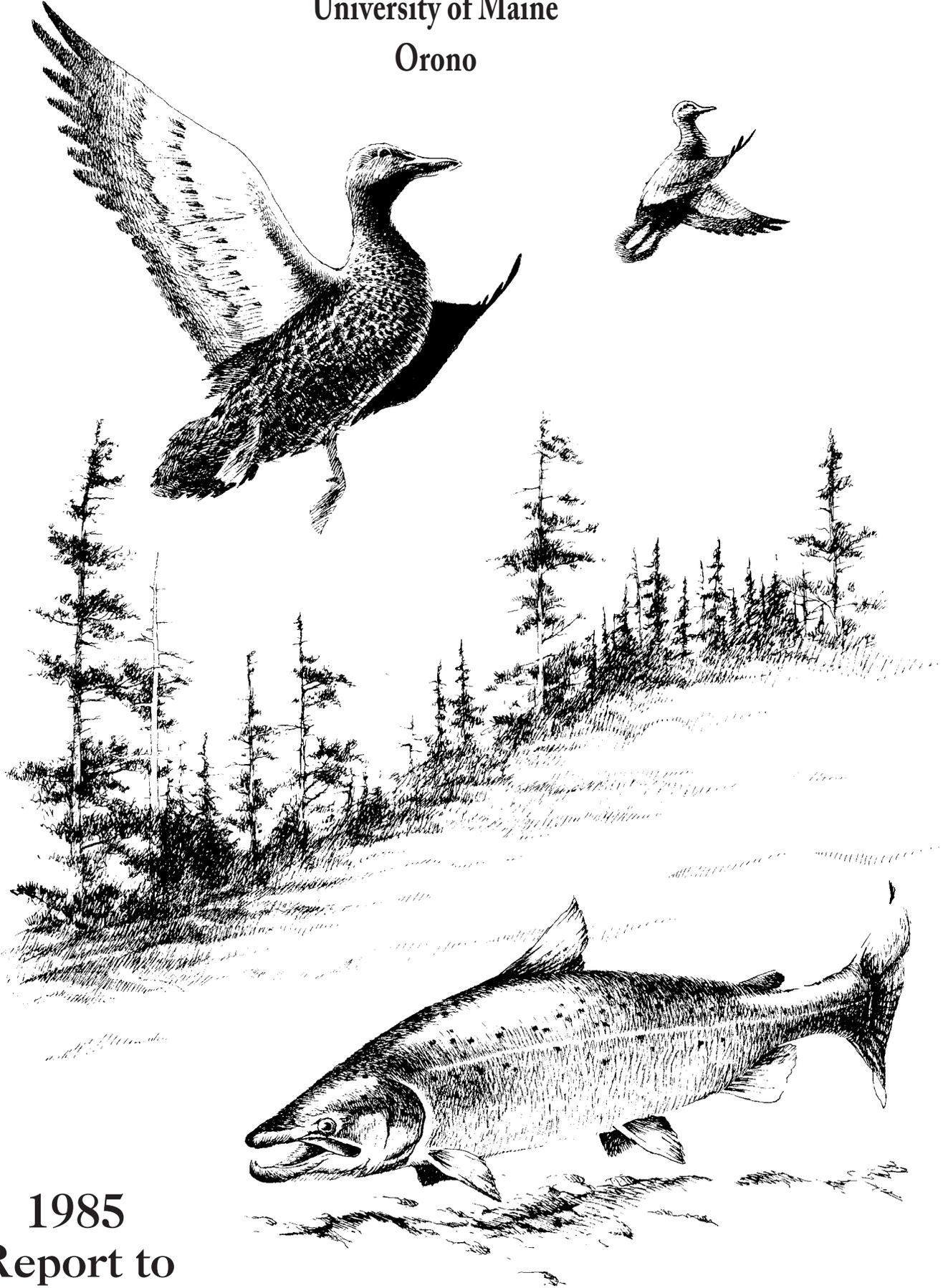


MAINE COOPERATIVE FISH AND WILDLIFE RESEARCH UNIT

University of Maine

Orono



1985
Report to
Cooperators

—Mark McCollough '86

MAINE COOPERATIVE FISH AND WILDLIFE RESEARCH UNIT

240 Nutting Hall*
University of Maine
Orono, Maine 04469



COOPERATORS

UNIVERSITY OF MAINE AT ORONO
MAINE DEPARTMENT OF INLAND FISHERIES AND WILDLIFE
FISH AND WILDLIFE SERVICE, U.S. DEPARTMENT OF THE INTERIOR
WILDLIFE MANAGEMENT INSTITUTE

October 1984 - September 1985



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

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

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PERSONNEL AND COOPERATORS (October 1985)

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 George J. Matula, Jr., Supervisor, Wildlife Division Research Section
 Kendall Warner, Supervisor, Fisheries Management Section

Personnel from many University departments as well as State, Federal, and private organizations are actively collaborating with the Unit. Individuals assisting with projects currently reported are listed in connection with the appropriate project summary.

GRADUATE STUDENTS

Name	Degree Candidacy	Support
Stephen M. Arthur	Ph.D	MDIFW; MCFWRU; ME Trappers Assoc. (NE Coastal Ch.)
Patrick W. Bley	M.S.	MDIFW, UMO, PVCC, MCFWRU
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Lisa A. DeBruyckere	M.S.	USFWS - Refuge Division
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Leslie J. Dubuc	M.S.	NPS
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Paul Eiler	M.S.	KLDC, UMO
Catherine A. Elliott	Ph.D.	IPC; MDIFW
Donald P. Engelhardt	M.S.	MDIFW; MCFWRU
Daniel J. Harrison	Ph.D.	MDIFW; MCFWRU
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Jonathan A. Jenks	M.S.	McIntire-Stennis; MCFWRU
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Susan A. Livingston	M.S.	MDIFW
Chet MacKenzie	M.S.	MDIFW, UMO, PVCC, USFWS, MCFWRU
Daniel G. McAuley	M.S.	USFWS (PWRC, CNFRL)

Mark A. McCollough	Ph.D.	USFWS; NWF; NC
Dennis M. Mullen	M.S.	IPC, MDIFW, PVCC, AMC, MCFWRU
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Cynthia M. Perry	Ph.D.	USFWS, UMO
David J. Santillo	M.S.	McIntire-Stennis
Richard E. Sayers	Ph.D.	MDIFW, UMO, MCFWRU
Mary F. Small	M.S.	Holt Woodlands Research Foundation
Michael E. Thompson	M.S.	MDIFW; MCFWRU; McIntire-Stennis
Joan G. Trial	Ph.D.	UMO
Beatrice E. Treiterer	M.S.	NWTF
Peter D. Vickery	M.S.	Nat., Conserv; MAS; MPCB; MAAS; CB
Pralad B. Yonzon	Ph.D.	UMO; WWF

Graduate Students: Dissertations/Theses Completed This Period

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Michael Brett	M.S.
Alan Crossley	M.S.
Chet MacKenzie	M.S.
Dennis M. Mullen	M.S.
Joyce E. Snyder	M.S.
Paul I.V. Strong	Ph.D.

COLLABORATING AGENCIES AND ORGANIZATIONS

Atlantic Flyway Cooperative Banding Program,
Atlantic Waterfowl Council - AFCBP

Big Bend National Park - BBNP

Canadian Federal Government (NSERC)

Canadian Wildlife Service (CWS)

Coastal Blueberry, Inc. - CB

Eagle Valley Environmentalists - EVE

Holt Woodlands Research Foundation - HWRF

International Paper Company - IPC

Kennebec Log Driving Company - KLDC

L.L. Bean, Inc. - LLB

Libby Sporting Camps - LSP

Maine Audubon Society - MAS

Maine Department of Conservation - MDC
Maine Department of Inland Fisheries and Wildlife - MDIFW
Maine Pesticides Control Board - MPCB
Massachusetts Audubon Society - MAAS
National Geographic Society - NGS
National Marine Fisheries Service, Northeast Fisheries Center - NMFS
National Park Service - NPS
National Rifle Association - NRA
National Wild Turkey Federation - NWTf
National Wildlife Federation - NWFd
Nature Conservancy - NC
 Maine Chapter - NC-MC
Newfoundland Wildlife Division (NWD)
North American Wildlife Foundation -
 Delta Waterfowl & Wetland Research Station - DWRS
Penobscot County Conservation Club - PCCC
Society of Sigma XI - SX
St. Regis Paper Co. - SR
University of Maine at Orono - UMO
 Graduate Student Board - GSB
 College of Forest Resources - CFR
 Hatch Act Funds - HAF
 McIntire-Stennis - MS
 College of Arts and Sciences - CAS
 Zoology Department - ZD
U.S. Environmental Protection Agency - EPA

U.S. Fish and Wildlife Service - USFWS

Columbia National Fishery Research Laboratory - CNFRL

Eastern Energy and Land Use Team - EELUT

National Coastal Ecosystem Team - NCET

Office of Migratory Bird Management - MBMO

Patuxent Wildlife Research Center - PWRC

Western Energy and Land Use Team - WELUT

U.S. Forest Service - USFS

Northeast Forest Experiment Station - NEFES

U.S. National Park Service - NPS

U.S. State Department - USSD

Wildlife Management Institute - WMI

Wheelabrator-Frye, Inc. (now part of Signal Fuels) - SF

World Wildlife Fund - WWF

Mr. Scott Skinner

Mr. Joseph Sewall

UNIT PERSONNEL CHANGES

John A. Bissonette left the Maine Unit in July, 1985, to become Leader of the Utah Cooperative Fish and Wildlife Research Unit, at Logan.

William B. Krohn became Leader of the Maine Unit in September, 1985. Dr. Krohn was previously the Assistant Chief in the U.S. Fish and Wildlife Service's Office of Migratory Bird Management, Washington, D.C.

POST-FLEDGING ECOLOGY AND POPULATION DYNAMICS OF BALD EAGLES IN MAINE

Investigator: Mark A. McCollough

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

Cooperators/ Maine Department of Inland Fisheries and Wildlife
Project U.S. Fish and Wildlife Service
Support: Acadia National Park
The Nature Conservancy
Eagle Valley Environmentalists

Objectives:

- (1) Describe post-fledging behavior of bald eagles in Maine with emphasis on movements in relation to breeding areas, habitat use, and associated adult-juvenile relationships.
- (2) Obtain information on juvenile dispersal and movements and location of wintering areas in Maine.
- (3) Investigate winter activity and habitat use of adult and immature eagles in Maine.
- (4) Evaluate artificial feeding of bald eagles during the winter as a technique to: (a) improve survival of juvenile and adult eagles, (b) provide a contaminant-free supplement of eagle diet in the winter, and (c) enhance subsequent nesting attempts of adult eagles.

Scope:

Despite recent improvements, bald eagle productivity in Maine remained below the reproductive rates of eagles in other areas. From 1977-85, 50 to 86 pairs have been located nesting in Maine with an average productivity of only .74 fledglings/occupied nest. Bald eagle populations in the Great Lake States, Chesapeake Bay region, and Nova Scotia had average productivities of 0.90 to 1.22 fledglings/occupied nest during the same time period. Persistent high levels of organochlorine residues and other contaminants in eagle eggs, prey items, and in Maine soils indicated that Maine's eagle production will likely be depressed for years to come.

Management goals have been to improve reproductive success and the recruitment of bald eagles into the breeding population and thereby restore a healthy eagle population in Maine. Maintaining or improving productivity has been essential, but the ultimate success of management efforts to encourage population growth depends on the survival of

individuals already in the population. Population modeling of bald eagles suggested that management efforts directed at improving survival will increase the population more rapidly than attempting to improve reproductive success.

The purpose of this study was to investigate the post-fledging ecology of bald eagles (their first 5 years of life), documenting movements and behavior immediately following fledging and subsequent dispersal. A state-wide winter feeding program was evaluated as a management technique to improve over-winter survival of young eagles. Large numbers of banded eagles were individually identified at the feeding stations from year to year. These data were used to calculate survival rates for eagles, evaluate the effect of feeding on survival, and document plumage changes with age in young eagles. Survival and reproductive data are being used to create a population model to predict future population trends and to better evaluate the bald eagle's status as an endangered species.

Project Status:

From 1981-83, 11 fledgling eagles were radio-tagged at 12 nest sites in Cobscook and Machias bays in eastern Maine. Over 2,000 relocations were made of radio-tagged eagles, their parents, and siblings. Data on perch trees habitat use and behavior were collected for each relocation. Radio-tagged eagles were monitored each year from July to October until they dispersed from natal areas. Nine of the radio-tagged eagles were resighted after dispersal in Maine, Connecticut, and New York.

The bald eagle winter-feeding program was continued for the fourth winter in Cobscook, Frenchman, Penobscot, and Merrymeeting bays. Approximately 95,000 pounds of food (mostly deer, livestock, poultry, and furbearer carcasses) were distributed to the feeding stations from October 1984 to March 1985. At least 325 different eagles were observed at the feeding stations. The greatest response was in Cobscook Bay where up to 78 different eagles, mostly immatures, used the feeding stations daily. Band numbers from 170 different eagles were obtained at the Cobscook Bay station while observing birds from a blind with an 80X telescope. One hundred and forty-four eagles were from Maine, originally banded at 45 nest sites across the state. Of particular interest were 42 adult eagles banded from 1975-79. Also resighted were single eagles from Michigan, Ontario, South Carolina, Massachusetts, and Saskatchewan, 7 eagles from Nova Scotia (Cape Breton Island), 13 from New Brunswick, and 3 from Prince Edward Island.

In 1985, 70 of the 74 eaglets produced in Maine were banded with individually coded color bands and band tags to investigate movements, dispersal and survival. An additional 5 eaglets were banded in New Brunswick. During the winter of 1984-85, color-marked eagles were

resighted in Massachusetts, Connecticut, and Labrador. To date over 59% of the 387 eagles banded in Maine since 1975 have been resighted. These data are being used to construct models of Maine's eagle population.

Future Plans:

Field work for a Ph.D. dissertation was completed in March, 1985. Data analysis and writing of the dissertation are now in progress. Expected completion of the Ph.D. degree is in March, 1986. The winter feeding program is scheduled to be continued until 1990. Research emphasis will be to determine yearly variation in survival rates and investigate age at first breeding and recruitment into the breeding population.



While Maine's bald eagle population, consisting of at least 85 nesting pairs in 1985, is slowly increasing, there is concern over the continued low reproductive rate (Photo by W. B. Krohn).

EFFECTS OF TIMBER HARVESTING PRACTICES
ON PRIMARY PRODUCTION IN A STREAM

Investigator: D. M. Mullen

Advisors: J. R. Moring, Chairperson
T. B. Saviello
P. D. Uttormark

Cooperators/ International Paper Company
Project Appalachian Mountain Club
Support: Penobscot County Conservation Association
Maine Department of Inland Fisheries and Wildlife
University of Maine at Orono
Maine Cooperative Fish and Wildlife Research Unit

Objective: Measure changes (if any) in primary production following salvage cutting along a stream.

Project Status:

All requirements for the degree of Master of Science (Zoology) were completed in May 1985. An abstract of the thesis follows:

Autochthonous energy input, in the form of periphyton production and growth, was studied before and after logging of the watershed surrounding School Brook, a small tributary to the Aroostook River, Maine. Due to infection by spruce budworm, no buffer strip was left on one bank of the stream. The objective of this study was to assess the impact of the removal of the buffer strip on the autochthonous energy source of the stream and add to the understanding of the mechanisms operating within a stream ecosystem that are essential for sound management of the forest resources.

The effect of the logging on the periphyton community was insignificant, apparently due to several factors. Only a small part of the canopy was actually removed, thus minimizing the intensity of changes in available light. Small springs in the area helped maintain a stable thermal regime, and only a small portion of the shallow watershed was actually logged. As a consequence, there was no increase in runoff, thus preventing an elevation in the amount of nutrients reaching the stream. The relatively low concentrations of nitrates and phosphates, both before and after logging, are cited as major factors limiting the autochthonous input and, therefore, reducing the effect of the logging on the stream community.

ATLANTIC SALMON SPAWNING AND INTRAGRAVEL REARING CONDITIONS

Investigator: C. MacKenzie

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

Cooperators/
Project
Support Penobscot County Conservation Association
Maine Department of Inland Fisheries and Wildlife
Maine Cooperative Fish and Wildlife Research Unit

Objectives: (1) Measure and identify the extent and stage of intragravel mortality of developing Atlantic salmon eggs and alevins.
(2) Determine if alevin emergence patterns occur in a randomized pattern.

Project Status:

All requirements for the degree of Master of Science (Zoology) were completed in August 1985. An abstract of the thesis follows:

Survival of Atlantic salmon between fertilization and emergence was monitored in Northern Stream, Washington County (T 19 E.D.), Maine. Known numbers of green eggs were placed in modified Whitlock-Vibert egg boxes and buried in Northern Stream. Survival was estimated on four occasions prior to emergence and at emergence. Survival through hatching was high (74%) but decreased rapidly after hatching. Average survival at emergence was 2%.

The distributions of emerging Atlantic salmon fry from natural redds were also studied. The non-random distribution of emergent fry may be caused by non-random horizontal intragravel movements which were oriented to intragravel flow. Substrate permeability and dissolved oxygen were measured in redds after emergence. Emergent-fry density and substrate permeability in each section of the circular fry traps were not significantly correlated in the redd with the higher total fry density (30 fry/m²). Emergent fry density and substrate permeability at 14 cm and 20 cm depths were positively correlated ($p < 0.05$) in the redd with lower density (12 fry/m²).

POTENTIAL HABITAT COMPETITION BETWEEN ATLANTIC SALMON AND BROOK TROUT
IN THE UPPER ST. JOHN RIVER SYSTEM

Investigator: P. W. Bley

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

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

Objectives:

- (1) Quantify the habitat selection by brook trout in waters of the upper St. John River system.
- (2) Attempt to predict whether or not introduced sea-run Atlantic salmon would compete with brook trout for space and/or food.

Scope:

At the urging of the state's largest salmon club, the introduction of sea-run Atlantic salmon was recently authorized for the upper St. John River. However, when the proposal was first aired, state biologists had several concerns. Would adult fish migrating upstream and transported in tanks above the impassable Grand Falls dam bring with them unwanted diseases and unwanted warmwater species to the upper river? Would sea-run Atlantic salmon unfavorably compete with native brook trout in an internationally-known fishing area?

The last question is addressed in this research project. Research sites were selected in the upper St. John River system in which brook trout were indigenous, both with and without cohabiting landlocked salmon. Stream placement from ice-out to ice-in was determined by electrofishing surveys. The habitats selected were quantified using a modification of Habitat Evaluation Procedures for brook trout. Any detected habitat shift in the brook trout populations as a result of cohabitation with landlocked salmon would serve as an index of expected completion of brook trout and sea-run Atlantic salmon.

Project Status:

Three sites (Sly Brook, West Twin Brook, Fox Brook) were selected in the fall of 1984, based on past electrofishing by state biologists. These sites were surveyed at approximately 3-week intervals over the spring-to-fall 1985 season. Data were obtained for a number of physical and biological parameters, including depth, temperature, current and speed.

Future Plans:

Complete analysis of the habitat data associated with seasonal stream preference is in progress. A thesis will be prepared by May 1986.

FOOD CHAIN OF SCHOODIC LAKE, MAINE

Investigator: R. E. Sayers, Jr.

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

Cooperators/
Project

Support: Maine Department of Inland Fisheries and Wildlife

Objective: Quantify elements of the food chain in Schoodic Lake to indicate possible reasons for the poor productivity and growth of game fishes, and to recommend possible management options.

Scope:

The Schoodic Lake fisheries for landlocked salmon and lake trout have been poor for many years. The success rate for winter salmon anglers of 0.05 fish per angler-hour is well below the regional average. The regional manager has established as a goal landlocked salmon of 16 inches and 1 pound by the end of the second year of growth. Results of trapnetting operations in October, 1985 indicate that this goal is not being met despite drastic cuts in the salmon stocking rate. Lake trout growth also appears to be poor. Approximately 80% of all lake trout caught during the 1985 winter season were below the legal size limit of 18 inches. The most likely cause of slow salmonid growth is insufficient forage-fish populations. Several attempts have been made to establish a smelt population but these have been largely unsuccessful. The State of Maine requested a fishery investigation to assess the plankton and forage base and to recommend management options.

Project Status:

A literature review is in progress and discussions with the regional biologist are ongoing. These discussions have included a thorough review of the management history and goals for Schoodic Lake. Recent trends indicate that growth of salmon is improving, probably as a result of reducing the stocking rate, but growth is still well below the regional average. A study plan is being formulated to provide management options for the Schoodic Lake fishery.

Future Plans:

Field work, principally gillnetting, trawling, and angler surveying should begin in early 1986. Using systematic trawl sampling, we hope to estimate the abundance and distribution of forage fish. Combining these estimates with salmonid food habits and abundance data should provide a basis for refining the stocking and harvest policies for Schoodic Lake. Field work should be completed in 1987 and the thesis by May 1988.

EVALUATION TECHNIQUES FOR DISTINGUISHING STOCKS OF ATLANTIC SALMON

Investigator: C. M. Perry

Advisor: J. R. Moring

Cooperators/ U.S. Fish and Wildlife Service - Wellsboro National
Project Fishery Research and Development Laboratory,
Support: Wellsboro, PA.

Objective: Describe the impacts of varying levels of pH on the survival, growth, and development 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. Of particular importance is the loss of Atlantic salmon stocks. 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 over harvesting, 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 have shown species differences. Investigations of low pH tolerance on various strains of salmonid species have been inconclusive. This project proposes to shed more light in this area of strain differences.

In this project, five strains (sources) of Atlantic salmon taken from various sites in New England will be reared and tested. Three strains (sources) will be of sea-run origin and two will be from landlocked populations. One-half of each strain (source) will be raised one pH unit lower than its' counterparts. At six life stages from embryo through smolt, these fish will be subjected to various levels of pH below their optimum.

Lower lethal limits or EC_{50} 's will be calculated for each life stage in each strain. Photographic, histological and written records will be kept of fish at each stage and pH.

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 there, and (b) choosing a strain whose

overall survival may be improved by their tolerance of lowered pH levels during various periods of their lives and using these strains to enhance present populations.

Project Status:

The project is just beginning, with equipment construction and acquisition underway.

Future Plans:

Eyed eggs from five sources will be in place at Wellsboro by January 1986. Initial testing will begin soon thereafter, with periodic testing and measurement continuing in stages for an 18-month period. A thesis will be prepared by May 1988.



Maine's Atlantic salmon population, due to intensive management, is increasing. Here anglers try their luck at the Bangor Salmon Pool, Penobscot River (Photo by J. R. Moring).

POPULATION STUDIES OF MAINE INTERTIDAL FISHES

Investigator: J. R. Moring

Cooperators/ National Geographic Society
Project The Nature Conservancy
Support: University of Maine at Orono

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 check list 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 20 species of tidepool fishes in Maine. The movements of the rock gunnel have been examined in marking studies, and algal associations and food habits of lumpfish and Atlantic seasnails have been quantified. Three study pools on Schoodic Peninsula have been studied since 1981, and work has also involved the first description of rock gunnels as the first intermediate host of the digenean fluke, *Cryptocotyle lingua*.

Project Status:

Monitoring of three study pools continued at Schoodic Peninsula in 1985, and data were recorded on the impact of Hurricane Gloria on the physical and biological components of the pools. Significant changes were noted, including the absence of small invertebrates and changes in pool morphology. Additional data were collected on algal associations of juvenile lumpfish and Atlantic seasnails. Most fishes preferred species of *Laminaria*. Work in fall 1985 involved monitoring of environmental conditions affecting emigration of fishes from tidepools to subtidal areas, primarily temperature and salinity. Numerous journal papers and reports have been published.

Future Plans:

Work in Spring 1986 will document the environmental conditions affecting immigration of fishes to tidepools from subtidal areas. Stomach analyses of over 100 juvenile specimens of lumpfish and seasnails will be completed during winter 1986. Additional movement studies with rock gunnels are planned for summer 1986, including an assessment of fluke infestation as an indicator of intertidal and subtidal movements. Several journal manuscripts are being prepared.

REPRODUCTION OF BLUEBACK CHAR

Investigators: F. W. Kircheis
C. MacKenzie
M. McElroy

Cooperator: J. R. Moring

Cooperators/
Project
Support: The Nature Conservancy
Maine Bureau of Public Lands

Objective: Describe the spawning behavior and fecundity of blueback char.

Scope:

The blueback char, a landlocked form of Arctic char, is rare, and perhaps is a threatened subspecies. It is managed as a separate "species" by the State of Maine. Genetically, it has been shown to be similar to Arctic char, but the spawning behavior appears to be unique. This spawning activity has not been adequately investigated or described.

Project Status:

Field work for this 6-month project has been completed. Oneida trap nets and fyke nets were used to collect blueback char from late October to mid-November, 1985, in three lakes in Deboullie-Red River Township (T15, R9). These lakes in central Aroostook County are among only a handful of lakes in Maine known to contain blueback char. Information was gathered on the population characteristics of all species collected in the lakes as well as the reproductive habits of blueback char.

Future Plans:

All field work is completed. A final report will be prepared by January 31, 1986.

FISHERIES INDICES IN LAKE SEBASTICOOK AS AFFECTED BY WATER DRAWDOWN

Investigators: F. Jiffry
C. Fay
J. Snow
L. S. Weiss-Glanz
J. G. Trial

Advisors: J. G. Stanley, Chairperson (for F. Jiffry)
R. L. Vadas
S. Tyler

Cooperator: J. R. Moring

Cooperator/
Project

Support: Maine Department of Environmental Protection

Objective: Measure biological changes associated with water drawdown of Lake Sebasticook, Maine.

Scope:

In an effort to improve the water quality and fishery of the eutrophic Lake Sebasticook, water levels were drawn down over several years. Prior to and after these drawdowns, populations of fishes and freshwater mussels were studied in several interrelated projects.

The notable result was the elimination of almost all freshwater mussels following drawdown. Mussel movement was slower than the receding waters, so the mussels burrowed and eventually starved.

Project Status:

Work is underway on the analysis of fisheries data, including calculations of PSD (Proportional Stock Density) and creel census, and a draft final report has been prepared.

Future Plans:

The draft report will be reviewed, edited, and completed this year.

INTERACTIONS AMONG WATERFOWL, FISHES, INVERTEBRATES, AND
MACROPHYTES IN FOUR MAINE LAKES OF DIFFERENT ACIDITY

Investigators: M. L. Hunter, Jr.
K. E. Gibbs
J. R. Moring
J. J. Jones
M. Brett

Cooperators/ U.S. Fish and Wildlife Service - Eastern Energy
Project and Land Use Team, Kearneysville, WV.
Support: U.S. Environmental Protection Agency
University of Maine Entomology Department

Objectives:

- (1) Study the biotic structure of four ponds of differing acidities emphasizing the components most directly related to waterfowl.
- (2) Assess the function of each pond by studying competitive interactions among fish, ducklings, invertebrates, and macrophytes.
- (3) Test two alternative hypotheses:
 - (a) Acidic precipitation is deleterious to waterfowl because their food, aquatic invertebrates and macrophytes, is reduced.
 - (b) Acidic precipitation is beneficial to waterfowl because it reduces fish populations that compete with waterfowl for food.

Project Status:

Field work has been completed and a number of scientific publications are in progress. A final report was submitted to the funding agencies; an abstract of that report is as follows:

This study focused on two pairs of ponds that were physically similar but which had markedly different acidities. Salmon Pond (pH 6.3) had fish, while 120m away, Mud Pond (pH 4.6) was fishless. The second pair, Killman Pond (pH 6.5) and Unnamed Pond (pH 4.8), were also physically similar, but again the circumneutral pond had fish and the acidic pond was fishless. In Salmon and Mud ponds we studied macrophytes, zooplankton, macroinvertebrates, fish, and black ducks and attempted to elucidate their interactions. We replicated the macrophyte, fish, waterfowl, and a portion of the macroinvertebrate work in Killman and Unnamed ponds.

Macrophyte abundance and species richness varied among the ponds. The acidic ponds had low species richness (Mud - 10; Unnamed - 6) and intermediate biomasses (33.8 and 74.6 g/m², respectively). Salmon Pond supported 15 species and 157.9 g/m² while Killman Pond had a similar species richness, 14, but very low biomass, 14.0 g/m². The differences

in species richness were probably related to pH, and transparency differences probably explain the biomass pattern. It is unlikely that this distribution of macrophytes played a major role in shaping the ponds' fauna.

Eighteen species of zooplankton were identified from Mud Pond, and 21 species from Salmon Pond. Rotifer species richness and density were lower in Mud Pond (1.6 spp. per sample and 42.6 individuals per 10 liters) than in Salmon Pond (5 spp. per sample and 503.5 individuals per 10 liters). Crustacean species richness (4.4 spp. per sample) was similar for both ponds, but density was lower in Mud Pond than Salmon Pond (63.7 and 228.3 individuals per 10 liters, respectively). Three large crustaceans were more abundant in the acid pond. The crustaceans *Diaptomus minutus*, *Mesocyclops edax*, *Bosmina*, and seven rotifers were more abundant in the circumneutral pond. Backswimmers were abundant in Mud Pond, but apparently absent in Salmon Pond. Laboratory experiments indicated backswimmers consumed an average of 78 copepods per day, thus having an important impact on the planktonic community. The large numbers of backswimmers present in the acidic lake suggests they may have replaced fish as a significant planktivore.

Annual mean abundance of benthic macroinvertebrates in Salmon and Mud ponds was similar at depths of 0.5 m (1,380 and 1,219/m²) but lower in Mud than in Salmon at 2-4 m (2,584 and 7,144/m²) and 9-12 m (191 and 2,973/m²). Annual mean biomass (wet weight) was lower in Mud than Salmon at all depths; diversity was lower in Mud than Salmon. Amphipoda, Mollusca and Hirudinea were present in Salmon but absent from Mud. Ephemeroptera were less abundant in Mud than Salmon with *Leptophlebia* spp. occurring in both ponds and *Caenis* spp. abundant in Salmon but absent from Mud Pond. Odonata were less abundant in Mud but included the same species as Salmon. Trichoptera were more abundant in Mud but less diverse than in Salmon. Diptera were the most abundant macroinvertebrates in both ponds. Chironomids were more diverse in Salmon than Mud but represented a higher proportion of the total fauna in Mud than in Salmon (20% and 36% at 0.5 m, 91% and 55% at 2-4 m, and 100% and 30% at 9-12 m). Fish exclusion cage studies showed macroinvertebrates more abundant outside than inside cages in Mud but with similar abundance in Salmon. This suggests that a caging effect apparent in fishless Mud Pond may be compensated for by fish feeding in Salmon Pond and that fish may decrease the abundance of macroinvertebrates. Sweep net samples of invertebrates available to ducklings indicated that Unnamed Pond had a significantly greater abundance of macroinvertebrates. Sweep net samples of invertebrates available to ducklings indicated that Unnamed Pond had a significantly greater abundance and biomass than Killman Pond; there were also more invertebrates in the Mud Pond sample than in the Salmon Pond samples but the difference was not significant.

Studies confirmed the apparent absence of fishes in Mud and Unnamed ponds. Salmon Pond had populations of brook trout, golden shiner,

rainbow smelt; Killman Pond had these species plus white sucker, blacknosed dace, and killifish.

Imprinted black duck ducklings grew faster on acidic ponds than those on the circumneutral ponds. After 12 days, Mud Pond ducklings weighed 88 g versus 70 g for Salmon Pond ducklings; Unnamed Pond ducklings weighed 116 g after 17 days versus 77 g for those in Killman Pond, (slopes of the growth curves were different at $p < 0.01$ for both study areas). Differences in behavior also indicated that the acidic ponds were better duckling habitat; ducklings on Mud and Unnamed ponds spent less time searching and moving, and more time feeding and resting, compared to ducklings on Salmon and Killman ponds. There was substantial overlap in the diets of trout and ducks; two of the three indices calculated indicated that ducklings sharing a circumneutral pond with fish had diets that were more similar to those of fish than to the diets of ducklings on acidic ponds. These results support the hypothesis that ducklings and fish compete for invertebrates and that, under certain circumstances, the negative effect of acidification on fish may produce a beneficial effect for ducklings.

BIOSPHERE RESERVE DATA BASE -- BIG BEND NATIONAL PARK, TEXAS

Investigator: J. W. Ault III

Supervisor: J.A. Bissonette

Cooperators/
Project
Support: U.S. National Park Service - Big Bend National Park, TX
U.S. State Department - Regional Office, Santa Fe, NM
- MAB Project 8 Office,
Washington, D.C.

Objectives:

- (1) Compile an annotated bibliography of the archaeology, aquatic systems, climate, geology/geneology/paleontology, history, soils, terrestrial fauna, use and effects, and vegetation references for Big Bend National Park, Texas and the northern Chihuahuan Desert.
- (2) Summarize the kind of data available for BBNP, and describe the facilities available to researchers.
- (3) Make recommendations that will enable the Park Service to attain MAB objectives at BBNP.

Scope:

Big Bend National Park (BBNP), Texas was designated a Biosphere Reserve in 1976. This designation made BBNP part of the Man and the Biosphere (MAB) Program, and international conservation effort established by UNESCO. The purpose of this work was to assist the Park Service in its participation in the MAB Program and provide encouragement and suggestions for interdisciplinary research.

Project Status:

The annotated bibliography has been printed and will be available on computer at BBNP and the Southwest Region Office of the Park Service. We have identified approximately 3600 citations; 868 concern research conducted at BBNP and have abstracts included with the citation. Citations only are provided for 2700 entries concerning the Chihuahuan Desert, 700 entries are in Spanish.

The second volume of the report provides summaries of the data bases included in the annotated bibliography. Also completed for this section are (1) a discussion of facilities available to researchers, (2) a list of names and addresses of scientists interested in research in the Chihuahuan Desert, and (3) a "quick reference" table of the kinds of work completed at BBNP.

Recommendations for actions needed to achieve MAP objectives have been developed. Guidelines for the recommendations came from three sources (1) National Science Foundation recommendations for long-term

ecological research, (2) Man and the Biosphere Program, Project -8 objectives, and (3) suggestions from 3 questionnaires sent to 144 scientists who have worked either in BBNP or in other parts of the Chihuahuan Desert. Recommendations are grouped into three categories, RESEARCH FACILITIES AND DATA BASES, LONG-TERM ECOLOGICAL MONITORING, and POLICY/ADMINISTRATION. Within each category the recommendations were ranked according to their importance.

The project is now complete.

A LONG-TERM FOREST ECOSYSTEM STUDY

Investigators: M. L. Hunter, Jr.
A. J. Kimball
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.

We know surprisingly little about forest ecosystems. This is true because foresters' attentions have been focused almost entirely on the trees; botanists have largely ignored forests on the assumption that foresters were studying them; and other biologists such as entomologists and wildlifers have only undertaken autecological studies concerned with a single species or group of species. In short, broad scope studies of Maine's forest ecosystems have "fallen through the cracks." It is particularly important that ecosystem level studies be long-term because of the complexity and variability of forest ecosystems.

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.

During the first three years our primary objective is to describe the structure of the plant and animal community. We are undertaking (1) a 100% inventory of trees (>10 cm 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 transect counts, (7) phenological observations on life history events in 40 plant species, (8) estimates of litter and fruit production, fruit prod (9) general surveys of canopy insect abundance, and (10) meteorological observations. These data, largely population estimates, are integrated by area units (usually 0.25 ha blocks) and analyzed to portray the forest's community structure. After three years we will begin 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:

The third year of field work was 1984-85 and tasks 1 through 8, and 10 as outlined above were completed.

Future Plans:

In 1985-86 we will initiate task 9 and continue 1, 3 through 8, and 10.

SONGBIRD SPECIES DIVERSITY IN RELATION TO
THE STRUCTURE AND SIZE OF FOREST STANDS AND EDGES

Investigator: C. A. Elliott

Advisors: J. R. Gilbert, Chairperson
P. W. Brown
W. E. Glanz
G. L. Jacobson
T. Saviello

Cooperators/

Project

Support:

International Paper Company
Maine Department of Inland Fisheries and Wildlife

Objectives:

- (1) Determine songbird species diversity (BSD) in habitat types in alpha (within stand) diversity.
- (2) Determine the effect of stand size on BSD for each habitat type.
- (3) Determine BSD in edge habitat varying in beta (between stand) diversity.
- (4) Determine the effect of length of edge on BSD for each edge type.
- (5) Determine the relationship between bird species composition of the edge zone and that of the adjoining habitats.
- (6) Use the results of objectives 1-4 to quantify the relationship between alpha and beta diversity and gamma (landscape) diversity.
- (7) Use the results of this study to predict the effect of forest management practices on habitat diversity (alpha, beta, and gamma) and BSD.

Scope:

Habitat diversity is an important concept in wildlife management, with each species having certain habitat requirements. Management for a diverse wildlife community means management for habitat diversity. Two major components of habitat diversity are vertical and horizontal structure. Combined, these can be considered landscape diversity.

Vertical structure, also termed "within stand" or "alpha" diversity, is a function of the number of layers of vegetation present in a habitat and the variety and abundance of plant species present within and among layers. It is often measured as foliage height diversity (FHD).

Horizontal structure, also termed "between stand" or "beta" diversity, is a function of the change in vertical structure between

habitat types. The transition zone, or edge, has length, width, and vertical structure, may include characteristics of the adjoining habitats, may have unique characteristics and may be the result of environmental gradients or man's activities.

"Landscape" or "gamma" diversity combines alpha and beta diversity and is a function of the interspersion, patchiness, size, and shape of habitat types. Management for habitat diversity is primarily concerned with maximizing gamma diversity.

This study will examine the relationship between habitat diversity at the alpha and beta levels, and songbirds.

As alpha diversity and stand size vary from low to high, the diversity of the songbird community will also vary. There is a point where, for a given alpha diversity (or FHD), any further increase in stand size will have little effect on bird species diversity (BSD). Similarly, for an edge of given beta diversity, as length of that edge increases there is, in theory, a point where any further increase in edge length will have little effect on BSD. Four stands and 4 edge types will be chosen to represent a range of alpha and beta values and censused for songbirds. By taking larger and larger portions of the area censused, species-area or species-length curves will be constructed for each value of alpha and beta. Each edge type will also be censused on transects across the edge to provide information on the composition of the bird community within the edge zone relative to the adjacent stands.

Dividing the vegetation into 9 layers (0-0.5, 0.5-1, 1-3, 3-5, 5-10, 10-15, 15-20, 20-25, 25+ meters), the composition and volume of foliage present in each layer will be determined in 10 by 10 m plots placed at 10-100 m intervals in stand and edge plots. FHD values will be calculated from these data and used to assess the homogeneity of the study areas.

A quantitative expression of gamma diversity will be developed from the results obtained from alpha and beta diversity values. All 3 levels of diversity are important in determining the overall diversity of an area, and, together with information on stand composition and the spatial and temporal arrangement of different stand types, can be used to assess the effect of forest management practices on habitat diversity.

Project Status:

All field work has been completed. Four stands (softwood, hardwood, mixedwood, and clearcut), ranging from 40-64 ha, have been censused and vegetation data taken. Four edge types (softwood-clearcut, hardwood-clearcut, mixedwood-clearcut, and softwood-partial cut) have

been censused in both 1984 and 1985, and vegetation data taken. Each edge type was censused along 1000 m of the edge, and in a plot 250 m wide extending 250 m into each of the adjacent stand types.

Data analyses on bird species diversity and foliage height diversity has begun.

Future Plans:

Data analyses will continue and Ph.D. dissertation writing will begin this fall. Projected date of completion is May 1986.

SONGBIRD AND SMALL MAMMAL POPULATIONS
IN MAINE RIPARIAN AND EDGE OAK-PINE FORESTS

Investigator: M. F. Small

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

Cooperators/
Project

Support: Holt Woodlands Research Foundation

Objectives:

- (1) Determine densities of bird and small mammal populations in riparian oak-pine forests and forests with a powerline edge.
- (2) Determine productivity of birds and small mammals in these study areas.
- (3) Compare the densities of various species in the riparian forest to their densities in the area with a powerline edge.
- (4) Compare the changes in vegetation height and composition near the powerline edge with those of a riparian zone.
- (5) Observe the effects of distance from edge upon species density.

Scope:

Research on animal populations in riparian ecosystems has focused on the arid Southwest. Animal populations seem to be greater in this habitat than in surrounding habitats, a phenomenon similar to the effect of an edge. In the Northeast, the demand for riverfront housing continues, and logging beside rivers and streams is common. State and local agencies need to know how shoreline development affects wildlife populations before deciding how it should be managed. This project is designed to compare animal populations in riparian forests to those in forests with an edge, and to discover the effect of distance from the river upon population characteristics. The data gathered may be used to assess the characteristics of riparian populations, whether they differ from those of a population near an altered habitat, and how they could be affected by shoreline development.

Project Status:

Two field seasons were completed in 1984 and 1985. Songbirds were censused on four study areas: two in Lincoln County near a powerline, and two beside rivers in Sagadahoc County. Thirty-five nests situated on the four areas were monitored for evidence of predation or cowbird

parasitism. Artificial nests containing quail eggs were also placed in these areas, as well as in four additional forests, and the amount of predation upon them was recorded. Small mammals were censused on one of the powerline areas and one of the riparian areas. Height and species of vegetation were recorded at sample points within 30 m of the edge or river to create height profiles.

Future Plans:

Complete analyses and write thesis by May 1986.

AVIAN USE OF LAKESHORE BUFFER STRIPS IN EASTERN MAINE

Investigator: W. N. Johnson, Jr.

Advisors: P. W. Brown, Chairperson
G. L. Jacobson
J. R. Gilbert

Cooperators/

Project

Support: McIntire-Stennis

Objectives:

- (1) Compare avian community parameters (i.e. diversity, richness, and density) between lakeshore buffer strips and undisturbed lakeshore.
- (2) Quantify the composition and structure, or other specific components of vegetation used by selected species for breeding and foraging.
- (3) Use the results of this study to evaluate the effects of habitat perturbations on breeding birds of lakeshore areas.

Scope:

There are approximately 3,400 ponds and lakes, greater than one acre in size, within the unorganized townships of Maine. The Maine legislature has enacted laws that regulate use along the shoreline of these areas. Regulations have been designed to: (1) protect and enhance water quality, (2) protect shoreland areas from erosion, (3) protect and preserve vegetation and wildlife, and (4) conserve natural beauty.

Timber harvesting adjacent to lakes and ponds must conform to standards provided by the Land Use Regulation Commission. These standards require the retention of a buffer of well-distributed trees along the shoreline. Buffer strips may provide adequate food and cover for some species of wildlife.

This study will investigate avian use of lakeshore buffer strips. Data obtained through vegetation analysis will be used to examine the vegetation components utilized by breeding birds. The results of this study will be used in evaluating the effects of timber harvesting on breeding birds in lakeshore areas.

Project Status:

Two summer field seasons were completed in July 1985. Songbirds were censused at two study sites, a lakeshore buffer strip and an undisturbed lakeshore. Vegetation was sampled using 160 0.04 ha

circular plots during July and August 1984. Additional vegetation plots were centered at singing perches of territorial males and at active nests of selected species.

Future Plans:

Analysis of the data will be completed in the fall. Thesis and manuscripts are scheduled for completion by May 1986.



Buffer strips often have dead trees (snags) which are used by woodpeckers and other wildlife. Here a male pileated woodpecker is feeding young (Photo by W. N. Johnson, Jr.).

RESPONSE OF SONGBIRDS AND SMALL MAMMALS
TO GLYPHOSATE-INDUCED HABITAT CHANGES

Investigator: D. J. Santillo

Advisors: M. L. Hunter, Jr., Chairperson
W. E. Glanz
D. M. Leslie
M. L. McCormack
T. Filauro

Cooperators/ Great Northern Paper
Project Maine Department of Inland Fisheries and Wildlife
Support: Maine Cooperative Forestry Research Unit

Objectives:

- (1) Determine the effects of herbicide-induced vegetational changes on species composition, densities, and distribution of breeding birds.
- (2) Determine effects of herbicide-induced vegetational changes on the relative abundance and species composition of the small mammal community.
- (3) Examine abundance of birds and small mammals in relation to vegetation structure and composition.
- (4) Observe patterns in the response of small mammals and breeding birds to herbicide treatment over a range of 1 to 3 years following treatment.

Scope:

Herbicides are commonly applied to regenerating forest stands in Maine, to release softwood seedlings from undesirable competition with deciduous trees and shrubs. When properly applied, herbicides are not toxic to wildlife; however, they do have a potential effect on wildlife through habitat modification.

There have been a few studies investigating effects of herbicide application for forest management on the habitat quality of wildlife species, and none have been conducted in the intensively managed spruce-fir forests of the northeastern United States. This study is designed to determine the effects of habitat changes resulting from treatment of clearcuts with Glyphosate (Roundup) on songbirds and small mammals.

Project Status:

Six study sites were selected in northern Maine, based on cutting, planting, and herbicide application history. These represented typical sites treated with herbicides in the region; clearcuts with a suppressed softwood component. One site was cut in 1979, the others in 1980.

For the 1985 field season, 4 sites were untreated controls, and 2 sites were treated with Glyphosate in 1983 (2 years post-treatment). Birds were censused by spot-mapping on 10 ha plots on each clearcut. Small mammals were sampled by snap and pit trapping on 1.44 ha plots within each bird plot, for 5 consecutive nights in July. Vegetation composition and cover were estimated on circular 200 m² plots randomly located throughout each 10 ha bird plot. Techniques used included visual estimates of cover by strata, density board measurements, and an ocular tube for ground cover estimates.

Following the completion of fieldwork in August, two of the untreated controls were treated with Glyphosate. Small mammals were sampled on all plots again in October. Preliminary analysis of 1985 data has been completed.

Future Plans:

Data analysis will continue. Songbirds, small mammals, and vegetation will be censused and sampled again in 1986, on the same study plots. Two sites will still be controls, 2 will now be 3 years post treatment, and 2 will be a 1 year post-treatment.

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

Investigator: P. D. Vickery

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

Cooperators/ The Nature Conservancy - Maine Chapter
Project - Northeast Regional Office

Support: Maine Audubon Society
Maine Pesticides Control Board
Massachusetts Audubon Society
Coastal Blueberry, Inc.

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 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 affect 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. In Maine, to date, it has only been found breeding on the Kennebunk Blueberry Barrens and on adjacent blueberry land in Wells.

Project Status:

This study has examined nesting densities and species diversity in relation to blueberry management. Permanent study plots were established in 1984 and expanded in 1985 to measure nesting diversity and density under different management practices. Commercial blueberries are harvested or burned in alternate years. Study plots

were placed in both production-year fields and in non-production (burn year) fields. Nesting densities of four species (grasshopper sparrow, vesper sparrow, bobolink, and eastern meadowlark) were significantly greater on blueberry fields not treated with herbicide. Interestingly, species diversity did not appear to decline in herbicide-treated preferences with vegetation structure.

Future Plans:

Placement of artificial song perches into areas of low usage will examine whether the absence of song perches limits usage in non-production (burn year) plots. A new method of measuring reproductive success, developed in 1985, will be expanded and refined in 1986.



Although blueberry barrens, maintained by periodic controlled burns, occupy less than 1% of Maine's surface area, this habitat supports a distinctive avian community (Photo by M. L. Hunter, Jr.).

AQUATIC AND TERRESTRIAL RESOURCE INVESTIGATIONS OF
ACID PRECIPITATION AND ASSOCIATED METALS

Investigators: J. R. Longcore, Maine Field Station, PWRC
D. G. McAuley, Maine Field Station, PWRC
K. L. Stromborg, PWRC
G. L. Hensler, PWRC

Cooperators/ U.S. Fish and Wildlife Service - Patuxent Wildlife
Project Research Center (PWRC)
Support: Laurel, MD.
- Columbia National
Fishery Research
Laboratory, Columbia, MO.

Objectives:

- (1) Measure and catalog pH and alkalinity of ponds, marshes, and other wetlands suitable for waterbird habitats.
- (2) Map wetland vegetation and classify vulnerable and resistant wetlands according to the criteria of the National Wetlands Inventory.
- (3) Document annual variability in waterbird abundance and productivity as acidification on wetlands increases or decreases and to intensify the measurement of ring-necked duck use and survival on wetlands of different susceptibility to acidification.

Scope:

Acidification of lakes, ponds and other wetlands has reduced or eliminated some fish and aquatic invertebrate populations in some areas of the northeast. Most studies have been conducted on fish populations in high elevation lakes. Little is known of the effects that acidification might have on the avifauna that use these lakes and associated beaver flowage habitats. This study is designed to assess wetland avian productivity and habitat relationships within an area of high vulnerability (based on bedrock characteristics) to acidification.

Project Status:

All field work has been completed and data analyses are underway. Highlights of completed data analyses include the following. Bedrock type underlying wetlands is a useful criterion to predict wetland alkalinity and thus is useful in identifying waters vulnerable to acidification. Avian use of wetlands is greater ($P < 0.0001$) for downstream (84%) versus headwater (16%) wetlands. The headwater wetlands, which are most vulnerable, are used extensively by common goldeneye, common loon, common merganser, and spotted sandpiper. The majority of species (16), including dabbling ducks, used wetlands

classified as downstream or beaver-created. For all 3 years of the study 87% of the 246 broods observed were on the downstream wetlands that are at risk to be acidified because they overlie bedrock that lacks buffering capacity.

In conjunction with other ongoing work at the Moosehorn National Wildlife Refuge, 28 ring-necked duck broods were followed to determine survival rates. Also, 5 ducklings, 1 each from 5 different broods from several wetlands, were collected to determine foods eaten. Foods from ducklings and invertebrates from samples collected from the wetlands have been identified and numbers and weights of each taxon determined. Survival rates of broods and ducklings for 1983-84 have been calculated using the Mayfield method.

Future Plans:

A final report, a M.S. thesis and several technical papers will be prepared by the scheduled completion date of March 31, 1986.

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

Investigators: C. M. Jagoe
S. J. Pauwels
C. Fay
T. A. Haines
M. Brett

Advisors: T. A. Haines, Chairperson (for Jagoe, Brett and Pauwels)
J. R. Moring
K. E. Gibbs
M. L. Hunter, Jr.

Cooperators/

Project U.S. Fish and Wildlife Service - Columbia National
Support: Fishery Research Laboratory, Columbia, MO.

Objective: Analyze levels of acidity in waters of northern
New England and related water chemistry to
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 sample zooplankton.

A survey was conducted of 226 headwater lakes and low order streams in the six new England states. Acidic surface waters (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 order streams in New England are vulnerable to acidification.

Project Status:

Recently, a study of nine Atlantic salmon rivers indicated first order streams reached levels of pH and aluminum concentration that are toxic to early life stages of Atlantic salmon. Second and third order streams were less critical. Additional monitoring work is continuing and journal manuscripts are being prepared.

All requirements for the degree of Master of Science (Zoology) were completed by M. Brett in August 1985. An abstract of the thesis follows:

An intensive study of two lakes of dissimilar pH, and a survey of 22 lakes encompassing a broad range of pH values were conducted to assess the effects of acidity on zooplankton and nekton community structure. In the intensive study, one lake was acidic (pH 4.61) and

fishless, and the other circumneutral (pH 6.22) with three species of fish. These lakes were similar in size and morphology and situated less than 120 m apart. The 22 lakes surveyed were generally small (surface area \bar{x} = 6.2 ha) and of moderate depth (maximum depth \bar{x} = 7.5 m) but varied considerably according to pH, 4.46 to 6.41, and fish species numbers, zero to eight.

In the intensively studied lakes, rotifer species numbers, and rotifer crustacean density were significantly higher in the circumneutral lake, whereas crustacean species numbers were similar in the two lakes. The planktivorous backswimmer, *Buena* spp., was abundant in the acidic lake, but was not collected in the adjacent circumneutral lake. In laboratory experiments, *Buena* spp. pierced an average of 78 *Diaptomus minutus* per day. The differences in the zooplankton and nekton communities of these two lakes were presumably effects of their contrasting chemical and biological parameters.

The major determinants of rotifer species numbers in the 22 lakes surveyed were pH, rotifer density, fish predation, and total phosphorus. Several rotifer species were absent or rare in the lakes below pH 5.0. In contrast to previous work, lake pH had a strong negative rather than positive effect on rotifer density. Total phosphorus showed the strongest relationship with rotifer density in these lakes. Both crustacean species numbers and crustacean density failed to correlate with any of the physical or chemical variables tested. This is in contrast to previous studies, which found strong reductions in crustacean species numbers and density with decreased pH. However, pH was included as a predictor variable of crustacean species numbers and density in stepwise multiple regression. At pH values below 5.0, the crustacean fauna was dominated by the copepods, *Diaptomus minutus* and *Mesocyclops edax*, and the cladocerans, *Bosmina longirostris*, *Diaphanosoma brachyurum*, and *Holopedium gibberium*.

Nektonic invertebrate community structure in the 22 lakes was strongly affected by loss or reduction of fish populations with declining pH. Five acidic, fishless lakes contained dense nektonic communities, whereas 17 lakes with fish contained very few nektonic invertebrates. The numerically dominant member of this community was the backswimmer *Buena* spp., but several other nektonic invertebrates, including the backswimmer *Notonecta* spp., the dytiscid larvae *Graphoderus* spp., the trichopteran larvae *Iriaenodes* spp., water mites (Hydracarina), and corixids were also commonly collected. This parallels trends found in Scandinavia, where limnetic corixids were often abundant in fishless, acidic lakes.

Future Plans:

A second thesis is scheduled for completion in December 1985. The project has been continued for a two-year period, with a third year of work possible, contingent on funding.

SPECIES PROFILES OF FISHES AND SHELLFISHES OF THE GULF OF MEXICO
AND ATLANTIC OCEAN

Investigators: J. R. Moring
H. Hidu
K. H. Kelly
C. MacKenzie
D. M. Mullen
C. Newell
J. G. Stanley

Cooperators/

Project U.S. Fish and Wildlife Service - National Coastal
Support: Ecosystem Team, Slidell, LA.

Objective: Summarize and publish life history information dealing
with economically important marine species for use
in environmental assessments.

Scope:

Environmental alterations can be particularly severe for aquatic organisms. If regulatory agencies have access to up-to-date information on life histories, environmental requirements, fisheries, and the ecological role of impacted species, some potential problems can be avoided. The U.S. Fish and Wildlife Service and U.S. Army Corps of Engineers are producing a series of such "species profiles." Eventually, most of the important species of coastal fishes and shellfishes will be covered in concise booklets, presenting quantified information and references.

Project Status:

Four such profiles were produced under an earlier contract. Currently, 10 profiles have been prepared and are in different stages of publication: American oyster (Gulf of Mexico), American oyster (mid-Atlantic), Atlantic herring (North Atlantic), American shad (mid-Atlantic), sea scallops (North Atlantic), blueback herring/alewives (North Atlantic), hard clam (North Atlantic), softshell clam (North Atlantic), American shad (North Atlantic), and American lobster (North Atlantic). Three profiles were recently published and three profiles are currently at the Government Printing Office.

Future Plans:

Editing and printing of the remaining four profiles will be completed during the coming year.

ECOLOGICAL EFFECTS OF LOG DRIVING IN RELATION TO NAVIGABLE RIVERS

Investigators: P. D. Eiler
J. R. Moring

Advisors: K. E. Gibbs, Chairperson (for Eiler)
W. A. Halteman
J. B. Dimond
J. R. Moring

Cooperators/
Project
Support: Kennebec Log Driving Company

Objectives:

- (1) Assess fish and invertebrate populations and water quality in areas of the Kennebec River with and without submerged pulpwood logs.
- (2) Make predictions as to the potential ecological impacts of log salvaging.
- (3) Measure movements and ecological associations of freshwater mussels.

Scope:

Until log driving was stopped in 1976 by environmental lawsuits, several million cords of pulpwood logs sunk in the Kennebec River system. It is not known whether the loss of logs in log driving is beneficial or harmful to the environment. Short-term detrimental changes in water quality are known to occur, but long-term effects are unknown. Since 1979, studies have been conducted in Wyman Lake and Indian Pond to assess this environmental alteration.

Project Status:

Field work on the impacts of the log drives on macroinvertebrates has been completed.

Future Plans:

A thesis dealing with impacts on macroinvertebrates is scheduled for completion in December 1985. Field work dealing with freshwater mussels is scheduled to start during the summer of 1986.

CONSTRUCTION AND EVALUATION OF HABITAT SUITABILITY INDEX MODELS
FOR JUVENILE ATLANTIC SALMON AND OTHER COLDWATER FISHES

Investigator: J. G. Trial

Advisors: J. G. Stanley, Chairperson
J. R. Gilbert
W. E. Glanz
T. A. Haines
J. B. Dimond

Cooperator: J. R. Moring

Cooperators/
Project
Support: Maine Cooperative Fish and Wildlife Research Unit
U.S. Fish and Wildlife Service - Western Energy
and Land Use Team, Ft. Collins, CO.

Objective: Develop a Habitat Suitability Index (HSI) model for juvenile Atlantic salmon and test that model and other HSI models for brook trout and other species of stream fishes.

Scope:

The U.S. Fish and Wildlife Service has developed the Habitat Evaluation Procedures (HEP), including HSI models, to assess impacts of water resource development projects, management alternatives, and other uses. A key assumption of HEP is that quality of habitat can be expressed as an index that is directly proportional to potential carrying capacity. HSI models provide the means of calculating an index of habitat quality.

The model developed for juvenile Atlantic salmon is mechanistic, using Suitability Index (SI) curves to represent the relationship between measurements of habitat (e.g., dissolved oxygen, water velocity, pH) and habitat quality. These SI are then combined mathematically into life stage component indices and finally into a species HSI. At each step in the model, there are assumptions about how habitat variables affect potential carrying capacity and how variables interact to determine potential carrying capacity. Tests of models include tests of assumptions made in constructing SI curves, calculating life stage components and final HSI. Tests also compare the species and component HSI values with population data to evaluate the performance of the model as a whole.

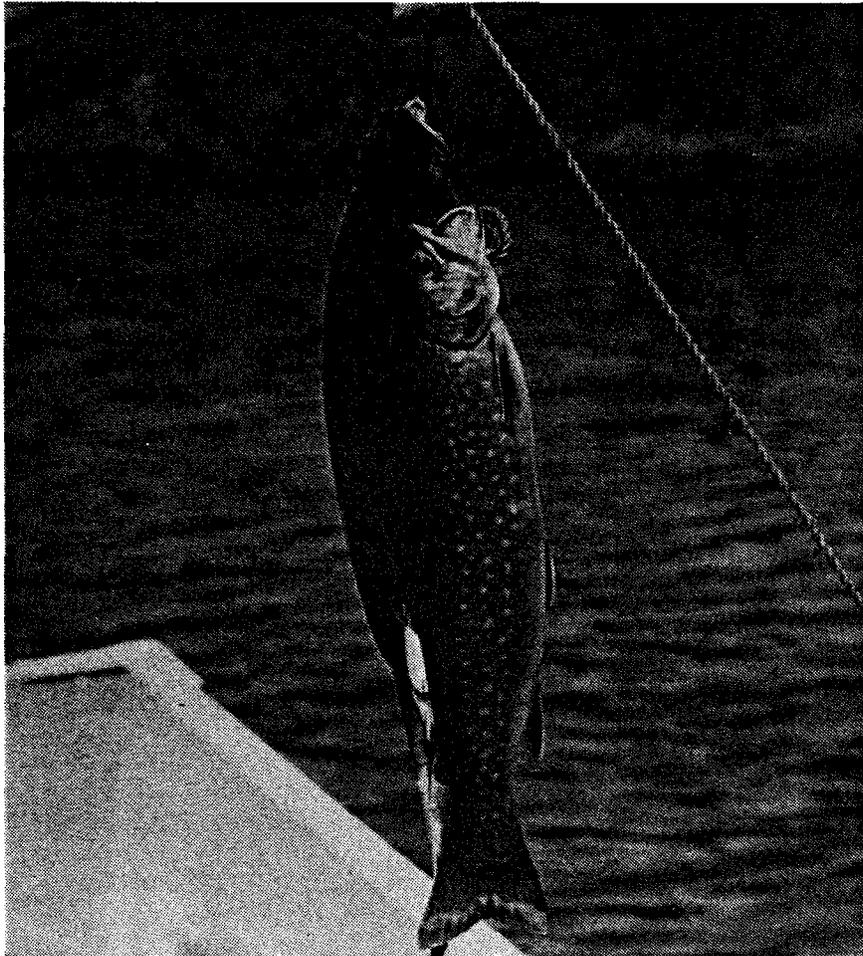
Project Status:

The Atlantic salmon HSI model for stream stages of the species as well as three other species have been completed and published. A test of overall model performance for brook trout, Atlantic salmon, blacknose dace, fallfish, and common shiner has been completed and published. Based on this test, the Atlantic salmon model has been revised and sent

to interested Fish and Wildlife Service and state biologists. Habitat measurements for 12 sites in the St. John River, Canada, have been collected as a final test of model performance. Data for testing Atlantic salmon model assumptions, at all levels, have been collected and analyzed. Although each model tested had some problems, the overall performance encourages the refinement and use of models in the context for which they were developed.

Future Plans:

Field work and data analyses for all aspects of the project, except the test of model performance using St. John data, are now completed. The final analysis of the St. John data is in progress, and a first draft of the dissertation is expected in February 1986.



Brook trout, which can be negatively impacted by acid rain and other factors, is a major coldwater game fish throughout the species' range, including Maine (Photo by C. Fay).

HABITAT SELECTION BY COMMON LOONS

Investigator: P. I. V. Strong

Advisors: J. A. Bissonette, Chairperson
W. E. Glanz
P. W. Brown
J. B. Dimond
M. L. Hunter, Jr.

Cooperators/ Maine Department of Inland Fisheries and Wildlife
Project Maine Cooperative Fish and Wildlife Research Unit
Support: Maine Audubon Society
Libby Sporting Camps
Mr. Scott Skinner
Mr. Joseph Sewall

Objectives: (1) Determine the use and importance of traditional nest sites for loons in undisturbed areas.
(2) Determine the use and characteristics of brood rearing areas.

Project Status:

All requirements for the degree of Doctor of Philosophy (in Wildlife) were completed in August, 1985. An abstract of the dissertation follows:

Selection of breeding ground habitats by common loons was investigated. Nesting and chick rearing areas and areas used during non-reproductive activities were characterized on large lakes. Year to year reuse of nest sites and chick rearing areas was quantified. Previously used nest sites were barricaded in some territories to evaluate flexibility in nest site selection.

Loons preferred islands and deadwaters over mainland nest sites. Nest site reuse was 0.82 (18/22) on remote lakes in northern Maine, 0.78 (43/55) on a lightly developed lake in New Hampshire, and 0.84 (55/64) and 0.88 (29/33) on two heavily developed lakes in New Hampshire. Reuse of old nest sites was not related to previous or subsequent nest success ($p > 0.05$).

Barricades around previously used nests did not greatly affect nesting patterns. Frequency of nesting and nest success were slightly lower. Nest location varied with water level. Nests were within 1 m of barricaded sites when the old sites were above water. Nest locations were 150-500 m from barricaded sites when the old sites were covered by water during the nesting season.

Chick rearing areas were in shallow coves protected from prevailing winds. Adult loons tending chicks preferred shallow water (< 2.0 m) areas close to land (< 150 m). Deep water (> 3.0 m) areas distant from land (>250 m) were avoided. Chicks were in areas protected from wave action in 40 of 52 observations with appreciable wave action. Pairs with chicks two or more years during the study reused old chick rearing areas. Mean year to year overlap of chick rearing areas in four territories was 0.69 ± 0.11 .

Areas preferred for feeding by adult loons without chicks were of moderate depth (1.1-4.0 m) and distance from land (51-150 m). Extremely shallow areas (< 1 m) close to land (< 50 m) and deep water areas distant from land were avoided. Preference and avoidance during resting activities were similar to feeding. Swimming and interaction activities occurred nearly randomly over the territories.

Management recommendations for protection of important shoreline habitat were made. Protection of shoreline areas adjacent to known nesting and chick rearing areas was considered the best strategy of habitat management for common loons.

NUTRITIONAL AND THERMODYNAMIC ASPECTS OF
THE ECOLOGY OF BLACK DUCKS WINTERING IN MAINE

Investigator: D. G. Jorde

Advisors: R. B. Owen, Jr., Chairperson
P. W. Brown
L. J. Kling
J. R. Longcore
M. A. Vietti

Cooperators/ College of Forest Resources -- Hatch Act Funds
Project Maine Department of Inland Fisheries and Wildlife
Support: U. S. Fish and Wildlife Service

Objectives:

- (1) Determine if the microclimates of roost sites influence black duck use and energetics.
- (2) Examine the nutrient content and true metabolizable energy of foods selected by wintering black ducks.
- (3) Determine the relationship between specific dynamic action and thermoregulation.

Scope:

As black duck populations continue their long-term decline, it becomes increasingly critical to more precisely understand habitat relationships to ensure appropriate management actions are taken.

This study focuses on the winter survival of black ducks by examining components of their daily energy balance. Foods utilized and their nutrient values and metabolism are compared to energy costs for thermogenesis. In addition, energy conservation measures such as changes in daily activity budgets and the use of microhabitats associated with cold weather are being evaluated.

Project Status:

The fourth field season was conducted from January through March 1985. The study continued to center on selected coves adjacent to Frenchman Bay, located in the central portion of Maine's coast. For the third consecutive field season, warm weather prevailed through winter and black ducks did not establish regular shoreline roost sites. Instead, the birds usually formed rafts and drifted off shore until the tide was low enough for them to start foraging. The microclimate at black duck roost sites, especially those used during previous field seasons, was recorded during 67 data-logging days. Water temperatures and ice conditions at the Raccoon Cove study area were recorded daily.

Time budget (52 hours) and habitat use of 226 individual birds were recorded during different weather and tide conditions. During the coldest periods black ducks occasionally used shoreline roost sites during the day. Black ducks foraged at the tide line among rockweed ledges, exposed mud flats, and mussel beds.

Food and fecal samples collected during 29 weeks of nutrition studies were analyzed for protein, fat, and calcium content. Gammarus spp. provided the highest nutrition value and metabolizable energy followed by blue mussels, soft-shelled clams, and periwinkles. Twenty-six open circuit respiration trials were completed to study the influence of heat of digestion on thermoregulation. Heat energy from the digestion of earthworms and corn partially compensated for the energy cost of thermoregulation. The type of food digested influenced thermogenesis at ambient temperatures below lower critical temperature.

Future Plans:

Finish writing Ph.D. dissertation and prepare final reports.

BEHAVIOR AND HABITAT USE OF COMMON GOLDENEYES WINTERING IN MAINE

Investigator: D. R. Eggeman

Advisors: P. W. Brown, Chairperson
W. E. Glanz
W. A. Halteman
J. R. Longcore

Cooperators/

Project Support: Delta Waterfowl and Wetlands Research Station, Manitoba Graduate School, University of Maine

Objectives: (1) Examine intraspecific differences in habitat use.
(2) Compare relationships between habitat and behavior of common goldeneyes among groups based on sex, age, and paired status.

Scope:

Recent studies indicate that sex-ratios of common goldeneyes differ among sites within study areas in several areas of their winter range. Researchers suggested that these local differences in distribution of the sexes may result from sex-specific differences in habitat preference, and females were predicted to be found in less harsh conditions. This study was designed to compare characteristics of habitats used by common goldeneyes according to sex/age and paired status. This study also investigates relationships between behavior and sex/age and paired status, and examines the influence of environmental conditions on behavior.

Project Status:

The second field season was completed on 31 March 1985. Censuses and behavior observations were conducted in riverine, inland tidal and coastal areas of central Maine. Sites in the study area were censused regularly to determine sex/age ratios and pairing chronologies. Behavior observations were made by focal-animal sampling. Individuals were observed for 10-minute periods, and behavior was recorded every 15 seconds. During the two field seasons, 523 census sightings and 419 behavioral observations were made.

Census and behavior sightings were plotted on large scale maps of observation sites. Habitat and climatic characteristics of each location were recorded. Water depth and substrate type were determined by returning to the sites by boat in April and May, 1985.

Preliminary findings indicated that the entire range of sex-ratios was unrelated to habitat and climatic conditions. However, climatic conditions associated with observations of 90% or greater adult males were different from climatic conditions associated with observations of 10% or less adult males in early winter. The mostly adult-male groups were more often observed when temperatures were warmer, cloud-cover less, and wind speeds lower.

Future Plans:

Data are being analyzed to determine (1) relationships among sex/age/paired status and habitat use, and (2) behavior and habitat use of birds of each status. Thesis writing is also under way. This project is expected to be complete in February 1986.



As special restrictions on the hunting of black ducks continue, Maine hunters are becoming increasingly interested in goldeneyes as well as other diving and sea ducks (Photo by W. B. Krohn).

ECOLOGY OF MALE BLACK DUCKS MOLTING IN LABRADOR

Investigator: T. D. Bowman

Advisors: P. W. Brown, Chairperson
R. B. Owen, Jr.
J. R. Longcore
K. E. Gibbs

Cooperators/ Canadian Wildlife Service
Project Atlantic Flyway Cooperative Banding Program
Support: Graduate School, University of Maine

Objectives:

- (1) Investigate the ecological requirements of molting male black ducks by determining: body condition changes during the wing molt, habitat use by molting black ducks, chronology of wing molt, and food habits of molting black ducks.
- (2) Obtain information, through banding, on the harvest, wintering, and breeding areas of male black ducks molting in Labrador.

Scope:

A major decline in the black duck population over the past 20-30 years has prompted increased studies to examine the possible causes of the decline and to gather information on the ecology of the black duck throughout its life cycle. Information on adult/subadult black ducks during the molting period is sparse. Only recently has extensive banding of male black ducks been conducted in the far northern areas where they molt.

The purpose of this study is to collect baseline information on the ecology of male black ducks during the post-breeding wing molt that will help clarify the strategies used during this stage of the life cycle, and provide banding data useful in harvest management.

Project Status:

During the summers of 1983 through 1985, 723 black ducks were banded in Okak Bay, northern Labrador. During 1984 and 1985, a total of 231 flightless adult male black ducks were captured by hand or retrieving dog. Body weight and structural measurements were recorded for each duck.

During 1985, radio transmitters were attached to 12 male black ducks to obtain information on habitat use and movements while flightless. These birds were relocated daily, or as often as possible, for a total of 132 bird-tracking days. While some black ducks remained relatively sedentary, others moved several miles over large expanses of

water and varied terrain. Two were killed by predators. The remaining 10 birds were tracked down, and radios removed, before the birds regained flight ability.

Nasal saddles were attached to 125 flightless male black ducks to aid in the identification of paired males on the breeding grounds in subsequent years to determine the breeding locations of males molting in Okak Bay. Invertebrates were collected at weekly intervals from three ponds used by molting black ducks to determine the temporal and relative abundance of food sources.

Future Plans:

Another field season is planned for the summer of 1986. Data analysis will be completed during the fall of 1986 and thesis writing will be initiated.



Flightless adult male black duck captured in July, 1985, near Okak Bay, northern Labrador. Adult black ducks are flightless for about 3 weeks during July while new flight feathers grow (Photo by T. D. Bowman).

HABITAT REQUIREMENTS AND LONG-TERM TRENDS
IN BREEDING BLACK DUCKS AND THEIR HABITAT IN SOUTH-CENTRAL MAINE

Investigator: D. R. Diefenbach

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

Cooperators/ College of Forest Resources, Hatch Act Funds
Project Maine Department of Inland Fisheries and Wildlife
Support: 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 south-central Maine.
- (2) Determine the number of breeding pairs of black ducks (and other waterfowl species) on the study area.
- (3) Develop a mathematical model to predict the number of breeding pairs of black ducks on a beaver flowage based on physical/chemical/biological characteristics of the habitat.
- (4) Attempt to determine if the restricted harvest regulations in Maine and the Atlantic Flyway for black ducks has affected the population on the study area.

Scope:

Data from the black duck winter survey indicate the population has declined approximately 2% per year since 1955. Restrictive regulations have been established to reduce the U.S. harvest by at least 25%. Maine has established even more restrictive harvest regulations. Maine's restrictions are predicated on an objective of increasing protection for Maine birds since more than 60% of the harvest of Maine black ducks occurs within the state. Few states, if any, have historical data on black duck numbers and habitat change that can be used to assess the effects of restricted harvest.

The 151 km² study area is located in southern Dixmont and northern Monroe townships of south-central Maine. This is in the northern hardwoods-spruce ecoregion and is characteristic of 18% of the black duck's U.S. breeding habitat. From the first settlement in 1800 until the early 1900's the area was an important crop and timber producing region; however, as of 1975 only 12% of the study area was classified as

active agricultural land. The landscape has a broken, diverse appearance with much abandoned farmland reverted to early and mid-successional stages.

Wetland density on the study area is approximately 0.7 wetlands/km² (in comparison, the prairie pothole region has approximately 8.0 wetlands/km²). The surface water area/pond ranges from 0.1 to 60.5 ha (x=1.8 ha) with the largest wetlands being deciduous forest and ericaceous bog types.

An intensive census of black duck breeding and nesting populations was conducted in the late 1970's on the study area along with an accurate documentation of the wetland habitat. Surveys of waterfowl populations were conducted in the 1960's by the Maine Department of Inland Fisheries and Wildlife in the same area. These data can be used to assess breeding black duck population levels as related to changes in habitat quantity and quality. This could provide a unique opportunity to calibrate black duck population levels to habitat changes, thus providing the possibility of evaluating the impacts of exceptionally restrictive harvest regulations on breeding black ducks.

Project Status:

A study proposal is being developed for the objectives outlined. A literature review is being conducted as well as an in-depth review of the methods and results of previous waterfowl censuses of the study area done 5 and 20 years ago. The Advisory Committee will review the study proposal during December 1985.

Future Plans:

Prior to the first field season, tree observation stands from the most recent of the 2 past studies will be refurbished and the investigator will familiarize himself with the study area. Field work will begin in mid-April with a second field season scheduled for 1987. Thesis completion is expected in fall of 1987.

SURVIVAL, HABITAT USE AND DISPERSAL OF
POST-FLEDGING BLACK DUCKS IN MAINE

Investigators: J. R. Longcore, Maine Field Station, PWRC
D. G. McAuley, Maine Field Station, PWRC
C. Frazer, Graduate Assistant

Cooperators/
Project
Support: U.S. Fish and Wildlife Service - Patuxent Wildlife Research
Center, (PWRC), Laurel, MD.
- Moosehorn National
Wildlife Refuge (NWR)
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.
- (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.

Scope:

The black duck population has declined drastically over the last 30 years. In an effort to ascertain the reasons for this decline there has been an increase in research on black duck ecology. Information on survival and the relative importance of specific causes of mortality, particularly of young ducks, is lacking.

The purpose of this study is to determine survival of post-fledging black ducks in the fall, with particular emphasis on determining the extent of natural mortality. Radiotelemetry will be used to determine survival. This technique also allows for the gathering of information on other aspects of black duck ecology such as habitat use and dispersal of ducks from natal areas.

Project Status:

The fall of 1985 was designed to be a preliminary field season. In late August, 13 hatching-year, black duck hens were captured with rocket nets, banded and equipped with radiotransmitters. An additional hen was instrumented in late September. Radioed birds were located daily, usually two or more times, to discover both roosting and feeding areas. One hundred and ninety-six hatching-year black ducks and 28 after-hatching year black ducks were banded at the Refuge.

By early October the following information was obtained. All the birds remained on, or within 10 km of the Moosehorn NWR. The general activity pattern was for the birds to roost on one large refuge marsh at night and then to move to smaller flowages during the day. Birds often used habitats in New Brunswick, Canada. Six hens, including one killed by a great-horned owl, were paired.

Future Plans:

The 1985 field season will continue until the batteries fail in radios (early December) or the ducks leave Maine. During both the 1986 and 1987 field seasons 70 birds will be equipped with radiotransmitters. An estimated 60 hatching-year hens and 10 hatching-year drakes will be instrumented in mid-August each year. An additional 3 technicians will be hired to help monitor the birds.

A M.S. Thesis, a final report and several technical papers will be prepared in 1988.

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 water-bird species breeding on the tundra.

Scope:

Blackflies and mosquitoes are considered pest species in many zoogeographical regions because of their role in disease transmission and the effects of mass biting on man and livestock. The potential exists to spray Bacillus thuringiensis israelensis (BTI) in tundra areas of Alaska to control dipteran populations. BTI reduces blackfly, mosquito, and chironomic populations, all three of which are potential food sources for adult and juvenile waterbirds breeding in these areas. The purpose of this study is to assess the potential effects of BTI use in tundra regions of Alaska based on the food habits of waterbirds breeding there.

Project Status:

The first field season was conducted from May through July in 1985. Eighty-one adult and juvenile waterbirds were collected for food habits analysis. All birds and their internal organs were weighed to determine changes in body condition through the breeding season and to correlate food habits with reproductive status. Skins of adult ducks were preserved for laboratory analysis of molt to correlate body condition with molt cycle.

Physical factors of the wetlands where birds were collected were measured including water temperature, water depth, and dominant vegetation present. Core and sweep samples were taken where birds were feeding to determine the relative availability of bottom dwelling and nektonic invertebrates. Invertebrate emergence traps were used to collect emerging adult insects from three wetland types throughout the field season for purposes of identifying dipterans to the species level.

Future Plans:

Food habits have been identified and all data are being entered into the computer. Analyses should be complete by January of 1986. Changes for the next field season which resumes in May of 1986 include more extensive sampling of emerging dipterans using emergence traps and classification of wetlands according to vegetative types.

HABITAT SUITABILITY INDEX MODEL FOR THE AMERICAN EIDER

Investigators: A. K. Blumton
R. B. Owen, Jr.

Cooperators/
Project
Support: U.S. Fish and Wildlife Service - National Coastal Ecosystem
Team, Slidell, LA.

Objectives: (1) Develop a Habitat Suitability Index for the
American eider.
(2) Field test key variables in the model.

Scope:

The common eider, a sea-going duck, is found near offshore shoals and islands around the World's northern coasts; however, Maine supports the only major breeding population of the eider duck in the lower 48 states. Crucial to the eider's life cycle, the islands of Maine are being subjected to increasing recreational and coastal developments creating potential disturbances to eider breeding colonies. During recent years interest in the eider has increased both in terms of viewing and hunting. Waterfowl hunters shifted some of their emphasis to sea ducks which permit larger bag limits and longer seasons than other game ducks.

A need exists to document the species-habitat relationships to estimate impacts of development on this wildlife resource. The Habitat Suitability Index (HSI) model being developed is a measure of the quality of the habitat and its capacity to support the eider.

Project Status:

A review of the literature to identify life requisites and document life history information began in September, 1985. The breeding habitat of the American eider, a race of the common eider, has been the major focus in development of the HSI model. Environmental variables have been determined and HSI models are being formulated.

Future Plans:

The HSI for the American eider will be reviewed by species authorities, and comments will be incorporated into the final draft. Field testing of critical habitat variables on several islands on the coast of Maine will begin during May 1986. Completion of a final HSI model of the American eider is scheduled for September 1986.

MARTEN USE OF CLEAR-CUTS AND RESIDUAL FOREST STANDS
IN WESTERN NEWFOUNDLAND

Investigator: J. E. Snyder

Field

Assistant: S. Perin

Advisors: J. A. Bissonette, Chairperson
P. W. Brown
D. B. Field
W. E. Glanz

Cooperators/ Maine Cooperative Fish and Wildlife Research Unit
Project Newfoundland Wildlife Division
Support: Canadian Government, NSERC

Objectives:

- (1) Determine if stage of regeneration in clear-cuts influence use by marten.
- (2) Determine if size of residual balsam fir and black spruce stands related to marten use.
- (3) Determine which habitat variables characterized successful trap sites.

Project Status:

All requirements for the Master of Science (in Wildlife Management) were completed in December, 1984. An abstract of the thesis follows:

Habitat use by marten was investigated by livetrapping and snow tracking. Residual stands were classified into five size categories and clear-cuts into three categories based on height of balsam fir regeneration.

From June to December 1983, marten were trapped in 43 residual stands and 35 clear-cuts. A total of 3,587 trap-nights yielded 57 captures of 10 male and 8 female marten. Six (10.5%) captures were in clear-cuts, all less than 8 years old; 51 (89.5%) marten were captured in residual stands. Capture rates were greater in larger residual stands. Only five captures were in residual stands <15 ha.

From January to March 1984, marten tracks were followed for 29 km. Although clear-cuts represented 41% of the study area, only 26% of marten travel was recorded here, all in clear-cuts <10 years old. Residual stands and undisturbed forest composed 46% of the study area; 74% of marten travel was recorded in these forested habitats. These data indicate that marten seldom use clear-cuts, or residual stands <15 ha, but do use larger residual stands. Management recommendations are discussed.

SUMMER POND USE BY MOOSE IN NORTHERN MAINE

Investigator: A. Crossley

Advisors: J. R. Gilbert, Chairperson
J. A. Bissonette
M. L. McCormack

Cooperators/

Project College of Forest Resources, McIntire-Stennis
Support: Maine Department of Inland Fisheries and Wildlife

Objectives: (1) Determine the optimal time seasonally and diurnally to conduct aerial summer pond surveys.
(2) Determine the effects of changing biomass and nutritional quality of aquatic vegetation on summer pond use.

Project Status:

All requirements for the Master of Science (in Wildlife Management) were completed in May, 1985. An abstract of the thesis follows:

Pond use habits of moose were studied during summers of 1981 and 1982 in the Mooseleuk Lake area of northern Maine. Five female moose were radio-collared and located 454 times during the study. Collared cows exhibited a preference for aquatic areas during the summer. Of 804 moose observed in 1,121 hours of pond observation, 43.8% were bulls, 36.6% were cows not accompanied by calves, 15.4% were cows with calves, 1.6% were lone calves, and 2.6% could not be classified. A peak in pond use was observed for bulls and lone cows during the last 2 weeks of July in both years. Peak pond use by cow-calf groups occurred from late August to early September. Moose, in general, exhibited a diurnal peak in pond use during the early morning (sunrise-0900) and late evening (1700-sunset). Mid-day periods (0900-1700) were used to a lesser extent. Bulls preferred the early morning period whereas cow-calf groups used all daylight periods proportionately.

The chemical composition of aquatic plants (N=327) was compared to that of terrestrial browse (N=80). Of the 13 minerals and crude protein tested, aquatic plants had higher levels of sodium, iron, manganese, silicon, and aluminum than terrestrial plants. Only sodium seems deficient in the terrestrial diet, implying moose seek aquatics as a source of supplemental sodium. Late summer pond use by cows with calves reflects their greater dietary sodium requirement than that of bulls or barren cows.

Aerial summer pond surveys, designed to assess cow-calf ratios, should be conducted in late August or early September. Moose, as an appreciative resource, are most visible to the public during the early mornings and late evenings of July.

HARBOR SEAL POPULATION AND MARINE MAMMAL-FISHERIES INTERACTIONS

Investigators: J. R. Gilbert
K. M. Wynne

Cooperators/

Project Support: U.S. National Marine Fisheries Service - Northeast Fisheries Center,
Woods Hole, MA.

Scope:

Several marine mammal species interact with commercial fisheries through direct and indirect competition for fish, entanglement of the marine mammal in nets, and damage to fishing gear. In New England, the potential for such conflicts has increased with the concurrent intensification of inshore fishing pressure and increase in marine mammal numbers. Because the number of harbor seals has increased dramatically following Federal protection, the status, distribution, and discreteness of their population have become a concern to several fisheries. In addition to their potential role as competitive predators, seals and other marine mammals, such as the harbor porpoise, are caught accidentally in fishing gear. Although these entanglements may result in monetary loss to the fishermen and biological loss to the marine mammal populations involved, they may also provide a population sample from which valuable and often inaccessible life history data may be obtained.

Project Status:

Since 1981, 105 (71M:34F) harbor seal pups have been tagged in order to monitor seasonal movements of individuals in New England; 24 (15M:9F) were tagged in June 1985. In addition to telemetric relocations, 30 sightings of seals tagged from 1983 to 1985 have been reported. Among these reports are 5 mid-winter sightings on Cape Cod and Nantucket Island, sightings of a tagged yearling and 2 pups in Nova Scotia, and numerous sightings of pups offshore in Maine waters. Results of these returns indicate that harbor seal pups (1) are capable of long distance (30-200 km) movements from their natal areas within 1 month of weaning, (2) contribute to the transient seal population that overwinters in southern New England, and (3) are involved in direct conflicts with both U.S. and Canadian fisheries.

A small-take exemption to the Marine Mammal Protection Act was drafted and obtained on behalf of the New England groundfish gillnetters to allow the incidental taking, reporting, and salvage of small numbers of marine mammal species in the course of fishing operations. Thirty-two carcasses (28 harbor porpoise, 2 Atlantic white-sided dolphins, and 2 harbor seals) were collected in 1985 and necropsied to determine the age, sex, health, reproductive condition, and food habits

of animals taken as by-catch. Other data collected by project observers on active fishing vessels will be used to develop a profile of gear characteristics relative to marine mammal capture rate. The success of this small-take exemption program has prompted the examination of other New England fisheries which incidentally capture small numbers of marine mammals and may qualify for a similar exemption to the Marine Mammal Protection Act.

Future Plans:

Complete coastal surveys will be conducted in March and June 1986 to estimate harbor seal abundance and seasonal distribution in New England. Abundance and productivity estimates obtained from the June 1986 survey will be compared to 1981 estimates to illuminate 5-year trends in population growth and distribution.

Seal tag returns and sightings will be monitored throughout the year; pups will be tagged again in June. Gillnetters will be advised of the small-take exemption and organized as participants. At-sea observations will continue through fall and resume again in early spring. Carcass samples will be analyzed during the mid-winter lull in fishing activity. Contact with purse seiners, strip seiners, weir fishermen, lobstermen, trawlers, and longliners will be made to determine the nature and extent of their interactions with marine mammals.



Attempting to capture and tag a harbor seal pup; note the pup just in front of the adult (Photo by K. M. Wynne).

THE MAINE AMPHIBIAN AND REPTILE ATLAS PROJECT (MARAP)

Investigators: M. L. Hunter, Jr.
Jane Arbuckle
John Albright

Advisors: Barry Burgason
Shirley Davis
Arthur Ritter

Cooperators/ The Nature Conservancy
Project The Maine Audubon Society
Support: 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:

In the project's second year some interesting results have already been obtained. Three species that have been unrecorded for many years were found, albeit in very limited numbers (spotted turtle, Blanding's turtle, and black racer). One species formerly thought to be very rare, the four-toed salamander, appears to be just very secretive. One new species, ribbon snake, was located during the project's second year leaving box turtles as the only Maine herp species unreported in this effort. Data from the MARAP project has been instrumental in the development of a draft State Endangered Species List. Box turtles and black racers have been proposed as State Endangered, and spotted turtles and Blanding's turtles proposed as State Threatened. Major range extensions have been recorded for at least two species, mink frog and gray tree frog.

Future Plans:

It is anticipated that it will take several years to complete the project. Next year we plan to use "Wanted Posters" to locate box turtles and other rare species.

AMPHIBIANS, REPTILES AND SMALL MAMMALS OF MAINE'S PEATLANDS

Investigator: S. S. Stockwell

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

Cooperators/ Maine Department of Inland Fisheries and Wildlife
Project Signal Fuels, Inc.
Support: Maine Chapter of The Nature Conservancy
Maine Land Use Regulation Commission
Maine Department of Environmental Protection

Objectives:

- (1) Identify those species of small mammals, and reptiles and amphibians that inhabit Maine's peatlands.
- (2) Quantify the relative abundances of these species to peatland vegetation and hydrology.
- (3) Determine whether large, commercially valuable peatlands differ in their "value" to wildlife from smaller non-commercially valuable peatlands.

Scope:

This is part of a larger study looking at the use of Maine peatlands by all non-fish, vertebrate species of wildlife. Peatlands are one of the last remaining undisturbed ecosystems in the Northeast. Before this project was initiated no extensive or intensive survey of the wildlife in Maine peatlands had been conducted. As a result we know little about how important peatlands are to various wildlife species.

Recently several commercial mining companies have expressed an interest in developing Maine's peatlands for a new source of energy for the state. Before issuing any mining permits, it is critical that the state know what species depend on peatlands for their continued survival, if any, and whether certain species are restricted to particular types or sizes of peatlands.

Amphibians, reptiles, and small mammals were trapped with drift fences and pit traps. Traplines were erected in seven different plant communities in 1983 and operated for 3 to 7 days each during May, June, July and September. In 1984, 17 additional pitfall traplines were erected in 6 new peatlands. All traplines were operated for 4 to 7 days each month between April and August, 1984.

In 8,733 trap nights, 2,182 individuals of 11 amphibian and 1 reptile species were caught. Anurans represented 94% of all captures, salamanders 5%, and snakes 1%. Species richness ranged from 5-10 per vegetation type, and evenness was generally low. *Rana sylvatica* composed 59% of all captures, and *B. clamitans* composed 29% of all captures. Juveniles constituted 82% of all captures, and were most abundant in July and August.

In 8,733 trap nights, 822 small mammals of 12 species were trapped; 67% of all captures were *Sorex cinereus* and 13% were *Zapus hudsonius*. Ten other species each composed 1-4% of all captures. Species richness ranged from 5-11 per vegetation type. Overall abundance and species richness were correlated with distance of trap site from the nearest upland.

Future Plans:

A Master's thesis will be completed in October 1985. A Ph.D. dissertation on peatland bird communities will be undertaken.

COYOTE/RED FOX INTERACTIONS IN MAINE

Investigator: D. B. Engelhardt

Advisors: J. A. Bissonnette, Chairperson
J. R. Gilbert
W. E. Glanz

Cooperators/

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

Objective: Examine the responses of free-ranging coyotes and red foxes to the placement of scent marks within their home ranges.

Scope:

The establishment of a coyote population in Maine caused concern among trappers and biologists for other predators with which the coyotes might compete, including the red fox. Little information is available about the interactions between sympatric coyote and red fox populations, and their partitioning of resources such as food and space. The primary goal of this investigation is an attempt to determine whether coyote presence causes a displacement of red foxes. Two study areas were chosen: the Pierce Pond area in western Maine (Wildlife Management Unit 3), and the Cherryfield area in eastern Maine (Wildlife Management Unit 6). Information was collected by tracking the movements of free-ranging, radio-collared red foxes before and after the placement of artificial scent marks of coyote or red fox urine within their home ranges, and by snowtracking. Predator food habits and prey abundance data were also collected.

Project Status:

Field work was completed in late August 1984. Data collected from the fall of 1982 through the summer of 1984 were compiled and analyzed. A second draft of the thesis is in review.

Future Plans:

It is anticipated that the thesis will be completed by January 1986.

COYOTE SOCIAL ORGANIZATION, DISPERSAL, AND SPATIAL INTERACTIONS
WITH RED FOXES IN EASTERN MAINE

Investigator: D. J. Harrison

Advisors: J. A. Bissonette, Chairperson
J. A. Sherburne
D. M. Leslie
W. E. Glanz
P. W. Brown

Cooperators/

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

Objectives:

- (1) Describe the social factors influencing coyote populations in eastern Maine, including territory size and composition, territorial fidelity, and the prevalence of non-territorial adult coyotes.
- (2) Evaluate the mechanisms of juvenile coyote dispersal including, proportion emigrating, and the distance, timing, direction, and sex-specific patterns.
- (3) Determine the effect of resident coyotes on the spatial distribution of red foxes in eastern Maine.

Project Status:

Data collection and analyses were completed during 1985. A preliminary summary of results follows:

A study of the social factors influencing coyote populations in eastern Maine was conducted from May 1981 to June 1984. Territorial fidelity, the role of non-territorial coyotes, juvenile dispersal, and spatial interactions with other canids were investigated. More than 5,100 relocations were obtained from 51 coyotes, representing 10 family groups.

Coyote families consisted of a mated adult pair and their offspring which occupied territories exclusive of other family groups. Size and boundaries of territories remained stable between years, and traditional rendezvous sites were used for several consecutive years by adults with pups.

Movements of 7 non-territorial adult coyotes indicated intensive use of small areas adjacent to territories of family groups. These coyotes periodically wandered throughout the territories of several families, seemingly in search of an unoccupied area in which to breed.

No evidence of reproduction was observed in non-territorial individuals before they secured a territory. On 2 occasions, solitary wanderers acquired a territory following the death of a resident adult. A rigid land tenure system seems to limit and stabilize the number of coyote pairs that maintain an exclusive breeding area.

Territory sizes were similar (range 70-76 km²) for 5 coyote families containing adults and offspring, despite differences ($P < 0.05$) in habitat composition as determined from LANDSAT satellite imagery. Home range areas of 7 adult coyotes within family territories were also similar in size (mean = 46.4 km², SE = 7.5), despite habitat differences ($P < 0.05$). These similar sized areas composed of different habitats indicate that social factors may be of primary importance in determining the sizes of coyote territories, with habitat and food variables of lesser importance.

The emigrating segment of the population consisted mainly of juvenile coyotes, however, dispersal was observed by 3 adults. Eighty-one percent (22 of 27) of juveniles dispersed during their first year of life. Peaks of dispersal activity were observed during both the early fall (October - November) and during the breeding season (February - March). No differences ($P > 0.10$) between sexes were observed in percent dispersing, mean age at dispersal, distribution of dispersal by month, or mean distance of dispersal. For both sexes combined, the mean distance of dispersal from natal ranges was 91 km, with a maximum distance of 342 km by a juvenile female in 118 days. Initial relocations of dispersing animals were oriented away from the coast, but otherwise did not differ from random directions ($P > 0.10$). Subsequent locations were non-random ($P < 0.025$), approximating the compass bearing of the initial relocation. Dispersing coyotes were deflected parallel to major geographic barriers (large rivers and coastal bays), resulting in concentrations of coyotes along impassable barriers. Mortality rates of emigrating juveniles were higher than the rates for juveniles remaining on the family territory ($P < 0.10$), indicating enhanced reproductive potential as the probable factor promoting dispersal.

Eleven red foxes were radio-collared to determine their spatial interactions with coyotes. Home ranges of foxes did not overlap with coyote territories. No foxes were captured in over 5,000 trap-nights of effort within core areas used by coyote groups. Foxes centered their activity in small areas adjacent to and/or between coyote territories. Red foxes in eastern Maine are a fugitive species whose spatial distribution and densities are restricted by the presence of coyotes.

Future Plans:

A Ph.D. dissertation is being written and the projected date for completion is February 1986.

ECOLOGY OF FISHERS IN SOUTH-CENTRAL MAINE

Investigator: S. M. Arthur

Technician: M. Miller

Field Jeffrey Bernatowicz

Assistants/ Tracy Goldstein

Volunteers: Sully Howard
Toby Montgomery
John Waring

Advisors: J. R. Gilbert, Co-chairperson

W. B. Krohn, Co-chairperson

M. D. Ashley

W. E. Glanz

G. J. Matula

Cooperators/

Project Maine Department of Inland Fisheries and Wildlife

Support: Maine Cooperative Fish and Wildlife Research Unit

Objectives:

- (1) Evaluate fisher home range size and dynamics.
- (2) Determine fisher habitat use and its relation to small mammal distribution.
- (3) Document fisher activity patterns.
- (4) Document fisher food habits.

Scope:

The fisher is the largest terrestrial member of the weasel family currently inhabiting Maine, with males usually 90-110 cm long and weighing 4-5 kg. A high-priced pelt, recent record-setting harvest levels, and a past history of over-exploitation make the fisher one of the most important furbearers in North America, yet little is known about the species' ecology. This study is examining the ways in which fisher behavior and habitat requirements affect their populations in an area of high fisher abundance. Information gained through telemetry and winter snow tracking will be used to determine fisher home range dynamics and the relationship between fisher movements, habitat use, and small mammal (important fisher food) distribution.

Project Status:

A total of 26 fishers have been captured and equipped with radio-collars. Individuals were located several times per week, for periods ranging from a few days to 18 months. Home ranges of adults were generally 10-20 km² although some were considerably larger. Fishers preferred coniferous trees for resting sites, except in midwinter, when ground burrows were also used. Snowshoe hares were the

most common food of fishers, while squirrels, mice, porcupines, apples, and other fruits were also eaten. From Jan-Feb, 1985, fisher trails in snow were followed for 20 km, and 30 km of random transects were surveyed. In July, 300 random plots were sampled to determine distribution of understory types in the area.

Future Plans:

Trapping efforts will continue at least through the end of the open trapping season (December) so that at least 15 fishers will be available for monitoring during the winter and, hopefully, spring. Fisher trails in snow will be followed whenever snow conditions permit. Special attention will be given to determining reproductive success of females. Monitoring of radio-collared animals will continue through at least August 1986. During summer 1986, areas of concentrated fisher activity will be identified, and understory characteristics will be compared between these areas and the random plots sampled in 1985.



A tranquilized fisher is fitted with a radio-collar for subsequent monitoring in south-central Maine (Photo by M. Miller).

HABITAT USE AND HOME RANGE CHARACTERISTICS
OF MOOSE IN NORTHERN MAINE

Investigator: M. E. Thompson

Advisors: J. R. Gilbert, Chairperson
G. J. Matula
M. D. Ashley

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

Objectives: (1) Quantify seasonal habitat use and home range characteristics of moose.
(2) Compare these parameters for moose using areas of different logging intensities.

Scope:

Young forest communities are important components of good moose range. In Maine, these habitats are largely the result of tree harvesting, but in other areas they may be created by fire or flooding.

The thriving populations of moose currently found throughout much of northern Maine are a result of logging operations conducted during the past several decades. These operations varied in the type of cut and methods used; hence, the characteristics of the resulting cut-overs are quite diverse.

This project was designed to assess which cut-overs, out of the diverse array available, were being used by moose. To accomplish this, adult moose were radio-collared and monitored from the air throughout the year, supplemented occasionally, by ground radio-tracking and direct observation. Habitat information for sites used by moose was obtained at the time of aerial relocation and from forest cover-type maps. Logging history was determined from site characteristics and landowner records.

Project Status:

All field work for this project was completed on 30 August 1984. Preliminary results are as follows:

A total of 991 relocations were obtained (825 aerial, 158 ground telemetry observations, and 8 direct observations) from 36 radio-collared adult moose (13 males and 23 females) that were radio-collared on two study areas.

Moose movements were plotted and home range sizes calculated using the minimum convex polygon method. In the winter of 1983, the home ranges of four bulls averaged 6.06 km² (range 1.13 - 12.77 km²), whereas the 10 radio-collared cows had an average home range of 9.24 km² (range 0.99 - 21.50 km²).

Other seasonal home ranges calculated in km² were: (1) Summer 1983 - bulls: mean = 15.97 (n=10), range 0.72 - 45.53; cows: mean = 28.94 (n=19), range 3.83 - 126.33; (2) Fall 1983 - bulls: mean = 11.67 (n=9), range 0.27 - 41.13; cows: mean = 6.38 (n=17), range 0.20 - 41.37; (3) Winter 1984 - bulls: mean = 1.30 (n=9), range 0.33 - 2.87; cows: mean = 1.92 (n=20), range 0.13 - 9.15; and (4) Summer 1984 - bulls: mean = 31.48 (n=9), range 6.70 - 120.54; cows: mean = 25.21 (n=21), range 3.30-108.23.

The number of relocations used to calculate home ranges was small (winter: mean = 4.95, range 3 - 6; summer: mean = 11.15, range 3 - 30; fall: mean = 3.9, range 3 - 5), but the results suggest, as other telemetry studies in Maine have shown, that moose home ranges in Maine are larger than have been reported in most other studies of moose populations that do not make seasonal migrations. This is particularly true during the summer months.

Twenty-four hour movements of moose were quantified during the summer of 1983. Bull and cow movements were similar with 24-hour moves ranging from 0 to 13 km (mean = 1.70 km); however, when moves were to or from a pond used for feeding on aquatic plants, 24-hour movements averaged 4.62 km.

Future Plans:

Analysis of the habitat data associated with moose relocation sites is in progress; following completion, the final thesis will be written. Project completion is anticipated in early 1986.

SUMMER HOME RANGE AND HABITAT USE BY MOOSE IN NORTHERN MAINE

Investigator: D. J. Leptich

Advisors: J. R. Gilbert, Chairperson
D. M. Leslie
M. L. McCormack

Cooperators/

Project McIntire-Stennis

Support: Maine Department of Inland Fisheries and Wildlife

Objectives:

- (1) Examine the summer home range characteristics, including size and utilization distribution, of free-ranging moose.
- (2) Describe 24-hour patterns of summer habitat selection by moose.
- (3) Describe the characteristics of moose calving sites in Maine.

Scope:

Most moose habitat use studies have not considered nocturnal activities. Consequently, most of the moose habitat use information is biased toward day-time use and, where aerial radio-telemetry was employed, good weather. This project was designed to eliminate these biases and elucidate temporal patterns of moose summer habitat selection on a 24-hour basis.

The study also makes a preliminary examination of the characteristics of moose calving sites in Maine. Measurements of overstory and shrub layer vegetation as well as abiotic components of moose calving sites and compared to similar measurements recorded at randomly located plots. Multivariate analysis is being used to determine which habitat attributes help distinguish calving sites from random plots.

Project Status:

Fieldwork has been completed. Seven additional study animals were radio-collared in 1985. A total of 1,323 radio-relocations were recorded on 13 (6M:7F) moose. Habitat availability has been determined by plotting 1,218 random points across the study area and determining habitat type from forest cover type maps. Moose habitat use was also determined using forest cover type maps. Analysis of habitat selection patterns is in progress. Ten moose calving sites were located during the 1984 and 1985 field seasons and 20 randomly selected sites were chosen for comparison. Summary of the vegetation characteristics data and stepwise discriminant analysis is underway.

Home range analysis will begin soon pending the arrival of a computer package necessary to complete the work.

Future Plans:

Data analysis is expected to be completed by December 1985, and the planned time for thesis submission is early 1986.

SYNERGISTIC RELATIONSHIPS AMONG IMPORTANT WINTER FORAGES
OF WHITE-TAILED DEER

Investigator: J. A. Jenks

Advisors: D. M. Leslie, Jr., Chairperson
R. B. Owen, Jr.
B. A. Barton
G. J. Matula

Cooperators/
Project

Support: McIntire-Stennis

Objectives:

- (1) Determine if synergisms exist among important winter forages of white-tailed deer using in vitro digestion.
- (2) Determine whether certain winter forage combinations can decrease rumen turnover time in captive white-tailed deer.
- (3) Determine rumen protozoa numbers in captive white-tailed deer on known winter diets.

Scope:

Browse species utilized by white-tailed deer in winter are generally low in dietary digestibility. However, winter forage combinations (diets) may exceed expected digestibilities due to synergisms that enhance particle size reduction, nutrient uptake, and microbial growth. This study will evaluate the winter nutrition of white-tailed deer concentrating on winter forage combinations and their effect on dietary digestibility, turnover rate, and rumen protozoa population numbers.

Project Status:

Four feeding trials were conducted during January through March, 1985, to determine passage rate and rumen protozoa numbers of captive deer on known diets. During the fourth trial, 3 mortalities occurred because of a combination of behavioral and nutritional stresses. Fecal samples were collected during the trials and analyzed for an added marker (Ytterbium Chloride, $YbCl_3$) and passage rate estimates determined using a computer model. Fecal and forage samples were also analyzed for nitrogen content. Rumen samples for determining protozoa population numbers were not obtained because a stomach tube could not be inserted into the rumens of captive fawns.

In vitro digestion trials were conducted during June-August 1985. Diets fed to captive deer in winter 1985 were reconstructed from dried forage samples collected in January 1985. Diets were digested in rumen fluid obtained from fistulated cattle.

During June and July 1985, 9 fawns (2M:7F) were obtained in conjunction with the Maine Department of Inland Fisheries and Wildlife. Fawns were maintained as were those of the previous year with slight modifications. Three fawn mortalities occurred in June that were attributed to pneumonia (2) and skull anomalies (1). A perimeter fence encircling the captive animal research facility was completed in July. Exercise routines for yearling deer were initiated in August.

Future Plans:

Complete in vitro digestions of forages collected in January 1985. Collect forages for feeding trials scheduled for January 1986. Complete data analysis and initiate writing thesis in January 1986.

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

Investigator: M. Chillell

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) Predict sustained annual harvest rates for antlered and antlerless deer in selected wildlife management units.

Scope:

As demands placed on natural resources by different consumer groups increase, management decisions become more complex. Comprehensive management plans, utilizing all available data, are necessary to provide a sustained harvest of white-tailed deer while ensuring a healthy population. Models, consisting of a set of hypotheses that define how an ecological system functions, provide a means of relating hypotheses, tracking the populations as management proceeds, and allowing experimentation (i.e. simulation) of alternative management strategies.

The overall goal of this project is to develop a predictive population dynamics model for white-tailed deer in Maine. The development of this model will not only integrate the large and varied data array provided by the Maine Department of Inland Fisheries and Wildlife, but will help to identify interactions among various parameters pertaining to white-tailed deer ecology, pinpoint weaknesses in current data sets, and help guide future management and research endeavors.

Project Status:

An extensive literature review on white-tailed deer population dynamics and modeling was conducted to develop the model's conceptual framework. Existing research and management information will continue to be collected and synthesized. Work was initiated on defining relationships between major components of the model.

Future Plans:

The conceptual framework will be refined and existing models continue to be reviewed. Mathematical relationships among the model components will be formulated, tested and begin to be integrated into a population dynamics model. Thesis writing is planned to begin in the summer of 1986 with project completion scheduled for the end of June 1987.



The white-tailed deer is Maine's most important big game animal. The management of this species will become increasingly more intensive in response to habitat and population changes (Photo by W. B. Krohn).

NESTING ECOLOGY, HABITAT USE AND REPRODUCTIVE SUCCESS OF
WILD TURKEYS IN SOUTH-CENTRAL MAINE

Investigator: B. E. Treiterer

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

Cooperators/ Maine Department of Inland Fisheries and Wildlife
Project National Wild Turkey Federation
Support: National Rifle Association
L. L. Bean, Inc.

Objectives:

- (1) Document nesting chronology, proportion of females nesting, nest site characteristics, and the success of eggs and nests of free-ranging turkeys in south-central Maine.
- (2) Determine the types of habitat used by these turkeys and changes in habitat use during the nesting period.

Scope:

Wild turkeys once existed in the southern portion of Maine but were extirpated before the advent of legal protection. Reintroductions in the late 1970s have resulted in expanding populations in southern (centered in York County) and south-central (centered in Waldo County) Maine. Little is known about the breeding characteristics and requirements of the wild turkey in Maine. Turkeys nesting in Maine, especially the flock in Waldo County, are considered at the edge of their northern range. Information on nesting ecology is critical to the selection of future release sites, and to the population itself if it is to expand and be successfully managed as a game species.

Project Status:

A telemetry study of the Waldo County turkeys has been initiated to gather reproductive data. Sighting cards have been distributed in the area to locate potential trapping sites. Bait stations were put out and cannon netting was begun in September. Five turkey hens have been equipped with radios and are being monitored.

Future Plans:

Establishment of bait stations and cannon netting will continue through February in order to capture 11-16 additional hens and equip them with radios. Data collection on nesting ecology and reproductive success on the radioed hens will begin in April.

STATUS OF RIVER OTTER IN ACADIA NATIONAL PARK

Investigator: L. J. Dubuc

Advisors: R. B. Owen, Jr. Chairperson
C. J. Schell
W. E. Glanz
G. J. Matula

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

Objectives:

- (1) Determine the present distribution and status of otters in Acadia National Park by means of systematic surveys of inland, estuarine, and marine waterways.
- (2) Assess the suitability of aquatic habitats in Acadia National Park for river otter.
- (3) If river otter are present in sufficient numbers, conduct preliminary diet and population analyses.
- (4) If river otter are not present in sufficient numbers, provide recommendations for otter reintroduction in Acadia National Park.
- (5) Provide Acadia National Park with recommendations for managing otters.

Scope:

Historically, river otters occurred on Mt. Desert Island; however, trapping success and the abundance of otter sightings have decreased over several years generating conflicting speculations on the population status and distribution. This study is designed to reduce the uncertainties concerning the extent of otter use of freshwater, marine and estuarine habitats on Mt. Desert Island.

Project Status:

Field work was initiated in August 1985 with a preliminary survey of the watershed on Mt. Desert Island. These initial efforts produced otter signs including latrines and rolling areas where 29 scats were collected. Initial contacts with naturalists, game wardens, and trappers on Mt. Desert Island were completed. Trapping records covering the last 7 years for Mt. Desert Island and the adjacent mainland areas and freshwater fish surveys have been obtained from the Maine Department of Inland Fisheries and Wildlife.

Future Plans:

A final project proposal will be completed and submitted to the Advisory Committee for review and approval.

During the winter of 1985-86 experimental trapping techniques will be conducted and surveys of all watersheds will continue.

PUBLICATIONS, THESES AND DISSERTATIONS,
AND PROFESSIONAL TALKS GIVEN

SCIENTIFIC PUBLICATIONS

- Akielaszek, J.J., J.R. Moring, S.R. Chapman, and J.H. Dearborn. 1985. Experimental culture of young rainbow smelt *Osmerus mordax*. Trans. Am. Fish. Soc. 114(4):596-603.
- Bissonette, J.A., and J.W. Ault III. 1984. Bibliography summary and recommendations for scientific research at Big Bend National Park, Biosphere Reserve, Texas. U.S. Dept. of Interior, N.P.S. MAB Report, 1087 pp.
- Brown, P.W., and M.L. Hunter, Jr. 1985. Potential effects of insecticides on the survival of dabbling duck broods. J. Minnesota Acad. Sci. 50:41-44.
- Duwors, R., C.S. Houston, and P.W. Brown. 1984. Survival of the common goldeneye banded at Emma Lake, Saskatchewan. J. Field Ornithol. 55:382-383.
- Gustafson-Marjanen, K.I., and J.R. Moring. 1984. Construction of artificial redds for evaluating survival of Atlantic salmon eggs and alevins. N. Am. J. Fish. Manage. 4(4A):455-456.
- Hunter, M.L., Jr., J.W. Witham, and H.B. Dow. 1984. Effects of a pesticide-induced depression in invertebrate abundance on the growth and behavior of American black duck and mallard ducklings. Can. J. Zool. 62:452-456.
- Johnson, D.H., G.L. Krapu, K.J. Reinecke, and D.G. Jorde. 1985. An evaluation of condition indices for birds. J. Wildl. Manage. 49(3):569-575.
- Johnson, W.N., and K. McGarigal. 1985. Pileated woodpecker nest in natural cavity. J. Field Ornithol. 55(4):490.
- Krausman, P. R., J.R. Mongarat and M. Chillemi. 1984. Annotated bibliography of desert bighorn sheep literature, 1897-1983. Southwest Natural History Assn., Phoenix, AZ. 204 pp.
- Leslie, D.M., Jr., E.E. Starkey, and M. Vavra. 1984. Elk and deer diets in old-growth forests in western Washington. J. Wildl. Manage. 48(3):762-777.
- Leslie, D.M., Jr., and K.J. Jenkins. 1985. Rutting mortality among Roosevelt elk. J. Mammal. 66(1):163-164.

- Litvaitis, J.A., J.A. Sherburne, and J.A. Bissonette. 1985. A comparison of methods used to examine snowshoe hare habitat use. *J. Wildl. Manage.* 49(3):693-695.
- Moring, J.R. 1985. Formulating simple angler profiles to better manage "catchable" trout fisheries. *N. Am. J. Fish. Manage.* 5(3A): 413-414.
- Moring, J.R., G.C. Garman, and D.M. Mullen. 1985. The value of riparian zones for protecting aquatic systems: general concerns and recent studies in Maine. Pages 315-319 in *Proc. N. Am. Riparian Conf., USDA For. Serv. Gen. Tech. Rep. R-120.*

TECHNICAL AND SEMI-TECHNICAL PUBLICATIONS

- Douglas, C.L., and D.M. Leslie, Jr. 1984. Simulated effect of transplant removal from the River Mountain bighorn herd. *Desert Bighorn Council Trans:*26-29.
- Danie, D.S., J.G. Trial, and J.G. Stanley. 1984. Species profiles: life histories and environmental requirements of coastal fish and invertebrates (North Atlantic) - Atlantic salmon. U.S. Fish and Wildl. Serv. and U.S. Army Corps of Eng., FWS/OBS-82/11.22 and TR EL-82-4. 19pp.
- Garman, G.C. 1985. Book review of: Barnes and Minshall (eds.). *Stream ecology: application and testing of general ecology theory.* *Trans. Am. Fish. Soc.* 114(2):315-316.
- Hunter, M.L., Jr. 1984. Discovering Maine's little known animals. *The Nature Conservancy--Maine Chapter News, No. 5:6.*
- Hunter, M.L., Jr. 1985. Are there any rattlesnakes in Maine? *Habitat* 2(6):40-41.
- Hunter, M.L., Jr. 1985. The jumping frog of Kennebec County. *Habitat* 2(7):42-44.
- Hunter, M.L., Jr., J.W. Witham, and J.J. Jones. 1985. Use of imprinted ducklings to evaluate brood-rearing habitat. *Maine Agric. Expt. Stn. Tech. Bull.* 117. 18pp.
- Hunter, M.L., Jr., J.J. Jones, K.E. Gibbs, J.R. Moring, and M. Brett. 1985. Interactions among waterfowl, fishes, invertebrates, and macrophytes in four Maine lakes of different acidity. U.S. Fish and Wildl. Serv. Eastern Energy and Land Use Team. *Biol. Rep.* 80(40.29). 80 pp.

- Hunter, M.L., Jr. A preliminary guide to finding and identifying the amphibians and reptiles of Maine. The Nature Conservancy, Brunswick, Maine. 44pp. (2nd ed.).
- Lendt, D.L., with E.E. Klaas, J.R. Moring, and R.W. Gregory. 1984. 50 years of achievement, the Cooperative Research Unit Program in Fisheries and Wildlife, 1935-1985. U.S. Dept. of the Interior, Fish and Wildl. Serv. 14 pp.
- Leslie, D.M., Jr. 1985. Wildlife ecology and management. (Book Review). Forest Sci. 31:20.
- MacKenzie, C., and J.R. Moring. 1985. Species profiles: life histories and environmental requirements of coastal fish and invertebrates (North Atlantic) -- American lobster. U.S. Fish and Wildl. Serv. Biol. Rep. 82(11.33), U.S. Army Corps of Eng. Rep. TR EL-82-4. 19pp.
- MacKenzie, C., L.S. Weiss-Glanz, and J.R. Moring. 1985. Species profiles: life histories and environmental requirements of coastal fish and invertebrates (mid-Atlantic) -- American Shad. U.S. Fish and Wildl. Serv. Biol. Rep. 82(11.37), U.S. Army Corps of Eng. Rep. TR EL-82-4. 18pp.
- McCullough, M., C.S. Todd, and R.B. Owen, Jr. Winter 1984-85. Refueling the big birds. Maine Fish and Wildlife 26(4):12-15.
- Moring, J.R. 1985. A unique partnership for Maine. Maine Fish and Wildlife 27(1):8-10.
- Moring, J.R. 1985. Logging and fishes. Maine Sunday Telegram, Portland, Maine, March 3, 1985:9H.
- Moring, J.R. 1985. New trouble in the tide pools. Sea Frontiers 37(4):196-204.
- Moring, J.R. 1985. Smelt culture...a new business for Maine. Maine Fish and Wildlife 27(2):13-15.
- Moring, J.R., J. Bernatowicz, P.W. Bley, D.P. Boucher, L.A. Debruyckere, C. Graham, E.C. Grant, and A.M. Swiecicki. 1985. Fish populations of Lac D'Or, Hirundo Wildlife Refuge, 1983 and 1984. Maine Coop. Fish. Res. Unit, Invest. Rep. 85-1. 11pp.
- Owen, R.B., Jr. 1984. Maine land use regulations--their benefits to fish and wildlife. Pages 344-346 in Forest Resources Management--the Influence of Policy and Law. International Forest. Congress Convention, Quebec City.

- Sellers, M.A., and J.G. Stanley. 1984. Species profiles: life histories and environmental requirements of coastal fish and invertebrates (North Atlantic) - American oyster. U.S. Fish and Wildl. Serv. FWS/OBS-82/11.23, U.S. Army Corps of Eng. Rep. TR EL-82-4. 16 pp.
- Stanley, J.G. 1985. Species profiles: life histories and environmental requirements of coastal fish and invertebrates (mid-Atlantic)- hard clam. U.S. Fish and Wildl. Serv. Biol. Rep. 82(11.41), U.S. Army Corps of Eng. Rep. TR EL82-4. 24pp.
- Stockwell, S.S. 1985. Peatlands: habitat for thousands. Maine Fish Wildlife. 27(2):8-12, 30-32.
- Trial, J.G., and P.D. Kingsbury 1984. Spruce budworm management planning - limiting environmental impacts. Pages 133-140 in D.M. Schmitt, D.G. Grimbale, J.L. Searcy (tech. coord.), Managing the spruce budworm in eastern North America. USDA For. Serv., Agric.. Handbook 620.
- Trial, J.G., C.S. Wade, and J.G. Stanley. 1984. HSI models for northeastern fishes. In J.W. Terrell, Proceedings of a Workshop on Fish Habitat Suitability Index Models. U.S. Fish and Wildl. Serv. West. Energy and Land Use Team, Biol. Rep. 85(6):17-56.

THESES AND DISSERTATIONS

- Bazan, W.H. 1985. The status and conservative of the wildlife resources in Cajamarca, Peru. M.S. Thesis, Univ. of Maine, Orono. 85 pp.
- Brett, M. 1985. Zooplankton and nekton community structure in lakes of varying pH in Maine, USA. M.S. Thesis, Univ. of Maine, Orono. 44 pp.
- Crossley, A. 1985. Summer pond use by moose in northern Maine. M.S. Thesis, Univ. of Maine, Orono. 39 pp.
- Mackenzie, C. 1985. Survival and horizontal movements of Atlantic salmon (*Salmo salar*) during the intragravel period. M.S. Thesis, Univ. of Maine, Orono. 41 pp.
- Mullen, D.M. 1985. The effects of deforestation on energy input into a small New England trout stream. M.S. Thesis, Univ. of Maine, Orono. 35 pp.
- Snyder, J.E. 1984. Marten use of clear-cuts and residual forest stands in western Newfoundland. M.S. Thesis, Univ. of Maine, Orono. 331 pp.
- Strong, P.I.V. 1985. Habitat selection by common loons. Ph.D. Dissertation, Univ. of Maine, Orono. 53 pp.

PROFESSIONAL TALKS PRESENTED

- Bowman, T. Black duck banding and research in northern Labrador. Atlantic Flyway Council - Technical Section, February 1985. 70 state and federal professionals.
- Buchanan, D.V., and J.R. Moring. April 1, 1985. Management problems with recycling of adult summer steelhead trout at Foster Reservoir, Oregon. Symposium on the Role of Fish Culture in Fishery Management, Lake Ozark, MO. 250 attendees.
- Chilcote, M. Desert bighorn sheep in Arizona. UMO Student Chapter of The Wildlife Society. February 1985. 30 students and faculty.
- Eggeman, D.R., D. Humburg, D. Graber, and L. Korschgen. December 5, 1984. Fall-winter foods of Canada geese in the Swan Lake Zone, Missouri. 46th Midwest Fish and Wildlife Conf. Indianapolis, IN. 150 federal, state, university.
- Eggeman, D.R., and P.W. Brown. January 7-10, 1985. Poster-behavior of common goldeneyes wintering in Maine. Waterfowl in Winter Symposium and Workshop, Galveston, TX.
- Elliott, C.A. The Ontario Ministry of Natural Resources, or, there and back again. UMO Wildlife Noontime seminar. February 1985. 40 students and faculty.
- Hunter, M.L., Jr. Acid rain and waterfowl. Unity College. September 1985. 75 students and faculty.
- Jenks, J.A. Passage rate in white-tailed deer maintained on winter diets in Maine. Am. Soc. of Mamm., 65th Annual Meeting. June 1985, Univ. of Maine, Orono.
- Litvaitis, J.A. Bobcat habitat use and home range in relation to prey density. Wildlife Biology Class at Rutgers University, New Brunswick, NJ. April 1985. 20 students and faculty.
- Litvaitis, J.A. Bobcat habitat use and home range in relation to prey density. Invited Seminar. Yale School of Forestry and Environmental Studies, New Haven, CT. April 1985. 15 graduate students.
- Litvaitis, J.A. Integrating forest and wildlife management in industrial forests of Maine. Forest Biology Class at Yale School of Forestry and Environmental Studies, New Haven, CT. April 1985. 20 graduate students and faculty.
- McCullough, M. Bald eagles in Maine. May 1985. Maine State Park Managers, Squaw Mountain, Greenville, ME 52 people.

- Moring, J.R. November 14, 1984. Ecology of tidepool fishes. Unity College Environmental Sciences Seminar, Unity, ME. 75 attendees.
- Moring, J.R. and G.C. Garman. March 7, 1985. The value of riparian zones for fisheries. Symposium on "Is Good Forestry Good Wildlife Management?" Portland, ME. 200 attendees.
- Moring, J.R. April 1, 1985. Stocking anadromous species to restore or enhance fisheries. Symposium on the Role of Fish Culture in Fishery Management, Lake Ozark, MO. 450 attendees.
- Moring, J.R., G.C. Garman, and D.M. Mullen. April 18, 1985. The value of riparian zones for protecting aquatic systems: general concerns and recent studies in Maine. N. Am. Riparian Conf., Tucson, AZ. 120 attendees.
- Moring, J.R. June 4, 1985. Stocking anadromous fishes in North America. UMO Wildlife/Zoology Seminar, Orono, ME. 20 attendees.
- Moring, J.R. August 22, 1985. Intertidal areas of northern New England: nursery habitat for coastal fishes. Gulf of Maine Workshop, Portland, ME. 80 attendees.
- Strong, P. Loons. UMO Student Chapter of The Wildlife Society. February 1985. 30 attendees.
- Todd, C.S. Ecology and management of bald eagles in Maine. Slide presentation and showing "Bart", a live bald eagle. College of the Atlantic Summer Lecture Series, Bar Harbor. August 1985. 70 students and faculty.
- Todd, C.S., and A.E. Hutchinson. Peregrine falcons, bald eagles and Maine's non-game program. Slide presentation and showing "Bart", the eagle. Univ. of Me. at Farmington, Biology Club. March 1985. 20 students and faculty.

