Maine Cooperative Fish and Wildlife Research Unit and Department of Wildlife, Fisheries, and Conservation Biology; University of Maine

2014 Report to Cooperators

UNIT COOPERATORS

University of Maine

Maine Department of Inland Fisheries and Wildlife

United States Geological Survey

United States Fish and Wildlife Service

Wildlife Management Institute

Compiled and Edited by
Cynthia S. Loftin, Rena A. Carey, and Katherine Goodine

Special thanks to Mark McCullough for allowing us to use his original pen and ink drawings throughout the report.

To download a digital copy of this report, please visit:
http://www.coopunits.org/Maine/Documents/ *or*
http://umaine.edu/wle/maine-cooperative-fish-and-wildlife-research-unit/

Cover Photo: Avery Peak on Mount Bigelow by Connor Wood

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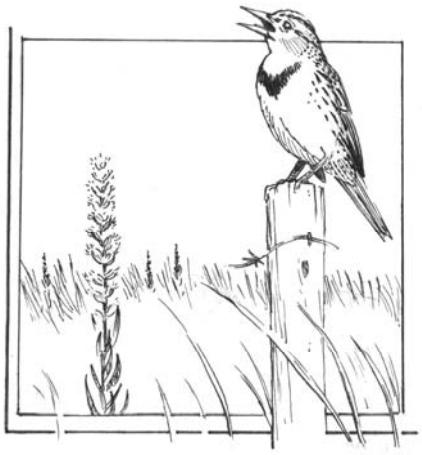
UNIT Mission

The Maine Cooperative Fish and Wildlife Research Unit (CFWRU) is uniquely suited to pursue research relevant to fish and wildlife conservation in northern ecosystems. Maine is the most heavily forested state in the Nation and is covered by numerous ponds, lakes, wetlands, streams, and rivers. Maine has an extensive coast line with a rich variety of habitats adjacent to one of the most productive marine areas of the world, the Gulf of Maine. Tourism and forest product industries are extremely important to Maine's economy and culture. These industries generate management challenges for fish and wildlife that require solutions based on sound science. The Maine CFWRU applies expertise in both terrestrial and aquatic ecology to State and Federal natural resource management priorities.

The primary objectives of the CFWRU are to: (1) facilitate and strengthen professional education and training of fisheries and wildlife scientists; (2) carry out research programs of aquatic, mammalian, and avian organisms and their habitats; and (3) disseminate research results through the appropriate media, especially peer-reviewed scientific articles. The educational and training objective is through advisement of graduate students and their research projects, formal classroom instruction, and supervision of technicians and research associates conducting collaborative research with University staff. In addition, Unit personnel are involved with extension and technical assistance to cooperating agencies and to the general public.

The research program of the Maine CFWRU broadly reflects the needs of the cooperators. Funding in recent years reflects a diversity of studies. Priority research areas are: (1) ecological studies on species of State and Federal interest (e.g., amphibians, Atlantic salmon, brook trout, native pollinators, black bears); (2) management and habitat-related studies with special reference to the effects of land and water-use practices (e.g., logging, dams) on fish and wildlife; and (3) issues related to the effects of land management and forestry on aquatic and wetland systems, and fisheries management in Maine and northern New England.



STATE of the Unit and Department

The Maine Cooperative Fish and Wildlife Research Unit and the University of Maine Department of Wildlife, Fisheries, and Conservation Biology are pleased to summarize the past year's research accomplishments and activities in this annual report. Together, we have collaborated with scientists from State and Federal agencies, universities, and non-governmental organizations on 37 research projects presented in the pages that follow. These collaborative relationships enable us to pose a variety of research questions in interdisciplinary studies to address the resource management information needs of our research sponsors and to advance science in wildlife and fisheries ecology, management, and conservation. We value these opportunities to work together and look forward to continuing these relationships as well as developing new collaborations in the year ahead.

Our research occurs primarily in Maine and New England, however, our science is applicable beyond this geographical area. We broadly group our diverse array of projects into three categories: Fisheries and Aquatic; Wildlife and Habitats; Integrated Ecology. This report includes summaries of research ranging from defining species-habitat relationships, to modeling species responses to habitat change, and to developing tools to integrate public input into natural resource management decisions. Many of these projects have been recent, some are long-term, and some have been completed during the past year. The majority of our research is conducted as part of graduate degree programs; during the past year, Unit and Department faculty mentored 43 graduate students and postdocs, 5 graduate students completed requirements for M.S. or Ph.D. degrees, and 3 graduate students completed requirements for the MWC degree. Our recent graduates are working for universities, state and federal agencies, non-governmental organizations, and environmental consulting firms, as well as pursuing additional graduate degrees.

The year brought several changes to the Unit and its cooperators. The Department has changed its name to the Department of Wildlife, Fisheries, and Conservation Biology to reflect the Department's breadth of undergraduate and graduate education, the interdisciplinary nature of our research, and the substantial growth in our programs. The *Forests, Wildlife and the Environment* academic area was identified as a University of Maine *Signature Area*, increasing the visibility and support for the Department and Unit. The Maine Department of Inland Fisheries and Wildlife (MDIFW) welcomed new staff to their programs during the past year. We look forward to continuing to work with them to address their resource management information needs.

The past year has been a productive research year for the Department and Unit, with external research funding increasing during the past year by a third. Our graduate program continues to be active and attract great students who ably represent our academic and research programs locally and at professional meetings across the country. Undergraduate student enrollment in Wildlife Ecology also has increased to 149 students, providing new challenges, expanded course and advising responsibilities, and exciting new opportunities. The Department continues to be the administrative home for the Ecology and Environmental Sciences (EES) undergraduate and graduate degree programs, directed by Dr. Aram Calhoun. Lindsay Seward, Instructor of Wildlife Ecology, also serves a dual-role as undergraduate coordinator for the growing EES program. Other changes are on the horizon for the department, as we hire new faculty to address growing undergraduate and graduate enrollments while also meeting expanding research needs and opportunities, and faculty transitions.

The Unit and Department look forward to another year (and the 80th anniversary of both) of continuing and new relationships with our colleagues. You can reach the investigators of the projects summarized in this report via contact information listed on the Unit (www.coopunits.org/Maine/) or Department (www.umaine.edu/wle/) websites. We welcome your comments.

COOPERATING PERSONNEL

UNIVERSITY OF MAINE

Dr. Carol H. Kim, Vice President for Research
Dr. Daniel J. Harrison, Chair: Department of Wildlife, Fisheries, and Conservation Biology

MAINE DEPARTMENT OF INLAND FISHERIES AND WILDLIFE

Mr. James Connolly, Director, Bureau of Resource Management

U.S. FISH AND WILDLIFE SERVICE

Ms. Laury Zicari, Supervisor, Maine Field Office

U.S. GEOLOGICAL SURVEY

Dr. John Organ, Chief, Cooperative Research Units Program

WILDLIFE MANAGEMENT INSTITUTE

Mr. Steve Williams, President

UNIT PERSONNEL

SCIENTISTS

Cynthia S. Loftin, Unit Leader, and Associate Professor of Wildlife Ecology
Shawn T. McKinney, Assistant Unit Leader for Wildlife and Assistant Professor of Wildlife Ecology
Joseph D. Zydlewski, Assistant Unit Leader for Fisheries, and Associate Professor of Wildlife Ecology

SUPPORT STAFF

Rena Carey, Administrative Support Supervisor
Katherine Goodine, Administrative Specialist

COLLABORATING AGENCIES AND ORGANIZATIONS

American Forest Management
American Recovery and Reinvestment Act (ARRA)
Army Corps of Engineers
Atlantic Salmon Federation
Baxter State Park
Biodiversity Research Institute
Biology Department, Acadia University, Nova Scotia, Canada
Biology Department, SUNY Potsdam, NY
Central Maine Power
Connecticut Department of Energy and Environmental Protection
Cooperative Fish and Wildlife Research Unit, University of Massachusetts
Eastern Maine Conservation Initiative
Fulbright Student Scholar Program
Gerald Pelletier, Inc
Holt Woodlands Research Foundation
Katahdin Forest Management
Lowe's Home Centers, Inc.
Maine Association of Wetland Scientists
Maine Audubon Society
Maine Department of Environmental Protection
Maine Department of Inland Fisheries and Wildlife
Maine Department of Marine Resources
Maine Outdoor Heritage Fund
Maine River Bird Volunteer Network
Maine Sea Grant
Maine State Planning Office
Massachusetts Division of Fisheries and Wildlife
Massachusetts Institute of Technology (MIT) Lincoln Laboratory
National Fish and Wildlife Foundation
National Oceanic and Atmospheric Administration
National Park Service
National Science Foundation – Experimental Program to Stimulate Competitive Research
National Science Foundation – REU Program in Sensor Science and Engineering
New Hampshire Fish and Game Department
New York State Department of Environmental Conservation
NSF Adaptation to Abrupt Climate Change IGERT
Orono Land Trust
Orono, Town of
Pennsylvania Fish & Boat Commission's Natural Diversity Section
Penobscot Indian Nation
Penobscot River Restoration Trust
Penobscot Valley Audubon Chapter
Swampwalkers Wetland Ecosystem Specialists, Parker River Association, MA
The Nature Conservancy
Topsham, Town of
U.S. Department of Agriculture
U.S. Fish and Wildlife Service
U.S. Fish and Wildlife Service – Craig Brook National Fish Hatchery
U.S. Geological Survey – Biological Resources Discipline
U.S. Geological Survey – Eastern Regional Cooperative Fish and Wildlife Research
U.S. Geological Survey – Maine Cooperative Fish and Wildlife Research Unit
University of California, Merced
University of Guelph
University of Maine
University of Maine – Department of Wildlife, Fisheries, and Conservation Biology
University of Maine – Electrical and Computer Engineering Department (ECE)
University of Maine – Graduate School
University of Maine – Maine Agricultural and Forest Experiment Station
University of Maine – Maine Cooperative Forestry Research Unit
University of Maine – School of Biology and Ecology
University of Maine – School of Marine Sciences
University of Maine – Senator George J. Mitchell Center for Environmental and Watershed Research
University of Maine – Sustainable Solutions Initiative
USDA SARE Grants
West Enfield Fund
Wildlife Management Institute

UNIVERSITY OF MAINE COLLABORATORS

Department of Wildlife, Fisheries, and Conservation Biology

Daniel J. Harrison, *Chair, Professor*
Erik J. Blomberg, *Assistant Professor*
Aram J.K. Calhoun, *Professor*
Krista A. Capps, *Research Assistant Professor*
Stephen M. Coghlan, Jr., *Associate Professor*
Cory Gardner, *Scientific Research Assistant*
Malcolm L. Hunter, Jr., *Professor*
William B. Krohn, *Professor Emeritus*
Sabrina Morano, *Research Associate*
Judith M. Rhymer, *Professor Emeritus*
Frederick A. Servello, *Professor*
Lindsay C.N. Seward, *Instructor*
Jack W. Witham, *Assistant Scientist*
Faren Wolter, *Lecturer*

Department of Anthropology

Samuel P. Hanes, *Assistant Professor*

School of Biology & Ecology

Allison Dibble, *Assistant Research Professor*
Francis A. Drummond, *Professor*
Jacquelyn L. Gill, *Assistant Professor*
Hamish S. Greig, *Assistant Professor*
Rebecca L. Holberton, *Professor*
Michael T. Kinnison, *Professor*
Brian J. McGill, *Assistant Professor*
Brian J. Olsen, *Assistant Professor*
Mary S. Tyler, *Professor*

School of Economics

Kathleen P. Bell, *Associate Professor*
Mario Teisl, Director, *Professor*
Timothy M. Waring, *Assistant Professor*

School of Forest Resources

Alan J. Kimball, *Associate Professor*
Robert J. Lilieholm, *E.L. Giddings Professor of Forest Policy*
Robert S. Seymour, *Curtis Hutchins Professor of Forest Resources*
Erin Simons-Legaard, *Assistant Research Professor*
Alan S. White, *Professor*

School of Marine Sciences

Teresa R. Johnson, *Associate Professor*
Jeffrey A. Runge, *Research Professor*
Gayle B. Zydlewski, *Research Associate Professor*

Department of Mathematics & Statistics

David E. Hiebeler, *Associate Professor*

External Collaborators

Brad Allen, *Wildlife Biologist, Maine Department of Inland Fish and Wildlife*
Michael M. Bailey, *Fish Biologist, U.S. Fish and Wildlife Service*
Kyle Barrett, *Assistant Professor, Clemson University*
Dana M. Bauer, *Assistant Professor, Boston University*
James P. Bogart, *Professor Emeritus, University of Guelph*
Phillip deMaynadier, *Wildlife Biologist, Maine Department of Inland Fisheries and Wildlife*
Angela K. Fuller, *Assistant Professor and Unit Leader, NY Cooperative Fish and Wildlife Research Unit*
Joseph E. Hightower, *Assistant Unit Leader, NC Cooperative Fish and Wildlife Research Unit*
David Irons, *Alaska Seabird Coordinator, U.S. Fish and Wildlife Service*
Walter Jakubas, *Mammal Group Leader, Maine Department of Inland Fisheries and Wildlife*
Michael W. Klemens Ph.D., *Michael W. Klemens, LLC.*
John Kocik, *Maine Task Chief, NOAA - NMFS Maine Field Station*
Daniel G. McAuley, *Station Leader, USGS Patuxent Wildlife Research Center*
Mark McCollough, *Endangered Species Specialist, U.S. Fish and Wildlife Service*
Jerry V. Mead, *Assistant Research Professor, Drexel University*
Dave Owen, *Professor and Associate Dean for Research, University of Maine School of Law*
Donna L. Parrish, *Research Professor and Unit Leader, VT Cooperative Fish and Wildlife Research Unit*
Kelsey Sullivan, *Wildlife Biologist, Maine Department of Inland Fish and Wildlife*
William Sutton, *Adjunct Assistant Professor, University of Tennessee*
Brad Timm, *Postdoctoral Research Association, University of Massachusetts Amherst*
Jennifer H. Vashon, *Wildlife Biologist, Maine Department of Inland Fish and Wildlife*
Andrew R. Whiteley, *Assistant Professor, University of Massachusetts Amherst*
Karen Wilson, *Assistant Research Professor, University of Southern Maine*
Petra B. Wood, *Assistant Unit Leader-Wildlife, WV Cooperative Fish and Wildlife Research Unit*

GRADUATE COMMITTEE LEADERSHIP

Unit scientists served as major advisors for these students during the reporting period.

Loftin	Abdulai Barrie, MS (September 2013 – Present) Shannon Chapin , MS (January 2012 – May 2014) Brianne Du Clos, PhD (September 2012 – Present) Luke Groff, PhD (January 2011 – Present) Jared Homola, PhD (September 2013 – Present) Alyson McKnight, PhD (September 2013 – Present) Brian Rolek, PhD (September 2012 – Present) Nikko Shaidani, MS (September 2012 – Present)
McKinney	John Clare, PhD (September 2013 – Present) Alyson McKnight, PhD (September 2013 – Present) Alyssa Vitale, MS (September 2013 – Present) Connor Wood, MS (September 2013 – Present)
Zydlewski	Abdulai Barrie, MS (September 2013 – Present) Megan Begley, MS (May 2014 – Present) Betsy Irish, PhD (May 2013 – Present) Lisa Izzo, MS (September 2013 – Present) George Maynard, PhD (May 2013 – Present) Andrew O'Malley, MS (May 2012 – Present) Silas Ratten, MS (January 2011 – January 2014) Daniel Stich, PhD (March 2011 – Present) Daniel Weaver, PhD (May 2013 – Present)

RECENT GRADUATES AND CURRENT PURSUITS

Student, Degree, Curriculum Current Pursuits	Graduate Date Advisor(s)
 **Shannon Chapin**, MS, Ecology and Environmental Sciences GIS Analyst, Southern Environmental Law Ctr.	May 2014 Cynthia S. Loftin, Francis A. Drummond
 **Brittany Cline**, PhD, Wildlife Ecology Postdoctoral Research and Teaching Assistant, University of Maine	August 2014 Malcolm L. Hunter, Jr.
 **Rachel Dunham**, Master of Wildlife Conservation	January 2014 Malcolm L. Hunter, Jr.
 **David Mallett**, MS, Wildlife Ecology	May 2014 Daniel J. Harrison
 **Margaret Owens**, Master of Wildlife Conservation Regional Conservation Coordinator, Mass*LIFT*-Americor, MA	June 2014 Malcolm L. Hunter, Jr.
 **Jennifer Raber**, Master of Wildlife Conservation	January 2014 Malcolm L. Hunter, Jr.
 **Silas Ratten**, MS, Wildlife Ecology Ellsworth School System	January 2014 Joseph D. Zydlewski
 **Kevin Ryan**, PhD, Wildlife Ecology FB Environmental Consulting, Portland, ME	May 2014 Aram J.K. Calhoun

CURRENT STUDENTS & POSTDOCS

Student, Degree, Curriculum	Advisor(s)
Abdulai Barrie, MS, Wildlife Ecology	Cynthia S. Loftin, Joseph D. Zydlewski
Megan Begley, MS, Wildlife Ecology	Stephen M. Coghlan, Jr., Joseph D. Zydlewski
Dana Berendt, Master of Wildlife Conservation	Malcolm L. Hunter, Jr.
Erynn Call, PhD, Wildlife Ecology	Malcolm L. Hunter, Jr.
John Clare, PhD, Wildlife Ecology	Shawn T. McKinney
Brittany Cline, Postdoctoral Associate	Malcolm L. Hunter, Jr.
Samantha Davis, MS, Wildlife Ecology	Erik J. Blomberg
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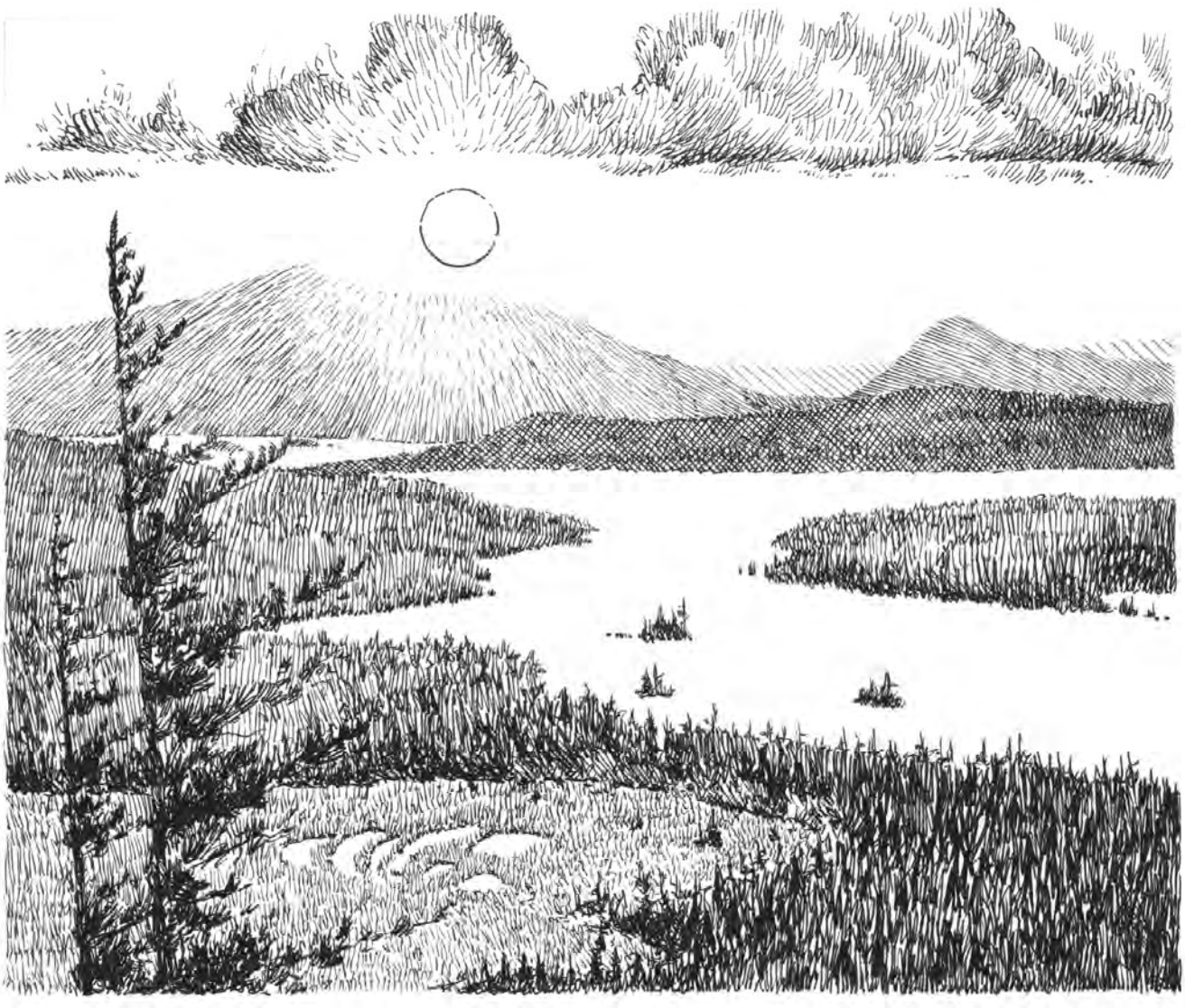
Stephen Dunham, MS, Wildlife Ecology	Daniel J. Harrison
Carly Eakin, PhD, Wildlife Ecology	Aram J.K. Calhoun, Malcolm L. Hunter, Jr.
Luke Groff, PhD, Ecology and Environmental Sciences	Aram J.K. Calhoun, Cynthia S. Loftin
Kristine Hoffmann, PhD, Wildlife Ecology	Aram J.K. Calhoun, Malcolm L. Hunter, Jr.
Jared Homola, PhD, Ecology and Environmental Sciences	Cynthia S. Loftin, Michael T. Kinnison
Betsy Irish, PhD, Wildlife Ecology	Joseph D. Zydlewski
Lisa Izzo, MS, Wildlife Ecology	Joseph D. Zydlewski
Mitchell Jones, PhD, Wildlife Ecology	Aram J.K. Calhoun, Malcolm L. Hunter, Jr.
Vanessa Levesque, PhD, Ecology and Environmental Sciences	Aram J.K. Calhoun, Kathleen P. Bell
Daniel Linden, Postdoctoral Associate	Shawn T. McKinney
Ellie Mangelinckx, MS, Wildlife Ecology	Erik J. Blomberg
George Maynard, PhD, Wildlife Ecology	Joseph D. Zydlewski
Alyson McKnight, PhD, Ecology and Environmental Sciences	Cynthia S. Loftin, Shawn T. McKinney
Allison Moody, Postdoctoral Associate	Cynthia S. Loftin
Ryo Ogawa, Master of Wildlife Conservation	Malcolm L. Hunter, Jr.
Sheryn Olson, MS, Wildlife Ecology	Daniel J. Harrison
Andrew O'Malley, MS, Wildlife Ecology	Joseph D. Zydlewski
Laura Podzikowski, PhD, Wildlife Ecology	Aram J.K. Calhoun, Krista A. Capps
Brian Rolek, PhD, Wildlife Ecology	Cynthia S. Loftin, Daniel J. Harrison
Nikko-Ideen Shaidani, MS, Zoology	Cynthia S. Loftin, Michael T. Kinnison
Daniel Stich, PhD, Wildlife Ecology	Joseph D. Zydlewski
Joel Tebbenkamp, PhD, Wildlife Ecology	Erik J. Blomberg, Daniel J. Harrison
Alyssa Vitale, MS, Wildlife Ecology	Shawn T. McKinney
Jonathan Watson, MS, Wildlife Ecology	Stephen M. Coghlan, Jr.
Daniel Weaver, PhD, Wildlife Ecology	Stephen M. Coghlan, Jr., Joseph D. Zydlewski
Connor Wood, MS, Wildlife Ecology	Shawn T. McKinney

UNIT SUPPORTED RESEARCH

Name, Affiliation	*Unit Advisor(s)*
Catherine Johnston, MS, Marine Biology	Joseph D. Zydlewski
Matthew Altenritter, PhD, Biological Science	Joseph D. Zydlewski



FISHERIES and aquatic

Investigating lake whitefish and Arctic charr reintroductions

1. Characterize lake whitefish movements as they relate to thermal stratification and potential spawning locations.
2. Examine the seasonal movements of reintroduced Arctic charr.
3. Assess lake whitefish growth (annual and seasonal) and spawning within Clear and St. Froid Lakes.
4. Model physical habitat data to identify potential spawning areas for lake whitefish in St. Froid Lake.

Abstract: Artic charr (*Salvelinus alpinus*) and lake whitefish populations located in the contiguous United States lie at the southernmost limit of the species range, and can be found in a select few number of Maine lakes. These populations are under considerable stress for a variety of reasons and some have suffered extirpation. A number of strategies have been utilized to promote and enhance these vulnerable populations including chemical reclamation and stocking practices. It is unknown how these populations of these native fish species will function once reintroduced.

This study assesses the seasonal vertical and thermal habitats of both reintroduced fish species in their respective waters using acoustic telemetry. In addition, I utilized otolith aging and back calculation methods to describe growth of the reintroduced lake whitefish population in relation to a source population.

Arctic charr utilized deep and cold water habitats during daylight hours, during periods of stratification and inhabited shallower warmer waters at night. I discuss the bioenergetic implications of these movement patterns. Lake whitefish demonstrated reduced levels of activity during ice cover (December-March), while fish in the summer months (June-September) fish displayed the highest levels of activity. During periods of thermal stratification fish displayed diel vertical migrations, actively selecting depths and temperatures that may be more energetically profitable. During late season stratification, fish routinely utilized areas of warmer (>15˚C) than optimal temperatures for growth. Arctic charr and lake whitefish seasonal activity and depth use were driven by periods of ice cover during the winter months and thermal stratification during the summer months. To describe growth of a reintroduced lake whitefish population in relation to a source population age at length data were incorporated into a von Bertalanffy growth function and used to model lifetime growth in two lakes; additionally, growth trajectories from individual fish were examined to evaluate length at age variability within and among lake whitefish populations. Ages for lake whitefish from Clear Lake ranged from 8-30 years, and the oldest individuals demonstrate the slowest incremental growth when compared to younger cohorts. Lake whitefish from St. Froid Lake ranged from 2-9 years. Von Bertalanffy models suggest reduced growth in lake whitefish from St. Froid Lake when compared with Clear Lake. Findings suggest complex early life history interactions may limit the scope for growth in reintroduced populations from hatchery stocks.

Investigator: Silas Ratten (MS)

Advisors: Joseph D. Zydlewski (Advisor)
Stephen M. Coghlan, Jr.
Michael T. Kinnison
Gayle B. Zydlewski

Duration: January 2010—December 2013

Cooperators:

Maine Department of Inland Fisheries and Wildlife
U.S. Geological Survey – Maine Cooperative Fish and Wildlife Research Unit

Shortnose sturgeon demographics in the Penobscot River Maine

1. Characterize the movements and demographics of shortnose sturgeon in the Penobscot River.
2. Use microchemical analysis to infer life history and movement patterns in shortnose sturgeon.

Determining individual origins, movements and life histories within complex population networks is important for understanding how such networks function as a whole. In the Gulf of Maine, shortnose sturgeon move extensively among multiple river systems, though successful spawning has only been observed in one, the Kennebec River complex. Efforts have continued to better characterize the complex life history of this species through telemetry, demographics and microchemican analysis.

Sturgeon are captured via gill netting and implanted with acoustic "pingers" and tracked through the entire Penobscot River system using an extensive deployment of stationary receivers. These acoustic receivers are deployed as part of ongoing cooperative work between NOAA-Fisheries, Maine Cooperative Fish and Wildlife Research Unit and the University of Maine. The observed series of detections of an individual fish are used to characterize immigration and emmigration rates to improve population estimates.

Microchemical analysis of hard structures provides a method for inferring life history movements. Dorsal scutes from shortnose sturgeon were used to develop non-lethally sampled hard structure that could be used for chronological analysis.

This work builds on a near decade long effort to characterize the demography and movement patterns of sturgeon in the Gulf of Maine. Data collected during this period are being used to characterize movement between river systems, which, together with demographic data, are being used to model population constraints. This work is anticipated to be completed by 2015. Microchemical analysis on scutes has been completed and is being prepared for publication.

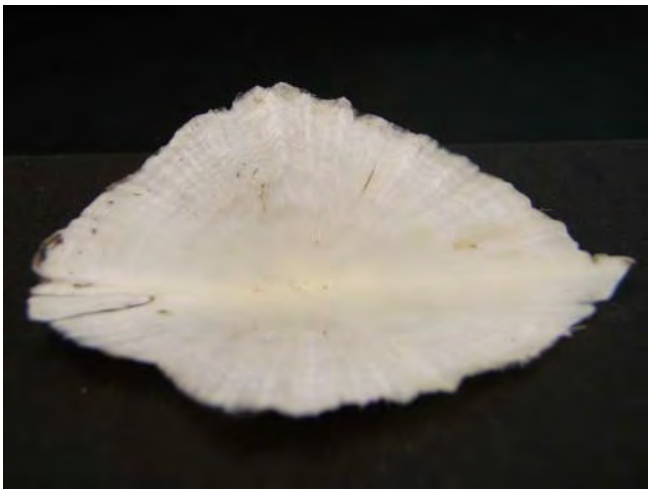
Investigator: Matthew Altenritter (PhD)

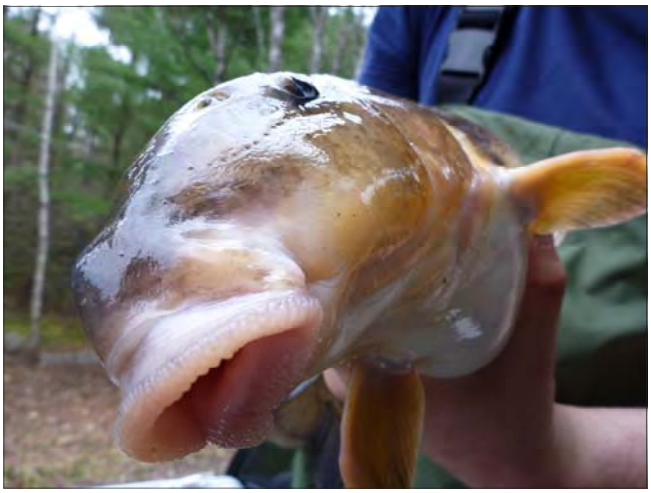
Advisors: Gayle B. Zydlewski (Co-Advisor)
Michael T. Kinnison (Co-Advisor)
Joseph D. Zydlewski

Duration: January 2012—December 2015

Cooperators:

Maine Department of Marine Resources
National Oceanic and Atmospheric Administration
U.S. Geological Survey – Maine Cooperative Fish and Wildlife Research Unit
University of Maine – School of Marine Sciences
University of Maine – School of Biology and Ecology





Understanding the impact of commercial harvest on white sucker (*Catostomus commersonii*) in Maine

1. Compare the demographics of spawning suckers from fished and unfished lakes.
2. Use demographic data to assess sensitivity of suckers to fishing pressure.

The State of Maine issues an unlimited number of commercial permits to harvest white sucker in Maine's inland waters. The fishery provides a necessary source of lobster bait to coastal communities at a time when other bait sources are scarce. The impact of the increasing number of permits and subsequent numbers of fishermen on the white sucker population is unknown. The Maine Department on Inland Fisheries and Wildlife (MDIFW) has closed a number of waters due to concerns that overfishing and/or incidental catch of other fish species may occur. The goal of this project is to determine the impacts of commercial fishing on white sucker populations and review the existing management structure to optimize the population size and commercial white sucker harvest in waters that are open. This information will allow the MDIFW to determine which waters that are currently closed can be reopened to harvest.

Before additional waters can reopen, the department needs to determine the effect of the current commercial fishery on existing populations of white sucker. Specific biological data (age, length, sex, fecundity), catch/harvest information, assessment of existing data, needs to occur to determine which areas are overfished from those area that are not overfished. Currently, harvesters are not required to report the number or weight of the fish they harvest. This information is critical to manage a growing fishery that an increasing number of commercial fishermen are relying on to supply lobster bait and household income.

Beginning in 2014, the three locations chosen for sites open to harvest of suckers while those closed to harvest were then paired by size and depth to provide each harvested lake with a reference. During spawning in the spring, white suckers were captured using traps to target reproducing individuals. Biological data was recorded for each individual fish: total length, fork length, total weight, and sex. Entire gonads and heads were removed as well for otilith extraction (for age and growth estimates) fecundity estimates. These analyses are ongoing.

Investigator: Megan Begley (MS)

Advisors: Stephen M. Coghlan, Jr. (Co-Advisor)
Joseph D. Zydlewski (Co-Advisor)

Duration: January 2012—December 2017

Cooperators:

Maine Department of Inland Fisheries and Wildlife
U.S. Geological Survey – Maine Cooperative Fish and Wildlife Research Unit
University of Maine

Trophic and marine interactions in the St. Croix River, Maine; status of diadromous fishes, connectivity, water quality, and food webs

1. Concurrent with river herring reintroduction actions, provide a synthesis of life cycle, passage and habitat requirements of all sea-run and riverine migratory fish species native to the St. Croix River.
2. Model the food web to better understand conditions in the watershed including the seasonal dynamics of water quality.

The purpose of this study is to determine how the presence of anadromous fishes affects the St. Croix watershed, both in terms of nutrient input and in food web interactions. This will be done through the development of a model of the existing food web including both landlocked and anadromous populations. The food web will be mapped using stable isotope data procured through sampling river, lake, and estuarine sites. Isotopes will include carbon and nitrogen, which typically show distinct signatures when moving from marine to freshwater environments.

The food web description produced by this study will help determine how alewives affect the input and output of nutrients within streams and lakes in the St Croix watershed. The presence of alewives has the potential to directly affect other species in the system, including species of interest such as small mouth bass. As alewives are reintroduced into the St. Croix watershed in large numbers this study will be able to track their effect on nutrient cycling, as well as determine their role in the food web. Samples will be taken in areas where alewives are both spawning and migrating. Sampling will be collected over a period of 5-7 days, and will occur three times annually.

Initial sampling was carried out in the spring and summers of 2013 and 2014 over a wide spatial scale. These samples are currently being prepared for analysis and run for stable isotope ratios. Preliminary data revealed expected trophic associations between fish and invertebrate taxa in the region. A marine "signal" was also clear from migrating alewife in the St. Croix system. In 2014 sampling in a reference system with an intact alewife run was also conducted so that the influence of alewife introduction might be better assessed.

Investigator: Betsy Irish (PhD)

Advisors: Joseph D. Zydlewski (Advisor)

Duration: May 2012—October 2017

Cooperators:

International Joint Commission on the St. Croix Waterway
University of Maine
U.S. Geological Survey – Maine Cooperative Fish and Wildlife Research Unit

Upstream passage of adult Atlantic salmon in the Penobscot River; assessing critical thresholds for restoration

1. Assess delays that might be incurred through the Great Works and Veazie Dam remnants and the Stillwater Branch using radio telemetry and PIT telemetry of Atlantic salmon.
2. Assess approach behavior and passage delays of Atlantic salmon adults approaching Milford Dam using DIDSON sonar.

Returning adult Atlantic salmon will be captured at the Milford trap on the Penobscot River, maintained by the Maine Department of Marine Resources. As part of ongoing work, PIT tags will be implanted and adult Atlantic salmon released into the river following capture. Data will be generated for time of entry at the Milford fishway and time of exit for successful passage. This effort afford significant information as to success rate and speed of transport from the lower river to Milford Dam through the remnants of Veazie and Great Works Dams. In addition, gastric inserted radio tags will be used to track the movements of adult salmon. Up to 50 fish annually will be tagged. No more than 10 fish will be tagged weekly so that variability of conditions associated with flow levels might be captured.

At the Milford lift, a DIDSON imaging system will be used to view the behavior of adult Atlantic salmon approaching the structure. The DIDSON will be placed at or near the entry way of the fish lift so as to avoid turbulence. Behaviors will be identified to assess approaches (being attracted to the vicinity of the entry), attempts (unsuccessful movement into the fishway), entry, and reversal (leaving the lift after entry). These data will be assessed in conjunction with "known arrivals" of tagged salmon using PIT and Radio telemetry.

Access to fish for use in this study were limited in 2014 due to the low run return, but telemetry data on tagged fish provided clear information that the two remnant dams provided no impediment to upstream migration of Atlantic salmon. Under some flow conditions, the Stillwater branch was associated with delays in mainstem progress. Significant delays in passage occurred at Milford Dam. Work using the DIDSON in the Milford fishway was hampered by persistent entrainment of air that obscured viewing ability. Effort to reduce entrainment in 2015 are anticipated to improve progress for this objective.

Investigator: Lisa Izzo (MS)

Advisors: Joseph D. Zydlewski (Advisor)
Joseph E. Hightower
Gayle Zydlewski

Duration: May 2012—December 2016

Cooperators:

Maine Department of Marine Resources
U.S. Fish and Wildlife Service
U.S. Geological Survey – Maine Cooperative Fish and Wildlife Research Unit
National Oceanic and Atmospheric Administration
The Nature Conservancy

Shortnose sturgeon movements and habitat use in the Penobscot River Maine

1. Assess the movements and habitat use of shortnose sturgeon after dam removal in the Penobscot River.
2. Monitor for sturgeon spawning activity in the Penobscot River.

The habitat use of shortnose sturgeon in the Penobscot River is poorly characterized, but telemetry efforts and habitat assessments are being used to understand the seasonal use of this river. The recent removal of the two lower most dams on the river has opened up access to this species' entire historic range. This access is important as previous research has been unable to document spawning in the Penobscot River prior to dam removal, rather fish are thought to travel to the Kennebec River to spawn. It is possible that the increase in habitat access will allow these fish to spawn in the Penobscot River if river habitat accessibility was a biological constraint.

Sturgeon are captured via gill netting and implanted with acoustic "pingers" are tracked through the entire Penobscot River system using an extensive deployment of stationary receivers. These acoustic receivers are deployed as part of ongoing cooperative work between NOAA-Fisheries, Maine Cooperative Fish and Wildlife Research Unit and the University of Maine. Extensive habitat surveys are being conducted in the lower river by foot and by boat. Monitoring for sturgeon spawning activity in the river will continue using egg mats and D-nets to capture eggs or young.

Habitat assessment was initiated in July 2014 to determine the quality of potential spawning habitat for sturgeon in areas upstream of the recently removed dams. Pebble counts were conducted along the east and west shores of the river between the Veazie Dam removal site and Ayer's Rips. These assessments will be used to generate information on grain size distribution along the shore to illuminate spawning habitat suitability. Pebble counts were performed in uniform intervals (approximately every 450 m) along the shore with additional counts performed at intermediate distances within the intervals when possible. Qualitative descriptions of the substrate features of each area were described and underwater video was collected to further explore the substrate type.

Investigator: Catherine Johnston (PhD)

Advisors: Gayle B. Zydlewski (Advisor)
Michael T. Kinnison
Joseph D. Zydlewski

Duration: January 2012—December 2015

Cooperators:

Maine Department of Marine Resources
U.S. Geological Survey – Maine Cooperative Fish and Wildlife Research Unit
National Oceanic and Atmospheric Administration
Penobscot River Restoration Trust
University of Maine – School of Marine Sciences
University of Maine – School of Biology and Ecology

PIT tag monitoring of migrating anadromous fish in the Penobscot River, Maine

1. Determine the rate, timing and efficiency of upstream passage of Atlantic salmon, American shad and alewife through major dams in Penobscot River.
2. Provide near real time information to cooperating agencies as to the effects of fishway operation on migratory success.
3. Provide a quantitative assessment of the effect of dam removal on the migratory success of migratory fish in the Penobscot River.

The Penobscot River watershed is Maine's largest and hosts a number of anadromous species including the largest remaining run of Atlantic salmon in the USA. For many species, however, the majority of high quality spawning and rearing habitats are located upstream of lower river dams. By the fall of 2013, the two most downstream dams have been removed as part of the Penobscot River Restoration Project (PRRP). Ultimately, benefits of dam removal for Atlantic salmon and other species will depend on the degree and fashion by which remaining dams facilitate fish passage success. In order to assess migratory success, we are using passive integrated transponders (PIT tags) to remotely track fish through nine major dams in the lower Penobscot River. Beginning in 2013, PIT tagging of fish will occur at the lower most dam (Milford) requiring an antenna installation at the new fishway in coordination with Maine Department of Marine Resources. This work will incorporate and build on recent research that demonstrated migratory behavior and passage efficiency of Atlantic salmon in the Penobscot River. The long term scope of this project is to monitor the effects of the PRRP with respect to Atlantic salmon in accordance with the State Operational Plan for the Restoration of Anadromous Fishes to the Penobscot River. This study will require coordination with USGS, NOAA, DMR, the Penobscot River Restoration Trust (PRRT), the Penobscot Indian Nation, USFWS, and the various dam operators.

The project was initiated September 2009 and has included a M.S. student and a post-doctoral associate over the years. By spring of 2010, PIT arrays were installed at all targeted lower mainstem dams and preliminary passage data were collected from more than 1000 tagged fish. By spring of 2011 eight sites were fully functional and were maintained through the 2011 adult salmon season. Coordination with Department of Marine Resources allowed the successful tagging and tracking of 2429 adult Atlantic salmon in 2011. Efforts were continued in 2012 and priorities will shift to data analysis and "near real time" coordination with management agencies for the optimization of fish passage. A Ph.D. student began this work in spring of 2013 and low Atlantic salmon returns have necessitated a shift in focus to other species.

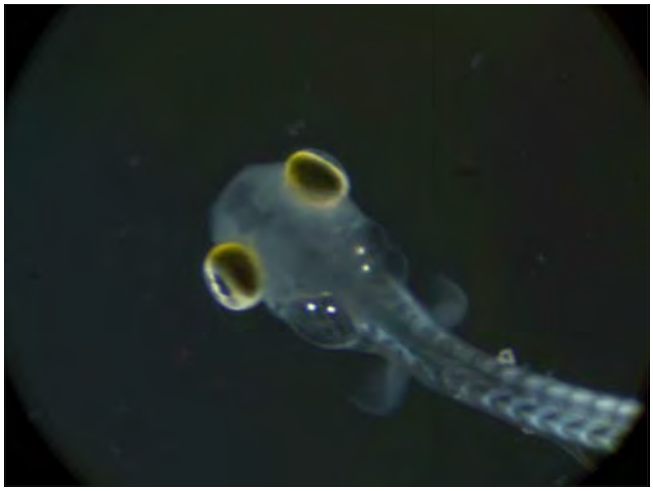
Investigator: George Maynard (PhD)

Advisors: Joseph D. Zydlewski (Advisor)
Erik Blomberg
Michael Kinneson
Joan Trial
Gayle Zydlewski

Duration: September 2009—October 2017

Cooperators:

American Recovery and Reinvestment Act (ARRA)
Maine Department of Marine Resources
U.S. Geological Survey – Maine Cooperative Fish and Wildlife Research Unit
National Oceanic and Atmospheric Administration
Penobscot River Restoration Trust
U.S. Fish and Wildlife Service – Craig Brook National Fish Hatchery



Rainbow smelt enhancement as a fisheries management tool

1. Develop a technique to effectively mark larval smelt to distinguish them from wild smelt by comparing three different marking techniques, and the persistence of the marks over two years.
2. Estimate the survival and growth of stocked rainbow smelt fry into Maine lakes. This data will inform a population model.
3. Survey the existing fish and plankton community in the water bodies stocked for the study.

Landlocked rainbow smelt are a common fish in lakes in Maine. They are a coldwater fish that generally grow to 10-20 cm in length. They are important both for consumption by people, and as a food source for other game fish. They are currently known to inhabit 558 lakes, across all regions of the state, from York to Aroostook counties. Most of these populations were not naturally occurring, but a result of both private and state stockings. The landlocked salmon, is one of Maine's most popular sport fish, and draws many anglers from out of state. Smelt are the primary forage for landlocked salmon and fluctuations in population levels influence the size and health of landlocked salmon.

There is substantial benefit to anglers and local businesses to maintain a strong smelt population, and thus a strong landlocked salmon fishery. In attempts to boost salmon fisheries that have declined due to low smelt populations, many thousands of smelt fry have been stocked in Moosehead and East Grand Lakes. Thousands of dollars were spend in these efforts but there has been no clear answer to the efficacy of these efforts. There has been some indication that smelt numbers have increased, but there was no way to distinguish stocked fish from wild ones to validate that stocking worked. We are using a quantitative approach in investigating what contribution these stocked smelt will make to population in a lake, as well as what impacts they might have on the lake community.

We are marking smelt embryos before hatching with three different techniques using the otoliths (ear bones) of these fish. This will be useful in future stocking efforts and provide a reference data set for the effectiveness of mark detection. Additionally, we are stocking smelt in lakes and then sampling to estimate the survival and contribution to the population of the stocked fish.

Trawl sampling was carried out in the spring and summer of 2013 and 2014 in lakes stocked with smelt fry. Intensive efforts to recapture these fish have been employed with variable results among systems, time of day and depth. Samples from stocked lakes are being sorted and will provide information as to post stocking survival. The analysis of these samples is expected to be completed by October of 2015.

Investigator: Andrew O'Malley (MS)

Advisors: Joseph D. Zydlewski (Advisor)
Stephen M. Coghlan, Jr.
Donna L. Parrish

Duration: May 2012—October 2015

Cooperators:

Maine Department of Inland Fisheries and Wildlife
Maine Outdoor Heritage Fund

Passage of anadromous fish at mainstem dams on the Penobscot River, Maine

1. Model the survival of wild- and hatchery-origin Atlantic salmon smolts through the Penobscot River and Estuary.
2. Assess movement patterns and rates of migration for Atlantic salmon smolts through the Penobscot River.
3. Characterize patch choice and survival of Atlantic salmon smolts at Milford Dam on the Penobscot River.
4. Characterize the development of seawater tolerance and behavioral preference for seawater of Atlantic salmon smolts.

This project will draw upon a growing body of telemetry data reaching back to work begun in 2005 and continued through to present. Targeted releases of Atlantic salmon smolts implanted with acoustic "pingers" are tracked through the entire Penobscot River system using an extensive deployment of stationary receivers. These acoustic receivers are deployed as part of ongoing cooperative work between NOAA-Fisheries, Maine Cooperative Fish and Wildlife Research Unit and the University of Maine. The observed series of detections of an individual fish are used to construct a model of survival through the River system. Such a model allows the assessment of areas of high mortality, such as dams. Beginning in 2010, greater emphasis has been placed on movements near Milford Dam, a known site of high mortality, using radio telemetry. We will continue tagging wild and hatchery-origin Atlantic salmon smolts from the Penobscot River through this periods of study. Beginning 2013, a series of laboratory experiments will be conducted using direct seawater transfer (to assess seawater tolerance) and seawater preference (using a novel selection apparatus). Data from these experiments will be used to inform the interpretation of movement patterns of Atlantic salmon smolt migration through the Penobscot River estuary.

Acoustic telemetry data have been collected since 2005 for hatchery-origin and 2006 for wild origin Atlantic salmon smolts to assess movement and survival through the Penobscot River and Estuary. These data have been used to estimate survival of Atlantic salmon smolts throughout the system and are routinely used by agencies associated with the management of this federally endangered species. The use of radio telemetry was successfully initiated in 2010 and continued in 2012 to refine estimates of survival and path choice in smolts past Milford Dam in the Penobscot River. These data have been used to model smolt survival in this segment of the River and a manuscript has been submitted for publication. Physiological experiment were initiated in 2013 and will continue into 2014.

Investigator: Daniel Stich (PhD)

Advisors: Joseph D. Zydlewski (Advisor)
Michael M. Bailey
Michael T. Kinnison
John Kocik
Gayle B. Zydlewski

Duration: January 2006—January 2016

Cooperators:

American Recovery and Reinvestment Act (ARRA)
Maine Department of Marine Resources
U.S. Geological Survey – Maine Cooperative Fish and Wildlife Research Unit
National Oceanic and Atmospheric Administration
University of Maine – Department of Wildlife, Fisheries, and Conservation Biology
University of Maine – Graduate School
National Fish and Wildlife Foundation
Penobscot River Restoration Trust
West Enfield Fund
Penobscot Indian Nation

Ecological importance of anadromous Sea Lamprey and juvenile distribution in the Penobscot Watershed

1. Quantify the spatial and temporal effects of marine-derived nutrients from Sea Lamprey carcasses
2. Compare autotrophic and heterotrophic nutrient response pathways from Sea Lamprey
3. Characterize the spatial heterogeneity of juveniles (ammocoetes)
4. Develop a model that predicts nutrient responses in freshwater streams

Historically, many freshwater systems were linked to the marine environment by spawning migrations of adult anadromous fishes and subsequent seaward migration of juveniles. These fish were important vectors of marine-derived nutrients that fertilized otherwise oligotrophic freshwater systems until populations declined due to widespread damming, habitat loss, and overharvest. Stream food web structure and function may be dependent upon this influx of carbon, nitrogen, and phosphourus into these systems. In Maine, recent dam removal projects are designed to rehabilitate anadromous fish populations and their habitats. These large-scale management actions may benefit from a thorough understanding of how ecosystems respond to the loss and then to the eventual reestablishment of these fishes. Literature documenting the effects of Pacific salmonines Oncorhynchus spp. in deriving nutrient and energy flows among freshwater and marine systems is replete; however, the effects of Sea Lamprey in Atlantic coast streams are not well understood. This research will quantify Sea Lamprey nutrient subsidies, evaluate their role in freshwater systems, and "close the loop" on adult-juvenile nutrient exchange. We hypothesize that nutrient subsidies from Sea Lamprey may arrive at a critical seasonal period that serves to alleviate primary productivity limitations and benefit stream food webs.

We quantified Sea Lamprey decomposition rates and corresponding water enriching effects in a controlled laboratory experiment. Carcass decay resulted in rapid liberation of phosphorus (1 week) and nitrogen (3 weeks) and patterns of liberation were accelerated at higher temperatures. We examined the effects of Sea Lamprey Petromyzon marinus carcass addition on Sedgeunkedunk Stream, a 3rd – order tributary to the Penobscot River. We measured chlorophyll a biomass downstream and upstream of carcass addition using four treatments of nutrient diffusing substrata: control, nitrogen addition, phosphorous addition, and nitrogen + phosphorous combined. We observed chlorophyll a biomass increase 57 – 71% in response to carcass additions, alleviating stream nitrogen limitations. Ongoing work will continue to quantify autotrophic and heterotrophic responses to Sea Lamprey carcasses and characterize the distribution of juvenile Sea Lamprey (ammocoetes) in the Penobscot Watershed.

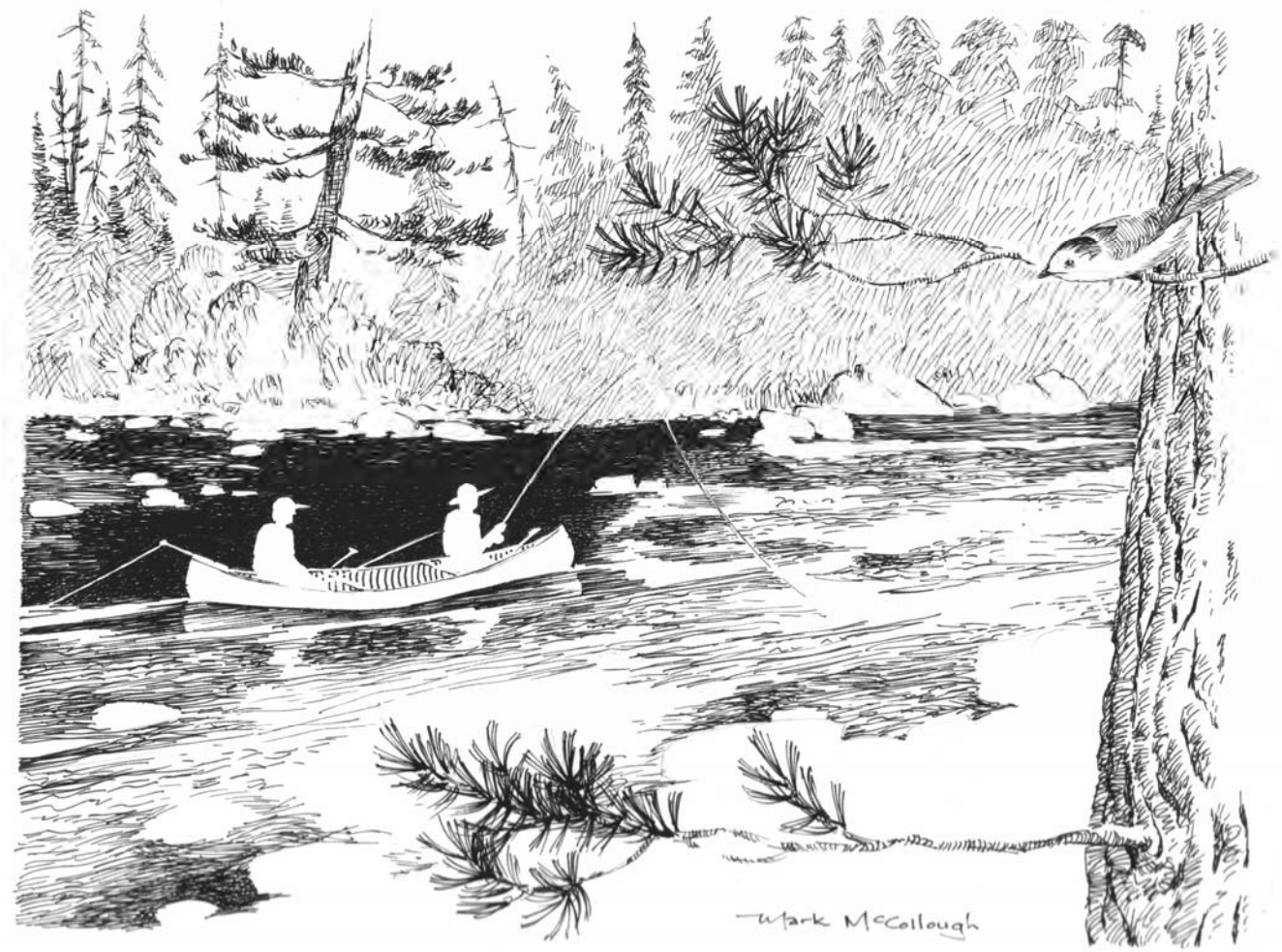
Investigator: Daniel Weaver (PhD)

Advisors: Stephen M. Coghlan, Jr. (Co-Advisor)
Joseph D. Zydlewski (Co-Advisor)
Hamish S. Grieg
Michael T. Kinnison
Jerry V. Mead

Duration: May 2013—May 2017

Cooperators:

Maine Sea Grant
Atlantic Salmon Federation
Maine Audubon Society
Maine Department of Inland Fisheries and Wildlife
Maine Department of Marine Resources
University of Maine – Department of Wildlife, Fisheries, and Conservation Biology
U.S. Geological Survey – Maine Cooperative Fish and Wildlife Research Unit
Penobscot Valley Audubon Chapter
National Oceanic and Atmospheric Administration
The Nature Conservancy


Mark McCollough

WILDLIFE and habitats

WILDLIFE and habitats continued

Effects of landscape composition and pattern on native bee assemblages in wild and cultivated fruit crops in the Northeast

1. Assess the suitability of the InVEST pollinator model for studying relationships between landscape composition and pattern on Maine's wild blueberry pollinators.

Abstract: Non-native honeybees historically have been used to pollinate many crops throughout the United States, however, recent population declines have revealed the need for a more sustainable pollination plan. Native bees are a natural resource that can play an important role in pollination. I used spatial modeling tools to evaluate relationships between landscape factors and native bee abundance, with a focus on the wild native bees that pollinate Maine's lowbush blueberries. I applied the InVEST Crop Pollination ecosystem spatial modeling tool, which predicts pollinator abundance based on available floral resources and nesting habitat, to the Downeast Maine region. The InVEST model is a generic tool that can be adapted to any landscape with development of location specific parameters and a validation dataset. I surveyed botanists, entomologists and ecologists who are experts in native bee ecology and familiar with Maine's landscape, and asked them to rank the suitability of landcover types as native bee habitat. I used previously collected bee abundance data to validate model assumptions. I evaluated the sensitivity and explanatory power of the InVEST model with four model parameterization methods: 1) suitability values assigned through the expert survey; 2) suitability values developed through a sensitivity analysis; 3) informed suitability values developed through an optimization based on the sensitivity analysis; and, 4) uninformed suitability values developed through machine-learning simulated annealing optimization. I evaluated the improvement in prediction gained from expert-informed and optimization-informed parameterization compared with prediction based on the relationship between proportion of landcover surrounding blueberry fields and native bee abundance as an alternative to the InVEST model. The InVEST model parameterized through expert opinion predicted native been abundance ($r = 0.315$; $P = 0.047$), whereas, the uninformed optimization improved model performance by 28% ($r = 0.404$; $P = 0.010$), and the informed optimization technique improved model performance by 58% ($r = 0.486$; $P = 0.002$). The landcover analysis found a significant relationship between the proportion of deciduous/mixed forest within a 2000 meter buffer around a field and native bee abundance within the field ($r = 0.446$; $P = 0.004$). Although the InVEST model reliably predicts bee abundance across a landscape, simpler models quantifying relationships between bee abundance and proportional land cover around focal fields may be suitable alternatives to the InVEST simulation model.

Investigators: Shannon Chapin (MS)

Advisors: Cynthia S. Loftin (Co-Advisor)
Francis A. Drummond (Co-Advisor)
Brian J. McGill

Duration: January 2012—May 2014

Cooperators:

U.S. Geological Survey – Maine Cooperative Fish and Wildlife Research Unit
University of Maine
U.S. Department of Agriculture


Amphibians in complex landscapes: Quantifying habitat connectivity and permeability of juvenile movements and dispersal

1. Quantify differences in habitat permeability of open-canopy habitats (forest clear-cuts, lawns, hayfields, row crops) to juvenile wood frogs during post-metamorphic dispersal period.
2. Develop a miniaturized harmonic direction finding (HDF) system for direct tracking of individual amphibians, with applications for other small-bodied organisms or commercialization of the technology.
3. Assess effects of heavy partial harvest systems on dispersing and overwintering juveniles.
4. Assess effects of landscape composition on dispersing and overwintering juveniles – using a combination of direct-tracking and field/laboratory trials to quantify movement, microhabitat selection and terrestrial settling patterns (aspects of amphibian terrestrial ecology heretofore limited by transmitter lifespan).
5. Quantify individual amphibian movement parameters for building and validating an individual-based behavioral model of dispersal.

Abstract: Maintaining amphibian populations in fragmented landscapes depends on preserving functional connectivity for animals that need to transit multiple vegetation types to satisfy habitat requirements. For many pool-breeding amphibians, successful dispersal is essential for gene flow; thus, quantifying the ability of juveniles to locate and reach suitable habitat in the terrestrial matrix is necessary to predict the consequences of landscape configuration for populations. I evaluated if different open-canopy vegetation types alter the behavior of juvenile wood frogs (*Lithobates sylvaticus*). First, I quantified the relative permeability of different open-vegetation types by experimentally releasing frogs in 35 x 3 m enclosures extending from forest edge into five treatments. Based on an index that compounds four metrics and scales relative to mature forest, permeability varied: Row crop<hayfield<clearcut< open lawn<moderate-cover lawn. Results indicated that juveniles may make forays into the open, assess habitat, and change directionality. Second, I tested juvenile orientation at silvicultural edges in heavy partial harvests (31-60% retention). Overall, a slightly greater, statistically insignificant, percentage of individuals entered control; harvester trails running perpendicular to the edge of uncut forest may represent a partial filter to movements. Finally, I quantified the fine-scale movements of individuals released on five substrates (asphalt, corn, forest leaf litter, hay, lawn), and the directionality of frogs released at different distances from forest using fluorescent-powder tracking. Movement performance differed: frogs demonstrated straighter paths, and greater net movements, path lengths and velocities through treatments with lower structural complexity. Frogs exhibited directionality toward forest in asphalt, lawn, and corn, indicating that differing characteristics of the non-forest matrix may influence the ability of frogs to traverse open cover and orient toward forest from distances of 40-55m. Differences in the willingness of animals to enter treatments, coupled with motility and residency times, support the differing roles of open-canopy vegetation as filters and conduits to movement. Thus, it may be overly simplistic to estimate matrix permeability as uniformly low in models that predict movement in fragmented landscapes. To promote functional connectivity, modification of vegetation composition and configuration may provide an underutilized tool for conservation practitioners to reduce the effective isolation of habitat patches for post-metamorphic amphibians.

Investigator: Britt B. Cline (PhD)

Advisors: Malcolm L. Hunter, Jr. (Advisor)
Aram J.K. Calhoun
David E. Hiebeler
Robert S. Seymour
Joseph D. Zydlewski

Duration: January 2010—June 2014

Cooperators:

National Science Foundation – Experimental Program to Stimulate Competitive Research
University of Maine – Department of Wildlife, Fisheries, and Conservation Biology
University of Maine – Sustainable Solutions Initiative
Maine Association of Wetland Scientists
Massachusetts Institute of Technology (MIT) Lincoln Laboratory
University of Maine – Electrical and Computer Engineering Department (ECE)
University of Maine – Senator George J. Mitchell Center for Environmental and Watershed Research
National Science Foundation – REU Program in Sensor Science and Engineering

Spatial responses of Canada lynx to changing hare densities

1. To understand the effects of vegetation type, topography, and season on accuracy and success of GPS fixes of radio-collared lynx.
2. To evaluate how changing hare densities affect spatial requirements and extent of spatial overlap among adjacent resident lynx.
3. To determine whether landscape-and stand-scale habitat choices by resident lynx change from periods of high vs. low hare densities.

Abstract: Previous studies of Canada lynx (*Lynx canadensis*) within the northern boreal forest region have documented that lynx respond spatially to a decline in snowshoe hare (*Lepus americanus*) density, as exhibited by expansion of territories and changes in social structure. I compared home range area and spatial overlap in the southeastern portion of their geographic range during periods of relatively high and relatively low hare density. Home range areas of lynx did not change between periods of high and low hare density, except that home ranges of females during the denning season expanded during the low period. The presence of kittens constrained home range areas of reproductive females during denning because females were attending kittens. Intra- and intersexual overlap did not change as hare density declined, with the exception of a decrease in overlap between females. This decrease was likely caused by decreased reproduction during the low period, which reduced potential for territorial overlap among mothers and daughters. Hare density during the nadir of cycles in more northerly populations can reach levels nearly a magnitude lower than reported for Maine during my study. This may have prevented breakdowns in territories and changes in social structure by lynx, which may have shifted life history strategies towards territorial maintenance and reduced reproduction as hare densities declined.

I also investigated changes in use of high-quality hare habitat (HQHH) at the landscape scale, and habitat selection of HQHH within home ranges of lynx between periods of high and low hare density. Lynx did not change their extent of use of HQHH at the landscape scale, suggesting lynx had adequate amounts of HQHH within their home ranges to encounter hares during both the high and low periods of hare density. Lynx exhibited stand-scale selection for HQHH during both hare density periods, but the intensity of female selection for HQHH declined as hare density declined. This suggests that lynx continued to remain focused on foraging for hares during both periods, but that females may become more generalized in habitat and prey selection during the period of lower hare density.

Lynx monitored during this study wore GPS collars during a period of low hare density and VHF collars during a period of high hare density. This presented methodological challenges when I compared lynx responses between hare density periods. Errors associated with VHF collars were known for this study, but errors associated with GPS collars were not. Failed fix attempts and location inaccuracy caused by environmental and satellite configurations can bias habitat selection and spatial analyses. I evaluated fix success and location error of GPS collars in 7 habitat classes during 2 seasons in northern Maine. I also used an information-theoretic modeling approach to investigate covariates influencing fix success and location error. Canopy cover had the greatest influence on fix success and the configuration of available satellites had the greatest influence on location error. Results were used to compensate for habitat bias and location error caused by GPS collars worn by lynx during a period of low hare density.

Investigator: David Mallett (MS)

Advisors: Daniel J. Harrison (Co-Advisor)
Angela K. Fuller (Co-Advisor)
Robert S. Seymour
Jennifer H. Vashon (ex-officio)

Duration: May 2008—May 2014

Cooperators:

University of Maine – Department of Wildlife, Fisheries, and Conservation Biology
University of Maine – Maine Agricultural and Forest Experiment Station
U.S. Geological Survey – Maine Cooperative Fish and Wildlife Research Unit
U.S. Fish and Wildlife Service
Maine Department of Inland Fisheries and Wildlife
University of Maine – Maine Cooperative Forestry Research Unit

Movement patterns, terrestrial habitat use, and conservation of New England's rarest amphibians: The eastern spadefoot (*scaphiopus holbrookii*) and blue-spotted salamander (*ambystoma laterale*)

The objectives of the study are to collect information on:

1. breeding population size,
2. breeding philopatry,
3. movement patterns of adults/juveniles to and from breeding wetlands (immigration and emigration orientation),
4. juvenile recruitment,
5. juvenile and adult dispersal rates,
6. non-breeding habitat use and home range size,
7. burrowing ecology (eastern spadefoot), and
8. larval interactions (blue-spotted salamander and spotted salamanders [*A. maculatum*]).

Abstract: Pure-diploid Blue-spotted Salamanders (*Ambystoma laterale*) are the smallest members of the family Ambystomatidae which makes tracking with radio-transmitters difficult because of small battery capacity. Passive integrated transponder (PIT) tags provide another tracking approach for small fossorial animals such as salamanders. We evaluated the use of portable PIT tag readers (PIT packs) to detect PIT tag-implanted pure-diploid Blue-spotted Salamanders in situ. We also examined the detection probability of salamanders with PIT tags held in enclosures in wetland and terrestrial habitats, as well as the underground detection range of PIT packs by scanning for buried tags not implanted into salamanders. Of the 532 PIT tagged salamanders, 6.84% were detected at least once during scanning surveys. We scanned systematically within a 13.37 ha area surrounding a salamander breeding pool on 34 occasions (~119 hours of survey time) and detected PIT tags 74 times. Fifty-five percent were detected in tagged salamanders and 45% were expelled tags. We were able to reliably detect buried PIT tags from 1–22 cm below the ground surface. Because nearly half the locations represented expelled tags, our data suggest this technique is inappropriate for future studies of pure-diploid Blue-spotted Salamanders, although it may be suitable for polyploid Blue-spotted Salamanders and other ambystomatid species which are larger in size and may exhibit higher tag retention rates. It may also be prudent to conduct long-term tag retention studies in captivity before tagging and releasing salamanders for in situ study, and to double-mark individuals.

Investigator: Kevin J. Ryan (PhD)

Advisors: Aram J.K. Calhoun (Advisor)
Michael W. Klemens
Joseph D. Zydlewski
Brad Timm
Malcolm L. Hunter, Jr.

Duration: January 2008—May 2014

Cooperators:

University of Maine – Department of Wildlife, Fisheries, and Conservation Biology
University of Maine – Sustainable Solutions Initiative
Connecticut Department of Energy and Environmental Protection
Lowe's Home Centers, Inc.

River restoration in the northeast: Implications for avian assemblages

1. Develop a citizen science monitoring framework that will assess the response of River Bird Assemblage RBA to dam removal.
2. Characterize RBA prior to dam removal.
3. Examine pre-dam removal Osprey nest distribution and nest success as a baseline for measuring response to fish restoration.
4. Investigate the relationship between habitat and RBA.
5. Evaluate the relative importance of marine and freshwater prey to bald eagle, osprey, belted kingfisher, and tree swallow using analysis of marine derived nutrients.

Understanding the feeding and habitat relationships of various species is a key to unraveling ecosystem function and thus is critically important in discerning responses to human impacts. Most research within river systems identifies fish as the top predators and focuses at this or lower levels in the food web. However, many bird species also rely on the river system and can be linked to the river food web as omnivores, insectivores, and piscivores. Their importance in riverine ecosystems is often overlooked. This study examines community dynamics of riverine birds and their interactions with dams and river habitat variation.

The ultimate goal of the study is to quantify how river associated bird assemblages respond to various habitat conditions that are likely to be impacted by dam removal and the subsequent restoration of spawning diadramous fishes. It is reasonable to assume that dam removal will alter some of these river variables and thus affect bird assemblages in both the short and long-term.

The phase 1 river bird monitoring framework was initiated in the spring of 2009 with a network of 45 volunteers along the Penobscot and other Maine rivers. The first 4 years (5/09 – 3/13) documented pre-dam removal conditions (Great Works - 2012, Veazie - 2013) and provided context for subsequent river bird monitoring. Analysis of the survey and habitat data is underway. Phase 2 protocol (4/13 – present) facilitates quality data collection with less effort to encourage continued monitoring. In several years, a third phase will document how the Penobscot River system responded and investigate other river bird-habitat questions. Funding was awarded by the Maine Outdoor Heritage Fund (MOHF) to assess baseline, pre-dam removal osprey nest distribution and brood size and the relative importance of marine nutrients in the diet of representative river bird species.

Investigator: Erynn M. Call (PhD)

Advisors: Malcolm L. Hunter, Jr. (Advisor)
Cynthia S. Loftin
Brian J. Olsen
Karen Wilson
Joseph D. Zydlewski

Duration: April 2009—May 2015

Cooperators:

Eastern Maine Conservation Initiative
Maine Department of Inland Fisheries and Wildlife
Biodiversity Research Institute
Maine Audubon Society
Maine River Bird Volunteer Network
Maine Outdoor Heritage Fund
The Nature Conservancy
Penobscot River Restoration Trust
University of Maine – Sustainable Solutions Initiative
University of Maine – Department of Wildlife, Fisheries, and Conservation Biology
National Oceanic and Atmospheric Administration

American marten in Maine: Understanding spatial population dynamics and evaluating monitoring methods

1. Compare remote cameras and hair-snares as sampling methods for estimating marten occurrence and density.
2. Evaluate the power and precision of different combinations of sampling methods and analyses to detect population trend.
3. Develop optimal sampling design for future monitoring with consideration for cost and effort constraints.
4. Construct spatially-explicit predictive models of marten population parameters in relation to exploitation and habitat composition.
5. Determine the relative sensitivity of marten population size to changes in the underlying mechanistic components (recruitment, adult survival, immigration and emigration).

American marten are valued in Maine for commercial and conservation purposes. Changes in forest management over previous decades have led to reductions in suitable habitat for the species, and climate change poses a major risk to the its long-term viability within the state. Accordingly, Maine's Department of Inland Fisheries and Wildlife (IFW) seeks to enhance current monitoring efforts in order to more accurately gauge population trends. We will weigh different combinations of sampling scheme, methodology, and subsequent metrics in order to indentify monitoring designs that are both robust and cost-effective.

Focusing our survey efforts in northcentral Maine, we will also investigate how marten vital rates respond to different environmental and anthropocentric influence, and in turn, how influential specific vital rates are upon population size and stability. This information may be critical for evaluating the potential of varied management actions for manipulating population trend, and understanding how forest condition and configuration influences martens at a population-level scale more aligned with the scale of forest management.

A brief pilot season was conducted in late winter 2014 to both evaluate the ability to identify individual martens based upon photographs, and assess joint camera/hair-snare detection stations. Work in the summer and fall of 2014 has focused on optimizing detection station design, and the first full season will be initiated in January 2015.

Investigator: John Clare (PhD)

Advisors: Shawn T. McKinney (Advisor)
Walter Jakubas
Erin Simons-Legaard
Erik J. Blomberg
Daniel W. Linden
Michael T. Kinnison

Duration: September 2013—May 2018

Cooperators:

Maine Department of Inland Fisheries and Wildlife
U.S. Geological Survey – Maine Cooperative Fish and Wildlife Research Unit
University of Maine – Department of Wildlife, Fisheries, and Conservation Biology

Understanding population dynamics of ruffed grouse inhabiting multiple use forest landscapes to inform habitat and harvest management

1. Inform state harvest management decisions and improve management practices by evaluating seasonal variation in ruffed grouse survival and rates of harvest.
2. Explore mechanisms that contribute to variation in harvest risk among individuals, such as age, sex, and proximity to roads and trails.
3. Quantify characteristics of ruffed grouse natural history in Maine forests, and compare with results of similar studies conducted in other portions of the species' range.
4. Contribute to the broader understanding of forest management effects on wildlife populations by examining variation in ruffed grouse demographic rates as a function of forest structure, composition, landscape characteristics, and forest management practices.
5. Explore similar lines of research on other forest wildlife species, or on ruffed grouse in other geographic locations, to compliment ongoing work on Maine ruffed grouse. Conduct this work as additional external funding becomes available.

Ruffed grouse are a native Maine bird, and are arguably the most popular small game animal in the state. We are using a combination of banding and radio-telemetry to monitor demographics (survival and reproductive success) of ruffed grouse at two studies areas in Maine. Our objectives are to quantify seasonal survival, harvest rates, and to evaluate the effects of habitat composition on ruffed grouse nest success and chick survival in areas with differing forest land uses. Ruffed grouse are captured during the late summer using cloverleaf interception traps, and birds are fitted with very high frequency (VHF) radio collars that include mortality sensors so that marked birds may be monitored remotely for survival. Additionally, birds are fitted with aluminum leg bands stamped with relevant contact information to allow for hunter reporting of shot grouse. Radio signals are checked regularly to establish live/dead status, and all mortalities are investigated and cause of death determined. During the breeding season we will quantify characteristics of reproduction, such as clutch size, nest success, and brood productivity, and will evaluate the effects of habitat characteristics (e.g. stem density, understory coverage, species composition) on reproductive output. This work seeks to inform ruffed grouse management and improve our ability to conserve the species in Maine.

Our initial field season began during the summer of 2014, and during August and September 2014 we captured over 150 ruffed grouse between the two study areas. One hundred and five radio-collared ruffed grouse were being monitored at the beginning of the 2014 hunting season (starts October 1) and we have been receiving regular reports of harvested grouse through our toll-free reporting line. Field work for the project is ongoing, and our first year of breeding season work and reproductive monitoring will commence during spring of 2015.

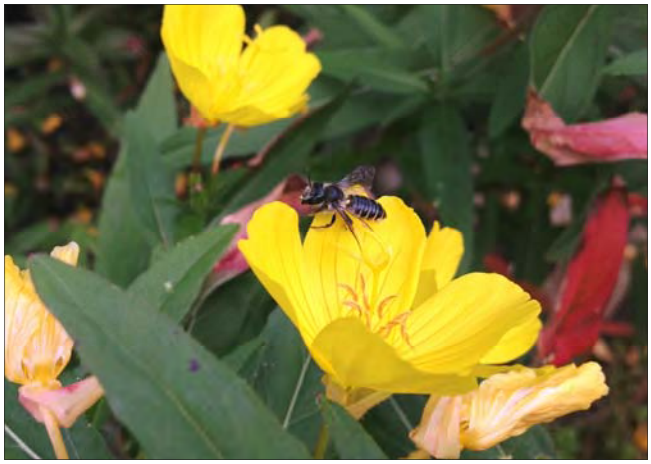
Investigators: Samantha Davis (MS)
Joelle "Ellie" Mangelinckx (MS)

Advisors: Erik J. Blomberg (Advisor)
Kelsey Sullivan
Brad Allen

Duration: July 2014—May 2017

Cooperators:

Maine Department of Inland Fisheries and Wildlife
American Forest Management



Landscape pattern and native bee communities in the Northeastern United States

1. Determine if a relationship exists between pesticide residues in pollen loads and landscape configuration.
2. Examine power line rights-of-way as semi-natural habitat for native bees.
3. Compare the performance of a spatially explicit ecosystem service simulation model in landscapes with different complexities.
4. Develop a tool for blueberry growers to assess native bee habitat in the landscape surrounding their crop fields.

Native bees provide a critical ecosystem service to human and wildlife populations by pollinating fruit-bearing cultivated crops and wildlife forage. Historically, commercially managed bees have been an important pollinator of agricultural crops, however, Colony Collapse Disorder has decreased hive availability, increasing reliance on native bees to provide this service. Enhancing habitat around crop fields to promote native bee populations will benefit fruit production for both agricultural interests and wildlife populations. In Maine, wild blueberry growers invest heavily in honey bees for pollination; concern about pollination deficit due to fewer honey bees and growing costs has lead to increased interest in management to promote native bee pollination. This study is examining factors that potentially affect native bee abundance in wild and cultivated fruits from a spatial ecology perspective. Our spatial assessment includes evaluation of relationships between landscape pattern and composition and exposure of native bees to pesticides applied to crop fields; evaluates habitat quality of power line rights-of-way as semi-natural habitat for native bees; compares performance of a spatially explicit ecosystem service simulation model (InVEST) in landscape with different pattern complexities; and, develops a tool for blueberry growers to use to assess native bee habitat in the landscape surrounding their crop fields.

Native bees have been surveyed in power line rights-of-ways in Downeast Maine during 2 summers, and in mid-coast Maine during 2014. These surveys will be repeated and completed in summer 2015. Pesticide burden samples collected in 2013-2014 have been analyzed and data are being prepared for spatial analyses. Additional pesticide data provided by project collaborators in MA, CT, and ME will be added to the database during 2015. Development of a web-based spatial tool for wild blueberry growers and land managers will be completed during 2015. Modification of the spatial model will begin during late 2015, incorporating data from bee surveys conducted in non-crop land cover types to improve model accuracy.

Investigators: Brianne Du Clos (PhD)

Advisors: Cynthia S. Loftin (Co-Advisor)
Francis A. Drummond (Co-Advisor)
Dana M. Bauer
Samuel P. Hanes
Allison Dibble

Duration: January 2012—December 2016

Cooperators:

U.S. Geological Survey – Maine Cooperative Fish and Wildlife Research Unit
University of Maine
University of Maine – Sustainable Solutions Initiative
U.S. Department of Agriculture
USDA SARE Grants

Relative densities, patch occupancy, and population performance of spruce grouse in managed and unmanaged forests in northern Maine

1. Quantify patch occupancy of breeding spruce grouse across a variety of harvested and unharvested stands to determine the link between measurements of forest structure and breeding habitat occupancy.
2. Document home range and within-stand habitat selection and composition of brood rearing female spruce grouse with regard to forest vegetation, structure, and harvest history to evaluate effects of forest management on brood rearing habitat.
3. Monitor the survival of both banded and telemetered adult spruce grouse, as well as brood survival, as an index of relative reproductive success across forest management treatments.

Spruce grouse (*Falcipennis canadensis*) are a species of forest grouse dependent on conifer dominated forests. The southeastern extent of the geographic range of spruce grouse coincides with southeastern distribution of red and black spruce within the Acadian forests of Maine, northern New Hampshire, northernmost Vermont, the Adirondacks region of New York State, as well as the eastern maritime provinces of Canada. Spruce grouse are a state-listed species in NY and VT and a species of conservation concern in NH. Although there is no hunting season on the species in Maine, little else is known about their current status in the state.

Although industrial forest management has been shown to reduce the survival and reproductive success of spruce grouse, populations in unharvested portions of the Adirondack Forest Preserve also have exhibited substantial declines. Additionally, spruce grouse have been documented to occur in plantations and PCT stands. The effects of extensive forest management in commercially managed landscapes on habitat viability for spruce grouse is unknown. Thus, this study will evaluate of the effects of commercial forest management in northern Maine on patterns of habitat occupancy, habitat use, and reproductive success of spruce grouse using breeding season occupancy surveys and radio telemetry of females during the brood rearing season.

In May and June of 2014 we conducted breeding season occupancy surveys in 41 stands and captured and banded 8 new males, 1 new female (radioed), and had 13 observations of recaptured males and 2 observations of recaptured females. Later, in late June and early July , we conducted brood surveys to capture females with broods within 30 stands. We captured and banded 8 new females, 7 of which received radio transmitters. An additional female was caught during telemetry, giving us a total of 8 radioed females. Of these 8 birds, 5 survived the summer monitoring season (July-Sept. 1). During August 2014 vegetation measurements were taken at 15 known locations for the 10 birds tracked in 2013 that had at least 15 locations.

In total we have observed 41 marked males and have documented the summer home range size and survival of 29 females. Of the 29 females studied, vegetation measurements have been collected for 24 individuals.

Investigator: Stephen Dunham (MS)

Advisors: Daniel J. Harrison (Advisor)
Brian J. Olsen
Shawn T. McKinney
Daniel G. McAuley (ex-officio)

Duration: July 2011—May 2016

Cooperators:

University of Maine – Maine Cooperative Forestry Research Unit

Effects of urbanization on pool-breeding amphibians: Implications of condition for persistence of wood frog (*Lithobates sylvaticus*) and spotted salamander (*Ambystoma maculatum*)

1. Characterize wood frog and/or spotted salamander breeding pools along a development gradient via documentation of biotic factors (faunal assemblages, vegetation characteristics), abiotic factors (temperature, water quality, hydroperiod), and land cover types and configuration at various scales in the surrounding landscape
2. Examine the effects of breeding pool characteristics on amphibian health (i.e., immune and metabolic condition)
3. Examine population dynamics (e.g., occupancy, breeding effort and success, and connectivity) relevant to population persistence

Pool-breeding amphibians in Maine, similar to most groups of amphibians worldwide, are threatened by land development and the resultant habitat loss, fragmentation, and degradation. Habitat changes associated with development can exacerbate effects of climate change (e.g., heat island effect, acid rain, UVB light) and introduce environmental pollutants and disease. These amphibians require both aquatic and terrestrial habitats to complete their life cycles and are, thus, sensitive to disturbances in both environments. Animal response to changes in landscape conditions may not immediately affect population demographics; i.e., there may be a time lag between impaired condition and reductions in fecundity and survival. Amphibian populations that are chronically exposed to adverse factors may have reduced likelihood of survival. It is currently unknown how amphibian health and survival are affected by various intensities of development. Understanding how pool-breeding amphibians respond to development will provide crucial information for land managers and policy makers to make decisions about development that best conserves pool-breeding amphibian species.

Our project addresses how land development affects the likelihood of pool-breeding amphibian population persistence via examination of amphibian health, occupancy, and abundance and habitat parameters.

I will continue to collect data from amphibians in various life stages.

We have completed one field season focusing on characterizing vernal pools and the health and survival of larval wood frog (*Lithobates sylvaticus*) and mole salamander (*Ambystoma spp.)* populations along a development gradient. We conducted egg mass and larvae counts to estimate reproductive effort and the percent of eggs that survived to leave pools. We also conducted weekly health surveys, which consisted of measuring body length, mass, and volume and noting developmental stage, injuries, malformations, and indications of disease. We collected blood to count white blood cells which is used as a proxy to measure baseline metabolic and immune function. Throughout the season we quantified changes in within-pool vegetation and water characteristics, which likely affect larval amphibian health and survival. We conducted trail camera and visual detection surveys to describe vertebrate predator pressures on pool-breeding amphibians.

Investigator: Carly Eakin (PhD)

Advisors: Malcolm L. Hunter, Jr. (Co-Advisor)
Aram J.K. Calhoun (Co-Advisor)
Hamish S. Greig
Rebecca L. Holberton
Michael T. Kinnison

Duration: August 2013—May 2017

Cooperators:

National Science Foundation – Experimental Program to Stimulate Competitive Research
University of Maine – Department of Wildlife, Fisheries, and Conservation Biology
University of Maine – Maine Agricultural and Forest Experiment Station

Habitat use by pool breeding amphibians In Maine's montane region

1. Determine micro- and macro-habitats selected for by Wood Frogs (*Lithobates sylvaticus*) during the post-breeding period.
2. Determine hibernaculum characteristics selected for by wood frogs prior to the overwintering period.
3. Examine how Wood Frog and Spotted Salamander (*Ambystoma maculatum*) breeding site occupancy is influenced by local and landscape scale variables across an elevational gradient.

Maine is ecologically diverse with a varied landscape. Although pool-breeding amphibians generally are distributed across the state, the vernal pools they typically use for breeding are more limited geographically. Current legislation to protect vernal pools is based on research conducted in southern, central, and downeast Maine where vernal pools are relatively abundant; it is not clear how these species use alternative breeding habitat where vernal pools are scarce. For example, Maine's montane region is rugged and relatively wetland-limited, with one of the coldest climates in New England. Very little is known about pool-breeding amphibian dispersal, migration, hibernation, and habitat selection in this pool-limited region of Maine. Hibernaculum selection may be critical to individual fitness; six-months of hibernation ends with a short, explosive breeding period in nearby wetlands that are not necessarily typical vernal pool habitat used elsewhere in the state. Our research examines habitats used by pool-breeding amphibians throughout the annual life cycle in Maine's western and interior mountains.

We have completed four field seasons; two investigated wood frog post-breeding and overwintering habitat selection, and two investigated wood frog and spotted salamander breeding site occupancy in Maine's Upper Montane/Alpine Zone Ecoregion. We used radio telemetry to track the post-breeding movements of 71 wood frogs at Turtle Ridge in Maine's Nahmakanta Public Reserved Land during 2011-2013. We continued to track a reduced number of individuals throughout fall and early winter, until they were poised for hibernation, and erected enclosures around each hibernating frog. The enclosures served to contain the frogs until we arrived on-site to attach new radio transmitters, allowing us to track individuals across all annual life history periods (i.e., breeding, post-breeding, and hibernal periods). We conducted amphibian egg mass and larvae surveys at >150 wetlands in six study areas during late spring and summer in 2013 and 2014.

Investigator: Luke Groff (PhD)

Advisors: Cynthia S. Loftin (Co-Advisor)
Aram J.K. Calhoun (Co-Advisor)
Daniel J. Harrison
Brian J. McGill
Francis A. Drummond

Duration: January 2010—December 2015

Cooperators:

Maine Department of Inland Fisheries and Wildlife
U.S. Geological Survey – Eastern Regional Cooperative Fish and Wildlife Research
U.S. Geological Survey – Maine Cooperative Fish and Wildlife Research Unit
University of Maine – Department of Wildlife, Fisheries, and Conservation Biology
University of Maine – Sustainable Solutions Initiative

Breeding ecology and habitat selection of the blue-spotted salamander (*Ambystoma laterale*) and its unisexual kleptogen

1. Compare the breeding site selection of blue-spotted salamanders to that of unisexual salamanders.
2. Explore variation in egg masses.
3. Explore terrestrial habitat use by unisexual salamanders.
4. Examine the breeding success of each lineage at 4 vernal pools.

The blue-spotted salamander complex in Maine consists of the blue-spotted salamander (*Ambystoma laterale*) and a unisexual lineage containing both the DNA of the blue-spotted and Jefferson salamander (*A. jeffersonianum*). The unisexuals are almost entirely polyploid females, and parasitize sperm from the blue-spotted salamanders to reproduce (kelptogens). We are examining the breeding site selection, reproductive variation, and upland habitat use of this complex.

Breeding site selection: We will trap salamanders, collect tissue samples, and record environmental data at wetlands in several landscapes. We will model which factors influence the breeding site selection of each lineage.

Egg mass variation: We will capture breeding salamanders from several wetlands, and move these animals into breeding chambers for egg deposition. We will collect tissue for genotyping, then compare the egg masses.

Habitat use: We implanted breeding salamanders with radio transmitters and followed them as they emigrate from the pool.

Breeding success: Using drift fences at four vernal pools, we captured adult and juvenile salamanders and collected tissue samples for genotyping.

We have completed a two seasons of radio telemetry, during which we followed 35 salamanders dispersing from breeding pools. We have collected data and tissue samples for both breeding adults and dispersing juveniles from 4 vernal pools across three years. We conducted a pilot season trapping salamander at pools to examine breeding site selection.

Investigator: Kristine Hoffmann (PhD)

Advisors: Aram J.K. Calhoun (Co-Advisor)
Malcolm L. Hunter, Jr. (Co-Advisor)
Daniel J. Harrison
Michael T. Kinnison
James P. Bogart

Duration: January 2012—May 2016

Cooperators:

National Science Foundation – Experimental Program to Stimulate Competitive Research
University of Guelph
Orono Land Trust
University of Maine – Department of Wildlife, Fisheries, and Conservation Biology
University of Maine – Sustainable Solutions Initiative

Black bear population modeling

Investigator: Daniel Linden (Post-doc)

Advisor: Shawn T. McKinney

Duration: April 2012—April 2015

Cooperators:

Maine Department of Inland Fisheries and Wildlife
U.S. Geological Survey – Maine Cooperative Fish and Wildlife Research Unit

1. Estimate demographic parameters and population change rates from long-term black bear data in Maine.
2. Predict population trajectories.
3. Evaluate the effectiveness of the Maine Department of Inland Fisheries and Wildlife's current bear monitoring program and population estimates.
4. Determine whether alternative research and monitoring methods are appropriate.

For more than 30 years, the Maine Department of Inland Fisheries and Wildlife has used information acquired from intensive field work and data collection on black bears (*Ursus americanus*) in Maine, including trapping and marking bears, radio telemetry of female bears, and visiting winter dens, to estimate and monitor Maine's black bear population. While this long-term project has produced a unique data set and tremendous insight into black bear biology, current fiscal constraints and emerging wildlife issues have necessitated an evaluation of the program with an aim of increasing efficiency while maintaining a high-quality management program. The black bear population modeling project will use this extensive and unique data set and explore new modeling approaches to quantify black bear population trends and investigate whether efficiencies can be gained in the program. One approach to explore will be the use of integrated population models which allow for the joint estimation of population parameters by exploiting the overlap in information across multiple surveys providing data on demographic rates. This approach has numerous benefits including proper accounting of uncertainty and increased precision of parameter estimates; it can also help identify which surveys are vital for adequately monitoring population trends.

Individual, colony, and metapopulation-scale drivers of seabird colony dynamic

1. investigate long-term costs of reproduction in a long-lived seabird
2. investigate differences in life-history strategy between two allopatric seabird populations with differing survival rates
3. investigate factors driving seabird productivity
4. investigate seabirds' ability to buffer productivity against fluctuations in food availability
5. investigate factors driving seabird colony initiation and extinction
6. investigate factors affecting seabird nesting patch selection
7. use results from 1-6 to develop an agent-based model of seabird dynamics to allow population-level prediction in novel situations

The purpose of this research is to investigate seabird dynamics on multiple scales and to use the resulting information to assess the resilience of seabirds to ecosystem perturbation. First, I will use a long-term mark-recapture dataset to revisit a reproductive cost experiment on Black-legged Kittiwakes (*Rissa tridactyla*) in Alaska to examine how cumulative reproductive costs may play out over an individual's lifespan. I then will use the same dataset to explore differences in life history strategy between this Pacific population vs. published accounts of an Atlantic population with differing survival rates. Next, I will use a 30-year monitoring dataset from the same region to examine how multiple stressors interact to affect kittiwake productivity on a colony scale and to identify which productivity components are used to buffer productivity. I then will investigate factors driving colony initiation and extinction. As a part of this last component, I will test several hypotheses regarding recruit attraction to nesting patches. Finally, I will synthesize this work in developing a general agent-based model to predict seabird responses to changes in the marine ecosystem.

All data are collected, most cleaning and proofing is complete, and some analysis has begun. The bulk of the analysis will occur after I have completed my comprehensive examinations in Fall 2015.

Investigator: Alyson McKnight (PhD)

Advisors: Shawn T. McKinney (Co-Advisor)
Cynthia S. Loftin (Co-Advisor)
Erik J. Blomberg
Brian J. Olsen
Jeffrey A. Runge
David Irons

Duration: September 2013—May 2017

Cooperators:

U.S. Fish and Wildlife Service
University of Maine
U.S. Geological Survey – Maine Cooperative Fish and Wildlife Research Unit
Maine Department of Inland Fisheries and Wildlife

Seasonal variation of snowshoe hare density and implications for Canada lynx in managed forests of northern Maine

1. To document the influence of different forest stand types and seasonality on stand-level snowshoe hares densities.
2. To determine the relationship between seasonal changes in vegetation structure among different forest stand types and seasonal snowshoe hare densities.
3. To document seasonal food habits of Canada Lynx in northern Maine.

The federally threatened Canada lynx (*Lynx canadensis*) are specialist predators of snowshoe hare (*Lepus americanus*) which comprise up to 97% of lynx diet. Lynx movement, survival, and recruitment are closely associated with snowshoe hare availability. Harvest activities alter the composition and structure of forests, affecting the quality and availability of snowshoe hare and lynx habitat. Refugia from predators provided by vegetative cover changes seasonally and by forest stand type, which may affect relative densities of hares and their vulnerability to predation by lynx.

Our study is evaluating how relative hare densities change seasonally across forest types and management regimes within the Acadan forest region and we have quantified seasonal changes in vegetation structure and visual obstruction of hares associated with phenological change to understand the mechanisms associated with seasonal changes in habitat selection by hares and lynx.

Lynx can shift to alternative prey at their southern extents of their distribution, during low hare density periods and during snow-free periods. Thus, the third component of this project will document seasonal food habits of lynx to determine if there are dietary shifts associated with seasonal changes in lynx habitat selection.

Hare fecal pellet counts were conducted semi-annually in 28 stands composed of four forest stand types in 2010 through 2013 to continue a time series collected since 2001. We are evaluating how relative hare densities change among the types across seasons and years.

Vegetation structural and compositional data were collected from 20 plots in each of the 28 stands during summer 2011 and winter 2012. Metrics used were lateral cover, canopy cover, and vegetation composition at four strata within a 10 m squared plot. In winter 2012, those stands were re-measured for the same lateral and canopy cover variables, as well as snow depth. Summer 2012 and 2013 vegetation metrics include forestry tree data. Analyses show significant seasonal differences in pellet densities across regenerating forest stand types, but not in mature or in selection harvest stand types. The suite of vegetation structural and compositional components are currently being assessed to determine whether food or cover components of forest stands affect seasonal fecal pellet densities of hares. This project will be completed by May 2014.

Lynx diet assessment has begun to compare 60 winter scat samples with 193 summer scats that were collected using a scat detection dog team. Genetic analyses verified that 249 of those scats were deposited by lynx. Winter scats were collected by MDIFW and lab personnel between 2002-2003, which will allow diet comparisons between periods of low and high hare densities.

Investigator: Sheryn J. Olson (MS)

Advisors: Daniel J. Harrison (Advisor)
William B. Krohn
Robert S. Seymour
Jennifer H. Vashon (ex-officio)
Mark McCollough (ex-officio)

Duration: January 2010—May 2014

Cooperators:

University of Maine – Department of Wildlife, Fisheries, and Conservation Biology
University of Maine – Maine Agricultural and Forest Experiment Station
U.S. Geological Survey – Maine Cooperative Fish and Wildlife Research Unit
U.S. Fish and Wildlife Service
Maine Department of Inland Fisheries and Wildlife
University of Maine – Maine Cooperative Forestry Research Unit

Genetic analysis of Blanding's turtle populations in the Northeast

Investigator: Judith M. Rhymer

Duration: June 2011—May 2014

Cooperators:

Maine Department of Inland Fisheries and Wildlife
University of Maine – Department of Wildlife, Fisheries, and Conservation Biology
University of Maine – Maine Agricultural and Forest Experiment Station
U.S. Fish and Wildlife Service
Cooperative Fish and Wildlife Research Unit, University of Massachusetts
Massachusetts Division of Fisheries and Wildlife
New York State Department of Environmental Conservation
Biology Department, Acadia University, Nova Scotia, Canada
Swampwalkers Wetland Ecosystem Specialists, Parker River Association, MA
Biology Department, SUNY Potsdam, NY
New Hampshire Fish and Game Department
Pennsylvania Fish & Boat Commission's Natural Diversity Section

1. Assess the population genetic structure of Blanding's turtle populations in the Northeast and incorporate findings into conservation planning and priority area management in Maine, Massachusetts, New Hampshire, New York, and Pennsylvania.
2. Examine isolated/outlier Blanding's turtle populations in Pennsylvania and New York to determine origin (naturally occurring or introduced).
3. Compare the genetic structure of Blanding's turtle populations within the Northeast region to those in the Midwest region and Canada to provide a spatially explicit assessment of the discrete population groups across the species' range.

Blanding's turtle populations are declining throughout their range, as well as in the Northeast. There is a small contiguous population in Massachusetts, New Hampshire and Maine, two disjunct populations in eastern New York, and one population in Pennsylvania of unknown status. An assessment of genetic variation throughout the region was completed based on an assay of Blanding's turtle samples from 56 populations in Maine, Massachusetts, New Hampshire, New York, and Pennsylvania at 14 variable microsatellite loci. Populations in New York are genetically distinct from those in Maine, Massachusetts and New Hampshire and have several alleles in common with those in Pennsylvania, Ontario and Midwest populations that are not found in those in New England. Genetic results were incorporated into a Northeast regional conservation plan and monitoring protocol and will be useful for informed management and conservation planning for Blanding's turtles across the species range.

Softwood forest birds

1. Quantify and define the composition and forest associations of coniferous bird communities in several silvicultural treatments including: regenerating, mature, overstory removal, precommercially thinned, selection, and shelterwood harvest.
2. Model the influences of silvicultural practices and vegetative attributes on coniferous forest bird communities.
3. Model factors influencing the abundance, occupancy, and distribution of focal species. This analysis will take a multi-scale approach and use both USGS Breeding Bird Surveys along with surveys that will be conducted 2013-2015.

We will conduct field surveys during the breeding season of most passerine species (June through August) in the silvicultural treatments listed above. These surveys will document the number of each species encountered along with many variables that may influence their probabilities of detection. We will analyze occupancy or abundance accounting for the probability of detection of each species. We also will measure vegetation at each stand which we survey. These stand attributes will be used to assess effects on focal species and communities. We will supplement this study with USGS Breeding Bird Survey data to address large-scale questions, such as the effects of climate and budworm outbreaks. We will model the breeding habitat of these species and make inferences about their responses to silvicultural management. We thank the U.S.F.W.S. Migratory Bird Division, U.S.F.W.S. National Wildlife Refuge System, UMaine Cooperative Forestry Research Unit, and UMaine Department of Wildlife Ecology, Maine Cooperative Fish and Wildlife Research Unit, and Baxter State Park for access to sites, project support, and funding.

We established sampling protocols for birds and vegetation and collected bird species data at five areas throughout the Acadian forest region: Nulhegan NWR (VT), Umbagog NWR (NH), North Maine Woods (ME), Baxter State Park (ME), Aroostook NWR (ME), and Moosehorn NWR (ME). A total of 1,832 and 2,084 bird surveys were conducted during the summer of 2013 and 2014 respectively, while 19,431 and 22,784 detections of birds were collected during surveys at 657 point count locations within 117 forest stands. Vegetation surveys were completed at all sites during 2014. We plan to continue bird surveys during the breeding season through the summer of 2015. Data analyses will begin in 2015.

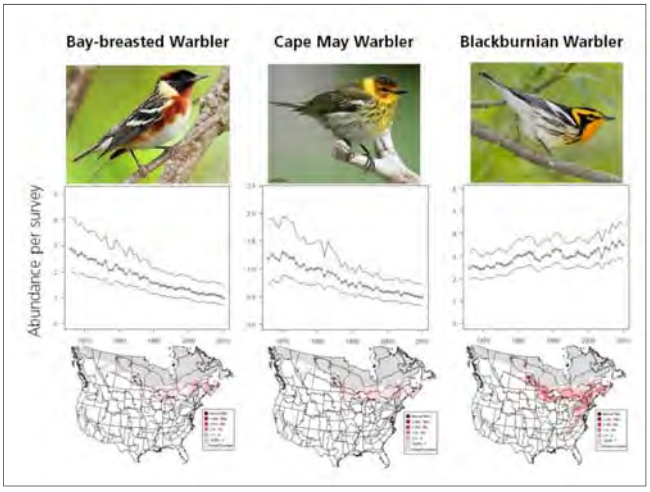
Investigator: Brian Rolek (PhD)

Advisors: Daniel J. Harrison (Co-Advisor)
Cynthia S. Loftin (Co-Advisor)
Petra B. Wood
Brian J. McGill
Brian J. Olsen

Duration: August 2012—August 2016

Cooperators:

University of Maine – Department of Wildlife, Fisheries, and Conservation Biology
U.S. Geological Survey – Maine Cooperative Fish and Wildlife Research Unit
U.S. Fish and Wildlife Service
University of Maine – Maine Cooperative Forestry Research Unit
Baxter State Park



Biogeography and conservation of Maine's island amphibians, with focus on redback salamanders (*Plethodon cinereus*)

1. Survey Maine islands and near coastal areas for redback salamanders (*Plethodon cinereus*).
2. Conduct microsatellite DNA and trait-based assessments of genetic diversity, local adaptations, and colonization history of island redback salamanders and relate these data to spatial analyses of island features and historic sea levels.
3. Share information on islands likely to support genetically unique populations with stakeholders, and collaborate on outreach concerning the importance of islands for the natural history and conservation of Maine's amphibians.

Amphibians face some of the greatest rates of local and global extinctions among vertebrates. A significant challenge for conservation of amphibians is simply a lack of sufficient data on their historic and current distribution and where important genetic resources exist to target for conservation. Much of what we know about amphibian distributions is from accessible mainland habitats, and information about amphibian distributions on coastal islands is largely lacking. Amphibians are physiologically intolerant of seawater, and thus, island populations may have been isolated for thousands of years. Such populations can serve as important reserves of unique genetic diversity. Indeed, island populations of other taxa often possess unique morphological, behavioral and physiological adaptations relative to mainland populations. The proposed project seeks to conduct surveys of amphibians on coastal islands along the entire Maine seaboard to enhance current knowledge of their distributions. It also seeks to characterize genetic diversity and the ancient history of island colonization in one species, the redback salamander (*Plethodon cinereus*), that we anticipate is widely distributed on Maine's islands. By combining our surveys and genetic data with spatial analyses (GIS) we will identify islands most likely to support amphibian populations and communities that warrant conservation priority. We also will collaborate with project partners on outreach surrounding the role of islands in the natural history and conservation of Maine's amphibians.

We have conducted surveys for redbacked salamanders on 16 coastal islands and 9 mainland locations, and have collected over 600 genetic samples. We are examining genetic variation at nine published microsatellite loci. Stable isotope analysis will be conducted for a subset of approximately 100 individuals. All data will be analyzed in 2015.

Investigator: Nikko-Ideen Shaidani (MS)

Advisors: Cynthia S. Loftin (Co-Advisor)
Michael T. Kinnison (Co-Advisor)
Rebecca L. Holberton

Duration: September 2012—May 2015

Cooperators:

Maine Outdoor Heritage Fund
U.S. Geological Survey – Maine Cooperative Fish and Wildlife Research Unit
U.S. Fish and Wildlife Service—Maine Coastal Isla
University of Maine
National Park Service

Population dynamics of spruce grouse in the managed forest landscapes of northern Maine

1. Estimate demographic rates of spruce grouse, such as adult survival for males and females, nest success, and chick survival, using a combination of radio-telemetry and capture-mark-recapture methods.
2. Evaluate micro-habitat characteristics such as understory composition, canopy cover, or tree basal area, at locations used by spruce grouse during important life phases (e.g. brood rearing or nesting) and determine the influence of these habitat characteristics on demographic rates.
3. Relate objectives 1 and 2 to population performance using predictive stage-structured population models. Use these models to evaluate the overall trajectory of spruce grouse populations, and classify populations as stable, increasing, or experiencing decline.
4. Provide guidance in the form of a status evaluation and recommendations for future conservation of spruce grouse populations, to include evaluation of forest management activities that promote habitat composition that is consistent with healthy spruce grouse populations.

Spruce grouse are native forest birds that inhabit conifer forests found throughout the northern U.S. and Canada. In other northeastern states spruce grouse are state-listed as an endangered species, but currently very little information exists to evaluate whether similar status is warranted in Maine. We will use a combination of radio telemetry and mark-recapture methods to collect data on survival and reproductive success of marked individuals. Survival will be evaluated year-round, as well as during distinct biological season's (e.g. breeding vs. overwinter). Reproductive success will be monitored during the spring and summer breeding season (May - August). We will monitor birds in areas of varying forest composition and silvicultural activities, and will also sample vegetation characteristics, such as tree basal area and canopy cover as well as forest understory composition and structure, at spruce grouse locations. We will also evaluate the current status of spruce grouse populations based on whether their demographic rates are consistent with stable or declining population trajectories. Ultimately, we will link population characteristics to components of spruce grouse habitat for the purpose of informing forest management and state-level regulatory decisions.

Starting in the fall of 2014, this project marks the continuation and expansion of spruce grouse research in Piscataquis County, ME. The continuation of this project was enabled by the acquisition of grants from the University of Maine Cooperative Forestry Research Unit, the Maine Outdoor Heritage Fund, and Dr. Harrison's ongoing McIntire-Stennis project. During the first fall of fieldwork we captured 20 spruce grouse, and radio-marked 16. Throughout the winter we will monitor survival monthly. In the spring of 2015, trapping efforts will be continued and the survival and reproductive success of individuals will be monitored on a weekly basis throughout the summer.

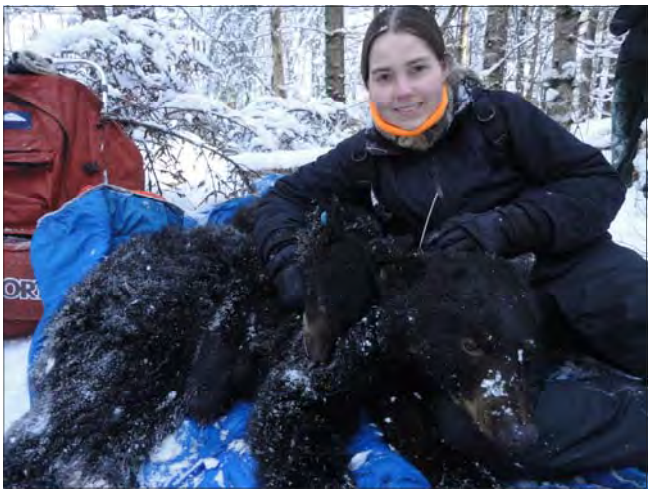
Investigator: Joel Tebbenkamp (PhD)

Advisors: Erik J. Blomberg (Co-Advisor)
Daniel J. Harrison (Co-Advisor)
Brad Allen
Kelsey Sullivan

Duration: September 2014—May 2018

Cooperators:

Maine Department of Inland Fisheries and Wildlife
Maine Outdoor Heritage Fund
University of Maine – Maine Cooperative Forestry Research Unit
Katahdin Forest Management
Gerald Pelletier, Inc



Influence of maternal effect, philopatry, and primiparity on subadult female black bear den selection in Maine

1. Examine the influence of maternal effect and philopatry on den type selection in female subadult black bears.
2. Determine if there is regional variation in the age of primiparity of Maine black bears.
3. Evaluate the effects of den type and age of primiparity on lifetime productivity and offspring recruitment.

Female black bears (*Ursus americanus*) require a den in which to give birth and protect their offspring during early development. Maine black bears utilize a variety of den types, each providing a different degree of protection to the bear. The current Maine black bear population is estimated to be greater than 30,000, making it one of the largest in the United States. Since 1975, the Maine Department of Inland Fisheries and Wildlife (IFW) has conducted a black bear research and monitoring program in order to effectively manage the population.

Denning data from the last 33 years, collected as part of this IFW program, are being used to examine subadult den selection with regards to philopatry (tendency to remain near birth place) and a maternal effect on den type selection. These data are also being used to analyze the age of primiparity (first reproduction) of Maine bears and the effects that differences in this age have on population recruitment and lifetime productivity measures. Regional and temporal variation in both den type selection and primiparity will also be examined to test for differences among study areas and time periods.

A revised den type classification system was created based on the degree of protection each type affords to bears. In 2014, a cooperative agreement was created with IFW and additional data were made available, allowing us to examine dens from 1981-2013. These new data were used to analyze recruitment rates by den type, den type use by offspring age class, and the den type use of observed primiparous bears. Regional den type use and mean age of primiparity were also examined. GIS analysis of the denning data was conducted in order to calculate distance data necessary for philopatry analysis. We are continuing analysis of the data in order to determine whether maternal effect on den type or philopatry has more of an impact on den selection as well as to determine the effects of age of primiparity on population recruitment.

Investigator: Alyssa Vitale (MS)

Advisors: Shawn T. McKinney (Co-Advisor)
Daniel W. Linden (Co-Advisor)
Mary S. Tyler

Duration: September 2013—May 2015

Cooperators:

University of Maine
Maine Department of Inland Fisheries and Wildlife

A long-term forest ecosystem study

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

This continuing study is being conducted on a 120 ha, red oak-white pine woodlot in Arrowsic, Maine, called the Holt Forest. A 40 ha study area is gridded into forty 1-ha blocks with 20 ha serving as a control area and 20 ha as an experimental area.

Over the years we have collected data sets that include a 100% inventory of trees (>10cm DBH), intensive inventories of tree saplings and seedlings, tree mapping on 20ha, a complete record of the vascular plant vegetation using the relevé technique, an inventory of all breeding bird territories, annual small mammal trapping, salamander cover object counts, estimates of seed and fruit production, frass counts of canopy insect defoliators, and vascular plant densities in 1m2 plots.

A 1987/1988 timber harvest with three objectives: (1) increase wood production; (2) increase wildlife diversity and abundance; and (3) maintain the forest's aesthetic value has provided a basis of comparison to better understand the impacts of harvesting. By continuing to monitor populations and processes, we have better insights into plant and wildlife populations. Over the course of nearly 30 years, we have begun to better understand seasonal and annual changes in populations and the ecosystem structure.

In 2013, our 31st field season, all yearly monitoring projects were completed. No field crew for the summer put limitations on the additional tasks that could be accomplished. In 2014, our goal is to continue work on improving our tree map and inventory data and numbering methods. This will give us better control over tree number loss and improve the efficiency of future inventory work. All yearly monitoring will be conducted.

Vegetation resampling around small mammal stations and salamander ACO stations will be conducted to improve our understanding of microhabitat influences on abundance. The results of the red oak acorn mast of 2010 will continue to be monitored. This will allow us to assess the success of this cohort of oak seedlings and its influence on maintaining oak as a major component of the overstory.

Investigators: Malcolm L. Hunter, Jr.
Alan J. Kimball
Alan S. White
Jack W. Witham

Duration: January ongoing

Cooperators:

Holt Woodlands Research Foundation
University of Maine – Sustainable Solutions Initiative

Small mammal community ecology

1. Determine if elevational gradients in northern New England harbor distinctive small mammal communities.
2. Understand patterns of community assembly and predict response to climate change.
3. Identify foundational species in each community and model their abundance.
4. Survey for high-elevation specialist species (Northern Bog Lemming, Yellow-nosed Vole).

Upon completion of two field season, we hope to address the stated projected objectives. Community-level analyses will rely primarily on multivariate statistics; species-level analyses will be primarily univariate. We plan examine patterns of intraspecific variation using basic field data and stable isotope analyses. These results will inform management of Maine's forests and address broad ecological questions.

One field season has been completed, and we are currently working on data analysis and writing. A note documenting a record long-distance movement by a Deer Mouse has been submitted for publication.

Investigator: Connor Wood (MS)

Advisors: Shawn T. McKinney (Advisor)
Jacquelyn L. Gill
Malcolm L. Hunter, Jr.

Duration: September 2013—December 2015

Cooperators:

Maine Outdoor Heritage Fund
U.S. Geological Survey – Maine Cooperative Fish and Wildlife Research Unit
University of Maine – Department of Wildlife, Fisheries, and Conservation Biology

INTEGRATED ecology

Changes in fish communities and chimpanzee distributions following impoundment of the Seli/Rokel River by Sierra Leone's Bumbuna Hydroelectric Project

1. Characterize patterns in fish assemblages from estuary to the upper reaches of the Seli River prior to impoundment.
2. Compare the changes in fish assemblages in the upper reaches of the Seli River pre and post impoundment.
3. Assess changes in the distribution and abundance of chimpanzees through direct and indirect observation in the Bumbuna Project area prior to and after completion of the impoundment.
4. Characterize the distribution of the chimpanzees in the Bumbuna hydroelectric project area before and after impoundment.

The Bumbuna Hydroelectric Project and dam impounds the Seli and Rokel Rivers in Sierra Leone. Completed in 2006, the reservoir impounded 3,920 km^2 of riparian forest and forested savannah to provide electricity to the region's rural populations. The impoundment has altered the river hydrology from that driven by dry and wet season dynamics to a flow regime dictated by electrical demand. Changes in the river hydrology potentially have affected the fish and wildlife communities in the project area, as well as the human settlements dependent on these resources. Prior to completion of the dam, biologists surveyed fish communities in the river and chimpanzees in the adjacent riparian zone. The surveys were repeated following filling the reservoir. This study will compare the pre- and post-impoundment surveys to identify changes in the fish and mammal (particularly chimpanzee *Pan troglodytes verus* and *P. t. ellioti*) communities attributable to the Bumbuna project and reservoir creation.

Project data have been organized and proofed for analyses. A thesis proposal is complete and will be presented in a seminar in Spring 2015. Spatial analysis of the pre- and post-impoundment chimpanzee population distributions is underway. Data analysis will be conducted during the first half of 2015, and the thesis will be completed in Fall 2015.

Investigators: Abdulai Barrie (MS)

Advisors: Cynthia S. Loftin (Co-Advisor)
Joseph D. Zydlewski (Co-Advisor)
Erik J. Blomberg
Robert J. Lilieholm

Duration: September 2013—December 2015

Cooperators:

Fulbright Student Scholar Program
University of Maine – Department of Wildlife, Fisheries, and Conservation Biology
U.S. Geological Survey – Maine Cooperative Fish and Wildlife Research Unit

Eco-evolutionary implications of environmental change across developing landscape

1. Empirically evaluate the eco-evolutionary consequences of ongoing urbanization on the structure and connectivity of Maine's wood frogs and spotted salamanders.
2. Develop eco-evolutionary agent-based models to examine consequences of varying rates and forms of environmental perturbation across a complex landscape.
3. Quantify the gene expression profiles of ESD infected and uninfected lobsters to evaluate correlations between environmental stress and disease presence.

The influence of natural and anthropogenic barriers to gene flow among wood frog and spotted salamander populations will be assessed using a landscape genetics approach, whereby observable inter-population genetic structure is evaluated for correlations with various landscape features. The patterns documented using landscape genetic analyses will be incorporated into agent-based simulation models (ABMs), which will be used to assess the ecological and evolutionary responses of species to environmental perturbation. Because ABMs allow simulated individuals with unique characteristics to interact with each other in a simulated environment, they provide an excellent tool for capturing emergent phenomena in naturally complex eco-evolutionary systems. Model parameterization and validation will be informed using empirical data on vernal pool amphibians originating from landscape genetic analyses and the literature. Finally, as part of an interdisciplinary research effort designed to improve understanding of the causes of epizootic shell disease (ESD), I will be quantifying differences in gene expression profiles of infected and uninfected lobster from presumably high stress and low stress environments. These analyses will be competed using the RNA-Seq technique, which has recently been developed to utilize advances in next generation sequencing technologies to quantify gene expression profiles in non-model organisms.

Sampling for wood frog and spotted salamander larvae for use in landscape genetic analyses began in the spring of 2014. During this time, 1190 wood frogs were collected from 60 sites and 1228 spotted salamanders were collected from 65 sites from throughout central and southern Maine. Collection of microsatellite data is underway with 12 loci being genotyped for wood frogs and 10 for spotted salamanders. The agent-based model simulation framework is currently under development with hypotheses being established and the details of the models being finalized.

During the last several months, I have worked with experts in epizootic shell disease, lobster biology and ecology, and disease ecology to finalize methods for sampling and analyzing lobster from the Gulf of Maine. Tissue samples for analyses will be obtained between March and April 2015 with laboratory analyses proceeding immediately afterward.

Investigators: Jared J. Homola (PhD)

Advisors: Cynthia S. Loftin (Co-Advisor)
Michael T. Kinnison(Co-Advisor)
Malcolm L. Hunter, Jr.
Timothy M. Waring
Andrew R. Whiteley

Duration: September 2013—May 2018

Cooperators:

Maine Department of Marine Resources
U.S. Geological Survey – Maine Cooperative Fish and Wildlife Research Unit
Maine Association of Wetland Scientists
NSF Adaptation to Abrupt Climate Change IGERT
Central Maine Power

An examination of the drivers, institutions and economics of sustainability planning in Maine

Investigator: Vanessa Levesque (PhD)

Advisors: Aram J.K. Calhoun (Co-Advisor)
Kathleen P. Bell (Co-Advisor)
Mario Teisl
Teresa R. Johnson
Dave Owen

Duration: January 2010—December 2014

Cooperators:

Maine Department of Environmental Protection
Maine Department of Inland Fisheries and Wildlife
University of Maine – Sustainable Solutions Initiative
Maine State Planning Office
Army Corps of Engineers
Topsham, Town of
Orono, Town of

1. Characterize sustainability policies in Maine municipalities and identify the drivers that lead to the adoption of such policies.
2. Study efforts of two Maine towns that are developing vernal pool regulatory policy, as an example of a sustainable policy.
3. Conduct economic policy analysis to inform local vernal pool policy development.

The project plan is as follows: 1) Examine patterns of adoption using spatial analysis and statistical classification; write article (January through June 1014); 2) Analyze interview transcripts; conduct network analysis; write papers (Oct 2013 through June 2014); and 3) Conduct economic policy analysis and present to vernal pool policy team for feedback (Oct through Dec 2013); Refine analysis and write paper (January through June 2014).

1. Collected several hundred land use, subdivision and zoning ordinances from Maine towns, and identified which towns have adopted specific policies that support sustainability. Collected independent variables about all Maine towns. Created excel spreadsheets compiling data collected.

2. Participant observation of all policy meetings regarding vernal pools. Developed, tested and carried out interview protocol with 27 vernal pool policy stakeholders. Began transcribing interviews and pulling out relevant themes.

3. Collected town data required for analysis, including GIS layers on zoning, vernal pools, growth zones, infrastructure, and natural resources. Collected property sales data for two towns. Developed research plan and began conducting analysis.

Assessing vulnerability of treeline ecosystems in the Sierra Nevada

1. Produce species distribution models for high-elevation white pine species–whitebark pine (*Pinus albicaulis*) and foxtail pine (*P. balfouriana*)–under current conditions and under projected climate change scenarios within Sierra Nevada Network national parks. Exploit the latitudinal gradient of environmental conditions and variety of management contexts among park units to discern relationships and provide a regional view.
2. Produce distribution models for the invasive pathogen, white pine blister rust under current conditions and under projected climate change scenarios within the parks.
3. Use these two sets of models to evaluate the potential effects of the two interacting stressors (climate change, pathogen) on the future distribution of high-elevation white pine species.

The high-elevation occurrence of whitebark pine and foxtail pine render these two species and the communities they define particularly vulnerable to continued trends in atmospheric warming. The non-native disease, white pine blister rust (WPBR) and its associated impacts on community dynamics pose the most severe near-term threat. Increased atmospheric warming and its secondary effects (e.g., large-scale mountain pine beetle outbreaks) present a potentially bleak long-term outlook for these species.

Projecting shifts in the climate envelopes of white pines and WPBR will inform long-term monitoring of high-elevation white pines. It will also help evaluate the long-term threat posed by WPBR to subalpine communities by determining the amount of potential future overlap between the ranges of the tree species and the pathogen. We expect that monitoring targets of species composition and demography, stand structure, and the incidence of WPBR will respond directly to alterations in temperature and moisture. Our products will assist in moving beyond determining status and trend by addressing causes of change in subalpine ecosystems, and will help park managers anticipate short- and long-term changes in high-elevation ecosystems. Modeling results will assist with characterizing the vulnerability of subalpine forest communities in Sierra Nevada national parks for use in adaptive management planning.

1. Data compilation and summarization describing abundance by species for each of 10 ecological and survey plot data sets. 2. Preparation of current climate surfaces for precipitation (PPT), monthly maximum temperature (Tmax), monthly minimum temperature (Tmin), and monthly mean temperature (Tmean). 3. Preparation of climate surfaces for 2050 and 2090 for the same climatic variables. 4. Construction of current distribution models for whitebark pine and foxtail pine based on climatic and topographic variables. 5. Comparison and ranking of competing current distribution models to inform variable selection for 2050 and 2090 distribution models.

Investigators: Shawn T. McKinney, Peggy Moore, Qinghua Guo, Otto Alvarez, Matthew Brooks

Duration: October 2010—September 2014

Cooperators:

National Park Service
U.S. Geological Survey – Biological Resources Discipline
U.S. Geological Survey – Maine Cooperative Fish and Wildlife Research Unit
University of California, Merced

Assessing Priority Amphibian and Reptile Conservation Areas (PARCAs) and vulnerability to climate change in the North Atlantic Landscape Conservation Cooperative

1. Gather reptile and amphibian species record data from states in the NE-LCC region to compile in a central data base.
2. Develop maps of current distributions of priority amphibians and reptiles in the NA-LCC region. Combine these maps with maps of climate change-projected habitat suitability maps.
3. Rank species vulnerability to climate change based projected losses in the species' ranges, and identify areas within the NA-LCC where losses of vulnerable species are anticipated, where there is potential for climatic refugia for priority species, and identify species for which gaps in current known distributional data prohibit these projections.
4. Identify conservation lands that fall within the priority amphibian and reptile areas identified in Objective 3, and identify areas with highest priority for supporting reptiles and amphibians in the Northeast that are not currently protected.
5. Incorporate climate vulnerability projections into final PARCA analysis, including a ranking of high priority current and future conservation areas.
6. Communicate results to key state, federal, and NGO partners via publications and a Northeast regional workshop.

Amphibians and reptiles are experiencing severe habitat loss throughout North America; however, this threat to biodiversity can be mitigated by identifying and conserving areas that serve a disproportionate role in sustaining herpetofauna. Identification of such areas must take into consideration the dynamic nature of habitat suitability. As climate rapidly changes it is possible that areas currently deemed suitable may no longer be so in the future. To address these needs, we are collaborating with scientists from Clemson University and the Association of Fish and Wildlife Agencies to generate spatially-explicit data that will (1) identify Priority Amphibian and Reptile Conservation Areas (PARCAs) – those discrete areas most vital to maintaining reptile and amphibian diversity, (2) project regions of current and future climatic suitability for a number of priority reptiles and amphibians in the North Atlantic Landscape Conservation Cooperative, and (3) identify gaps in distributional data for these species that may prevent or inhibit the identification of species-level climatic suitability.

We received species occurrence data from NA-LCC states and have nearly completed converting datasets into a spatial format. We compiled environmental spatial variable data layers spanning the NALCC region from a variety of sources and have begun applying them in species distribution models. We have two models sets representing levels of agreement among expert herpetologists of the variables' importance to the species' distribution predictions. We are developing models of suitable habitat for the target priority species with MaxEnt. We have run exploratory analyses to evaluate sensitivy of the PARCA delineation process to metric thresholds, species weightings, approaches for modeling species richness, alternative metrics to describe landsacpe viability, and alternative equations for combining SDMs and richness to identify proposed PARCAs. The final phase of the project will shift to drafting PARCAs to share with state experts for their review and revision, and combining the proposed PARCAs with species climate niche models to evaluate predicted distributions of climate suitable habitat with climate change.

Investigator: Allison Moody (Post-doc)

Advisor: Cynthia S. Loftin

Collaborators: Phillip deMaynadier
Kyle Barrett
Bill Sutton

Duration: August 2012—June 2016

Cooperators:

U.S. Fish and Wildlife Service
U.S. Geological Survey – Maine Cooperative Fish and Wildlife Research Unit
University of Maine
Maine Department of Inland Fisheries and Wildlife
Wildlife Management Institute

PUBLICATIONS and presentations

SCIENTIFIC PUBLICATIONS

Blomberg, E.J., D. Gibson, J.S. Sedinger, M.L. Casazza, and P.S. Coates. 2013. Intraseasonal variation in survival and cause-specific mortality of greater sage-grouse. *Wildlife Biology* 19:347-357.

Blomberg, E.J., J.S. Sedinger, D.V. Nonne, and M.T. Atamian. 2013. Annual male lek attendance influences count-based population indices of greater sage-grouse. *Journal of Wildlife Management* 78:1583-1592.

Blomberg, E.J., P.L. Wollf, and J.S. Sedinger. 2013. Geographic variation in liver metal concentrations of greater sage-grouse. *Journal of Fish and Wildlife Management* 4:298-302.

Blomberg, E.J., S.R. Poulson, J.S. Sedinger, and D. Gibson. 2013. Prefleding diet is correlated with individual growth in greater sage-grouse (*Centrocercus urophasianus). Auk* 130:715-724.

Blomberg, E.J., D. Gibson, M.T. Atamian and J.S. Sedinger. 2014. Individual and environmental effects on egg allocations of female Greater Sage-grouse. *The Auk: Ornithological Advances* 131:507-523.

Coates, P.S., M.L. Casazza, E.J. Blomberg, S. Gardner, S. Espinosa, M. Farinha, L.Wiechman, and B. Halstead. 2013. Evaluating space use of greater sage-grouse to identify area thresholds for surface use designation in sagebrush ecosystems. *Journal of Wildlife Management* 78:1598-1609.

Duffy, D.C., A. McKnight, and D.B. Irons. 2013. Trans-Andean passage of migrating Arctic terns over Patagonia. *Marine Ornithology* 41:155-159.

Fiedler, C.E., and S.T. McKinney. 2014. Forest structure, health, and mortality in two Rocky Mountain whitebark pine ecosystems: Implications for restoration. *Natural Areas Journal* 34:290-299.

Fuller, A.K. and D.J. Harrison. 2013. Modeling the influence of forest structure on microsite habitat use by snowshoe hares. *International Journal of Forestry Research*: Volume 2013, Article ID 892327, 7 pages, http://dx/doi.org/10.1155/2013/892327.

Gibson, D., E.J. Blomberg, G.L. Patricelli, A.H. Krakauer, M.T. Atamian, and J.S. Sedinger. 2013. The effects of radio-collars on male sage-grouse survival and lekking behavior. *Condor* 115:769-776.

Gibson, D., E.J. Blomberg, M.T. Atamian, and J.S. Sedinger. 2014. Lek fidelity and movement among leks by male Greater Sage-grouse: A capture-mark-recapture approach. *Ibis* 156:729-740.

Grote, A., M. Bailey, J. Zydlewski, J. Hightower. 2014. Multibeam sonar (DIDSON) assessment of American shad (*Alosa sapidissima)* approaching a hydroelectric dam. *Canadian Journal of Fisheries and Aquatic Sciences 71(4):545-558.*

Grote, A., M. Bailey, and J. Zydlewski. 2014. Migration and spawning behavior of American shad in the Penobscot River Maine. *Transactions of the American Fisheries Society* 143:552-563.

Guyette, M.Q., C.S. Loftin, J. Zydlewski, and R. Cunjak. 2014. Carcass analogues provide marine subsidies for macroinvertebrates and juvenile Atlantic salmon in temperate oligotrophic streams. *Freshwater Biology* 59:392-406. doi: 10.1111/fwb.12272.

Hogg, R., S. Coghlan., Jr., J. Zydlewski, and K. Simon. 2014. Anadromous sea lamprey (*Petromyzon marinus)* serve as ecosystem engineers in a coastal spawning tributary. *Freshwater Biology 59(6):1294-1307*.

Jansujwicz J.S., A.J.K. Calhoun, R. Lilieholm. 2013. The Maine Vernal Pool Mapping and Assessment Program: Engaging Municipal Officials and Private Landowners in Community-Based Citizen Science. *Environmental Management 52(6):1369-1385*. doi: 10.1007/s00267-013-0168.

Kazyak, D., B.H. Letcher, and J. Zydlewski. 2013. Growth variability of brook char (*Salvelinus fontinalis)* in coastal Maine. *Ecology of Freshwater Fish 23(4):516-526*. doi: 10.1111/eff.12105.

Kiraly, I., S. Coghlan, J. Zydlewski, and D. Hayes. 2014. A comparison of two sampling designs for fish assemblage assessment in a large river. *Transactions of the American Fisheries Society 143 (2):508-518*.

Kiraly, I., S. Coghlan, J. Zydlewski, and D. Hayes. 2014. An assessment of fish assemblage structure in a large river prior to dam removal. *River Research and Applications*. doi: *10.1002/rra.2738*.

Linden, D.W., and G.J. Roloff. 2013. Retained structures and bird communities in clearcut forests of the Pacific Northwest, USA. *Forest Ecology and Management* 310:1045-1056.

McCullough, I.M., C.S. Loftin, S.A. Sader. 2013. Landsat imagery reveals declining clarity of Maine's lakes during 1995-2010. *Freshwater Science* 32:741-752.

McKnight, A., A.J. Allyn, D.C. Duffy, and D.B. Irons. 2013. 'Stepping stone' pattern in Pacific Arctic tern migration reveals the importance of upwelling areas. *Marine Ecology Progress Series* 491:253-264.

Ryan, K., J. Zydlewski, and A. Calhoun. 2013. Using passive integrated transponder (PIT) systems for terrestrial detection of blue-spotted salamanders in situ. *Journal of Herpetology* 9(1):97−105.

Stich, D.S., M.M. Bailey, and J. Zydlewski. 2014. Survival of Atlantic salmon (*Salmo salar)* smolts through a hydropower complex in the lower Penobscot River, Maine USA. *Journal of Fish Biology 85(4):987-1296*. doi: 10.1111/jfb.12483.

Wang, G., N.T. Hobbs, N.A. Slade, J.F. Merritt, L.L. Getz, M.L. Hunter, Jr., S.H. Vessey, J.W. Witham and A. Guillaumet. 2013. Comparative population dynamics of large and small mammals in the Northern Hemisphere: Deterministic and stochastic forces. *Ecography* 36:439-446.

Zydlewski, J., G. Zydlewski, B. Kennedy, and W. Gale. 2014. Smolting in coastal cutthroat trout, (*Onchorhynchus clarkii clarkii). Journal of Fish Biology 85(4):1111-1130*. doi: 10.1111/jfb.12480.

Zydlewski, J., O. Cox, A. O'Malley, P. Ruksznis, and J. Trial. 2014. Growth and smolting in lower mode Atlantic salmon (*Salmo salar*) stocked into the Penobscot River, Maine. *North American Journal of Fisheries Management* 34:147-158.

TECHNICAL AND SEMI-TECHNICAL PUBLICATIONS

Harrison, D., S. Olson, D. Mallett, A. Fuller, and J. Vashon. 2014. Relationships among forest harvesting, snowshoe hares, and Canada lynx in Maine. Pages 57-62 *in* B.E. Roth, editor, Cooperative Forestry Research Unit: 2013 Annual Report, University of Maine, Orono.

Dunham, S., and D. Harrison. 2014. Patch occupancy, habitat use, and population performance of spruce grouse in commercially managed conifer stands. Pages 63-66 *in* B.E. Roth, editor, Cooperative Forestry Research Unit: 2013 Annual Report, University of Maine, Orono.

Loftin, C.S, R. Carey, and K. Goodine. 2014. The Maine Cooperative Fish and Wildlife Research Unit and University of Maine Department of Wildlife Ecology 2013 Annual Report to Cooperators. 50 pp.

Rolek, B., D. Harrison, and C. Loftin. 2014. Bird communities of coniferous forests in the Acadian Region: Habitat associations and response of birds to forest management. Pages 67-73 *in* B.E. Roth, editor, Cooperative Forestry Research Unit: 2013 Annual Report, University of Maine, Orono.

THESES AND DISSERTATIONS

Chapin, Shannon J. 2014. The application of spatial modeling tools to predict native bee abundance in Maine's lowbush blueberries. M.S. thesis, Ecology and Environmental Sciences, University of Maine, Orono, 55pp.

Cline, Brittany B. 2014. Amphibians in complex landscapes: Quantifying habitat connectivity for juvenile movements and dispersal. PhD. University of Maine, 152 pp.

Mallett, David. 2014. Spatial and habitat responses of Canada lynx in Maine to decline in snowshoe hare density. M.S. thesis, University of Maine, 196 pp.

Ryan, Kevin. 2014. Movement patterns, terrestrial habitat use, and conservation of New England's rarest amphibians: The Eastern Spadefoot (*Scaphiopus holbrookii*) and Blue-Spotted Salamander

(*Ambystoma laterale*). Doctoral Dissertation. University of Maine, 98 pp.

Ratten, Silas. 2013. Behavior, ecology, and restoration of lake whitefish (*Coregonus clupeaformis*) and arctic charr (*Salvelinus alpinus*) in Maine lakes. M.S. thesis, University of Maine, 59 pp.

PROFESSIONAL TALKS PRESENTED

Altenritter, M., G. Zydlewski, M. Altenritter, M. Kinnison, and J. Zydlewski. 2014. "Demographics and movement patterns of Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*) in the Penobscot River, Maine." Presented at 2014 Atlantic Salmon and Their Ecosystems Forum, University of Maine, January 8, Orono, ME.

Altenritter, M., G. Zydlewski, M. Kinnison, M. Dzaugis, J. Zydlewski, M. Altenritter. 2014. "Atlantic sturgeon movements and habitat use in the Penobscot River, with implications of dam removal." Presented at 144th Annual Meeting of the American Fisheries Society, August 17-21, Québec City, Canada.

Altenritter, M., M. Kinnison, G Zydlewski, J. Zydlewski, and M. Yates. 2014. "Assessing microchemical analysis of dorsal scutes to infer the origins and life histories shortnose sturgeon." Presented at 2014 Atlantic Salmon and Their Ecosystems Forum, University of Maine, January 8, Orono, ME.

Altenritter, M., M. Kinnison, G. Zydlewski, J. Zydlewski, and M. Yates. 2014. "Microchemical analysis of dorsal scutes to infer the origins and life histories of shortnose sturgeon." Presented at 144th Annual Meeting of the American Fisheries Society, August 17-21, Québec City, Canada.

Barrie A., C.S. Loftin, and J. Zydlewski. 2014. "Changes in Fish and mammals in the Bumbuna Hydroelectric Project, Sierra Leone." Northeast Fish and Wildlife Conference, April 13-15, Portland, ME. Poster.

Barrie, A., C. Loftin, and J. Zydlewski. 2014. "Changes in fish assemblages after completion of the Bumbuna hydroelectric dam on the Seli–Rokel River in Sierra Leone, West Africa." Presented at 144th Annual Meeting of the American Fisheries Society, August 17-21, Québec City, Canada.

Barrie, A., C.S. Loftin, and J. Zydlewski. 2014. "Changes in Fish and Mammals in the Bumbuna Hydroelectric project, Northern Sierra Leone, West Africa." Annual Coordinating Committee Meeting of the U.S. Geological Survey, Maine Cooperative Fish and Wildlife Research Unit, April 2, Orono, ME. Poster.

Barrie, A., C.S. Loftin, and J. Zydlewski. 2014. "Changes in fish assemblages after completion of the Bumbuna hydroelectric dam in Sierra Leone, West Africa." American Fisheries Society Annual Meeting, August 17-21, Quebec, Canada. Poster.

Blomberg, E. 2013. "Climatic processes influence the dynamics of a candidate species: Greater sage-grouse in the Great Basin." Presented at The Wildlife Society Annual Conference, October 8, Milwaukee, WI.

Chapin, S.J., C.S. Loftin, and F. Drummond. 2014. "Effects of landsacpe pattern and arrangement on native bee abundance in Maine's wild blueberries." Presentation at the 70th Annual Northeast Association of Fish and Wildlife Agencies, April 13-15, Portland, ME.

Clare, J.D.J., E.M. Anderson, D.M. MacFarland, B.L. Sloss, and T.W. Ginnett. 2013. "Relating bobcat detection, distribution, and density in central Wisconsin." Presented at The Wildlife Society National Conference, October 9, Milwaukee, WI.

deMaynadier, Phillip G., Derek Yorks, Beth I. Swartz, Trevor B. Persons, Jonathan D. Mays, Malcolm. L. Hunter, Aram J.K. Calhoun, and Mark McCollough. 2014. "The Maine Amphibian and Reptile Atlas Project: Keeping Track of Maine's Herpetofauna for 27 Years." Presented at Northeast Fish and Wildlife Conference, April 13, Portland ME.

Dever, M., J. Kocik, J. Zydlewski, D. Hebert, and B. Greenan. 2014. "Linkage between coastal conditions and migration of Atlantic Salmon smolts along the Halifax Line." Presentation at 144th Annual Meeting of the American Fisheries Society, August 17-21, Québec City, Canada.

Du Clos, B., C.S. Loftin, and F.A. Drummond. 2014. "Native bee communities in electric transmission easements of Washington County, Maine." Annual Coordinating Committee Meeting of the U.S. Geological Survey, Maine Cooperative Fish and Wildlife Research Unit, April 2, Orono, ME. Poster.

Du Clos, B.E., C.S. Loftin, and F. Drummond. 2014. "Native bee communities in electric transmission easements of Washington County, Maine." Poster presentation at the 70th Annual Northeast Association of Fish and Wildlife Agencies, April 13-15, Portland, ME.

Dunham, S. and D. Harrison. 2014. "Spruce grouse breeding season patch occupancy and home range comparisons across forest management treatments

in Maine." Presentation at 70th Northeast Fish and Wildlife Conference, April 14, Portland, ME.

Dunham, S. and D. Harrison. 2014. "Habitat selection of female spruce grouse during brood rearing in commercially managed forests." Presentation at Annual Meeting of the American Ornithologists Union, September 27, Estes Park, CO.

Durso, E, K. Hoffmann, A. Calhoun, M. Hunter. 2013. "Variation in Direction of Immigrating Breeding Amphibians into Vernal Pools in Maine." Poster presented at the Wildlife Society Annual Meeting, October 5-10, Milwaukee, WI.

Gardner, C. and J. Zydlewski. 2014. "Assessing the influence of stocking location and salinity acclimation in the Penobscot River on smolt to adult returns." Presentation at 2014 Atlantic Salmon and Their Ecosystems Forum, University of Maine, January 8, Orono, ME.

Goulette, G., J. Hawkes, and J. Zydlewski. 2014. "When is a smolt not a smolt? Identifying predation in the Penobscot River estuary using acoustic telemetry." Presented to 144th Annual Meeting of the American Fisheries Society, August 17-21, Québec City, Canada.

Goulette, G., J. Hawkes, and J. Zydlewski. 2014. "When is a smolt not a smolt? Identifying predation in the Penobscot River estuary using acoustic telemetry." Presented at 2014 Atlantic Salmon and Their Ecosystems Forum, University of Maine, January 8, Orono, ME.

Groff, L.A., A.J.K. Calhoun and C.S. Loftin. 2014. "Habitat Selection by Pool-breeding Amphibians in Maine's Montane Landscape." Presented at Annual Coordinating Committee Meeting of the US Geological Survey, Maine Cooperative Fish and Wildlife Research Unit, April 2, Orono, ME.

Groff, L.A., C.S. Loftin, and A.J.K. Calhoun. 2014. "Hibernation Ecology of *Lithobates sylvaticus* in Maine's Montane Landscape." Presented to the annual Northeast Association of Fish and Wildlife Agencies Conference, April 13-15, Portland, ME.

Groff, S.C., C.S. Loftin, and F.A. Drummond. 2014. "The application of spatial modeling tools to predict native bee abundance in Maine's lowbush blueberries." Presented to Northeast Fish and Wildlife Conference, April 13-15, Portland, ME.

Groff, S.C., C.S. Loftin, and F.A. Drummond. 2014. "The application of spatial modeling tools to predict native bee abundance in Maine's lowbush blueberries." Presented at Annual Coordinating Committee Meeting of the U.S. Geological Survey, Maine Cooperative Fish and Wildlife Research Unit, April 2, Orono, ME.

Groff, S.C., C.S. Loftin, and F.A. Drummond. 2014. "The application of spatial modeling tools to predict native bee abundance in Maine's lowbush blueberries." University of Maine's College of Natural Sciences, Forestry and Agriculture Graduate Students Awards Competition, February 27, Orono, ME.

Groff, S.C., C.S. Loftin, and F.A. Drummond. 2014. "The application of spatial modeling tools to predict native bee abundance in Maine's lowbush blueberries." Presented at Maine Department of Inland Fisheries & Wildlife Research and Assessment Section meeting, February 26, Bangor, ME.

Groff, S.C., C.S. Loftin, and F.A. Drummond. 2014. "Using GIS to predict solitary bee abundance in Maine's landscape." Presented at Organization of Fish and Wildlife Information Managers Annual Meeting, September 30, Flagstaff, AZ.

Harrison D. and E. Blomberg. 2014. "Population dynamics of spruce grouse on commercially managed forestlands in Maine: A proposal." Presentation at winter meeting of CFRU Advisory Committee, January 22, Orono, ME.

Harrison, D., S. Olson, S. Dunham, B. Rolek, and C. Loftin. 2014. "Updates of research findings from Studies of snowshoe hares, Canada lynx, spruce grouse and forest songbirds funded by the Maine Cooperative Forestry Research Unit (CFRU)." Presentation at winter meeting of CFRU Advisory Committee, January 22, Orono, ME.

Hogg, R., S. Coghlan Jr., K. Simon, and J. Zydlewski. 2014. "Anadromous Sea Lampreys Recolonize a Maine Coastal River Tributary After Dam Removal: Ecosystem Engineers?" Presentation at Oregon Chapter AFS meeting, February 25-28, Eugene OR.

Homola, J.J., M.T. Kinnison, C.S. Loftin, A.J.K. Calhoun, K.P. Bell, K. Capps, M.L. Hunter, D.M. Bauer, and E.J. Nelson. 2014. "Of pools and people: Application of vernal pool amphibian landscape genetics in a socio-environmental coupled-systems model." Poster presentation at the 70th Annual Northeast Fish and Wildlife Conference, April 13-15, Portland, ME.

Hunter, Malcolm. 2013. "Maintaining biodiversity in a period of uncertain climate change: Where are the trees and beetles going." Initial Roque Island Environmental Lecture, University of Maine at Machias, October 2, Machias, ME.

Hunter, Malcolm. 2014. "Should we actively assist tree species to shift their geographic ranges in response to climate change?" Presented to Forestry Guild, June 20, Burlington, VT.

Irish, B., J. Zydlewski, and R. Cunjak. 2014. "Marine-derived nutrient cycling in the St. Croix River, Maine." Presented at 2014 Atlantic Salmon and Their Ecosystems Forum, University of Maine, January 8, Orono, ME.

Irish, B., J. Zydlewski, and R. Cunjak. 2014. "Marine-derived nutrient cycling in the St. Croix River, Maine." Presented at 144th Annual Meeting of the American Fisheries Society, August 17-21, Québec City, Canada.

Izzo, L. and J. Zydlewski. 2014. "Upstream passage of anadromous species in the lower Penobscot River, ME; assessing the Milford fish lift using Dual Frequency Identification Sonar (DIDSON)." Presented at 144th Annual Meeting of the American Fisheries Society, August 17-21, Québec City, Canada.

Izzo, L. and J. Zydlewski. 2014. "Upstream passage of anadromous species in the lower Penobscot River; assessing the Milford fish lift using Dual Frequency Identification Sonar (DIDSON)." Presented at 2014 Atlantic Salmon and Their Ecosystems Forum, University of Maine, January 8, Orono, ME.

Kenney, S.R., B. Du Clos, and F.A. Drummond. 2014. "A Comparative Study of Urban and Forested Roadsides as Potential Bee Habitat." 2014 Maine EPSCoR High School Research Internship Poster Session. August 20, Orono, ME. Poster.

Kocik, J., J. Hawkes, D. Stich, J. Zydlewski, M. Dever, and C. Byron. 2014. "Migration Timing of Atlantic Salmon Smolts from Penobscot Bay to the Scotian Shelf." Presented at Atlantic Salmon and Their Ecosystems Forum, University of Maine, January 8, Orono, ME.

Linden, D.W. and S.T. McKinney. 2014. "Integrated population modeling of American black bears: An application of robust-design spatial capture-recapture combined with mark-recovery and recruitment." Presented at 4th International Statistical Ecology Conference, July 01, Montpellier, France.

Linden, Daniel W. and Shawn T. McKinney. 2013. "Improved inferences on population dynamics of black bears in Maine through integrated modeling." Presented at The Wildlife Society Annual Conference, October 6, Milwaukee, WI.

Loftin, C.S. and M.Q. Guyette. 2014. "A Bayesian belief network assessment of vegetation spatial dynamics in response to fire in the Okefenokee National Wildlife Refuge, Georgia, USA." Presentation at the Joint Aquatic Sciences Meeting, 18-23 May, Portland, OR.

Loftin, C.S., J.E. Kurth, and J. Rhymer. 2014. "Experimental PIT-tagging and translocation of Yellow Lampmussels (*Lampsilis cariosa*), Tidewater Muckets (*Leptodea ochracea*), and Eastern Lampmussels (*Lampsilis radiata radiata*) for removal of the Fort Halifax Dam on the Sebasticook River, Maine." Presentation at the Freshwater Mollusk Conservation Society 2014 Workshop, 24-25 April, Portland, ME.

Looze, B.E., C.S. Loftin, and F.A. Drummond. 2013. "Characterization of native pollinator habitat in electric transmission easements of Washington County, Maine. Landscape-level conservation in Downeast Maine: Collaborating for strategic effectiveness." Poster presented at the Schoodic Education and Research Center, October 23, Winter Harbor, ME.

Maynard, G. and J. Zydlewski. 2014. "Size selection of adult Atlantic salmon at fish passage facilities on the Penobscot River, Maine." Presented at 144th Annual Meeting of the American Fisheries Society, August 17-21, Québec City, Canada.

Maynard, G. and J. Zydlewski. 2014. "Size selection of adult Atlantic salmon at fish passage facilities on the Penobscot River, Maine." Presented at 2014 Atlantic Salmon and Their Ecosystems Forum, University of Maine, January 8, Orono, ME.

McCarthy, E., A. Moody, C.S. Loftin, and P. deMaynadier. 2014. "Effects of climate change and urbanization on core habitat for common Maine herpetofauna." Poster presentation at the 70th Annual Northeast Association of Fish and Wildlife Agencies, April 13-15, Portland, ME.

McKinney, S. T. and D. F. Tomback. 2014. "The viability of evolutionary rescue in natural populations." Presented to Society for Conservation Biology North America Congress for Conservation Biology, July 14, Missoula, MT.

Moody, A.T., B. Sutton, C. Loftin, P. deMaynadier, K. Barrett, and P. Nanjappa. 2014. "Assessing priority amphibian and reptile conservation areas in the North Atlantic Landscape Conservation Cooperative." Presentation at the 70th Annual Northeast Association of Fish and Wildlife Agencies, April 13-15, Portland, ME.

Olson, S. and D. Harrison. 2014. "Seasonal influences of vegetation on snowshoe hare pellet densities across forest management types in

Maine." Presentation at 70th Northeast Fish and Wildlife Conference, April 14, Portland, ME.

Olson, S. and D. Harrison. 2014. "Snowshoe hare response to seasonal changes in Acadian managed forests of northern Maine." Presentation at American Society of Mammalogy, June 10, Oklahoma City, OK.

O'Malley, A., J. Zydlewski, and D. DeGraaf. 2014. "Assessment of a hatchery based rainbow smelt (*Osmerus mordax)* and supplementation effort." Presentation at 70th Annual Northeast Fish and Wildlife Conference, April 14-15, Portland, ME.

O'Malley, A., J. Zydlewski, and D. DeGraaf. 2014. "Assessment of a hatchery based rainbow smelt (*Osmerus mordax)* and supplementation effort." Presented at 144th Annual Meeting of the American Fisheries Society, August 17-21, Québec City, Canada.

O'Malley, A., J. Zydlewski, O. Cox, P. Rukszni, and J. Trial. 2014. "The fate of lower mode Atlantic salmon (*Salmo salar)* stocked into the Penobscot River watershed." Presented at 70th Annual Northeast Fish and Wildlife Conference, April 14-15, Portland, ME.

Parkhill, N. S., D. Harrison, and S. Dunham. 2014. "Effects of forest vegetation on spruce grouse nest -site selection across 2 spatial scales." Poster at 70th Northeast Fish and Wildlife Conference, April 14, Portland, ME.

Rolek, B., C.S. Loftin, D. Harrison, and P.B. Wood. 2014. "The influence of silviculture on New England bird communities in northern coniferous forests." Presentation at the 70th Annual Northeast Association of Fish and Wildlife Agencies, April 13-15, Portland, ME.

Ryan, K. and A.J.K. Calhoun. 2014. "Post-breeding Habitat Use of the Rare Pure-Diploid Blue-spotted Salamander (*Ambystoma laterale)*." Presented at the Annual Northeast Association of Fish and Wildlife Agencies Conference, April 13-15, Portland, ME.

Shaidani, N., M.T. Kinnison, C.S. Loftin, L. Welch, and B. Connery. 2014. "The biogeographic origins and population structure of Maine's island red-backed salamanders (*Plethodon cinereus)*." Poster presented at the 70th Annual Northeast Fish and Wildlife Conference, 13-15 April, Portland, ME.

Simons-Legaard, E. and D. Harrison. 2014. "Trends in habitat conditions in LURC-zoned deer wintering areas: Implications for management of deer on commercially-owned forestlands." Invited presentation and panel discussion at Maine Industrial Forest Forum, February 16, Bangor, ME.

Stich, D., M. Bailey, and J. Zydlewski. 2014. "Expecting the Unexpected: Combined Effects of Dam Removal and Re-allocation of Hydropower on Atlantic Salmon Smolt Migrations." Presented at 144th Annual Meeting of the American Fisheries Society, August 17-21, Québec City, Canada.

Stich, D., M. Bailey, and J. Zydlewski. 2014. "Survival of Atlantic salmon smolts through a hydropower complex in the lower Penobscot River, Maine USA." Presented at 2014 Atlantic Salmon and Their Ecosystems Forum, University of Maine, January 8, Orono, ME.

Sutton, W.B., K. Barrett, A.T. Moody, C. Loftin, P. deMaynadier, P. Nanjappa. 2014. "Determining Vulnerability of Priority Amphibian and Reptile Conservation Areas in the North Atlantic Landscape Conservation Cooperative to Climate Change." Presentation at the 70th Annual Northeast Association of Fish and Wildlife Agencies, April 13-15, Portland, ME.

Weaver, D., S. Coghlan, and J. Zydlewski. 2014. "Effects of anadromous Sea Lamprey as vectors of marine-derived nutrients in freshwater ecosystems." Presented at 144th Annual Meeting of the American Fisheries Society, August 17-21, Québec City, Canada.

Weaver, D., S. Coghlan, and J. Zydlewski. 2014. "Anadromous sea lamprey (*Petromyzon marinus)* as vectors of marine-derived nutrients: Implications for dam removal and Atlantic salmon restoration." Presented at 2014 Atlantic Salmon and Their Ecosystems Forum, University of Maine, January 8, Orono, ME.

Weaver, D., S.M. Coghlan Jr., J. Zydlewski, and M. Canton. 2014. "Anadromous Sea Lamprey (*Petromyzon marinus)* as vectors of marine-derived nutrients." Presented at the Atlantic Salmon and their Ecosystems Forum, January 10, Orono, ME.

Witham, J. 2014. "From Forest to Farm and Back Again: Land Use History of Holt Research Forest." Presented at the Maine Master Naturalist Program, Maine Audubon, at Gisland Farm, February 12, Falmouth, ME.

Zydlewski, J. 2013. "Restoration of the Penobscot River- facts, fish and fantasy." Presentation at the University of New Brunswick Biology Seminar Series, November 22, Fredericton, New Brunswick, Canada.

Zydlewski, J. and D. Stich. 2014. "Hard Choices in Assessing Survival Past Dams Using Telemetry." Presented at 144th Annual Meeting of the American Fisheries Society, August 17-21, Québec City, Canada.

Zydlewski, J. and D. Stich. 2014. "Hard choices in assessing survival past dams using telemetry." Presented at 2014 Atlantic Salmon and Their Ecosystems Forum, University of Maine, January 8, Orono, ME.

PUBLIC TALKS PRESENTED

Groff, S.C., C.S. Loftin, and F.A. Drummond. 2014. "Using spatial modeling tools to predict native bee abundance in Maine's lowbush blueberries." Presented at Annual Celebration of the Life and Legacy of Dr. Edith Marion Patch - Earth Day Reception, April 27, Orono, ME.

Maynard, G. and J. Zydlewski. 2014. "Recovery of American shad in the Penobscot River." Presented to Eddington Salmon Club, June 4, Eddington ME.

WORKSHOPS, NEWSPAPER, RADIO, TELEVISION INTERVIEWS/ARTICLES, AND OUTREACH

Blomberg, E. 2014. "The role of climatic processes in governing the population dynamics of greater sage -grouse in the Great Basin." Western Associations Sage and Columbian Sharp-tailed grouse Workshop, June 19, Elko, NV.

Blomberg, E.J. and B. Allen. 2014. "Ruffed Grouse in Maine". Live interview on Maine Outdoors Radio Program, aired 3 August.

Blomberg, E.J. and K. Sullivan. 2014. "State, UMaine biologists embark on ambitious grouse research project". Interview and field site visit for staff writer and photographer from the Bangor Daily News. Story and video featured online on 11 September and in print 14 September.

Blomberg, E.J. 2014. "Maine Grouse Study Underway". Interviewed by the Maine Public Broadcasting Network. Aired on MPBN Radio and online 14 September.

Du Clos, B. 2014. "Bees in the landscape surrounding wild blueberry fields." University of Maine Cooperative Extension Wild Blueberry Field Day, July 16, Jonesboro, ME.

Hunter, Malcolm. 2014. "What is the importance of conserving old forests?" Workshop on Land Trusts and Forestry, February 12, Holden, ME.

AWARDS

Du Clos, B. and C.S. Loftin. 2014. Increasing parameter accuracy of an agriculturally-focused, spatially-explicit bee abundance model. US Department of Agriculture Northeast Sustainable Agricultural Research and Education Program.

Groff, L. 2013. YR4 Research Grant, Maine's Sustainability Solutions Initiative.

Groff, L. 2013. Supplemental Grant, Maine's Sustainability Solutions Initiative.

Groff, L. 2013. Graduate Student Government Travel Award, University of Maine.

Groff, S.C. 2014. Outstanding Graduate Student Award; University of Maine, Department of Wildlife Ecology.

Groff, S.C. 2014. Norris Charles Clements Graduate Student Research Award; University of Maine, College of Natural Sciences, Forestry and Agriculture.

Groff, S.C. 2014. Edith M. Patch Distinguished Woman in Science Award; Friends of Edith M. Patch.

Homola, J. May 2014. Maine Association of Wetland Scientists Research Stipend, $500.

Homola, J., K. Tanaka, and S.L. Belknap. 2014. Shell disease in Gulf of Maine American lobster: Identification of infection-promoting agents and projections for an expanding epizootic. University of Maine Adaptation to Abrupt Climate Change IGERT.

Homola, J. 2014. University of Maine School of Biology and Ecology Graduate Student Travel Award.