United States Geological Survey

Massachusetts Cooperative Fish and Wildlife Research Unit

Biennial Report 2024-2025

Amherst, MA
May 2026

Executive Summary

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 (UMass), 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. Allison Roy, who specializes in fisheries and aquatic ecology, and two Assistant Unit Leaders, Dr. Graziella DiRenzo and Dr. Tammy Wilson, who are quantitative wildlife ecologists. 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, administrative and supervisory staff at the CRU headquarters, and our cooperating agencies.

Research in the MA Coop Unit

We conduct research in terrestrial and aquatic ecosystems on a variety of topics. Some quick facts about our research funding, collaborations, and productivity:
- Typical operating budget of $1.5–2 million annually (approximately half is research grants)
- Grant funding includes a variety of federal (e.g., USGS, USFWS, USDA, NSF, NPS), state (e.g., MassWildlife, MDMF), and nonprofit (e.g., TNC, Woods Hole Sea Grant) sources
- 44 scientific papers and reports published or listed as in review, in revision, or in press in 2024 and 2025
- 23 data releases and 13 software releases in the last 2 years
- 74 presentations at conferences and public meetings in the last 2 years
- Collaborators include scientists and managers from over 39 state, federal, and private conservation agencies, institutions, and groups

Mentorship and Graduate Education in the MA Coop Unit

In the last 2 years, we:
- Advised or co-advised 9 postdoctoral researchers, 7 PhD students, 11 MS students, and 4 BS Honors students, including students currently in the program and completed students
- Provided 2 working professionals with graduate school opportunities
- Provided field and laboratory research experiences to numerous undergraduate student technicians, independent study students, practicum students, and volunteers
- Mentored 9 students in the Doris Duke Conservation Scholars and Conservation Collaborative Programs
- Taught 8 graduate courses on topics related to research design, data analysis and modeling, data management, and aquatic ecology
- Served on 17 graduate student committees
- Had 4 students in the USFWS Pathways Program

Bedlam Brook rock formation (Anna Baynes)

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Bumblebee on butterfly weed (I. Ragonese)

Abbreviations

CARC = Cronin Aquatic Resource Center
CHC = Commonwealth Honors College
Conte = Conte Anadromous Fish Laboratory
CRU = Cooperative Research Unit
CRUP = Cooperative Research Units Program
C-SWG = Competitive State Wildlife Grant
CWD = Chronic Wasting Disease
DDCSP = Doris Duke Conservation Scholars Program
DFP = Directorate Fellowship Program
ECo = Department of Environmental Conservation
FWCO = Fish and Wildlife Conservation Office
MassWildlife = Massachusetts Division of Fisheries & Wildlife
MDMF = Massachusetts Division of Marine Fisheries
NE CASC = Northeast Climate Adaption Science Center
NGO = Non-governmental organization
NHESP = Natural Heritage & Endangered Species Program
NSF = National Science Foundation
OEB = Organismic and Evolutionary Biology
PIT = Passive Integrated Transponder
SDM = Structured Decision Making
SFS = Society for Freshwater Science
SSP = Science Support Partnership
SUNY = State University of New York
TNC = The Nature Conservancy
UMass = University of Massachusetts Amherst
URC = Undergraduate Research Conference
USDA = US Department of Agriculture
USFWS = US Fish and Wildlife Service
USGS = US Geological Survey
WRRC = Water Resources Research Center

Cover Photos

Front Left: Winter turkey tail (I. Ragonese)
Front Top: Juvenile shad (James Garner)
Front Bottom: Red eft (Elsa Cousins), Monarch caterpillar (I. Ragonese)
Back Cover: Westfield River and Windsor Jambs Brook confluence (Anna Baynes)

Photo Credits Provided in Parentheses

Table of Contents

STAFF

Allison H. Roy
Unit Leader, Fisheries
413-545-4895
aroy@eco.umass.edu

Graziella V. DiRenzo
Assistant Unit Leader, Wildlife
413-545-4888
gdirenzo@umass.edu

Tammy L. Wilson
Assistant Unit Leader, Wildlife
413-545-4889
tammywilson@umass.edu

Deb Wright
Administrative Assistant
Department of Environmental Conservation
University of Massachusetts
413-545-0398
dwright@eco.umass.edu

CRU Contact Information
U.S. Department of the Interior, U.S. Geological Survey
Massachusetts Cooperative Fish and Wildlife Research Unit
Department of Environmental Conservation
160 Holdsworth Way
University of Massachusetts
Amherst, MA 01003
https://www.usgs.gov/programs/cooperative-research-units
http://eco.umass.edu/

Massachusetts Cooperative Fish and Wildlife Research Unit

COORDINATING COMMITTEE MEMBERS

Sammy King, Northeast Regional Unit Supervisor
sking@usgs.gov
U.S. Geological Survey
Cooperative Research Units Program
Louisiana State University
224 School of Renewable Natural Resources
Baton Rouge, LA 70803

Everose Schlüter, Deputy Director & Acting Director
eve.schluter@mass.gov
Mike Huguenin, Asst. Director of Wildlife
michael.huguenin@mass.gov
Jesse Leddick, Asst. Director of NHESP
jesse.leddick@mass.gov
Emily Myron, Asst. Director of Land and Habitat Conservation
emily.myron@mass.gov
Todd Richards, Asst. Director of Fisheries
todd.richards@mass.gov
MA Division of Fisheries and Wildlife
1 Rabbit Hill Road
Westborough, MA 01581

Ben Gahagan, Recreational Fisheries Program Leader
ben.gahagan@mass.gov
MA Division of Marine Fisheries
Annisquam River Marine Fisheries Station
30 Emerson Avenue
Gloucester, MA 01930

Daniel McKiernan, Director
dan.mckiernan@mass.gov
MA Division of Marine Fisheries
836 S Rodney French Blvd,
New Bedford, MA 02744

Alex Schreyer, Department Head
schreyer@umass.edu
Department of Environmental Conservation
University of Massachusetts
210 John W. Olver Design Building
551 N. Pleasant Street
Amherst, MA 01003

Sharon Marino, Acting Regional Director, Northeast Region
sharon_marino@fws.gov
Lisabeth Willey
lisabeth_willey@fws.gov
U.S. Fish and Wildlife Service
300 Westgate Center Drive
Hadley, MA 01035-9589

Audrey Mayer, Field Office Supervisor
New England Field Office
70 Commercial Street, Suite 300
Concord, NH 03301

Scot Williamson, Northeast Representative
swilliamson@wildlifemgt.org
Wildlife Management Institute
RR 1, Box 587, Spur Road
North Stratford, NH 03590

COLLABORATING FACULTY AND COOPERATORS

Amherst College
Thea Kristensen
American Rivers
Andy Fisk
Antioch University
Michael Akresh
Appalachian State University
Jon M. Davenport
Aquatic & Herpetological Research Cooperative
Marc P. Hayes
Biodrawversity, Inc.
Ethan Nedeau
California Academy of Sciences
Rayna C. Bell
Centro Universitário Nossa Senhora do Patrocínio
Ana Gabrielle Morais da Silva
Cole Ecological, Inc.
Mike Cole
Connecticut Department of Energy and Environmental Protection
Chris Bellucci, Jacque Benway, Justin Davis, Kevin Job, Laura Saucier
Charles River Watershed Association
Lisa Kumpf, Marielena Lima
Department of Defense
Kyle Crafts
Dewberry Engineers
Andrew E. Dietrich
EcoHealth Alliance
Morgan Kain
Florida International University
Alessandro Catenazzi, John Kominoski, Liz Ortiz Muñoz. Christopher Rizzie
Maine Department of Inland Fisheries and Wildlife
Merry Gallagher, Lee Kantar, Jerrod Parker, Beth Swartz
Mass Audubon
Alex Hackman, Linda Hutchins
Massachusetts Department of Conservation and Recreation
Jamie Carr, Jillian Whitney
Massachusetts Department of Environmental Protection
Stephanie Figary, Robert Smith

COLLABORATING FACULTY AND COOPERATORS (CONTINUED)

Massachusetts Division of Ecological Restoration
Kate Bentsen, Joseph Gould, Chris Hirsch, Beth Lambert
Massachusetts Division of Marine Fisheries
Mike Armstrong, Mike Burgess, Brad Chase, Ben Gahagan, Joe Holbeche, Gary Nelson, John Sheppard
Massachusetts Division of Fisheries and Wildlife
Jason Carmignani, Meghan Crawford, Martin Feehan, Mike Huguenin, Mike Jones, Adam Kautza, Steven Mattocks, Susan McCarthy, Carolyn Mostello, Rebecca Quiñones, Todd Richards, Jason Stolarski, Dave Wattles
Massachusetts Military Reserve
Jacob McCumber, Annie Curtis
Michigan State University
Neil Gilbert, Elise Zipkin
Monmouth University
Sean Sterrett
Mount Holyoke College
Renae Brodie
Mount Rainier National Park
Tara Chestnut
Mystic River Watershed Association
Andy Hrycyna
National Park Service
Nina Chambers, Heather Coletti, Kyle Cutting, Troy Hamon, Buck Mangipane, Benjamin Pister, Dylan Schertz, Joshua Schmidt, Carlene Schultz
Neponset River Watershed Association
Sean McCanty
New Hampshire Department of Fish and Game
Catherine Callahan, Matt Carpenter, Henry Jones, Jillian Kilborn, Melissa Winters
New Hampshire Department of Environmental Services
Andrew Chapman
Oxbow Associates
Brian Butler
Penobscot Nation
Ben Simpson
Pennsylvania State University
C. Guilherme Becker, Molly Bletz, Shannon Buttimer, Daniel Medina, Carolina Lambertini, David Miller, F. Javiera Rudolph, Veronica Saenz Calderon, Jo Werba
Portland State University
Jennifer Morse, Jacob Rudolph
The Nature Conservancy
Alison Bowden, Barbara Charry, Angela Sirois-Pitel
North Carolina Wildlife Resources Commission
Lori Williams
Norcross Wildlife
Calvin Fisher, Ed Hood, Caro Munoz Agudelo, Dan Wilder
Rhode Island Department of Environmental Management
Alan Libby, Corey Pelletier
Saskatchewan Ministry of Environment
Iga Stasiak
Smithsonian Environmental Research Center
Rebecca Hale
SUNY- ESF
Paul Jensen
Texas State University
Wesley Neely
Universidade Estadual Paulista, Rio Claro, São Paulo, Brazil
Renato Martins, Célio Haddad
Universidade Federal de São Carlos
Renato Martins
University of California Los Angeles
Gary Bucciarelli
University of California Santa Barbara
Michelle Lee, Katja Seltmann, Samuel Sweet
University of Connecticut
James Knighton, Eric Schultz
University of Florida
Ana Longo
University of Georgia
Krista Capps, Shuo Chen, Peter Hazelton, Seth Wenger
University of Maine
Sydne Record, Michelle Staudinger
University of Maryland College Park
Karen R. Lips, Jennifer Mullinax
University of Massachusetts Amherst
Jeremy Andersen, Konstantinos Andreadis, Caitlyn Butler, Brian Cheng, John Finn, Todd Fuller, John Gibbons, Curt Griffin, Xinchen He, Scott Jackson, Adrian Jordaan, Jason Kamilar, William Pfadenhauer, Bethany Bradley
University of New Hampshire
Kyle Dunfey-Ball, Alexej Sirén
University of Oklahoma
Shenglai Yin
University of Rhode Island
Johanna Harvey, Jannelle Couret
University of Texas Austin
Kelly Zamudio
University of Vermont
Laurence Clarfeld, Brittany Mosher, Elias Rosenblatt, Alexej Sirén, Cheryl Sullivan
USDA Forest Service
Robert Abrams, Suzanne Gifford, Dave King, Keith Nislow, Leighlan Prout, Sue Staats, Scott Wixom
U.S. Fish and Wildlife Service
Rachel Cliché, Sandra Doran, Donovan Drummey, Christine Dumoulin, Corey Eddy, Katherine Ineson, Stephanie Koch, Zachary Ladin, Christine McCue, David Perkins, Ken Sprankle, Anthony Tur, Timothy Warren, Linda Welch, Nathan Whelan, Lisabeth WIlley, Thomas Wittig
U.S. Geological Survey
Cooperative Research Units Program
Christina Murphy, John Organ, Claire Teitelbaum
Eastern Ecological Science Center
Adrianne Brand, Jonathan Cook, Christine Dumoulin, Jenn Fair, Jillian Fleming, Mary Freeman, Evan H.C. Grant, Ben Letcher, Steve McCormick, Riley Mummah, Diann Prosser, Michael Runge, David Smith
Forest and Rangeland Ecosystem Science Center
Rebecca McCaffery, Michael Adams, Brome McCreary, Christopher Pearl, Jennifer Rowe
Fort Collins Science Center
Erin Muths
National Wildlife Health Center
Jeff Lorch, Daniel A. Grear, Charles W. Robinson, Megan E. Winzeler
Northeast Climate Adaptation Science Center
Toni Lyn Morelli
Northern Rocky Mountain Science Center
Blake Hossack
South Atlantic Water Science Center
Kristina Hopkins, Daniel Calhoun
Upper Midwest Water Science Center
David Krabbenhoft, Jacob Ogorek
Upper Midwest Environmental Sciences Center
Mark Roth, Walt Sadinski
Southwest Biological Science Center
Brent Sigafus
Western Ecological Research Center
Adam Backlin, Robert Fisher, Brian Halstead, Patrick Kleeman
Wetland and Aquatic Research Center
Brad 'Bones' Glorioso, Hardin Waddle, William Barichivich, Susan Walls
Vermont Department of Fish and Wildlife
Chris Bernnier, Courtney Buckley, Nick Fortin, Katrina Gieder, Tony Smith
Vermont Department of Environmental Conservation
James Deshler, Michelle Graziosi
Yale University
Gregory Watkins-Colwell

A Brief History

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 43 Cooperative Research Units in 41 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.

Early spring at Arcadia Wildlife Sanctuary, Easthampton, MA (Elsa Cousins)

ALLISON H. ROY
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, climate change) and their associated stressors result in degraded biotic assemblages is an overarching challenge of my research program. I examine effects of alterations on fishes, mussels, and macroinvertebrates; population ecology and conservation of rare and endangered species; and potential for management to restore freshwater ecosystems.

GRAZIELLA V. DIRENZO
Assistant Leader - Wildlife
Research Assistant Professor

I am a quantitative ecologist interested in examining community and population ecology, disease dynamics, and developing biologically realistic quantitative tools. To mimic natural hierarchical systems, I develop hierarchical Bayesian models, and I use data collected over space and time to separate ecological and observational processes to answer ecological questions. My research program focuses on unifying ecological and evolutionary theory to address fundamental questions in ecology using field, experimental, and quantitative approaches.

TAMMY L. WILSON
Assistant Leader - Wildlife
Research Assistant Professor

My research informs active wildlife management by unlocking the power of large datasets using cutting-edge data science tools, including hierarchical models and artificial intelligence. I lead research that drives actionable conservation and management for game and non-game species. I work with managers to answer difficult and timely applied conservation questions that require interdisciplinary thinking and active partnership. My passion is mentoring young scientists to help sustain wild places, species, and our connection to nature.

DEB WRIGHT
Administrative Assistant

I have been with the MA Cooperative Research Unit since 2014 and still find the work as meaningful as when I first started. Whether it's a grant proposal, ordering supplies, or juggling vehicle maintenance there's never a dull moment with this bustling Unit! In my free time, I thoroughly enjoy being outdoors whether it's on a run, hike, or just hanging out in the garden. I feel very fortunate to be a part of such an energetic, invaluable program that connects and benefits so many.

COOPERATOR SERVICE

University

- ECO Quantitative Science Group (DiRenzo, Wilson)
- ECO & OEB Graduate Committee member (DiRenzo, Roy, Wilson)
- ECO & OEB R Hacky Hour (DiRenzo)
- OEB Admissions Committee Chair (Roy)
- OEB Graduate Faculty & Steering Committee (DiRenzo, Roy, Wilson)
- UNVEIL Program Advisory Committee (DiRenzo & Roy)

Other

- Brook Floater Working Group (Roy)
- Yellow Lampmussel Working Group (Roy)
- Blanding's Turtle Working Group (Roy, DiRenzo)
- Structured decision-making workshop for Chronic Wasting Disease (DiRenzo)
- Survey design co-creation and consultation for Penobscot Nation, MDIFW, NPS, USFS, USFWS (Wilson)

USGS SERVICE

- 2023 All Hands Meeting Planning Committee (Roy)

PROFESSIONAL SERVICE

- Long Range Planning Committee, Publications Committee, Urban Chapter, and Headwaters Leadership Academy; Society for Freshwater Science (Roy)
- Associate Editor, Journal of Wildlife Management (Wilson)
- Associate Editor, Ecosphere (DiRenzo)
- Data Paper Editor, Ecology (DiRenzo)
- Vice Chair, Statistical Ecology Section of Ecological Society of America (DiRenzo)

AWARDS AND RECOGNITION

- ADVANCE Faculty Peer Mentoring Award, University of Massachusetts 2025 (Roy)

GRADUATE COURSES TAUGHT

Fall 2024

- *Research Concepts (ECO 601: DiRenzo)*
- *Readings in Watershed Conservation (ECO 692W: Roy)*
- *Analysis of Environmental Data (ECO 602: Wilson)*

Fall 2025

- *Data Wrangling (ECO 690W: DiRenzo)*
- *Data Visualization (ECO 690V: DiRenzo)*
- *Data Simulation (ECO 690S: DiRenzo)*
- *Analysis of Environmental Data (ECO 602: Wilson)*
- *Research Concepts (ECO 601: Roy)*

Changes in an impoundment following a dam removal (Alexa Hershberger)

We welcome the following people in their new roles associated with the Massachusetts Coop Unit:

Sammy King

Regional Unit Supervisor
U.S. Geological Survey
Cooperative Research Units Program

Sammy is a wetland and waterbird ecologist that received his B.S. from Nicholls State University, M.S. from Auburn University, and his Ph.D. at Texas A&M University. He has worked as a research ecologist at the USGS National Wetlands Research Center, an Assistant Professor at the University of Tennessee, and for 22 years, as the Unit Leader and research wildlife biologist for the Louisiana Cooperative Fish and Wildlife Research Unit. His research has focused on restoration and management of wetland systems including bottomland hardwoods, coastal marshes and arid wetlands. In addition, he has worked extensively with secretive marshbirds and assisted in the reintroduction of Whooping Cranes to Louisiana. He has served as the Regional Supervisor for the CRU program since January 2025. He resides in Louisiana and enjoys hunting, fishing, and a host of other outdoor activities.

Ben Gahagan

Program Leader
Recreational Fisheries Program
MA Division of Marine Fisheries

Ben is a fisheries biologist who is interested in the conservation, restoration, and responsible management of fish species large and small. He received a B.A. from Kenyon College before beginning his fisheries career at the Connecticut Department of Energy and Environmental Protection (CTDEEP) working with diadromous fish. He subsequently attended the University of Connecticut, where he studied emigration patterns of juvenile alewife and earned his M.Sc. using otolith microchemistry to determine the natal fidelity of river herring. He worked for two years at the University of Maryland Center for Environmental Science at Solomons Island in Maryland, supporting research on striped bass, bluefin tuna, and menhaden. He has been at the Division of Marine Fisheries since 2012, spending his first 11 years in the Diadromous Fisheries Project before becoming Recreational Fisheries Program Leader. During his time with the Division, Ben has worked with state, federal, and academic partners to further conservation and management goals, improve aquatic resources, and mentor younger students and professionals.

Alex Schreyer

Department Head
Environmental Conservation
University of Massachusetts Amherst

Alex Schreyer is Senior Lecturer II, Department Head of Environmental Conservation, and Program Director of Building and Construction Technology at UMass Amherst. As BCT Program Director he has shaped the program's growth since 2013 through innovative curriculum development, industry partnerships, and a sustained focus on student success. He assumed departmental leadership in Fall 2025 when Paige Warren became an Associate Dean in the College of Natural Sciences. Schreyer's work spans structural engineering, wood science, and digital technologies, complemented by influential textbooks on construction materials and digital design, widely used open-source digital design tools, and research in mass timber systems, digital fabrication, and structural optimization. He holds an M.A.Sc. in Wood Science from the University of British Columbia, Canada, and a Dipl.-Ing. (B.S. equiv.) in Civil Engineering from Rhein-Main University of Applied Sciences in Germany.

CURRENT GRADUATE STUDENTS AND POSTDOCS

John Draper, Post-doc (Wilson)
Devin Edmonds, Post-doc (DiRenzo)
James Garner, Post-doc (Roy)
Margaret McEachran, Post-doc (DiRenzo)
Anna Baynes, Ph.D. (Roy)
Matt Devine, Ph.D. (Roy and Jordaan)
Alexa Hershberger, Ph.D. (Roy)
Gillian Kruskall, Ph.D. (DiRenzo)
Leslie Skora, Ph.D. (Wilson)
Shelby Truckenbrod, Ph.D. (DiRenzo and Roy)
Abigail Blair, M.S. (Roy and Jordaan)
Rebecca Cusick, M.S. (Roy and Jordaan)
Reese Dorroh, M.S. (Roy and Jordaan)
Adrienne Dunk, M.S. (Roy)
Marielena Lima, M.S. (Roy)
Jesus Rodriguez Riverol, M.S. (DiRenzo and Roy)
Matthew Schlaikjer, M.S. (Wilson)
Jacob Sorensen, B.S., Honors (Roy)
Mickala Stratton, B.S., Honors (Roy)

COMPLETED GRADUATE STUDENTS AND POSTDOCS 2024-2025

Andreas Eleftheriou, Post-doc (DiRenzo) – Linking between- and within-host dynamics in mechanistic models of wildlife disease systems while accounting for imperfect detection (July 2025)

Becca O'Brien, Post-doc (DiRenzo and Roy) – Identifying environmental drivers and projected impacts of climate change on Massachusetts freshwater mussels for successful conservation and protection of water quality (January 2024)

Isabella Ragonese, Post-doc (DiRenzo) – Illegally traded wildlife repatriations: Incorporating uncertainties to assess impacts on vulnerable populations (May 2025)

Jenny Rogers, Post-doc (DiRenzo and Roy) – Framework for protecting aquatic biodiversity in the Northeast under changing climates (June 2025)

Alexej Siren, Post-doc (Wilson) – Climate and habitat shape density-dependent parasitism at species' range edges (May 2024)

Stefanie Farrington, Ph.D. (Roy) – Examining host fishes, habitats, and range-wide status of the yellow lampmussel (*Lampsilis cariosa*) (February 2026)

Julian Burgoff, M.S. (Roy and Jordaan) – Linking juvenile river herring growth, diets and habitat use in freshwater and estuarine environments (May 2025)

Connor Morrow, M.S. (Wilson) – Habitat use of black bear, moose, and gray fox in a human-dominated landscape of western Massachusetts (May 2025)

Jackie Stephens, M.S. (Roy and Jordaan) – Cascading conservation: Assessing the repeated spawning migrations and freshwater mussel host potential of blueback herring (*Alosa aestivalis*) (February 2025)

Ednita Tavarez-Jimenez, M.S. (DiRenzo) – Exploring the potential disease and genetic risks in wildlife translocations focusing on long-lived species in the United States (September 2024)

Isabella Ceresia, B.S., Honors (Roy) – Evaluating factors contributing to common loon egg hatching success in the Quabbin Reservoir (May 2024)

Kayla Pacheco, B.S. (Roy) - Using morphometrics to identify freshwater mussel glochidia on host fishes (May 2025)

November at the Rock Dam, Turners Falls (Elsa Cousins)

National and Regional Awards

Alexa Hershberger: Wiederhold Research and Veterinary Science Award 2025

UMass ECo Awards

Julian Burgoff: Roger J. Reed Fund 2024
Stefanie Farrington: Richard Cronin Fisheries Research Fund Award 2024
Leslie Skora: Herschel G. Abbott Natural Resources Conservation Award 2024
Leslie Skora: Paula Milner Memorial Scholarship 2024
Anna Baynes: Richard Cronin Fisheries Research Fund Award 2025

UMass Awards

Jill Bakey: Honor's Research Fellowship UMass 2024, 2025

Conference Awards

Jackie Stephens: Saul B. Salia Best Student Paper Award, American Fisheries Society 2025
Anna Baynes: Runner-up for Best Student Poster, Northeast Aquatic Biologists Conference 2024
Kayla Pacheco: Best Student Poster, Northeast Aquatic Biologists Conference 2025

Travel Awards

Alexa Hershberger: Society for Freshwater Science Systematics and Natural History Award 2025

Aerial perspective of mussel survey (James Garner)

Juvenile shad (James Garner)

High School STEM Internships: For the first time, high school students participated in the research internships with the MA Coop Unit in summer 2025. The program, which falls under collaborative.org, provides paid, 100-hour internships where students could gain experience in a wide range of disciplines within Science, Technology, Engineering, or Mathematics (STEM). The program director provides students with career preparation training (cover letters, resumes, interviews) and the Coop Unit provided safety training, including CPR and First Aid and Over the Water. We had five students who assisted with field-based research projects alongside graduate students and undergraduate technicians.

Coldwater Fish

Violet assisting with electrofishing (Anna Baynes)

Violet Berube, Amherst Regional High School
Graduation Year: 2025

"I worked in local stream ecosystems, where we collected data on coldwater fish populations using electrofishing equipment. This was my first experience doing fieldwork, and it was a really valuable opportunity to see if I wanted to pursue this type of research in the future. I also learned how to enter our data into spreadsheets, which was a new part of the research process for me."

Blanding's Turtle

Corinne holding baby painted turtle (Jesus Rodriguez Riverol)

Corinne Charlebois, Amherst Regional High School
Graduation Year: 2027

"I spent a few weeks working with UMass students, trekking through various woods and bodies of water to find Blanding's turtles. I learned how to track, trap, check, and mark them. It was a really cool experience and I'm happy to have had the opportunity to see what that type of job was like."

Freshwater Herring

Abigail collecting zooplankton sample (Reese Dorroh)

Abigail Nicholson, Pioneer Valley Chinese Immersion Charter School
Graduation Year: 2026

"I worked alongside UMass students in a research project on river herring. I was able to help in the lab extracting otoliths and also worked in the field on night fishing trips to Eastern Mass. I was able to learn a lot about the research process both in the field and the lab and I am happy for the opportunity to work with students interested in similar things that I am."

Freshwater Mussels

Myla excavating freshwater mussels (Madison Newman)

Myla Peltier, Amherst Regional High School
Graduation Year: 2026

"I worked in local rivers around Western Massachusetts, studying the many species of freshwater mussels that live there. I learned field techniques such as using a quadrat and the proper method of excavating rocks without harming the mussels. I also learned a lot about the natural surrounding area, including many mussel species, where they live, and how rivers move and change with time. This was a really exciting opportunity for me and I am so thankful for what I have learned from being a part of this project."

Blanding's Turtle

Malcolm notching Blanding's Turtle (Jesus Rodriguez Riverol)

Malcolm Sullivan-Flynn, Amherst Regional High School
Graduation Year: 2026

"I had the wonderful opportunity to work with the team trapping, tracking, and processing turtles in the wetlands of Eastern Mass last summer. I learned a lot about working with and processing wild animals and got to experience a college lab firsthand. It really helped me learn about the work and career I want to pursue in the future."

collaborative.org
Collaborative for Educational Services

"Pathways" into the U.S. Fish and Wildlife Service

The U.S. Fish and Wildlife Service (Service) Northeast Regional Office in Hadley, MA has supported many CRU students in recent years through two programs: the Pathways Internship Program and the Directorate Fellowship Program (DFP). Both programs provide students with the opportunity to explore career paths or interests related to their academic fields of study in the conservation field. The positions also provide opportunities for employment with the Service following graduation, and many of our recent graduates have been hired by the Service. The most recent alumni are featured on this page.

Juliana Berube, Fish & Wildlife Biologist
MS Environmental Conservation 2024, Advisor: Dr. Tammy Wilson
Maine Ecological Services Field Office, East Orland, Maine

I conduct consultations and draft recovery plans for threatened and endangered species under Sections 7 and 10 of the Endangered Species Act. In Maine, I am the federal contact for work related to the Canada lynx, roseate tern, piping plover, rufa red knot, rusty patched bumblebee, eastern prairie fringed orchid, small whorled pogonia, and Furbish's lousewort. I also work closely with the Maine Department of Inland Fisheries and Wildlife on the recovery and management of these species.

I participated in the Pathways program, where I assisted the Office of Conservation Investment (formerly Wildlife and Sport Fish Restoration Program) at the Service's regional office for two years to distribute grants to state fish and wildlife agencies across New England. This experience gave me an understanding of how the various programs within the Service work together to facilitate conservation through grants, legal compliance, science-based recommendations, and more for other federal, state, and private partners.

Andrew Gordon, Fish & Wildlife Biologist
MS Environmental Conservation 2023, Advisor: Dr. Graziella V. DiRenzo
New York Ecological Services Field Office, Cortland, NY

My role is to review development, habitat restoration, and species recovery projects for compliance with Section 7 and Section 10 of the Endangered Species Act (1973). I coordinate with consultants and state and federal agencies to propose conservation measures that minimize adverse effects to federally listed species like the northern long-eared bat, bog turtle, and Karner blue butterfly. I am also our office's point of contact for consultations pertaining to the Department of Defense lands in New York.

During my DFP, I prepared a document describing the best management practices for conserving the Eastern arogos skipper, which is an imperiled species that occurs on Joint Base McGuire-Dix-Lakehurst in New Jersey. My internship taught me how the USFWS uses the most updated scientific data to support species protection efforts and how we collaborate with DoD to conserve the natural resources that occupy their installations.

Jacqueline Stephens, Biologist
MS Environmental Conservation 2025, Advisors: Dr. Allison Roy and Dr. Adrian Jordaan
Lower Great Lakes Fish and Wildlife Conservation Office, Basom, NY

As a field biologist, my work focuses on the prevention, early detection, rapid response, and control efforts of aquatic invasive species (AIS) within the Lake Erie and Lake Ontario watersheds. To maximize the probability of detecting the new introduction or spread of AIS within these waters, our field crews conduct whole-community and species-specific surveys using both traditional fisheries and environmental DNA sampling techniques.

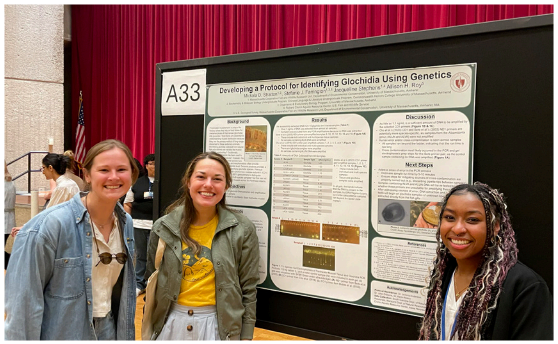
The opportunities provided by my Pathways position helped me build the technical skill set necessary for my current position. These opportunities ranged from job-specific trainings/certifications to hands-on experiences assisting with multi-partner projects.

Audrey and Kayla at Freshwater Mussel Site (Alexa Hershberger)

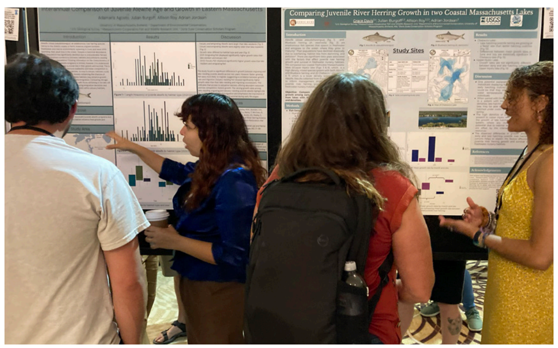
The Doris Duke Conservation Scholars Program (DDCSP)

was a two-year experiential conservation training program for undergraduates who are interested in careers in conservation and in promoting diversity, equity, and inclusion in the field. The program aimed to empower a diverse new generation of conservation leaders. UMass Amherst joined the consortium (with four other Universities) in 2020. Scholars conducted applied field research projects in their first summer and participated in professional internships in their second summer. Scholars learned a variety of research techniques and presented their research at a national scientific conference.

In 2023, Doris Duke announced that they were no longer funding the program. With support from USGS and UMass, we created the "Conservation Collaborative" with two undergraduate students in a research-only cohort in summer 2024 who worked on freshwater mussel projects. These students participated in research mentoring meetings in 2024-2025 and presented at a conference in May 2025. In summer 2025, USGS funds supported mentors for three undergraduate students working on freshwater turtles who will present research posters in spring 2026 with funding from UMass ECo.



Jackie, Stefanie, and Mickala at the UMass URC 2025 (Alexa Hershberger)



Ada and Grace presenting posters at SFS (Allison Roy)

Research Presentations

DDCSP scholars who conducted research in the summer of 2023 presented research posters at the Society for Freshwater Science meeting in Philadelphia, PA in June 2024.

- Ada Agosto: *Interannual comparison of juvenile alewife age and growth in eastern Massachusetts (USA)*
- Grace Davis: *Comparing juvenile river herring growth in two coastal Massachusetts lakes*
- Estela Garcia: *Yellow Lampmussel distribution in the Connecticut River: connecting habitat use to species presence for future conservation*
- Julia Hatzis: *Run-of-river dam impacts on water quality and freshwater mussels in Massachusetts (USA)*

Students in the Conservation Collaborative in summer 2024 presented research posters at the Northeast Aquatic Biologists Conference in Bartlett, NH in February 2025 and the Society for Freshwater Science meeting in San Juan, Puerto Rico in May 2025.

- Kayla Pacheco: *Using morphometrics to identify freshwater mussel glochidia on host fishes*
- Mickala Stratton: *Developing a protocol for identifying glochidia using genetics*

Students who worked on turtle research in summer 2025 will present research posters at the Northeast Natural History Conference in Burlington, VT in April 2026.

- Sophie Bonazoli: *Prevalence of scute abnormalities in a large Blanding's turtle population in central Massachusetts*
- Sofia Harlow: *Effect of temperature on growth rates of juvenile Blanding's turtles in central Massachusetts*
- Audrey Methot: *Demography of an isolated spotted turtle population in Massachusetts*

Freshwater Mussel Research - Summer 2024

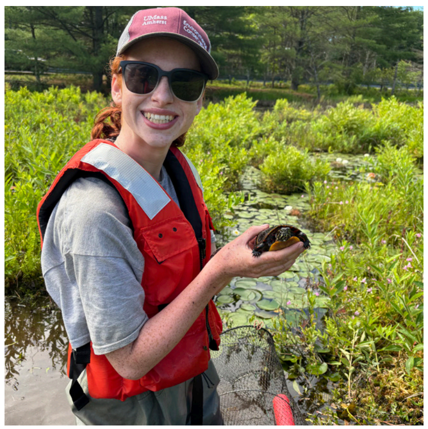
The scholars (Kayla Pacheco and Mickala Stratton) participated in a variety of field and lab work under the supervision of PhD students Alexa Hershberger and Stefanie Farrington while stationed at the USFWS Cronin Aquatic Resource Lab in Sunderland, MA. Field work included: 1) sidescan sonar habitat mapping on the Connecticut River, 2) mussel snorkel surveys on the Connecticut River, 3) sediment trap deployment, water quality sampling, and PIT tagging mussels in the Ware River at a dam removal site, and 4) snorkel surveys for mussels and habitat in several streams in Connecticut and Massachusetts. In the lab, the scholars extracted glochidia from the gills of preserved fish, extracted chlorophyll a from water samples, and assisted with data entry. Both students worked with Stefanie Farrington for their independent projects. Pacheco assessed host fish use by mussels by extracting mussel glochidia from fish gills and using morphometric measurements to classify and identify mussels—that project became her Honor's thesis that she completed in May 2025. Stratton developed techniques for identifying the mussel glochidia using genetics, which informed a chapter of Stefanie's dissertation.

Mickala collecting freshwater mussel eDNA (Alexa Hershberger)

Kayla at freshwater mussel site (Alexa Hershberger)

Freshwater Turtle Research - Summer 2025

Three undergraduate scholars (Sophie Bonazoli, Sofia Harlow, and Audrey Methot) worked on a project investigating population demographics and spatial ecology of Blanding's turtle (a state-threatened species) in eastern Massachusetts under the supervision of Shelby Truckenbrod (PhD student) and Jesus Rodriguez-Riverol (MS student and former Doris Duke scholar). The project covered three large properties: the Devens Reserve Forces Training Area (RFTA), Bolton Flats Wildlife Management Area (WMA), and the Oxbow National Wildlife Refuge (NWR). Two of the students lived at the U.S. Fish and Wildlife Service property nearby with the rest of the team, and one of the students commuted to the field site. During the day, the students typically worked in pairs to either a) set and check traps or b) track turtles using radio telemetry. After capturing a turtle, they would take a variety of body/shell measurements, determine sex, estimate age, assess scute morphology, and mark turtles (if needed). When weather prevented field work, they assisted with data entry. The students each conducted independent study projects during the 2025-2026 school year.



Sophie holding painted turtle captured in a trap (Shelby Truckenbrod)

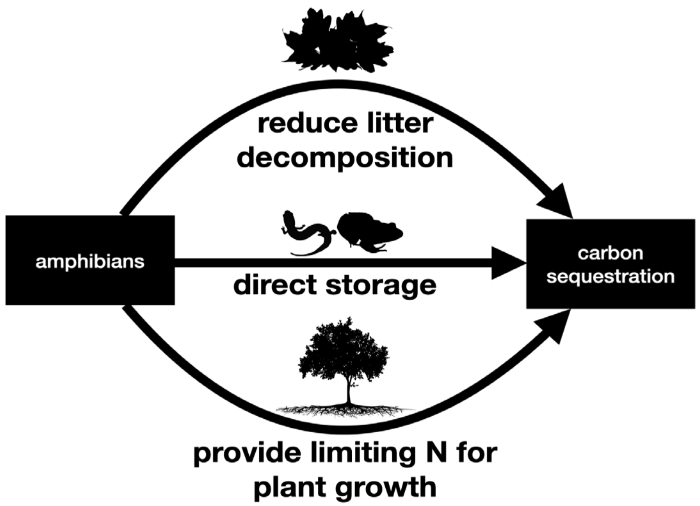
Audrey with radio-tracked Blanding's turtle (Shelby Truckenbrod)

Sofia with a Blanding's turtle she tracked via radio telemetry (Audrey Methot)

Quantifying amphibian ecosystem services across the continental U.S.

Amphibians promote ecosystem health and benefit human society in a number of ways. For example, they cycle nutrients, increase productivity, are nutrient-rich prey, create habitats for other species, predate pests and disease-carrying vectors, are medicinal, and have cultural significance. Because amphibians are difficult to observe and because their roles in ecosystems are complex and dynamic, it is challenging to determine the magnitude of their contributions and develop a holistic understanding of their value. However, as amphibians experience rapid declines and extirpations across the United States, developing this understanding is critical to evaluate the consequences of amphibian declines and remove undervaluation as an obstacle to conservation. In this project, we aim to (1) develop a framework for understanding the value of amphibians, (2) quantify the various ecosystem services that amphibians provide across the continental United States, and (3) clarify the consequences, including economic costs, of amphibian population declines. Collectively, these results will aid policymakers and managers factor in the loss of amphibian ecosystem functions to economic projections and conservation plans.

POST DOC Tiffany Dias
ADVISOR Graziella DiRenzo
Evan H.C. Grant
FUNDING USGS Ecosystem Mission Area



Pathways by which amphibians contribute to carbon sequestration

Black bear habitat selection in a human-dominated landscape

The Massachusetts landscape is defined by human modification. Within Massachusetts, 17% of the land area is a building or hardscape, and 99% is within 1 km of a road. Animals with large home ranges, such as black bears (*Ursus americanus*), must regularly interact with human development, experiencing a push-pull of risks and rewards associated with it. We sought to model how black bears in this heavily modified environment use and engage with both natural and developed spaces. We found that throughout the year, bears use space close to development but with lower development density. Essentially, bears appear to be attracted to the easy food resources found near development (bird feeders, trash cans, etc.), but still favor spending the bulk of their time in lower development-density areas. For example, we found bears spending time in wooded backyards between houses in suburban areas. These areas are close to the resources associated with development for the bears to exploit, but allow them to avoid the perceived and real risks of spending time in high-density development. Bears are still utilizing available natural spaces in expected ways. Throughout the year, bears favor the cover provided by forested areas and woody wetlands. In the spring, they show an increased usage of woody wetlands, where wetland and riparian vegetation, including skunk cabbage, provide early natural forage.

POST DOC John Draper
ADVISOR Tammy Wilson
FUNDING MassWildlife, USFWS
COLLABORATORS Dave Wattles

John Draper in the field (John Draper)

A decision support tool to help repatriate turtles confiscated from the illegal wildlife trade

North America supports a rich assemblage of freshwater turtles, yet many are declining due to overexploitation for the international pet and food trades. Illegal trade has emerged as a particularly complex challenge, with officials facing difficult decisions about what to do with confiscated animals of unknown origin and health status. To address this problem, we are developing a decision support tool that evaluates potential risks to wild populations from repatriating confiscated turtles. Building on population matrix models for wood turtles (*Glyptemys insculpta*) developed by former postdoctoral researcher Isabella Ragonese, we are incorporating the output of repatriation scenarios into a decision analysis framework. Our work will generate estimates of population growth under a wide range of plausible scenarios, including varying confiscation sizes, wild population sizes, and assumptions about genetic and health status. The outputs will then be integrated into a user-friendly interface with accompanying guidance and educational information for managers. The resulting tool will help decision makers weigh uncertainty and risk tolerance when considering repatriation and will ultimately support more informed conservation decisions.

POST DOC	Devin Edmonds
ADVISOR	Graziella DiRenzo
FUNDING	USGS, USFWS
COLLABORATORS	Evan H.C. Grant

Devin Edmonds in the field (Devin Edmonds)

Biodiversity Monitoring for Vinica Brook Restoration

The Vinica Brook watershed is undergoing a watershed-scale restoration that will reconnect more than 14 miles of stream and 300 acres of wetlands through dam removals, culvert replacements, and road decommissioning. Using environmental DNA (eDNA) metabarcoding and targeted, species-specific qPCR, we are surveying aquatic and semi-aquatic communities at strategically selected locations upstream and downstream of proposed restoration sites to document species presence, relative abundance, detection probability, and community structure prior to barrier removal. The resulting datasets, spatial maps, and analytical visualizations create a scientifically grounded framework for evaluating ecological outcomes, demonstrating restoration success, and securing future funding to sustain and expand watershed recovery efforts.

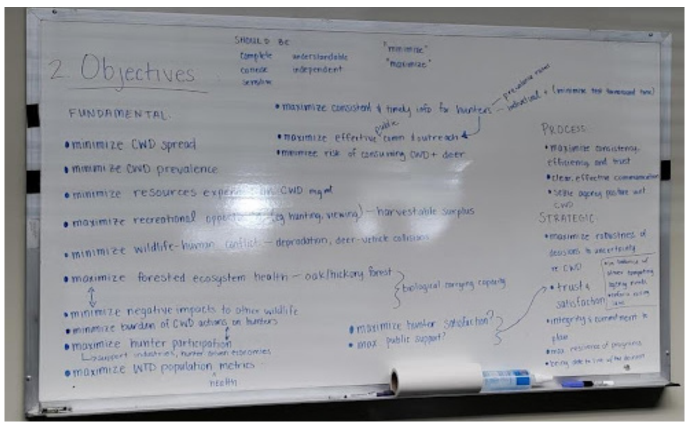
POST DOC	James Garner	
ADVISOR	Allison Roy	
FUNDING	Mass Audubon Norcross Wildlife Foundation	
COLLABORATORS	Calvin Fisher Andy Fisk Alex Hackman Ed Hood	Linda Hutchins Caro Munoz Agudelo Dan Wilder

Calvin Fisher and Norcross summer interns pose in the Beaver Meadow eDNA monitoring site (James Garner)

Supporting decision-making for chronic wasting disease management by state, federal, and tribal wildlife agencies

Chronic wasting disease (CWD) is a progressive, neurodegenerative prion disease that is fatal to the cervid species it infects, including white-tailed deer, mule deer, and Rocky Mountain elk. Because CWD is incurable and infectious prions can last for years in the environment, agencies across the country are faced with limited options for managing its negative impacts once the disease is introduced to free-ranging populations. Many affected species are culturally and ecologically important to the communities that rely on them, so agencies are motivated to find balanced strategies for CWD management that meet the needs of hunters, community members, and other important stakeholders. To help agencies navigate these difficult decisions, our project applies structured decision making (SDM). We are applying SDM for agencies in several disease and governance contexts, including for a tribal agency in Oregon where CWD is not yet found, for the USFWS managing elk in the Greater Yellowstone Ecosystem where CWD was recently discovered, and for Ohio's deer program where CWD has been steadily increasing for a few years. We provide quantitative support to make predictions about the effectiveness of proposed management actions and guide decision makers through the structured process of identifying the best alternatives to meet their agency goals and needs.

POST DOC	Margaret McEachran
ADVISOR	Graziella DiRenzo
FUNDING	USGS
COLLABORATORS	USGS, USFWS, wildlife management agencies in 4 different states



White board showing the SDM process for CWD management unfold (Margaret McEachran)

Climate refugia and flow effects on stream fish assemblages

Climate change and anthropogenic disturbances alter stream temperature and flow, with consequences for fish assemblages. Coldwater refugia—networks of coldwater patches that are expected to persist despite changing climates—provide thermal shelter for coldwater fishes and other organisms from warming stream temperatures. Stream flow is altered by anthropogenic impacts such as water supply reservoirs storing and diverting water for human consumption. However, the change in flow specifically due to withdrawals at water supply reservoirs has unknown consequences on fish assemblages. Our objectives are to 1) quantify the heterogeneity of coldwater patch quantity and quality and how it changes throughout the summer, 2) quantify how thermal heterogeneity varies among cold- and coolwater streams and its effect on fish assemblages, 3) identify fish species-specific use of coldwater patches in a laboratory setting, and 4) quantify flow alteration and the predictability of flow downstream of water supply reservoirs and its impacts on fish assemblages. Results will help guide coldwater conservation of stream habitat and fishes and water allocation management.

STUDENT	Anna Baynes (PhD)	
ADVISOR	Allison Roy	
FUNDING	MassWildlife, USGS Conte	
COLLABORATORS	Jenn Fair	Ben Letcher
	Adam Kautza	Todd Richards

Electrofishing surveys in Harris Brook (Leanda Fontaine)

Population dynamics and restoration ecology of anadromous river herring

Anadromous river herring (alewife and blueback herring) populations have declined dramatically over the last several decades, sparking an urgent need to understand and address mechanisms leading to these reductions. Our research is focused on 1) examining the factors that regulate juvenile productivity during their freshwater developmental stage, a critical bottleneck affecting population recovery, and 2) assessing river herring response to dam removal and restored access to historic freshwater spawning habitats. We aim to quantify juvenile density and growth across temporal, spatial, and habitat gradients, including freshwater lakes and ponds and Connecticut River coves. Our approach uses standardized juvenile sampling, otolith-based growth assessments, environmental measurements, and statistical models, to evaluate the influence of biotic and abiotic variables—such as habitat availability, water quality, and food resources—on juvenile productivity. Additionally, we are studying differences in juvenile density, growth, and hatch timing in systems with restored aquatic connectivity compared to those at established reference sites, to better understand recovery trajectories and recolonization dynamics. The results from this work will provide managers with insights into inter-annual variation in density and growth and help guide pathways and expectations for recovery.

STUDENT	Matt Devine (PhD)	
ADVISORS	Allison Roy Adrian Jordaan	
FUNDING	TNC, MDMF, USGS, USFWS SSP	
COLLABORATORS	Jacque Benway Alison Bowden Ben Gahagan	Gary Nelson Ken Sprankle

River herring underwater (Matt Devine)

Investigating the importance of dams, dam removals, and habitat in freshwater mussel conservation

Freshwater mussels are facing a global extinction crisis, and a stronger understanding of the impacts of stressors and habitat requirements across species ranges can help inform management and restoration. The spatial scope of many freshwater mussel studies is often limited to a single site or watershed, while regional analyses are valuable to better understand range-wide conservation needs. This research will address these information gaps through 1) a global meta-analysis investigating the impact of dams and dam removals on freshwater mussels, 2) a framework that can be used to monitor freshwater mussels at dam removal sites, 3) an assessment of how habitat and co-occurring freshwater mussels affect the abundance of rare mussel species, and 4) an assessment of how habitat and co-occurring species affect the presence and detection of an imperiled freshwater mussel, Brook Floater (*Alasmidonta varicosa*) along the Atlantic slope of North America. We anticipate that the results of this research will be used by practitioners to aid in the development and implementation of future restoration actions.

STUDENT	Alexa Hershberger (PhD)	
ADVISOR	Allison Roy	
FUNDING	USFWS C-SWG, UMass OEB, Wiederhold Research and Veterinary Science Award	
COLLABORATORS	Brook Floater Working Group Jason Carmignani Laura Saucier Graziella DiRenzo	Peter Hazelton Tim Warren David Perkins

Members of UMass Amherst, CT DEEP, and the Bee Brook Association conducting a mussel survey in a stream (Rory Larson)

Overview of upcoming One Health and Avian Influenza research

The term "One Health" is routinely used to acknowledge the interconnectedness of human, animal, and environmental health. One Health promotes an interdisciplinary and collaborative approach to managing the health of the three domains simultaneously, and includes complex health challenges, such as food safety, the development of antibiotic resistance, and environmental factors (e.g., climate change and zoonotic diseases). However, the term One Health varies in its definition and approach throughout the scientific literature and application. Therefore, our research objectives include 1) to understand what approaches are being proposed and implemented on a global scale in relation to One Health and environmental health, 2) to document and summarize how various wildlife health agencies in each state implement Wildlife Health Programs, 3) to understand the development of potential resistance to Avian Influenza before birds enter the winter flyways in Massachusetts, and 4) to determine if insects are vectors of Avian Influenza and other infectious viruses. Collectively, this research synthesizes theory and applications of One Health frameworks, as well as investigates immunity and transmission of a highly pathogenic virus.

STUDENT Gillian Kruskall, DVM (PhD)

ADVISOR Graziella DiRenzo

FUNDING USFWS Zoonotic Disease Initiative, USDA APHIS CWD, UMass OEB

COLLABORATORS Martin Feehan

Gillian Kruskall in the field (David Paulson)

Estimating brown bear abundance using aerial surveys in Katmai National Park, Alaska

Katmai National Park in Southwest Alaska is home to one of the world's largest brown bear (*Ursus arctos*) populations, supported by the largest sockeye salmon run in the world. Katmai's remote location coupled with harsh weather and limits to staff and funding make it difficult to estimate and monitor brown bear population dynamics using traditional mark-recapture techniques. Yet the park's mission to protect high concentrations of brown bears, increasing public interest, and concerns over how the bear population might be changing drives the need to understand this unique bear population. Recent advances in quantitative techniques may offer a way to use Katmai's long-term (1970–present) aerial survey data to estimate trends in the bear population. Our research goals are to combine counts of bears congregating along salmon spawning streams with demographic data from Brooks River to estimate trends in 1) brown bear use of salmon spawning streams, 2) trends in brown bear population abundance, and 3) to examine environmental factors influencing these trends.

STUDENT Leslie Skora (PhD)

ADVISOR Tammy Wilson

FUNDING The Katmai Conservancy, Katmai National Park, Southwest Alaska Network

COLLABORATORS Amy Miller
Troy Hamon
Josh Schmidt

Bear survey aircraft in Katmai National Park and Preserve (Tammy Wilson)

Spatial ecology and conservation of Blanding's Turtle in Eastern Massachusetts

Freshwater turtles are one of the most imperiled vertebrate groups, with population declines primarily driven by habitat loss and degradation. The Blanding's Turtle (*Emydoidea blandingii*) is one such at-risk turtle currently under review for federal listing. In New England, most Blanding's turtle populations are small (< 50 individuals) and often exist within residential and urban landscapes, but a stronghold (> 700 individuals) remains on several adjacent protected lands, including a military installation, in eastern Massachusetts. Given the review for federal listing and the potential impacts of military activities on reproductive success and population size, it is critical to reassess the status and spatial patterns of this population, which were last evaluated in the early 2000s. This project aims to 1) assess the population size, density, and demographic parameters of Blanding's turtles on these protected lands, 2) identify hotspots of nesting activity and assess impacts of military activities on nesting behavior at the military installation, and 3) quantify seasonal turtle movement patterns and landscape connectivity of these protected lands. Results from this study will guide management strategies for this local population and serve as a reference for conservation efforts regionally.

STUDENT	Shelby Truckenbrod (PhD)	
ADVISORS	Graziella DiRenzo Allison Roy	
FUNDING	Department of Defense, USFWS, UMass OEB	
COLLABORATORS	Brian Butler Kyle Crafts Katherine Ineson	Michael Jones Stephanie Koch Lisabeth Willey

Blanding's turtle captured in emergent wetland (Shelby Truckenbrod)

Examining the relationship between juvenile river herring and zooplankton density

As juveniles, river herring (Alewife, *Alosa pseudoharengus* and Blueback Herring, *Alosa aestivalis*) are planktivorous; their dependence on zooplankton is a critical aspect of their early development. River herring populations have plummeted in the past century, making research that emphasizes this vulnerable life stage critical in understanding their movement and identifying limiting factors to their growth. My research will integrate over a decade of data at four sites in eastern Massachusetts to investigate the effects of climate, water quality, and river herring on intra-annual, and inter-annual variation in zooplankton assemblages. Results from this study will allow us to understand the dynamics between zooplankton and river herring, and the factors that modify this relationship, to inform support management strategies that support juvenile river herring.

STUDENT	Abigail Blair (MS)
ADVISORS	Allison Roy Adrian Jordaan
FUNDING	MDMF, UMass ECo
COLLABORATORS	Stephanie Figary

Juvenile river herring (Calan Kirkpatrick)

Managing fishways and water levels for river herring on a tributary of the St. Croix River, Maine

Mainstem passage improvements have allowed for a resurgence of river herring (alewife and blueback herring) in recent decades within the Skutik (St. Croix) River watershed. The first accessible tributary on this international boundary, Magurrewock Stream, was historically managed by USFWS staff for waterfowl production; however, in recent years, management goals have shifted to focusing on improving fish passage and aquatic connectivity. Information about adult river herring movements and juvenile habitat use within the tributary is limited. The objective of this study is to 1) evaluate the amount, suitability, and use of habitat currently available to adult and juvenile river herring on the National Wildlife Refuge, 2) assess the ways in which impoundment management may impact river herring populations, and 3) propose best management practices to be implemented within the system to improve or sustain available habitat and corridors. Results from this study aim to inform the management of Magurrewock Stream and other similarly impounded systems, as well as provide insight for further aquatic connectivity improvements and impoundment use by fishes, migratory birds, and other wildlife.

STUDENT	Becca Cusick (MS)	
ADVISORS	Allison Roy Adrian Jordaan	
FUNDING	Project SHARE, USFWS, UMass ECo	
COLLABORATORS	Chris Federico Steve Koenig	John Magera

Overlooking Middle Magurrewock Marsh in the summer (Becca Cusick)

Examining the effects of drought on river herring populations

For anadromous fishes—those that spend most of their lives in saltwater and migrate into freshwater systems to spawn—movement between systems is at the core of their life history strategies. Blueback herring (*Alosa aestivalis*) and alewife (*A. pseudoharengus*), collectively known as river herring, have experienced drastic population declines over the past century, due in part to breakdown of migratory connectivity. Their dependence on freshwater spawning habitats makes them particularly vulnerable to changes in hydrology driven by climate and land use change. This research focuses on understanding how such environmental changes affect river herring populations by comparing systems with different hydrology. Specifically, we will 1) quantify returning adult fish year-class strength using otolith and scale analyses, and 2) sample, measure and determine age in days of in-lake and out-migrating juveniles to quantify cohort losses attributable to in-lake mortality and emigration. We will use forecasting models to inform water and fisheries managers of drought risk to river herring populations. By linking hydrologic and biological data, this study aims to provide insight into the future of river herring population health under shifting environmental conditions.

STUDENT	Reese Dorroh (MS)	
ADVISORS	Allison Roy Adrian Jordaan	
FUNDING	US EPA, CT Sea Grant, NY Sea Grant	
COLLABORATORS	Kevin Job James Knighton	Eric Schultz Ken Sprankle

Time lapse photography setup at Bride Lake (Adrian Jordaan)

Quantifying wetland change following small dam removals in Massachusetts

The rate of dam removal pales in comparison to the number of aging dams across Massachusetts. Because dam removals alter open water and contiguous wetlands, they must be authorized through multiple regulatory paradigms. These regulations ask specific questions about resource area impacts; however, little standardized data exists to satisfactorily answer these questions. To address this uncertainty, this research is focused on measuring wetland area changes over the first 10 years following removal using imaging and geospatial information systems (GIS). We will evaluate the effect of landscape characteristics and dam removal design on wetland change. These results will help describe wetland change following dam removals, as well as identify practices to minimize wetland conversion.

STUDENT	Adrienne Dunk (MS)
ADVISORS	Allison Roy
FUNDING	Society of Wetland Science – New England Chapter
COLLABORATORS	Paul Davis Scott Jackson

Ox Pasture Brook before dam removal (left, 2008) and ten years after dam removal (right, 2019). Aerial imagery is provided by Massachusetts Bureau of Geographic Information Systems (MassGIS)

Evaluating the impacts of road salt at road-stream crossings in the Charles River watershed

Salinization of streams and rivers is a major threat to freshwater ecosystems globally. In New England, the application of road de-icers is one of the main sources of chloride. Data on chloride are typically constrained to grab water samples at limited sites due to costs, which is not adequate to determine impairment or understand factors explaining differences in salinity spatially across streams and temporally across seasons. Moreover, while laboratory studies have determined the toxicity of salt on benthic macroinvertebrates, few studies have evaluated how conductivity impacts stream macroinvertebrate assemblages. Our project objectives are to 1) determine how road crossings alter stream conductivity levels and what factors explain the extent of impact, 2) determine how conductivity varies temporally between seasons and with discharge, and 3) evaluate how conductivity impacts benthic macroinvertebrate assemblages. These data will be used to assess chloride impairment, model the major drivers of conductivity in the watershed, and determine effects of salinization on biotic assemblages. Results will be used to inform road salt application practices to minimize impacts to freshwater ecosystems.

STUDENT	Marielena Lima (MS)
ADVISOR	Allison Roy
FUNDING	USGS WRRC Charles River Watershed Association
COLLABORATORS	Lisa Kumpf Bob Smith

Collecting benthic macroinvertebrates using the kick net sampling method in Muddy River (CRWA)

Habitat selection and fine-scale nesting movement of Blanding's Turtles

Blanding's Turtles (*Emydoidea blandingii*) are a long-lived, semi-aquatic species of conservation concern across much of their range. They rely on wetland complexes and frequently move among different wetlands throughout the active season, with females often undertaking long-distance migrations to reach suitable nesting sites. In order to conserve and manage properly for this species, a specific understanding of how these animals utilize the surrounding landscape is needed for effective conservation planning. The objective of this study is to 1) quantify habitat selection at multiple spatial scales, and 2) characterize fine-scale nesting movement and behaviors. Results from this study will inform management strategies aimed at protecting critical habitat and maintaining movement corridors to support long-term population persistence.

STUDENT	Jesus Rodriguez Riverol (MS)	
ADVISORS	Graziella DiRenzo Allison Roy	
FUNDING	Department of Defense, USFWS	
COLLABORATORS	Kyle Crafts Brian Butler Katherine Ineson	Michael Jones Stephanie Koch Lisabeth Willey

Nesting Blanding's turtle (Jesus Rodriguez Riverol)

Identifying hot spots of automobile and American black bear collisions in Massachusetts

Roads in the United States are one of the most disruptive and destructive anthropogenic land uses for wildlife and are a leading cause of vertebrate mortality. In Massachusetts, the American black bear (*Ursus americanus*) is increasingly finding itself in conflict with human transportation corridors. Due to the species' need for expansive home ranges, bears often traverse roads to access critical habitat patches. Over the past decade, these crossing events have led to the deaths of hundreds of bears in Massachusetts. To reduce these mortality events, a road study will be conducted to determine whether altering road conditions will improve safety for bears. By merging a decade's worth (2013–2023) of bear and automobile collision data with MassDOT GIS shapefiles, road design patterns associated with high numbers of bear strike events will be identified. This analysis is expected to show that specific road design attributes (e.g., presence of lighting, higher speed limits, narrow shoulders, etc.) are directly correlated with elevated auto/bear collisions. Results will inform lighting, signing, fencing, or retrofitting of proximate underpasses toward reducing bear collisions

STUDENT	Matthew Schlaikjer (MS)
ADVISORS	Timothy Randhir Tammy Wilson
COLLABORATORS	MassWildlife MassDOT

Matthew Schlaikjer on a canoe trip.

Mussel stranding in the Wheelwright Dam impoundment drawdown

While dams fragment streams that freshwater mussels inhabit, their removal can negatively impact mussels and their habitat. Dam removal can cause rapid declines in water level in the dam's impoundment (the area upstream of the dam with higher water level and lower flows than the free-flowing river), which can lead to widespread stranding events, whereby mussels are trapped in sediment as the water level declines. We surveyed stranded mussels at the Wheelwright Dam in Hardwick, Massachusetts during a multi-phase drawdown and dam removal. At 30 sites (15 locations with paired left and right bank sites) along a ~5 river km impoundment, we counted mussels and surveyed habitat (e.g., wood, bed texture, bank slope) to understand where and when mussels are most vulnerable to declining water levels. We also deployed trail cameras to monitor an additional three sites for signs of mussel predation. These findings could be beneficial for managers to focus conservation efforts such as mussel relocations in areas with the highest risk of stranding events.

STUDENT	Jacob Sorensen (BS)
ADVISORS	Allison Roy
FUNDING	USFWS C-SWG
COLLABORATORS	Jason Carmignani Alexa Hershberger

Alex Tran (left) and Jacob Sorensen conducting a habitat survey in the impoundment. (Jacob Sorensen)

Using environmental DNA for rare freshwater mussel detection and restoration planning

Brook Floater (*Alasmidonta varicosa*) is a state-endangered freshwater mussel species in Massachusetts, where only four populations remain. Current restoration efforts are focused on propagating and stocking the species, but restoration sites must be carefully identified to avoid causing harm to newly introduced individuals. Traditional survey methods, such as snorkeling, are typically used to identify these sites; however, these methods are time-intensive and limited in spatial scope. It is also difficult to obtain data for rare mussel species due to their restricted and patchy distribution. To overcome these challenges, environmental DNA (eDNA) surveys, which only require water samples, have become a desirable tool for determining species presence and distribution. The goals of this project are to 1) evaluate eDNA as a tool for rare mussel species detection, 2) create a standardized protocol for wadeable streams in Massachusetts, and 3) use eDNA to detect mussels associated with *A. varicosa* at potential restoration sites.

STUDENT	Mickala Stratton (BS)	
ADVISOR	Allison Roy	
FUNDING	UMass CHC, USFWS C-SWG	
COLLABORATORS	Jeremy Andersen Jason Carmignani Stefanie Farrington	James Garner Alexa Hershberger Tim Warren

Mickala collects water samples for a Brook Floater eDNA survey (Allison Roy)

ONGOING RESEARCH PROJECTS

Linking between- and within-host dynamics in mechanistic models of wildlife disease systems while accounting for imperfect detection

A consistent challenge in infectious disease ecology and evolution has been linking within- and between-host dynamics to generate insights otherwise unattainable. For disease systems where host parameters, such as transmission, are tightly connected to processes at the within-host scale such as pathogen reproduction, ignoring these links can lead to erroneous conclusions and misleading inferences. In disease systems, such as chytrid fungi in amphibians, within-host dynamics affect infection intensity, which determines host mortality, recovery, and transmission, and contamination of the environment with spores (infectious stage). Existing models are primarily phenomenological and do not account for imperfect detection of the host and pathogen.

To address this gap in methods, we integrated two existing models, multi-state Cormack-Jolly-Seber model (host model) and generalized stage-structured N-mixture model (pathogen model), which estimate parameters of marked and unmarked populations, respectively. We used the amphibian-chytrid system to showcase our novel embedded multi-scale model (Fig. 1).

The model followed a capture-mark-recapture robust design framework and incorporated a mechanistic description of host-pathogen dynamics, which included the pathogen's two distinct life-stages (spores and sporangia [reproductive stage]). We validated the model using simulated data and evaluated model performance, including accuracy, coverage, precision and bias. We also identified parameter value and study design combinations that yield accurate, precise, and unbiased estimates of host survival and pathogen reproduction, two key demographic parameters. We fitted models using a Bayesian approach and estimated posterior distributions for all parameters with Markov chain Monte Carlo methods implemented in JAGS and RStudio.

We found that our multiscale model recovered host parameters to a greater extent than pathogen parameters, and that estimates were more accurate and precise with greater coverage and lower bias when there was a higher sampling effort (larger number of primary occasions and observed hosts). When performance metrics were considered all together, our model performed best when uninfected host survival was high, and pathogen reproduction was low. Generally, we found that parameters were most optimally estimated when abundance of initial sporangia was lower than spores, host survival, recovery, transmission and spore maturation (into sporangia) were not too high or low, and pathogen reproduction rate was lower than external infection rate.

Although we acknowledge that there are important limitations to our study, our novel framework offers exciting extensions to examine life-history tradeoffs in relevant disease systems and track dynamics of more than one pathogen genotype within the same host-pathogen system. The capacity of our multi-scale embedded model to estimate host parameters while conditioning on pathogen predictor parameters and accounting for observation errors represents a significant advance in the field. Future directions can focus on improving estimation of pathogen parameters and linking between- to within-host dynamics in a reciprocal feedback loop.

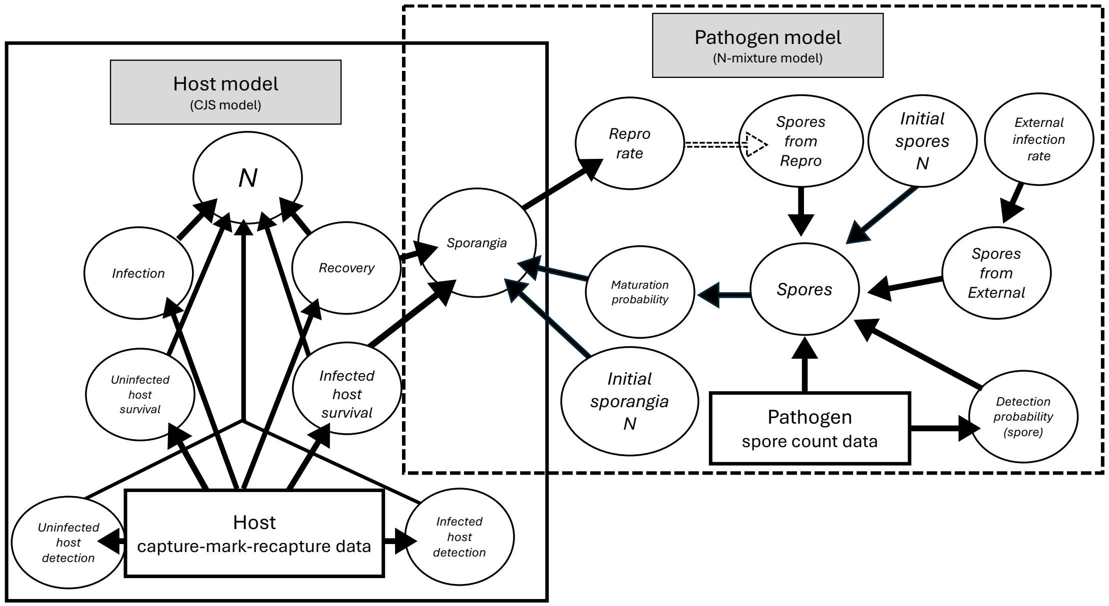


Figure 1. Schematic of the embedded multi-scale model that combines a multi-state Cormack-Jolly-Seber (CJS) and a stage-structured generalized N-mixture model. The observed data that are fed into the embedded model are capture-mark-recapture data for the host and spore counts from infected hosts for the pathogen. Host and pathogen models share the latent state variable of sporangia found on infected hosts in the embedded framework. Parameters not shown include intercepts and slopes that determine infected host survival and recovery, and spore detection on infected hosts. The dashed arrow corresponds to a process that occurs at the next time step.

POST DOC Andreas Eleftheriou
ADVISOR Graziella DiRenzo
FUNDING USGS
COLLABORATORS Evan H.C. Grant
David Miller

Prioritization in freshwater mussel conservation

Faced with the widespread and rapid decline of many freshwater mussel species, natural resource managers must decide how to focus conservation efforts to maximize the benefits of their actions. However, gaps in knowledge about where species are (or are likely to be), has hindered decisions about where to focus land protection efforts. Previous research into drivers of freshwater mussel distribution has identified several factors that influence species occurrence, including broad-scale factors like land cover, dispersal limitations, tidal influence, host fish occurrence, and dam density as well as reach-specific variables like stream discharge, stream bed composition, and shear stress. Species distribution models can build on this knowledge to identify areas of potential species occurrence and facilitate evidence-based decision making in the face of uncertainty.

Our study area encompassed six states in the Northeastern U.S.: Maine, New Hampshire, Vermont, Massachusetts, Connecticut, and Rhode Island. We focused on twelve species of native freshwater mussel. We compiled survey data on each of these species from each state's fish and wildlife agencies and then created individual maximum entropy (MaxEnt) distribution models at the HUC12-scale priority level for each species. Our models included 15 environmental variables and the known presence of a species within the encompassing HUC8 and the presence of host fish when applicable.

We determined the distribution of species richness throughout the study area and then determined HUC12 priority for each of three different conservation actions based on our distribution results and other relevant criteria – HUC12 priority for surveys, population restoration, and land protection.

We found that the percent of catchments predicted to have species occurrence (based on a probability threshold) varied across species, with Eastern elliptio (*Elliptio complanata*) predicted to occur in the greatest percent of available catchments (33.92%) and Dwarf wedgemussel (*Alasmidonta heterodon*) expected in the smallest percent (5.30%). The predicted overall species richness within our modeled catchments ranged from zero to all twelve species, with an average of two species per catchment. We found a strong correlation in predicted distributions across most freshwater mussel species. Although conservation priority HUC12s varied depending on the conservation action of interest, we found some areas of consistent importance including much of Maine and the southern reaches of the Connecticut River (Fig. 1).

Our results document the distribution of native freshwater mussels in the Northeastern U.S. and provide guidance to managers on prioritizing catchments for a variety of different conservation-related actions. Although there has been considerable effort invested in spatial conservation prioritization based on large numbers of species and extensive landscapes, this effort adds to the smaller body of work focused on conservation prioritization for a limited number of species in a smaller spatial extent that can provide more targeted conservation guidance. Additionally, we simultaneously considered several different conservation actions rather than focusing on one action alone, which is a strategy that has been applied in other species to support holistic guides for managers.

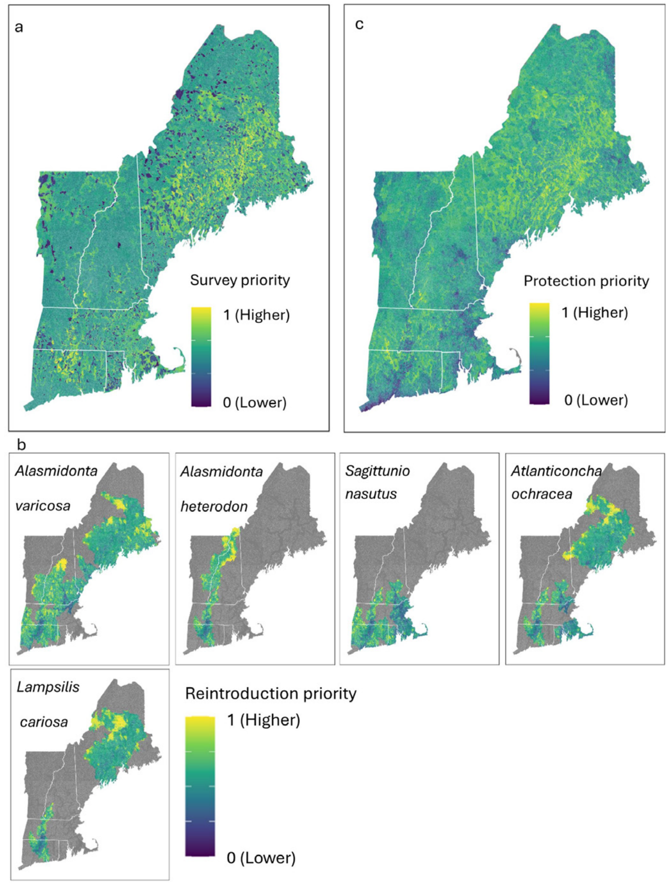


Figure 1. Priority scores for (a) surveys, (b) land protection, and (c) population restoration. Survey and protection priority were assessed for all species together, while we assessed population restoration priority individually for species that were considered high or very high Regional Species of Greatest Conservation Need (RSGCN) priority.

Freshwater mussels collected from the Connecticut River (Stefanie Farrington)

POST DOC: Becca O'Brien

ADVISOR: Graziella DiRenzo, Allison Roy

FUNDING: NE CASC, MassWildlife (Resilient Mass)

COLLABORATORS

Jason Carmignani
Melissa Winters
Michelle Graziosi
Corey Pelletier
Rebecca Quiñones
Laura Saucier
Beth Swartz

Illegally traded wildlife repatriations: Incorporating uncertainties to assess impacts on vulnerable populations

The illegal wildlife trade is a threat to species across the globe, but decisions to repatriate confiscated animals are complicated by uncertainty (and the associated risks) of introducing incompatible genetics or infectious disease into existing populations. Specifically, many freshwater turtle populations in the United States are particularly vulnerable to harvest-driven declines. Turtles are especially common in the illegal trade, and confiscations are increasing in frequency. To support repatriation decisions, we need to quantitatively estimate the impacts of disease and genetic risks.

Using wood turtles (*Glyptemys insculpta*) as a case study, we created tunable population matrices to model turtle population outcomes across a range of repatriation scenarios. For each scenario, we ran 200 simulations, drawing matrix parameter values from probability distributions to account for disease, genetic, and demographic uncertainty. We used the matrices to project wild population size over a 20-year period, and assessed outcomes given different probabilities (0, 0.1, 0.5, 1) of infection or incompatible genetics in confiscated turtles.

For each scenario, we plotted the mass density distribution of population growth rate (λ) values from 200 simulations. To compare repatriation decisions, we calculated the percent overlap in λ distributions and the area under the mass density curve where λ is greater than 1.0 ($AUC_{\lambda>1}$). Larger $AUC_{\lambda>1}$ values represent scenarios that are more likely to lead to a growing population.

POST DOC	Isabella Ragonese
ADVISOR	Graziella DiRenzo
FUNDING	USGS, USFWS
COLLABORATORS	Evan H.C. Grant

We found that small-scale repatriations (e.g., 1-10 confiscated turtles) do not pose a large risk to wild populations. Across probabilities of infection or incompatible genetics, simulated λ values for populations with released turtles had high overlap with baseline population growth rates.

The most notable differences in λ distributions arose when the ratio of confiscation size to recipient wild population size was highest (100 turtles released into a wild population with 100 adults). In this case, the benefit of repatriation decreased as probability of infection increased (Fig. 1). In contrast, even when all confiscated turtles had incompatible genetics, repatriation of 100 adults always benefitted a mid-sized recipient population.

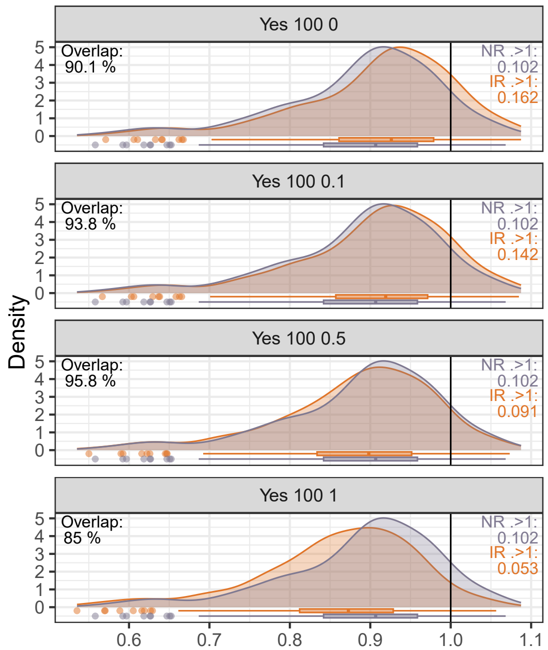


Figure 1. Distributions of λ values for the baseline population with 100 adults ("no release" NR; gray) overlaid with λ distributions for the population when 100 confiscated adult turtles are immediately released (IR; orange) given 0 (a), 0.1 (b), 0.5 (c), or 1 (d) probability of infection. The vertical solid line represents λ equal to 1, where values to the right suggest population growth and values to the left suggest population decline. Percent overlap of the two distributions is in the top left and AUC when λ > 1.0 is shown in the top right. Boxplots beneath distributions depict the median and range of simulated λ values.

The focused sensitivity analyses indicated that, under most scenarios, the net benefit of repatriation is not limited by uncertainty in infection-induced reductions in survival, disease transmission probability, or genetics-induced reductions in survival and fecundity.

For decision makers, pathogen testing is most valuable when the confiscation size is large relative to the recipient population size, when risk depends on the epidemiological parameters (Fig. 2). Genetic testing is unnecessary except in situations when the decision maker is very risk-averse.

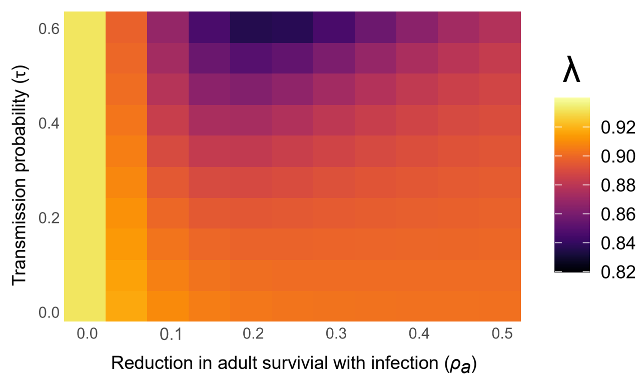


Figure 2. Sensitivity of population growth rate (λ) to parameters of interest in the scenario: 100 confiscated adults with infection released into a recipient population with 100 adults (probability of infection = 1.0). The reduction in adult survival probability (ρa) was covaried with annual transmission probability (τ). Assuming frequency-dependent transmission, population growth rate is most sensitive to infectious disease introduction when transmission probability is high and when infection causes moderate reductions in adult survival probability.

The impacts of climate change and land use on freshwater fishes and mussels in the northeastern United States

Many species of freshwater fishes and mussels have experienced population declines over the past century, which, combined with projected climate and land use change, make it challenging to identify the drivers of species vulnerability. Management actions may offset climate-related changes to biodiversity, but identifying those key drivers is important to ensure that resources are focused appropriately. In this study, we explored the distributions of different freshwater fish and mussel guilds and projected the distributions of each using climate and land use change scenarios.

This study focused on rivers and streams in Maine, New Hampshire, Vermont, Massachusetts, Connecticut, and Rhode Island. Fish and mussel species occurrence data were compiled from state agencies. We developed species specific models to predict the probability of occurrence using climate, geographic, or land use data and used these models to predict the occurrence of each species throughout the region. Then we attributed all the fish and mussel species for different groupings (e.g., habitat guilds, origin, empirically derived streamflow clusters) and assessed the probability of occurrence by group. We compared the regional distribution of the groups and identified the relationships that each species and group had with land use or climate influenced variables.

We then applied the species specific models to projected end-of-century (year 2100) stream temperature and streamflow scenarios plus a series of management scenarios combined with climate change. Results from the species-specific fish models support existing work that suggests mean summer stream temperatures, impervious land cover, and dam density are negatively related to coldwater fishes. Brook Trout alone had a negative relationship with winter flood frequency (predicted to increase in future years), suggesting this species is particularly vulnerable to climate change.

Brook Trout specific management may not be sufficient to support other coldwater species because they do not geographically correlate with all coldwater species. Similarly, because habitat guilds did not clearly relate to streamflow clusters, this work identified a novel way to group species for management concerned with future changes to streamflow.

We predict that climate change will negatively impact coldwater fishes (Fig 1), lotic mussels, host specialist mussels, drying intolerant mussels, and RSGCN listed mussels. There are also possible negative impacts to coolwater fishes and fluvial specialist fishes due to disproportionate positive impacts to macrohabitat generalist species. Additionally, low elevation mussel species richness is projected to decrease by an average of two mussel species per watershed.

The combined and the forest management scenarios had the largest potential to restore habitat suitability for coldwater and fluvial specialist fish (Fig 1) and for lotic, drying intolerant, and RSGCN listed mussel species, and mussel species richness; however, in many cases these management actions did not offset climate change entirely. This work showed that forest cover at the watershed scale can partially offset the impacts of climate change on freshwater fishes and mussels. This suggests that watershed wide forest conservation or restoration (in areas that were historically forested) can benefit stream habitat, and may open up new collaborations.

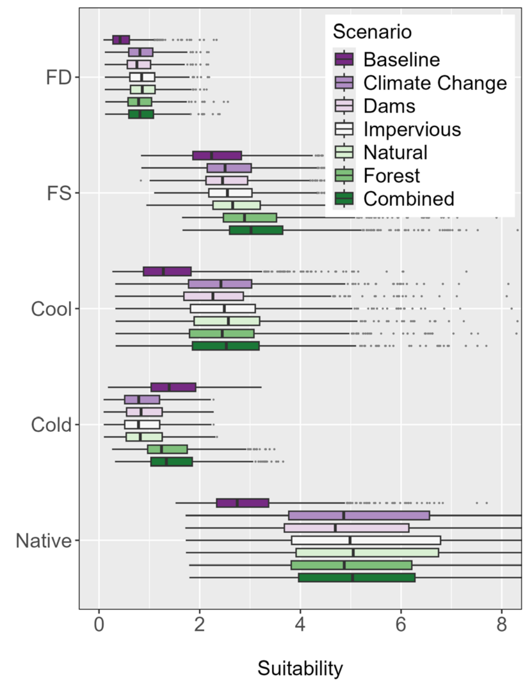


Figure 1. Scenarios include 1) removal of all dams (dams), 2) removal of all impervious surfaces in the 100-m riparian area in the watershed (impervious), 3) 100% natural land in the riparian area (natural), 4) 100% watershed forest (forest), and 5) all individual management scenarios (combined). Projected suitability (summed probabilities of occurrence by group) for five freshwater fish biodiversity groups and each scenario. FD = Fluvial dependent, FS = fluvial specialist, MG = Macrohabitat generalist.

POST DOC Jenny Rogers

ADVISORS Graziella DiRenzo
Allison Roy

FUNDING NE CASC, MassWildlife (Resilient Mass)

COLLABORATORS
Chris Bellucci
Courtney Buckley
Jason Carmignani
Matt Carpenter
Andrew Chapman
James Deshler
Melissa Winters
Merry Gallagher
Michelle Graziosi
Alan Libby
Jerrod Parker
Corey Pelletier
Rebecca Quiñones
Todd Richards
Laura Saucier
Jason Stolarski
Beth Swartz

Climate and habitat shape density-dependent parasitism at species' range edges

Moose (*Alces alces*) populations have declined by at least 30% in the Northeastern U.S. over the past couple of decades. Winter tick (*Dermacentor albipictus*) infestations increase calf mortality and reduce reproductive output, making tick parasitism a major driver of this decline. Concern has risen amongst natural resource agencies charged with maintaining viable moose populations, spurring research initiatives throughout the northeast. As ectotherms, winter ticks benefit from milder winters and abundant moose populations. Paradoxically, parasitism rates are hypothesized to be reduced along the southernmost part of moose range – a region where low-density moose populations have expanded in recent decades. Our objectives were to understand the regional drivers of tick abundance on moose in New England.

We used winter tick count data obtained from harvested moose in Maine, New Hampshire, and Vermont to identify 1) the latitudinal and environmental drivers of tick abundance, 2) the extent to which climate and resource availability influences winter tick parasitism on moose, and 3) evidence for broad scale density-dependent dynamics. We hypothesized that climate and weather conditions would influence annual patterns of winter tick abundance, and that moose density would explain underlying spatial patterns of tick abundance.

We counted ticks on 4,084 moose (Maine = 2,787, New Hampshire = 730, Vermont = 567) harvested in 576 towns from 2006–2023. The median number of moose harvested each year was 220 (mean = 227, standard deviation = 91, range = 63–384). There were a higher number of adult bulls harvested (n = 2,885) compared to adult cows (n = 1,089) and calves (n = 110).

Tick abundance on harvested moose was highest at mid-latitudes and positively correlated with moose density and optimal moose habitat (Fig. 1). Lower tick abundance and moose density were associated with older-aged mixed wood forests along the southernmost edge of moose range. Variation in tick abundance between years was associated with drought and excessive moisture during the summer and early questing period when ticks are not on moose and therefore exposed to environmental conditions (Fig. 2). Our findings suggest that bottom-up processes can affect parasite-host interactions and that a more careful examination of non-climate factors may better inform management decisions for range-edge populations.

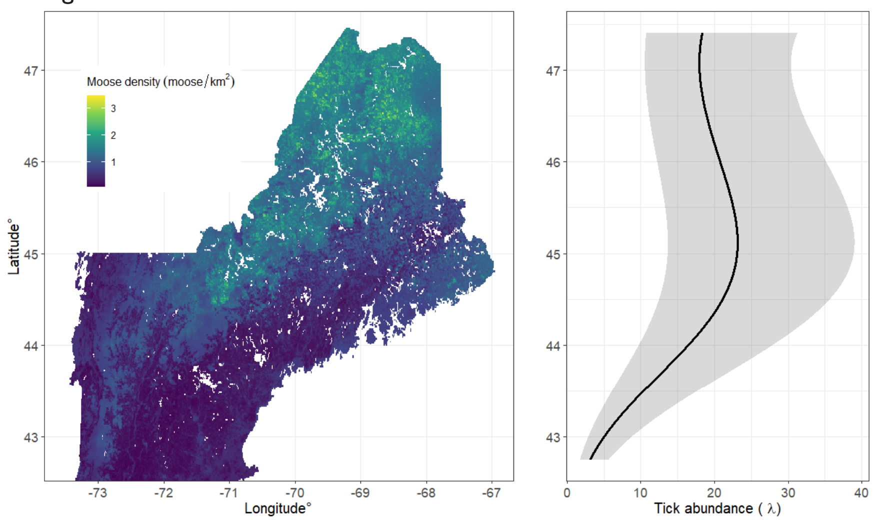


Figure 1. The effect of latitude (third-order polynomial) on larval tick abundance counted on harvested moose from 2006–2023 in Vermont (west), New Hampshire (central), and Maine (east), USA.

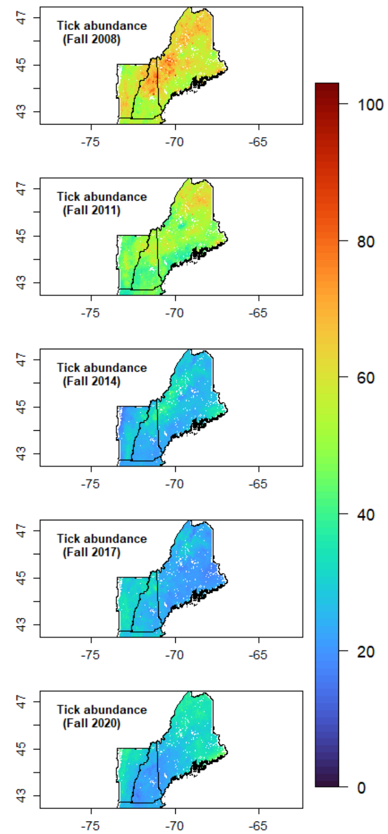


Figure 2. Subset of predicted annual (2006–2023) larval winter tick abundance on harvested moose in Vermont (west), New Hampshire (central), and Maine (east) based on the top environmental model.

POST DOC	Alexej Siren
ADVISOR	Tammy Wilson
FUNDING	Maine Department of Inland Fisheries and Wildlife, NH Fish and Game Department, University of New Hampshire, Vermont Department of Fish and Wildlife, USGS

COLLABORATORS

Chris A. Bernier
Catherine B. Callahan
Rachel M. Cliché
Kyle Dunfey-Ball
Bryn E. Evans
Nicholas Fortin
Katherina D. Gieder
Henry F. Jones
Jillian R. Kilborn
Toni Lyn Morelli
Alessio Mortelliti
Leighlan S. Prout
Tony Smith
Susan Staats
Scott Wixsom

Examining host fishes, habitats, and range-wide status of the Yellow Lampmussel (*Lampsilis cariosa*)

The freshwater mussel Yellow Lampmussel (*Lampsilis cariosa*) is declining throughout its range along the Atlantic Slope of the eastern US and Canada, and the species is a target for proactive conservation to avoid federal listing. This research sought to better understand this species' host fishes and habitat use through (1) a comprehensive literature review on the species, (2) evaluation of Striped Bass (*Morone saxatilis*) as a host fish using laboratory trials and naturally-infected fish, (3) assessment of host fish use across geographies, and (4) predicting species distribution and habitat use in the Connecticut River.

We outlined 16 emergent research and conservation management needs based on literature review and discussion with stakeholders (state and federal mussel biologists, researchers, and tribal groups). These needs range from research on the basic physiology and behavior of the species, to creating standardized protocols for surveys and DNA sampling, to ultimately developing a range-wide species conservation and restoration plan.

Striped Bass is an anadromous species that co-occurs with Yellow Lampmussel during the reproductive season and is a close relative to a known host, White Perch, suggesting it might be a suitable host fish for this mussel. To evaluate Striped Bass as a host for Yellow Lampmussel, we 1) confirmed the ability of juvenile mussels to successfully metamorphose in laboratory experiments and 2) described the use of Striped Bass by mussels in native environments by extracting glochidia from wild-caught fish. For objective 1, we inoculated 205 Striped Bass with glochidia from three female Yellow Lampmussel, and counted juveniles produced over four weeks. In total, 282 juveniles were produced using Striped Bass, confirming successful metamorphosis. For objective 2, we collected glochidia from the gills of 15 Striped Bass in the Connecticut River watershed, and two of ten glochidia collected were confirmed as Yellow Lampmussel. Our results suggest that Striped Bass may play a critical role in long-distance dispersal Yellow Lampmussel within and across drainages, which has important implications for conservation and management of both species.

While Yellow Lampmussel occur in a variety of habitats across geographies, there is limited data characterizing the reach-scale habitats where they reside in large rivers, such as the Connecticut River. We used side-scan sonar and spatial analysis tools to map and characterize habitat types (bed texture, depth, distance from banks, and large wood) within a 160 km stretch of the Connecticut River where Yellow Lampmussel has been documented (Haddam, CT to Northfield, MA). In addition to compiling 60 mussel occurrences from state databases, we performed visual-tactile surveys at 40 stratified-random sites. Using a binomial generalized linear model, we predicted high probabilities of Yellow Lampmussel presence in two distinct habitat schemes: 1) sandy, shallow (0-2 m) areas near banks and islands (<50 m), and; 2) non-sandy areas further from banks (25-125 m) at shallow-intermediate depths (0-4 m) (Fig. 1). The mapped habitat features, Yellow Lampmussel occurrences, and predicted occurrences of Yellow Lampmussel may be a valuable tool in planning Yellow Lampmussel conservation and restoration activities such as long-term monitoring and translocation.

Gravid Yellow Lampmussel displaying its mantle lure (Stefanie Farrington)

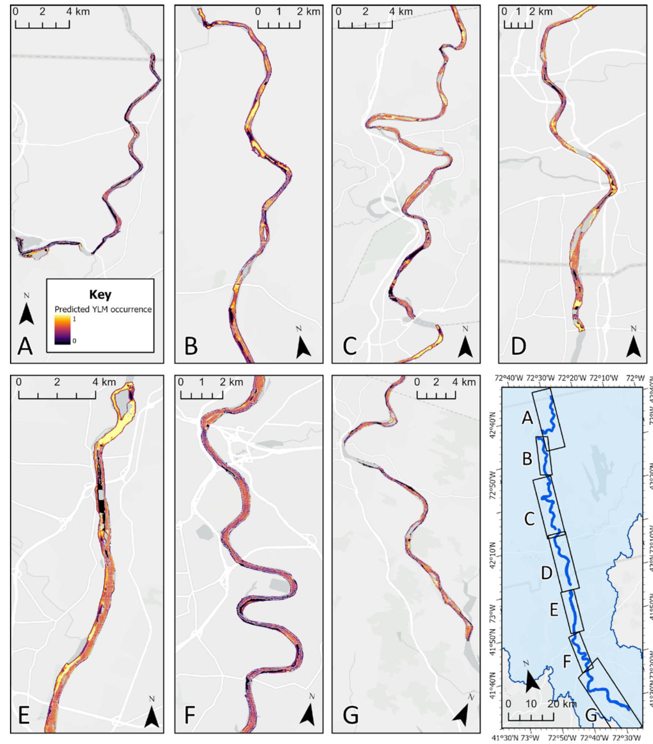


Figure 1. Maps of predicted Yellow Lampmussel (*Lampsilis cariosa*) occurrence. Dark purple corresponds to predicted absence; light yellow corresponds to predicted presence.

STUDENT Stefanie Farrington (PhD)

ADVISOR Allison Roy

FUNDING USGS SSP, USFWS Pathways

COLLABORATORS

Jeremy Andersen
Jason Carmignani
Graziella DiRenzo
John Gibbons
Christina Murphy
David Perkins
Laura Saucier
Timothy Warren
Yellow Lampmussel Working Group

Linking juvenile river herring growth, diets and habitat use in freshwater and estuarine environments

Alewife (*Alosa pseudoharengus*) and blueback herring (*A. aestivalis*) populations, collectively “river herring”, have declined drastically over the last century due to overfishing, habitat degradation and impediments to migration. River herring provide critical ecosystem services in coastal watersheds, serving as forage for a wide variety of predators and as a link between marine and freshwater environments where adults import marine nutrients into freshwater lakes and their offspring export nutrients from freshwater back into the ocean. This research focused on habitat use, diets and growth rates of juvenile river herring within freshwater lake habitats and after they migrate from freshwater to estuarine habitats. The objectives of this study were to 1) characterize differences in growth rates between lake resident and associated downstream river and estuary resident juvenile river herring over three summers, and 2) investigate the differences in juvenile river herring diets and prey selectivity in littoral and pelagic lake habitats over time.

To assess the influence of estuarine access on growth, we analyzed sagittal otoliths from 1,791 juvenile river herring collected across seven lake, river, and estuary sites in three coastal Massachusetts watersheds. Results indicated that access to downstream estuarine habitats was associated with enhanced juvenile growth rates, particularly in systems with high in-lake densities and unimpeded connectivity (e.g., Weymouth Back River watershed; Fig. 1C). In contrast, growth bottlenecks were observed in high-density systems with restricted passage (e.g., Mystic River watershed; Fig. 1A), where emigrating juveniles occupied shallow, eutrophic river reaches. Growth rates were similar between lake and estuarine habitats in low-density systems (e.g., Essex River watershed; Fig. 1B). These findings underscore the importance of maintaining connectivity between freshwater and estuarine habitats and addressing density-dependent growth constraints to support juvenile production and inform river herring restoration strategies.

To investigate the differences in juvenile river herring diets between fish occupying littoral and pelagic lake habitats, we examined gut contents from 358 juvenile river herring across four sites from July through October 2023, where a total of 39 unique prey taxa were identified across 13 orders. In August 2023, the only month when all four sites were sampled, the differences in diet composition between fish collected from littoral and pelagic habitats were most pronounced in the high-density sites (Great Herring Pond and Upper Mystic Lake), while diets were relatively similar between habitat types in the low-density sites (Chebacco Lake and Whitmans Pond).

These findings support the ecological importance of littoral habitats in lakes and the value of preserving habitat complexity and connectivity across freshwater and estuarine nursery environments. Moreover, this research provides novel insights into the mechanisms driving juvenile river herring production and offers practical guidance for protecting access to quality nursery habitats that will maximize juvenile river herring growth and survival.

STUDENT	Julian Burgoff (MS)
ADVISOR	Allison Roy
FUNDING	TNC, Woods Hole Sea Grant, MDMF

COLLABORATORS

Mike Armstrong	Kevin Job
Mike Burgess	Gary Nelson
Brad Chase	John Sheppard
Corey Eddy	Ken Sprankle
Ben Gahagan	Jason Stolarski
Joe Holbeche	

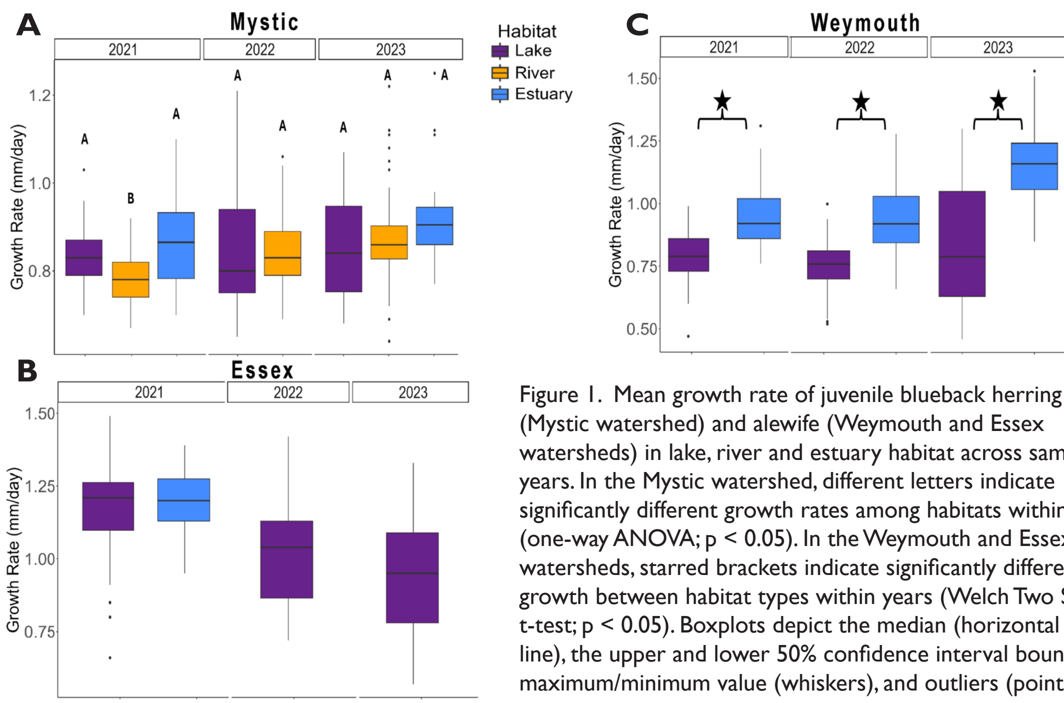


Figure 1. Mean growth rate of juvenile blueback herring (Mystic watershed) and alewife (Weymouth and Essex watersheds) in lake, river and estuary habitat across sampling years. In the Mystic watershed, different letters indicate significantly different growth rates among habitats within years (one-way ANOVA; $p < 0.05$). In the Weymouth and Essex watersheds, starred brackets indicate significantly different growth between habitat types within years (Welch Two Sample t-test; $p < 0.05$). Boxplots depict the median (horizontal black line), the upper and lower 50% confidence interval bounds, the maximum/minimum value (whiskers), and outliers (points).

Habitat use of black bear, moose, and gray fox in a human-dominated landscape of western Massachusetts

Human development and landscape fragmentation continue to shape wildlife habitat use, influencing species distributions and movement patterns. Studying how the human environment influences animal distribution at multiple scales can improve our understanding of human-animal interactions. We used a 60-camera array deployed in a multiscale design to evaluate how the built environment influenced the distribution of three species: black bear (*Ursus americanus*), gray fox (*Urocyon cinereoargenteus*), and moose (*Alces alces*) at three grid sizes (2X2 km, 4x4 km, and 8x8 km).

We found that modeled relationships between animal presence and covariates representing human influence (e.g., roads, development) were sensitive to the grid size. moose and gray fox models had highest predictive performance at the 4X4 km grid size, while bears were ubiquitous and not well modeled at any scale. Our results suggest that black bears and moose were less likely to occur in areas with high road density and human infrastructure, while gray foxes exhibited greater adaptability to human-modified landscapes.

Connor Morrow captured on a trail cam

STUDENT	Connor Morrow (MS)
ADVISOR	Tammy Wilson
FUNDING	MassWildlife
COLLABORATORS	Kelly Klingler

Trail camera images from top to bottom: collard black bear and cub, moose, and grey fox kits

Cascading conservation: Assessing repeated spawning migrations and freshwater mussel host potential of Blueback Herring

Anadromous blueback herring (*Alosa aestivalis*) interact with numerous species during their spring migrations from the Atlantic Ocean to their natal freshwater systems to spawn. As such, the drastic declines in blueback herring populations and altered population dynamics over the last centuries may be affecting not only the stability of blueback herring, but also other species they interact with, including freshwater mussels. To effectively evaluate the impacts of blueback herring population changes on freshwater mussels, demographic assessments of blueback herring data, such as number of spawning events, and a robust understanding of blueback herring as hosts for mussels is required. Therefore, the objectives of this research were to 1) evaluate the quality of spawning history data through identified precision and bias metrics, and 2) investigate the prevalence and intensity of different mussel larvae infections found on blueback herring within the lower Connecticut River watershed.

For the quality assessment of spawning history data, we calculated the precision and bias between paired spawning mark estimates of 8,698 blueback herring collected by the USFWS Connecticut River Fish and Wildlife Conservation Office over the past decade. Systematic (non-random) bias was found in 70% of years by the Bowker's test of symmetry, and 30% showed coefficient of variation (CV) values >10% threshold indicating imprecision. Bias was absent and precision was highest in most recent years where new training requirements and reference collections were incorporated. These findings support future improvements to spawning mark estimation through implementing standardized precision thresholds and uniform trainings.

STUDENT Jackie Stephens (MS)

ADVISORS Allison Roy
Adrian Jordaan

FUNDING USFWS CARC, USFWS Connecticut River FWCO

COLLABORATORS

Jeremy Andersen
David Perkins
Artemis Roehrig
Ken Sprankle
Timothy Warren

To investigate the host potential of blueback herring, the frontmost gills of 1,011 fish from the 2023 USFWS survey were examined for mussel larvae (glochidia). In total, we observed 18,738 glochidia from seven distinct morphotypes and an overall 64% infection prevalence (i.e. # infected fish / # total fish examined). Through a combination of morphometric and genetic analyses, 4 genera were positively identified, with one morphotype recognized as a new species to the watershed (*Utterbackia imbecillis,* paper pondshell). Glochidia infections were then evaluated by location and time, which displayed differences in the infection prevalence and intensity for each morphotype (Figure 1).

Water temperature had a significant effect on glochidia infection prevalence, with infection prevalence peaking at 14.2 °C for alewife floater (*U. implicata*) and 18.8 °C for eastern elliptio (*Elliptio complanata*). For *U. implicata*, higher infection prevalence was related to higher densities of blueback herring, highlighting the linkage between these two species. Maximum infection intensities were predicted for smaller fish that were female and virgin spawners, which may be primarily explained by temporal patterns in migrating blueback herring and correspondence to glochidia release by mussels. While further research is necessary to continue unveiling details of this species interaction, the host potential for freshwater mussels within the Connecticut River is an additional ecological service blueback herring provide during their spring spawning migrations.

Together, the results of both project components highlight the value of understanding and monitoring organisms with unique, coupled life cycles toward developing effective, comprehensive conservation strategies.

Fig 1. Total count of the four glochidia morphologies observed on blueback herring at five sample sites (colored bars) over the 2023 sample season. The panels from top to bottom are (A) combined *Utterbackia imbecillis* and *Pyganodon species* (n = 45), (B) *Utterbackiana implicata* (n = 1419), (C) assumed *Elliptio complanata* (n = 17152), (D) assumed *Elliptio* species (n = 119). Note the differences in vertical axis scales among the four panels.

Exploring the potential disease and genetic risks in wildlife translocations focusing on long-lived species in the United States

Conservation translocations are the deliberate movement of organisms to restore or bolster populations, and they have become essential tools for managing threatened and endangered species. However, these efforts pose significant challenges, particularly for long-lived species, such as chelonians, with delayed sexual maturity, low reproductive output, and dependence on high adult survival. Population-level impacts of genetic losses or disease can take decades to observe in such species.

We conducted a narrative review of peer-reviewed articles, agency reports, and grey literature between 1971 and 2023 to examine the challenges and risks associated with conservation translocations. We identified key organizations involved in translocations and tools commonly used, then explored genetic and disease risks using case studies from long-lived species, particularly chelonians (turtles and tortoises).

For genetic risk, we identified five key genetic factors requiring careful consideration: outbreeding depression, inbreeding depression, heterozygosity, genetic diversity, and hybridization. Case studies of bog turtles (*Glyptemys muhlenbergii*) demonstrated that captive breeding programs can successfully maintain genetic diversity, with one program achieving 84% annual survival and higher gene diversity than any individual source population.

Traffickers targeted several species of turtles included the spotted turtle. (USFWS)

A spotted turtle confiscated by law enforcement is released back to the wild in Virginia. (Meghan Marchetti/Virginia Department of Wildlife Resources)

For disease risks, we found that translocation can disrupt existing pathogen transmission dynamics, potentially triggering outbreaks. The gopher tortoise (*Gopherus polyphemus*) case study illustrated the challenges of Upper Respiratory Tract Disease (URTD), though most translocated individuals (76%) showed no clinical signs of illness.

Despite challenges, translocations have been instrumental in the recovery of 30% of delisted taxa in the U.S. Key integrative principles emerged: early veterinary and genetic specialist involvement is crucial; translocation decisions involve trade-offs between maximizing genetic diversity and minimizing disease risk; and the life history traits of long-lived species may benefit from sustained, multi-decadal coordination. Collaborative initiatives, well-informed decision-making, and adaptable strategies can shape wildlife translocation outcomes and ensure the resilience of biodiversity.

STUDENT	Ednita Tavarez-Jimenez (MS)
ADVISOR	Graziella DiRenzo
FUNDING	USGS Ecosystems Mission Area
COLLABORATORS	Evan H.C. Grant Molly C. Bletz

Evaluating factors contributing to common loon egg hatching success in the Quabbin Reservoir

The common loon (*Gavia immer*) is an aquatic bird recognized as an indicator species for environmental health. Loons are water-dependent and only come to shore to breed and nest. In Massachusetts (MA), they come from late May to early July to breed, and one prime location is the Quabbin Reservoir. While their populations are stable globally, they are currently considered a species of special concern in MA.

The primary objectives of this study were to (1) evaluate the differences in hatching success among different loon nest types (scrape, bowl, and raft), (2) understand whether egg failure types (predation, intruding loons, flooding, nest abandonment) differ among nest type, (3) evaluate how interannual differences in temperature and water levels during nesting affect hatching success, and (4) identify if there is a relationship between loon nest failure and territory in the Quabbin Reservoir.

The MA DCR has monitored common loons nesting in the Quabbin Reservoir from April through September since 1996. We analyzed observational data DCR collected annually from 2009–2022 during breeding season. Environmental data was compiled to assess the potential impacts of temperature and reservoir water level changes during the breeding season.

Our data supports rafts as a conservation solution in the Quabbin Reservoir as they have the highest hatching successes compared to other nest locations (shore, island) (Fig 1). The hatching success between bowls and scrapes was not different, and may have been due to the low sample size of scrapes. In the Quabbin Reservoir, the most prevalent known cause of hatching failure during the study period was predation. To better understand causes of failure, cameras could be set up near the nests to record how the eggs are being affected.

From 2009–2022, temperature did not have a significant effect on hatching success; however, interannual hatching success did vary during this time period. A possible explanation for the lack of effect could be nests having enough shade cover from canopies (on rafts) or surrounding vegetation, thereby mediatingthe effects of hot temperatures. It is also possible that the temperature during this period was not sufficiently high to affect loon behavior. Changes in reservoir elevation did not significantly negatively impact nests during this time period. However, there are recorded observations of flooded nests, which suggested that the distance of the nest from the water should be analyzed in the future. We identified that the most successful territories for hatching are in the northern region in the Quabbin Reservoir (Fig 2).
One future management solution may be to deploy rafts in areas where nesting and hatching failures occur. This adaptive management action may become more important as climate change increasingly impacts migratory bird populations.

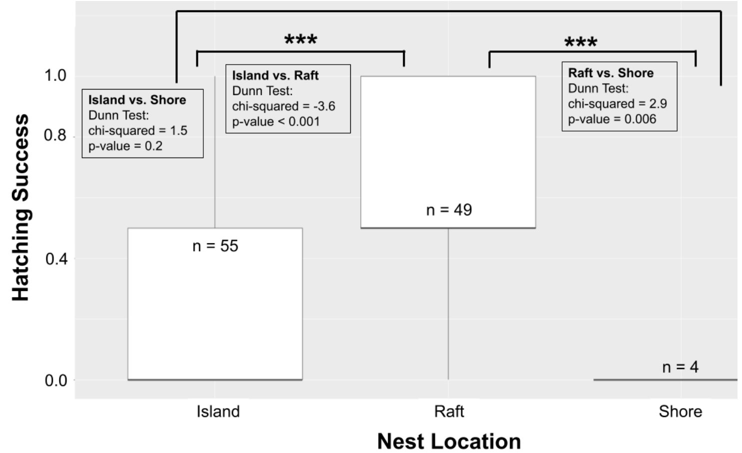


Figure 1: Comparison of loon hatching success between nest locations (Chi-square test: chi-squared = 17.8, p- value <0.001).

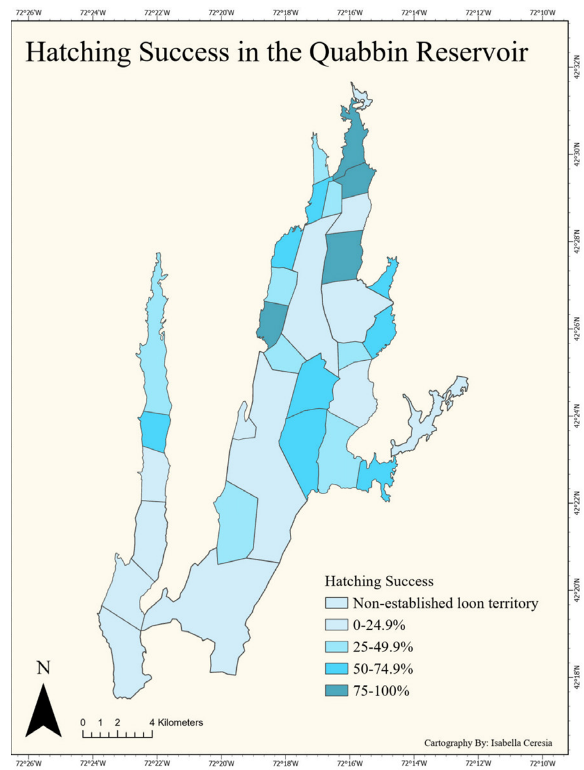


Figure 2: Map of Quabbin Reservoir hatching success by territories (2009 – 2022).

Common loon with chicks (Dale Monette)

STUDENT	Isabella Ceresia (BS, Honors)
ADVISOR	Allison Roy
FUNDING	UMass CHC
COLLABORATORS	Jillian Whitney Alexa Hershberger

Using morphometrics to identify freshwater mussel glochidia on host fishes

Freshwater mussels provide several ecosystem services that are critical for maintaining healthy aquatic ecosystems; however, many species are experiencing population declines. Since mussels require a host fish to complete their life cycle, their reproductive success and distribution is dependent on suitable host fishes. Prior research has primarily focused on successful metamorphosis in lab conditions to identify host species; however, lab propagation does not confirm suitability of fish as hosts in natural settings. Assessing mussel glochidia on host fishes collected in the wild can increase understanding of host fish use by freshwater mussels.

This study used morphometrics to identify species of freshwater mussel larvae (glochidia) found on 12 freshwater fish species collected from lakes and rivers in four U.S. states along the Atlantic Slope (Fig 1). The objectives of this study were to 1) describe and identify glochidia based on shell morphology, 2) determine host fish species for freshwater mussel taxa in natural environments across the study sites, and 3) assess whether host species differ between the Northeast and the Southeast sites.

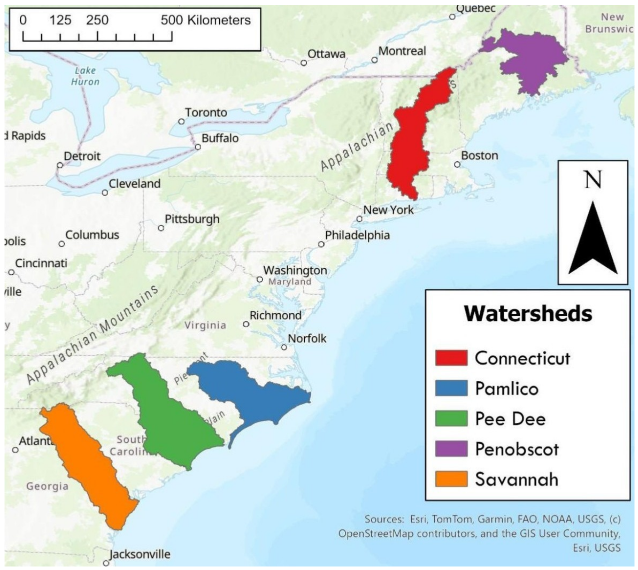


Figure 1: Five major watersheds included in the study (HUC 6).

Fishes were collected in late spring and summer 2023 and 2024, with gills and fins preserved in 95% ethanol (Fig 2). Glochidia were extracted from fishes, photographed using a compound microscope and camera, and analyzed with SPOT imaging software. Measurements of shell length, height, and hinge length were taken, along with documentation of shell shape, color, and hooks.

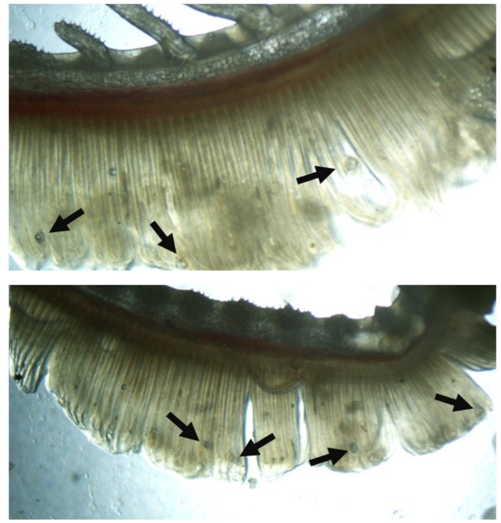


Figure 2: Image of gills with glochidia on them (Stefanie Farrington).

Eight glochidia morphologies were classified, and three were assigned to likely mussel genera based on visual comparisons with existing glochidia morphology studies (Fig 3). The shape classified as elliptical was identified to the genus *Lampsilis*, d to the genus *Elliptio*, and triangular to the genus *Alasmidonta*. A Principal Components Analysis based on the three shell measurements was used to further refine these preliminary identifications and make comparisons between Northeast and Southeast samples. These identifications will be confirmed using genetic analysis in future studies. Understanding host fish dynamics will aid managers in assessing the potential distribution and population viability of freshwater mussels in order to establish conservation strategies such as reintroduction efforts.

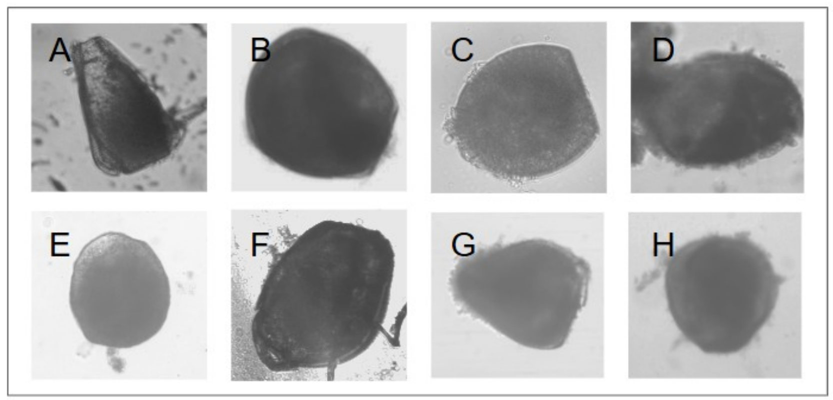


Figure 3: Examples of the eight glochidia morphologies found: A) axe-head, B) elliptical, C) d-shaped, D) bean, E) round, F) shovel, G) triangular, and H) oval

STUDENT Kayla Pacheco (BS, Honors)
ADVISOR Allison Roy
FUNDING USFWS, USGS SSP
COLLABORATORS Stefanie Farrington
Jacqueline Stephens

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MASSACHUSETTS BOBCAT (GILLIAN KRUSKALL)

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Agosto, A., J. Burgoff, A. Roy, and A. Jordaan. 2024. Interannual comparison of juvenile alewife age and growth in eastern Massachusetts (USA). Society for Freshwater Science Annual Meeting, 2-6 June 2024, Philadelphia, PA. (poster)

Baker, M., A. Roy, and P. Hazelton. 2025. Quantifying the bias associated with spatial vs temporal replication in single season occupancy models: an application for rare freshwater mussels. Georgia Chapter of the American Fisheries Society 2025 Annual Meeting, 28-30 January 2025, Augusta, GA.

Baker, M., J. Carmignani, B. Irwin, A. Roy, C. Rushing, S. Sterrett, B. Swartz, and P. Hazelton. 2024. An application of capture-recapture methods for long term monitoring of freshwater mussel populations. Georgia Chapter of the American Fisheries Society, 13-15 February 2024, LaGrange, GA.

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Baynes, A.Y., J.H. Fair, B.H. Letcher, J.H. Pilchik, and A.H. Roy. 2026. Characterizing spatial and temporal variability in coldwater patches to improve understanding of coldwater refugia. Geological Society of America Northeast Section Conference, 21-24 March 2026, Hartford, CT.

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Berube, J., A.P.K. Sirén, B. Simpson, K.B. Klingler, and T.L. Wilson. 2024. Moose'n around with ticks in New England. Northeast Association of Fish and Wildlife Agencies annual conference. 24 April 2024. Hyannis, MA.

Ghost Pipes, a parasitic plant in spring (Elsa Cousins)

Burgoff, J., A. Roy, and A. Jordaan. 2024. Comparing juvenile river herring growth and density in freshwater lakes and associated estuaries. Northeast Fish and Wildlife Conference, 21-24 April 2024, Hyannis, MA.

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DiRenzo, G. V.. 2024. The U.S. Geological Survey: Home to over 1,400 Biologists?!? Society for the Advancement of Chicanos and Native Americans. 30-31 October 2024, Phoenix, AZ.

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Hatzis, J., A. Hershberger, and A. Roy. 2024. Run-of-river dam impacts on water quality and freshwater mussels in Massachusetts. Society for Freshwater Science Annual Meeting, 2-6 June 2024, Philadelphia, PA. (poster)

He, X., K. Andreadis, C. Butler, A. Kumar, and A.H. Roy. 2024. Estimating 40-year daily lake ice cover under the climate change for northern temperate lakes. Northeast Aquatic Biologists Conference, 14-16 February 2024, Fairlee, VT. (poster)

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Hershberger, A., A. Roy, J. Carmignani, P. Hazelton, A. Skorupa, and S. Sterrett. 2025. Freshwater mussel and habitat rapid assessment monitoring protocol for wadeable streams. Northeast Aquatic Biologists Conference, 5-7 February 2025, Bartlett, NH.

Hershberger, A.M., A.H. Roy, and J. Carmignani. 2024. Assessing effects of a phased dam removal on freshwater mussels and habitat. Northeast Aquatic Biologists Conference, 14-16 February 2024, Fairlee, VT. (poster)

Mercado-Silva, N., J. Lyons, S.J. Magnelia, J.T. Petersen, A.H. Roy, and S. Wenger. 2023. Standard methods for sampling fishes in wadeable streams. World Fisheries Congress, 3-9 March 2024, Seattle, WA. (poster)

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O'Brien, R., J. Carmignani, G.V. DiRenzo, R.M. Quiñones, T. Richards, J.B. Rogers, and A.H. Roy. 2024. Drivers of freshwater mussel distributions in the northeastern United States. Society for Freshwater Science Annual Meeting, 2-6 June 2024, Philadelphia, PA.

Pacheco, K.P., S.J. Farrington, J. Stephens, and A.H. Roy. 2025. Using morphometrics to identify freshwater mussel glochidia on host fishes. Northeast Aquatic Biologists Conference, 5-7 February 2025, Bartlett, NH. (poster)

Pacheco, K.P., S.J. Farrington, J. Stephens, and A.H. Roy. 2025. Using morphometrics to identify freshwater mussel glochidia on host fishes. Society for Freshwater Science Annual Meeting, 18-22 May 2025, San Juan, Puerto Rico. (poster)

Quick, A., A. Roy, R. Hale, K. Hopkins, S. Chen, and L. Ortiz Muñoz. 2024. Temporal variation in water quality and dissolved organic carbon in three urbanized streams. Society for Freshwater Science Annual Meeting, 2-6 June 2024, Philadelphia, PA.

Quick, A., A. Roy, R. Hale, K. Hopkins, S. Chen, and L. Ortiz Muñoz. 2024. Urbanization effects on stream dissolved organic carbon and water quality across seasons and storm events. American Geophysical Union Fall Meeting, 9-13 December 2024, Washington, DC. (poster)

Solar eclipse over the river 2024 (Elsa Cousins)

Quick, A., R. Hale, J. Morse, A. Roy, K. Capps, J. Kominoski, K. Hopkins, J. Rudolph, S. Chen, L. Ortiz Muñoz, and A. Blinn. 2025. Variability and interactions among carbon and nutrients in urban streams: implications for management. 7th Symposium on Urbanization and Stream Ecology, 13-16 May 2025, San Juan, Puerto Rico. (poster)

Rogers, J.B., G.V. DiRenzo, R. O'Brien, R.M. Quinones, T. Richards, and A.H. Roy. 2024. Can management alleviate impacts of climate change to support freshwater fish and mussel biodiversity? Northeast Fish & Wildlife Conference, 21-24 April 2024, Hyannis, MA.

Roy, A.H and K.M. Abbott. 2025. Restoring aquatic habitats through dam removal. Southern New England Chapter of the Soil and Water Conservation Society Annual Meeting, 10 July 2025.

Cryptic camouflage of a ruffed grouse (Elsa Cousins)

Roy, A.H. 2024. Urban streams: To avoid or to embrace? Northeast Fish & Wildlife Conference, 21-24 April 2024, Hyannis, MA.

Roy, A.H., A. Quick, R. Hale, K.G. Hopkins, and J. Soucie. 2024. Drivers of spatial and temporal variability in conductivity in temperate, urban streams. Society for Freshwater Science Annual Meeting, 2-6 June 2024, Philadelphia, PA.

Roy, A.H., A. Quick, R. Hale, K.G. Hopkins, and J. Soucie. 2024. Spatial and temporal variability in stream conductivity in the Boston metropolitan area. Northeast Aquatic Biologists Conference, 14-16 February 2024, Fairlee, VT.

Sheppard, J.J., M.N. Marjadi, S. Batchelder, R. Govostes, A.H. Roy, M.G. Slocombe, and J.K. Llopiz. 2024. A video monitoring and computational system for estimating juvenile river herring abundance. American Fisheries Society Annual Meeting, 15-19 September 2024, Honolulu, HI.

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Sirén, A.P.K, M. Zimova, R.M. Cliché, J.R. Kilborn, C.S. Bernier, K.D. Gieder, R. Patry, L.S. Prout, S. Wixsom, S. Gifford, L.E. Kantar, T.L. Wilson, and T.L. Morelli. 2025. Matrix habitat offsets the impacts of climate change on southern prey populations. Northeast Association of Fish and Wildlife Agencies annual conference. 21-24 April 2025, Bretton Woods, New Hampshire

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Sirén, A.P.K., T.L. Wilson, K.Dunfey-Ball, K.D. Gieder, C.A. Bernier, N.L. Fortin, T. Smith, J.R. Kilborn, C.B. Callahan, R.M. Cliché, L.S. Prout, S. Wixsom, S. Staats, R. Abrams, S. Gifford, R. K. Patry, L.E. Kantar, and T.L. Morelli. 2024. Broad-scale climate and habitat influences winter tick-moose dynamics along trailing range edges. North American Moose Conference, 13-16 May 2024, Midway, UT, USA.

Skora, L.C. and T.L. Wilson. 2024. Flying low and slow: estimating brown bear (Ursus arctos) density using aerial distance sampling in Katmai National Preserve, Alaska. International Statistical Ecology Conference. 14-19 July 2024, Swansea, United Kingdom.

Skorupa A.J., A.H. Roy, S. Doran, C.E. Dumoulin, and D.R. Smith. 2025. Identifying locations for restoration actions for freshwater mussels in the Delaware River Basin. Northeast Fish & Wildlife Conference, 21-24 April 2025, Bretton Woods, NH.

Someshwar, M., J. Burgoff, A. Roy, and A. Jordaan. 2024. Comparing zooplankton communities and juvenile river herring diets and littoral and pelagic habitats. Northeast Fish & Wildlife Conference, 21-24 April 2024, Hyannis, MA. (poster)

Stephens, J., A. Roy, A. Jordaan, D. Perkins, and K. Sprankle. 2024. Investigating the host role of returning river herring as hosts for freshwater mussels in the Connecticut River watershed. Northeast Fish & Wildlife Conference, 21-24 April 2024, Hyannis, MA

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Stratton, M.D., S.J. Farrington, J. Stephens, and A.H. Roy. 2025. Developing a protocol for identifying glochidia using genetics. Society for Freshwater Science Annual Meeting, 18-22 May 2025, San Juan, Puerto Rico. (poster)

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CONTRIBUTIONS

Information included in this report was drafted by Graziella DiRenzo, Allison Roy, and Tammy Wilson, the featured cooperators, and the featured students and interns. Elsa Cousins compiled, formatted, and edited the report with organizational and editing input from DiRenzo, Roy, and Wilson. A special thanks to the photographers who shared their art, including past and current Coop Unit students, postdocs, and friends.

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Trail camera overlooking working UMass Amherst students (Alexa Hershberger)

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