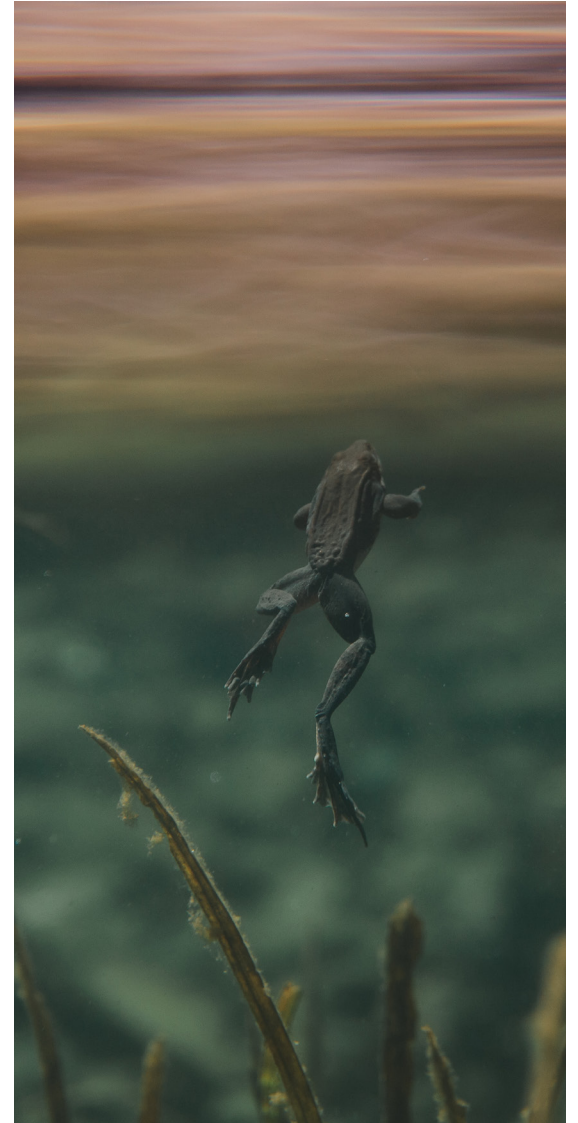


UNITED STATES GEOLOGICAL SURVEY

Massachusetts Cooperative Fish and Wildlife Research Unit



BIENNIAL REPORT 2020-2021

Amherst, MA
December 2021

The Cooperative Research Units Program

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

The CRU Mission is to provide:

- Graduate education to develop the workforce
- Actionable research to meet cooperator science needs
- Technical assistance to cooperators

The Massachusetts Cooperative Fish and Wildlife Research Unit

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

The Massachusetts Unit is currently comprised of a Unit Leader, Dr. 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-Amherst and our cooperating agencies.

Research in the MA Coop Unit

We conduct research in terrestrial and aquatic ecosystems on a variety of topics; current research projects include:

- Habitat requirements for endangered and at-risk freshwater mussel species
- Juvenile river herring ecology, productivity, and restoration
- Effects of dams and dam removal on stream ecosystems
- Population ecology and habitat use of endangered bog turtles in Massachusetts
- Winter drawdown extent and impacts on lake and downstream ecosystems
- Using aerial surveys to estimate trends in brown bear population dynamics at Katmai National Park and Preserve, Alaska
- Abundance and habitat use of suburban black bears in Massachusetts
- Effects of habitat, density, and climate on moose and winter tick ecology in the Northeast U.S.
- Assessing the risk of chronic wasting disease introduction in Massachusetts
- Using decision analysis to frame and address the problem of illegal turtle confiscations
- Examining the spatial distribution, movement, and habitat use of eastern box turtles at Joint Base Cape Cod

Some quick facts about our research budgets and productivity include:

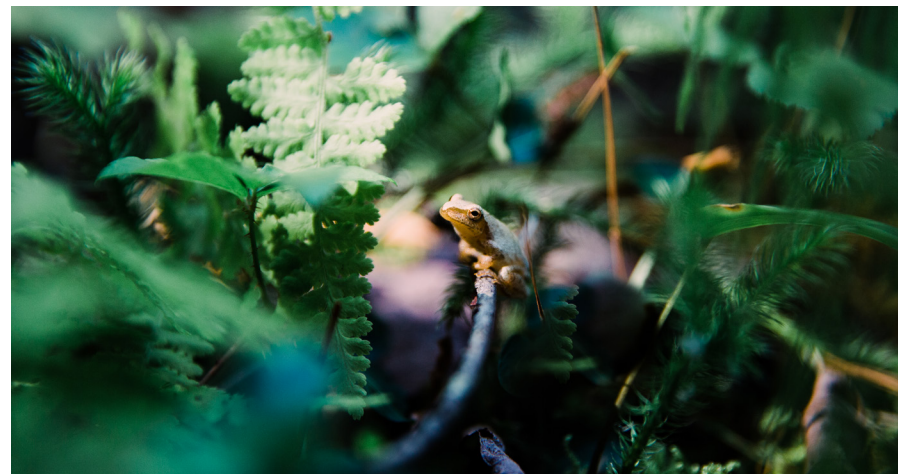
- Typical operating budget of **\$1-2 million** annually (including research grants, salaries of Unit scientists and staff, etc.)
- Research grants expenditures totaled **\$704K** in 2019 and **\$383K** in 2020 (with only 1 Unit scientist)
- New research grants in 2020-2021 totaled **>\$3 million** from a variety of federal (e.g., USGS, USFWS, NSF), state (e.g., MassWildlife, MDMF, MDER), and nonprofit (e.g., TNC, Woods Hole Sea Grant) sources
- **23** scientific papers and reports were published in the last 2 years
- **46** presentations at conferences and public meetings in the last 2 years
- Collaborators include scientists and managers from over **38** state, federal, and private conservation agencies, institutions, and groups

Graduate Education in the MA Coop Unit

In the last 2 years, we:

- Advised or co-advised 3 postdoctoral researchers, 9 PhD students, 14 MS students, and 4 BS Honor's 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
- Taught graduate courses on Research Concepts and Aquatic Ecology
- Served on 6 graduate committees

Recent postdocs and graduates of the CRU program have positions in federal agencies (e.g., USFWS, U.S. Forest Service), state agencies (e.g., MassWildlife), and universities (e.g., SUNY Stony Brook University).



A SPRING PEEPER ON THE FOREST FLOOR IN WARWICK, MA (AYLA SKORUPA).

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· ABBREVIATIONS
· B.A.S.S. = Bass Anglers Sportsman Society
· BIPOC = Black, Indigenous, and People of Color
· CHC = Commonwealth Honors College
· CRU = Cooperative Research Unit
· CRUP = Cooperative Research Units Program
· DDCSP = Doris Duke Conservation Program
· DEIJ = diversity, equity, inclusion, and justice
· DOC = dissolved organic carbon
· ECO = Department of Environmental Conservation
· IBA = International Association for Bear Research and Management
· ICES = International Council for the Exploration of the Sea
· ASC = Annual Science Conference
· MassWildlife = Massachusetts Division of Fisheries & Wildlife
· MDCR = Massachusetts Division of Conservation and Recreation
· MDER = Massachusetts Division of Environmental Resources
· MDMF = Massachusetts Division of Marine Fisheries
· MEPA = Massachusetts Environmental Policy Act Office
· NE CASC = Northeast Climate Adaption Science Center
· NMDS = Nonmetric multidimensional scaling
· NSF = National Science Foundation
· NWR = National Wildlife Refuge
· OEB = Organismic and Evolutionary Biology
· SDM = Structured Decision Making
· SSP = Science Support Partnership
· SUNY = State University of New York
· TNC = The Nature Conservancy
· USDA = US Department of Agriculture
· USFWS = US Fish and Wildlife Service
· USGS = US Geological Survey
· WC = Wethersfield Cove
· WD = Winter drawdowns
· WNS = white nose syndrome
· WRRC = Water Resources Research Center

· COVER PHOTOS
· TOP: Mt. Snow (Katherine Abbott), Bumblebee in Anemone flowers (Ayla Skorupa)
· BOTTOM: Common shiners spawn in Mill River tributary, MA (Ayla Skorupa), Roaring Branch in the Green Mountain Nation Forest, VT (Peter Zaidel)
· RIGHT: Wood frog floats in a vernal pool at sunset (Ayla Skorupa)
· BACK COVER: Wood Kayaking on Levrett Pond (Katherine Abbott)
· PHOTO CREDITS PROVIDED IN PARENTHESES
· REPORT COMPILED BY: JENNIFER RYAN

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FERNS GLOW IN LATE-AFTERNOON SUN (PETER ZAIDEL).

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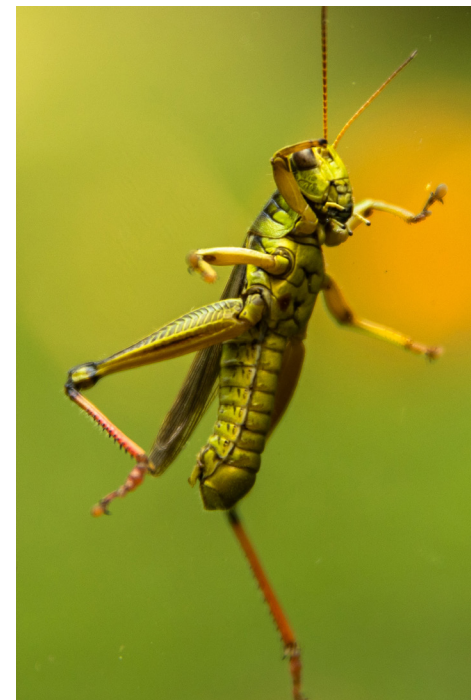
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AN UNEXPECTED, BUT HAPPILY WELCOMED,
WORK-FROM-HOME COWORKER (PETER ZAIDEL).

COLLABORATING FACULTY, ADJUNCTS, COOPERATORS

Amherst College

Thea Kristensen

Audubon Society

Donald Lyons, Joan Walsh

Biodrawversity, Inc.

Ethan Nedeau

Cole Ecological, Inc.

Mike Cole

Connecticut Department of Energy and Environmental Protection

Chris Bellucci, Jacque Benway, Justin Davis, Laura Saucier

Connecticut River Conservancy

Andy Fisk

Cornell Lab of Ornithology

Gemma Clucas

Charles River Watershed Association

Lisa Kumpf

Fitchburg State University

John Ludlam

Florida International University

John Kominoski

Idaho State University

Rebecca Hale

Maine Department of Inland Fisheries and Wildlife

Lee Kantar, Beth Swartz

Massachusetts Department of Conservation and Recreation

Jamie Carr

Massachusetts Department of Environmental Protection

Robert Smith, Allyson Yarra

Massachusetts Division of Ecological Restoration

Kate Bentsen, Kris Houle, Beth Lambert, Nick Wildman

Massachusetts Division of Marine Fisheries

Mike Armstrong, Brad Chase, Ben Gahagan, Gary Nelson, John Sheppard

Massachusetts Division of Fisheries and Wildlife

Jason Carmignani, Martin Feehan, Mike Huguenin, Mike Jones, Steven Mattocks, Carolyn Mostello, Rebecca Quiñones, Todd Richards, Jason Stolarski, Dave Wattles

Massachusetts Military Reserve

Jacob McCumber, Annie Curtis

Monmouth University

Sean Sterrett

Mount Holyoke College

Renae Brodie

Mystic River Watershed Association

Andy Hrycyna

National Park Service

Krista Bartz, Heather Coletti, Troy Hamon, Mike Hanam, Buck Mangipane, Benjamin Pister, Joel Reynolds, Joshua Schmidt, William Thompson

Neponset River Watershed Association

Jennifer Rogers

New Hampshire Department of Fish and Game

Henry Jones

Portland State University

Jennifer Morse

The Nature Conservancy

Alison Bowden, Sara Burns, Katie Kennedy, Angela Sirois-Pitel

SUNY- ESF

Paul Jensen

SUNY-Cobleskill

Andrew Gascho-Landis

Trout Unlimited

Erin Rodgers

University of Connecticut

Margaret Rubega

University of Georgia

Krista Capps, Peter Hazelton

University of Maryland Baltimore County

Matt Baker

University of Massachusetts Amherst

Konstantinos Andreadis, Caitlyn Butler, Brian Cheng, John Finn, Colin Gleason, Lian Guo, Adrian Jordaan, Jason Kamlar

University of Montana

Andrew Whiteley

University of New Hampshire

Elizabeth Craig, Nathan Fuery

University of Vermont

Brittany Mosher, Alelej Sirén, Cheryl Sullivan

USDA Forest Service

Dave King, Keith Nislow

U.S. Fish and Wildlife Service

Meredith Bartron, Sandra Doran, Christine Dumoulin, Heather Galbraith, Melissa Grader, Rachel Katz, Virginia Martell, Christine McCue, Dave Perkins, Ken Sprankle, Susi von Oettingen, Anthony Tur, Tim Warren, Linda Welch

U.S. Geological Survey**Cooperative Research Units Program**

Therese Donovan, John Organ

Eastern Ecological Science Center

Steve McCormick, Kevin Mulligan, David Smith

National Wildlife Health Center

Robin Russell, Dan Walsh

New England Water Science Center

Dave Armstrong

Northeast Amphibian Research and Monitoring Initiative

Evan Grant

Northeast Climate Adaptation Science Center

Toni Lyn Morelli, Michelle Staudinger

South Atlantic Water Science Center

Kristina Hopkins

Western Ecological Research Center

Liz Bowen

Vermont Department of Fish and Game

Nick Fortin, Katrina Gieder

Woods Holes Oceanographic Institute

Joel Llopiz

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

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

The Massachusetts Unit was established in 1948 and was one of a second wave of new Units, which included Missouri, Pennsylvania, Colorado, Idaho, Oklahoma, Alaska, Arizona, and Montana. Originally, Cooperative Wildlife Research Units preceded Cooperative Fishery Research Units, and the two

types of Units were separate entities. In 1963, the Massachusetts Fishery Unit was formed. In 1990, most Wildlife Units and Fishery Units were combined, and the two Units at the University of Massachusetts became the combined Massachusetts Cooperative Fish and Wildlife Research Unit.

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

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



DIFFERENT SPECIES OF FIREFLIES FLASH WITH DIFFERENT TIMING, PATTERNS, AND COLORS OVER A WETLAND IN WEST DOVER, VT (PETER ZAIDEL)



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 epizootic and enzootic disease dynamics, community and population ecology, and developing quantitative tools. To mimic natural hierarchical systems, I develop hierarchical Bayesian models, and I exploit 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

I joined the Massachusetts Cooperative Fish and Wildlife Research Unit in November 2020. I collect datasets that will answer important conservation and management questions based on the programmatic needs of cooperating agencies. I specialize in the application of statistical models to determine species distribution, abundance, and habitat selection and apply this work to support science-based decision-making in wildlife management and conservation.



DEB WRIGHT
Administrative Assistant

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

COOPERATOR SERVICE

- OEB Graduate Faculty (DiRenzo, Roy, Wilson)
- Graduate Committee member (DiRenzo, Roy, Wilson)
- Quantitative Science Group (DiRenzo, Wilson)
- Brook Floater Working Group (Roy)
- Roseate Tern Working Group (DiRenzo, Wilson)
- DEIJ Awards Committee (DiRenzo, Wilson)
- OEB/ECO DEIJ Task Force (Roy)

PROFESSIONAL SERVICE

- Vice President, Society for Freshwater Science (Roy)

GRADUATE COURSES TAUGHT

- Research Concepts (ECO 601: DiRenzo and Roy), Fall 2021
- Aquatic Ecology (ECO 590AE: Roy), Fall 2020
- Dam Removal Practicum (NRC 596D, CE-ENGIN 596DY: Kate Abbott with Roy and Kevin Mulligan)

CURRENT GRADUATE STUDENTS AND POSTDOCS

Abhishek Kumar, Post-doc (Roy)

Annika Quick, Post-doc (Roy)

Katherine Abbott, Ph.D. (Roy)

Matthew Devine, Ph.D. (Roy and Adrian Jordaan)

Stefanie Farrington, Ph.D. (Roy)

Meghna Marjadi, Ph.D. (Roy)

Leslie Skora, Ph. D. (Wilson)

Ayla Skorupa, Ph.D. (Roy)

Alec Baker, M.S. (Roy)

Juliana Berube, M.S. (Wilson)

Douglas Bishop, M.S. (Roy)

Jessica Bonin, M.S. (Wilson)

Adrienne Dunk, M.S. Professional (Roy)

Andrew Gordon, M.S. (DiRenzo)

Susan McCarthy, M.S. (DeStefano and John Organ)

Desiree Smith, M.S. (DiRenzo)

Joy Trahan-Liptak, M.S. (Roy)

Julia Vineyard, M.S. (Roy)



A SEA LAMPREY TRAVELS UPSTREAM TO SPAWN IN THE SAWMILL RIVER, MA (AYLA SKORUPA)

**COMPLETED GRADUATE STUDENTS AND POSTDOCS
2020-PRESENT**

Katherine Zeller, Post-doc (DeStefano) – Modeling Black Bear Habitat Use, Movement, and Connectivity in Massachusetts (May 2020)

Jason Carmignani, Ph.D. (Roy) – Investigating the effects of winter drawdowns on the ecological character of littoral zones in Massachusetts lakes (February 2020)

Tanya Lama, Ph.D. (Organ and DeStefano) – Conservation Genomics of the Threatened Canada Lynx (*Lynx canadensis*) in the Northern Appalachian-Acadian Ecoregion (February 2021)

Nereyda Falconi Lopez, Ph.D. (Organ and DeStefano) – Data access, distribution models, and stable isotopes: merging approaches to improve bear distribution estimates and bear carnivory for conservation (February 2021)

Christopher Cahill, M.S. (Organ and DeStefano) – Assessing the impacts to society associated with the use of alternative ammunition for hunting on national wildlife refuges (February 2021)

Virginia Martell, M.S. (Roy) – Improving growth and survival of cultured yellow lampmussel (*Lampsilis cariosa*) for restoring populations (February 2020)

Calvin Ritter, M.S. (King and DeStefano) – The ecological value of spruce plantations in Massachusetts (May 2020)

Jennifer Ryan, M.S. (Roy) – In-vitro propagation and fish assessments to inform restoration of dwarf wedgemussel (*Alasmidonta heterodon*) (September 2020)

Julian Burgoff, B.S. Honor's (Roy and Jordaan) – In the weeds: a comparison of juvenile river herring diets in pelagic and littoral habitat (May 2021)

Sarah Endyke, B.S. Honor's (Roy) – Quantifying the effects of algae availability on freshwater mussel growth (May 2020)

Meghan Slocombe, B.S. Honor's (Roy) – Temporal shifts in migratory river herring diets and zooplankton assemblages within Connecticut River coves (May 2020)

Samuel Spelman, B.S. Independent Study (Roy) – Toxic metal bioaccumulation in dam impoundments: implications for food webs (May 2021)



Dr. Stephen DeStefano
Unit Leader, 1999-2019

Massachusetts Cooperative Fish and Wildlife
Research Unit

Steve retired in December 2019 after a 40+ year association with the Cooperative Research Unit Program. He served as Assistant UL with the Arizona Unit from 1994-1999 before coming to the Massachusetts Unit. Steve received his Ph.D. and M.S. with the Idaho and Wisconsin Units and worked as a research associate for the Wisconsin and Oregon Units. He was born in Watertown, MA and got a B.S. at UMass-Amherst, but spent the next 20 years living and working in the midwest, northwest, and southwest U.S., with extensive travel and work in Alaska, Canada, Mexico, and Australia. His research interests focused on wildlife population dynamics, habitat relationships, and human-wildlife interactions, primarily with forest and urban wildlife. He worked closely with the Minority Training Program while in Arizona and established the Graduate Program for Working Professionals while in Massachusetts. Steve is enjoying retirement with his wife, Ki, traveling, pursuing outdoor activities (hiking, birding, kayaking, e-bike riding, snowshoeing), managing their meadow and woodlot, dabbling in the art of pyrography, and especially riding his motorcycles.

Department Head
Department of Environmental
Conservation
University of Massachusetts Amherst



Dr. Curtice Griffin
Term 2012-2021



Dr. Paige Warren
2021-present

Paige received her B.S. in Biology from the University of North Carolina at Chapel Hill and Ph.D. in Zoology at the University of Texas at Austin. She has been a faculty member at UMass since 2004. Her interdisciplinary research seeks to understand patterns of biodiversity in urban regions and their underlying ecological and social processes.

Assistant Director
Natural Heritage & Endangered
Species Program
MA Division of Fisheries & Wildlife



Dr. Tom French
Retired 2019



Dr. Everose Schlüter
2020-present

Eve received her B.S. in biology and literature from Claremont McKenna College and her Ph.D. in biology from Tufts University. She was previously the Assistant Director of the Massachusetts Environmental Policy Act Office (MEPA) at the Massachusetts Executive Office of Energy and Environmental Affairs. She also served as the Chief of Regulatory Review for NHESP at MassWildlife.

Assistant Regional Director
Science Applications
North Atlantic-Appalachian Region
U.S. Fish and Wildlife Service



Dr. Ken Elowe
Retired 2019



Dr. Valerie Hipkins
2020-present

Valerie received her B.S. in Forestry from Humboldt State University, and her M.S. and Ph.D. in Forestry and Genetics from Oregon State University. Prior to coming to USFWS, Valerie held assignments in the Forest Service as Acting Station Director at the Pacific Southwest Research Station, the Acting National lead for Reforestation and Nurseries, and the Director of the National Forest Genetics Lab.

These last two years have been...well...we all know how they have been! While the pandemic certainly altered everything we do, we are happy to have maintained our research, graduate mentoring, teaching, technical support, and outreach. While home laboratories and driving in separate vehicles to field sites are thankfully a thing of the past, we appreciate how Zoom has allowed us to stay connected with our Cooperators in a time of physical distancing.

Just prior to the pandemic, Allison helped with organizing two exciting workshops/conferences. A week-long USFWS/USGS Structured Decision Making (SDM) workshop was held at MassWildlife headquarters in Westboro, MA. The workshop provided opportunities for biologists and managers to frame problems and decisions around brook floater restoration, saltmarsh sparrow restoration, and cold water refugia. Because the workshop was sponsored by the National Conservation Training Center, all participants received training in SDM and projects benefited from SDM expert coaches and facilitation. Allison also served as the Advisory Board chair for the 5th Symposium on Urbanization and Stream Ecology that was held in Austin, TX in February 2020. This international forum included ~150 participants from around the world who worked during the meeting to solve 'wicked' urban stream problems in disciplinary, interdisciplinary, and trans-disciplinary teams as an experiment to understand the role of community members in addressing problems.



At home laboratory setup (Katherine Abbott)

In November 2020, we welcomed Grace and Tammy as new Assistant Unit Leaders. This is the first time since 2015 that we have had a full Unit, and their expertise and creativity will help move the Unit in new and exciting directions. With their arrival, we have new research on moose and winter tick ecology, brown bear population dynamics, and an evaluation of chronic wasting disease risk for the state of MA. We also have new capacity to work on turtles, with projects including population dynamics and habitat use of bog turtle and box turtle, and illegal turtle confiscations. Collectively, the Unit brought on 4 postdocs, 2 PhD students, and 6 MS students in 2021 to meet these growing research needs.



Structured Decision Making Workshop Participants, February 2020 (MassWildlife)

In the last two years, Unit staff and students have invested considerable time working to address diversity, equity, inclusion, and justice (DEIJ) issues within our labs, the University, and the CRU. We have participated in discussions and book groups, developed DEIJ statements, updated our courses, and adopted new fieldwork, hiring, and mentoring practices. Allison served on a DEIJ recruitment and retention task force, and Tammy and Grace reviewed applicants for DEIJ awards in the Department. Grace also serves on the CRU DEIJ committee and has been working on several DEIJ outreach events, including career panels at institutions with large populations of students in underrepresented groups. We strive to be more inclusive and provide opportunities for Black, Indigenous, and People of Color (BIPOC) students that will become the conservation leaders of the future.

During the May 2021 Cooperator's meeting, Deb Wright was acknowledged for her incredible service to the MA Coop Unit over the last seven years, and her heroic efforts over the previous year during the pandemic. Deb not only had to develop new processes and work flows for administration, but unprecedented early staff retirements at UMass (due to incentives related to the pandemic) resulted in Deb doing the work of multiple staff members. We are so lucky to have her with us! The virtual Cooperator's meeting also included Unit graduate students giving brief introductions and highlighting their research in lightning talks. We look forward to having an in-person meeting in 2022 (fingers crossed!) where we can share more of our collaborative research.

The Doris Duke Conservation Scholars Program (DDCSP) Collaborative is 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 is a consortium of universities united to empower a diverse new generation of conservation leaders. UMass Amherst joined the consortium in 2020. The other members of the consortium are the University of Florida, University of Arizona, University of Idaho, and North Carolina State University. Scholars conduct applied field research projects in their first summer and participate in professional internships in their second summer. Scholars learn a variety of research techniques and present their research at the Ecological Society of America conference. The students meet regularly with graduate student mentors to discuss research and leadership skills, graduate school, conservation careers, and other topics. Through this program, students develop strong professional networks and are prepared to help increase diversity, equity, and inclusion in the field of conservation through coursework in communication, creative problem solving, leadership, and diversity, equity, and inclusion.

In summers 2020 and 2021, DDCSP scholars in the MA Coop Unit took part in cutting edge research investigating the population dynamics of anadromous river herring, under the guidance of Doug Bishop (MS student), Matt Devine (PhD student), and Meghna Marjadi (PhD student). River herring are migratory fish that inhabit both marine and freshwater ecosystems to complete their life cycle. Although river herring are vital to marine and freshwater food webs, little is known about their densities, growth, and mortality across these habitats. Scholars participated in field work that included fish and water quality sampling across coastal Massachusetts lakes (using a purse seine at night from a boat!) as well as deploying and maintaining emigration traps to intercept fish leaving these lakes. In addition, in the laboratory, scholars extracted, imaged, and aged juvenile river herring otoliths (tiny ear bones!) and used the data to estimate age and growth. Ongoing research using the data collected include investigating how river herring respond to restoration projects that restore aquatic connectivity (e.g., dam removal) and examining the behavioural effects of being tagged to track their movement. All current Doris Duke Students major in Natural Resource Conservation with concentration in Wildlife. All DDCSP scholars in the MA Coop Unit major in Natural Resource Conservation.



Calvin Fisher
2021-2022

I am from Attleboro, MA, and grew up along the Ten Mile River which is where my passion for wildlife and conservation began. I grew up fishing and kayaking in this riv-

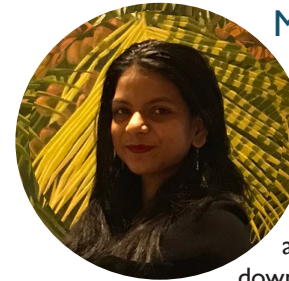
er, watching the fish below and the birds above. These experiences, over the course of years, made me interested in wildlife overall and that is where I began to be interested in a career working with wildlife. Throughout my lifetime I have seen the deterioration of this river system that jump started my interest in wildlife, and in recent years it is starting to improve back to where it once was. Observing species like river otters, which had never been present in my lifetime, come back and play around in the river really moved me and made me want to extend this experience to other people. I hope to do that through conservation and restoration of habitat and wildlife populations. Though I am still not quite sure exactly what I want to do within the field of conservation, I hope to make a difference like I've experienced in the lives of many others.



Tyler Pina
2020-2022

I have worked primarily with fish and amphibians during my career, but am interested in all types of practical and applied ecology. During my recent

internship with the Memphis Zoo, I was able to examine the effectiveness of cryo-preserved gametes as a viable method for recruitment in fowler's toads. Although I'm still learning about where I fit into the field of ecology, predator-prey interactions, coastal management, endangered species conservation, and urban forestry are all some of the many topics I wish to explore further in my future career. When I am not conducting research my favorite activities include socializing with friends, playing basketball, editing photos in lightroom, and watching adventure movies.



Malvika Someshwar
2021-2023

I am originally from India, but live in New York City (Manhattan). All my life I knew that I wanted to help animals, which brought me down a veterinary path. I grew

up working at a veterinary clinic, and thought I had found my direction in life. In 2018, I traveled back to India to volunteer at a cow rescue, thinking that I would learn new veterinary skills; however, during my time there I saw first-hand the necessity of improving wildlife management for the benefit of these animals. This experience really changed the way I looked at the interactions between people and animals; I saw that wildlife conservation needed to be addressed and their situation improved. I realized that I wanted to make a positive impact for wildlife on a larger scale. There are currently numerous environmental threats we are facing, and we can trace many back to ecological factors- specifically poor environmental and wildlife management. I am specifically interested in wildlife behavioural studies and hope to continue in the field.

Prevalence of winter water level drawdowns and sensitivity to climate

Annual winter water level drawdowns (WDs) are commonly used to reduce nuisance macrophyte biomass; however, the future utility and impacts to ecosystems under climate change remains uncertain. Using remote sensing data, validated with on-the-ground water level and cyanobacteria data, we will characterize water level fluctuations and cyanobacteria blooms in WD lakes in the Northeast and Upper Midwest US. These data will be coupled to novel hydrologic models that assess sensitivity of WDs and vulnerability of cyanobacteria blooms to future climate and precipitation. The results from this research, which will be shared in scientific publications and online data repositories, will help evaluate WDs as a macrophyte management tool under future climate change and weigh any remaining benefits with the ecological and socioeconomic costs of performing WDs.

POST DOC	Abhishek Kumar
ADVISOR	Allison Roy
FUNDING	Northeast Climate Adaptation Science Center
COLLABORATORS	Konstantinos Andreadis Caitlyn Butler Colin Gleason Xinchen He (PhD student) Partners from USEPA and 7 state agencies



Different phases of winter drawdown (Jason Carmignani).

Carbon in Urban River Biogeochemistry

Rivers and the landscapes through which they flow vary widely in both human factors (e.g., wastewater infrastructure, housing density, impervious surfaces) and biophysical factors (e.g., discharge, precipitation, temperature, canopy cover). During 2020–2021, 100 sites in the Charles, Mystic, and Neponset River watersheds in the Boston urban area will be sampled four times to determine how human and biophysical factors and their interactions influence dissolved organic carbon (DOC) and stream function. Sampling locations in tributaries and rivers reflect gradients in factors such as canopy cover, housing density, environmental justice communities, age of development, impervious land cover, and wastewater infrastructure. We are also deploying sensors to continuously measure DOC at three sites. Together with samples collected in four other cities (Portland, OR; Salt Lake City, UT; Atlanta, GA; Miami, FL), these data will lead to better understanding of human and biophysical controls on DOC across urban rivers and provide important information for carbon budgets and river management.

POST DOC	Annika Quick
ADVISOR	Allison Roy
FUNDING	National Science Foundation
COLLABORATORS	Rebecca Hale Krista Capps Kristina Hopkins John Kominoski Jennifer Morse Lisa Kumpf Andy Hrycyna Jennifer Rogers



The Muddy River in downtown Boston, a tributary of the Charles River (Annika Quick).

Aquatic Restoration Through Dam Removal

Across New England, thousands of small dams fragment the landscape and alter stream ecosystems. Resource managers are using dam removal as a strategy to restore aquatic habitat, remove obsolete structures, and mitigate negative impacts to humans. The goal of this research is to quantify multiple ecological dimensions of dam removal. We are collecting data on water quality, benthic macroinvertebrates, and fishes at >16 dam removal sites to quantify variation in responses across the Massachusetts landscape. We are also conducting surveys of resource managers and restoration practitioners to understand current dam removal practices and the extent to which climate change predictions are incorporated into such projects. Results from this study will provide information to partners and stakeholders regarding the timing and extent of stream recovery following dam removal, guide the prioritization of dam removal projects, and inform the use of dam removal as a tool to increase climate change resilience.

STUDENT Kate Abbott (PhD)

ADVISOR Allison Roy

FUNDING MA Division of Ecological Restoration,
MA Environmental Trust, Trout Unlimited,
MassWildlife, NE CASC

COLLABORATORS Erin Rodgers Rebecca Quiñones
Keith Nislow Todd Richards
Kris Houle
Nick Wildman



Electrofishing a dammed river in Andover, MA, to assess fish populations prior to dam removal (Steven Mattocks).

Population Dynamics and Restoration Ecology of Anadromous River Herring

Anadromous river herring (collectively alewife and blueback herring) populations declined sharply over a half century ago, and conservation measures have not resulted in population recovery. Factors limiting recovery remain unclear and lack of information about growth and mortality in freshwater and estuarine environments limits the ability of population models to determine important factors. Additionally, variation among years in river herring densities presents challenges to understanding the effects of restoration on fish productivity. This project is investigating: (1) inter-annual variation in juvenile river herring densities and growth in relation to lake specific and regional environmental conditions, and (2) the timing and magnitude of recovery of juvenile river herring productivity and dynamics following dam removal. We are using a newly developed lake sampling protocol for juveniles to estimate densities, and laboratory analysis of otoliths to determine age and growth rates from 30+ lakes, a large river and adjacent coves, and estuaries across New England.

STUDENT Matt Devine (PhD)

ADVISORS Allison Roy
Adrian Jordaan

FUNDING TNC, MDMF, USGS/USFWS
SSP, MA Sea Grant, USGS CRU

COLLABORATORS Alison Bowden Gary Nelson
Mike Armstrong Jacque Benway
Ben Gahagan Justin Davis



Juvenile river herring being released after capture in a purse seine (Chris Devine).

Yellow Lampmussel Habitat Assessment in the Connecticut River

Yellow lampmussel (*Lampsilis cariosa*) is a priority at-risk freshwater mussel species for the USFWS and has been designated as endangered or another special status in many states, including MA and CT. Yellow lampmussel populations occur in a variety of habitats throughout its range; the species inhabits a variety of substrates and flow conditions, making it challenging to understand habitat requirements and stressors across its range. This project aims to assess potential locations for yellow lampmussel conservation action within the Connecticut River watershed based on mussel densities, host fish densities, and mussel habitat requirements. We are using side-scan sonar and GIS tools to characterize and map habitat types within the Connecticut River watershed. These data, combined with existing state data for yellow lampmussel and known host fish presence/absence, will be used to identify suitable habitats in the study area. This information may be useful for identifying target areas for novel surveys or candidate areas for release of propagated or relocated yellow lampmussel.

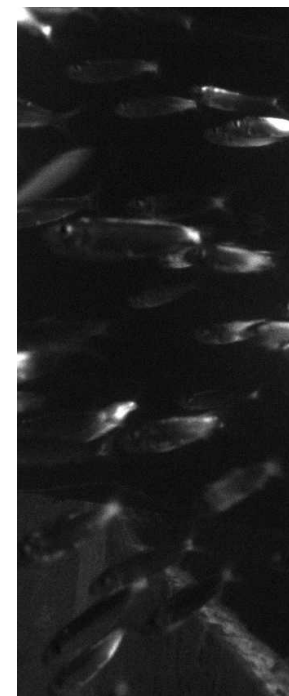
STUDENT	Stefanie Farrington (PhD)
ADVISOR	Allison Roy
FUNDING	USFWS Pathways Program UMass OEB Program
COLLABORATORS	David Perkins & Tim Warren Jason Carmignani Laura Saucier



Stefanie collects side-scan sonar imagery in the Connecticut River (Jack Soucie).

Climate Change Implications for Phenological Events and Reproductive Success in River Herring

Anadromous river herring populations have experienced declines over the last century and effective management requires a better understanding of the timing of life cycle events in freshwater. Climate change will influence the life cycles of river herring and other anadromous fishes at different stages. We are using continuous video monitoring, biological sampling, and historical data collected from Massachusetts and Connecticut populations to explore 1) how long adult alewives remain and reproduce in freshwater ponds, 2) which environmental variables trigger juvenile emigration, 3) how adult migration timing and duration have changed over time and influence reproductive output. To accomplish this, we are employing novel combinations of methods, including genetic pedigree analysis, otolith analysis, computational assessment of videos, and long-term trends analysis. Understanding how environmental variables influence the timing and duration of various life cycle events will support work to predict the implications of climate change on these events and, subsequently, river herring populations.



STUDENT	Meghna N. Marjadi (PhD)
ADVISOR	Allison Roy
FUNDING	MDMF USGS/USFWS SSP UMass Graduate School Switzer Foundation NE CASC USGS CRU
COLLABORATORS	Jacque Benway Justin Davis Ben Gahagan John Sheppard Adrian Jordaan Joel Llopiz Steve McCormick Ken Sprankle Michelle Staudinger

Footage of juvenile river herring passing through the outlet from Great Herring Pond in Plymouth, MA to the Cape Cod Canal.

Brook Floater Population Restoration

The brook floater (*Alasmodonta varicosa*) is a species of freshwater mussel that ranges in Atlantic Slope drainages from Canada (Newfoundland and New Brunswick) south to Georgia. Historically brook floater occurred in 11 watersheds in Massachusetts, but now is found in four watersheds and is listed as state endangered. Our objective was to develop and implement steps that could inform future population restoration. We evaluated 10 fish species as hosts for propagating brook floater in a laboratory, and we developed methods to maximize juvenile mussel growth and survival both in the laboratory and in ponds. To identify locations that would support brook floater reintroduction, we conducted surveys for mussels and habitat in rivers throughout Massachusetts and then modeled brook floater abundance using habitat predictors. Lastly, we compared propagated brook floater growth and survival in enclosed systems among rivers with extant populations and related changes in growth to water quality, temperature, and food (chlorophyll a) concentration. Ultimately, this information will help guide decisions around future population restoration initiatives for the species in Massachusetts.

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



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

Impacts of Winter Lake Drawdowns on Downstream Hydrology and Ecosystems

Winter lake drawdowns are a common management tool for many recreational lakes in Massachusetts where lake surface levels are lowered during the winter to expose shoreline and destroy nuisance aquatic vegetation and protect in-lake structures from ice damage. To manage lake water levels, dam managers release water during the fall, maintain a period of run-of-river flows during the winter, and reduce outflows during the spring when flows are typically high, flipping the natural hydrologic cycle. However, the rate and volume of water releases for each lake is unique leading to unknown altered downstream flow conditions and impacts on downstream ecology. This study aims to quantify downstream changes in hydrology, temperature, and benthic macroinvertebrates in response to winter lake drawdowns in Massachusetts' streams. I predict alterations to natural flows, including changes in variation, frequency, and magnitude of high flows, and altered stream temperatures. These changes in flow and temperature could lead to changes in macroinvertebrate community composition, while rapid increases of river stage (as lakes refill during large storms) will lead to exclusion of some non-fluvial taxa closer to the dam. Results from this study will advance our understanding of how drawdowns are impacting downstream hydrology and ecology.

STUDENT	Alec Baker (MS)
ADVISOR	Allison Roy
FUNDING	MassWildlife USGS WRRC
COLLABORATORS	Todd Richards
	Jason Carmignani
	Jason Stolarski
	Kate Bentsen



Measuring discharge downstream of Ashmere Lake (Alec Baker).

Assessing Juvenile River Herring Migration from Freshwater to Estuary Habitats

Juvenile anadromous river herring spend their first weeks of life in freshwater before migrating seaward during the summer and fall months. There is limited information available on the demographics of out-migrating juveniles and the factors associated with these movements. The goal of this research is to characterize freshwater emigration to evaluate how access to estuarine habitats can influence growth and survival during early life stages. We are conducting bi-monthly sampling in the headwater ponds and estuaries of three coastal watersheds and experimenting with passive gear types to sample freshwater emigrants throughout the season. Otolith analysis will be conducted to estimate age and growth metrics for comparison among habitats over time. This work will contribute to a broader understanding of how juvenile emigration influences river herring productivity and results will enhance population modeling efforts by providing novel early life history data across the freshwater to marine transition.

STUDENT	Doug Bishop (MS)
ADVISORS	Allison Roy Adrian Jordaan
FUNDING	Woods Hole Sea Grant MDMF USGS CRU
COLLABORATORS	Ben Gahagan Michelle Staudinger

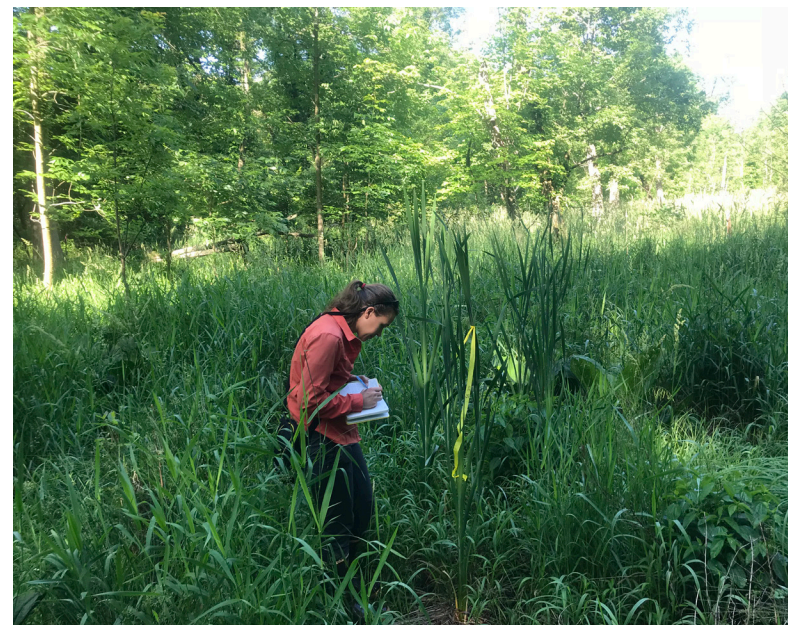


Deploying a purse seine in Essex Bay (Jacob Dorothy).

Habitat Response to Dam Removal

Dams are a common and aging site across Massachusetts. Increasingly, communities and owners are electing to remove these structures to remove risk and restore stream connectivity. The significant benefit of removing these dams has overshadowed other habitat alteration questions. The goal of this research is to examine and quantify habitat characteristics such as wetland configuration, open water coverage, and vegetation composition before and after dam removal to better understand how these habitats may change. Specific emphasis will be placed on the conversion of open water habitat to other wetland, stream, and upland ecosystems following dam removal. The information will assist future dam removal practitioners and regulatory agencies in establishing expectations and performance standards for successful conversion or creation of habitat.

STUDENT	Adrienne Dunk (MS Professional)
ADVISOR	Allison Roy
COLLABORATORS	Kris Houle Nick Wildman



Adrienne characterizing vegetation for a wetland delineation (Blaine Rothausen).

Assessing Long-Term Phytoplankton Trends in Wachusett Reservoir

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

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

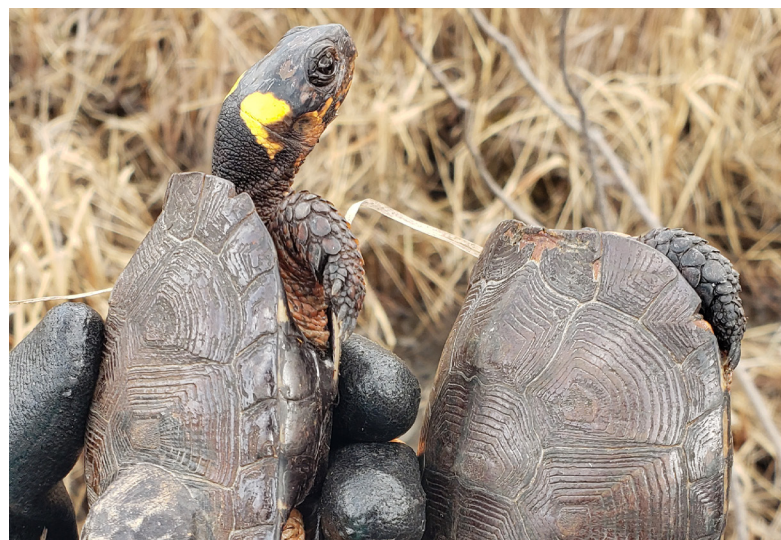


Cold weather plankton sampling in Wachusett Reservoir (Daniel Crocker).

Assessment of Bog Turtle Population and Habitat Utilization in Massachusetts

The Northern population of bog turtle has been federally listed as a threatened species since 1997 and is listed as endangered under the Massachusetts Endangered Species Act. There are two known sites currently occupied by bog turtles within Massachusetts. As the species continues to face threats of habitat loss, fragmentation, and degradation, information about the population status and habitat is critical. The two sites have been studied on a 10-year rotation since the early 2000's, with supporting studies since the 1980's. The overall goals of this project are to examine the current population status within the known sites, evaluate habitat available and habitat used at each site, and search for other potentially occupied sites. To address these goals, we will employ bi-weekly radio telemetry, passive trapping, and vegetation structure analysis. As one of the longest-running studies on the species, these data will contribute to a regional database to help inform priority habitat management projects for the bog turtle.

STUDENT Julia Vineyard (MS)
ADVISOR Allison Roy
FUNDING USFWS State Wildlife Grant
MassWildlife
COLLABORATORS Mike Jones
Angela Sirois-Pitel



Bog turtles with radio transmitters (Julia Vineyard).

Comparing Emigrating and Non-Emigrating Juvenile River Herring to Identify Emigration Triggers

The project seeks to identify some potential triggers for juvenile river herring emigration from freshwater to saltwater. Specifically, I am comparing age, length at age, and growth rate of emigrating and non-emigrating juveniles from Great Herring Pond in Plymouth, MA. Juvenile river herring were collected in June and July of 2019 from the pond using a purse seine and from the Herring River using a dip net. I will extract otoliths to determine age and growth rates. Zooplankton collected biweekly from the pond will be used to assess the relationship between zooplankton biomass and juvenile herring growth rate, and comparing the timing of emigration with dominant zooplankton species.

STUDENT	Dulani Sandanayaka (BS)
ADVISORS	Allison Roy
FUNDING	USGS SSP MDMF UMass Amherst William Lee Science Impact Program
COLLABORATORS	Meghna Marjadi Adrian Jordaen Joel Llopiz John Sheppard



Collecting water chemistry data in eastern MA lake (Meghna Marjadi).

Freshwater Macroinvertebrate Taxa Temperature Tolerances

Macroinvertebrates are excellent water quality indicators, especially due to their diversity and known range of sensitivities to pollutants. The direct link between macroinvertebrates and temperature sensitivities is less known. The purpose of this research study is to evaluate freshwater macroinvertebrate taxa tolerances to water temperature in the Northeast region of the United States (ME, NH, VT, NY, MA, RI, and CT). The specific objectives are to assess macroinvertebrate taxa responses to temperature using occurrence (presence/absence) and abundance data, develop thermal tolerance categories for macroinvertebrates to create thermal tolerance indices, and compare the thermal tolerance indices to other macroinvertebrate traits and biotic metrics. Creating a categorized list of macroinvertebrate taxa that denotes temperature sensitivities and tolerances similar to pollution tolerances will allow future studies to classify stream temperature groups and track changes in temperature effects over time throughout the Northeast region.

STUDENT	Emily Chalfin (BS)
ADVISOR	Allison Roy
COLLABORATORS	Jennifer Stamp



Macroinvertebrates from Moore's Pond in Warwick, MA (Emily Chalfin).

In-vitro Propagation and Fish Assessments to Inform Restoration of Dwarf Wedgemussel

The dwarf wedgemussel (*Alasmodonta heterodon*) is a federally endangered freshwater mussel that once ranged from New Brunswick to North Carolina, but now only exists in isolated populations throughout its diminished range. Laboratory propagation in conjunction with augmentation or reintroduction is considered a critical component of dwarf wedgemussel restoration. The goals of this study were to develop in-vitro propagation techniques including methods to minimize microbial contamination for two *Alasmodonta* species and compile and assess critical fish assemblage information at existing dwarf wedgemussel presence and absence locations to inform future restoration activities.

To minimize microbial contamination for in-vitro propagation (Figure 1), three methods of contamination mitigation were assessed: media change frequency, concentration of the antifungal Amphotericin B, and method of antifungal replenishment. Across all experiments, higher levels of contamination severity had a negative impact on transformation success. In these experiments, dishes that had media changes every

Figure 1. In-vitro propagation petri dish with excessive contamination (Ayla Skorupa).



STUDENT
ADVISOR
FUNDING

COLLABORATORS

Jennifer Ryan
Allison Roy
USGS/USFWS SSP
Heather Galbraith
Peter Hazelton
David Perkins
Robert Wick

other day (vs. those changed daily and every 3 days) had the highest contamination and the lowest glochidia transformation success. Treatments with the lowest (0 $\mu\text{g/mL}$) concentration of the antifungal, Amphotericin B, and got a low-dose replenishment of Amphotericin B (vs frequent media changes) had the highest transformation success (Figure 2). The findings suggest that low contamination results in high probability for transformation success; however, there is a tradeoff of apparent toxicity in higher concentrations of Amphotericin B.

The fungus present in the experiments was identified as *Candida parapsilosis*, a common fungus found in aquatic and human environments. Future propagation efforts should use mitigation methods specific to the fungal contaminant.

In the assessment of host fish near dwarf wedgemussel locations, two fish repeatedly emerged as indicators of dwarf wedgemussel occurrence and abundance: the tessellated darter (*Etheostoma olmstedi*) and brown trout (*Salmo trutta*) (Figure 3). Tessellated darter was positively related to dwarf wedgemussel which supports the importance of tessellated darter as a host fish in

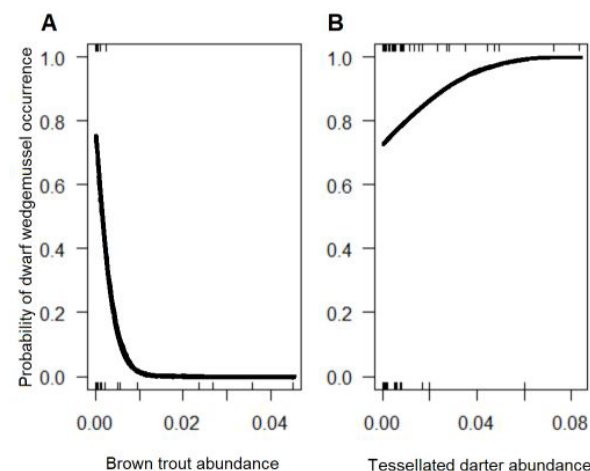
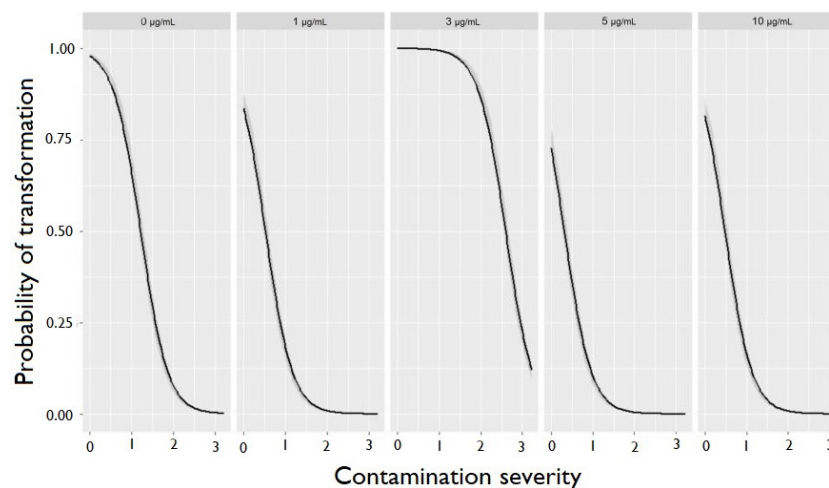


Figure 3. Model predictions for probability of dwarf wedgemussel occurrence based on A) brown trout abundance and B) tessellated darter abundance.

the wild. The negative relationship between dwarf wedgemussel and brown trout may indicate a difference in habitat between the species or brown trout's predation upon wild hosts. By focusing conservation efforts on tessellated darter with consideration of other native fish species, we may best protect for dwarf wedgemussel populations, since their host-specificity is still largely unknown. Results from this project will be used

in conjunction with habitat and genetic information to inform future restoration plans in the northeast and add to the growing body of literature on in-vitro propagation of freshwater mussels.

Figure 2. Bootstrapped data indicating how probability of transformation is affected by contamination across different treatments of Amphotericin B (n = 5 replicates per treatment).

Comparing Juvenile River Herring Diets in Pelagic and Littoral Habitat

Juvenile river herring (alewife and blueback herring) are size-selective predators that forage on populations of large-bodied zooplankton present in the pelagic zones of lakes and ponds. During their seasonal (May-Oct) presence in freshwater systems, large-bodied zooplankton are rapidly grazed from the water column as juvenile river herring forage throughout the summer months, causing a shift in the zooplankton community structure that results in fewer large-bodied pelagic prey available for juvenile river herring later in the year. Studies have suggested that anadromous juvenile river herring will shift towards foraging in littoral habitat as a response to the depletion of pelagic prey, and that this shift will occur more rapidly in lakes with dense juvenile populations.

STUDENT Julian Burgoff (BS)
ADVISORS Allison Roy, Adrian Jordaan
FUNDING MA DMF
COLLABORATORS Meghan Slocombe
 Matt Devine
 Doug Bishop

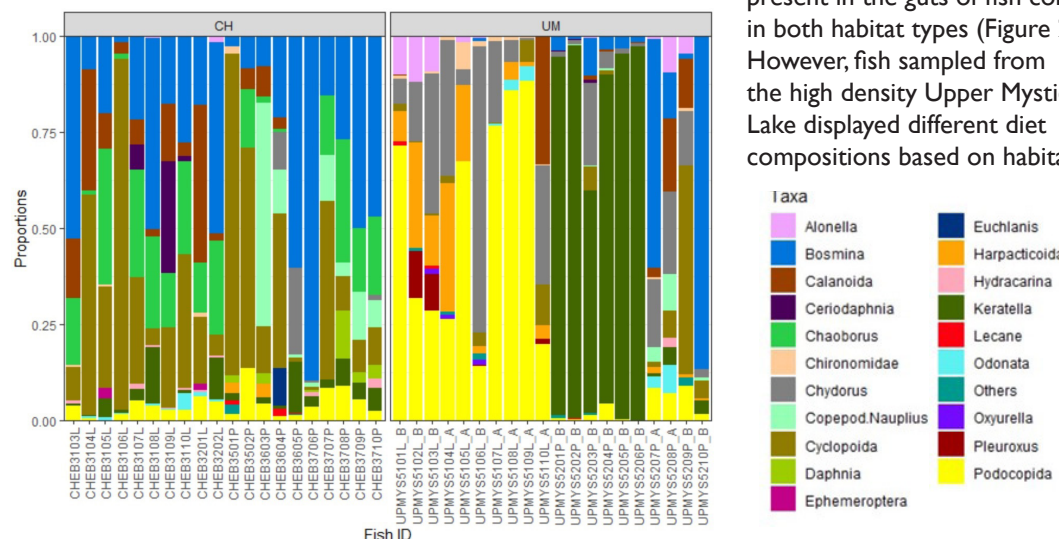


Figure 2. Proportions of prey taxa for individuals grouped by site. Fish ID ending in “L” indicate littoral habitat and “P,” pelagic habitat. Upper Mystic Fish IDs include an extra character denoting species- “A”= Alewife, “B”=Blueback.

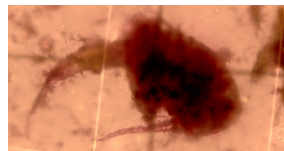


Figure 1. Cyclopoid copepod extracted from a river herring gut (Julian Burgoff).

The objective of this study was to compare the direct diet composition between juvenile anadromous river herring in both pelagic and littoral habitat from two lakes with different in-lake river herring densities. From August-October 2020, juvenile river herring were sampled via purse seine in Chebacco Lake (low juvenile density) and Upper Mystic Lake (high juvenile density) in both pelagic habitat (>5m) and littoral habitat (<2m). Ten fish from both pelagic and littoral habitat at each lake were sampled and immediately frozen. Gut content analysis was performed on each of the 40 fish, where each prey item was enumerated and identified to the lowest feasible taxon (Figure 1). In the lower density Chebacco lake, fish sampled from pelagic and littoral habitat largely foraged on similar prey taxa, where large-bodied zooplankton prey items such as cyclopoid copepods were present in the guts of fish collected in both habitat types (Figure 2). However, fish sampled from the high density Upper Mystic Lake displayed different diet compositions based on habitat type

(Figure 3). Pelagic fish from Upper Mystic foraged predominantly on small-bodied zooplankton such as Keratella, while fish collected from littoral habitat heavily foraged on podocopa ostracods and other zooplankton taxa associated with littoral zones.

The results from this study provide an example of the effects of intraspecific competition on the pelagic prey resources available to juvenile river herring late in the season. These findings suggest that even though littoral foraging occurs in both sites with varying densities, littoral prey items such as ostracods are consumed more intensely when large-bodied pelagic prey resources are scarce. This information helps to inform the factors associated with juvenile river herring growth and survival in freshwater systems, and further to inform management decisions that alter the quality of littoral habitats in headwater ponds (e.g. herbicide treatments targeting aquatic macrophytes).

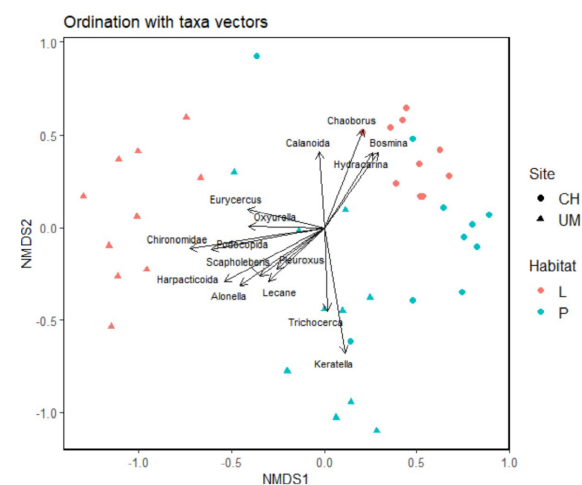


Figure 3. Non-metric multidimensional scaling (NMDS) ordination of prey taxa communities within fish guts coded by site (circles=Chebacco, triangles=Upper Mystic) and colored by habitat type (L = littoral, P = pelagic). Each point represents a community of prey taxa within a single fish gut and the arrows each represent a unique prey taxon that is driving the spread of the ordination.

Quantifying the Effects of Algae Availability on Freshwater Mussel

Freshwater mussels play a vital role in forging a healthy environment for the ponds, streams, and rivers they inhabit. Although they are highly diverse in North America, freshwater mussels are particularly susceptible to extirpation, comprising almost 50% of the most vulnerable freshwater species. Propagation and reintroduction of mussels is a potentially valuable approach to restore populations at risk. Freshwater mussel propagation facilities use a laboratory to propagate mussels for future reintroduction and conduct research to improve rearing systems. Rearing mussels in a laboratory involves evaluating factors that are essential to achieving success and optimal growing conditions, such as diet. Although it is well known that mussels filter feed, little research has been conducted to understand how differences in algal size and quantity influence growth.

STUDENT
ADVISOR
FUNDING
COLLABORATORS

Sarah Endyke (BS)
Allison Roy
UMass Amherst CHC
David Perkins



Figure 1. The North Attleboro National Fish Hatchery (Sarah Endyke).

To inform optimal dietary regimens for laboratory propagation, I conducted an experiment examining the effects of algal concentration on mussel growth. Using yellow lampmussel (*Lampsilis cariosa*) as a study species, I compared mussel growth between wild water (from a pond at the North Attleboro National Fish Hatchery) and commercial algae feed. I created four treatments of North Attleboro National Fish Hatchery pond

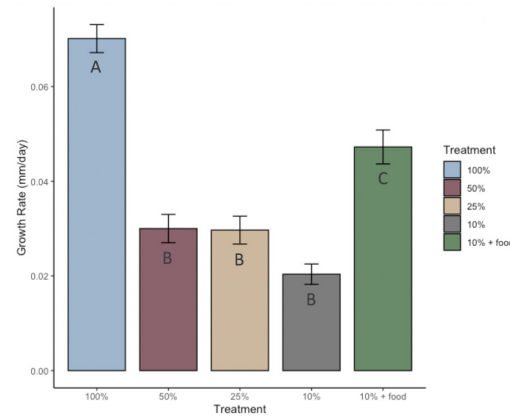


Figure 2. Mean (\pm standard error) growth rates for each pond treatment over the 4-week experiment with ANOVA results (different letters = significant differences between treatments).

water diluted with different amounts of water as well as one treatment mimicking a feeding regimen administered in the laboratory. Each treatment had three replicates and the experiment was conducted for four weeks in August 2019. Temperature was controlled using water heaters and tracked with continuous temperature loggers.

Mussel growth was highest in the treatments with high concentrations of pond water and gradually declined with diluted pond water (Figures 2 & 3). The treatment with an attached feeding system had the second highest growth rate, just under

100% pond water, suggesting that mussels are food-limited with only the commercial algae feeding system.

This experiment showed highest mussel growth rates in systems containing wild water, suggesting that this is the best method for maximizing growth. However, this type of feeding system is inconvenient and often unavailable to facilities. The commercial algae diet is a promising way to administer food to mussels in a propagation center, given that it showed the second highest overall mussel growth rates, and it is simple and more convenient than rearing mussels in wild water. Nevertheless, the information from this study may only be pertinent to the single cohort age and yellow lampmussel from the Connecticut River, and future studies are needed to assess the applicability of these results to other species, life stages, and regions.

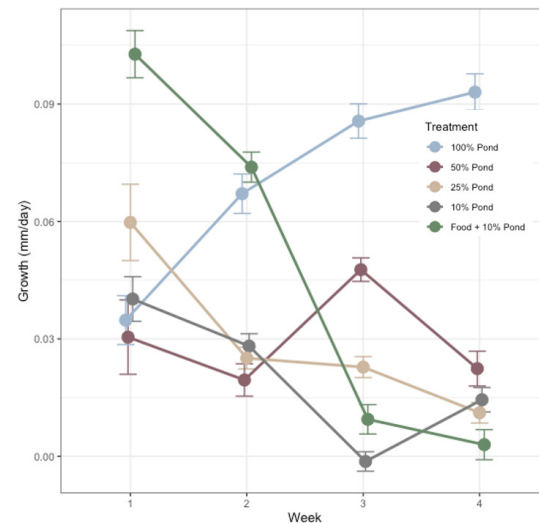


Figure 3. Mean (\pm standard error) growth rates for each pond treatment over the 4-week experiment. Week 1 refers to the period of 0-7 days, Week 2 is the period from 8-14 days, Week 3 is the period from 15-21 days, and Week 4 is the period from 22-29 days.

Temporal Shifts in Migratory River Herring Diets and Zooplankton Assemblages within Connecticut River Coves

Juvenile river herring (alewife, *Alosa pseudoharengus* and blueback herring, *A. aestivalis*) feed on zooplankton while in freshwater before migrating to the ocean. As a limited resource, zooplankton availability may influence juvenile river herring growth, health, and timing of emigration to the ocean. This study worked to better understand the seasonal shifts in food resources and river herring through three main questions: 1) How do zooplankton assemblages vary among three Connecticut River coves? 2) What do river herring consume in the coves? 3) Do juvenile river herring diets vary, and if so, why?

STUDENT	Meghan Slocombe (BS)
ADVISOR	Allison Roy & Adrian Jordaan
FUNDING	USGS UMass Amherst CHC MADMF
COLLABORATORS	Meghna Majardi Matthew Devine Lian Guo

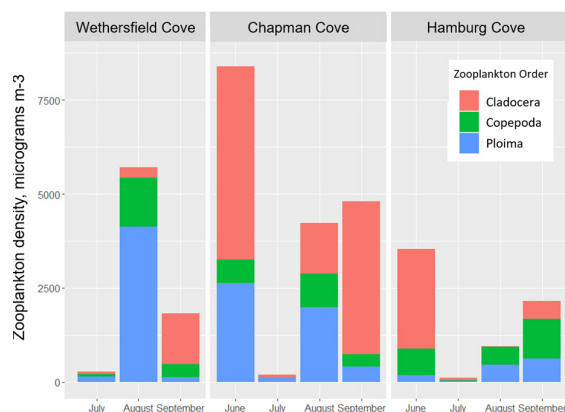


Figure 2. Average zooplankton density by Order for Wethersfield Cove (WC), Chapman Pond, and Hamburg Cove for June, July, August, and September (excluding June for WC).

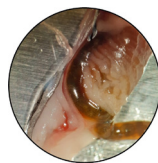


Figure 1. A closeup of a river herring gut, the dark brown tube. *Ostracoda* are visible as spherical items within.

Samples were collected monthly during 1-week sampling periods June-September of 2019 from Wethersfield, Chapman, and Hamburg Coves. Juvenile river herring were collected with a pelagic purse seine and then euthanized, measured, and put in labeled tubes on dry ice (July-September). Zooplankton samples were collected and preserved with formalin (June-September). Fish and plankton samples were analyzed in the lab. Fish were dissected, with all prey items identified, enumerated, and the first twenty prey items of a unique taxa measured (Figure 1). Subsamples of the zooplankton samples were processed similarly. Zooplankton assemblages, both by size and species composition, varied by month and site. In all sites, Ploima had the highest densities; however, the small size of Ploima means that they accounted for the smallest portion of the total plankton biomass across all three sites. Conversely, *Cladocera* and *Cyclopoida* had lower densities, but made-up considerable portions of the total zooplankton biomass across sites and months (Figure 2). While the overall zooplankton composition varied greatly among the three sites, zooplankton biomass consistently decreased in July, when juvenile river herring densities were highest, and rebounded in the following months (Figure 2).

The prey biomass within juvenile river herring guts were dominated by *Ostracoda* and *Cladocera* (Figure 3). *Cladocera* live in the water column and were found in the zooplankton samples (Figure 2), whereas *Ostracoda* are microcrustaceans commonly found near vegetation and were not in the zooplankton samples. *Ostracoda*'s dominance within juvenile river herring guts was unexpected. *Ostracoda* were most abundant in Chapman Cove fish guts, a heavily vegetated site (Figure 3).

If *Ostracoda* are deemed an efficient prey, vegetation within freshwater coves may be important for juvenile river herring. High river herring densities at Wethersfield Cove appear to have led to an overexploitation of plankton and the corresponding low prey biomass in fish guts seen at the site (Figure 3). River herring migration further upstream is impeded by dams.

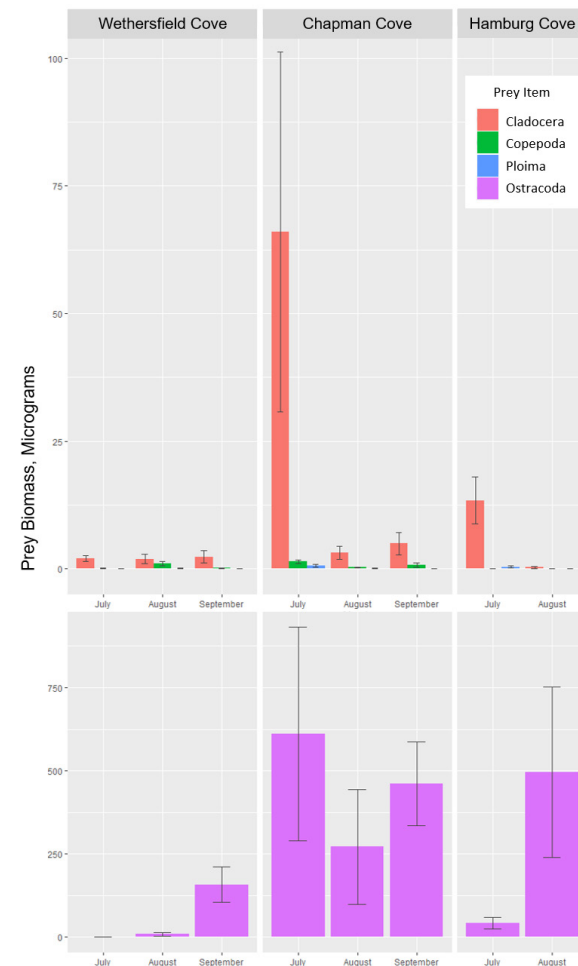


Figure 3. Average (± 1 standard error) prey biomass per fish gut for Wethersfield Cove, Chapman Cove, and Hamburg Cove. Categories are by Order for zooplankton (Cladocera, Copepoda, Ploima) and by class for *Ostracoda*.

Difficult Disease Decisions: How to Reduce Risk When Dealing with Multiple Competing Objectives and Opposing Risk Tolerances

Ecosystem resource management becomes complicated quickly when managers have multiple objectives and different risk tolerances to a given management action. For example, when faced with the potential threat of disease emergence, resource managers must balance: (a) the risk of a disease outbreak if delaying management, which may result in animal mass mortality at some unspecified point in time, and (b) the risk of implementing unnecessary management if no disease outbreak occurs, which may require tradeoffs in the near-term (e.g., preemptive culling reduces the immediate population size). Using the high-profile emerging pathogen of amphibians, *Batrachochytrium salamandrivorans* (Bsal), that threatens invasion into North America, we will identify approaches to improve decision-making in the face of multiple objectives and opposing risk tolerances. This work builds on ongoing work; we have already framed the decision related to a possible Bsal invasion with three NWR managers in the northeastern United States (a hotspot for Bsal risk). We will use simulations, modeling, and optimization techniques to identify optimal actions when there are multiple objectives and opposing risks. We will generate user-friendly visualization tools intended to support risk reduction. We anticipate that our approach and framework can be modified and used for future decisions on human well-being and society related to emerging infectious diseases (and other hazards). Therefore, we foresee that our approach and framework will help better understand, predict, and communicate the tradeoffs decision-makers are forced to make in the face of uncertainty.

POST-DOC Molly Bletz
ADVISOR Graziella DiRenzo
FUNDING USGS Risk Community of Practice
COLLABORATORS Evan H. C. Grant

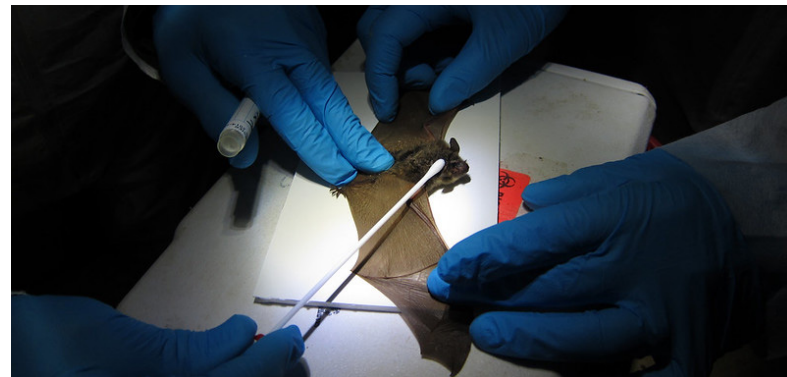


Eastern Red-Spotted Newts are expected to be particularly vulnerable to Bsal invasion in the United States (Brian Gratwicke).

Improving Management and Surveillance Decisions Related to White Nose Syndrome by Accounting for Imperfect Detection and Misclassification Error

Management decisions for emerging infectious diseases, endangered species, and invasive species depend on the true state of the system and must be made quickly to maximize opportunities for mitigation. However, molecular detection methods, like any diagnostic test used in the detection of pathogens, may occasionally yield false negatives (i.e., when a sample appears negative but is truly positive) as well as 'ambiguous,' 'uncertain,' or 'equivocal' results (i.e., an inability to confidently classify a sample as negative or positive). Here, we will construct a hierarchical Bayesian model to account for imperfect pathogen detection and ambiguity in the white nose syndrome (WNS) system; our model will use surveillance data to improve forecasts of the invasion front, improve state-dependent decision making, and improve our ability to identify high priority areas for WNS surveillance. We foresee our model also improving the management and decision-making process of other pressing issues which benefit from early detection but are challenged by imperfect and ambiguous detections, including those related to invasive species, endangered species, and pathogen surveillance.

POST-DOC Riley O. Mummah
ADVISORS Graziella DiRenzo
FUNDING USGS Biological Threats
COLLABORATORS Brittany A. Mosher Robin E. Russell
 Evan H. C. Grant Dan Walsh



Biologists swabbing a bat for the presence of white nose syndrome, a fungus causing widespread bat mass mortality across the United States (Steve Taylor).

Using Aerial Surveys to Estimate Trends in Brown Bear Population Dynamics at Katmai National Park, Alaska.

Katmai National Park, in Southwest Alaska, is home to one of the world's largest brown bear 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 goals are to combine counts of bears congregating along salmon spawning streams with demographic data from Brooks River to estimate trends in brown bear use of salmon spawning streams, trends in brown bear population abundance, and to examine environmental factors influencing these trends.

STUDENT	Leslie Skora (PhD)
ADVISOR	Tammy Wilson
FUNDING	Katmai National Park The Katmai Conservancy Southwest Alaska Network
COLLABORATORS	Amy Miller Troy Hamon Buck Mangipane

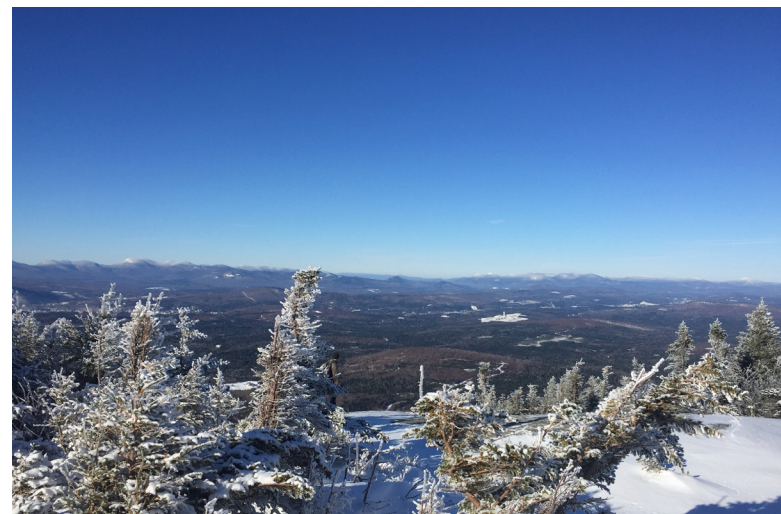


Conducting aerial surveys along the Savonoski River in Katmai National Park, AK. Researchers count bears congregating on salmon spawning streams (Leslie Skora).

Effects of Habitats, Density, and Climate on Moose and Winter Tick Ecology in the Northeastern U.S.

Over the past several decades, moose populations in the northeastern U.S. have declined by at least 30%. This has caused concern among natural resource agencies and prompted research initiatives across the region. Results have indicated that high winter tick infestations are a major factor in the negative trend of moose populations, with some animals found to be hosting over 60,000 ticks. Building upon recent research in ME, NH, and VT, the focus of this project is to develop and assess approaches for monitoring moose and winter ticks, and to identify the extent to which climate, habitat, and density-dependence influences moose-tick dynamics. This research will extend from MA to ME and be important for informing management decisions in New England.

STUDENT	Juliana Berube (MS)
ADVISORS	Tammy Wilson
FUNDING	USGS CRUP
COLLABORATORS	Therese Donovan, Alexej Sirén, and cooperators in MA, ME, VT, NH, and NY



Alpine vista in northern New Hampshire (Juliana Berube).

Black Bear Habitat and Resource Selection

With the expansion of urbanization in Massachusetts, black bear habitat has become less abundant and more fragmented. As a result, black bears have adapted to use new habitats and have changed their foraging habits to take advantage of garbage, crops, birdfeeders, and livestock that residential areas provide. While these sources of food may improve individual bears' body condition, they are detrimental for bear populations. Increased bear presence in developed areas means increased human-wildlife conflicts, including increased bear mortality from unnatural causes such as vehicle collisions and lethal removal. This project will examine what kind of habitats and resources black bears are using in Massachusetts in relation to what is available to them. I will use radio collar data collected from female black bears and GIS spatial layers to assess habitat and resource use. I will use Resource Selection Functions to investigate resource availability and selection for bears. The results will allow the state to further understand what resources and habitats are being used by black bears to make management decisions that benefit both human and bear populations. This may be in the form of hunting regulations, feeding restrictions, and/or infrastructure mitigation suggestions.

STUDENT Jessica Bonin (MS)
ADVISORS Tammy Wilson
FUNDING MassWildlife
COLLABORATORS Dave Wattles



Jessica with sedated black bear trapped for the project (Dave Wattles).

Eastern Box Turtle Population Dynamics in the Pine Barrens of Joint Base Cape Cod

Eastern box turtles (*Terrapene carolina carolina*) are listed under the Massachusetts Endangered Species Act as a species of special concern. This species occurs in Pine Barren habitats, where many other species are listed as species of special concern at the state and federal levels. We are currently developing a research study to assess the population dynamics of the eastern box turtle at Joint Base Cape Cod. We aim to explore the effects of either prescribed fire management or a parasitic fly larva on box turtle home range, survival, dispersal, and habitat selection. We will collect radio telemetry data during the summer of 2022, and we will monitor their behavior and/or distribution in comparison to records kept prior to prescribed fire implementation and parasitic larval infestation. The results of this study will be used to inform the upcoming federal listing decisions of species that inhabit Pine barrens habitats by the USFWS.

STUDENT Andrew B. Gordon Jr (MS)
ADVISORS Graziella DiRenzo
FUNDING USFWS
COLLABORATORS Anthony Tur
Christine McCue
Jacob McCumber
Annie Curtis
Mike Jones

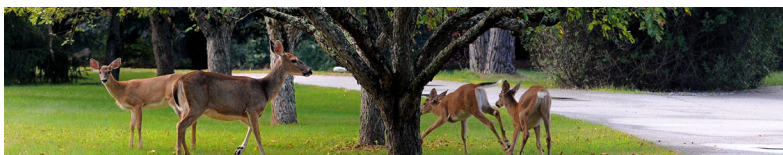


Eastern box turtle (*Terrapene carolina carolina*) with radio transmitter hiding in leaf litter (Andrew B. Gordon Jr).

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

White-tailed deer (*Odocoileus virginianus*) are abundant throughout eastern Massachusetts, where suburban landscapes provide high quality habitat. Ecological degradation from over-browsing and increased human-deer conflicts results in a need to address overabundant deer populations. Regulated hunting is a widely accepted deer management strategy used to effectively reduce and maintain deer densities, although its use in suburban landscapes presents challenges. Of particular concern is the long-term participation of devoted hunters. Presumably, hunter participation is driven largely by participants' satisfaction with the hunting experience, which may be low in highly controlled hunts such as the Blue Hills Reservation Deer Management Hunt. A better understanding of suburban hunters' expectations, preferences, and limitations is of great importance if effective deer management programs are to be implemented. A survey of hunters participating in the Blue Hills hunt was conducted in 2015 and 2016 to assess hunters' motivations and experiences. A total of 2,938 individuals who applied to participate in the hunt were contacted and asked to complete one of six web surveys. Respondents were asked questions related to their motivations for hunting, likelihood to participate in controlled suburban hunts, success and experience at the Blue Hills hunt, if their expectations were met, and opinions on restrictions and implementation of controlled hunts, among other topics. Total response rates were high, ranging from 50% to 79% and averaging 68% and a majority of respondents (94%) completed the survey. Survey responses may result in a better understanding of what motivates suburban hunters to participate in controlled hunts and thus, potentially guide the development of more effective deer management programs.

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



Deer in suburban Massachusetts (Bill Byrne).

Structured Decision Making Application to the Problem of Turtle Confiscations

In the Northeastern U.S., turtles are routinely confiscated from trade routes after being illegally harvested from their natural habitats. The origins, health and genetic make-up of these turtles are often unknown, which makes returning individuals to their original population difficult. Therefore, the goal of my project is to work with decision makers (e.g., managers from state and government agencies) to (1) frame the problem using structured decision making, and (2) outline a conceptual model to identify points of intervention and decision-making authority at each point. In framing the problem, I will help decision-makers consider the uncertainties, constraints and many different possible outcomes of their problem. In outlining a conceptual modeling, I will help decision-makers map out decision points and options, as well as show the possible outcomes and uncertainties that will be the result of particular decisions. Using decision analysis tools, I aim to equip decision-makers with the knowledge needed to make informed decisions to conserve affected turtle species.

STUDENT Desiree Smith (MS)
ADVISOR Graziella DiRenzo
FUNDING USGS & USFWS
COLLABORATORS Evan H.C. Grant



Wood turtle (*Glyptemys insculpta*) (Mike Jones).

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

The Andean bear (*Tremarctos ornatus*) is the sole bear species in South America (Figure 1). The Andean bear is also a species of conservation interest by the International Union for Conservation of Nature and Peruvian government. However, the lack of knowledge on different aspects of Andean bear ecology, biogeography, and abundance patterns hinders current conservation efforts for the species.

We compiled Andean bear occurrence records in Peru in collaboration from many and collected new records by camera traps (Figure 2) and direct or indirect Andean bear signs from four study



Figure 3. Andean bear on tree canopy (Nereyda Falconi Lopez).

areas. We created an open-access database at the Global Biodiversity Information Facility data repository, and we used these data to model the distribution of Andean bear within Peru (Figure 3). Our models included areas in central Peru omitted by previous assessments. These results are being included in the last assessment of the threatened species of Peru by the National Forest and Wildlife Service.

We used ^{15}N stable isotopes analyses of hair samples to infer diet composition and trophic position for all eight bear species in the world by comparing bear ^{15}N values to reference mammal species and to published dietary studies. We also examined how the frequency of reported human-bear conflicts related to bear trophic positions. I found that most bear species were mainly herbivorous (low ^{15}N) and similar, while the few more highly carnivorous species (high ^{15}N) differed among themselves in trophic position. Brown bears ranged from herbivorous to carnivorous between sampling localities. The ^{15}N signatures of bears were uncorrelated to the frequency of livestock predation or crop damage reported, indicating bear-human conflicts are not related to bear diet composition.

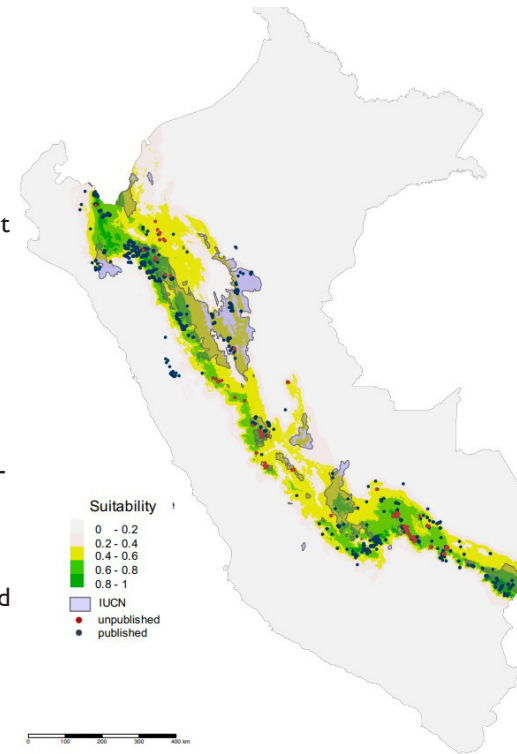


Figure 3. Estimated Andean bear distribution



Figure 2. Andean bear capture in camera trap (Nereyda Falconi Lopez).

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

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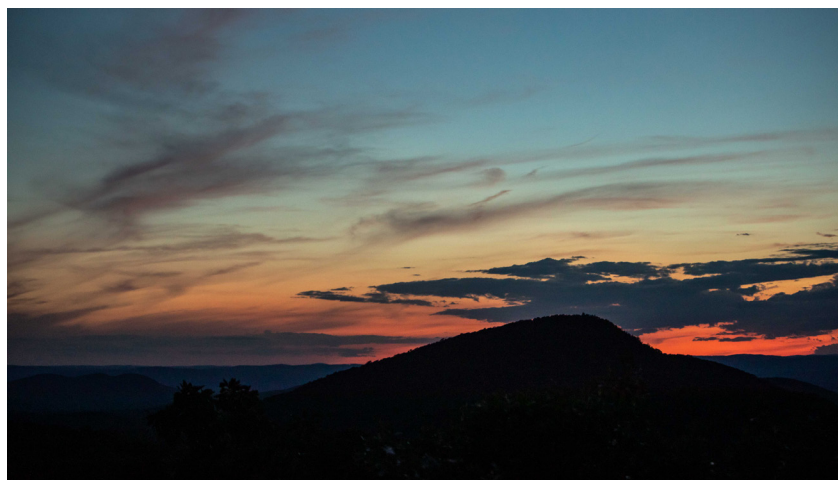
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A CRESCENT MOON GLOWS OVER THE HOLYOKE RANGE'S HIGHEST POINT, MOUNT NORWOTTUCK, SHORTLY AFTER SUNSET IN AMHERST, MA (PETER ZAIDEL)

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AN EASTERN POND MUSSEL SIPHONS WATER IN A RIVER IN MA (AYLA SKORUPA)

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Baker, A.M. and **A.H. Roy**. April showers in November: Flipping the flow regime: Examining how altered hydrology from winter drawdowns can impact downstream ecology. ASLO-SFS 2020 Joint Summer Meeting, 7-11 June 2020, Madison, WI. (Poster)

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GOLDEN SHINERS IN LATE AFTERNOON IN LONG POND, MA (AYLA SKORUPA)

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Grant, E.H.C., **G.V. DiRenzo**, J. Werba, and A.B. Brand. Incorporating competition and climate in management of a high-elevation endemic salamander: modeling. The Wildlife Society Meeting, 2020.

Grant, E.H.C., A.B. Brand, **G.V. DiRenzo**, and R.F. Bernard. Using Decision Analysis to Facilitate Proactive Decision Making for Disease Response: Challenges and Opportunities for Bsal Management. The Wildlife Society Meeting, 2021.

Halstead, B.J., Kleeman, P.M., **DiRenzo, G.V.**, and J.P. Rose. Occurrence of Shasta salamanders (*Hydromantes spp.*) in little-studied portions of their range, with implications for optimizing survey design. Joint Meetings of Ichthyologists and Herpetologists, 26-27 July 2021, virtual.

Hazelton, P., **A. Roy**, A. Skorupa, and J. Carmignani. Changes in freshwater mussel abundance and habitat availability following dam removal. Georgia Chapter American Fisheries Society Annual Meeting, 19-21 January 2021, virtual.

Hazelton, P., **A. Roy**, A. Skorupa, and J. Carmignani. Trends in mussel abundance and habitat change 5-years post dam removal. Freshwater Mollusk Conservation Society Meeting, 12-14 April 2021, virtual.

Marjadi, M.N., J.J. Sheppard, M. Slocombe, and J. Llopiz. Development and implementation of an automated video counting system for quantitatively assessing the migrations of juvenile diadromous fishes. ICES Annual Science Conference, 9-12 September 2019, Gothenburg, Sweden.

Marjadi, M.N., Drakopoulos, L., Guo, L., Robertson, D., Koehn, J.Z., Panchang, S. Increased risk for urban subsistence fishers: why fisheries and urban policy should match fishing practices. ICES Annual Science Conference, 9-12 September 2019, Gothenburg, Sweden. (Poster)

Norwood, P., M.T. Devine, E. Molden, **A.H. Roy**, and A. Jordaan. Investigating juvenile river herring productivity in Nantucket Ponds: Insights for pond management. Southern New England American Fisheries Society Winter Meeting, 13-14 January 2020, Cambridge, MA. (Poster)

Roy, A.H., D.S. Armstrong, M.E. Baker, C.N. Bentsen, R.F. Smith, and J.T. Stolarski. Unpacking fish responses to impervious cover in Massachusetts. Southern New England American Fisheries Society Winter Meeting, 13-14 January 2020, Cambridge, MA.

Roy, A.H., P.D. Hazelton, and S.C. Sterrett. Modeling and monitoring for rangewide conservation of a rare mussel. Northeast Aquatic Biologist Conference, 4-6 March 2020, Newport, RI.

Roy, A.H. and J. R. Carmignani. Ecological responses of shallow littoral zones to annual wintertime water level drawdowns in reservoirs. ALSO-SFS 2020 Joint Summer Meeting, 7-11 June 2020, Madison, WI.

Roy, A.H., J.R. Carmignani, J.T. Stolarski, and T. Richards. Hydrology of annual winter water level drawdowns in recreational lakes of Massachusetts, USA. North American Lake Management Society Meeting, 16-20 November 2020, virtual.

Roy, A.H., J.R. Carmignani, J.T. Stolarski, and T. Richards. Hydrology of annual winter water level drawdowns in recreational lakes of Massachusetts, USA. National Monitoring Conference, 19-23 April 2021, virtual.

Roy, A.H. and A.C. Engman. Biotic diversity in urban ecosystems: Current knowledge and research needs. Annual Meeting of the Society for Freshwater Science, 23-27 May 2021, virtual.

Ryan, J.E., **A.H. Roy**. Fish Assessments to Inform the Recovery of Dwarf Wedgemussel. Northeast Aquatic Biologist Conference, 4-6 March 2020 Newport, RI.

Ryan, J.E., **A.H. Roy**, D.L Perkins, and T.M. Warren. In-vitro propagation of *Alasmidonta heterodon* (dwarf wedgemussel). Northeast Natural History Conference, 17-19 April 2019, Stamford, CT.

Ryan, J.E., **A.H. Roy**, D.L Perkins, and T.M. Warren. In-vitro propagation of dwarf wedgemussel. ASLO-SFS 2020 Joint Summer Meeting, 7-11 June 2019, Madison, WI.

Ryan, J.E., **A.H. Roy**, P.D. Hazelton, D.L Perkins, and T.M. Warren. Mitigating contamination for in-vitro propagation of dwarf wedgemussel. Freshwater Mollusk Conservation Society Meeting, 12-14 April 202, virtual.

Ryan, J.E., **A.H. Roy**, P.D. Hazelton, D.L Perkins, and T.M. Warren. Mitigating contamination for in-vitro propagation of dwarf wedgemussel. Northeast Natural History Conference, 15-18 April 2021, virtual.

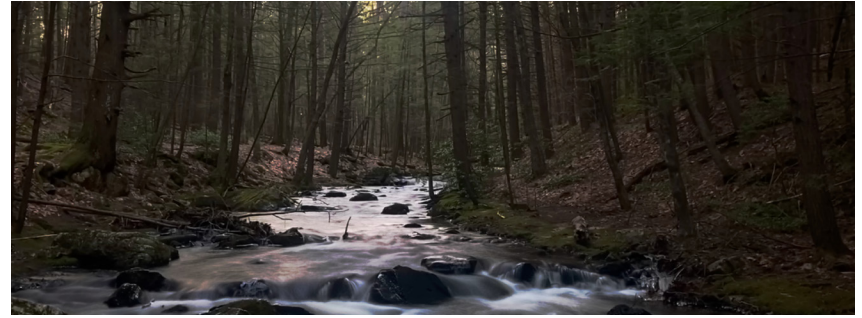
Scoggins, M., A. Gonzales, R. Hawley, R.F. Smith, E. Bilger, R. Hale, M. Fork, K. Hopkins, Martin Neale, and **A.H. Roy**. Moving the bar on multidisciplinary solutions to wicked urban stream problems: A summary of SUSE5. ASLO-SFS 2020 Joint Summer Meeting, 7-12 June 2020, Madison, WI.

Skorupa, A., **A.H. Roy**, P.D. Hazelton, A. Fisk, D. Perkins, and T. Warren. Propagation as a tool for restoration of a state endangered freshwater mussel. Northeast Aquatic Biologists Conference, 4-6 March 2020, Newport, RI.

Skorupa, A., **A.H. Roy**, P.D. Hazelton, D. Perkins, and T. Warren. Assessing propagated brook floater growth and survival across four rivers with extant populations. ASLO-SFS 2020 Joint Summer Meeting, 7-11 June 2020, Madison, WI.

Skorupa, A., **A.H. Roy**, P.D. Hazelton, A. Fisk, D. Perkins, S.C. Sterrett, and T. Warren. Habitat predicts abundance of five freshwater mussel species in Massachusetts. Freshwater Mollusk Conservation Society Symposium, 12-14 April 2021, virtual.

Skorupa, A., **A.H. Roy**, P.D. Hazelton, A. Fisk, D. Perkins, S.C. Sterrett, and T. Warren. Habitat predicts abundance of five freshwater mussel species in Massachusetts. Northeast Natural History Conference, 15-18 April 2021, virtual.



MIDDLE BRANCH OF SWIFT RIVER ON BEAR'S DEN RESERVATION (KATHERINE ABBOTT)

Slocombe, M.G., M. Marjadi, J.K. Llopiz, J.J. Sheppard, and **A.H. Roy**. Collaborating with citizen scientists to count migrating juvenile river herring from videos. Southern New England American Fisheries Society Summer Meeting, 27 June 2019, Hadley, MA.

Slocombe, M.G.P., M.N. Marjadi, M. Devine, L.W. Guo, A. Jordaan, and **A.H. Roy**. Temporal shifts in migratory river herring diets and zooplankton assemblages within a Connecticut River cove. Southern New England American Fisheries Society Winter Meeting, 13-14 January 2020, Cambridge, MA. (Poster)

Spelman, S.B., K.M. Abbott, J.B. Richardson, and **A.H. Roy**. Toxic metal bioaccumulation in dammed streams: Implications for food webs. Northeast Aquatic Biologists Conference, 3-11 March 2021, virtual. (Poster)

Sterrett, S.C., L. Stevenson, M. Endries, T.L. Morelli, P.D. Hazelton, and **A.H. Roy**. Development of a species distribution model to inform proactive conservation decision making: A case study with a freshwater mussel. Northeast Association of Fish and Wildlife Agencies, 19-21 April 2020, Long Beach, NJ.

Wilson, T.L. Landscape factors affecting lake trout mercury concentration in Lake Clark and Katmai National Parks. International Association for Landscape Ecology - North America, 12-16 April 2021, Reno, NV, virtual. (Poster)

Zeller, K., D. Wattles, and **S. DeStefano**. Forecasting seasonal connectivity in a developing landscape. Annual meeting of The Wildlife Society. 29 September – 3 October 2019, Reno, Nevada.

Zeller, K.A., D.W. Wattles, L. Conlee, and **S. DeStefano**. Movement and density of black bears in Massachusetts. East Quabbin Land Trust Monthly Meeting. 22 September 2019. (Invited)

International and National Awards

Katherine Abbott: Noreen Clough Memorial Scholarship for Females in Fisheries, B.A.S.S., 2020

Rick Harper: Public Education Award, Tree Canada, 2020

Meghna Marjadi: Switzer Foundation Fellowship, Robert & Patricia Switzer Foundation, 2021

UMass ECO Awards

Katherine Abbott: Richard Cronin Fisheries Research Fund Award, 2021

Julian Burgoff: Outstanding Senior Fisheries, Spring 2021

Meghan Slocombe: Outstanding Senior- Environmental Science, 2020

UMass Awards

Abhishek Kumar: Darwin Teaching Fellowship Award, OEB Program, 2021

Isabella Ceresia: CHC Honor's Research Fellowship, 2021

Callista Macpherson: CHC Honor's Research Fellowship, 2021

Meghna Marjadi: Teaching Award, OEB Program, 2020

Jennifer Ryan: 3-minute Thesis Runner-Up, 2019

Meghan Slocombe: Roger J. Reed Scholarship, 2020

Conference Awards

Katherine Abbott: Student Poster Award 2nd place, "Resilient river restoration through dam removal," Massachusetts Association of Conservation Commissions, 2020

Meghna Marjadi: Travel Funding Award, Woods Hole Oceanographic Institute ICES ASC, 2019



SUNSET ON LEVERETT POND IN LEVERETT, MA (PETER ZAIDEL)

USGS Massachusetts Cooperative Fish and Wildlife Research Unit Biennial Report 2020-2021

