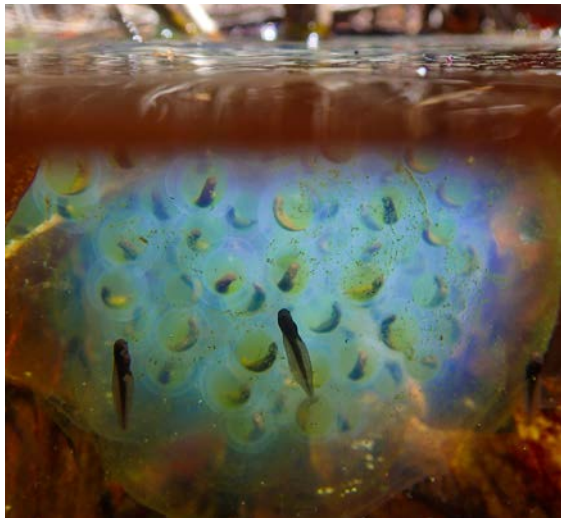
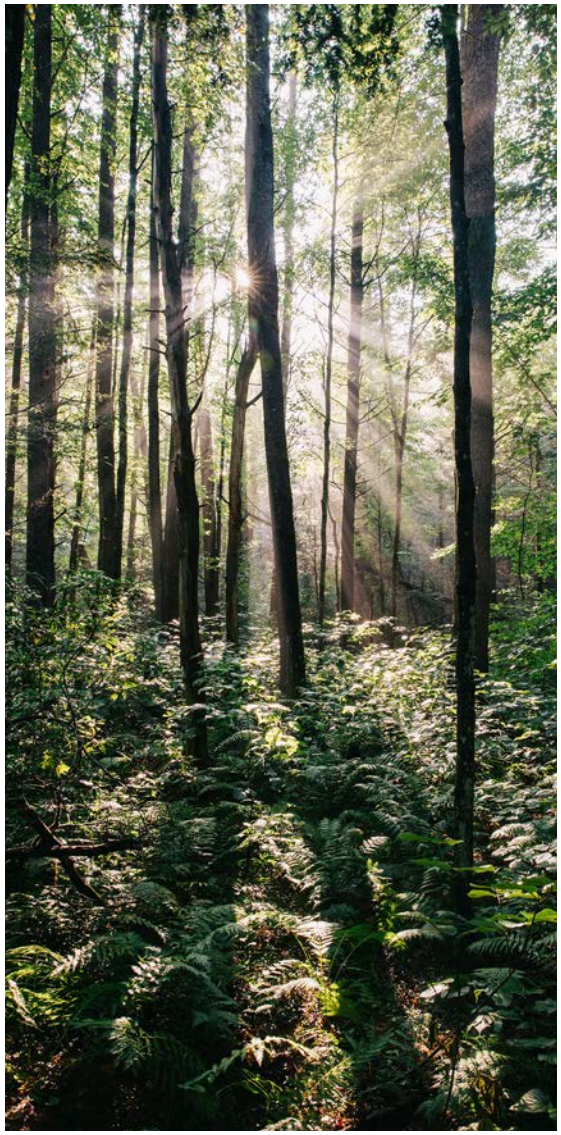
United States Geological Survey

Massachusetts Cooperative Fish and Wildlife Research Unit





Biennial Report 2018–2019

Amherst, MA
August 2019

The Cooperative Research Units Program

The Cooperative Research Unit (CRU) program is a nationwide program within the U.S. Geological Survey, with cooperators from the U.S. Fish and Wildlife Service, the Wildlife Management Institute, state conservation agencies, and a host university where the Unit is housed.

The CRU Mission is to provide:
- Graduate education to develop the workforce
- Actionable research to meet cooperator science needs
- Technical assistance to cooperators

The Massachusetts Cooperative Fish and Wildlife Research Unit

The Massachusetts CRU began in 1948, with cooperators from the University of Massachusetts Amherst, the Massachusetts Division of Fisheries and Wildlife, the Massachusetts Division of Marine Fisheries, the U.S. Fish and Wildlife Service, and the Wildlife Management Institute.

The Massachusetts Unit is currently comprised of a Unit Leader, Dr. Stephen DeStefano, who specializes in Wildlife and Terrestrial Ecology, and an Assistant Unit Leader, Dr. Allison Roy, who focuses on Fisheries and Aquatic Ecology. One Assistant Unit Leader position has been vacant since early 2015.

The Unit's Administrative Assistant is Ms. Deb Wright, who is a University employee; we are also assisted by several other administrative specialists in the Department of Environmental Conservation at UMass-Amherst and our cooperating agencies.

Research in the MA Coop Unit

We conduct research in terrestrial and aquatic ecosystems on a variety of topics; current research projects include:
- Freshwater mussel propagation for restoration
- Habitat requirements for endangered freshwater mussel species
- Juvenile river herring ecology, productivity, and restoration
- Effects of dams and dam removal on stream ecosystems
- Water supply reservoirs and downstream hydrology and biota
- Spatial and temporal variation in phytoplankton in a water supply reservoir
- Winter drawdown impacts on lake littoral and downstream ecosystems
- Demography, movements, and human dimensions of black bears
- Genetics of Canada lynx in Maine and eastern Canada
- Conservation of Andean bears in Peru
- Experimental exclosures for moose and deer
- Avian use of plantation and natural conifer stands
- Alternative ammunition for hunting deer on National Wildlife Refuges
- Ecological and sociological aspects of urban wildlife and forestry

Some quick facts about our research budgets and productivity include:
- Total operating budget of **$1-2 million** annually (including research grants, salaries of Unit scientists and staff, etc.)
- Research grants totaled **~$790,000** in 2018 and **~$637,000** in 2019
- Approximately **$264,000** in overhead charges were brought to UMass-Amherst in 2019 while the University contributed **~$190,000** in waived indirect (overhead) costs for research projects
- **27** scientific papers and reports were published in the last 2 years
- **45** presentations at conferences and public meetings in the last 2 years
- Collaborators include scientists and managers from over **33** state, federal, and private conservation agencies, institutions, and groups

Graduate Education in the MA Coop Unit

In the last 2 years, we:
- Advised or co-advised 4 postdoctoral researchers, 11 PhD students, 8 MS students, and 5 BS Honor's students
- Provided 6 working professionals with graduate school opportunities
- Provided field and laboratory research experiences to numerous undergraduate student technicians, independent study students, practicum students, and volunteers
- Taught graduate courses on Research Concepts, Aquatic Ecology, Conservation in Practice, and Dam Removal
- Served on 4 graduate committees

Recent graduates of the CRU program have positions in federal agencies (e.g., U.S. Fish and Wildlife Service), state agencies (e.g., MassWildlife), universities (e.g., University of Delaware), and non-profit organizations (e.g., Highstead Foundation).

A brook floater filters water while anchored in a stream (Ayla Skorupa)

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Abbreviations

ASMFC = Atlantic States Marine Fisheries Commission
CAFE = Center for Agriculture, Food, & the Environment
CGM = Columbia Gas of Massachusetts
CHC = Commonwealth Honor's College
CRU = Cooperative Research Unit
CRUP = Cooperative Research Units Program
ECO = Department of Environmental Conservation
IBA = International Association for Bear Research and Management
MDCR = Massachusetts Department of Conservation & Recreation
MDOT = Massachusetts Department of Transportation
MDER = Massachusetts Division of Ecological Restoration
MassWildlife = Massachusetts Division of Fisheries & Wildlife
MDMF = Massachusetts Division of Marine Fisheries
NFWF = National Fish and Wildlife Foundation
OEB = Organismic and Evolutionary Biology Program
SWSC = Springfield Water and Sewer Commission
UMass = University of Massachusetts-Amherst
USFWS = U. S. Fish and Wildlife Service
USGS = U. S. Geological Survey

Cover Photos

Top: Train tracks (Peter Zaidel), Spotted salamander eggs in a vernal pool (Ayla Skorupa)
Bottom: River herring migrate up the Parker River in MA (Matt Devine), Black bear and cub (Bill Byrne)
Right: Sunlight filtering through the forest on a foggy morning in New Salem, MA (Ayla Skorupa)
Back Cover: Sunset from atop Mt. Toby in Leverett, MA (Peter Zaidel)

Photo Credits Provided in Parentheses
Report Compiled By: Peter Zaidel

Table of Contents

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A painted turtle retracts into its shell for protection
(Ayla Skorupa)

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A red fox pounces on a field mouse
(Peter Zaidel)

COLLABORATING FACULTY, ADJUNCTS, COOPERATORS

American Rivers
Amy Singler

Amherst College
Thea Kristensen

Antioch College of New England
Lisabeth Willey

Biodrawversity, Inc.
Ethan Nedeau

Boston University and Harvard Forest
Adrien Finzi, Marc-André Giasson

Cole Ecological, Inc.
Mike Cole

Connecticut Department of Energy and Environmental Protection
Jacque Benway, Justin Davis

Connecticut River Conservancy
Andy Fisk

Fitchburg State University
John Ludlam

Highstead and Harvard Forest
Ed Faison, David Foster

Lycoming College
Robert Smith

Maine Department of Inland Fisheries and Wildlife
Beth Swartz, Jennifer Vashon

Massachusetts Department of Conservation and Recreation
Jamie Carr, Dan Clark, Kiana Koenen, Ken MacKenzie, Jillian Whitney

Massachusetts Department of Transportation
Tim Dexter

Massachusetts Division of Ecological Restoration
Michelle Craddock, Kris Houle, Beth Lambert

Massachusetts Division of Marine Fisheries
Mike Armstrong, Brad Chase, Ben Gahagan, Gary Nelson, John Sheppard, Sara Turner

Massachusetts Division of Fisheries and Wildlife
Nate Buckhout, Bill Davis, Tom French, Dave Fuller, Peter Hazelton, Mike Huguenin, Steven Mattocks, Mike Morelley, Dave Paulson, Rebecca Quinones, Jonathan Regosin, Todd Richards, Jason Stolarski, Ralph Taylor, Mark Tisa, Dave Wattles

Monmouth University
Sean Sterrett

New York State Department of Environmental Conservation
Gordon Batcheller (retired), Lisa Holst

Responsive Management
Mark Duda

Smithsonian Conservation Biology Institute
Warren Johnson

The Nature Conservancy
Alison Bowden, Sara Burns, Katie Kennedy

Trout Unlimited
Erin Rodgers

University of Maryland Baltimore County
Matt Baker

University of Massachusetts Amherst
Brian Cheng, David Bloniarz, Andy Danylchuk, Todd Fuller, Curt Griffin, Christine Hatch, Scott Jackson, Adrian Jordaan, Lisa Komoroske, Derek Lovley, Ezra Markowitz, Hank Moylan, Paul Sievert

University of Montana
Andrew Whiteley

University of Pittsburgh and Harvard Forest
Walter Carson, Sarah C. Pasquini

U.S.D.A. Forest Service
Dave King, Keith Nislow

U.S. Fish and Wildlife Service
Mike Bailey, Meredith Bartran, Sandra Doran, Mark Endries, Melissa Grader, Scott Kahan, Rachel Katz, Dave Perkins, Ken Sprankle, Lindsay Stevenson, Tim Warren, Susi von Oettingen

U.S. Geological Survey
Cooperative Research Units Program: John Organ, Mike Tome
S.O. Conte Anadromous Fish Research Center: Evan Grant, Ben Letcher, Steve McCormick, Kevin Mulligan
Leetown Science Center: Heather Galbraith
New England Water Science Center: Dave Armstrong
Northeast Climate Adaptation Science Center: Toni Lyn Morelli, Michelle Staudinger

Woods Holes Oceanographic Institute
Joel Llopiz

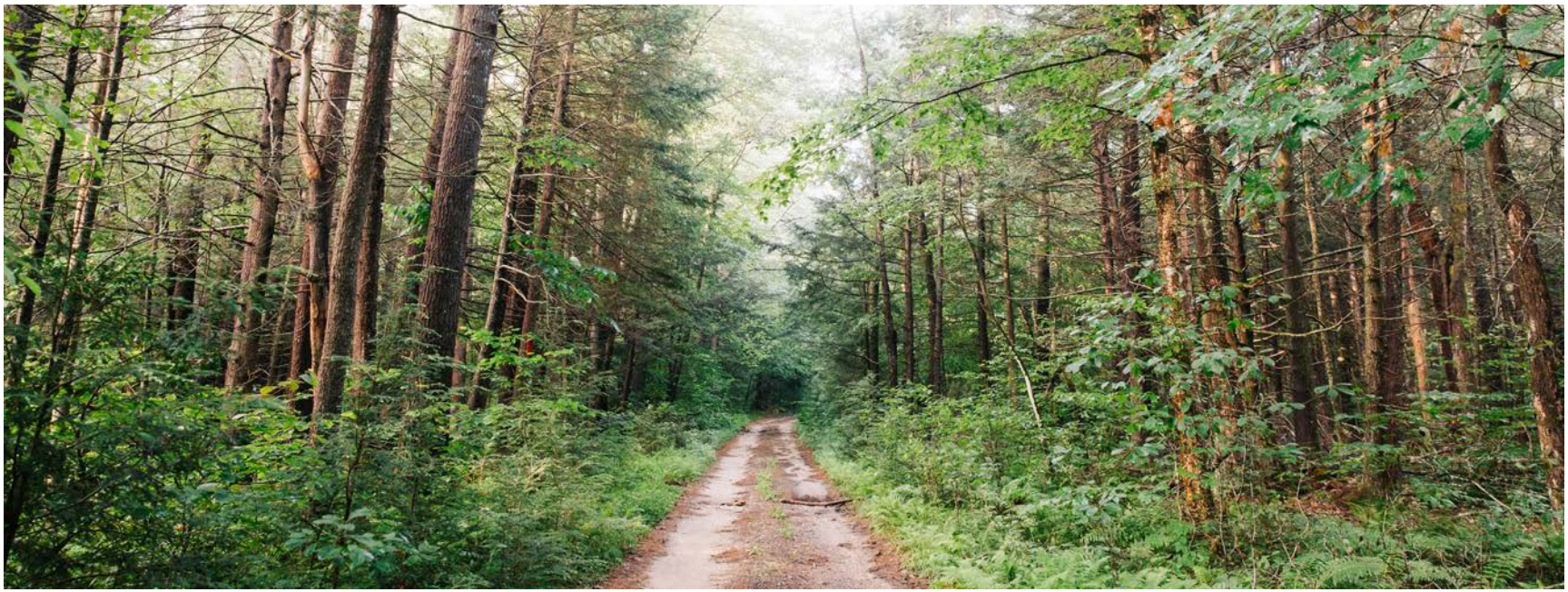
The Cooperative Research Units Program (CRUP) was established in the 1930s to enhance graduate education in fisheries and wildlife sciences and to facilitate research between natural resource agencies and universities on topics of mutual concern. The catalyst for the idea of a cooperative program was the conservationist and political cartoonist, J.N. "Ding" Darling. Darling's innovative thinking and push for conservation reforms in Iowa led to the first Unit, which was established between Iowa State College and the Iowa Fish and Game Commission in 1932. Paul Errington, a student of Aldo Leopold and a notable wildlife biologist, became the Iowa Unit's first leader.

In 1935, Darling and others successfully established a national program for Cooperative Research Units, which involved a federal agency (the Bureau of Biological Survey, a precursor to today's U. S. Fish and Wildlife Service) as well as a land-grant university and a state agency. Nine Units were formed: Oregon, Utah, Texas, Iowa, Maine, Connecticut, Virginia, Alabama, and Ohio. The Connecticut Unit was only in operation from 1935-1937, and the Ohio Unit was closed in 1991.

The Massachusetts Unit was established in 1948 and was one of a second wave of new Units, which included Missouri, Pennsylvania, Colorado, Idaho, Oklahoma, Alaska, Arizona, and Montana. Originally, Cooperative Wildlife Research Units preceded Cooperative Fishery Research Units, and the two types of Units were separate entities. In 1963, the Massachusetts Fishery Unit was formed. In 1990 most Wildlife Units and Fishery Units were combined, and the two Units at the University of Massachusetts became the combined Massachusetts Cooperative Fish and Wildlife Research Unit.

The CRUP was part of the U. S. Fish and Wildlife Service until the 1990s, when CRUP joined the U. S. Geological Survey. Today, there are 40 Cooperative Research Units in 38 states. Each Unit consists of 2-5 federal scientists and 1-2 administrative specialists, and each is a partnership among the U.S. Geological Survey, state natural resource agencies, a host university, the Wildlife Management Institute, and in many cases the U. S. Fish and Wildlife Service. A formal Cooperative Agreement specifies the responsibilities of each cooperator, and a Coordinating Committee meets annually and serves to advise and guide the Unit. Staffed by Federal personnel, Cooperative Research Units conduct research on applied conservation questions, participate in the education of graduate students, provide technical assistance and consultation on natural resource issues, and provide continuing education for natural resource professionals.

Throughout its history, the primary three-fold mission of the CRUP has remained the same: (1) Graduate Education, (2) Research, and (3) Technical Assistance in matters related to fish and wildlife populations and their habitats.



An old road connects several northeastern towns in Massachusetts (Ayla Skorupa)

Stephen DeStefano
Leader - Wildlife
Research Professor

I have worked on a variety of species and topics related to wildlife population dynamics, habitat relationships, and wildlife-human interactions, particularly within forested ecosystems and urban-suburban environments. I am particularly interested in the influence of anthropogenic factors (development, disturbance) on wildlife, how large animals that require large spatial scales use fragmented and human-dominated landscapes and the implications for land conservation, and the science and management of "overabundant" wildlife – what makes some species successful and how that influences human-wildlife interactions.

Allison H. Roy
Assistant Leader - Fisheries
Research Associate Professor

My research broadly revolves around characterizing anthropogenic impacts on aquatic ecosystems and identifying conservation strategies for effectively protecting and restoring watersheds. Understanding the mechanisms by which human threats (e.g., urbanization, dams, water withdrawals) and their associated stressors result in degraded biotic assemblages is an overarching challenge of my research program. I am interested in examining effects of alterations (e.g., hydrology, temperature, habitat, food resources) on fishes, mussels, and macroinvertebrates; population ecology and conservation of rare and endangered species; and potential for management to restore freshwater ecosystems.

Deb Wright
MA Cooperative Research Unit
Administrative Assistant

I joined the MA Cooperative Research Unit in December 2014 and have thoroughly enjoyed learning about the various research projects. In working with grant tracking and budgeting, I'm always curious as to when the next order of sardines will be for those bears! With a background in education, I have worked at a variety of schools in Idaho, Washington, and Vermont-both in the classroom and on the financial end. After raising a family of four kids in Vermont I continue to love the outdoors, whether it be in the garden, out on a run, or Nordic skiing.

COOPERATOR SERVICE

- Associate Editor, Freshwater Science (Roy)
- Graduate Committee member (DeStefano, Roy)
- Seminar Committee Chair, OEB Graduate Program (Roy)
- ECO Graduate Student Symposium, Faculty Representative 2017-18 (Roy)

GRADUATE COURSES TAUGHT

2017-2018

- Research Concepts (ECO 601: Roy)
- Conservation in Practice (ECO 697CP: DeStefano and Zeller)
- Dam Removal Independent Study (NRC 496Y, ECO 696Y: Roy with Kris Houle and Kevin Mulligan)

2018-2019

- Research Concepts (ECO 601: DeStefano and Zeller)
- Aquatic Ecology (ECO 590AE: Roy)
- Bayesian Modeling in R (ECO 696: Sterrett)
- Dam Removal Independent Study (NRC 496Y, ECO 696Y: Roy with Kris Houle and Kevin Mulligan)

Amethyst Brook in Pelham, MA (Peter Zaidel)

GRADUATE STUDENTS AND POSTDOCS (MAJOR PROFESSOR) 2018-PRESENT

COMPLETED

Sean Sterrett, Post-doc (Roy) – Brook floater conservation and restoration initiative (December 2018)

Rick Harper, Ph.D. (DeStefano and David Bloniarz) – Natural-ecological and socio-political factors influencing urban forest management in Massachusetts (August 2019)

Matthew Devine, M.S. (Roy) – Juvenile river herring in freshwater lakes: Sampling approaches for evaluating growth and survival (September 2017)
Peter Zaidel, M.S. (Roy) – Impacts of small, surface-release dams on stream temperature and dissolved oxygen in Massachusetts (May 2018)

Renee Bouldin, B.S. Honor's (Roy) – Responses of stream fishes to dam removal in Massachusetts (May 2018)
Julia Cox, B.S. Honor's (Roy) – The spatiotemporal relationship between parasitic mussel larvae and river herring of the Connecticut River watershed (May 2019)
Holly Giard, B.S. Honor's (Roy) – Investigating the effects of winter lake drawdowns on freshwater mussels and consequences for water quality (May 2018)

CURRENT

Katherine Zeller, Post-doc (DeStefano)

Kate Abbott, Ph.D. (Roy)
Jason Carmignani, Ph.D. (Roy)
Laura Conlee, Ph.D. (DeStefano)
Matthew Devine, Ph.D. (Roy and Adrian Jordaan)
Nereyda Falconi Lopez, Ph.D. (John Organ and DeStefano)
Tanya Lama, Ph.D. (John Organ and DeStefano)
Meghna Marjadi, Ph.D. (Roy)
Todd Richards, Ph.D. (Roy)
Ayla Skorupa, Ph.D. (Roy)

Christopher Cahill, M.S. (DeStefano and John Organ)
Virginia Martell, M.S. (Roy)
Susan McCarthy, M.S. (DeStefano and John Organ)
Calvin Ritter, M.S. (Dave King and DeStefano)
Jennifer Ryan, M.S. (Roy)
Joy Trahan-Liptak M.S. (Roy)

John Organ (USGS, CRUP)

Dr. John Organ retired as Chief of the USGS Cooperative Research Units Program in January 2019 after a combined career of over 40 years with U. S. Fish and Wildlife Service and USGS. John was Chief of Wildlife and Sport Fish Restoration for the northeast region of USFWS. He then served as Chief of the Coop Unit Program from 2014–2019, where his vision and energy strengthened and broadened the program. Throughout his career John played an active role in research, education, and service. He has mentored many graduate students and has published dozens of scientific, technical, and popular articles. John is now Scientist Emeritus with USGS and remains adjunct faculty with the University of Massachusetts, Michigan State, and the Universidad Andres Bello in Santiago, Chile. John is an alumnus of the Massachusetts Coop Unit, having done PhD work on river otters under the direction of Dr. Wendell Dodge.

Tom French (MassWildlife)

Dr. Tom French, Assistant Director of MassWildlife's Natural Heritage and Endangered Species Program (NHESP), retired in February 2019 after 35 years in the position. Tom was the first MassWildlife employee to be hired with a PhD (although many have been hired since then). Tom was a strong supporter of the Coop Unit program, and NHESP has supported a wide array of projects on reptiles and amphibians, coastal birds, small mammals (including bats), and freshwater mussels, which have funded a large number of Coop Unit postdocs and graduate students. Tom grew the NHESP staff from 4 to 29 people over his tenure, and his legacy includes many stories of habitat conservation and species recovery. He remains active in a variety of roles related to the conservation of heritage species in the Commonwealth of Massachusetts.

Ken Elowe (USFWS)

Dr. Ken Elowe retired from the U.S. Fish and Wildlife Service in May 2019, after having served as Assistant Regional Director for Science Applications, where he provided leadership and direction in the development and execution of high-priority regional science activities, including those involving climate change, adaptive resource management, and landscape conservation. Before working for USFWS, Ken was Director of Resource Management with the Maine Department of Inland Fisheries and Wildlife, where he was responsible for fish and wildlife programs. Ken was the USFWS representative on our Unit Coordinating Committee, and an avid supporter of and contributor to the Coop Units in the Northeast. He received his MS and PhD from the University of Massachusetts working on black bears under the direction of Dr. Wendell Dodge of the Massachusetts Coop Unit.

A Big Birthday for the Unit – The Massachusetts Unit celebrated its 70th anniversary last year (2018) with a grand meeting at the Massachusetts Division of Fisheries and Wildlife's Field Headquarters in Westborough, MA. About 70 people attended, and included a large number of agency personnel, university faculty, graduate students, board members, and other friends and supporters. The celebration began with a series of lightning talks by current Unit graduate students and post-docs and featured two talks from Unit alumni: Dr. Ken Elowe (USFWS) and Dr. Mike Jones (MassWildlife) on their memories and perspectives as graduate students of the Massachusetts Unit. The morning finished with a stimulating panel and group discussion on the "Hallmarks of Wildlife and Fisheries Science". We then adjourned for a group lunch and a birthday cake adorned with USGS green frosting on the patio behind the Division headquarters overlooking the Wayne F. MacCallum Wildlife Management Area.

Happy 70th birthday to the Massachusetts Unit!

Research – Although our Unit works on a broad array of research topics, we have maintained long-term interests in projects focused on black bears, ungulates, river herring, and stream ecology.

The Unit collaborated with MassWildlife and Responsive Management (a public opinion survey research firm specializing in natural resource, wildlife, environmental, and outdoor recreation issues) to conduct a telephone survey of Massachusetts residents on their opinions, beliefs, and knowledge of, and experience with, black bears and black bear management across the Commonwealth. Laura Conlee is currently analyzing the survey data for her dissertation. MassWildlife and the Unit reached close to 50 individual bears fitted with GPS collars. We hired postdoctoral researcher Zeller to analyze this massive data set. Our first paper on the GPS bear data has been published in the journal Movement Ecology (Zeller, Wattles, Conlee, and DeStefano co-authors). Additionally, Zeller and Dr. Thea Kristensen of Amherst College have teamed up with MassWildlife and MDCR to conduct a two-year study on black bear genetics and population abundance. An extensive network of hair collection corrals have been set up in central and western Massachusetts to collect bear hair samples. Genetic and population estimation analyses will commence this winter, followed by a second field season of hair sample collection in 2020. Our involvement in the challenge of managing overabundant deer populations in suburban Massachusetts is continuing with Susan McCarthy's study of attitudes and experiences of hunters taking part in a controlled hunt in the Blue Hills.

Beyond our long-term focus projects on black bears and ungulates, Tanya Lama and her collaborators, including biologists from Maine, were the first to publish the entire genome for Canada lynx, which is an exciting and important advancement for the conservation of lynx in North America. Chris Cahill's study of alternative ammunition (i.e., copper instead of lead) for deer hunting on refuges, Cal Ritter's work on avian use of Norway spruce stands, and Rick Harper's investigations into urban forests and forest management are providing information and answering questions of importance to our cooperators.

On the aquatic side, major projects focus on river herring, freshwater mussels, and dam/lake management. In collaboration with UMass faculty (Adrian Jordaan, Michelle Staudinger, Andrew Whiteley), the Coop Unit has been involved in 4 MS projects (Matt Devine, Meghna Marjadi, Steven Mattocks, Julianne Rosset) that have advanced our understanding of spawn timing, reproductive success, juvenile river herring sampling approaches, factors influencing river herring densities and growth, and influences on lake food webs. Current Unit PhD students Devine and Marjadi have expanded this research to understand interannual variation in densities and growth, emigration timing, habitat use in river coves and estuaries, and responses to dam removal.

Freshwater mussel research has focused on propagating and culturing endangered brook floater (Ayla Skorupa), yellow lampmussel (Virginia Martell), and dwarf wedgemussel (Jennifer Ryan) at the USFWS Richard Cronin Aquatic Resource Center, in collaboration with Dave Perkins (USFWS), Tim Warren (USFWS), and Peter Hazelton (MassWildlife). We have also developed standard methods for brook floater field assessment that are being implemented range-wide (Dr. Sean Sterrett, in collaboration with the Brook Floater Working Group) and have sampled brook floater to understand habitat requirements for restoration (Skorupa).

We have continued research on the effects of dams (Peter Zaidel) and dam removal (Kate Abbott); this work is in collaboration with Keith Nislow (Forest Service), Kris Houle and others at MDER, Erin Rodgers (Trout Unlimited), and Steven Mattocks and others at MassWildlife. We are wrapping up research on the effects of lake drawdowns on littoral communities (Jason Carmignani) and starting new research on downstream effects of drawdowns on stream ecosystems in collaboration with MassWildlife and MDER. Research is also underway on the effects of surface water supply reservoirs on downstream flows and fishes (Todd Richards, MassWildlife) and lake phytoplankton communities (Joy Trahan-Liptak, MDCR).

Citizen Science and Outreach – The Coop Unit has engaged citizen scientists for help with several research projects. For the brook floater project, volunteers with the Connecticut River Conservancy assisted with mussel and habitat surveys in local rivers and streams. This provided a unique opportunity for citizen scientists to snorkel while learning about native freshwater mussels. More than 20 people have participated in the project, with a core of 5 repeat volunteers who have been involved since the start in 2016. We are also starting a new project where citizen scientists will count migrating juvenile river herring through the online platform Zooniverse using pictures extracted from video footage. This not only provides essential data collection support but serves to educate the public about river herring biology and conservation.

In 2018 and 2019, students in the Roy Lab collaborated with the Mystic River Watershed Association (MyRWA) to participate in the Cambridge Science Festival, a citywide event to communicate science and ecology to the general public. Our group was part of a broader outreach event at the Mystic Lakes Dams in Arlington, MA, where MyRWA coordinates a volunteer adult river herring count. We developed hands-on activities and shared information about the river herring life cycle, invertebrate identification, otolith aging, and the impact of dams with over 150 participants between the two years.

Students working at the USFWS Richard Cronin Aquatic Resource Center in Sunderland, MA have participated in 15 outreach events in the last two years. Events have ranged from tours for kids in elementary school and summer camp to students at universities. Tours highlight research conducted by graduate students at UMass and the Coop Unit and provide an opportunity for the general public to learn about freshwater mussel biology and restoration.

Graduate Training and Courses – In keeping with the collaborative nature at the heart of the Unit, our Unit leaders have designed and taught courses at UMass that center on providing real-world work exposure to students interested in conservation. Chief among these courses is the long-term commitment by Roy and DeStefano to teach incoming graduate students Research

Unit students from the Roy Lab participated in the Cambridge Science Festival in Arlington, MA (Meghna Marjadi).

Concepts, a foundational graduate course designed to assist them with writing and presenting the first draft of their graduate research proposal.

For the last 4 years, we also offered a year-long, 3-credit Dam Removal practicum course for environmental conservation and engineering undergraduate and graduate students. The course has been taught by Kris Houle of MDER, with help from Roy and an engineering faculty member (Dr. David Ahlfeld or Dr. Kevin Mulligan). Students learn about the dam removal process by attending topical seminars, conducting independent projects, and participating in phone calls, site visits, and meetings with the technical teams of active dam removal restoration projects. These hands-on experiences and interactions with state and federal agencies, non-profits, and consulting firms have provided a foundation for those students seeking careers in river restoration.

In 2017, Zeller and DeStefano teamed up to teach a graduate level course titled "Conservation in Practice." Several biologists, conservationists, and managers from a number of different federal and state agencies and NGOs came to campus to talk to students about their jobs, motivations, and goals for conservation, and to describe what "a day in the life" is like for them. Each student chose to either interview or shadow for a day a professional biologist to find out firsthand what they do. Students also attended public hearings or meetings to gain further insight into how conservation is done in the Commonwealth.

Several former postdoctoral researchers and doctoral students from our Massachusetts Unit have entered academia as faculty members at colleges and universities. As Coop Unit students and postdocs, in addition to their research, they mentored undergraduate and graduate students, helped teach special workshops and courses, and interacted with numerous natural resource agencies throughout the region. These experiences set the stage for developing their own labs in applied resource conservation. Here, we have highlighted five Coop Unit postdocs and graduate students who finished within the last 10 years and are now established faculty.

Sean Sterrett leads an Aquatic Ecology class on herpetology as a postdoc at UMass (Allison Roy).

Dr. Kyle McCarthy
Coop Unit PhD 2006–2010
Associate Professor
Department of Entomology and Wildlife Ecology
University of Delaware
Newark, DE

As a faculty member at UD, I teach wildlife courses in ecology and conservation, management, and spatial ecology, as well as courses on conservation of tropical biodiversity and mammalogy. My research interests focus on applying advanced resource selection models and population abundance models to rare and elusive species, developing new methods for quantitative analysis of wildlife data, evaluating wildlife behavioral responses to human recreation, and the ecology and conservation of wild felids.

Dr. Justin Compton
Coop Unit Postdoc 2008–2010
Associate Professor
Department of Biology
Springfield College
Springfield, MA

I am an educator and ecologist with a passion for working with students in the classroom and in the field. My teaching and research experiences have focused on the integration of environmental and biological sciences. This multidisciplinary focus has helped me develop and hone collaborative teaching and research skills toward cultivating sustainable relationships between humans and the environment. Among my research interests are social-ecological systems involved in land conservation, community and ecosystem dynamics, species-interaction modeling, and zoonotic diseases.

Dr. Lisabeth Willey
Coop Unit PhD 2008–2010
and Postdoc 2012–2014
Assistant Professor
Department of Environmental Studies
Antioch University of New England
Keene, NH

At Antioch, I work with students and collaborators to employ field sampling and modeling techniques to tackle applied ecological questions, both inside and beyond the classroom. I teach biostatistics, conservation biology, and vertebrate ecology classes and mentor MS and PhD students in research projects ranging from the human dimensions of red wolf conservation to hoverfly ecology. I also work with local, state, and federal partners to develop and implement broad-scale conservation planning efforts for rare species and ecosystems, with a focus on rare turtle species.

Dr. Robert Smith
Coop Unit Postdoc 2012–2015
Assistant Professor and Research Associate
Department of Biology
Lycoming College
Lycoming College Clean Water Institute
Williamsport, PA

I teach courses in support of the ecology track in the biology department and the environmental science minor, which include aquatic biology and introduction to GIS. I mentor undergraduate students performing research in aquatic ecology, plant biology, wildlife ecology, sustainability, and any other area of research students find interest in. My personal research is currently focused on examining dispersal processes by aquatic biota (mostly aquatic insects) and studying assessment methods, management, and rehabilitation of urban streams.

Dr. Sean Sterrett
Coop Unit Postdoc 2017–2018
Assistant Professor
Biology Department
Marine and Environmental Biology
and Policy Program
Monmouth University
West Long Branch, NJ

I focus my research on understanding the influences of anthropogenic threats on wildlife populations and identifying effective and efficient management strategies for wildlife restoration and conservation, including the use of structured decision making. I specialize in reptiles and amphibians but have interests in all wildlife with conservation-related problems. At Monmouth, I teach courses in biodiversity and evolution, herpetology, wildlife ecology and management and field methods in environmental biology. I also mentor undergraduate students with interests in wildlife and environmental biology.

Aquatic Restoration Through Dam Removal

Across Massachusetts, thousands of small dams alter stream hydrology, impair sediment and nutrient transport, and impede fish, making ecosystems less resilient to natural and anthropogenic disturbances. Dam removal is an increasingly prevalent method of reducing risk and restoring stream habitats, with >70 dams removed in Massachusetts since 2000. Despite increasing removals, the extent and timescale of physical and biotic responses are not well-understood. The goal of this research is to build upon extensive pre-removal data (from P. Zaidel's MS thesis) to quantify the responses of water quality (i.e., temperature and dissolved oxygen), macroinvertebrate assemblages, and fishes to dam removals in ~14 streams across Massachusetts. Additionally, we will investigate dam, stream, and landscape factors that influence variability in ecosystem responses. This information will be critical for the prioritization of future projects and will increase our ability to effectively address questions from the public and regulatory agencies regarding expectations following removal.

STUDENT	Kate Abbott (PhD)
ADVISOR	Allison Roy
FUNDING	Massachusetts Environmental Trust MDER Society for Ecological Restoration
COLLABORATORS	Erin Rodgers Keith Nislow Kris Houle

Pre- and post-removal of Upper Roberts Meadow Dam (Peter Zaidel, Kate Abbott).

Population Dynamics and Restoration Ecology of Anadromous River Herring

Anadromous river herring populations declined sharply over a half century ago, and conservation measures have not resulted in population recovery. A lack of information about juvenile growth and mortality in freshwater and estuarine environments limits population models and effective management. This project will investigate: (1) inter-annual variation in juvenile river herring densities and growth in relation to lake-specific and regional environmental conditions, (2) differences in juvenile densities and growth among lake, estuarine, and large river cove habitats, and (3) the timing and magnitude of recovery of juvenile river herring productivity and dynamics following dam removal. We are using a newly developed lake sampling protocol to estimate juvenile densities, and laboratory analysis of otoliths to determine age and growth rates from 30+ lakes across New England. This work will quantitatively link river herring productivity at multiple life stages and incorporate information about habitat quantity and quality to provide a more accurate understanding of population dynamics.

STUDENT	Matt Devine (PhD)	
ADVISORS	Allison Roy Adrian Jordaan	
FUNDING	MDMF The Nature Conservancy UMass	
COLLABORATORS	Mike Armstrong Alison Bowden Brad Chase Justin Davis	Ben Gahagan Gary Nelson Ken Sprankle Michelle Staudinger

Matt conducting a temperature and oxygen profile prior to river herring sampling (Steven Bittner).

Relating Juvenile River Herring Emigration to Environmental Conditions

Anadromous river herring migrate to their natal freshwater lakes and streams to spawn in spring. There is limited data on the timing of juvenile emigration back to the ocean and abiotic and biotic factors linked to emigration timing. We are using video monitoring to assess when juvenile river herring leave freshwater. From May–November 2017–2019, we collected video data from an emigration outlet in the Monument River in Bourne, MA that will allow us to enumerate how many juvenile river herring pass by the outlet camera using both computational methods and citizen scientists. These data will be paired with environmental data (e.g., water quality, zooplankton composition, flow, water temperature) to investigate how environmental conditions influence emigration timing and duration. We will begin sampling juvenile blueback herring in Connecticut River coves in summer 2019 and will use growth rates and cohort analyses to better understand how the juvenile fish move down the river and estuary system.

STUDENT: Meghna Marjadi (PhD)

ADVISOR: Allison Roy

FUNDING: MDMF; UMass Graduate School; USGS SSP

COLLABORATORS: Jacque Benway, Justin Davis, Ben Gahagan, Adrian Jordaan, Lisa Komoroske, Joel Llopiz, Steve McCormick, John Sheppard, Ken Sprankle

Video monitoring at the Monument River (Meghna Marjadi).

Hydrological and Biological Impacts of Water Supply Reservoirs on Massachusetts Streams

Massachusetts has more than 150 surface water supply reservoirs that contribute to stream flow alteration in nearly one third of the surface area of the state. The goal of this research is to characterize stream flow alteration downstream of water supply reservoirs and examine impacts to fish communities. I will compare: (1) measured stream flows downstream of 6 water supply reservoirs to modeled estimates of stream flow at those same locations, (2) measured stream flow downstream of water supply reservoirs to measured stream flows on similar unimpounded streams, and (3) fish communities at all of the same locations. Fish community samples and hundreds of thousands of discharge estimates have been developed to this point. Results will provide valuable information on potential and actual streamflow alterations downstream of water supply reservoirs and the stream processes that determine fish community structure. Managers can use these data to assess cumulative impacts on natural resources and guide water allocation decisions.

STUDENT: Todd Richards (PhD)

ADVISOR: Allison Roy

FUNDING: MassWildlife; USGS CRUP

A stream spills over the dam of a water supply reservoir (Peter Zaidel).

Brook Floater Habitat Requirements and Propagation

Half of the freshwater mussels in Massachusetts are state protected due to their decline in abundance and range contraction. The brook floater is state endangered and currently is under review for federal protection under the Endangered Species Act. The overall goal of this project is to develop a restoration strategy for this species. Specifically, this includes determining the best host fish for propagating juveniles in a laboratory, developing methods for growing juveniles in the lab, and quantifying adult habitat in Massachusetts to identify which biotic and abiotic factors best predict their density. In spring 2019, we began deploying lab-propagated juvenile brook floater in enclosed systems to compare their growth and survival among rivers with extant populations. We are collecting water quality and host fish information at each of these sites; these data will help inform augmentation and restoration potential.

STUDENT	Ayla Skorupa (PhD)
ADVISOR	Allison Roy
FUNDING	Massachusetts Environmental Trust USFWS State Wildlife Grant
COLLABORATORS	Andy Fisk Peter Hazelton Dave Perkins Tim Warren

Sam Rode checks on chambers containing brook floater that are placed in rivers around MA (Ayla Skorupa).

Dwarf Wedgemussel Propagation and Restoration

The dwarf wedgemussel is one of many federally listed freshwater mussel species in need of recovery in North America. We are developing new *in-vitro* propagation methods to recover this species, in which a basal media and serum mixture will replace the need for propagation with a host fish. We will use different serum mixtures to determine which type produces the highest transformation rate from glochidia to juveniles. We are also compiling existing data and collecting new data on fish assemblages at dwarf wedgemussel sites in the Connecticut and Delaware River watersheds to assess how presence and abundance of potential host fish may affect population recovery. This information will be used to guide recovery and management decisions for this species.

STUDENT	Jennifer Ryan (MS)
ADVISOR	Allison Roy
FUNDING	USGS SSP
COLLABORATORS	Heather Galbraith Peter Hazelton Dave Perkins Tim Warren

Jennifer removes dwarf wedgemussel glochidia in the lab (Tim Warren).

Assessing Long-Term Phytoplankton Trends in Wachusett Reservoir

Phytoplankton can impact drinking water supplies by clogging filters, creating undesirable odors, and exposing humans to harmful toxins. Water suppliers are aware of these risks and many conduct periodic algal monitoring; however, consistent long-term monitoring programs are rare. Phytoplankton have been monitored continuously since 1989 by biologists at the MDCR Division of Water Supply Protection's Wachusett Reservoir, a surface water resource for Boston, Massachusetts. While these data have been analyzed on short time scales (e.g., weekly, seasonally, annually), long-term assessment and correlation with physical and chemical water quality data has not been conducted. This study seeks to identify inter- and intra-annual variation in phytoplankton density and composition, and the primary climatic, water chemistry and environmental drivers of observed phytoplankton variation. Results will assist managers in prioritizing watershed protection activities, planning water transfer regimes, and modeling future conditions.

STUDENT	Joy Trahan-Liptak (MS)
ADVISOR	Allison Roy
COLLABORATORS	Jamie Carr

Water samples from Wachusett Reservoir, MA (Joy Trahan-Liptak).

Juvenile River Herring Diets in the Connecticut River

A study will be conducted in summer 2019 to address the role zooplankton populations might play in juvenile river herring growth, as well as the potential shifts in zooplankton community composition due to selective feeding patterns of juvenile river herring. Juvenile river herring and zooplankton samples will be collected from both mainstem and cove sites along the southern portion of the Connecticut River. Zooplankton samples will be analyzed for community composition and density. We will compare the diets of juveniles relative to the zooplankton communities in the different habitats (cove vs mainstem) to understand the variable influence of juvenile river herring on zooplankton communities among freshwater habitats. Results will aid in modeling river herring populations and can inform management of these river herring, particularly in large river systems.

STUDENT	Meghan-Grace Slocombe (BS)
ADVISOR	Allison Roy
FUNDING	USGS SSP
COLLABORATORS	Jacque Benway Justin Davis Matt Devine (PhD student) Adrian Jordaan Meghna Marjadi (PhD student) Steve McCormick

Meghna Marjadi and Meghan sample zooplankton in Great Herring Pond, MA (Don Williams).

Brook Floater Conservation and Restoration Initiative

The brook floater (Fig. 1) is a small, stream-dwelling freshwater mussel found in Atlantic Slope drainages of the eastern United States and southern Canada and is declining in distribution and abundance across its range.

To address concerns over this decline, a Brook Floater Working Group (BFWG) including managers and scientists from federal and state agencies and academic institutions, was created to foster cross-state and regional relationships among partners working on brook floater conservation. BFWG partners learned about the various survey and propagation efforts taking place in different states across the species' range and helped to develop and initiate new methods. Because there is such a scarcity of information on brook floater propagation, this effort represents the best available knowledge of lab and field methods, which can guide state managers using these techniques for population restoration.

One of the major achievements of the BFWG has been the development and implementation of regionally coordinated protocols to improve distribution, abundance, and population viability monitoring of brook floater populations. The rapid assessment protocol was developed to estimate the occupancy of brook floater within watersheds that are recently (i.e., <20 years) known to have brook floaters present (Sterrett et al. 2018). Additionally, the protocol was designed to explore the effects of reach- and watershed-scale habitat features on brook floater occurrence and to understand how survey covariates influence detection (Fig. 2). The long-term monitoring protocol employs a mark-recapturing approach with at least 2 site visits per year for multiple years to estimate population status and trends and demographic rates, which allows for comparisons among populations throughout its range. Both protocols are being implemented in multiple states.

While limited information exists for the distribution of brook floater across its range, there are existing data that can help with predicting suitable brook floater habitat. We used the occurrence records from coordinating states (<20 years) and habitat data at multiple scales (i.e. catchment, riparian zone and watershed) to develop a presence-only species distribution model using Maxent software (Fig. 3). While this project is ongoing, there is promise for this distribution model to aid managers in determining the location of future survey efforts and to inform habitat management and land acquisition. Collectively, the efforts of BFWG to develop regional protocols for brook floater propagation and to build species distribution models provide a platform for future brook floater conservation and restoration efforts and a baseline for monitoring populations across its range.

POST-DOC	Sean Sterrett
ADVISOR	Allison Roy
FUNDING	USFWS State Wildlife Grant
COLLABORATORS	Mark Endries Peter Hazelton Toni Lyn Morelli Dave Perkins Lindsay Stevenson

Figure 1. A marked brook floater during a long-term monitoring survey (Sean Sterrett).

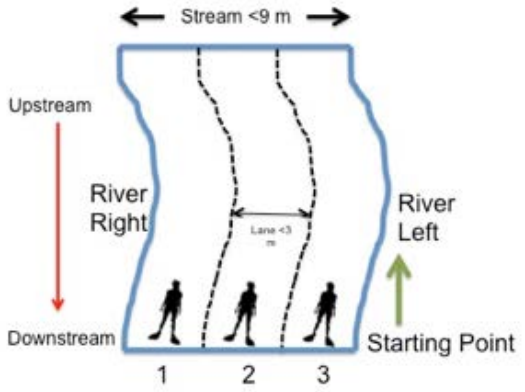


Figure 2. A diagram of stream survey lanes for the rapid assessment survey.

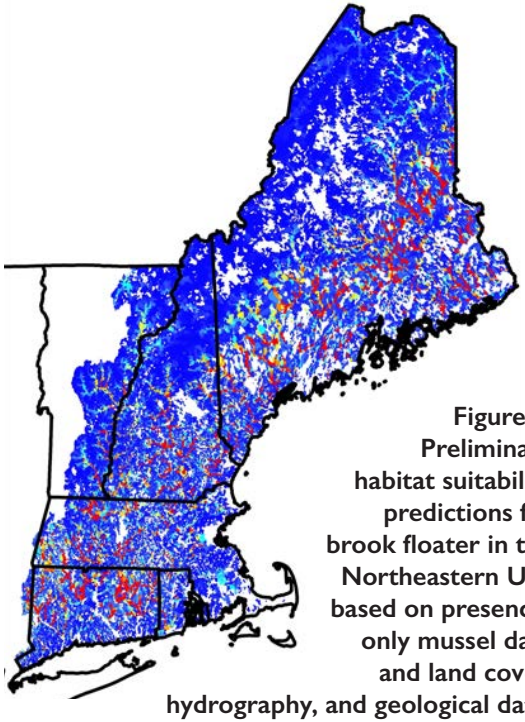


Figure 3. Preliminary habitat suitability predictions for brook floater in the Northeastern U.S. based on presence-only mussel data and land cover, hydrography, and geological data. Suitability increases from cooler colors (e.g., blue) to warmer colors (e.g., red).

Assessment of Wintertime Water Level Drawdown Impacts on Littoral Zone Ecology in Massachusetts Lakes

Annual winter water-level drawdown (WD) regimes are a widespread and long-standing management practice in Massachusetts recreational lakes to reduce nuisance levels of aquatic vegetation and to protect shoreline structures from ice erosion (Fig. 1). Despite its established use, few studies have quantified cumulative WD effects on non-target littoral zone biota and habitat, particularly with mild (i.e., <3 m) WD magnitudes (Carmignani and Roy 2017). We continuously monitored water levels along a WD magnitude gradient, and subsequently developed hydrological drawdown metrics to determine WD effects on: (1) physical habitat condition in terms of macrophyte assemblages, sediment particle size and large wood, (2) mussel density-distributions and mortality, (3) benthic and epiphytic macroinvertebrate abundance and composition, and (4) benthic carbon reliance of widespread fish species.

STUDENT Jason Carmignani (PhD)
ADVISOR Allison Roy
FUNDING MassWildlife
UMass OEB

COLLABORATORS Jason Stolarski
Peter Hazelton
Todd Richards

From 2014–2018, we recorded continuous water levels in 21 lakes. Drawdown magnitudes and percent lakebed exposure varied from 0.21–2.26 m and 1.3–37.6%, respectively, and remained consistent within lakes across WD events (Fig. 2). Drawdown events lasted from 34–240 days between initiation (i.e., Oct.–Dec.) and refill to normal pool level (i.e., Feb.–Jun.), with considerable variation across years. We observed decreased silt and increased coarse particle proportion with WD. This change in substrate corresponded to negative effects of WD magnitude on macrophyte biomass at 1 m, with a shift in macrophyte assemblages within WD-exposed depths. Both surface and buried mussel densities were lower in WD lakes compared to control lakes at the drawdown-exposed depth (Fig. 3). When mussels were present at drawdown-impacted depths, they were often buried, small, and matched size distributions of stranded mussels collected after water-level decline, suggesting that mussel colonization of exposure zones between drawdown events is short-lived (Carmignani et al. 2019). Across a WD magnitude gradient in 14 lakes, drawdown magnitude structured macroinvertebrate taxonomic and functional composition, and we tentatively identified taxa and functional traits (e.g., long-lived taxa) sensitive to WDs.

Figure 1. Normal pool water level during summer (top) and drawdown water level (bottom) at Lake Garfield, Monetery, MA (Jason Carmignani).

Our research documents the highly variable responses of different littoral biotic assemblages to the cumulative effects of annual WD regimes. The use of annual WDs as a short-term macrophyte control tool is supported; however, drawdown-tolerant macrophyte assemblages (including some invasive nonnative species) can develop under suitable growing water quality conditions (e.g., high water clarity, high alkalinity). Management of WDs should consider the vulnerability of drawdown-sensitive taxa (e.g., mussels) and the extent to which littoral zones are exposed, as these may drive significant changes in whole-lake ecosystem structure and function. Increased knowledge of lake-specific ecology will help minimize ecological impacts of WDs.

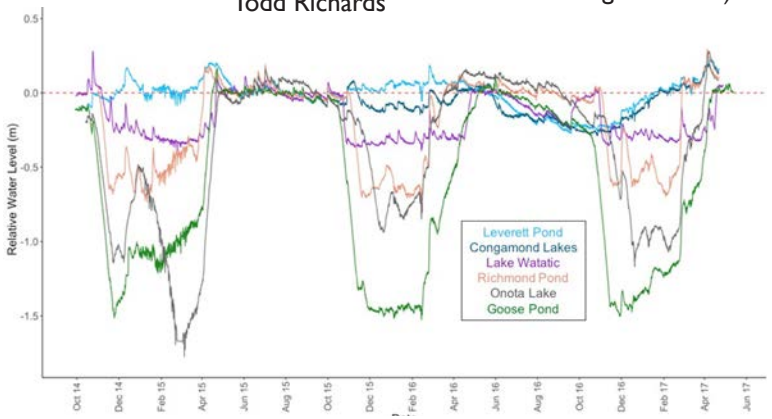


Figure 2. Water level time series for 4 drawdown lakes (Watatic, Richmond, Goose, Onota) and two non-drawdown lakes (Leverett, Congamond) over 3 winters.

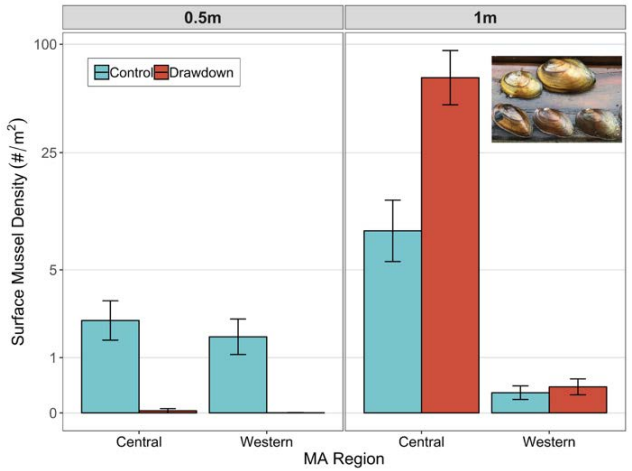


Figure 3. Mean (± SE) surface mussel densities at 0.5-m (exposed) and 1-m (non-exposed) depths in drawdown lakes (orange bars) compared to control lakes with no WD (blue bars).

Juvenile River Herring in Freshwater Lakes: Sampling Approaches for Evaluating Growth and Survival

Anadromous river herring (alewives and blueback herring) have declined over the past five decades due in large part to overfishing, degraded habitat quality, and disrupted access to critical freshwater spawning habitats. Their populations are currently assessed by counting adults in rivers during upstream spawning migrations; however, no field-based methods exist for estimating juvenile densities in freshwater nursery habitats. This makes it challenging to infer a link between adult counts and juvenile recruitment, to monitor juvenile productivity, and to develop effective management policy. The objectives of this study were to: (1) evaluate the effectiveness and sampling precision of a purse seine for capturing juvenile river herring in lakes, and (2) investigate the influence of abiotic and biotic factors on juvenile density, growth, and mortality.

STUDENT	Matt Devine (MS)
ADVISORS	Allison Roy Adrian Jordaan
FUNDING	ASMFC MDMF NFWF UMass ECO
COLLABORATORS	Mike Armstrong Michael Bailey Ben Gahagan Andrew Whiteley

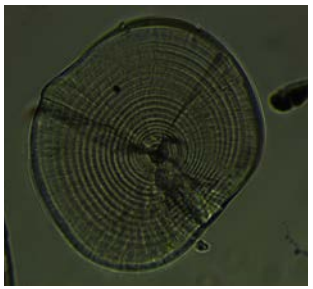


Figure 3: Saggital otolith extracted from juvenile river herring depicting daily rings (Matt Devine).

We used a purse seine (Fig. 1) to investigate juvenile densities, growth, and mortality across 16 New England lakes. Sampling at night in June or July resulted in highest catches. Precision, as measured by the coefficient of variation, was lowest in July (0.23) compared to June (0.32), August (0.38), and September (0.61) (Fig. 2). Bootstrap simulation results indicated that the effort required to produce precise density estimates is dependent on lake size, with small lakes (<50 ha) requiring up to 10 purse seine hauls and large lakes (>50 ha) requiring 15–20 hauls (Devine et al. 2018).

Using juvenile fishes captured during purse seining in June–September 2015, we calculated growth and mortality rates from sagittal otoliths (Fig. 3). Density, growth, and mortality were highly variable among lakes. Juvenile densities ranged over an order of magnitude and were inversely related to dissolved organic carbon. Juvenile growth rates were higher in productive systems (i.e., low secchi depth, high nutrients) and were strongly density-dependent (Fig. 4), leading to much larger fish at age in productive lakes with low densities of river herring compared to high density lakes. Water temperature explained 56–85% of the variation in juvenile growth rates during the first 30 days of life. These results indicate the importance of water quality and juvenile densities in nursery habitats for determining juvenile growth and survival. This study aids our understanding of factors explaining juvenile recruitment that can guide more effective and comprehensive management of river herring.

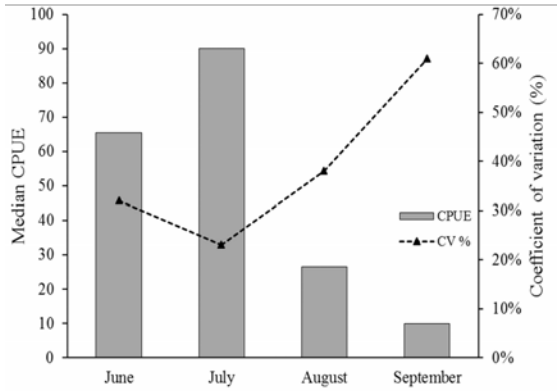


Figure 2: Median catch-per-unit-effort (CPUE) and percent coefficient of variation among 16 lakes sampled for juvenile river herring during June–September 2015.

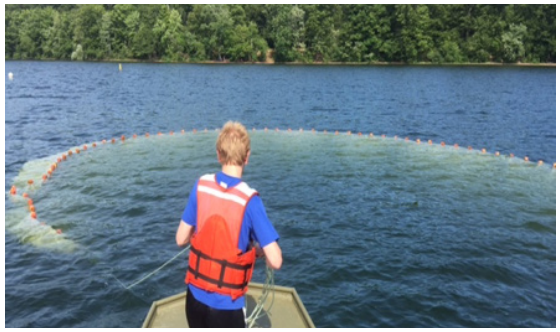


Figure 1: Deploying a purse seine (100' x 15') at Upper Mystic Lake, MA (Matt Devine).

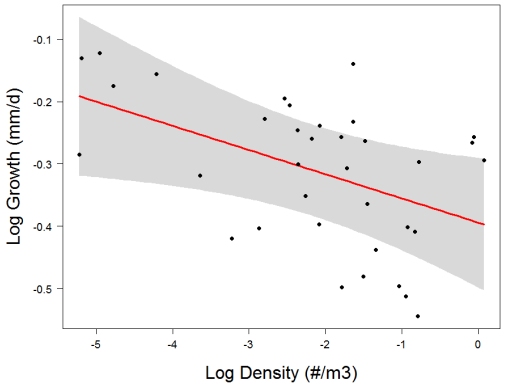


Figure 4: Relationship between juvenile density and juvenile growth (log scale). Red line is the mixed-effects regression model fit and gray band represents 95% confidence interval.

Improving Primary and Secondary Culture of Yellow Lampmussel for Restoring Populations

As of 2013, over 65% of freshwater mussel species were considered endangered, threatened, or vulnerable. Where dispersal limits freshwater mussel populations, reintroduction and augmentation using propagated mussels has been considered an ideal conservation strategy. Mussel propagation has been successful at multiple culturing facilities; however, methods are still being refined to develop best practices.

The yellow lampmussel is protected as endangered under the Massachusetts Endangered Species Act, and prior to 2006 was thought to be extirpated from the Commonwealth. In 2017, we began studies at the USFWS Richard Cronin Aquatic Resource Center (CARC) to improve primary and secondary culturing of yellow lampmussel (Fig. 1).

STUDENT	Virginia Martell (MS)
ADVISOR	Allison Roy
FUNDING	CGM SWSC USFWS UMass-Amherst
COLLABORATORS	Dave Perkins Peter Hazelton

Figure 1. Juvenile yellow lampmussels cultured at CARC, age 12–22 months (Virginia Martell).

Probiotics are used in aquaculture production for numerous species of fish, shrimp, and marine shellfish; however, few studies have been conducted on their use in freshwater mussel cultures. We conducted several studies to determine whether commercial probiotics (6 tested) could be used to improve the growth and survival of early development juvenile mussels. Juvenile mussel survival was significantly higher in cultures with some of the probiotics than in those without, although the probiotic concentration did not produce significantly different growth or survival (Fig. 2). To test whether probiotics improved survival due to denitrification and reduced ammonia build-up, we compared water quality and mussel growth and survival among treatments with water changeouts every 2 days vs 6 days. Ammonia levels increased with the longer water changeout, but this did not result in higher survival. More analysis is needed to determine when probiotics improve culture success and understand mechanisms of probiotic benefits.

To improve secondary culturing of yellow lampmussel, we compared the growth and survival of a surrogate species, the eastern lampmussel, in different rearing systems. The systems (troughs, floating baskets, dogpans, airlift upwellers, and tank upwellers) differed by water source type, filtration, flow rate, and sediment type. Three systems (troughs, dogpans, and airlift upwellers) were paired between two culturing facilities in Sunderland, Massachusetts (CARC) and North Attleboro, Massachusetts (NANFH). We saw higher survival at CARC (48–97%) compared to NANFH (10–76%), and larger mussels at CARC (6.3–10.4 mm) than NANFH (4.8–7.0 mm). However, the floating baskets at NANFH exhibited significantly higher growth than all other treatments across both locations (final average size= 14.3 mm; Fig. 3), suggesting that the NANFH pond should be considered for future secondary rearing of yellow lampmussel.

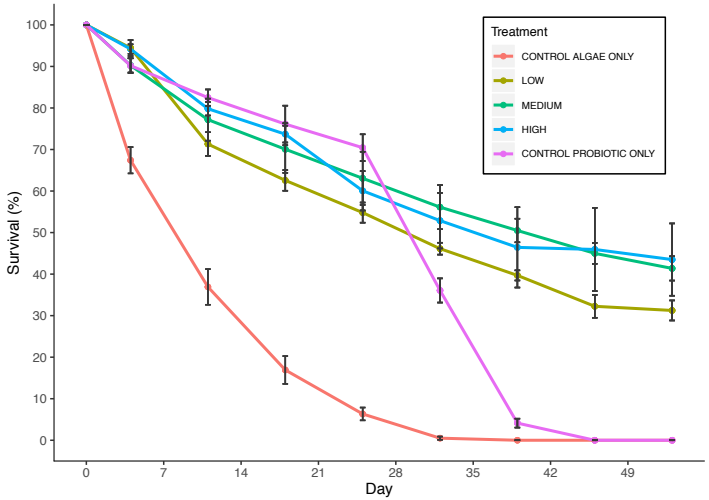


Figure 2. Mean (± SE) survival for each treatment of *Bacillus* mix probiotic. Treatment concentrations were Low: 0.0125g/L; Medium: 0.025g/L; High: 0.05g/L; Algae Only (Control; no probiotic), and Probiotic only (Control; 0.025g/L supplement and no algae). Each treatment had 4 replicates, except for 'Algae Only' that had 3.

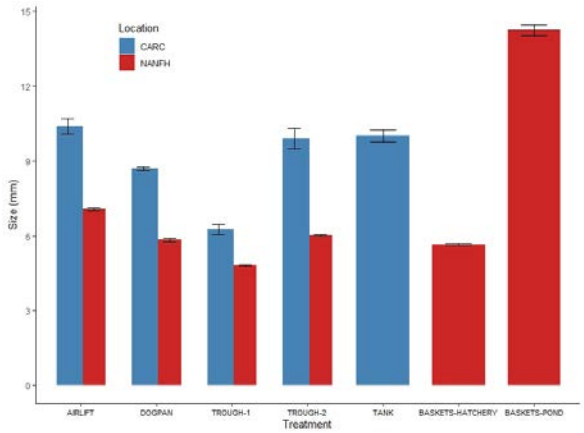


Figure 3. Mean (± SE) final average mussel size for each system at CARC and NANFH based on 3 replicates per system.

Impacts of Small, Surface-Release Dams on Stream Temperature and Dissolved Oxygen in Massachusetts

Dams are highly pervasive features of our landscape; many of these small, surface release dams (e.g., Fig. 1) are former mill dams and currently exist as little more than crumbling relics from a bygone era. Dam removal is increasingly being used to eliminate the public safety hazards posed by these aging structures and to restore stream ecosystems degraded as a result of centuries of damming. Despite their abundance on the landscape, the impacts of small dams to water quality, particularly to stream temperature and dissolved oxygen (DO), are not well understood. The goal of this study was to quantify the impacts of dams on stream temperature (30 sites) and DO (12 sites) across Massachusetts and identify factors (i.e., dam characteristics and watershed features) driving differences in response across sites.

STUDENT Peter Zaidel (MS)
ADVISOR Allison Roy
FUNDING MDER
NFWF
UMass ECO

COLLABORATORS Keith Nislow
Beth Lambert
Kris Houle

Figure 1. The former Upper Roberts Meadow Dam (Site #29 in Figure 2; Peter Zaidel).

Surface water of dam impoundments was consistently warmer than upstream temperatures outside of the upstream influence of the dam. After spilling over the dams, the warm impoundment surface water resulted in warmer downstream temperatures at two-thirds of sites, with mean August temperatures up to 5.3 °C higher downstream than upstream of the dams (Fig. 2). While temperatures cooled with distance below the dam at most sites, elevated temperatures persisted for 0.4–4.5 km downstream of the dams. The sites with the most downstream warming had the widest impoundments (relative to the natural upstream width) on the coldest streams (Fig. 3). Two-thirds of the dam impoundments studied had lower surface DO than upstream levels. Downstream DO levels were found to be minimally impacted, suggesting that aeration from spilling may help alleviate the negative effects from the lower impoundment DO levels and help recover all but the most severe impoundment DO losses. High-gradient, coldwater streams in small watersheds and dams with shallow impoundments had the greatest reduction in DO levels both within the impoundments and downstream of the dams.

Given the high number of dams in our region, prioritizing removals to maximize ecological benefits is necessary to best use limited restoration funds. Predicted changes in the regional climatic conditions suggest a reduction in critical coldwater habitat in the future. Management actions that remove high-impact dams and eliminate negative effects to temperature and DO from these dams can increase resiliency of these systems and the species that depend on them.

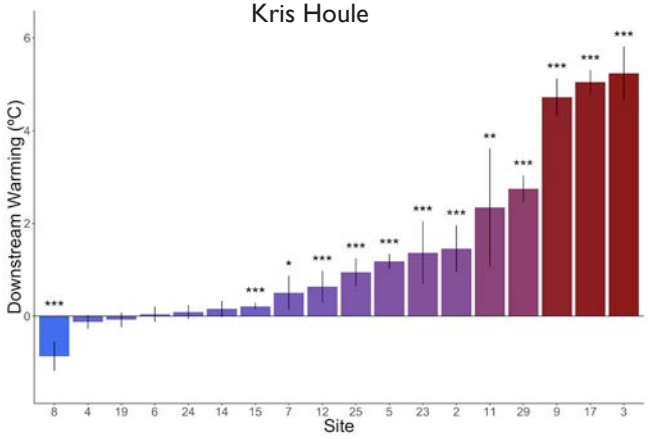


Figure 2. Mean daily August downstream warming (downstream – upstream temperatures) by site.

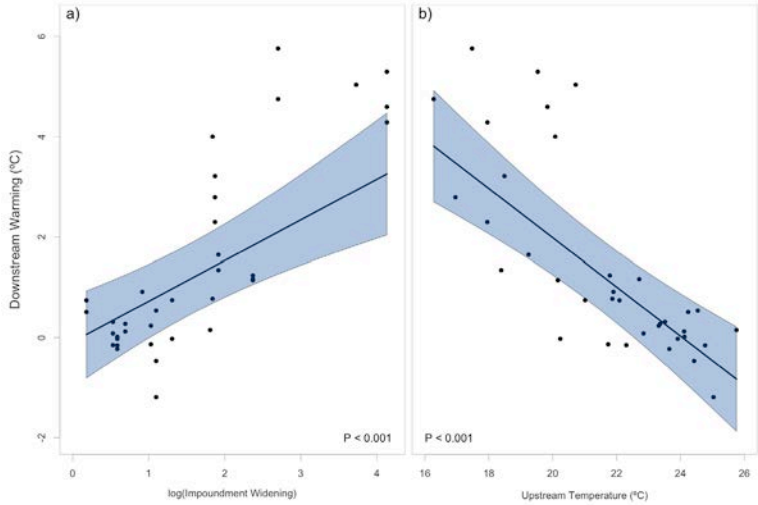


Figure 3. Downstream warming magnitudes were best explained by an additive linear mixed effects model of (a) the log-transformed relative widening of the stream channel within the impoundment and (b) the upstream average temperature, with random effects for site and year.

Parasitic Mussel Larvae and Anadromous River Herring in the Connecticut River Watershed

Freshwater mussels begin their lives as parasitic larvae that attach to the gills, fins, and scales of a variety of fishes (Fig. 1). Mussel larvae, or glochidia, have been found attached to anadromous river herring (alewife and blueback herring), but the phenological relationship between river herring and freshwater mussels in the Connecticut River watershed has yet to be described. The lifecycle of freshwater mussels is dependent on the presence of suitable host fish, and it is important to understand phenological relationships between migratory fish and freshwater mussels to manage host fish passage.

This study had three objectives: 1) to identify glochidia present on river herring gills to better understand which mussels are utilizing river herring as hosts, 2) to analyze the spatiotemporal relationship between glochidia density and river herring density to understand the timing and distribution of glochidia densities, and 3) to determine whether glochidia density on fish was associated with fish weight, length, and weight-length ratio.

From March–June 2018 during the adult spawning run, the USFWS collected river herring from the Mattabesset River, Farmington River, Chicopee River, Westfield River, and Wethersfield Cove via boat electrofishing. The most distal right gill of each fish was removed and frozen, and glochidia were later enumerated under a stereomicroscope. A subsample of glochidia were photographed and measured to determine their species.

At least four morphologies of glochidia were found on river herring gills, two of which are described river herring parasites (alewife floater, Fig. 2A, and common Elliptio, Fig. 2C). One of the glochidia species has not yet been described as a river herring parasite (Eastern floater, Fig. 2B), and one has yet to be identified ("little" glochidia, Fig. 2D), though some experts have hypothesized that they are a smaller morph of alewife floater. The unidentified little glochidia had the highest density, with 777 individuals counted. Glochidia density was out of phase with river herring density over time (Fig. 3), indicating that freshwater mussels do not release glochidia in response to increased river herring densities and instead rely on environmental cues for glochidia release. There was no significant relationship between glochidia density and river herring size, although skinnier fish (i.e., lower weight:length ratio) tended to have more glochidia. Future research should focus on understanding the relationship between glochidia density and river herring density over a longer timeseries and use DNA sequencing and genomics to identify the unknown little glochidia.

STUDENT	Julia Cox (BS)
ADVISOR	Allison Roy
FUNDING	UMass CHC Grant
COLLABORATORS	Darren Desmarais Ken Sprankle

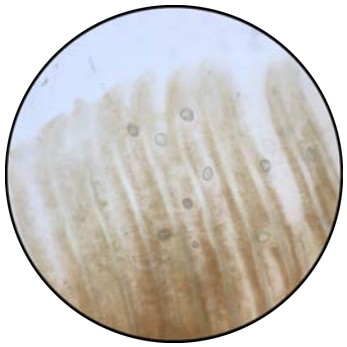


Figure 1. Glochidia attached to river herring gills (Julia Cox).

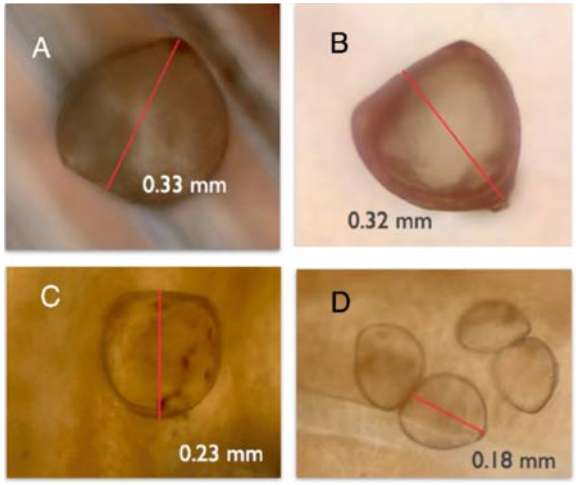


Figure 2. Four glochidia morphologies found: A) alewife floater, B) Eastern floater, C) common Elliptio, and D) "little" glochidia (unidentified).

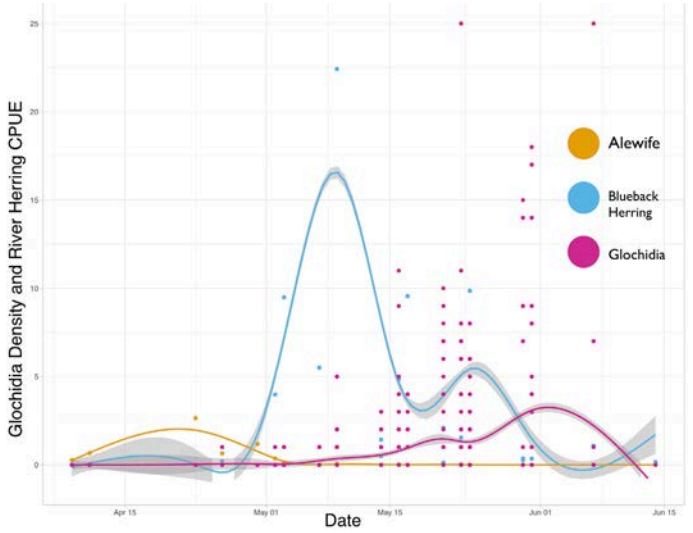


Figure 3. Glochidia density and river herring (alewife and blueback herring) catch per unit effort (CPUE) across all locations over time (2018).

Modeling Black Bear Habitat Use, Movement, and Connectivity in Massachusetts

The black bear population in Massachusetts has been growing in number and expanding into human-dominated areas due to conservative management and increasing availability of natural and human food resources. Quantifying seasonal black bear habitat use and movement in relation to land cover in natural and human-dominated areas is necessary for understanding black bear behavior and creating effective black bear management programs. Estimates of connectivity are also required to identify important movement corridors and predict black bear movement into currently unoccupied areas of the state. We are also modeling black bear movement in relation to the road network to identify road crossing hotspots and inform road mitigation efforts. Our analyses are based on GPS telemetry collar data from over 47 bears that have been collected since 2009 by MassWildlife. Results will be used to inform management of bears and bear habitat in both natural and human-dominated areas of the state.

POST-DOC	Kathy Zeller
ADVISOR	Stephen DeStefano
FUNDING	MDCR MDOT MassWildlife
COLLABORATORS	Tim Dexter Mike Huguenin Dave Paulson Dave Wattles

A yearling black bear gets outfitted with ear tags during a winter den check (Kathy Zeller).

Estimating Black Bear Density, Abundance, and Source-Sink Dynamics in Massachusetts

In the 1970s, black bears existed as a small and isolated population in the Berkshire Mountains of Massachusetts. Since then, the black bear population has grown in number and expanded eastward across the state. However, current black bear density estimates in different parts of the state are lacking, as are population estimates. This information is required for informed and successful management of this important game species. We are using hair snares and molecular techniques to conduct a capture-recapture survey for black bears to estimate density and abundance and understand how these population parameters change with different land cover types and levels of human influence. We are also quantifying black bear population sources and sinks to determine areas of population growth and decline. Hair collection corrals are set in the field in a matrix configuration in western and central Massachusetts. Results from this research will provide information on black bear population dynamics and allow us to estimate population size, examine dispersal patterns, and identify population sources and sinks for black bears statewide.

POST-DOC	Kathy Zeller
ADVISOR	Stephen DeStefano
FUNDING	Amherst College MDCR MDOT MassWildlife
COLLABORATORS	Dan Clark Thea Kristensen Dave Wattles

Black bear visiting a hair corral (USGS).

Massachusetts Residents' Attitudes Toward Black Bear and Black Bear Management

The black bear population in Massachusetts is growing in size and expanding in range, including areas where the general public is largely inexperienced with bears. A statewide human dimensions study of Massachusetts residents' attitudes toward black bear and black bear management will help MassWildlife better understand current species management challenges in the third most densely populated state in the country. This project has three primary objectives: (1) determine respondents' knowledge of black bear, attitudes toward the black bear population and basic experience with bears; (2) summarize respondents' experience with human-bear conflict, home practices that may lead to conflict, and opinions on ways to address these conflicts; and (3) summarize respondents' opinions on regulated hunting as a management tool, hunting methodologies, and management actions related to nuisance bears. For each objective, we will also evaluate the interplay of demographics, geography, and the relationships among various experiences and opinions. Results of this study will provide a more detailed understanding of Massachusetts residents' opinions on the black bear population and bear management and can be used to inform management decisions.

STUDENT	Laura Conlee (PhD)
ADVISOR	Stephen DeStefano
FUNDING	MassWildlife
COLLABORATORS	Mark Duda Dave Wattles

Black bears were the subject of a statewide human dimensions survey (Laura Conlee).

Andean Bear Distribution and Land Use Change Implications for Populations in Peru

The Andean bear is an iconic species of the tropical Andes, whose populations are threatened by habitat fragmentation and poaching. Details of its distribution limits are unclear and large areas of potential Andean bear habitat in Peru lack information, creating a challenge for the conservation of local populations. This research includes: compiling Andean bear locations and information from published and un-published existing records, collecting field data on bear locations from camera traps, and modeling of the Andean bear distribution in Peru. We concluded data compilation and field work, where we assessed a total of four areas within the bear's potential distribution, as indicated by our preliminary analysis, for direct or indirect Andean bear signs; this also allowed confirmation of predicted Andean bear presence by our model. We are currently analyzing spatial data to build information about the relationship between Andean bear presence and environmental, anthropogenic, and ecological characteristics.

STUDENT	Nereyda Falconi Lopez (PhD)
ADVISORS	John Organ Stephen DeStefano Todd Fuller
FUNDING	The Rufford Foundation IBA USGS CRUP

An Andean bear looks down from a tree in the mountains of Peru (Nereyda Falconi Lopez).

Using Genomic Data and Novel Analytical Tools to Understand Metapopulation Dynamics and Enhance Management of Extant Canada Lynx Populations

The Canada lynx is a wide-ranging felid listed as threatened under the U.S. Endangered Species Act. The listing pertained to the lower 48 States, and identified lynx as part of a single, biologically and genetically similar population. However, known populations of lynx are separated geographically, with no known population between the Northern Appalachian/Acadian Ecoregion and the western Great Lakes. This project aims to use genomic data to explore the population dynamics of geographically non-contiguous populations in the U.S. and Canada. A reference genome is currently under construction using high quality, whole genome sequence data from a 27 lb adult male from Aroostook County, Maine. We also plan on using genomic data to construct a custom capture array of single nucleotide polymorphisms. Analyses using these genetic markers will provide more precise estimates of effective population size, demographic history, inbreeding, gene flow, and genetic differentiation among lynx metapopulations.

STUDENT	Tanya Lama (PhD)
ADVISORS	John Organ Stephen DeStefano
FUNDING	Maine Department of Inland Fisheries & Wildlife

Male Canada lynx captured in Maine, 2016 (Tanya Lama).

Assessing Hunter Values, Expectations, and Satisfaction Regarding Controlled White-Tailed Deer Hunts in Suburban Eastern Massachusetts

White-tailed deer are abundant in eastern portions of Massachusetts, where suburban landscapes provide high quality habitat. Ecological degradation from over-browsing and increased human-deer conflicts have created a need to address overabundant deer populations. Regulated hunting is a widely accepted strategy to reduce and maintain deer densities, although its use in suburban landscapes presents challenges. Of particular concern is the long-term participation of devoted hunters that is presumably dependent on continued satisfaction with the hunting experience. Highly controlled hunts, such as the Blue Hills Reservation Deer Management Hunt (BHH), may restrict participants in ways that minimize satisfaction. As such, BHH presented an ideal opportunity for investigating the values, motivations, preferences, and expectations of deer hunters willing to participate in a highly controlled, suburban deer management program. From 2015–2016, 2,938 individuals who applied to participate were asked to complete a comprehensive web-based survey. Survey questions focused on motivations for hunting, interest in and likelihood to participate in controlled suburban hunts, and success and experience at the BHH, as well as opinions on restrictions and implementation of controlled hunts. Total response rates were high, ranging from 50-79% (mean 68%) and a majority of respondents (94%) completed the survey.

STUDENT	Susan McCarthy (MS)
ADVISORS	Stephen DeStefano John Organ
FUNDING	MassWildlife
COLLABORATORS	Mike Huguenin David Stainbrook Dave Wattles

Deer are abundant in suburban Massachusetts (Bill Byrne).

Natural-Ecological and Socio-Political Factors Influencing Urban Forest Management in Massachusetts

Urban forests supply an array of well-documented ecosystem benefits to over 90% of Massachusetts' residents who live and work in an urban setting. These urban settings, however, present challenging situations that undermine tree growth and survival. These conditions range from exposure to pollutants, to a lack of growing space, to a plethora of insect and disease pests. They also include a number of critical soil-related considerations including challenges related to soil pH, soil organic matter, and soil compaction. To add further complexity, urban forest practices may sometimes include inappropriate tree selection, improper installation, and lack of maintenance. Though assuredly unintentional, these practices may further stress urban trees, contributing to rates of tree morbidity and mortality.

To gain further understanding into emergent urban forest management issues, we conducted 50 qualitative research interviews with "tree wardens" in Massachusetts from 2014–2016 (Fig. 1). A tree warden is the local official responsible for the preservation, maintenance, and stewardship of municipal public trees, and is typically considered to be the critical human component necessary to a successful urban and community forestry management program.

Many of our findings corroborated the literature that tree wardens are typically housed in a municipal department (often public works or highway), routinely interact with a wide variety of local organizations (representatives from other municipal departments, community volunteer associations), and typically have access to a greater pool of resources as community size increases. Forest health was highly emergent and of concern to tree wardens, with 98% of interviewees indicating that they routinely monitor for urban forest pests (e.g., Asian longhorned beetle, emerald ash borer, and hemlock woolly adelgid). The potential for planting low-maintenance, host plant resistant tree species was explored as part of an overarching urban forest health management and diversification strategy. Interactions between tree wardens and community volunteer associations were further explored through research interviews with volunteers from 13 distinct Massachusetts urban tree committees (TC).

Our findings indicated that TC representatives are typically motivated, passionate volunteers who desire to work cooperatively with the many groups that comprise the local socio-political landscape. TC representatives must make a sustained, concerted effort to work collaboratively with their local tree warden to effectively advance the care of their community's urban trees (Fig. 2). Municipal managers and decision-makers should attempt to provide TC volunteers with appropriate training opportunities, resources, as well as demonstrate appreciation, to further encourage and solidify volunteer engagement.

STUDENT Rick Harper (PhD)

ADVISORS Stephen DeStefano
David Bloniarz

FUNDING UMass ECO
UMass CAFE

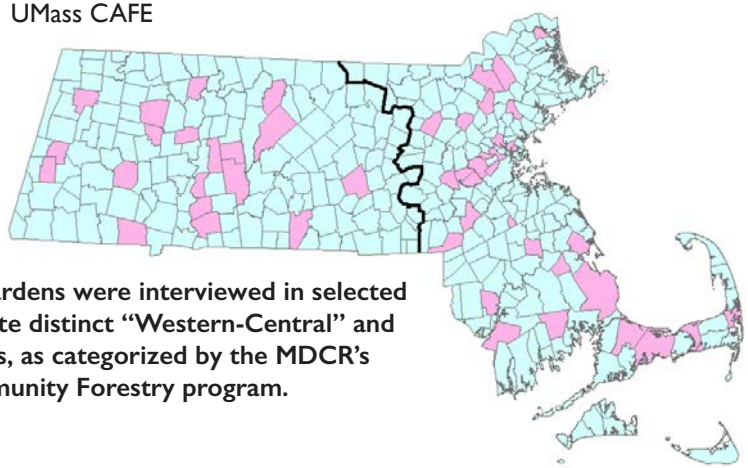


Figure 1. Tree wardens were interviewed in selected towns (pink). Note distinct "Western-Central" and "Eastern" regions, as categorized by the MDCR's Urban and Community Forestry program.

Figure 2. Urban trees in Springfield, MA (Rick Harper).

Assessing Attitudes and Impacts to Society Associated with Use of Alternative Ammunition for Hunting on National Wildlife Refuges

Lead ammunition (LA) use for harvesting game species such as white-tailed deer has the potential to negatively impact non-target scavenging species. Lead deposited in the gut piles and unrecovered carcasses of deer facilitates exposure pathways for scavenging species. We investigated the barriers to a voluntary transition to non-lead ammunition (NLA) for hunters currently using LA on National Wildlife Refuges (NWR) in the northeastern United States. Identifying prominent barriers to NLA use is critical when addressing LA use behavior and developing targeted outreach and education strategies to influence hunter ammunition choice.

While barriers to NLA adoption have been identified for hunters elsewhere in the U.S. and for other hunting applications, little is known about how northeastern deer hunters view NLA alternatives. We used a mixed-methods approach to identify barriers to NLA adoption and motivations behind the use of NLA alternatives by hunters at Rachel Carson NWR, ME, Edwin B. Forsythe NWR, NJ, and Rappahannock River Valley NWR, VA. Mail-back surveys were implemented at each refuge in conjunction with focus group interviews following the 2017/2018 hunting season.

Of the hunters surveyed (n = 228), 82% used LA. For hunters using NLA, performance was the primary reason for switching. While an increase in cost of NLA was reported by both groups, hunters currently using LA view the performance and effectiveness of NLA alternatives more negatively (Fig. 1).

Despite performance and efficacy concerns, the majority of hunters currently using LA indicated they would be willing to switch to NLA. For those unwilling to voluntarily switch, 45% indicated they would use a reimbursement program to purchase NLA (Fig. 2). Concerns about performance and efficacy may be rooted in the perceived inability of NLA alternatives to achieve a clean kill and increase potential for wounding and non-recovery of an animal. In addition, hunters can view a single projectile as not having a significant impact on non-target species due the volume of lead used relative to other hunting practices, illustrating that some hunters may not comprehend the mechanism of exposure for non-target species. Outreach and education strategies that emphasize the effectiveness of NLA alternatives in achieving a clean kill, clearly outline the mechanism of exposure for non-target species, and frame individual LA use in a broader context may aid in more effective behavioral change in hunter ammunition choice. In addition, incentive strategies may be effective to overcome initial barriers to behavioral change.

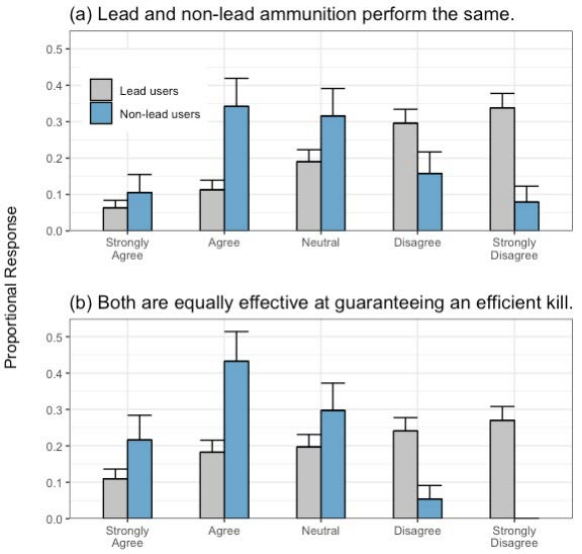


Figure 1. Proportional responses of lead and non-lead users to statements about the performance and efficacy of lead and non-lead ammunition.

Figure 3. Hunter training in Vermont (Christopher Cahill).

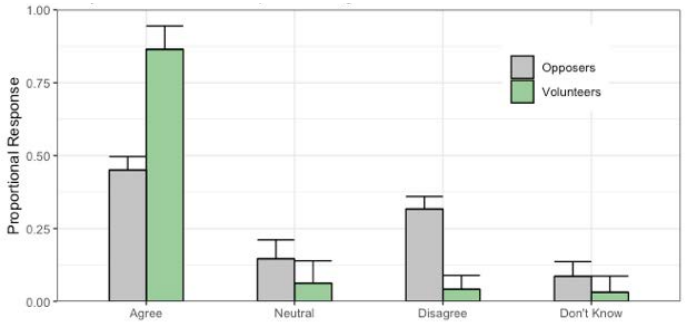


Figure 2. Proportional responses of lead hunters willing to voluntarily use non-lead ammunition (i.e., "Volunteers") and those unwilling (i.e., "Opposers").

STUDENT Christopher Cahill (MS)

ADVISORS Stephen DeStefano
John Organ

FUNDING USGS CRUP
USFWS

COLLABORATORS Gordon Batcheller

Ecological Value of Spruce Plantations in Massachusetts

During the 2016 and 2017 breeding seasons, we conducted nearly 1,000 avian point count surveys within the Quabbin Reservoir watershed and Beartown State Forest, MA. GIS data were used to select survey locations stratified across five forest types: Norway spruce, eastern hemlock, white pine, deciduous, and deciduous/conifer mixed forests. Using these count data, we compared avian communities across the five cover type categories and calculated abundance estimates for 51 individual bird species. Community level analyses suggest that Norway spruce plantations within the study sites do in fact support avian biodiversity at levels similar to that of nearby native forest habitats. The number of unique species observed per survey in Norway spruce plantations was similar to that of pine, deciduous, and mixed-forest stands, and was higher than hemlock stands. Ordination (Non-metric multidimensional scaling) of the data showed that the differences in avian communities between cover types was similar to the differences observed within cover types, further supporting the claim that Norway spruce plantations in the study sites supported comparable levels of biodiversity (Fig. 1).

Individual species abundances varied across cover types. Many species utilized all cover types (including spruce) at similar levels; however, some species showed preferences for certain habitat types. Golden-crowned kinglets showed the strongest cover type preference, with nearly all observations occurring in Norway spruce plantations. Red-breasted nuthatches, brown creepers, and Blackburnian warblers also demonstrated highest abundances in spruce plantations, though these species were also occasionally observed using native cover types. Black-throated green warblers were equally abundant in both spruce and hemlock stands, with other cover types supporting lower abundances. The evident use of spruce habitat by species commonly associated with eastern hemlock (Blackburnian warbler, black throated-green warbler) is of particular interest given the decline in healthy hemlock habitat due to hemlock woolly adelgid. Not surprisingly, species commonly associated with deciduous habitat tended to exhibit lower abundances in spruce habitat, given that the plantations were entirely coniferous. However, these species were often similarly abundant amongst spruce and native conifer habitat. The only species for which spruce supported the lowest abundance levels was the red-eyed vireo.

According to our results, exotic Norway spruce plantations in Massachusetts are capable of supporting avian communities similar to those found in native forest stands (Fig. 2). In many instances Norway spruce plantations supported equal or greater abundances of bird species that are more commonly associated with coniferous habitat.

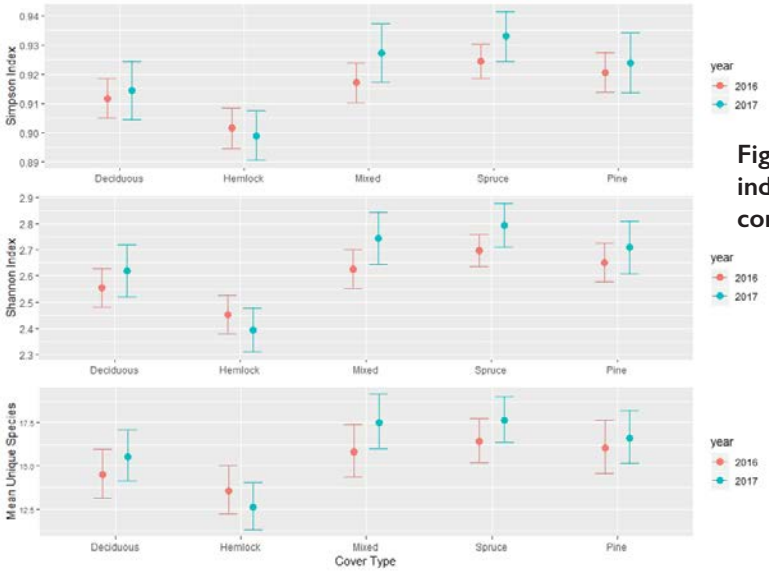


Figure 1. Comparative diversity indices for bird populations in coniferous forest stands.

Figure 2. Remnants of Norway spruce stands can provide habitat for a variety of passerine birds (Calvin Ritter).

STUDENT	Calvin Ritter (MS)
ADVISORS	Dave King Stephen DeStefano
FUNDING	MDCR U.S. Forest Service
COLLABORATORS	Peter Church Dan Clark

Algeo, T.P., J.F. Organ, T.K. Fuller, **S. DeStefano**, M. Adler, and D. Slate. In revision. Beaver damage management and water level control devices: success evaluation and risk assessment. Human-Wildlife Interactions.

Becker, S., S. Jackson, A. Jordaan, and **A. Roy**. 2018. Impacts of Tidal Road-Stream Crossings on Aquatic Organism Passage. U.S. Department of Interior, Fish and Wildlife Service, Cooperator Science Series FWS/CSS-131-2018, Washington, D.C. digitalmedia.fws.gov/digital/collection/document/id/2238/rec/32

Bocsi, T.J., P.S. Warren, R.W. Harper, and **S. DeStefano**. 2018. Wildlife habitat management on college and university campuses. Cities and the Environment (CATE) 11(1): 1-14.

Bocsi, T., R. W. Harper, **S. DeStefano**, and D. A. Lass. In review. Oak trees in the landscape: rural and urban. Arboriculture Journal.

Carmignani, J.R. and **A.H. Roy**. 2017. Ecological impacts of winter lake drawdowns on lake littoral zones: A review. Aquatic Sciences 79:803-824. DOI: 10.1007/s00027-017-0549-9

Carmignani, J.R., **A.H. Roy**, P.D. Hazelton, and H. Giard. 2019. Annual winter water level drawdowns chronically limit mussel densities in small lakes. Freshwater Biology. DOI: 10.1111/fwb.13324

Cheney, K.N., **A.H. Roy**, R.F. Smith, and R.E. DeWalt. Accepted. Effects of stream temperature and substrate type on emergence patterns of Plecoptera and Trichoptera from Northeastern USA headwater streams. Environmental Entomology.

Craig, L.S., J.D. Olden, A.H. Arthington, S. Entrekin, C.P. Hawkins, J.J. Kelly, T.A. Kennedy, B.M. Maitland, E.J. Rosi, **A.H. Roy**, D.L. Strayer, J.L. Tank, A.O. West, and M.S. Wooten. 2017. Meeting the challenge of interacting threats in freshwater ecosystems: A call to scientists and managers. Elementa 5:72. DOI: 10.1525/elementa.256

DeStefano, S., and C. Boal. 2018. Perspectives and future directions. Pages 273-286 in C. Boal and C. Dykstra, Eds. Urban raptors: ecology and conservation of birds of prey in an urbanizing world. Island Press, Washington, D.C.

Devine, M.T., **A.H. Roy**, A.R. Whiteley, B.I. Gahagan, M.P. Armstrong, and A. Jordaan. 2018. Precision and effectiveness of a purse seine for sampling age-0 river herring in lakes. North American Journal of Fisheries Management 38:650-662. DOI: 10.1002/nafm.10065

A Perseid meteor passes through the Big Dipper in Goshen, MA (Peter Zaidel)

Falconi, N., T.K. Fuller, **S. DeStefano**, and J.F. Organ. In press. An open access, occurrence database for Andean bears in Peru. Ursus.

Harper, R.W., E.S. Huff, D.V. Bloniarz, **S. DeStefano**, and C.R. Nicolson. 2018. Exploring the characteristics of successful volunteer-led urban forest tree committees in Massachusetts. Urban Forestry and Urban Greening 34: 311-317.

Harper, R.W., D.V. Bloniarz, **S. DeStefano**, and C.R. Nicolson. 2017. Urban forest management in New England: towards a contemporary understanding of tree wardens in Massachusetts communities. Arboricultural Journal 39:162-178.

Harper, R. W., E. S. Huff, D, V, Bloniarz, **S. DeStefano**, C. R. Nicolson, and M. Davidsohn. In review. Employing qualitative research interviews to understand urban forestry stakeholder continuing education needs. Aboricultural Journal.

LeFlore, E.G., T.K. Fuller, J.T. Finn, **S. DeStefano**, and J.F. Organ. 2019. Wild canid distribution and co-existence during Fall in the Pioneer Valley of western Massachusetts. Northeastern Naturalist 26:325-342.

Ludlam, J.P., and **A.H. Roy**. In review. Understanding effects of small dams on metabolism and primary production in temperate forested streams. Fundamental and Applied Limnology.

Marjadi, M.N., **A.H. Roy**, A. Jordaan, B.I. Gahagan, M.P. Armstrong, and A.R. Whiteley. 2019. Larger body size and earlier run timing associated with elevated reproductive success following experimental alewife translocation. Canadian Journal of Fisheries and Aquatic Sciences 76:1134–1146. DOI: 10.1139/cjfas-2017-0451

Rosset, J., **A.H. Roy**, B. Gahagan, A. Whiteley, M. Armstrong, J. Sheppard, and A. Jordaan. 2017. Temporal patterns of river herring migration and spawning in coastal Massachusetts. Transactions of the American Fisheries Society 146:1101–1114. DOI: 10.1080/00028487.2017.1341851.

Schlossberg, S., D.I. King, **S. DeStefano**, and M. Hartley. 2018. Effects of early-successional shrubland management on breeding wood thrush populations. Journal of Wildlife Management 82:1572-1581.

Sterrett, S., **A. Roy**, P. Hazelton, B. Watson, B. Swartz, T.R. Russ, L. Holst, M. Marchand, J. Wisniewski, M. Ashton, and B. Wicklow. 2018. Brook Floater Rapid Assessment Monitoring Protocol. U.S. Department of Interior, Fish and Wildlife Service, Cooperator Science Series FWS/CSS-132-2018, Washington, D.C. digitalmedia.fws.gov/digital/collection/document/id/2241/rec/29

Sunrise in Sunderland, MA (Ayla Skorupa)

A spotted salamander makes its way to a vernal pool (Ayla Skorupa)

Sterrett, S.C. and **A.H. Roy**. 2017. The Brook Floater Working Group: A collaborative initiative aimed at regional population restoration and conservation. Ellipsaria 19:20-21.

Tucker, M. et al. 2018. Moving in the Anthropocene: global reductions in terrestrial mammalian movements. Science 359:466-469. DOI: 10.1126/science.aam9712

Wattles, D.W., K.A. Zeller, and **S. DeStefano**. 2018. Range expansion in unfavorable environments through behavioral responses to microclimatic conditions: moose (Alces americanus) as the model. Mammalian Biology 93:189-197.

Wattles, D.W., K.A. Zeller, and **S. DeStefano**. 2018. Response of moose to a high-density road network. Journal of Wildlife Management 85:929-939.

Weinstein, S.Y., J.A. Coombs, K.H. Nislow, C. Riley, **A.H. Roy**, and A.R. Whiteley. Accepted. Evaluating the effects of barriers on Slimy Sculpin (*Cottus cognatus*) movement and population connectivity using novel sibship-based and traditional genetic metrics. Transactions of the American Fisheries Society.

Zeller, K.A., D.W. Wattles, and **S. DeStefano**. 2018. Incorporating road crossing data into vehicle collision risk models for moose (*Alces americanus*) in Massachusetts, USA. Environmental Management 62:518-528.

Zeller, K.A., D.W. Wattles, and **S. DeStefano**. 2019. American black bears (*Ursus americanus*) alter movements in response to anthropogenic features with time of day and season. Movement Ecology 7.

Armstrong, D.S., **A.H. Roy**, M.E. Baker, C.N. Bentsen, and J.T. Stolarski. 2017. Moving beyond impervious cover: Unpacking characteristics of impervious cover influencing stream biota in Massachusetts. Annual Meeting of the New England Association of Environmental Biologists, 14-16 March 2017, Hartford, CT.

Bouldin, R., **A. Roy**, S. Mattocks, R. Quinones, and T. Richards. 2018. Responses of stream fishes to dam removal in Massachusetts. Annual Meeting of the Northeast Association of Fish and Wildlife Agencies, 15-17 April 2018, Burlington, VT.

Cahill, C., **S. DeStefano**, J. Organ, and G. Batcheller. 2018. Transitioning to alternative ammunition on National Wildlife Refuges. 70th Anniversary Meeting of the Massachusetts Unit, 15 May 2018, Westborough, MA.

Carmignani, J., **A.H. Roy**, and J. Stolarski. 2018. Do annual winter water level drawdowns alter trophic pathways for common lake fish species? Annual Meeting of the New England Association of Environmental Biologists, 13-15 March 2018, Devens, MA.

Carmignani, J., **A.H. Roy**, and J. Stolarski. 2018. Do annual winter water level drawdowns alter trophic pathways for common lake fish species? Annual Meeting of the Northeast Association of Fish and Wildlife Agencies, 15-17 April 2018, Burlington, VT.

Purple trillium (Peter Zaidel)

Carmignani, J., **A.H. Roy**, and J. Stolarski. 2018. Do annual winter water level drawdowns alter trophic pathways for common lake fish species? Annual Meeting of the American Fisheries Society, 19-23 August 2018, Atlantic City, NJ.

Carmignani, J. and **A.H. Roy**. 2019. Littoral macroinvertebrate assemblage responses to annual winter lake drawdowns. Annual Meeting of the Northeast Aquatic Biologists, 27 February - 1 March 2019, Saratoga Springs, NY.

Conlee, L., D. Wattles, M. Duda, and **S. DeStefano**. 2018. Massachusetts residents' attitudes toward black bears and black bear management. 70th Anniversary Meeting of the Massachusetts Unit, 15 May 2018, Westborough, MA. (Poster)

Cox, J.S. and **A.H. Roy**. 2019. Parasitic freshwater mussel larvae attachment on river herring in Connecticut River tributaries. Connecticut River Atlantic Salmon Commission Research and Management Forum, 13 March 2019, Hadley, MA. (Poster)

DeStefano, S. 2018. The Massachusetts Cooperative Fish and Wildlife Research Unit – 1948-2018: 70 years of cooperative conservation in the Commonwealth. 70th Anniversary Meeting of the Massachusetts Unit, 15 May 2018, Westborough, MA. (Poster)

DeStefano, S. 2018. The Massachusetts Cooperative Fish and Wildlife Research Unit: 70 years of graduate research. 70th Anniversary Meeting of the Massachusetts Unit, 15 May 2018, Westborough, MA. (Poster)

DeStefano, S. 2018. Then and now … Massachusetts in 1948 versus today. 70th Anniversary Meeting of the Massachusetts Unit, 15 May 2018, Westborough, MA. (Poster)

DeStefano, S., and T.K. Fuller. 2018. State of the art: self-evaluation of wildlife and fisheries research and management. 70th Anniversary Meeting of the Massachusetts Unit, 15 May 2018, Westborough, MA.

Devine, M.D. 2018. Factors influencing anadromous river herring on Nantucket and in coastal New England watersheds. Nantucket Land Council Annual Meeting, 7 August 2018, Nantucket, MA.

Devine, M.T., **A.H. Roy**, A.J. Whiteley, B.I. Gahagan, M.P. Armstrong, and A. Jordaan. 2018. What goes in must come out? Investigating stock-recruitment relationships and factors influencing juvenile densities of anadromous river herring. Annual Meeting of the American Fisheries Society, 19-23 August 2018, Atlantic City, NJ.

The Nissitissit River flows freely after removal of Turner Dam (Peter Zaidel)

Devine, M.D. 2019. Factors affecting density and growth of juvenile river herring: Insights from 32 coastal New England lakes. Maine Water and Sustainability Conference, 28 March 2019, Augusta, ME.

Falconi, N., J. Organ, and **S. DeStefano**. 2017. Value of data sharing for conservation: A case study of a large scale project of spectacled bear (*Tremarctos ornatus*) in Peru. 25th International Conference on Bear Research and Management, 12-17 November 2018, Quito, Ecuador.

Falconi, N., J. Organ, and **S. DeStefano**. 2018. Value of data sharing for conservation of the spectacled bear in Peru. Annual Meeting of the Ecological Society of America, 5-10 August 2018, New Orleans, LA. (Poster)

Fallon Olmsted, C., T. Betras, **S. DeStefano**, S. C. Pasquini, E. Faison, and W. P. Carson. 2019. Evidence for moose as ecosystem engineers via non-trophic indirect effects. Ecological Society of America, Louisville, Kentucky, 11-16 August 2019. (Poster)

Giard, H., J. Carmignani, and **A.H. Roy**. 2018. Investigating the effects of winter lake drawdowns on freshwater mussels and consequences for water quality. Annual Meeting of the New England Association of Environmental Biologists, 13-15 March 2018, Devens, MA. (Poster)

Harper, R., and **S. DeStefano**. 2018. Working with volunteers. Tree City USA, Look Park, 15 November 2018, Northampton, MA.

Hazelton, P., S.S. Sterrett, and **A. Roy**. 2018. A standardized rapid survey protocol for rare freshwater mussels using an occupancy framework. Annual Meeting of the Northeast Association of Fish and Wildlife Agencies, 15-17 April 2018, Burlington, VT.

Jordaan, A., **A. Roy**, S. Jackson, and S. Becker. 2018. Impacts of tidal road-stream crossings on aquatic organism passage. 9th National Summit on Coastal and Estuarine Restoration and Management, 8-13 December 2018, Long Beach, CA.

Lama, T., J. Organ, **S. DeStefano**, and W. Johnson. 2018. Conservation genomics of Canada lynx. 70th Anniversary Meeting of the Massachusetts Unit, 15 May 2018, Westborough, MA.

Martell, V.M., **A.H. Roy**, P.D. Hazelton, D.L. Perkins, and T.M. Warren. 2018. The effect of probiotics on the growth and survival of a freshwater mussel. Annual Meeting of the Northeast Association of Fish and Wildlife Agencies, 15-17 April 2018, Burlington, VT.

McCarthy, S., and **S. DeStefano**. 2017. The human dimensions of suburban deer management in eastern Massachusetts. Massachusetts Fisheries and Wildlife Board, 15 November 2017, Pepperall, MA.

Perkins, D., S. Hanlon, P. Hazelton, and **A. Roy**. 2018. A new freshwater mussel collaborative in the northeast. Annual Meeting of the Northeast Association of Fish and Wildlife Agencies, 15-17 April 2018, Burlington, VT. (Presented by **A. Roy**)

Remiszewski, T.T., **A.H. Roy**, and J. Carmignani. 2018. Impacts of winter water-level lake drawdowns on fish growth. Southern New England Chapter of the American Fisheries Society Winter Meeting, 10 January 2018, New Bedford, MA. (Poster)

Remiszewski, T.T., J. Carmignani, and **A.H. Roy**. 2018. Impacts of winter water-level lake drawdowns on fish growth. Annual Meeting of the American Fisheries Society, 19-23 August 2018, Atlantic City, NJ. (Poster)

Ritter, C., D. King, and **S. DeStefano**. 2019. The ecological value of spruce plantations in Massachusetts. Annual Meeting of the Northeast Association of Fish and Wildlife Agencies, 14-16 April 2019, Groton, CT.

Roy, A.H., P.A. Zaidel, K. Houle, B. Lambert, and K.H. Nislow. 2018. Potential responses of stream water quality and macroinvertebrates to small dam removal. Annual Meeting of the New England Association of Environmental Biologists, 13-15 March 2018, Devens, MA.

Roy, A.H., H.R. Lubbers, and M.C. Miller. 2018. Biotic responses to multiple threats of urbanization and drying in headwater streams. Annual Meeting of the Society for Freshwater Science, 20-24 May 2018, Detroit, MI.

Roy, A.H., R. Bouldin, P.A. Zaidel, and S. Mattocks. 2018. Increasing resilience of coldwater fish habitat with dam removal. Annual Meeting of the American Fisheries Society, 19-23 August 2018, Atlantic City, NJ.

Roy, A.H., K.M. Abbott, M.B. Cole, K.M. Houle, and K.H. Nislow. 2019. Impacts of small, low-head dams on stream macroinvertebrate assemblages. Annual Meeting of the Society for Freshwater Science, 19-23 May 2019, Salt Lake City, UT.

Roy, A.H. 2019. Stream restoration through dam removal: Where to begin? University of Cincinnati, Department of Biological Sciences, Cincinnati, OH. (Invited)

Roy, A.H. and K.M. Abbott. 2019. Restoring aquatic habitats through dam removal. Massachusetts Division of Ecological Restoration, Boston, MA. (Invited)

Roy, A.H. 2019. Dams, drawdowns, mussels, and river herring: A potpourri of freshwater research in the Coop Unit. U.S. Geological Survey, Conte Anadromous Fish Laboratory, Turners Falls, MA. (Invited)

Sillen, S.J., P.A. Zaidel, **A.H. Roy**, K.H. Nislow, K. Houle, and B. Lambert. 2018. Dissolved oxygen response to dam removal in Massachusetts streams. Biannual Meeting of the Society for Ecological Restoration New England Chapter, 11-13 October 2018, New Haven, CT. (Poster)

Skorupa, A.J., **A.H. Roy**, P.D. Hazelton, D. Perkins, A. Fisk, and S. Sterrett. 2018. Brook floater (*Alasmidonta varicosa*) mesohabitat preferences in four Massachusetts watersheds. Annual Meeting of the Northeast Association of Fish and Wildlife Agencies, 15-17 April 2018, Burlington, VT.

Skorupa, A.J., **A.H. Roy**, P.D. Hazelton, D. Perkins, T. Warren, A. Fisk, and S.C. Sterrett. 2019. Developing a strategy to restore a freshwater mussel (*Alasmidonta varicosa*) to Massachusetts watersheds. Annual Meeting of the Northeast Aquatic Biologists, 27 February - 1 March 2019, Saratoga Springs, NY.

Sterrett, S.S., L. Stevenson, M. Endries, P. Hazelton, and **A.H. Roy**. 2018. Freshwater mussel species distribution models to inform proactive conservation decision making. Annual Meeting of the Northeast Association of Fish and Wildlife Agencies, 15-17 April 2018, Burlington, VT.

Zaidel, P.A., **A.H. Roy**, K.H. Nislow, B.H. Letcher, K. Houle, B. Lambert, and C.R. Smith. 2018. Small dams can have large thermal effects with negative implications for coldwater species. Annual Meeting of the Society for Freshwater Science, 20-24 May 2018, Detroit, MI.

Zeller, K.A., D.W. Wattles, and **S. DeStefano**. 2018. Black bear movements and habitat use. 70th Anniversary Meeting of the Massachusetts Unit, 15 May 2018, Westborough, MA.

Zeller, K.A., D.W. Wattles, and **S. DeStefano**. 2018. Modeling road crossings for moose (*Alces americanus*) and black bear (*Ursus americanus*) in Massachusetts, USA. 8th Northeastern Transportation and Wildlife Conference, 9-12 September 2018, Amherst, MA.

Zeller, K.A., M.K. Jennings, T.W. Vickers, H.B. Ernest, S.A. Cushman, W.M. Boyce. 2018. A comparison of data types and connectivity models for capturing dispersal movement in large carnivores. The Wildlife Society Annual Conference, October 7-11, 2018, Cleveland, OH.

Toads during amplexus in Orange, MA (Ayla Skorupa)

International Awards

Rick Harper: International Society of Arboriculture Early Career Scientist, 2019.

UMass ECO Awards

Matt Devine: John Boreman Fisheries Award, University of Massachusetts Department of Environmental Conservation, 2018. ($500)

Matt Devine: Richard Cronin Fisheries Research Award, University of Massachusetts Department of Environmental Conservation, 2018. ($750)

Meghan Slocombe: Outstanding Junior in Environmental Science, University of Massachusetts Department of Environmental Conservation, 2019. ($400)

Research Grants

Graduate students

Kate Abbott: Aimlee Laderman Student Grant, New England Chapter of the Society for Ecological Restoration Northeast Chapter, 2019 ($1200)

Matt Devine: University of Massachusetts Natural History Collections Summer Research Scholarship, 2019. ($3,000)

Nereyda Falconi Lopez: Rufford Small Grant, The Rufford Foundation, 2018. ($6950)

Meghna Marjadi: University of Massachusetts Pre-Dissertation Grant, 2018. ($1000)

Meghna Marjadi: National Socio-Environmental Synthesis Center (SESYNC) Graduate Pursuit Grant: Urban ecologies of vulnerability and risk: What is the role of fish consumption advisories? Co-PI for workshop funding, 2017-19.

Undergraduate students

Renee Bouldin: Ned Taft Internship Fund in Environmental Science, University of Massachusetts Department of Environmental Conservation, 2017 ($3000)

Julia Cox: Research Grant, University of Massachusetts Commonwealth Honor's College, 2019. ($630)

Sarah Endyke: Research Grant, University of Massachusetts Commonwealth Honor's College, 2019. ($695)

John Russell: Ned Taft Internship Fund in Environmental Science, University of Massachusetts Department of Environmental Conservation, 2018 ($3000)

Meghan Slocombe: Research Assistant Fellowship, University of Massachusetts Commonwealth Honor's College, 2019. ($500)

Meghan Slocombe: Research Grant, University of Massachusetts Commonwealth Honor's College, 2019. ($770)

Meghan Slocombe: Ned Taft Internship Fund in Environmental Science, University of Massachusetts Department of Environmental Conservation, 2019 ($3000)

Conference Awards

Presentation

Virginia Martell: Best Student Presentation Award for talk, "The effect of probiotics on the growth and survival of a freshwater mussel", Northeast Association of Fish & Wildlife Agencies Conference, 2018.

Virginia Martell: First place for best lightning talk, "The effect of probiotics on the growth and survival of a freshwater mussel", University of Massachusetts Department of Environmental Conservation Graduate Student Symposium, 2019.

Ayla Skorupa: First place and audience choice for best lightning talk, "Food sources supporting captive rearing of an endangered freshwater mussel", University of Massachusetts Department of Environmental Conservation Graduate Student Symposium, 2019.

Travel

Matt Devine: John E. Skinner Memorial Travel Award, American Fisheries Society Conference, 2018. ($800)

Meghna Marjadi: The Communicating Science workshop for graduate students (ComSciCon) Flagship Workshop/Travel Award, 2019.

Peter Zaidel: Society for Freshwater Science General Endowment Fund Travel Award, 2018. ($1000)

In 71 years, over 200 graduate students have been part of the Massachusetts Coop Unit. Eleven of those students earned both their MS and PhD with the Unit. There are 16 current graduate students; 198 completed their degrees. Masters students (165) are in black font, while PhDs (48) are in blue font.

Last Name	First Name	Year	Advisor
Ripley	Thomas H.	1954	Sheldon
Hagar Jr.	Donald C.	1954	Sheldon
Boyle	John D.	1955	Sheldon
Garvin	Lester E.	1955	Sheldon
Dodge	Wendell E.	1958	Sheldon
Kupa	John J.	1958	Sheldon
Larson	Joseph S.	1958	Sheldon
Werner	Jack W.	1958	Sheldon
Gehling Jr.	Raymond L.	1959	Sheldon
Moore	Dwight D.	1959	Sheldon
Belig	William H.	1960	Sheldon
Godin	Alfred J.	1960	Sheldon
Cowardin	Lewis M.	1961	Sheldon
Maxfield	Herbert K.	1961	Sheldon
Colby	David R.	1965	Sheldon
Jewell	Samuel R.	1965	Sheldon
Stanton	Philip B.	1965	Sheldon
Armour	Carl Lee	1966	Reed
Taub	Stephen H.	1966	Reed
Woronecki	David E.	1966	Reed
Hoyt Jr.	Walter L.	1966	Sheldon
Kivisalu	Bino	1966	Sheldon
Richards	Allan Paul	1966	Sheldon
Frisbie	Charles M.	1967	McCann
Zanella	Eugene Francis	1967	McCann
Modafferi	Ronald D.	1967	Sheldon
Pierce	Dale A.	1967	Sheldon
Frame	David Wilkes	1968	McCann
Scofield	Larry Rex	1968	McCann
Belusz	Lawrence C.	1968	Reed
Holsapple	John G.	1968	Reed
Keene	Charles I.	1968	Reed
Grandy IV	John W.	1968	Sheldon
Kelly	George M.	1970	Dodge
Elliot	Wayne Paul	1970	McCann
Freeman	Bruce, L.	1970	McCann
MacInnes	John Roderick	1970	McCann
Watson	Jay F.	1970	McCann
Godfrey	Paul J.	1970	Reed
Levesque	Raymond C.	1970	Reed
Moulton	James C.	1970	Reed
Oatis	Peter H.	1970	Reed
Rockwell	Harold William	1970	Sheldon
DeGraaf	Richard M.	1971	Larson
Katz	Harvey M.	1972	McCann
Piehler	Glenn R.	1972	McCann
Grandy IV	John W.	1972	Sheldon
Walsh	Lynn E.	1973	Dodge
Cooper	James A.	1973	Sheldon
Pank	Larry Fred	1974	Dodge
Portnoy	John W.	1974	Dodge
Jeffries, Jr.	Philip J.	1974	Reed
Layzer	James B.	1974	Reed
Scherer	Michael Dean	1974	Reed
Possardt	Earl E.	1975	Dodge
Bostrom	Donald Arthur	1975	Larson
Gray	Gary Gene	1975	Larson
Gilmore	Kirby S.	1975	Reed
Braunhardt	Denise Adrienne	1976	Larson
Cardoza	James Ernest	1976	Larson
Green Jr.	Arthur Allerton	1976	Larson
Domeruth	Robert B.	1976	Reed
Enoch	Larry S.	1976	Reed
Hughes	Peter D.	1976	Reed
Katz	Harvey M.	1976	Reed
Shapiro	Steven Mark	1976	Reed
Stira	Robert J.	1976	Reed
Kelly	George M.	1977	Dodge
Roberts	Thomas Allen	1977	Kennelly
Brooks	Robert P.	1977	Kennelly
Fleming	Michael William	1977	Kennelly
Kuzmeskus	Daniel M.	1977	Reed
Neves	Richard Joseph	1977	Reed
Harding	Judith	1978	Dodge
Schultz	William C.	1978	Dodge
Hodgdon	Harry Edward	1978	Larson
Cave	Jon Robert	1978	Reed
Lyons	Paul Joseph	1979	Kennelly
Lancia	Richard Angelo	1979	Larson
Kelso	William Edward	1979	Reed
Brooks	Robert P.	1980	Dodge
Ellison	Peter T.	1980	Dodge
Tzilkowski	Walter M.	1980	Dodge
Bollinger	Karen Sue	1980	Kennelly
Olsen	Glenn H.	1980	Kennelly
Sutter III	Frederick C.	1980	Kynard
Converse	Kathryn Ann	1981	Dodge
Sczerzenie	Philip James	1981	Dodge
Rosen	Rudolph Albert	1981	Kynard
Hill	Barbara Jeanne	1982	Dodge
von Oettingen	Susanna Lisalotte	1982	Dodge
Bell	Charles Edward	1982	Kynard
Buckley	John L.	1982	Kynard
Conover	David Olmstead	1982	Kynard
Howard	Rebecca J.	1982	Larson
Olsen	Glenn H.	1983	Dodge
Stier	David Joseph	1983	Kynard
Taylor	Ralph Edmund	1983	Kynard
Warner	John P.	1983	Kynard
Yergeau	Kathleen Marie	1983	Kynard
Tilghman	Nancy Grace	1983	Larson
Elowe	Kenneth David	1984	Dodge
Steiner	Alan John	1984	Dodge

Last Name	First Name	Year	Advisor
O'Leary	John A.	1984	Kynard
Safford	Susan E.	1985	Booke
Berendzen	Stephen L.	1985	Dodge
Converse	Kathryn Ann	1985	Dodge
Hearn	William Ernest	1985	Kynard
Nelson	David Herbst	1986	Dodge
McMenemy	James R.	1986	Kynard
Perham II	Roscoe E.	1987	Booke
Elowe	Kenneth David	1987	Dodge
Witherell	David B.	1987	Kynard
Narahara	Anne Megumi	1987	Sayre
Vander-Haegen	William Matthew	1987	Sayre
Lindell	Scott	1988	Booke
Kennedy	Ricky A.	1988	Dodge
Humphrey	Robert Charles	1988	Sayre
O'Connell Jr.	Allan Francis	1989	Sayre
Organ	John F.	1989	Dodge/Griffin
Newman	Douglas G.	1990	Griffin
Cieslewicz	Paul G.	1991	Booke
Kieffer	Micah C.	1991	Kynard
Seibel	David A.	1992	Kynard
Fuller	David Paul	1993	Fuller
Sanderson	Caroline J.	1993	Field
Wilson	Karen A.	1993	Field
Sadighi	Kay	1994	Hestbeck
Buerkett	Christopher G.	1994	Kynard
Stiles-Jewell	Sheila	1994	Booke
Mahaney II	Thomas J.	1994	Field
Richmond	Alan M.	1995	Kynard
McGinley	Kimber E.	1996	Field
York	Eric C.	1996	Fuller
Woytek	William Andrew	1996	Hestbeck
Amaral	Stephen V.	1996	Kynard
Schulze	Margo B.	1996	Mather
Kosa	Jarrad T.	1997	Mather
Theiss	Eric J.	1997	Kynard
Vinogradov	Phillip	1997	Kynard

Last Name	First Name	Year	Advisor
Zingo	James M.	1998	Field
McDonald Jr.	John E.	1998	Fuller
Sutherland	David W.	1998	Kynard
Nitschke	Paul C.	1998	Mather
Yako	Lisa A.	1998	Mather
Zingo	James M.	1998	Hestbeck
Bump	C. Adam	1999	Field
Fitzgerald	Thomas Joseph	1999	Field
Gore	Lamar B.	1999	Field
Langlois	Susan A.	1999	Fuller
Mayer	Michael S.	1999	Fuller
Giorgi	Kathleen S. H.	1999	Hestbeck
Campbell	Cara A.	1999	Mather
Carey	Michael P.	2002	Mather
Parker	Erika L.	2002	Kynard
Gaughan	Christopher R.	2003	DeStefano
Ferry	Kristen H.	2003	Mather
Maier	Thomas J.	2003	Hestbeck
Godinho	Alexandre Lima	2005	Kynard
Clark	Laura J.	2005	Sievert
Albanese	Eugene	2006	Sievert
Haggerty	Sarah A.	2006	Sievert
Wibisono	Hariyo T.	2006	Sievert
Parker	Erika L.	2007	Kynard
Rossi	Nichole A.	2007	DeStefano
Grgurovic	Mark	2007	Sievert
Pautzke	Sarah M.	2008	Mather
Jones	Michael T.	2009	Sievert
Frank	Holly J.	2009	Mather
McCarthy	Kyle P.	2010	DeStefano
Willey	Lisabeth L.	2010	Sievert
Paulson	David J.	2010	Sievert
Wattles	David William	2011	DeStefano
Burak	Matthew K.	2011	Mather
Strules	Jennifer E.	2012	DeStefano
Kauffman	Katherine E.	2012	Sievert
Spencer	Sarah M.	2012	Sievert

Last Name	First Name	Year	Advisor
Smith	Joseph M.	2012	Mather
Vitale	Kimberly O.	2013	Sievert
Kennedy	Cristina G.	2013	Mather
Clark	Daniel E.	2014	DeStefano
LeFlore	Eric G.	2014	DeStefano
Pusparini	Wulan	2014	Sievert
Faison	Edward K.	2015	DeStefano
Huguenin	Michael A.	2015	DeStefano
Barber	Grace W.	2015	Sievert
Naing	Hla	2015	Sievert
Yorks	Derek T.	2015	Sievert
Johnson	Luanne	2016	DeStefano
Argo	Emily E.	2016	Roy
Marjadi	Meghna N.	2016	Roy
Rosset	Julianne	2016	Roy
Loring	Pamela H.	2016	Sievert
Bentsen	Catherine N.	2017	Roy
Devine	Matthew T.	2017	Roy
Stengle	Anne G.	2018	Sievert
Zaidel	Peter A.	2018	Roy
Harper	Richard W.	2019	DeStefano
Conlee	Laura I.	Current	DeStefano
Falconi	Nereyda	Current	DeStefano
Lama	Tanya	Current	DeStefano
Cahill	Christopher R.	Current	DeStefano
McCarthy	Susan	Current	DeStefano
Ritter	Calvin	Current	DeStefano
Dowling	Zara R.	Current	Sievert
Richards	Todd A.	Current	Roy
Carmignani	Jason	Current	Roy
Devine	Matthew	Current	Roy
Marjadi	Meghna N.	Current	Roy
Skorupa	Ayla	Current	Roy
Abbott	Katherine	Current	Roy
Martell	Virginia	Current	Roy
Trahan-Liptak	Joy	Current	Roy
Ryan	Jennifer	Current	Roy

USGS Massachusetts Cooperative Fish and Wildlife Research Unit
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