Climate Change Impacts in the Northeast and Midwest United States

Michelle Staudinger, Ph.D.,
Science Coordinator and Deputy Director of the DOI Northeast Climate Center
University of Massachusetts Amherst
Outline

National climate change impacts
- Overview of the 2014 National Climate Assessment
- Observed and predicted trends in climate change
- Impacts on ecological resources

Who we are and what we do
- Program, science, projects, adaptation strategies

NE CSC Tribal engagement and outreach
- Goals
- Projects
- Opportunities
What is the National Climate Assessment?

- Report to Congress and the President not less than every 4 years
- Global Change Research Act (1990)
- The 2014 report is the 3rd NCA conducted
- Provide an overview of the current state of knowledge of climate change in the US (current and projected)
- Guide strategies to resolve risk and uncertainty

All available at globalchange.gov
Goal: Enhance the ability of the United States to anticipate, mitigate, and adapt to changes in the global environment

Vision: Advance an inclusive, broad-based and sustained process for assessing and communicating scientific knowledge of the impacts, risks, and vulnerabilities associated with a changing global climate in support of decision-making across the United States
Outline for 2014 NCA

SECTORS
• Water
• Energy
• Transportation
• Agriculture
• Forests
• Ecosystems
• Human health
• Energy, Water, and Land
• Urban
• Indigenous Peoples
• Land Use & Land Cover Change
• Rural Communities
• Biogeochemical

REGIONS
• Northeast
• Southeast
• Midwest
• Great Plains
• Southwest
• Northwest
• Alaska
• Hawaii & Pacific Islands
• Oceans
• Coasts

RESPONSE STRATEGIES
• Decision Support
• Mitigation
• Adaptation
• Research Needs
• Sustained Assessment
The NCA Process and Timeline

2011

Technical Input Teams conduct regional and sectoral assessments and engage stakeholders

2012

Chapter Author Teams develop report chapters based on technical inputs and other sources

2013

Public and expert review of draft report

2014

Final report released
Observed and projected trends in climate change across the Northeast and Midwest

Observed Changes

Projected Changes

2014 NCA report
10 Indicators of climate change

Figure source: NOAA National Climate Data Center
**Observed** trends in climate change

- U.S. average temperature has increased about 1.5°F since 1895
- >80% of this increase occurred since 1980
Observed changes in temperature (1991-2012)

Figure source: NOAA National Climate Data Center
Observed changes in precipitation (1991-2012)
Observed changes in frost-free season (1991-2012)

- Frost free and growing seasons have increased nationally since 1980s
- Largest increases in west, continued lengthening is projected

Figure source: NOAA National Climate Data Center

2014 NCA report
Projected trends in climate change

Emissions scenarios are the driving force, or cause of climate change
- Possible future releases of greenhouse gases and other pollutants
- Expected changes in population and technology
- Serve as a series of baseline emission projections


A1B storylines

RCP - Representative Concentration Pathways (IPCC, 2013)

RCP 2.6-8.5

Differences in projections reflect emissions scenarios and future human behaviors rather than differences in climate models

Climate scenarios capture the effect
- Describe possible mean characteristics of a future climate (e.g. hotter and drier)
Emission Scenarios → General Circulation Models (GCMs)

Bias Correction and Downscaling

Populations under future climate scenarios

Geography Department, U. Oregon
Projected seasonal temperature changes (2071-2099)
Projected changes in annual max precipitation (2071-2099)
Projected changes in consecutive dry days (2071-2099)
Projected impacts along the Atlantic coast

- Increased frequency and intensity of winter storms and hurricanes (Cat 4 and 5)

- Substantial increases in the maximum elevation of major coastal floods

- Substantial increases in the frequency of 100-year floods
Impacts of Climate Change on Biodiversity, Ecosystems, and Ecosystem Services

Technical Input to the 2013 National Climate Assessment

July 2012

Recommended Citation for overall document:

Chapter 8

Ecosystems, Biodiversity and Ecosystem Services

Convening Lead Authors
Paul W. Glickman, University of Nevada Reno
Peter Kareiva, The Nature Conservancy

Lead Authors
Stuart Carlton, US Geological Survey
Nancy R. Grimm, Arizona State University
Bruce A. Steen, NOAA
Toby Spribille, University of Colorado
Aneesah South Sherry III, University of California, Berkley
Mary Barkham, The Nature Conservancy
William E. Rees, Montana Tech Unviersity

Recommended Co-Author for Chapter

In the Web: http://www.globalchange.gov/portal/cover/8ecosystems

The Ecological Society of America

Frontiers in Ecology and the Environment
Special Issue
Impacts of climate change on biodiversity, ecosystems, and ecosystem services

EcoSociety
Biodiversity, Ecosystems, and Ecosystem Services Assessment Team

1) Impacts of Climate Change on Biodiversity
2) Impacts of Climate Change on Ecosystem Structure & Function
3) Impacts of Climate Change on Ecosystem Services
4) Climate Change Effects on Already Stressed Biodiversity, Ecosystems, and Ecosystem Services
5) Preparing for and managing change: climate adaptation for ecological systems
Framework and focus

**Biodiversity:** Biological responses to climate change across all components of biodiversity
- Genes
- Species
- Communities
- Ecosystems

**Ecosystem Structure & Function:** Fluxes and shifts in
- Biomes
- Hydrological cycle
- Winter season
- Ecosystem state changes

**Ecosystem Services:** What matters to people?
- Regulating services
- Supporting services
- Provisioning services
- Cultural services
Biodiversity and ecosystems are already more stressed than at any comparable period of human history.
Climate change is causing many species to shift their geographic ranges, distributions, and phenologies at faster rates than were documented previously; however, the timing, direction, and magnitude of these rates are not uniform across species or ecosystems.

**Phenology** - Timing of critical biological events, such as spring bud burst, emergence from overwintering, and the start of migrations, are shifting, leading to important impacts on species and habitats.
Shifts in time, space and self

- Rates of movement are 2-3 x greater than reported previously

- Faster rates of warming on land but faster shifts in ranges and phenology in ocean

- **Projected** shifts in species distributions are generally poleward, upward in elevation, or to deeper depths.....**but**

Staudinger et al. 2012, 2013
Shifts are highly idiosyncratic and sometimes counterintuitive as organisms respond to complex climate, biological and anthropogenic drivers

- Seasonal timing of energy (temp min/max)
- Water availability (precipitation, soil moisture, evapotranspiration)

- Differential shifts increase the potential for trophic mismatches and asynchronies among species and conditions

Mills et al, 2013. PNAS
Increasing evidence suggests that range shifts and novel climates will result in new ecological communities, new associations among species, and promote interactions that have not existed in the past

- Altered interspecific interactions
- Shifts in patterns of species dominance
- Reshuffling of communities
- New combinations of species
Climate-change-induced shifts in plant species distributions are changing the characteristics of biomes, altering ecosystem structure and functioning

- Changes in the distribution of biomes - ecosystems with the same dominant plant life-forms - are altering ecosystem structure and functioning
- Projected to occur in 5-20% of US by 2100

Grimm et al., 2013. FEE
Changes in winter have big and surprising effects on ecosystems and their services

• Changes in winter precipitation are leading to reduced snow cover
• Loss of insulation from snow is causing colder/frozen soils and increased root mortality; decreased composition; loss of N,P
• In agricultural ecosystems, winter warming may reduce soil carbon levels and sequestration
• Increased runoff can influence delivery of nutrients and water quality in nearby watersheds
Changes in the hydrological cycle are increasing water sustainability risk through:

- Susceptibility to drought
- Loading of contaminants and nitrogen to waterways
- Greater risk of waterborne disease outbreaks
- Expansion of dead zones
Conservation efforts will increasingly need to focus on managing for change

**Climate adaptation** - Initiatives and strategies to prepare for, accommodate to, and cope with climate impacts

- “Stationarity is dead”
- Consideration of uncertain future projections as well as historic conditions
- Emphasis on landscape-scale conservation, connectivity among protected habitats, and ecological functioning
Understanding sources of vulnerability and how species and systems are likely to respond to climate change is critical to developing effective climate adaptation strategies and management responses.

Vulnerability Assessments

- Exposure
- Sensitivity
  - Potential impact
  - Adaptive capacity

Vulnerability

*Figure adapted from Glick et al. 2011*
Northeast Climate Science Center
Who we are and what we do

http://necsc.umass.edu/
8 science-based Climate Science Centers with joint research interests
- Multiple LCCs per CSC with overlap
- Coordination across boundaries is critical - research, education, and outreach
- Host institutions (PIs) are key to coordination
NE CSC Consortium Members

University of Massachusetts Amherst
- Richard Palmer (Lead PI)
- Ray Bradley (PI)
- Curt Griffin (PI)
- Keith Nislow (PI)

College of Menominee Nation
- Chris Caldwell (Lead PI)

Columbia University
- Radley Horton (Lead PI)

Marine Biological Laboratory
- Linda Deegan (Lead PI)

University of Minnesota
- Anthony D’Amato (Lead PI)

University of Missouri Columbia
- Frank Thompson III (Lead PI)

University of Wisconsin-Madison
- Ken Potter (Lead PI)
Improving the way climate science informs resource management

The Northeast Climate Science Center provides scientific information, tools, and techniques that managers and other parties interested in land, water, wildlife and cultural resources can use to anticipate, monitor, and adapt to climate change in the Northeast region.
NE CSC – LCC Engagement

- NE CSC overlaps with 7 LCCs
- Monthly calls with Coordinators and Science Coordinators
- Steering Committee members and meetings
- RFP review panel members
- Partners on funded projects
Graduate and postdoctoral fellows training

• Recruit, educate, and support a new generation of scientists that can address the multi-disciplinary challenges associated with climate change

• Base funding devoted to support graduate and post-doctoral fellows at consortium universities

NE CSC Fellows Retreats
• Plum Island, MA 2013
• REIS Biological Station, MO 2014
NE CSC Science Themes

1. Climate change projections and assessments
2. Climate impacts on land-use and land-cover
3. Climate impacts on freshwater resources and ecosystems
4. Climate impacts on Atlantic and Great Lakes coastal and nearshore environments
5. Ecosystem vulnerability and species response to climate variability and change
6. Impacts of climate variability and change on cultural resources
7. Decision frameworks for evaluating risk and managing natural resources under climate change
Overall Proposal Selection Process for RFP

**STAGE 1**
- Statement of Interest

**STAGE 2**
- Invited Proposal

**STAGE 3**
- Selected Proposal

**Review Criteria**
1. Relevance/applicability to NE CSC science priority
2. Scientific merit/quality/design
3. Management significance
4. Stakeholder engagement
Examples of Ongoing NE CSC Projects

1. Future climate scenarios at a high resolution
   - Ray Bradley, UMass Amherst
2. Quantifying climate change impacts on forest ecosystems and evaluating associated adaptation strategies
   - Tony D’Amato, University of Minnesota
3. Making decisions in complex landscapes: headwater stream management across multiple agencies
   - Evan Grant, USGS Conte Anadromous Fish Laboratory
**Overarching Objectives**
- Understand how present day climate differs from climates in the past
- Understand the causes and mechanisms influencing climate change
Future climate scenarios at a high resolution
Ray Bradley, UMass Amherst

Approach

• Use of multi-model Regional Climate Model (RCM) simulations and multi-model statistical downscaling or Bias Correction and Downscaling (BCSD) to compare climate changes between present and future conditions

• Use of tree ring, lake sediment, and stalagmite cores to reconstruct extreme events over paleo time-scales
  o Droughts
  o Floods
  o Hurricanes
  o Fire regimes
Projected seasonal temperature changes
Multi-model means

Winter

Spring

Summer

Fall

Downscaled projections – Dr. Ray Bradley, UMass Amherst
Projected seasonal precipitation changes
Multi-model means

Winter

Spring

Summer

Fall

Downscaled projections – Dr. Ray Bradley, UMass Amherst
Overarching Objectives

• Evaluate and model effects of climate change on forest ecological function across large landscapes

• Develop and assess forest conservation and management strategies for enhancing adaptation across spatial and temporal scales
Forestry for a Sustainable Future

Approach

• Use long-term silvicultural treatments on experimental forests

• Test effects of climate variability on tree survival, recruitment growth and yield, and relative to wildlife habitat suitability and ecosystem services

• Identify vulnerable forest habitats and potential adaptation approaches in response to increasing natural disturbance rates and land use

Impacts of emerald ash borer and climate on black ash wetlands hydrology
Experimental Forest Monitoring for Climate Change

• In upper Lake States forests, reducing forest densities can lower drought vulnerability and alter species responses to temperature and precipitation

• Helping identify density management practices that can adapt a wide range of forest communities to climate change
Project objective: Evaluate the opportunities, benefits and costs to collaborative landscape conservation of headwater stream ecosystems.

Approach: use Structured Decision Making to identify a decision that satisfies multiple objectives which may be shared across the region for headwater stream systems.
Structured Decision Making
NE CSC tribal engagement and outreach activities
Impacts of climate variability and change on tribal and other cultural resources

*Secretarial Order No. 3289* identified climate impacts on tribes, tribal lands, and cultural heritage, as a priority for the Department of the Interior.

The NE CSC seeks to respond to this call by engaging the tribal community and working to:

- Build awareness, increase education, and develop research networks to improve the understanding of how climate change impacts tribes, TEK, and dependent natural resources.
- Evaluating options for adapting to climate change impacts.
NE CSC tribal engagement and outreach activities

- Conducted outreach mailing to 75 Northeast regional tribes (2012)
- Presentation to the United South and Eastern Tribes (USET) (2013)
- Participated in *National Adaptation Forum Working Group on Traditional Ecological Knowledge* (July-August 2013)
- Support of science and climate change adaptation projects with the College of Menominee Nation (PI Chris Caldwell) including *Shifting Seasons Summit*
- Call for proposals on cultural and tribal initiatives: FY13, FY14, FY15 RFPs
- Appointed Stakeholder Advisory Committee Tribal representative: John Daigle, University of ME
- Currently developing map of the tribal lands across the NE CSC region as a website tool for engagement
NECSC Base Funded Project

• NE CSC Tribal Advisory Council
• Literature Review of NE Tribal Climate Change projects
• Website development: Climate Change and NE Tribes
• Internships for Tribal College Students

NE CSC Directed Funding

• Shifting Seasons Summit
Northeast Regional Climate Assessment of Tribal Communities using SDI Model

Project Goals:

1. To create awareness about climate change impacts on Tribes in the Northeast region

1. To develop a set of working ideas about what capacities are needed for Tribes to adapt and to mitigate climate change impacts.
Primary Activity

SDI facilitating a relationship between a set of Tribes in the Northeast and the NE CSC that will provide future climate change scenarios:

- Identify climate change impacts unique to each participating Tribe
- Propose solutions for adaptation and mitigation that are relevant for each scenario
SDI Approach

1) Develop a Tribal Advisory Council to help guide tribal engagement and adaptation to climate impacts

2) Develop tools to help foster relationship-building among tribes and with federal partners
   • *Website* – providing guidelines for tribal-federal interactions
   • *Literature review* of NE CSC Strategic Science Agenda, and Indian Forest Management Assessment Team (IFMAT) to identify shared goals and connections
   • Shifting Seasons Summit

3) Conduct site visits of tribes to help increase knowledge and awareness
NE CSC / SDI Graduate Fellow Research: Wild Rice Revitalization

• Marie Schaefer
  – Research Assistant at SDI
  – Anthropology PhD Student at Michigan State University
  – NE CSC Fellow
• Proposed Dissertation
  – Funding under review
  – Impacts of climate change on wild rice (manoomin)
  – Impact of wild rice (manoomin) revitalization for tribes
Training and networking event for indigenous practitioners, tribal leaders, tribal land managers and federal and state agencies and academic researchers

Primary goals:

1) To facilitate a better understanding of CSCs and other federally led opportunities for tribes in addressing climate change impacts on tribal resources

2) To facilitate the development, improvement, and inclusion of tribal communities climate change needs and develop a best management practices approach for tribal engagement through research, policy and other initiatives in the region
How can tribes participate in CSC activities?

- By being here today!
- Come visit the Northeast, Southeast and North Central and South Central CSC Eco Café Tables
- Discuss collaboration potential with CMN and our other consortium PIs
- Apply for funding in CSC RFPs
  - Effects of climate change on the sustainability of cultural resources, including approaches that utilize traditional ecological knowledge, human dimensions, and adaptation strategies
- Join the NE CSC mailing list, visit our website, participate in webinars
THANK YOU!

Come visit the CSCs during the Eco Café