Maine Cooperative Fish and Wildlife Research Unit and Department of Wildlife Ecology, University of Maine

2013 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 McCollough 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: Jennifer Cote, School of Food and Agriculture, the University of Maine

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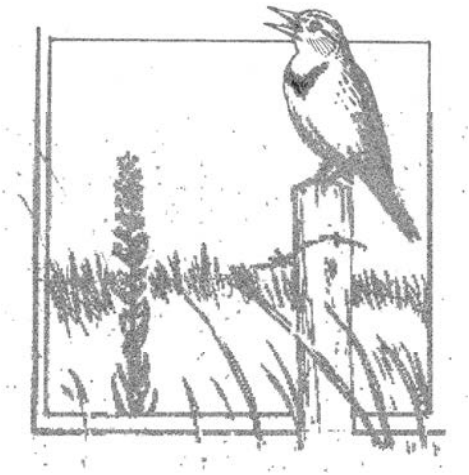
MISSION statement

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 coordinated 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 Ecology 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 28 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. 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; and 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 34 graduate students, and 3 graduate students completed requirements for M.S. or Ph.D. degrees. Our recent graduates are working for universities, state and federal agencies, and environmental consulting firms, as well as pursuing additional graduate degrees.

The year brought several changes to the Unit and its cooperators. Dr. Judith Rhymer retired from the University of Maine after 18 years as a faculty member where she also served as Chair of the Department of Wildlife Ecology for the past 1.5 years. Dr. Daniel Harrison assumed the Chair position in September 2013. We welcomed Dr. Erik Blomberg as an Assistant Professor in October 2013 and Dr. Faren Wolter as a Lecturer in August 2013. Dr. Blomberg is a population ecologist with particular interest in gallinaceous birds, and Dr. Wolter's teaching focuses on wildlife policy and human dimensions of wildlife management. The Maine Department of Inland Fisheries and Wildlife (MDIFW) also welcomed new staff to their programs. During the past year we have had opportunities to build relationships with MDIFW, and we look forward to continuing to work with them to address their resource management information needs. Sadly, our Department bid farewell to Dr. Linda Ilse who passed away after courageously battling cancer. Linda served as an Adjunct Instructor and Assistant Research Professor and taught our sophomore-level Ecology course for several years.

Undergraduate student s enrollments in Wildlife Ecology have nearly doubled in the past 3 years to approximately 125 students, providing new challenges, expanded course and advising responsibilities, and exciting new opportunities for our growing Department. The Wildlife Ecology Department also continues to be the administrative home for the Ecology and Environmental Sciences 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 that growing program. Other changes are on the horizon for the department, as plans develop for a future faculty hire and to address growing undergraduate and graduate enrollments, anticipated faculty retirements, and serious budget challenges.

The Unit and Department look forward to another year 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 Ecology

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. W. James Fleming, Acting 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 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

Connecticut Department of Energy and Environmental Protection

Cooperative Fish and Wildlife Research Unit, University of Massachusetts

Eastern Maine Conservation Initiative

Holt Woodlands Research Foundation

International Joint Commission on the St. Croix Waterway

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

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 Ecology

University of Maine – Electrical and Computer Engineering Department (ECE)

University of Maine – Maine Agricultural and Forest Experiment Station

University of Maine – Maine Cooperative Forestry Research Unit

University of Maine – Senator George J. Mitchell Center for Environmental and Watershed Research

University of Maine – Sustainable Solutions Initiative

UNIVERSITY OF MAINE COLLABORATORS

Department of Wildlife Ecology

Daniel J. Harrison, *Chair, Professor*

Aram J.K. Calhoun, *Professor*

Stephen M. Coghlan, Jr., *Assistant Professor*

Malcolm L. Hunter, Jr., *Professor*

William B. Krohn, *Professor Emeritus*

Dawn E. Morgan, *Research Associate*

Judith M. Rhymer, *Professor Emeritus*

Frederick A. Servello, *Professor*

Lindsay C.N. Seward, *Instructor*

Jack W. Witham, *Assistant Scientist*

Faren Wolter, *Lecturer*

School of Biology & Ecology

Francis A. Drummond, *Professor*

Michael T. Kinnison, *Associate Professor*

Brian J. McGill, *Assistant Professor*

Brian J. Olsen, *Assistant Professor*

School of Earth and Climate Sciences

Andrew S. Reeve, *Professor*

School of Economics

Kathleen P. Bell, *Associate Professor*

Mario Teisl, Director, *Professor*

School of Forest Resources

Alan J. Kimball, *Associate Professor*

Robert S. Seymour, *Curtis Hutchins Professor of Forest Resources*

Alan S. White, *Professor*

School of Marine Sciences

Teresa R. Johnson, *Assistant Professor*

Gayle B. Zydlewski, *Associate Professor*

Department of Mathematics & Statistics

David E. Hiebeler, *Associate Professor*

EXTERNAL COLLABORATORS

Michael M. Bailey, *Fish Biologist, U.S. Fish and Wildlife Service*

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 Acting Unit Leader, NY Cooperative Fish and Wildlife Research Unit*

Joseph E. Hightower, *Assistant Unit Leader—Fisheries, NC Cooperative Fish and Wildlife Research Unit*

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*

Dave Owen, *Professor, University of Maine School of Law*

Donna L. Parish, *Research Professor and Unit Leader, VT Cooperative Fish and Wildlife Research Unit*

Kevin S. Simon, *School of Environment, University of Auckland*

Brad Timm, *Department of Environmental Conservation, University of Massachusetts*

Jennifer H. Vashon, *Wildlife Biologist, Maine Department of Inland Fish and Wildlife*

Karen Wilson, *Assistant Research Professor, Department of Environmental Science and Aquatic Systems Research Group, University of Southern Maine*

Petra B. Wood, *Adjunct Professor, 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 – Present)
Sarah Drahovzal, MS (September 2008 – May 2013)
Brianne Du Clos, PhD (September 2012 – Present)
Luke Groff, PhD (January 2011 – 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)
Ann Grote, MS (January 2010 – May 2013)
Robert Hogg, MS (October 2009 – May 2013)
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 – Present)
Daniel Stich, PhD (March 2011 – Present)
Daniel Weaver, PhD (May 2013 – Present)

RECENT GRADUATES AND CURRENT PURSUITS

Student, Degree, Curriculum	*Graduate Date, Advisor(s)*
 **Sarah Drahovzal**, MS, Ecology and Environmental Sciences Biologist, Kleinschmidt Associates, Pittsfield, ME	May 2013 Cynthia S. Loftin, Judith M. Rhymer
 **Ann Grote**, MS, Wildlife Ecology US Fish and Wildlife Service, Washington	May 2013 Joseph D. Zydlewski
 **Margaret Guyette**, Postdoctoral Associate Postdoctoral Research Associate, University of Wisconsin-Madison	September 2013 Cynthia S. Loftin
 **Robert Hogg**, MS, Wildlife Ecology Oregon Fish and Wildlife	January 2013 Stephen M. Coghlan, Jr., Joseph D. Zydlewski
 **Doug Sigourney**, Postdoctoral Associate NOAA Affiliate, Woods Hole	January 2013 Joseph D. Zydlewski

CURRENT STUDENTS & POSTDOCS

Student, Degree, Curriculum	*Advisor(s)*
Abdulai Barrie, MS, Wildlife Ecology	Cynthia S. Loftin, Joseph D. Zydlewski
Erynn Call, PhD, Wildlife Ecology	Malcolm L. Hunter, Jr.
Krista Capps, Postdoctoral Associate	Aram J.K. Calhoun, Malcolm L. Hunter, Jr
Shannon Chapin, MS, Ecology and Environmental Sciences	Cynthia S. Loftin, Francis A. Drummond
John Clare, PhD, Wildlife Ecology	Shawn T. McKinney
Brittany Cline, PhD, Wildlife Ecology	Malcolm L. Hunter, Jr.
Brianne Du Clos, PhD, Ecology and Environmental Sciences	Cynthia S. Loftin, Francis A. Drummond
Rachel Dunham, Master of Wildlife Conservation	Malcolm L. Hunter, Jr.
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.
Betsy Irish, PhD, Wildlife Ecology	Joseph D. Zydlewski
Lisa Izzo, MS, Wildlife Ecology	Joseph D. Zydlewski
Vanessa Levesque, PhD, Ecology and Environmental Sciences	Aram J.K. Calhoun, Kathleen P. Bell
Daniel Linden, Postdoctoral Associate	Shawn T. McKinney
David Mallett, MS, Wildlife Ecology	Daniel J. Harrison
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
Sheryn Olson, MS, Wildlife Ecology	Daniel J. Harrison
Andrew O'Malley, MS, Wildlife Ecology	Joseph D. Zydlewski
Margaret Owens, Master of Wildlife Conservation	Malcolm L. Hunter, Jr.
Jennifer Raber, Master of Wildlife Conservation	Malcolm L. Hunter, Jr.
Silas Ratten, MS, Wildlife Ecology	Joseph D. Zydlewski
Brian Rolek, PhD, Wildlife Ecology	Cynthia S. Loftin, Daniel J. Harrison
Kevin Ryan, PhD, Wildlife Ecology	Aram J.K. Calhoun
Daniel Stich, PhD, Wildlife Ecology	Joseph D. Zydlewski
Alyssa Vitale, MS, Wildlife Ecology	Shawn T. McKinney
Daniel Weaver, PhD, Wildlife Ecology	Stephen M. Coghlan, Jr., Joseph D. Zydlewski
Connor Wood, MS, Wildlife Ecology	Shawn T. McKinney

FISHERIES and aquatic

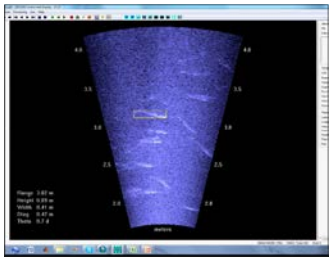
Establishing baselines for American shad in the Penobscot River

1. Develop age and length distributions of adult American shad in Penobscot River via electrofishing.
2. Characterize spawning migratory behavior and habitat use with radio and acoustic telemetry.
3. Generate a length frequency distribution of fish approaching Veazie Dam using high definition imaging sonar (DIDSON technology).
4. Generate a population estimate for American shad in the Penobscot River using a novel application of radio telemetry and DIDSON technology.

Abstract: The Penobscot River is currently the subject of an intensive river restoration effort. Under the Penobscot River Restoration Project (PRRP), the two lowest dams in the system, Veazie Dam (rkm 48) and Great Works Dam (rkm 60), will be removed. Great Works Dam was dismantled in the summer of 2012, and Veazie Dam is scheduled for demolition by 2014. This study examined the migratory movements, and age and spawning structure of American shad (*Alosa sapidissima*) in the Penobscot River prior to dam removal. Although shad were historically abundant in the system, little is known about the current-day population which was presumed to be small. This decline is attributed to a lack of migratory connectivity and accessible habitat; American shad do not pass the Veazie fishway, and freshwater spawning habitat (15 rkm) and brackish rearing habitat (□ 50 rkm) are limited below the dam. It is anticipated that the Penobscot River shad will benefit from restored connectivity and access to upriver freshwater habitats.

In the spring of 2011, a Dual-Frequency Identification Sonar (DIDSON) was used to record footage of fish approaching the entrance of the Veazie Dam fishway. Fork lengths (FLs) from high-quality images were measured, and the resulting FL distributions were compared against known length distributions of river herring, American shad, and Atlantic salmon using a Bayesian mixture model. The model classified over 76% of fish observations as American shad, and attributed 16% to Atlantic salmon and 8% to river herring. These results indicate shad were present at the base of dam. However, because the imaged fish were not uniquely identifiable and may have been imaged repeatedly, abundance at the base of the dam cannot be inferred from these proportions.

A combination of radio and acoustic telemetry was used to investigate the movements of migratory American shad in the springs of 2010 and 2011. Radio telemetry results indicate that few tagged shad (5 – 8 %) approached the Veazie Dam, but that those who did investigated the dam on at least two days. Tagged fish exhibited three main movement patterns in freshwater: using the upper end of the radio array above rkm 43, using the lower end of the array near rkm 34, or using the entire array. Mean freshwater residence time in freshwater ranged from 9.1 to 14.0 days. "Hotspots" where shad congregated included Eddington Bend (rkm 47) and the Bangor Dam headpond (rkm 44), and spawning activity was observed at the latter site. Freshwater survival and survival to the estuary were at least 71%. The high survival rate was confirmed the ageing and spawning histories obtained from shad scales, which indicated that 75 – 95% of the sampled fish were repeat spawners, and that adult migrants ranged from age 4 – 9. Acoustic tagged fish exhibited a series of upstream and downstream reversals upon entering the lower estuary. These movements were previously unreported for American shad, and may be related to osmoregulatory acclimatization for re-entry into saltwater, to the resumption of post-spawn feeding activity or both.



Investigator: Ann Grote (MS)

Advisors: Joseph D. Zydlewski (Co-Advisor)
Michael M. Bailey (Co-Advisor)
Joseph E. Hightower
Daniel J. Harrison

Duration: January 2006—May 2013

Cooperators:

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

Barrier removal and range expansion of anadromous sea lamprey

1. Characterize fish community changes (species, size, abundance, distribution, etc) in response to barrier removals.
2. Evaluate abundance, size-structure, habitat use, and nest fidelity of spawning sea lamprey.
3. Characterize fine scale changes to stream-bed in response to sea lamprey nest construction.
4. Characterize changes to aquatic invertebrate community in response to sea lamprey spawning activities

Abstract: Sedgeunkedunk Stream, a 3rd-order tributary to the Penobscot River, historically supported several anadromous fishes including Atlantic salmon *Salmo salar*, alewife *Alosa pseudoharengus*, and sea lamprey *Petromyzon marinus*. However, two small dams constructed in the 1800s reduced or eliminated spawning runs entirely. In 2009, efforts to restore marine–freshwater connectivity in the system culminated with removal of the lowermost dam thus providing access to an additional 4.6 km of lotic habitat. Because sea lampreys utilized accessible habitat prior to dam removal, they were chosen as a focal species to quantify recolonization. During spawning runs of 2008 through 2011 (pre- and post-dam removal), individuals were marked with PIT tags and their activity was tracked with daily recapture surveys. Open-population mark-recapture models indicated a four-fold increase in the annual abundance of spawning-phase sea lampreys with estimates rising from 59 ± 4 (SE) pre-dam removal (2008) to 223 ± 18 and 242 ± 16 post-dam removal (2010 and 2011 respectively). Accompanying the marked increase in annual abundance, we observed a nearly three-fold increase in nesting sites rising from 31 nests pre-dam removal (2008) to 128 and 131 nests post-dam-removal (2010 and 2011 respectively). Sea lampreys took six days to move past the former dam and nine days to expand into the furthest upstream reaches during the initial 2010 recolonization event. Conversely, sea lampreys took only three days to penetrate into the upstream reaches during the second post-dam removal spawning run suggesting a potential positive feedback in which larval recruitment into the system may have attracted adult spawners with conspecific pheromone cues. Although more research is needed to verify the migratory pheromone hypothesis, our study clearly demonstrates that small stream dam removal in coastal river systems has the potential to enhance recovery of declining anadromous fish populations

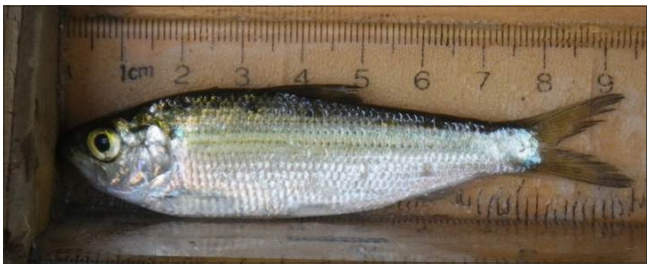
Investigator: Robert Hogg (MS)

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

Duration: January 2010—August 2012

Cooperators:

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



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 summer of 2013 over a wide spatial scale. These samples are currently being prepared for analysis and run for stable isotope ratios. The results of these data will be used to inform more targeted sampling in 2014.

Investigator: Betsy Irish (PhD)

Advisors: Joseph D. Zydlewski (Advisor)

Duration: May 2012—October 2017

Cooperators:

International Joint Commission on the St. Croix Waterway

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)

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.

Initial sampling was carried out in the spring and summer of 2013, and thermal marking of the otolith has shown the most promise as a technique. Samples from stocked lakes are being sorted and will provide information as to post stocking survival. The results of these data will be used to inform more targeted sampling in 2014.

Investigator: Andrew O'Malley (MS)

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

Duration: May 2012—October 2016

Cooperators:

Maine Department of Inland Fisheries and Wildlife

Maine Outdoor Heritage Fund

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.

Lake whitefish (*Coregonus clupeaformis*) and Arctic charr (*Salvelinus alpinus*) are native species of substantial historical and recreational importance in Maine. A combination of creel census and annual inventory data collected by Maine Department of Inland Fisheries and Wildlife (MDIFW) indicate lake whitefish and Arctic charr are both experiencing population declines. These findings prompted extensive restoration efforts, including hatchery programs and subsequent reintroductions of these species. This research will provide critical information regarding these lake whitefish and Arctic charr populations.

Acoustic telemetry will be used to characterize lake whitefish and Arctic charr movements. In concert with these efforts, temperature logger arrays will be deployed to provide a better characterize the thermal dynamics of the study lakes. Growth of lake whitefish in St. Froid and Clear Lakes will be assessed through otolith and scales collection. The efficacy of acoustic sonar (DIDSON) to document spawning will be evaluated in Clear Lake. Lastly, an autonomous underwater vehicle (AUV) will be utilized to collect physical habitat data to be incorporated into a habitat model in order to identify potential spawning habitat for lake whitefish in St. Froid Lake.

Lake whitefish otolith and scale samples were collected in 2010, 2011, and 2012 for age and growth analysis. Acoustic receivers were deployed in St. Froid Lake(15) and Clear Lake(5) to passively track movements of tagged lake whitefish. Seven lake whitefish have been tracked since 2009 in Clear Lake and additional fish are anticipated to be tagged in the winter of 2012-2013. Thirteen lake whitefish were tagged in St. Froid Lake. In the winter of 2012 an additional seven lake whitefish will be tagged in St. Froid Lake. In an analogous manner, acoustic receivers were deployed in Big Reed Pond to passively track the movements of Arctic charr. In the fall of 2011, ten sub-adult Arctic charr were tagged and released. Vertical temperature and light data logger arrays were deployed within each lake system to monitor thermal dynamics and relative light levels (to indicate ice cover). Retrieval of receivers from all of these sites in spring of 2013 will provide the data necessary for final analysis.

Investigator: Silas Ratten (MS)

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

Duration: January 2010—November 2013

Cooperators:

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

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 Ecology
National Fish and Wildlife Foundation
Penobscot River Restoration Trust
U.S. Fish and Wildlife Service
Penobscot Indian Nation

Anadromous sea lamprey (*Petromyzon marinus*) as vectors of marine-derived nutrients: Implications for dam removal and Atlantic salmon restoration

1. Characterize the role of adult sea lamprey as vectors of marine-derived nutrients in small streams
2. Understand the degree to which juvenile sea lamprey fix nutrients in a small stream

Historically, many freshwater systems in Maine 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. Sedgeunkedunk Stream, a 3rd order tributary to the Penobscot River, historically supported several anadromous fish species including sea lamprey and endangered Atlantic salmon. Several small dams constructed in the late 1800s reduced or eliminated spawning runs entirely. As of late 2009, a small population of sea lamprey used the accessible portion of Sedgeunkedunk regularly for spawning. Efforts to restore marine–freshwater connectivity in this system have included the construction of a rock-ramp fishway at 6 in 2008 and the removal of a dam in 2009. The latter has opened up 5 km of lotic habitat and facilitated recolonization and range expansion of sea lamprey, resulting in quadrupling of abundance of spawning adults after 4 years. We hypothesize that sea lamprey will contribute an influx of marine-derived nutrients thereby increasing primary and secondary production in the system.

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. Replicates of each treatment were sampled at 1, 2, and 3 weeks post carcass-addition and measured for chlorophyll a using spectrophotometry. We observed chlorophyll a biomass increase 57 – 71% in response to carcass additions, alleviating stream nitrogen limitations. To supplement our field experiment, we examined decay rates and corresponding water enriching effects of decomposing sea lamprey at 15, 20, and 25°C over a 45-day period in a controlled laboratory experiment. We found that the majority of total soluble phosphorous leached from carcasses within one week, and ammonium within three weeks. It is evident that nutrients from decomposing carcasses are vital for primary productivity in oligotrophic streams and are likely assimilated by other aquatic organisms. This research adds to a growing body of knowledge that may help predict the effects of sea lamprey recovery on aquatic communities and aid management decisions for Atlantic salmon and fish passage restoration.

Investigator: Daniel Weaver (PhD)

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

Duration: Ongoing—December 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 Ecology
U.S. Geological Survey – Maine Cooperative Fish and Wildlife Research Unit
Penobscot Valley Audubon Chapter
National Oceanic and Atmospheric Administration
The Nature Conservancy

Effects of aluminum on Atlantic smolt migration and physiology

1. Determine the impact of current fresh water acid-Al conditions on seawater tolerance of hatchery and wild Atlantic salmon smolts.
2. Use gill Al and Na+,K+-ATPase as biomarkers to connect current acid-Al conditions to impacts on salmon parr and smolts, and as a monitoring tool for assessing the potential beneficial effects of liming.

To examine the impacts of acid-Al on naturally reared (wild) migrating Atlantic salmon smolts, we will sample smolts as they migrate downstream in spring and subject them to a seawater challenge test. Once per year at each of six sites, 12 fish will be sampled non-lethally in freshwater for measurement of gill Al and gill Na+,K+/ATPase activity. An additional 12 fish will be transferred into 35 ppt seawater using water-jacketed tanks and river water to maintain appropriate temperature. After 24 hours in seawater animals will be bled for measurement of plasma chloride, allowed to recover for several hours in fresh water and released. Water chemistry data (field pH, aluminum (total, organic and inorganic), dissolved organic carbon (DOC) and Acid Neutralizing Capacity (ANC)) will be collected at each site at the time of fish collection. These studies will be conducted in spring 2011, 2012 and 2013.

In order to directly determine the impact of current water chemistry conditions on Atlantic salmon, we will hold hatchery smolts in cages at targeted field sites and subject them to a seawater challenge test after six days of exposure. Eight sites in Maine with known water chemistry representing a range of water chemistry were chosen. In late April, Penobscot River origin hatchery smolts will transferred to cages and then sampled after 5 d. Such data will allow us to determine if acid-Al conditions may be excluding salmon populations from these streams.

This work was initiated in 2012 and sampling was carried out using both naturally migrating Atlantic salmon smolts and "caged" smolts. In 2013, hatchery Atlantic salmon smolts were sampled in six streams. Sample assessment and analysis are in progress.

Investigator: Andrew Weinstock (PhD)

Advisors: Stephen McCormick (Co-Advisor)
Joseph D. Zydlewski (Co-Advisor)

Duration: January 2011—October 2015

Cooperators:

Maine Department of Inland Fisheries and Wildlife
Maine Department of Marine Resources
U.S. Geological Survey – Maine Cooperative Fish and Wildlife Research Unit
U.S. Fish and Wildlife Service
U.S. Geological Survey – Biological Resources Discipline

WILDLIFE and habitats

WILDLIFE and habitats continued

Environmental assessment of circumneutral fens with shrubby cinquefoil (*Dasiphora fruticosa*): Host plant of the endangered Clayton's copper butterfly (*Lycaena dorcas claytoni*)

1. Compare hydroperiod, pore water chemistry, peat chemistry/morphology, and plant species associated with shrubby cinquefoil among wetlands sites and between wetland sites inhabited and uninhabited by Clayton's copper butterfly.
2. Compare age structure, phenology, and size of stand among shrubby cinquefoil populations and between populations inhabited and uninhabited by Clayton's copper.
3. Compare morphology/robustness, quality of flowers and leaves, and location of shrubby cinquefoil plants within wetlands inhabited and uninhabited by Clayton's copper.

Abstract: Clayton's copper butterfly (*Lycaena dorcas claytoni*) is a Maine state endangered species that relies exclusively on shrubby cinquefoil (*Dasiphora fruticosa*) as its host plant. This shrub typically is found on the edges of wetlands rich in calcium carbonate or limestone. Calcareous wetland habitats that support large, persistent stands of *D. fruticosa* are rare in Maine (McCollough et al. 2001). Currently only 21 sites in Maine are known to support large stands of *D. fruticosa*, and *L. d. claytoni* populations have been observed at only nine of these. Because nearly the entire global range of this butterfly is in Maine, it is critical that Maine assumes the primary role in the conservation of this rare subspecies.

Conservation of *L. d. claytoni* depends in part on the ecological integrity of its habitat. Vegetation structure and hydrological conditions in wetlands may affect the distribution and robustness of *D. fruticosa*, which also may influence its use as a host plant by *L. d. claytoni*. I conducted field studies in 2009 and 2010 in ten wetlands in Maine with robust stands of *D. fruticosa* to evaluate pore water nutrients, hydrological conditions, shrub and tree species composition and distribution, and *D. fruticosa* distribution, structure, age and condition; seven of these wetlands support populations of *L. d. claytoni*, and three of these wetlands are unoccupied. I identified five hydrological types based on differences in water source and surface and ground water dynamics. Three wetlands were dominated by groundwater discharge, six wetlands were down-flow dominant, and one wetland fluctuated between groundwater discharge and recharge. Pore water analytes reflected hydrogen ion and conductivity gradients among the wetlands and vegetation community distributions within the wetlands, however, these differences did not reflect wetland occupation of *L. d. claytoni*. *Dasiphora fruticosa* age ranged from 7 to 37 years. Previously reported *Lycaena dorcas claytoni* encounter rates were greater in wetlands containing larger *D. fruticosa* plants of intermediate age and with greater bloom density. Butterflies are able to differentiate among glucose, fructose and sucrose in nectar. I found *D. fruticosa* produces hexose dominant nectar (sucrose/[glucose + fructose] □ 0.1), with only trace amounts of sucrose measured in □ 3% of the samples. Conservation and recovery of *L. d. claytoni* depends in part on the quality and distribution of its habitat. Although Maine's wetlands hosting *L. d. claytoni* currently support robust stands of *D. fruticosa*, their isolation likely limits movement of the butterfly. Increased connectivity among wetlands containing shrubby cinquefoil may aid dispersal and improve likelihood of long-term *L. d. claytoni* population.

Investigator: Sarah A. Drahovzal (MS)

Advisors: Cynthia S. Loftin (Co-Advisor)
Judith M. Rhymer (Co-Advisor)
Francis A. Drummond
Andrew S. Reeve

Duration: September 2008—May 2013

Cooperators:

Maine Outdoor Heritage Fund
Maine Department of Inland Fisheries and Wildlife
The Nature Conservancy
U.S. Geological Survey – Maine Cooperative Fish and Wildlife Research Unit
University of Maine – Maine Agricultural and Forest Experiment Station
University of Maine – Department of Wildlife Ecology

Assessment of vegetation succession and spatial dynamics in Okefenokee Swamp, Georgia

1. Establish a current vegetation map of the Okefenokee Swamp documenting post-2011 fire vegetation regrowth.
2. Use the new and previously created vegetation (1977, 1990, 2001, 2008) and fire perimeter and severity (1974-2011) maps to conduct an assessment of vegetation change with fire.
3. Use a Bayesian Belief Network approach to develop a spatially explicit forecast of vegetation succession with various swamp fire management scenarios. This approach will spatially relate environmental factors (fire and hydrology) with vegetation community composition in a Geographic Information System to develop spatial projections of vegetation change with swamp fire management.

Fire is a natural process in Okefenokee Swamp, where extensive as well as small and isolated fires have burned throughout the past several thousand years. Large fires, several of which have occurred in the past two decades, immediately alter the swamp vegetation structural complexity across a large area. However, fires during recent decades illustrate that the system is resilient to these disturbances, and vegetation rapidly regrows. Promptly capturing information to chronicle this recovery is critical to understanding the role of fire in the Swamp. Remote sensing technologies provide an invaluable record for rapidly assessing extent and effect of these fires on the Okefenokee National Wildlife Refuge vegetation communities, and these tools have improved greatly in recent decades. Our time series of satellite imagery interpretations of vegetation composition and change combined with archived fire extent and severity interpretations provide critical information that has enhanced our understanding of the Swamp's adaptive capacity to fire.

Large-scale fires in the past decade have changed the vegetation of the Okefenokee National Wildlife Refuge, and there is now greater structural diversity in vegetation with greater interspersion of patches with increased shape complexity. The three recent fires (in 2002, 2007, and 2011) were similar in relative proportion of total area burned at each severity level, although the 2002 fire burned less than ½ the total area of the 2007 and 2011 fires. Spatial distribution of burn severity levels and burn pattern metrics are relatively consistent among years, however, burn pattern metrics differ among severity levels within years. Change in the Okefenokee National Wildlife Refuge vegetation during the past two decades has resulted in greater amounts of herbaceous and mixed shrub/tree vegetation types during the past decade, decreasing amounts of mature and mixed mature forest, and greater interspersion and patch shape complexity of all vegetation types in the swamp creating a more structurally diverse system. Hydrological vegetation types occurring in areas typically burning severely and moderately (i.e., shrub prairie and tree prairie/cypress prairie) are characterized by short periods of shallow flooding and longer periods with minimal surface flooding. In contrast, flooded forest experienced only light or no burning and is characterized by greater duration of shallow flooding, with short periods of deeper inundation. Vegetation in the Okefenokee National Wildlife Refuge will continue to respond to changes in climate, drought frequency, and fire frequency and intensity. Our record of vegetation maps over the past two decades will help us to anticipate how these future changes may affect the Swamp.

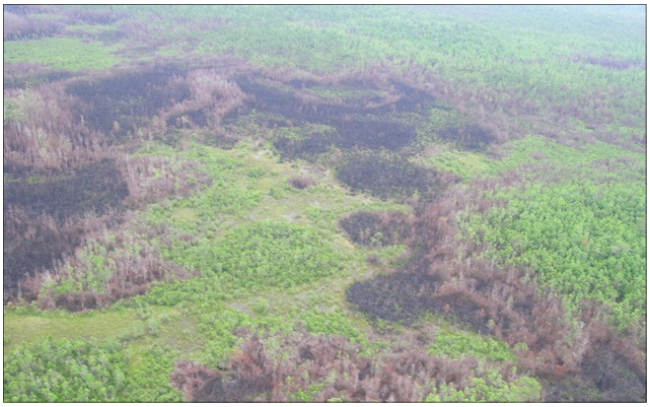
Investigator: Margaret Guyette (Post-doc)

Advisors: Cynthia S. Loftin (Advisor)

Duration: August 2012—September 2013

Cooperators:

U.S. Fish and Wildlife Service
U.S. Geological Survey – Maine Cooperative Fish and Wildlife Research Unit



River restoration in the northeast: Implications for avian assemblages

1. Develop a 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. Data were collected in 2011 and 2012 and a summary report was submitted to MOHF this year.

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 2014

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 Ecology
National Oceanic and Atmospheric Administration

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.
2. Assess the suitability of the InVEST pollinator model for studying relationships between landscape composition and pattern on pollinators or apples, squash, pumpkins, and cranberries in Maine and other northeastern states.
3. Examine how diversity and abundance of pollinators is affected by landscape composition and pattern.

Pollinator-dependent crops require a readily available source of pollinators. Although honey bees provide this service for a variety of crops, a diverse pollinator community is needed to ensure sustainability in in this service. Native bee pollinators potentially contribute to this sustainability, however, knowledge about factors that affect their abundance and distributions is lacking. Our team from the University of Maine is collaborating with teams from the University of Massachusetts, University of Connecticut, University of Tennessee, and Cornell University to examine a variety of factors, ranging from individual pollinators to the landscapes they inhabit, that potentially affect pollinators of fruit and vegetable crops in the northeastern US. The research focus in Maine is wild blueberries, while apples, cranberries, squash and pumpkins are the focal crops in the other participating states. Our role on the Maine team is to examine relationships between the pollinator community composition and abundance and arrangement and composition of the landscape where the focal crops occur. We are combining the team's field-based studies of pollinator communities with the National Capital Project's InVEST models and netrual landscape models in our spatial assessment of pollinator communities. Our research coordinates with the agricultural community through demonstration projects and collaborative interactions to improve distribution and implementation of research results by growers and the native pollinator conservation community.

We have focused this year's efforts on analysis of the InVEST pollination model for its suitability to Maine's wild blueberry crop. We concluded from our assessment of the available land cover data for the wild blueberry crop that a new land cover classification targeting blueberries was needed, and we purchased SPOT satellite imagery for this purpose. We conducted expert surveys of habitat suitability for native bees and incorporated this expert knowledge into the InVEST model runs. We have conducted sensitivity analysis and model parameter optimization analyses, and we are incorporating those results in landscape pattern analysis. in 2014, we will conduct spatial analysis of pollen pesticide loads and native bee use of powerline right-of-way corridors for travel. We also will be expanding our focus to cranberries, squash, pumpkins, and apples in our partner states during 2014, beginning with an assessment of land cover data quality. Eventually, we will examine applying the InVEST model to these crops and landscapes to examine relationships of landscape composition and pattern with the pollinator community.

Investigators: Shannon Chapin (MS)
Brianne Du Clos (PhD)

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

Duration: January 2012—December 2016

Cooperators:

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

Amphibian movement in complex landscapes: Effects of forestry and urbanization on juvenile dispersal of vernal pool-breeding amphibians

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.

For many amphibian species, the juvenile life stage represents the primary driver of gene flow and population connectivity. However, there is a paucity of data on juvenile movement/emigration because direct tracking is hampered by: (a) the small size of metamorphs; (b) the biphasic (terrestrial-aquatic) life history and cryptic behavior associated with this life stage; and (c) prior limitations in longevity/size of tracking technologies. Thus, our research focuses on juveniles, with a principal intent to describe breeding dispersal – or the process of emigration from natal pool to eventual breeding pool. Development of a miniaturized technology (harmonic radar transponder tags) will allow us to follow the fate and behavior of individually-marked amphibians across multiple life stages. Our ultimate objective is to assess the effects of different land-use and forestry practices on amphibian dispersal, to understand how these movement processes affect population persistence.

This project is part of the Land-use Effects on Amphibian Populations (LEAP) project. We also pursue interdisciplinary research in coupled social-ecological systems (SESs) through the Sustainability Solutions Initiative (SSI), as part of the subproject "Protecting Natural Resources at the Community Scale: Using Population Persistence of Vernal Pool Fauna as a Model System to Study Urbanization, Climate Change and Forest Management."

Our research in 2013 focused on the influence of different land-cover types on juvenile movements. The key question motivating our experiments was: Forest cover reduction may affect movements of emigrating juvenile wood frogs, but does it always lower functional habitat connectivity? Specifically, we tested if juvenile wood frogs (*L. sylvaticus*) responded similarly to the amount of forest cover (and oriented to contiguous forest) following experimental release trials in varying open-canopy types during the post-metamorphic period (Jul – Nov). We used a three-tiered methodological approach to describe individual movement patterns and estimate movement costs to frogs, including: (1) fluorescent-powder tracking; (2) PIT-tag tracking; and (3) least-cost path modeling. Using fluorescent-powder tracking, we estimated movement parameters (e.g., movement rates; path tortuosity and length) for >325 juvenile frogs during three large-scale experiments in forest, lawn, pavement, hayfields, and cornfields. Outcomes include a better understanding of functional connectivity for conservation of critical amphibian habitats.

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—January 2014

Cooperators:

National Science Foundation – Experimental Program to Stimulate Competitive Research
University of Maine – Department of Wildlife Ecology
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

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 2013 we conducted breeding season occupancy surveys in 28 stands and captured and banded 16 new males, 1 new female (radioed), and had 20 observations of recaptured males. Later, in late June and early July , we conducted brood surveys to capture females with broods. We captured and banded 12 new females, 10 of which received radio transmitters. An additional female was caught during telemetry, giving us a total of 12 radioed females. Of these 12 birds, 8 survived the summer monitoring season (July-Sept. 1). We have observed a total of 33 marked males and have documented home ranges and habitat selection for 22 female grouse over our first 2 years of study.

Vegetation measurements at both survey stands and 2012 spruce grouse telemetry locations were conducted during summer 2013. Vegetation measurements for the 2013 spruce grouse telemetry locations will be conducted during summer 2014. An additional 13 survey stands will be added for the 2014 survey season.

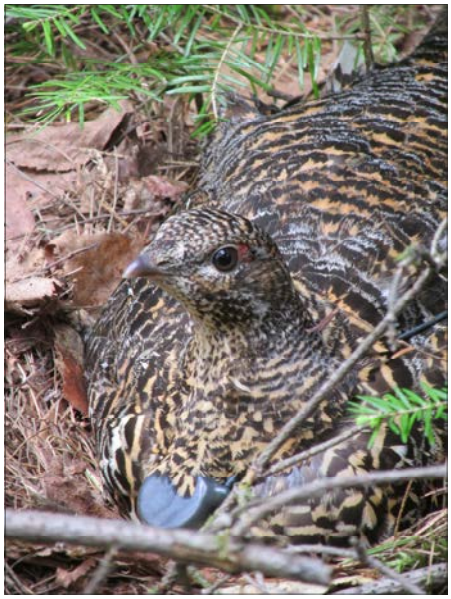
Investigator: Stephen Dunham (MS)

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



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 three field seasons focusing on assessment of Wood Frog post-breeding and overwintering habitat selection and documenting wood frog and spotted salamander breeding in Maine's alpine ecoregion wetlands. We used radio telemetry to track the post-breeding movements of wood frogs in the landscapes surrounding 2 study lakes, and we continued to track a reduced number of individuals throughout the fall until they were poised for hibernation. We erected enclosures around hibernacula selected by radio-tagged frogs so that they could again be tracked post-hibernation, allowing us to link overwintering and breeding habitats. We conducted amphibian occupancy surveys at >100 wetlands in 6 alpine ecoregions during late spring and summer 2013. The information obtained from these surveys will inform field surveys in spring 2014, specifically re-surveys of unoccupied wetlands to confirm non-use.

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 2014

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 Ecology
University of Maine – Sustainable Solutions Initiative

Breeding ecology and habitat selection of the blue-spotted salamander (*Ambystoma laterale*) an 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. jeffseronianum*). The unisexuals are almost entirely polyploid females, and parasitize sperm from the blue-spotted salamanders to reproduce. We will examine the urban ecology, 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 will implant 40 breeding salamanders with radio transmitters and follow them as they emigrate from the pool.

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

We have completed a pilot season of radio telemetry, during which we followed 9 salamanders dispersing from a single breeding pool. We have begun to explore this data to refine our questions for the coming spring. We have collected data and tissue samples for both breeding adults and dispersing juveniles from 4 vernal pools, and will continue this work in 2014.

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 2017

Cooperators:

National Science Foundation – Experimental Program to Stimulate Competitive Research
University of Guelph
Orono Land Trust
University of Maine – Department of Wildlife Ecology
University of Maine – Sustainable Solutions Initiative

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

Black bear population modeling

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.

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.

Canada lynx (*Lynx canadensis*) have been listed as federally threatened under the Endangered Species Act since 2000. Lynx are a specialist predator of snowshoe hares and their populations closely lag the snowshoe hare population cycle. During periods of lower hare abundance, lynx may be forced to alter aspects of their spatial ecology to survive. For example, habitat selection, home range area, recruitment, and territorial overlap may change as lynx adjust to declining numbers of prey. Some of these relationships have been studied in the northern portion of their range, but the existence of hare cycles, and the expected responses of lynx to changing hare densities are unknown within the Acadian Forest region where the dominant factor influencing the quality and supply of high quality lynx and hare habitat is commercial-scale forest harvesting.

The largest population of lynx in the contiguous U.S. occurs in Maine where large clearcuts were a common form of timber harvest prior to the enactment of the Maine Forest Practices Act in 1989. Since 1992, partial harvests have become the dominant form of timber harvest, thus reducing the extent, of regenerating conifer-dominated clearcut stands. Those changes densities of regenerating conifer stems, which are positively associated with hare density and patterns of lynx occupancy. Additionally, broad-scale factors that might contribute to regional changes in hare populations could exacerbate effects of anthropogenic processes on future habitat quality for hares and lynx.

This study is evaluating relationships among temporally changing hare densities, spatial ecology of lynx, and multi-scalar patterns of habitat selection by lynx within northern Maine. Additionally, we are evaluating effects of vegetation, topography and season on our success and accuracy at locating lynx using GPS collars to account for methodological biases that might occur using GPS technology.

Our study to evaluate relative fix success and location accuracy within 7 stand types previously documented as important habitat currencies for lynx has been completed across 2 seasons and 66 test sites. Results have been drafted into the first chapter of a 3 chapter thesis. Ongoing studies of spatio-temporal dynamics in hare populations have identified 2 periods of high and low hare density, and we have collaborated with Maine Department of Inland Fisheries and Wildlife to collect information for estimating home range, inra- and inter-sexual spatial overlap, and stand-scale and landscape-scale habitat selection for 13 male and 11 female Canada lynx during the high hare density period and for 10 male and 6 female lynx during the low hare density period. Lynx maintained territories during both the high and low hare density periods and exhibited similar patterns of spatial overlap and home range sizes between periods of high and low hare density. Further, patterns of second-order habitat use and 3rd-order habitat selection were similar between the 2 hare density periods, suggesting that hare densities do not reach the extreme low levels that might be associated with social disruption and large shifts in spatial use and habitat selection.

All analyses are complete and the expected date of project completion is May 2014.

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 2013

Cooperators:

University of Maine – Department of Wildlife Ecology
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

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 Ecology
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

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.

The geographic range of Blanding's turtle (Emydoidea blandingii) occurs in the mid-continent of North America, with the majority of populations occurring in the Great Lakes region and southern Ontario. In the Northeast United States, 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. Blanding's turtle populations are declining throughout their range, and are state-listed as threatened in New York and Massachusetts, as endangered in Maine and New Hampshire, and as a Species in Greatest Need of Conservation (SGCN) in all Northeast states where it occurs. In Canada, the Great Lakes/St. Lawrence population in Ontario and Quebec is listed as threatened and the disjunct population in Nova Scotia is listed as endangered (Committee on the Status of Endangered Wildlife in Canada, COSEWIC). A status assessment has been completed for the species in the Northeast and the next high priority action to implement is the development of a regional conservation plan including an assessment of genetic variation throughout the region, and development and implementation of a monitoring protocol. Although some research has been done on the genetic structure of Blanding's turtle populations among regions across their range, adequate information is not available to determine the degree and boundaries of discreteness of northeastern populations. This research will compare the genetic structure of populations in the Northeast with those across the species range in the United States and Canada using DNA genotyping. Results will be used to determine differences among Northeast populations as well as their distinctiveness those in the Midwest, which could affect the approach to managing the species in the Northeast. These data are essential for informed management and conservation planning for Blanding's turtles 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 Ecology
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

Effects of forest management practices in the Acadian Northern Forest region on forest bird communities

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 sites 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 bird surveys were conducted during the summer of 2013, and 19,431 detections of birds were collected during surveys in 110 forest stands. Vegetation surveys were completed at all sites in the North Maine Woods Region and Baxter State Park during 2013. We plan to expand vegetation surveys into the NWRs in 2014 and continue bird surveys during the breeding season through the summer of 2015. Data analyses will begin in 2014.

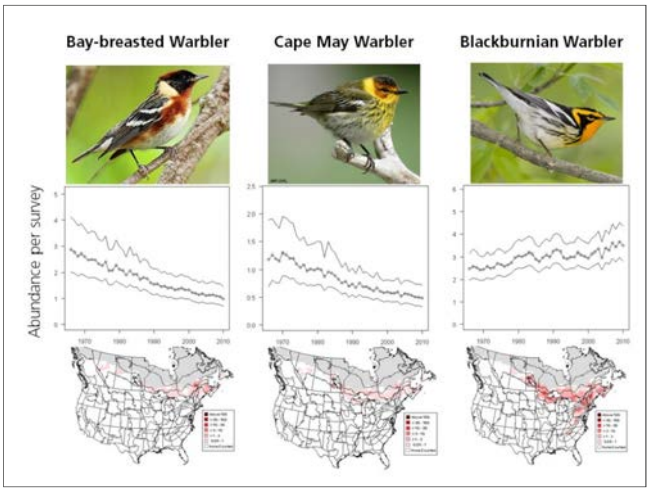
Investigator: Brian Rolek (PhD)

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

Duration: August 2012—December 2016

Cooperators:

University of Maine – Department of Wildlife Ecology
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



Breeding ecology and terrestrial habitat requirements of the eastern spadefoot (*Scaphiopus holbrookii*) and pure-diploid blue-spotted salamander (*Ambystoma laterale*) in eastern Connecticut

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*])

The research provides valuable information on two Massachusetts, New York and Connecticut State-listed species, the eastern spadefoot (*Scaphiopus holbrookii*) and the pure-diploid blue-spotted salamander (*Ambystoma laterale*). Both species merit scientific investigation as information on the terrestrial ecology of both animals is sparse. Our results will help to determine best management practices for mitigation of developments affecting habitat for these and other pool-breeding species that depend on adjacent terrestrial habitats for the majority of their lives.

Information is collected on study animals through the use of: (1) pitfall trapping (mark-recapture), (2) radio-telemetry, (3) PIT tag scanning: a technique entailing systematically scanning for animals with implanted PIT tags using a PITpack (an electronic tag reading device reminiscent of a metal detector), and (4) toad-totes (a stationary tag-reading device used to monitor eastern spadefoot toad burrow emergence). The larval experiment was conducted using a series of mescosms.

Fieldwork for this project has been completed. Data analyses and subsequent production of dissertation chapters/journal articles are ongoing. A manuscript entitled "Monitoring Eastern Spadefoot (*Scaphiopus holbrookii*) response to weather using a passive integrated transponder (PIT) system" has been accepted for publication in the *Journal of Herpetology*. A second chapter "Using passive integrated transponder (PIT) systems for terrestrial detection of blue-spotted salamanders in situ" has been submitted to *Herpetological Conservation and Biology* and is under review. Two additional manuscripts focusing on terrestrial habitat requirements of eastern spadefoots and blue-spotted salamanders are in progress and scheduled to be completed during the spring of 2014.

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

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 10 coastal islands and 3 coastal mainland locations, and have collected samples for genetic and stable isotope analysis. Additional island and coastal mainland locations will be surveyed for redback salamanders during the summer 2014. Analysis of samples collected during summer 2013 are underway.

Investigator: Nikko-Ideen Shaidani (MS)

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

Duration: August 2012—December 2015

Cooperators:

University of Maine – Department of Wildlife Ecology
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

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—January 2014

Cooperators:

Holt Woodlands Research Foundation
University of Maine – Sustainable Solutions Initiative

INTEGRATED ecology

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

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.

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—June 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

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, Matthew Brooks

Duration: October 2010—September 2013

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 have received species occurrence data from nearly all of the states in the NA-LCC and have converted datasets into a spatial format. We have compiled environmental spatial variable data layers spanning the NALCC region from a variety of sources and are completing preparations for their use in species distribution models. We will combine the SDMs with climate change projections to identify PARCAs, beginning first with Maine's data and then with other states' data.

Investigator:	Allison Moody (Post-doc)
Advisor:	Cynthia S. Loftin
Collaborator:	Phillip deMaynadier
Duration:	August 2012—December 2014

Cooperators:

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

PUBLICATIONS and presentations

SCIENTIFIC PUBLICATIONS

Bailey, M. and J. Zydlewski. 2013. Assessing restoration of an extant population of American shad with supplemental stocking. *North American Journal of Fisheries Management* 33:459-467.

Demi, L.M., K.S. Simon, S.M. Coghlan Jr., R. Saunders, and D. Anderson. 2012. Anadromous alewives in linked-lake-stream ecosystems: Do trophic interactions in lakes influence stream invertebrate communities? *Freshwater Science* 31(3): 973-985.

Dionne, P., G. Zydlewski, M. Kinnison, J. Zydlewski, and G. Wippelhauser. 2013. Reconsidering residency: Characterization and conservation implications of complex migratory patterns of shortnose sturgeon, *Acipenser brevirostrum*. *Canadian Journal of Fisheries and Aquatic Sciences* 70:119–127.

Fuller, A.K., S.M. Spohr, D.J. Harrison, and F.A. Servello. 2013. Nest survival of wild turkeys in a mixed-use landscape. *Wildlife Biology* 19(2).

Gardner, S.K., J. Jansujwicz, K. Hutchins, B. Cline, V. Levesque. 2013. Socialization to interdisciplinarity: Faculty and student perspectives. Higher Education DOI 10.1007/s10734-013-9468-2.

Gorsky, D. and J. Zydlewski. 2013. Evaluation of size dependant predation rates and efficiency of adult post-spawned rainbow smelt (*Osmerus mordax*) on larval lake whitefish (*Coregonus clupeaformis*) in a laboratory setting. *Transactions of the American Fisheries Society* 33(1):163-169.

Guyette, M.Q., C.S. Loftin, and J. Zydlewski. 2013. Carcass analog addition enhances juvenile Atlantic salmon (*Salmo salar*) growth and condition. *Canadian Journal of Fisheries and Aquatic Sciences* 70:860-870.

Hogg, R., S.M. Coghlan Jr., and J. Zydlewski. 2013. Anadromous sea lamprey (*Petromyzon marinus*) recolonize a Maine coastal river tributary after dam removal. *Transactions of the American Fisheries Society* 142: 1381-1394.

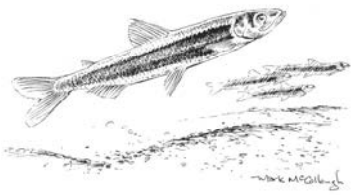
Jansujwicz, J.S., A.J.K. Calhoun, J.E. Leahy & R.J. Lilieholm. 2013. Using mixed methods to develop a frame-based private landowner typology. *Society and Natural Resources* 0:1-17.

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.

Loftin, C.S., A.J.K. Calhoun, S. Nelson, A. Elskus, and K. Simon. 2012. Does mercury bioaccumulate in wood frogs developing in seasonal woodland pools in Maine, USA? *Northeastern Naturalist* 19:579-600.

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

McCullough, I.M., C.S. Loftin, S.A. Sader. 2013. Lakes without Landsat? Implications of scale and an alternative approach to regional remote lake monitoring using MODIS 250 m imagery. *Lake and Reservoir Management* 29:89-98.



Nelson, S., K. Webster, C. Loftin, and K.Weathers. 2013. Seasonal controls on the temporal coherence of mercury and major ion throughfall flux in Acadia National Park, Maine, USA. *Biogeochemistry* 116:147-160.

Politi, N., M.L. Hunter Jr., and L. Rivera. 2012. Assessing the effects of selective logging on birds in a Neotropical montane forest. *Biodiversity and Conservation* 21:3131–3155.

Popescu, V. and M.L. Hunter Jr. 2012. Assisted colonization of wildlife species at risk from climate change. Pages 347-368 *in* Brodie J. (ed.) *Conserving wildlife populations in a changing climate*. Island Press, Washington DC.

Simons-Legaard, E.M., D.J. Harrison, W.B. Krohn, and J.H. Vashon. 2013. Canada lynx occurrence and forest management in the Acadian Forest. *Journal of Wildlife Management* 77:567-578.

Thompson, I.D., J. Fryxell, and D.J. Harrison. 2012. Improved insights into use of habitat by American martens, since the 2nd International Martes Symposium in 1991. Pages 209-229 *in* K.B. Aubry, W.J. Zielinski, M.G. Raphael, G. Proulx, and S.W. Buskirk (editors) *Biology and conservation of martens, sables, and fishers: A new synthesis*. Cornell University Press, Ithaca, NY, USA.

Zydlewski, J. and M. Wilkie. 2013. Freshwater-seawater transitions in juvenile euryhaline fish. Pages 253-326 *in* S.D. McCormick, A.P. Farrell and C.J. Brauner (editors) *Euryhaline Fishes Fish Physiology, Volume 32*. Academic Press, Watham, MA.

TECHNICAL AND SEMI-TECHNICAL PUBLICATIONS

Dunham, S. and D. Harrison. 2013. Patch occupancy, habitat use, and population performance of spruce grouse in commercially managed conifer stands. Pages 85-89 *in* B.E. Roth (editor) Cooperative Forestry Research Unit: 2012 Annual Report, University of Maine, Orono, ME.

Harrison, D., E. Simons-Legaard, K. Legaard, and S. Sader. 2013. Effectiveness of zoning to protect deer wintering habitats in Maine: Did the designation of LURC-zoned deeryards achieve desired objectives during the period 1975-2007? Final Report to Northeastern States Research Cooperative and USDA Forest Service. http://www.nsrc.org

Harrison, D., S. Olsen, D. Mallett, A. Fuller, and J. Vashon. 2013. Relationships among commercial forest harvesting, snowshoe hares and Canada lynx in Maine. Pages 79-84 *in* B.E. Roth (editor) Cooperative Forestry Research Unit: 2012 Annual Report, University of Maine, Orono, ME.

Kiraly, I.A., S.M. Coghlan Jr., J. Zydlewski, and D.B. Hayes. 2012. Characterizing fish assemblage structure in the Penobscot River prior to dam removal. Final report submitted to the Penobscot River Restoration Trust.

Loftin, C.S, R.Carey, and K. Goodine. 2013. The Maine Cooperative Fish and Wildlife Research Unit and University of Maine Department of Wildlife Ecology 2012 Annual Report to Cooperators. 57 pp.

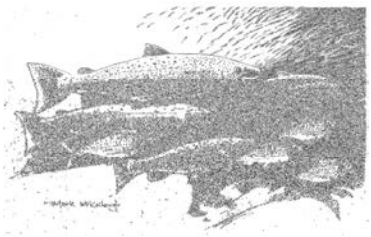
McCullough, I.M., C.S. Loftin, S.A. Sader. 2013. A manual for remote sensing of Maine lake clarity. Maine Agricultural Experiment Station Technical Bulletin 207, 28 pp.

Stucki, D.S., S.T. McKinney, and J.C.B. Nesmith. 2012. Sierra Nevada Network White Pine Community Dynamics Annual Monitoring Report. Natural Resource Data Series NPS/SIEN/NRDS —2012/405, National Park Service, Fort Collins, CO.

THESES AND DISSERTATIONS

Drahovzal, Sarah. 2013. Environmental assessment of circumneutral wetlands with shrubby cinquefoil (*Dasiphora fruticosa*), host plant of the endangered clayton's copper butterfly (*Lycaena dorcas claytoni*). Master of Science Ecology and Environmental Sciences. University of Maine, 145 pp.

Grote, Ann. 2013. Migration and spawning behavior of a remnant population of American shad (*Alosa sapidissima*) prior to dam removal. Master of Science Wildlife Ecology. University of Maine, 76pp.



Hogg, Robert. 2012. Fish community response to a small stream dam removal in a coastal Maine tributary. Master of Science Wildlife Ecology. University of Maine, 142 p.

PROFESSIONAL TALKS PRESENTED

Beier, P. and M. Hunter. 2013. "Conserving the stage, not the actors: Using geophysical units as coarse-filter targets in conservation planning for climate change." International Congress for Conservation Biology, July 23, Baltimore MD.

Chapin, C., C.S. Loftin, and F. Drummond. 2012. "Assessing the effect of landscape pattern and arrangement on native bee abundance in Maine's blueberry fields." Poster presented at the 27th Annual Northeast Arc Users Group Conference, November 11-14, Rockport, ME.

Chapin, C., C.S. Loftin, and F. Drummond. 2013. "Assessing the effect of landscape pattern and arrangement on native bee abundance in Maine's blueberry fields." USGS-Maine Cooperative Fish and Wildlife Research Unit Annual Coordinating Committee Meeting, March 21, Wells Conference Center, Orono, ME.

Chapin, S., C. Loftin, and F. Drummond. 2013. "The application of spatial modeling tools to assess the effect of landscape pattern and arrangement on native bee abundance in Maine's wild blueberries." Poster presented at the 2013 International Conference on Pollinator Biology, Health, and Policy; August 14-17; Penn State University, University Park, PA.

Chapin, S., C.S. Loftin, and F. Drummond. 2013. "Assessing the effect of landscape pattern and arrangement on native bee abundance in Maine's blueberry fields." Presented at the Northeast Natural History Conference, April 13-15, Springfield, MA.

Coghlan Jr., S.M. 2012. "Restoring the Penobscot River: Dam removal and recovery of native fishes." Maine Maritime Academy Department of Ocean Studies' Seminar Series, December 3, Castine, ME.

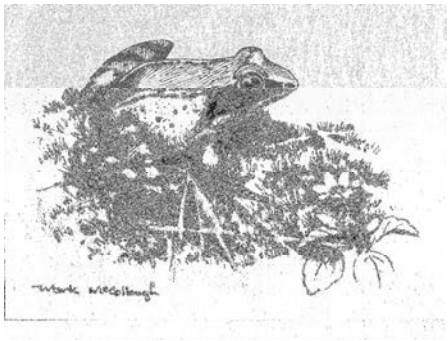
Coghlan Jr., S.M. 2013. "Current and future aquatic research at the University of Maine". Presented at the Maine Inland Fisheries and Wildlife Department's annual fisheries staff meeting, April 25, Bangor, ME.

Coghlan Jr., S.M. 2013. "The elephant in the room: Preparing the current generation of students for the limits to growth." Presented at the School of Biology and Ecology's weekly seminar series, April 12, Orono, ME.

Drahovzal, S., C.S. Loftin, and J. Rhymer. 2013. "Environmental assessment of Maine's circumneutral wetlands supporting Shrubby Cinquefoil, host plant of the state endangered Clayton's Copper butterfly." USGS-Maine Cooperative Fish and Wildlife Research Unit Annual Coordinating Committee Meeting, March 21, Wells Conference Center, Orono, ME.

Drahovzal, S., C.S. Loftin, and J. Rhymer. 2013. "Environmental conditions of wetlands hosting the endangered butterfly *Lycaena dorcas claytoni*." Northeast Natural History Conference, April 13-15, Springfield, MA.

Groff, L., C.S. Loftin, and A.J.K Calhoun. 2013. "Hibernation ecology of *Lithobates sylvaticus* in Maine's montane landscape." Northeast Natural History Conference, April 13-15, Springfield, MA.



Groff, L., C.S. Loftin, and A.J.K Calhoun. 2013. "Hibernation ecology of *Lithobates sylvaticus* in Maine's montane landscape." Poster presented at the Maine EPSCoR Conference, September 30, Orono, ME.

Groff, L., C.S. Loftin, and A.J.K. Calhoun. 2013. "Habitat use by pool-breeding amphibians in Maine's western highlands." USGS-Maine Cooperative Fish and Wildlife Research Unit Annual Coordinating Committee Meeting, March 21, Wells Conference Center, Orono, ME.

Grote, A., J. Zydlewski, and M. Bailey. 2013. "Demography and movements of spawning American shad (*Alosa sapidissima*) in the Penobscot River, Maine, prior to dam removal." USGS-Maine Cooperative Fish and Wildlife Research Unit Annual Coordinating Committee Meeting, University of Maine, March 21, Wells Conference Center, Orono, ME.

Guyette, M. and C.S. Loftin. 2013. "A Bayesian belief network assessment of wetland vegetation succession and spatial dynamics in response to fire and hydrological conditions." USGS-Maine

Cooperative Fish and Wildlife Research Unit Annual Coordinating Committee Meeting, March 21, Wells Conference Center, Orono, ME.

Guyette, M.Q. and C.S. Loftin. 2013. "A Bayesian belief network assessment of vegetation succession and spatial dynamics in response to fire and hydrological conditions in the Okefenokee National Wildlife Refuge, Georgia, USA." Presentation to the Okefenokee National Wildlife Refuge staff, July 17, Okefenokee National Wildlife Refuge, Folkston, GA.

Guyette, M.Q. and C.S. Loftin. 2013. "A Bayesian belief network assessment of vegetation succession and spatial dynamics in response to fire and hydrological conditions in the Okefenokee National Wildlife Refuge, Georgia, USA." Presentation at the annual meeting of the Ecological Society of America, August 4-9, Minneapolis, MN.

Harrison, D., C. Loftin, P. Wood, and B. Rolek. 2012. "Forestry and forest birds: Trends in FWS priority bird species in managed forest landscapes." Presentation to U.S. Fish and Wildlife Service Refuge Biologists, December 18, Portland, ME.

Harrison, D., D. Mallett, A.K. Fuller, and J.H. Vashon. 2013. "Snowshoe hares, forests, and Canada lynx: A dynamic interaction between populations, forestry and habitat." Presentation at Meeting of Maine Cooperative Forestry Research Unit, April 24, Orono, ME.

Hunter, M. 2013. "Advice for newcomers: How to attend a conference workshop." International Congress for Conservation Biology, July 23, Baltimore MD.

Hunter, M. 2012. "Conservation in 2012: The year in review." Student Conservation Science Conference, American Museum of Natural History, October 11, New York, NY.

Hunter, M. 2012. "Reaching beyond the choir and other career lessons from the history of conservation biology." Student Conservation Science Conference, American Museum of Natural History, October 12, New York, NY.

Irish, B., J. Zydlewski, and R.Cunjak. 2013. "Trophic and marine interactions in the St. Croix River, Maine." Meeting of the International Joint Commission of the St. Croix Waterway, June 24, Calais ME.

Kocik, J., M. Guyette, and S.M. Coghlan Jr. 2013. "Interactions among coevolved diadromous species and their implications for Atlantic salmon recovery." Presented at the Diadromous Species Restoration Science Meeting, January 10, Orono, ME.

Levesque, V., K.P. Bell, A. Calhoun. 2012. "Some do and some don't: Factors that enable smaller communities to contribute to sustainability." Association of Collegiate Schools of Planning, October 31, Cincinnati, OH.

Levesque, V., K.P. Bell, and A.J.K. Calhoun. 2013. "Sustainability in Maine Municipalities." Maine Water Conference, March 19, Augusta, ME.

Linden, D.W. 2013. "Using all the data: Maximizing information from population models of black bears in Maine." USGS-Maine Cooperative Fish and Wildlife Research Unit Annual Coordinating Committee Meeting, March 21, Wells Conference Center, Orono, ME.

Linden, Daniel W. and Shawn T. McKinney. 2013. "Using all the data: Improving inferences from population models." Eastern Black Bear Workshop, April 29, Millinocket, ME.

Loftin, C.S. 2012. "Conserving freshwater systems in Acadia National Park: An opportunity for reconciliation ecology?" Presentation at the 2nd Annual Acadia National Park Science Symposium at Schoodic Education and Research Center, October 23, Winter Harbor, ME.

Looze, B., C.S. Loftin, and F. Drummond. 2013. "Linear landscape features and pollinator ecology in wild blueberries." USGS-Maine Cooperative Fish and Wildlife Research Unit Annual Coordinating Committee Meeting, March 21, Wells Conference Center, Orono, ME.

McKinney, S.T. and D.F. Tomback. 2013. "Invasive pathogen trumps natural selection thwarting evolutionary rescue." Ecological Society of America 98th Annual Meeting, August 7, Minneapolis, MN.

Moody, A., C.S. Loftin, and P. deMaynadier. 2013. Assessing priority amphibian and reptile conservation areas (PARCAs) in the North Atlantic Landscape Conservation Cooperative, USGS-Maine Cooperative Fish and Wildlife Research Unit Annual Coordinating Committee Meeting, March 21, Wells Conference Center, Orono, ME.

Moody, A.T., B. Sutton, C. Loftin, P. deMaynadier, K. Barrett, and P. Nanjappa. 2013. "Assessing priority amphibian and reptile conservation areas (PARCAs) in the NA-LCC and determining vulnerability of these areas to climate change." Presentation at the Monthly LCC Webinar, August 29. Archived at www.northatlanticlcc.org.

Moody, A.T., C.S. Loftin, P. deMaynadier, B Sutton, K. Barrett, and P. Nanjappa. 2013. "Assessing priority amphibian and reptile conservation areas in the North Atlantic Landscape Conservation Cooperative." Presentation at the 2013 Northeast Partners in Amphibian and Reptile Conservation Annual Meeting, July 24-26, Branchville, NJ.

O'Malley, A., J. Zydlewski, S. Coghlan, and D. Parrish. 2013. "Assessing a hatchery based rainbow smelt (Osmerus mordax) supplementation effort." USGS-Maine Cooperative Fish and Wildlife Research Unit Annual Coordinating Committee Meeting, March 21, Wells Conference Center, Orono, ME.

Ratten, S. and J. Zydlewski. 2013. "An evaluation of reintroduced lake whitefish in St. Froid Lake." USGS-Maine Cooperative Fish and Wildlife Research Unit Annual Coordinating Committee Meeting, March 21, Wells Conference Center, Orono, ME.

Rolek, B., C.S. Loftin, D. Harrison, and P.B. Wood. 2013. "Softwood forest birds and forest management in New England." USGS-Maine Cooperative Fish and Wildlife Research Unit Annual Coordinating Committee Meeting, March 21, Wells Conference Center, Orono, ME.

Sigourney, D. and J. Zydlewski. 2012. "Passage at West Enfield Dam." Oral presentation at the Atlantic salmon passage working group, October 5, Bangor, ME.

Sigourney, D. and J. Zydlewski. 2012. "Passage at West Enfield Dam 2002-2004 and 2010-2012." Oral presentation at the Atlantic salmon passage working group, October 8, Bangor, ME.

Sigourney, D. and J. Zydlewski. 2013. "Modeling the downstream migration of silver American eel." The Nature Conservancy, September 17, Brunswick, ME.

Stich, D., J. Zydlewski, M. Bailey, M. Kinnison, J. Kocik, and G. Zydlewski. 2013. "Atlantic salmon smolt survival through dams in the Penobscot River." USGS-Maine Cooperative Fish and Wildlife Research Unit Annual Coordinating Committee Meeting, March 21, Wells Conference Center, Orono, ME.

Sutton, W.B., K. Barrett, A.T. Moody, C. Loftin, P. deMaynadier, and P. Nanjappa. 2013. "Framework for determining vulnerability of priority amphibian and reptile conservation areas in the north Atlantic landscape conservation cooperative to climate change." Presentation at the 2013 Northeast Partners in Amphibian and Reptile Conservation Annual Meeting, July 24-26, Branchville, NJ.

Witham, J.W. 2012. "Local Forests in Perspective." Kennebec Estuary Land Trust Lecture Series. Working Landscapes: Forests, October 25, Bath, ME.

Zydlewski, J. and S. Coghlan. 2012. "Fisheries Science at the University of Maine." Oral presentation to Maine Department of Inland Fisheries Commissioner, December 3, University of Maine, Orono, ME.

Zydlewski, J., D. Stich, and D. Sigourney. 2013. "Making the connection between freshwater production and the black box." Meeting of the Marine Estuary Action Team Atlantic salmon framework meeting, July 17, Augusta, ME.

Zydlewski, J., D. Stich, and D. Sigourney. 2013. "Understanding the impacts of dams on up and downstream passage - lessons from Atlantic salmon in the Penobscot River." Oral presentation to the USFWS Craig Brook Fisheries Complex Seminar Series, January 15, East Orland, ME.

Zydlewski, J., G. Zydlewski, W. Gale, and B. Kennedy. 2013. "Smolting in coastal cutthroat trout." Ninth International Smolt Symposium, August 15, University of Holar, Iceland.

PUBLIC TALKS PRESENTED

Altenritter, M., M. Dzaugis, G. Zydlewski, M. Kinnison, J. Zydlewski, and G. Wippelhauser. 2013. "Shortnose sturgeon of the Penobscot: local residency and regional connections." Poster presentation to DSSRN, January 10, University of Maine, Orono, ME.

Calhoun, A.J.K. 2012. "Conserving vernal pools with innovative local approaches." Belfast Bay Watershed Coalition, December 13, Belfast, ME.

Calhoun, A.J.K. 2012. "Using local initiatives to conserve natural resources on private property." UNB, December 7, Fredericton, NB, Canada.

Capps, K.A. 2013. "Biodiversity, ecosystem function & sustainable resource use in a changing environment." Presented to Environmental Change Initiative, Brown University, April 5, Providence, RI.

Capps, K.A. 2013. "Hotspots in forested landscapes: the functional role of vernal pools in nutrient dynamics." Presented to Sustainability Solutions Initiative, University of Maine, February 26, Orono, ME.

Capps, K.A. 2013. "Linking biodiversity & ecosystem function: Understanding the functional role of species across anthropogenically modified landscapes." Presented to School of the Environment, Washington State University, February 20, Pullman, WA.

Capps, K.A. 2013. "The functional role of aquatic organisms in ecosystem processes across anthropogenically modified landscapes." Presented to Department of Watershed Sciences, Utah State University, May 1, Logan, UT.

Capps, K.A. 2013. "Understanding the functional role of aquatic organisms in ecosystem nutrient dynamics." Presented to Department of Biology, University of South Dakota, January 28, Vermillion, SD.

Capps, K.A. 2013. "Integrating high school researchers into university research teams. Maine EPSCoR State Conference." Presented to Looking to the Future - Supporting Maine's R&D Capacity through STEM Workforce Development, Technology, and Communicating Science, September 30, Orono, ME.

Capps, K.A. 2013. "Quantifying the functional role of aquatic organisms in biogeochemical processes." Presented to School of Agricultural, Forest and Environmental Sciences, Clemson University, May 6, Clemson, SC.

Capps, K.A., C.L. Atkinson, A. Rugenski. 2013. "Summarizing patterns of consumer-driven nutrient dynamics in freshwater ecosystems." Presented to The Society for Freshwater Science, May 21, Jacksonville, FL.

Dunham, S., and D. Harrison. 2013. "Habitat ecology of the spruce grouse in Maine's northern forests." Presentation to Bangor Nature Club, May 15, Bangor, ME.

Harrison, D.J. 2013. "Conserving sustainable landscapes: Using Canada lynx and American martens as umbrella species to enhance landscape planning." Invited presentation at Kennebec Land Trust Lyceum, March 21, Wayne, ME.

Hunter, M. 2013. "Of birds and beetles: Biodiversity in a dynamic world." Sheepscot Well Spring Alliance, September 15, Freedom ME.

Olson, S. 2013. "Seasons of the snowshoe hare." Friends of Sunkhaze National Wildlife Refuge, April 20, Old Town, ME.

Simons-Legaard, E. and D. Harrison. 2012. "Habitat trends in Maine's LURC-zoned deer wintering areas." Seminar, Department of Wildlife Ecology, The University of Maine, October 15, Orono, ME.

Stich, D., M. Bailey, C. Holbrook, M. Kinnison, J. Kocik, G. Zydlewski, and J. Zydlewski. 2013. "Path choice and survival of Atlantic salmon smolts in the Penobscot River, ME." Poster presentation to DSSRN, January 10, University of Maine, Orono, ME.

Zydlewski, J., A. Grote, M. Bailey, and J. Hightower. 2013. "Penobscot River American shad; who's here and who cares?" Poster presentation to DSSRN, January 10, University of Maine, Orono, ME.

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

Carpenter, M. 2013. "Maine vernal pools still revealing new secrets." Interview with K. Hoffmann and A. Calhoun given to Maine Public Broadcasting Network for Maine Things Considered. Aired August 5, 2013.

Hoffmann, K. 2013. National Geographic films Maine amphibians with graduate student Kris Hoffmann. DoSSIer No 66.

Hoffmann, K. 2013. "The blue-spotted salamander complex: Maine's amphibian enigma." Sunkhaze Café: Outreach program for Friends of Sunkhaze Meadows National Wildlife Refuge, March 16, Old Town, ME.

Hoffmann, K. 2013. "Things that go bump in the night." Outreach program for Girl Scouts, August 9, Ellsworth, ME.

Hoffman, K. 2012. Pools, policy and people - Maine's vernal pools. Sustainable Maine. Maine's Public

Broadcasting Network. October 11, 2012. Television.

Staples, E. 2013. "Blue-spotted salamanders rely on vernal pool for life." Interview with K. Hoffmann. The Weekly. August 19, 2013.

Thomas, Erin. "Researcher studying conservation of blue spotted salamander." Interview with K. Hoffmann for Fox 22 Local News. Aired July 10, 2013.