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Another record warm
year marked by a
summer drought



Improving the way climate science informs resource management

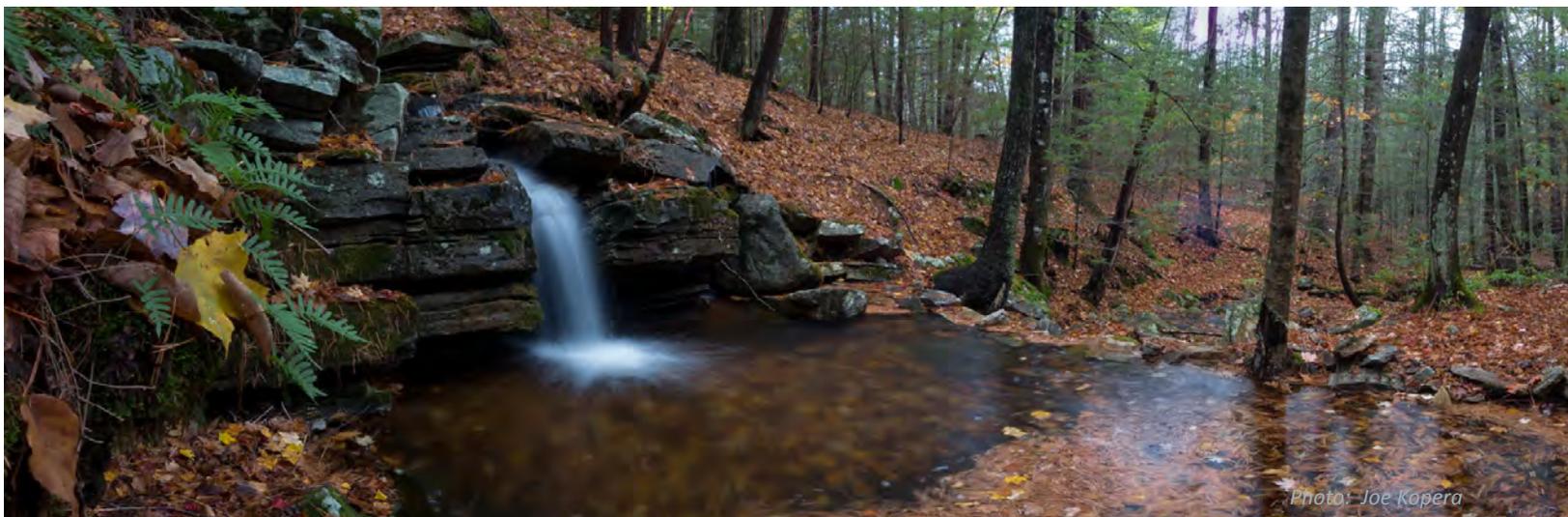


Photo: Joe Kopera

2016 NE CSC Highlights...

- \$700,000 in newly funded research, including two NE CSC capstone projects
- 16 projects completed to date
- National Student and Early Career Training hosted with over 70 participants from across the U.S.
- New USGS Deputy Director, based in Minnesota
- More than 110 papers presented at professional conferences, workshops, and meetings

Message from the Directors...

The Center has continued to produce actionable science on a wide range of topics. We are particularly proud that we have provided tools to managers and planners that support their challenging goals of helping species and ecosystems adapt to climate change. We have funded two broad-reaching, multi-faceted capstone projects that engage all of our consortium members in 2016. One project investigates the biological thresholds of species response to climate change and the second evaluates a “headwaters to ocean” approach to create more resilient watersheds that are impacted by both population growth and climate change in our region.



Richard Palmer
University Director,
UMass Amherst

After five years of building successful partnerships, the connections we’ve made are gathering energy and momentum. With the addition of Olivia LeDee, our Deputy Director based in the Midwest, we continue to broaden our relationships and find new ways to understand and meet the needs of our natural resource partners. It has been a great year and we look forward to working with our partners to develop the best science for the highest needs. We will continue to tailor our products to help those implementing conservation and management on the ground.



Mary Ratnaswamy
USGS Director

The Northeast Climate Science Center works with natural and cultural resource managers in the Northeast and Midwest regions to apply future climate scenarios to decision making and co-produce information and tools for climate change adaptation.

Priority Science Themes

- Climate change projections and assessments
- Climate impacts on land-use and land-cover
- Climate impacts on freshwater resources and ecosystems
- Climate impacts on Atlantic and Great Lakes coastal and nearshore environments
- Ecosystem vulnerability and species response to climate variability and change
- Impacts of climate variability and change on cultural resources
- Decision frameworks for evaluating risk and managing natural resources under climate change



Olivia LeDee is the Deputy Director of the NE CSC based in St. Paul, Minnesota. Before joining

the NE CSC in 2016, Olivia was with the Minnesota Department of Natural Resources in the Division of Fish & Wildlife as a planning and policy consultant. Welcome Olivia!

Decision Support: Protecting our National Heritage in the Face of Climate Change - Historic Jamestown

Some of the first European colonists to arrive in the New World in the early 17th Century landed on the shores of Jamestown Island. Now a National Park, visitors can walk the same grounds as Captain John Smith and Pocahontas. Sea level rise threatens to flood the grounds and the reconstructed fort used by colonists. NE CSC climatologist Alex Bryan used climate models to help managers at Colonial National Historical Park identify resources most vulnerable to climate change; from its historical landmarks, to its natural ecosystems, and its roadways, facilities, and other infrastructure. Park managers are using this information to take preventative action to protect and adapt these vulnerable resources in light of future projections.



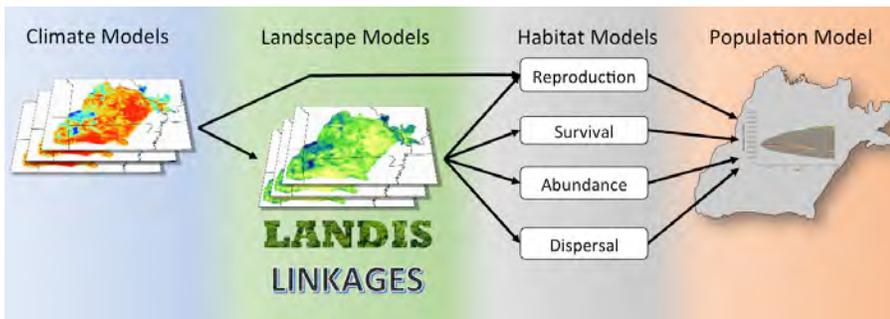
National Park Service - Colonial National Historical Park - Jamestown Collection

“For several decades, the Park has observed the receding shorelines due to increased storms and sea level rise. The impacts have come to a critical mass of loss and with current predictions, critical cultural and natural sites like Jamestown Island will disappear by 2100. The leadership of the URI Coastal Policy Institute, the DOI NE CSC, and the NPS Northeast Climate Change program helped the park quantify and qualify the parks’ vulnerable resources in this Vulnerability Assessment.”

- Dorothy Geyer, Natural Resource Specialist, Colonial National Historical Park

Featured Research: Supporting Landscape Conservation Decisions Amidst the Uncertainty of Global Change

The NE CSC works closely with Landscape Conservation Cooperatives to build collaborations across agency and ownership boundaries to conserve sustainable landscapes in the face of global change. The Gulf Coastal Plains and Ozarks Landscape Conservation Cooperative (GCPO) is challenged to design and conserve landscapes in the south-central US that are capable of sustaining plant and animal populations despite uncertainty in how species will respond to conservation actions amidst impacts from landscape and climate change, especially when those impacts are also uncertain. Their efforts are also complicated by the complexities of planning decisions, including strategic considerations such as the amount, configuration, and condition of habitat needed. And when important species fail to respond similarly to particular restoration scenarios, trade-offs further complicate the GCPO's decisions.



The many layers of data and scenarios resulting in a more informative predictor of the response of species and habitats to climate change. Figure from Tom Bonnot

To aid the GCPO and their partners, Thomas Bonnot, a Graduate Fellow with the NE CSC and the University of Missouri, and his advisors, Frank Thompson with the U.S. Forest Service (also a co-PI at NE CSC) and Josh Millsbaugh (now at the University of Montana), have developed a process to guide landscape conservation design. Their process involves developing and using dynamic-landscape meta-population models within a structured decision making (SDM) framework. The models predict wildlife responses to the threats of climate and landscape change and the conservation scenarios that address them. The SDM framework provides a structured way to compare those responses across multiple scenarios and uncertain climate change futures and resolve trade-offs between competing species objectives.

“Our regional bird conservation planning has been informed for many years by Frank and Tom’s work. We used habitat suitability models in a GIS framework to assess habitat quantity and quality for 24 species of land birds of conservation concern in the Central Hardwoods Bird Conservation Region. This work affected my thinking in that it convinced me that the notion that populations will increase directly in proportion to the amount of habitat we can put on the ground is very oversimplified, and that we really need to be able to incorporate demographic and other variables into conservation decision-making.”

- Jane Fitzgerald, Central Hardwoods Joint Venture Coordinator, American Bird Conservancy

Outreach: Connecting the Northeast on Invasive Species

Invasive species and climate change represent two of the five major global change threats to ecosystems.

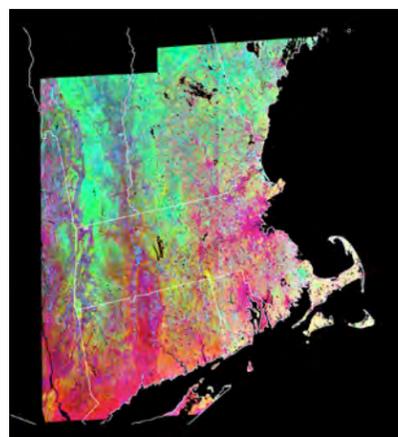
An emerging initiative of the NE CSC will develop management-relevant research to improve invasive species management in the face of climate change. Through working groups, information sharing and targeted research, this project addresses the information needs of invasive species managers in the context of climate change. The Northeast Regional Invasive Species and Climate Change (RISCC) Management network is collaboratively led by the NE CSC, the New York Invasive Species Research Institute, and the University of Massachusetts to combine climate and invasive species scientists with invasive species managers and policy makers from the northeast. The goal is to promote a two-way dialogue to 1) share regional knowledge about current management strategies and scientific insights; and 2) identify and address planning and information needs of managers related to invasive species and climate change. The First Annual Northeast RISCC Management Symposium will take place in July 2017 to bring together natural resource managers and scientists to discuss how climate change might affect invasion risk in the northeastern region and to identify ways to translate research into management action.



Timing of Life Events Shifting with Climate Change

Why it matters Shifts in phenology, or the timing of recurring life events, have been referred to as “fingerprints” of climate change impacts on ecological systems and species. Climate scientists and ecologists are working to understand how climate change will impact seasonal events for plants and animals such as migrations, spring emergence, and breeding. NE CSC researchers are working with resource managers to predict these shifts and adapt conservation and harvest practices to increase natural resilience to changing climate.

Remote Sensing Researchers at the NE CSC are using satellite imagery to learn how ecosystems and landscapes in the Northeast are changing over time. Using 30+ years of imagery from the USGS Landsat series of satellites, NE CSC Postdoctoral Fellow Valerie Pasquarella teases apart information to determine forest species composition, look for changes in vegetation phenology, and identify disturbances such as gypsy moth defoliation. She uses the long-term data set to detect changes in vegetation cover associated with development, forest management, and even beaver-related wetland flooding. Valerie’s work will inform a number of ongoing projects at the NE CSC, and the map products will serve a broader community of researchers and land managers who require more detailed local-scale information on landscape dynamics.



Satellite-derived data showing variability in spring and autumn phenology in New England states. Figure courtesy of Valerie Pasquarella

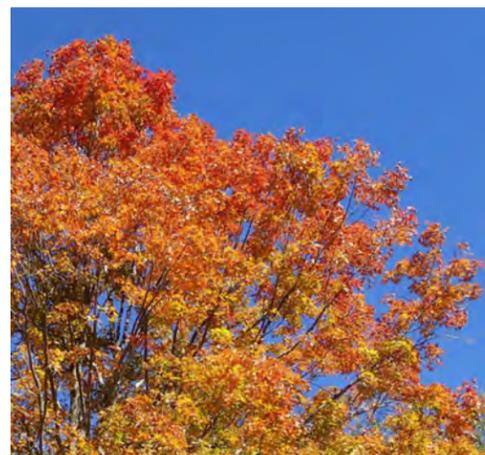


Photo: Joshua Rapp

Timing of Fish Migrations in the Great Lakes

Peter McIntyre, NE CSC co-PI at the University of Wisconsin, is studying the effects of climate change on fish populations in lakes and tributaries and how managers can incorporate information into harvest and conservation decisions. Earlier spring warming appears to be shifting the timing of fish migrations in the Great Lakes. Most of these species have traditionally moved into tributary spawning grounds in April-June, but starts in March are now commonplace. Equally troubling are unseasonable temperature variations that trigger migrations to start and stop, shifting the runs from a single large group to a protracted trickle of fish across several months. How this affects reproductive success is unknown, and there may also be reduced mixing of stocks on the spawning grounds as they arrive from different locations in the lake. Peter is filling this knowledge gap in partnership with the Great Lakes states, community groups, and local organizations.

Phenological Shifts in Marine Systems The NE CSC is working with a diverse array of state, federal, NGO and academic partners to improve understanding on climate-induced changes in timing of coastal and marine processes. Many marine species are migratory and rely on seasonal cues across their range such as the timing of phytoplankton and zooplankton blooms, sea surface temperatures, and seasonal oceanographic forces. The synchrony of ecological and environmental processes is critical to many biological events such as the successful rearing of young and availability of seasonal food resources (see sidebar). Affiliated investigators Adrian Jordaan of UMass Amherst, Daniel Pendelton with the New England Aquarium,

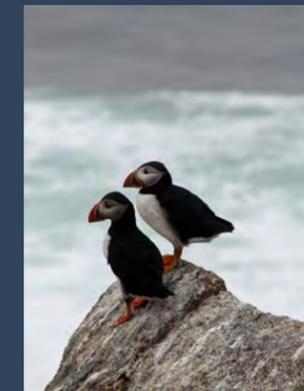
“This research will lend guidance to formulating adaptive strategies for short and long-term ecosystem management to cope with shifts in ecological and environmental conditions resulting from climate change.”

- John Sheppard, Diadromous Fish Biologist, Massachusetts Division of Marine Fisheries

and NE CSC’s Science Coordinator, Michelle Staudinger are analyzing long-term historical datasets to determine if coastal fish and wildlife have shifted the timing of their seasonal migrations and reproduction in the Gulf of Maine ecosystem, and to identify species that may be relatively more adaptive or vulnerable to climate change impacts in the future.

Carnivores in Boreal Forests Northern New England is a biodiversity hotspot due to variable climate, elevational gradients, and the convergence of forest communities. Like many other regions, it has experienced recent warming and is predicted to be significantly impacted by climate change. Given these dynamics, it is an ideal study system for evaluating the influence of climate and forest change on wildlife. Alexej Siren, a NE CSC Graduate Fellow, investigates how phenological patterns influence spatial ecology and demography at multiple scales. He has documented that American martens shift habitat use in response to changes in leaf emergence and senescence, and preliminary results from his Ph.D. research indicate that carnivores respond spatially to changes in snowpack. Alexej works with several state and federal natural resource agencies to understand the potential influence of climate change on specialist species such as Canada lynx and snowshoe hare.

See the NE CSC webinar recording on phenology by USGS’s Julio Bentancourt



Photos: Michelle Staudinger

Seabirds in the Gulf of Maine

NE CSC Graduate Fellow Keenan Yakola, who works with the National Audubon Seabird Restoration Program, Project Puffin, researches how the timing of nesting and availability of food will impact fledgling success. The Gulf of Maine has warmed rapidly in the past decade, altering the timing of physical and biological processes. Keenan’s field research across seven islands in the Maine Coastal Islands National Wildlife Refuge will examine how these changes are impacting coastal wildlife.



Photo: Hilary Cooke



Photo: Valerie Pasquarella



Photo: Evan Childress



Photo: Jukka Jantunen



Photo courtesy of Alexej Siren



Photo: Andrew Castillo



Photo courtesy of New England Aquarium

National Climate Science Center Training

The National Climate Science Centers' Student and Early Career Training

was held on the UMass, Amherst campus on November 2-3, 2016. There were 70 participants, from undergraduate to Post-doctoral level, early career professionals, and others who straddle career and higher education. Joined by 30 facilitators, educators and guest speakers, participants came from across the Climate Science Center's national network and from as far as Alaska and the Pacific Islands. Virginia Burkett, Associate Director of Climate and Land Use at USGS, and Alison Meadow from the Center for Climate Adaptation Science and Solutions were the featured speakers at this event. The two-day program offered a combination of skills development and discussion on topics such as climate science communication, building relationships with Native American tribes, and developing research portfolios.



I appreciated that we got to see how co-production is actually applied. It helped so much to see successful examples of this approach and to see examples of how to communicate compelling co-production stories.

- Jessica Blackband, SC CSC

The networking was fantastic. I made friends and connections across the nation (and even abroad!) and I am excited to continue to work with these people in the future. There are a lot of good ideas and intelligent people within this group and that was so incredibly refreshing to see.

- Tessa Hasbrouck AK CSC

Thinking about how to present my work to a non-science audience forced me to hone my message, which was actually a really useful exercise now that I am working on the manuscript for that work. Good, clear communication is important in journal articles as well.

-Katie Renwick, NC CSC



Photos courtesy of Toni Klemm, SC CSC

NE CSC Graduate Fellow Profile: Daniel Miller

University of Massachusetts, Amherst

One extremely complex impact of climate change is its effects on extreme events such as droughts and wildfires. While historical records of climate and wildfires extend back over 100 years in New England, fully understanding the natural mechanisms that control fire risk and occurrence requires continuous records of climatic variability and past fires on centennial to millennial timescales. Furthermore, little is known about how the direct (temperature and precipitation trends) effects of climate change will impact fire risk in New England under future climate scenarios. Daniel Miller's Ph.D. research aims to address these issues by investigating how long-term fluctuations in climate impact fire risk in pre-historic times through the generation of past records from lake sediment cores. With this increased understanding of past climate variability and fire activity, this research will allow us to estimate future trends in fire risk under various global warming scenarios through the end of the 21st century in New England.



Research Expertise from the NE CSC

The NE CSC, with its core of seven consortium institutions, assembles climatologists, biologists, ecologists, and hydrologists, working together to inform natural and cultural resource management.

Coastal processes • estuaries • eutrophication • freshwater input • food web interactions.

Led by Linda Deegan, Woods Hole Research Center

Temperate and boreal forests • adaptive management • silviculture • forest disturbance.

Led by Tony D'Amato, University of Minnesota

Ecological integrity • species responses • ecosystem risk management • ecological thresholds.

Led by Curt Griffin, University of Massachusetts

Hydrology • stream temperature • aquatic habitat • stream fish • extreme flow • ecological drought.

Led by Keith Nislow, University of Massachusetts

Landscape conservation design • forest management and succession • avian demographics and population dynamics.

Led by Frank Thompson, University of Missouri

Mammalian ecology • vulnerable species and habitats • landscape conservation design • conservation biology.

Led by Mary Ratnaswamy, USGS

Great Lakes • aquatic connectivity • temperature and flow regimes • fish migrations • coastal fisheries.

Led by Peter McIntyre, University of Wisconsin

Wildlife impacts • adaptation planning • decision analysis • natural resource policy • conservation funding.

Led by Olivia LeDee, USGS

Landscape and species conservation • climate adaptation • translational ecology • mammal vulnerability • decision analysis.

Led by Toni Lyn Morelli, USGS

Tribal resilience • connecting tribes and climate scientists • cross-cultural and cross-disciplinary education, applied research and outreach.

Led by Chris Caldwell, College of Menominee Nation

Aquatic and marine species vulnerability and adaptive capacity • phenology • adaptation and conservation strategies.

Led by Michelle Staudinger, USGS

Climate model assessment and future climate scenarios • paleoclimate • climate extremes.

Led by Raymond Bradley, University of Massachusetts

Climate extremes • risk assessment • combined impacts of multiple extremes • natural and built systems • science of adaptation.

Led by Radley Horton, Columbia University

Water resources • streamflow • stream temperature • stream health • water supply systems • decision analysis.

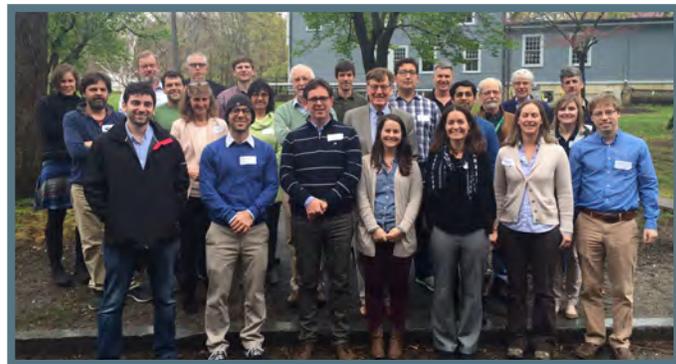
Led by Richard Palmer, University of Massachusetts

Climate model assessment for ecological applications • climate science communication • air quality.

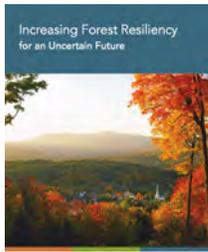
Led by Alex Bryan, USGS

Drought in the Northeast and Implications for Ecosystems

The Northeastern and Midwestern US was generally considered a well-watered region, yet droughts have occurred in the past due to large-scale changes in atmospheric circulation. In the 1960's, the 1980's, and as recently as 2016, widespread drought was experienced in this region. It is predicted that drought conditions will become more prevalent as climate change influences temperature and precipitation patterns. In May of 2016, a group of 26 climate and ecological experts explored how future drought may impact species, habitats, and ecosystems in this region. This workshop was part of a series of meetings at each of the nation's eight CSCs aimed at collating our existing knowledge of the ecological impacts, resistance, and recovery from drought. The eight CSCs provide a fantastic opportunity to compare the ecological effects of drought, related research activities, and management options at different regions, spatial scales, and biomes.



Other Notable News from the Year



New Resource Developed for Decision Makers in Forest Management

Anthony D'Amato, NE CSC Principal Investigator from the University of Minnesota, Paul Catanzaro of UMass, Amherst, and Emily Silver Huff with the USDA Forest Service created a guide for land owners and forest managers to improve the way we adapt to a changing climate. The publication "Increasing Forest Resiliency for an Uncertain Future" was written for forest decision makers in New England who are taking action to increase resiliency of our northern forests.

Interactive Tool for Rising Temperatures in Midwestern Lakes

As part of the NE CSC-funded project, "An Integrated Assessment of Lake and Stream Thermal Habitat Under Climate Change", led by Gretchen Hansen, MN DNR, and Jordan Reed of the USGS, this interactive website makes the results of a new study more accessible to a non-technical audience. The tool visually demonstrates new data on lake temperature changes and consequential effects on walleye and largemouth bass populations in Wisconsin.



Changes in Forested Landscapes & Effect of Climate Change on Spruce-fir Ecosystems

In 2016, PIs Frank Thompson and Anthony D'Amato wrapped up two far-reaching, stakeholder-identified projects that address NE CSC's science priorities in applying climate projections and assessments, determining ecological vulnerability and species response to climate variability and change, and climate impacts on land-use and land-cover change. The projects were: "Changes in Forested Landscapes of the Northeastern U.S. Under Alternative Climate Scenarios" (Thompson) and "Modeling Effects of Climate Change on Spruce-Fir Forest Ecosystems and Associated Priority Bird Populations" (D'Amato).

Climate Change Effects on Food Webs in the Great Lakes

In the recently completed NE CSC project, "Developing Fish Trophic Interaction Indicators of Climate Change for the Great Lakes," Richard Kraus (USGS Lake Erie Biological Station) and partners addressed regional climate change effects on aquatic food webs in the Great Lakes. The results were instrumental in the development of an interim decision rule for dealing with data collected during hypoxic events to improve stock assessment of Yellow Perch.



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This is the fifth Annual Report of the NE CSC and covers the activities of Jan-Dec 2016.*

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