

Regional Engagement Workshop Summary Report: Northeast Region

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Introduction

The Fourth National Climate Assessment (NCA4), currently in development, will assess the science of climate change and its impacts across the United States. It will document climate change-related impacts and responses for various sectors and regions, with the goal of better informing public and private decision-making at all levels.

To ensure that the assessment is informed by and useful to stakeholders, engagement workshops were planned for each of the 10 NCA4 regions. These workshops provided stakeholders an opportunity to provide input to and exchange ideas with the chapter author team on key message formulation, share relevant resources, and give feedback on issues of importance to their region.

Workshop Structure

In an effort to maximize participation while easing travel burden, organizers employed a ‘Hub and Satellite’ model for NCA4 Regional Engagement Workshops. A hub—or primary location—hosted stakeholders, the chapter author team, and NCA4 staff from the U.S. Global Change Research Program (USGCRP). Satellite locations throughout the region established remote connections to the hub for plenary presentations and discussion. Satellites were encouraged to hold break-out sessions on regional concerns and proposed topics for NCA4, reporting their discussions to the hub at a pre-determined time.

The Northeast Regional Engagement Workshop

On February 9, 2017, the NCA4 Northeast chapter team held its Regional Engagement Workshop. The objective of the workshop was to gather input from a diverse array of stakeholders throughout the Northeast to help inform the writing and development of NCA4, and to raise awareness of the process and timeline for NCA4.

The University of Massachusetts-Boston, in Boston, Massachusetts, served as the hub location. Six satellite locations were distributed throughout the region (Figure 1).

Due to inclement weather and the resulting closure of the University of Massachusetts-Boston, participants who originally registered to attend the meeting at the hub and several satellites connected virtually to NCA4 staff and chapter authors on-site in Boston. Three satellite locations held in-person meetings: Washington, DC; Huntington, WV; and Ithaca, NY. A number of stakeholders participated virtually.

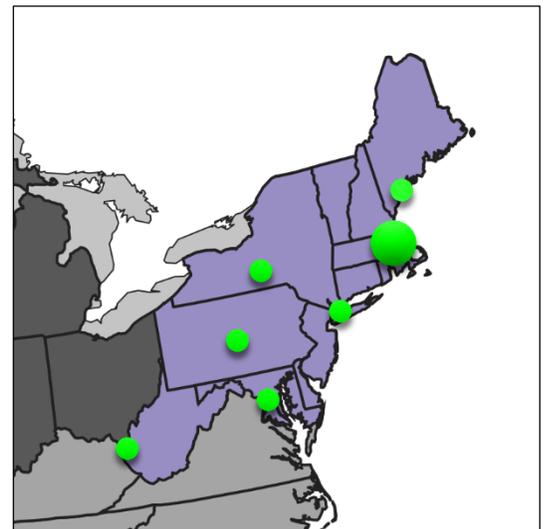


Figure 1. Map of the REW hub (Boston, MA) & satellite locations: Portland, ME; Huntington, WV; Washington, DC; Ithaca, NY; State College PA; and New York, NY.

Authors, Locations, and Staff

Authors

- Ellen Mecray, NOAA (Coordinating Lead Author)
- Lesley-Ann Dupigny-Giroux, University of Vermont (Chapter Lead)
- Glenn Hodgkins, USGS
- Mary Stampone, University of New Hampshire
- Kathy Mills, Gulf of Maine Research Institute
- Tony Macdonald, Monmouth University & Urban Coast Institute
- Erika Lentz, DOI-USGS
- David Hollinger, USDA-USFS
- Erin Lane, USDA-USFS
- Rawlings Miller, DOT
- Bill Solecki, Hunter College
- Perry Sheffield, Ichan School of Medicine at Mount Sinai
- Greg Wellenius, Brown University

Satellite & Hub Hosts

- Gulf of Maine Research Institute (Portland, ME)
- Marshall University (Huntington, WV)
- U.S. Global Change Research Program (Washington, DC)
- Cornell University (Ithaca, NY)
- Penn State University (State College, PA)
- NOAA Consortium for Climate Risk in the Urban Northeast (New York, NY)

USGCRP Staff

- David Reidmiller
- Chris Avery
- Katherine Weingartner
- Kristin Lewis
- Susan Aragon-Long
- Christina Bagdikian
- Apurva Dave
- Mark Shimamoto
- Reid Sherman
- Katie Reeves

Overview and Topics of Discussion

David Reidmiller, Director of the National Climate Assessment, opened the workshop with a welcome to all participants, and an introduction of all chapter authors and USGCRP staff who were present. Reidmiller went on to give an overview of the NCA, providing context and explaining the goals of the workshop.

Ellen Mecray and Lesley-Ann Dupigny-Giroux, the Coordinating Lead Author (CLA) and Chapter Lead (CL) respectively for the Northeast Chapter, then went into detail on the Northeast chapter itself. Additional information on the Northeast Chapter from NCA3 (2014) was presented, with specific detail provided on each of the key messages from that report. From there, Mecray and Dupigny-Giroux led a discussion on the proposed Focal Areas for the Northeast chapter of NCA4.

The Northeast Chapter authors presented the chapter's proposed initial focus areas. They were:

- Water Resources – Glenn Hodgkins, Mary Stampone
- Agriculture & Natural Resources – David Hollinger, Erin Lane
- Oceans – Kathy Mills
- Coastal Issues – Erika Lentz, Tony Macdonald
- Human Health – Gregory Wellenius
- Built Environment & Urban Issues – Bill Solecki, Rawlings Miller

In an open question-and-answer session to end the morning, stakeholders were invited to provide comment to the author team and USGCRP staff on the report development process, as well as the substance of the Northeast chapter.

During the afternoon, participants shared specific questions, issues, ideas, resources, and case studies for each of the aforementioned focal areas. For each focal area, stakeholders were asked a specific series of questions around which to structure their responses:

1. How is or how has climate change affected this topic (i.e. observed change)?
 - a. Are there specific case studies you would suggest to illustrate that observed change?
2. How is climate change projected to affect this topic in the next 20-30 years and at the end of the century (i.e. projected change)?
 - a. Are there specific case studies you would suggest to illustrate that projected change?
3. What challenges, opportunities, and success stories for addressing risk can be highlighted?
 - a. Are there specific case studies you would suggest to illustrate those challenges, opportunities, and success stories?
4. What are the emerging issues and/or research gaps on this topic?
 - a. Are there specific case studies you would suggest to illustrate those emerging challenges or research gaps?

Stakeholders were also given the opportunity to share thoughts on areas that were not covered by the previously-identified focal areas.

Key Takeaways

Stakeholders identified areas of opportunity and concern, case studies, and relevant regional information associated with each of the focal areas. This feedback was later distilled into key thematic takeaways for the chapter author team. These takeaways are summarized below.

Water Resources

- Examine the impacts of harmful algal blooms and their links to health
- Identify how climate change impacts may affect the water supply, such as through drinking water, well-water, groundwater, and seasonal aquifers
- Consider the effects of increases in extreme precipitation
- Explore changes in precipitation seasonality, including the effects on soil moisture, increases in summertime drought, etc.)
- Investigate the impacts of flooding on the economy, infrastructure, health, and culvert structures
- Review adaptation strategies for flooding such as the role of green infrastructure and plant phenology

Agriculture and Natural Resources

- Consider the shift in phenology (seasons) such as planting and harvesting dates, the wet/dry regime, the length of time soil remains frozen, winter hydrology changes, and the impact of high heat days on livestock
- Investigate the link between increased pests and disease which includes shifting ranges or life cycle dynamics, invasive species, and crop damage
- Examine saltwater intrusion into agricultural fields and inland, as well as its connection to coastal areas
- Survey soil improvement and management efforts

- Inspect environmental control structures including high tunnels, streambank stability, and artificial subsurface drainage systems
- Delve into economic risk and risk management
- Consider impacts on recreational land use including fishing, hunting, and working forests

Oceans

- Explore the impacts of climate change on off-shore fisheries, aquaculture, and shellfish resources such as lobster as well as the ramifications for community economies reliant on them
- Assess the interactions between ocean warming & ocean acidification
- Evaluate the impacts from changing ocean currents such as the Labrador and Gulf Stream
- Address research needs including improved bathymetry data and ocean acidification monitoring

Coastal Issues

- Examine the effects of flooding and sea level rise (SLR) on coastal infrastructure. Effects may come from saltwater intrusion to public water, agricultural fields, and nuisance flooding with its impacts on rising groundwater and septic tanks. SLR scenarios can be used in these instances.
- Inspect the effect on coastal tourism and economies, particularly with respect to old and vulnerable ports, historic downtowns, and adaptation challenges
- Consider links to ecosystems and wildlife, such as the loss and/or migration of coastal wetlands, SLR impacts on vegetated habitats and fishers, harmful algal blooms, and the inland migration of people, plants, and animals
- Quantify risk in economic terms
- Address research gaps and emerging issues including the interaction of warming and acidification, deep subsidence and SLR as well as the rate of SLR (Greenland & West Antarctic Ice Sheet)
- Provide better information to municipalities about the impact of sea level rise on the frequency of flooding

Health

- Investigate the interlinkages between health and other topical areas, such as the built environment, agriculture, flooding, etc.
- Prioritize how vulnerable populations will be affected, especially because the challenges facing these populations are radically different. Population differences include young vs. old, rural vs. urban, etc.
- Recognize that vector-borne diseases are likely to act quite differently in the future

Built Environment and Urban Issues

- Understand that the built environment component intersects with a number of other topical areas such as water, health, coastal, etc.
- Keep an eye on long-term planning on infrastructure of all kinds including roads, water systems, sewage systems, telecommunications, etc.)
- Note that economic concerns are a critical component of this topic
- Acknowledge that historic structures and sites as well as the impact of legacy building stock are huge issues
- Perceive that there must be a balance between urban and rural built environments
- Identify that telecommunications will be a significant issue

West Virginia

Participants at the satellite location at Marshall University in Huntington, WV, engaged in a West Virginia-focused discussion. Topics included:

- The importance of heavy precipitation and its impact on WV infrastructure, agriculture & aquaculture, water quality (due to mining tailings), and energy
- Determining research needs in the areas of rainfall characterization and additional data collection activities (stakeholder raised their concern that West Virginia is data-poor)
- Noting the possible opportunity in the future to engage in perennial agriculture due to warmer winter temperatures

New York

Participants at the satellite location at Cornell University in Ithaca, NY, also engaged in a locally-focused discussion. Topics included:

- It is important to consider the full range of issues around water, including the absence of water, flooding, snowpack, and groundwater, in addition to all the other pieces already discussed.
- Consider how the drastic differences between the urban and rural regions of the Northeast region might result in fundamentally different health-related challenges in those two areas. This is particularly important to New York, given the urban-rural differences in the state.
- Food security and food donations/access could be a particularly interesting point to consider under agriculture issues.

Results

The feedback provided during this workshop serves as valuable input to the development of not only the Northeast chapter of NCA4, but of all chapters. This summary report is being shared with all NCA4 authors to inform the development of their chapters, as well. It will also be made publicly available on the NCA4 website (www.globalchange.gov/nca4). Over 150 stakeholders throughout the Northeast region participated in the day-long virtual meeting, providing authors with a great deal of useful feedback – from concerns they face, to resources they use and specific case studies where communities are working to address the risks they face as a result of climate change. Responses from both authors and participants indicated that the workshop was not only positively received in and of itself, but it served to cultivate new relationships, research ideas and, hopefully, future collaborations across the Northeast.

About the NCA

The National Climate Assessment is the U.S. Government's premier resource for articulating the risks posed to the Nation by climate change, as well as what is being and can be done to minimize those risks. It is an inter-agency effort, bringing together experts from the 13 Federal agencies of USGCRP, the broader Federal government, as well as hundreds of experts in the academic, non-profit, and private sectors.

Appendix A: Workshop Agenda

4th National Climate Assessment **Northeast Regional Engagement Workshop**

Thursday, February 9

Objective: To gather input from a diverse array of stakeholders throughout the Northeast to inform the Northeast (and related) chapters of NCA4, and to make the stakeholder community aware of the process and timeline for the development of NCA4.

8:00	Registration opens
8:30	Introduction to workshop goals and brief introductions <i>David Reidmiller – Director, National Climate Assessment, U.S. Global Change Research Program</i>
9:15	What is the National Climate Assessment? <ul style="list-style-type: none">• Building on pre-workshop webinars• Ways to get involved (ex. author, technical contributor, reviewer, etc.)• Mandate, timeline, structure, etc. of NCA4• Areas of desired emphasis from public comments• Main findings from Northeast chapter of NCA3• Q&A <i>David Reidmiller – Director, National Climate Assessment, U.S. Global Change Research Program</i>
10:00	BREAK
10:15	Preliminary Author Thoughts on Northeast Chapter <ul style="list-style-type: none">• Introduce chapter team of authors• Present “strawperson” notional chapter outline <i>Lesley-Ann Dupigny-Giroux – Vermont State Climatologist, University of Vermont and Regional Chapter Lead of Northeast chapter of NCA4</i> <i>Ellen Mecray – Regional Climate Services Director, Eastern Region, NOAA and Coordinating Lead Author of Northeast chapter of NCA4</i>
10:45	Stakeholder Perspectives <ul style="list-style-type: none">• Open discussion for questions on process or content; suggestions on additional areas to address (or avoid); suggestions of resources to use or case studies to highlight; etc.

	<p>Potential guiding questions:</p> <ul style="list-style-type: none"> ➤ What are the key attributes, assets and things of greatest value to the Northeast? ➤ And how are those things vulnerable to or at risk from climate change? ➤ Are there resources (reports, studies, etc.) or case studies we should be aware of? 																	
11:45	<p>Charge for Break-out Groups <i>(D. Reidmiller – Director, National Climate Assessment, U.S. Global Change Research Program)</i></p> <p>Groups will rotate every 15 minutes and for each proposed Northeast focal area:</p> <table border="1" data-bbox="326 569 1378 1083"> <thead> <tr> <th data-bbox="326 569 899 604">TOPIC</th> <th data-bbox="899 569 1378 604">FACILITATORS & NOTETAKERS</th> </tr> </thead> <tbody> <tr> <td data-bbox="326 604 899 680">1. Water Resources</td> <td data-bbox="899 604 1378 680">Mary Stampone (UNH) & Glenn Hodgkins (USGS)</td> </tr> <tr> <td data-bbox="326 680 899 720">2. Agriculture and Natural Resources</td> <td data-bbox="899 680 1378 720">David Hollinger & Erin Lane (USDA)</td> </tr> <tr> <td data-bbox="326 720 899 795">3. Oceans</td> <td data-bbox="899 720 1378 795">Kathy Mills (GMRI) & Ellen Mecray (NOAA)</td> </tr> <tr> <td data-bbox="326 795 899 869">4. Coastal Issues</td> <td data-bbox="899 795 1378 869">Erika Lentz (USGS) & Betsy Nicholson and Adrienne Harrison (NOAA)</td> </tr> <tr> <td data-bbox="326 869 899 940">5. Human Health</td> <td data-bbox="899 869 1378 940">Perry Sheffield (Mt. Sinai) & Gregory Wellenius (Brown Univ)</td> </tr> <tr> <td data-bbox="326 940 899 1014">6. Built Environment & Urban Issues</td> <td data-bbox="899 940 1378 1014">Rawlings Miller (DOT) & Chris Avery (USGCRP)</td> </tr> <tr> <td data-bbox="326 1014 899 1083">7. Additional Ideas</td> <td data-bbox="899 1014 1378 1083">D. Reidmiller (USGCRP) & Katherine Weingartner (USGCRP)</td> </tr> </tbody> </table> <ul style="list-style-type: none"> • Introduce yourself (affiliation, area of expertise) and any role in previous NCAs • For the given topic: <ul style="list-style-type: none"> ○ How is or has climate change affected this topic (i.e., observed change)? ○ How is climate change projected to affect this topic in the next 20-30 years and at the end of the century (i.e., projected change)? ○ What challenges, opportunities and success stories for addressing risk can be highlighted? ○ Are there case studies or specific resources to highlight? ○ What are the emerging issues and/or research gaps on this topic? ○ Other issues? <p><i>Participants at the hub will count off 1 through 7 prior to breaking out and will be assigned to one topical Break-out Group to start. Participants will then rotate to a new Break-out Group every 15 min, so each participant gets a chance to discuss each topic. Should a participant wish to stay in one topic the whole time, that is entirely acceptable, as well.</i></p>		TOPIC	FACILITATORS & NOTETAKERS	1. Water Resources	Mary Stampone (UNH) & Glenn Hodgkins (USGS)	2. Agriculture and Natural Resources	David Hollinger & Erin Lane (USDA)	3. Oceans	Kathy Mills (GMRI) & Ellen Mecray (NOAA)	4. Coastal Issues	Erika Lentz (USGS) & Betsy Nicholson and Adrienne Harrison (NOAA)	5. Human Health	Perry Sheffield (Mt. Sinai) & Gregory Wellenius (Brown Univ)	6. Built Environment & Urban Issues	Rawlings Miller (DOT) & Chris Avery (USGCRP)	7. Additional Ideas	D. Reidmiller (USGCRP) & Katherine Weingartner (USGCRP)
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7. Additional Ideas	D. Reidmiller (USGCRP) & Katherine Weingartner (USGCRP)																	
12:00	Participants self-serve lunch																	
12:15	WORKING LUNCH Break-out A	Please note, lunch will NOT be provided at satellite locations , but beverages and snacks will																

12:30	WORKING LUNCH Break-out B	<p>be available throughout the day. Participants should plan accordingly.</p> <p>Satellite locations may wish to approach the lunch / Break-out session in a manner best suited to the number of participants and their interests.</p> <p>For example, if there are 20 participants at a given satellite location, it does not make sense to divide them into 7 Break-out Groups. Rather, you may all wish to stay in “Plenary” together and spend 15-30min on a few topical areas that are of most interest to the participants in the room.</p>
12:45	WORKING LUNCH Break-out C	
1:00	Break-out D	
1:15	Break-out E	
1:30	Break-out F	
1:45	Break-out G	
2:00	BREAK	
2:15	Satellite A Read-out: Gulf of Maine Research Institute (Portland, ME) <i>Mary Hudson / Riley Young Morse & Katie Reeves</i>	
2:35	Satellite B Read-out: Cornell University (Ithaca, NY) <i>Art DeGaetano & Kristin Lewis</i>	
2:55	Satellite C Read-out: Marshall University (Huntington, WV) <i>Kevin Law & Susan Aragon-Long</i>	
3:15	Satellite D Read-out: Penn State University (State College, PA) <i>Kyle Imhoff & Ben DeAngelo</i>	
3:35	Satellite E Read-out: U.S. Global Change Research Program (Washington, DC) <i>Christina Baghdikian & Apurva Dave</i>	
3:55	Satellite F Read-out: Consortium for Climate Risk in the Urban Northeast (New York, NY) <i>Dan Bader / Radley Horton / Adam Parris & Reid Sherman</i>	
4:15	BREAK	
4:30	Water Resources Read-out (from UMass-Boston hub)	
4:40	Agriculture and Natural Resources Read-out (from UMass-Boston hub)	
4:50	Oceans Read-out (from UMass-Boston hub)	
5:00	Coastal Issues Read-out (from UMass-Boston hub)	
5:10	Human Health Read-out (from UMass-Boston hub)	

5:20	Built Environment & Urban Issues Read-out (from UMass-Boston hub)
5:30	Additional Ideas Read-out (from UMass-Boston hub)
5:40	Wrap-up & Next Steps
6:00	End of Meeting

Appendix B: List of Northeast Regional Chapter Authors

Coordinating Lead Author: Ellen Mecray, National Oceanic and Atmospheric Administration

Chapter Lead: Lesley-Ann Dupigny-Giroux, University of Vermont

Authors:

- Mary Stampone (University of New Hampshire)
 - Expertise: climatology, geography, weather analysis
- Glenn Hodgkins (USGS)
 - Expertise: floods, runoff, streamflow, surface water (non-marine)
- David Hollinger (USDA)
 - Expertise: climate, fire, and carbon cycle sciences, plant physiology
- Erin Lane (USDA)
 - Expertise: agriculture, forestry, natural resources
- Kathy Mills (Gulf of Maine Research Institute)
 - Expertise: fisheries ecology, biological modeling
- Tony Macdonald (Monmouth University)
 - Expertise: resilient coastal development, ecosystem-based management
- Erika Lentz (USGS)
 - Expertise: coastal change from storms, sea-level rise, and geology
- Perry Sheffield (Mt. Sinai)
 - Expertise: climate modeling, children's health, air pollution
- Gregory Wellenius (Brown University)
 - Expertise: epidemiology, air quality, cardiovascular physiology
- William Solecki (CUNY- Hunter College)
 - Expertise: urban environmental change, resilience, adaptation
- Rawlings Miller (US DOT)
 - Expertise: transportation, energy storage, micro-grid technologies

USGCRP staff:

- Chris Avery, Senior NCA Manager
- Katherine Weingartner, NCA Program Coordinator

On-site Collaborators:

- Michelle Smith, University of Vermont

Appendix C: Detailed Stakeholder Feedback on Focal Area Issues

Focal area 1: Water Resources

How is or how has climate change affected this topic (i.e. observed change)? Climate change:

- Creates increases in extreme precipitation
- Changes the seasonality and timing of snowmelt with impacts on receiving water bodies and algal blooms. This includes ice-out dates for lakes and rivers
- Changes soil moisture due to changes in precipitation seasonality and its effect on runoff as well as evaporation production
- Increases the magnitude of 24 hour storms and the area of flooding. It is worth noting that there is a projected increase in flood plains.
- Causes thin glacial deposits in coastal areas which tends to result in less water within the public drinking wells which leads to challenges during drier periods, especially during the summer when higher heat causes significant evapotranspiration

How is climate change projected to affect this topic in the next 20-30 years and at the end of the century (i.e. projected change)?

- [Not addressed explicitly by stakeholders]

What challenges, opportunities, and success stories for addressing risk can be highlighted?

- Challenges
 - Culverts
 - Alewife stormwater wetlands in Cambridge, Massachusetts
 - Changing patterns in seasonal aquifer recharge will affect water supplies
 - There will be higher temperatures and evapotranspiration when water demand is the highest.
- Opportunities
 - There is an opportunity in the fact that the Northeast will have more freshwater than other parts of the US and should consider this in terms of the migration of people
- Success stories
 - A success story includes Protecting Maine's Water Quality which looks at forestry sector and how to manage forests in a way that protects water quality such as road crossing infrastructure by appropriately sizing culverts for climatic conditions
 - The Urban Long Term Ecosystem (ULTRA) grant program completed a detailed flood impact analysis under projected climate change was recently completed in Boston area
 - To build on the culverts comment, the North Atlantic Aquatic Connectivity Collaborative and partners have good aquatic connectivity success stories
 - The Maine Department of Environmental Protection, Maine Rural Water, and Drinking Water Program is holding tabletops with communities to simulate spills into wellhead protection areas and into surface water bodies during extreme weather events. They work with local partners on response and identify adaptation practices for future implementation. There are four communities in Maine to date

What are the emerging issues and/or research gaps on this topic?

- Emerging issues
 - There is a need for river temperature gauges in more rivers.

- Efficiency in resident consumption is an issue that hasn't been resolved and can actually be a really important adaptation strategy
- Gaps
 - We need to better understand flood-generating mechanisms--for example, our research suggests that rain is the dominant mechanism and winter/early spring is the dominant season, yet we don't know the relative importance of rain on saturated ground vs. rain on frozen ground. If the latter is really important, warming temperatures may decrease future flooding
 - There is a need for a better understanding of why some large precipitation events do not lead to large floods, while moderate precipitation events can lead to big floods.
 - High resolution land cover/land use scenarios as input to future flood models
 - How will changes in plant phenology affect floods? March-April-May (MAM) is a dominant flood producing season (and late fall is important too), so when leaf-on and leaf-off occurs will affect these flood-producing seasons in ways that will either damp or increase runoff generation.
 - Expanding the impacts of seasonality on phosphorus, nitrogen and sediment loading beyond Lake Champlain
 - Need a better understanding the combined impacts of precipitation and tidal flood-driven events.
 - Need a better understanding on soil being more or less saturated due to persistent changes in precipitation and potential evapotranspiration and how the future state of soil moisture in the future change runoff ratios

Suggested Case Studies:

- Ice off in Vermont
- The Regional Resiliency Project in Casco Bay by the US Department of Homeland Security and work by Argonne National Labs with future Intensity Duration and Frequency curves developed for the northeast
- The University of Rhode Island is working on modeling increase flooding with sea level rise in the Pawtuxet River in Rhode Island
- Need a case study on potential for increasing summertime drought and suggests Hayhoe et al 2007
- 2015 study on freshwater environmental conditions and river herring survival
<https://www.esrl.noaa.gov/psd/people/michael.alexander/tommasi.et.al.cjfas-2014-0259.pdf>
- Connecticut Department of Transportation has a case study on the impacts of climate change (flooding, etc.) on culvert structures
- Cape Cod study of sea-level rise and water resources, Walter et al. (2016) The cape also has a new 208 permit which include climate change adaptations, it's state of the art and could be a great example

Focal area 2: Agriculture & Natural Resources

How is or how has climate change affected this topic (i.e. observed change)? Climate change:

- Increases the length of the growing season
- Increases the risk of soil compaction due to weather conditions
- Shifts planting and harvesting dates and increases pests and diseases

- Changes seasonal trends, causing impacts on fertilization schedules
- Changes phenology
- Causes late winter thaw and freeze weather events that kill crops
- Creates increased tidal flooding which intersects with saltwater intrusion to ag fields
- Leads to a lack of alignment between pollinators and flowering as well as changes in farming techniques among Northeastern organic farmers to emphasize carbon sequestration
- Potentially results in shifts in harvestable species
- Increases in heatwaves
- Shifts ranges or life cycle dynamics for forest pests and diseases
- Creates difficulties in controlling pests due to warmer temperatures
- Lengthens vernal windows due to less snow lead from warming winters
- Causes saltmarsh migration or drowning of saltmarshes which impact fisheries
- Increases rate of artificial subsurface drainage system installations
- Creates difficulty in pesticide applications due to plants maturing at rates not in parallel with regulated pesticide application regulations
- Changes climate in the Midwest which impacts the agricultural market in the Northeast
- Impacts agriculture in a way that disproportionately affects rural and economically stressed communities

How is climate change projected to affect this topic in the next 20-30 years and at the end of the century (i.e. projected change)?

- *[Not addressed explicitly by stakeholders]*

What challenges, opportunities, and success stories for addressing risk can be highlighted?

- Challenges
 - Problem harvesting hay due to more variable dry/wet regime in the summer
 - Carbon sequestration and soil improvement/management
 - Winter forest harvest as days with frozen ground decrease
 - Managing fertilization through no-application periods (i.e., can't fertilize after December or before April) will no longer be manageable if winter hydrology changes
 - Increased high heat days in the summer creates a need for farmers to 'cool' the cows which affects milk production
 - Need for diversification as key risk management strategy
 - Problems with harvesting wood, specifically cedar in the winter with a reduction in the duration of frozen ground
- Opportunities
 - Opportunities are big in terms of having an extended growing season and new varieties such as wine, melons, peppers, etc.
 - Shared economic risk management such as through community supported agriculture might make a good sidebar
 - Could be beneficial to work with crop insurance companies to address adaptation and reduce risk
 - There is an opportunity to address shifting species ranges including landscape conservation design efforts. Connect the Connecticut and North Atlantic Landscape Conservation Cooperative's Regional Conservation Opportunity Areas are possible tools
- Success stories

- The Maine State Wildlife Action Plan used the Open Standards process for conservation planning to engage stakeholders and identify the recommended conservation actions. Overall, there are 37 actions that address climate change impacts on habitat and 21 actions that address climate change impacts on species.

What are the emerging issues and/or research gaps on this topic?

- Emerging issues
 - Northern progression of lobster shell disease
 - The potential economic issues associated with the dairy industry and whether agricultural production is shifting to the wine industry or others
 - Changes to aquatic habitats and shifts in freshwater aquatic populations
- Gaps
 - Invasive species are a huge gap, specifically regarding the relative role of climate vs. human influence as well as the impacts on wildlife, including moose, stream fish, etc.
 - There is a lot of great research projecting how tree species may migrate, but also a lot of uncertainty about exactly how quickly that may happen, so helping to shed some light there might be helpful so they know how much change to expect over the next few decades

Suggested Case Studies:

- Case study, a colleague recently submitted a paper to Global Change Biology about brook trout's thermal refugia in Shaver's Fork, West Virginia, on average increases in precipitation offset heating stream temp due to increased atmospheric temp, however; in dry years, stream temp increases drastically... will keep you posted on acceptance
- Natural Resources Conservation Service provides grants and funding mechanisms for farmers. The US Department of Agriculture and its Natural Resources Conservation Service are addressing climate change, and there may be case studies that can be highlighted
- Acadia National Park is doing an ecosystem restoration project at the top of Cadillac Mountain. They are accounting for uncertainty in projections by testing a variety of species which could be a possible case study.
- There are some case studies in Vermont that show carbon sequestration in their soils from "climate smart farming"

Focal area 3: Oceans

How is or how has climate change affected this topic (i.e. observed change)? Climate change:

- Increases sea level rise which will be greatest in the Northeast. Whether it goes in Oceans or Coasts, the Northeast has a bigger part of the national story.
- Creates vulnerabilities for shore-based facilities that support fishing and other marine dependent uses
- Increases ocean acidification
- Changes demands for ocean resources. For example, more demand for sand could detrimentally impact habitats
- Increases in warming has a profound effect on carbonate system solubility and has masked the impact of ocean acidification
- Causes metabolic depression in the blue mussel, *Mytilus edulis*, from the Gulf of Maine
- Increases nutrient runoff and harmful algal blooms

- May cause negative interactions with a potential shift in the Atlantic Multidecadal Oscillation phase

How is climate change projected to affect this topic in the next 20-30 years and at the end of the century (i.e. projected change)?

- *[Not addressed explicitly by stakeholders]*

What challenges, opportunities, and success stories for addressing risk can be highlighted?

- Challenges
 - The ability of existing waterfront infrastructure to adapt in terms of harvesting, aquaculture, processing, etc. given potential changes in fisheries
 - There is a challenge of changing fishing permits to reflect marine species distribution
 - As the Northwest passage becomes ice free, the Northeast may experience increase in sea port commerce
 - Difficult to gauge how quickly organisms will mature and reach reproductive age, and the ability of ecosystems to reach steady states based on stock assessment theory
 - Challenge in predicting interacting variables such as warming, acidification (+increased freshwater inputs from flooding, Arctic melting), increased pathogenicity, and altered food webs (invasive species and shifted distributions)
 - In some of the remote coastal communities, 60%-80% of revenue in the towns is from lobsters. If up to 80% of revenue is coming from one species, how do we appropriately manage under the current changing conditions that we are adapting to? Many communities are inviting the Department of Marine Resources to aid in their comprehensive plan development.
- Opportunities
 - *[Not addressed explicitly by stakeholders]*
- Success stories
 - A local effort looking at resilient commercial fishing communities (<http://resilientfisheriesri.org/>)
 - The Northeast Regional Action Plan includes example successes that may be useful to look at related to fishery management and other topics, gaps in information etc. (Hare et al., 2016; <https://www.st.nmfs.noaa.gov/ecosystems/climate/rap/northeast-regional-action-plan>)

What are the emerging issues and/or research gaps on this topic?

- Emerging issues
 - Need for increased funding efforts to understand coastal acidification as well as the potential effect on fisheries and the interaction with increased run-off and flooding events
- Gaps
 - Lack of monitoring data to understand ocean acidification
 - Ocean and coastal acidification monitoring and determining the relative importance of various drivers (atmospheric vs. land based)
 - The Northeast Regional Action Plan includes many gaps

Suggested Case Studies:

- The Island Institute has been hosting the Annual Fishermen's Climate Roundtables for 11 years. This is an annual, day-long event where fishermen come together and share observations from the past fishing season, discuss potentially longer-term, climate-related changes folks have been noticing while fishing, and learn more about a topic of interest from an invited scientist
- Emolt case study from Jim Manning at the National Oceanic and Atmospheric Administration
- An ocean acidification remediation case study through the Bigelow/Island Institute/University of New Hampshire/Ocean Approved (kelp farm) is working to determine if primary production from aquacultured sugar kelp captures enough CO₂ to remediate local waters from ocean acidification and improve the growing conditions for nearby shellfish. See: <http://www.islandinstitute.org/blog-post/can-growing-sugar-kelp-locally-reduce-ocean-acidification-maine's-waters>
- BOEM Atlantic sand assessment study
- Cape Cod fishermen's alliance might be a good case study. They do a lot of resiliency work with their fishermen

Focal area 4: Coastal Issues

How is or how has climate change affected this topic (i.e. observed change)? Climate change:

- Leads to substantial increases in "nuisance" flooding
- Increases the frequency of flooding in many low lying areas
- Creates saltwater intrusion into public water supplies
- Raises ground water levels due to sea level rise
- Increases risks as the pace of development in vulnerable coastal areas continues to rise
- Threatens the loss of wetlands habitats and the inland migration of coastal wetlands
- Increase tidal intrusion to drinking water intakes in coastal communities (e.g., Wilmington DE).
- Causes losses of habitat types (e.g., coastal wetlands) that are vital to many commercially harvestable species
- Increases coastal armoring and changes in sand transport
- Creates concern regarding the inability of coastal ecosystems to retreat
- Resulting in die-offs of dune grasses on the inland side of the dune crest
- Increases the impact of wave action from coastal storms with sea level rise
- Leads to salt marsh migration into upland areas

How is climate change projected to affect this topic in the next 20-30 years and at the end of the century (i.e. projected change)?

- *[Not addressed explicitly by stakeholders]*

What challenges, opportunities, and success stories for addressing risk can be highlighted?

- Challenges
 - Rising sea levels are outpacing wetland ability to build up or migrate inland
 - Historic downtowns in coastal towns are seeing increasingly levels of coastal flooding. Adaptation to historical buildings is difficult, expensive and towns aren't that keen on 'retreat' from these historic settlement areas.
 - Huge challenges for coastal communities managing infrastructure, including making decisions for retreat vs adaptation vs building barriers
 - Green crab explosion

- Coastal blue carbon, the value of coastal wetlands for climate mitigation, and potential economic benefits for coastal communities and states
- We are facing new legal issues as water rises such as potential liability for cities that continue to issue building and use permits in the vanishing land zone.
- In southern Delaware, people are still building in the most vulnerable areas. There are not enough disincentives (insurance, tougher ordinances)
- Strong private property rights and a lack of centralized planning makes it difficult to develop and implement regional solutions
- Hard to predict increased hurricane intensity in the Northeast
- Need to examine hydrodynamic versus bathtub modeling and information appropriate for education versus what needs be done for design and engineering
- Opportunities
 - Much of Northeast port infrastructure is older and flood prone—opportunity/need to upgrade for both economic benefits and inland flood control
- Success Stories
 - The Northeast Coastal Acidification Network and Maine Ocean and Coastal Acidification Partnership
 - There are lots of Hurricane Sandy recovery success stories. For ones on cultural resources examples among others, see https://www.nps.gov/subjects/climatechange/upload/NRSS_CASH_Chp9_111016.pdf
 - Rhode Island is creating a suite of tools for assessing coastal food risks and is currently doing outreach to coastal communities (www.beachsamp.org) as well as partnering with builders to create more resilient building strategies, also with realtors to communicate risk
 - The US Army Corps North Atlantic Coastal Comprehensive Study could be referred to as a success story in terms of the outputs (modeling, adaptation, reports, etc.)
 - Maryland State screens all their highway projects for sea level rise as part of their National Environmental Policy Act process.

What are the emerging issues and/or research gaps on this topic?

- Emerging issues
 - Septic tanks in coastal towns is going to be an enormous issue that is kind of a sleeper right now
 - Saltwater lens is moving upstream, creating issues for drinking water intakes, especially in the Delaware River.
 - Land ownership will be an issue. The Environmental Protection Agency's Climate Ready Utilities has been working on Rolling Easements.
 - How warming and acidification will impact shellfish aquaculture
 - Understanding the connection between coastal issues and both sea level rise and groundwater
 - Impact on tourism
 - Rising groundwater may intersect hazardous waste sites and on-site septic systems resulting in water quality issues
- Gaps
 - There is an enormous gap in knowledge about sediment accretion rates in coastal marshes, which impacts their ability to keep up with sea level rise
 - Methods to predict flood frequency/return periods on top of sea level rise are still too complex for most people. More work would be appreciated

- Need more research and monitoring of wetland hydrology landward of dune line. Operational forecast models in Delaware Bay would benefit from this
- Research gaps around determining the sources of coastal acidification (land, sea, sediments). There is a need for more river gages to get a better handle on nutrient loading
- Understanding deep subsidence and how it interacts to drive relative sea level rise along the coast

Suggested Case Studies:

- Climate Ready Boston has this as a case study: The City of Boston was expanded by 50% through filling tidelands. With two feet of sea level rise, that means 1/3 of the city is within the 1% flood zone. With 7.5 feet of sea level rise, that becomes tidal. <https://www.boston.gov/environment-and-energy/climate-ready-boston>
- The Portsmouth New Hampshire Coastal Resilience Initiative also focuses on serious impacts of historical Strawberry Banke <http://www.planportsmouth.com/cri/>

Focal area 5: Human Health

How is or how has climate change affected this topic (i.e. observed change)? Climate change:

- Projects greater heat-related mortality in the US urban Northeast
- Creates greater need for air conditioning in Maine from increased summer temperatures. This is complicated by the Northeast having some of the oldest housing stock in the nation.

How is climate change projected to affect this topic in the next 20-30 years and at the end of the century (i.e. projected change)?

- There are studies that are out which show human health effects to vibrio which could be more prevalent in the future
- There's a new paper projecting pollen-related asthma emergency department visits in the Northeast due out shortly: Anenberg et al., *Geohealth*, forthcoming

What challenges, opportunities, and success stories for addressing risk can be highlighted?

- Challenges
 - *[Not addressed explicitly by stakeholders]*
- Opportunities
 - There are opportunities for co-benefits in the transportation sector. Promoting walking/biking reduces transportation emissions and provides a human health benefit
- Success Stories
 - The Maine Building Resilience Against Climate Effects (BRACE) program supported by the Department of Health and Human Services and the Centers for Disease Control and Prevention (DHHS-CDC BRACE) identifies climate change risks to human health, adaptation strategies, and develop implementation plans and then evaluates them. It looks at vector-borne diseases such as ticks and Lyme disease expanding in a number of cases and geographically as well as potential for extreme heat events. It has developed Toxic exposures from either inundation of industrial zones or increased need for pesticide use on crops curriculum as well as piloted and delivered to schools and libraries through education intervention programs.

- Boston Harbor Now is working with the City to give local and regional presentations to inform community stakeholders and citizens.

What are the emerging issues and/or research gaps on this topic?

- Emerging issues
 - Dr. Atyia Martin at City of Boston is looking at climate and racial inequity
 - By 2050 there will likely be enough warm degree days for the tick to complete its lifecycle throughout the year in the entire state of Maine. If other conditions exist to support ticks as well, then this may become an endemic issue to the state. Children 5 - 15 and adults over 65 are most vulnerable.
 - Toxic exposures from either inundation of industrial zones or increased need for pesticide use on crops
 - With increasing temperatures, there's an issue of needing more air conditioning while at the same time needing to reduce our energy footprint
 - Outdoor workers are a vulnerable population. Though not unique to Northeast, this definitely applies to agricultural and resource-based communities in the region
 - Increased bacteria in water and recreational impacts
 - Need for a/c, especially in rural locations and schools
- Gaps
 - *[Not addressed explicitly by stakeholders]*

Suggested Case Studies:

- *[Not addressed explicitly by stakeholders]*

Focal area 6: Built Environment & Urban Issues

How is or how has climate change affected this topic (i.e. observed change)? Climate change:

- Increases runoff issues
- Increases erosion with consequences for brownfields
- Causes difficulties in piecing out what stressors lead to what impacts due to interdependencies across urban environments. A holistic approach to understanding resilience and vulnerability is critical.
- Increases erosion impacts to bulkheads and hardened infrastructure along coasts
- Threatens airport tarmacs which are terribly vulnerable to high heat
- Increases runoff leading to higher sedimentation loads to harbors that need to be dredged
- Increases coastal flooding/nuisance flooding which raise emergency response times significantly, especially in peninsular communities in Maine
- Causes higher groundwater tables which have been an issue with stormwater conveyance systems and are causing backups into houses

How is climate change projected to affect this topic in the next 20-30 years and at the end of the century (i.e. projected change)?

- *[Not addressed explicitly by stakeholders]*

What challenges, opportunities, and success stories for addressing risk can be highlighted?

- Challenges
 - Increased stressors to critical infrastructure sectors such as energy, transportation, and communications due to demand and extreme temperatures.

- Oil supply interruptions due to more extreme storms
- Port vulnerability
- Impacts on living shorelines
- Determining what modeling tools will be used to identify and map infrastructure dependencies/interdependencies
- Designing criteria for nature based solutions
- Opportunities
 - *[Not addressed explicitly by stakeholders]*
- Success Stories
 - *[Not addressed explicitly by stakeholders]*

What are the emerging issues and/or research gaps on this topic?

- Emerging issues
 - Projected climate change and projected urban growth/expansion patterns need to be looked at in tandem
 - Insurance and re-insurance issues are important for infrastructure
 - Governance, finance and indexing our regulations to climate are our big emerging issues
 - Telecommunications
 - Guidance for adapting historic structures
 - Interplay of sea level rise, storm surge and flooding in estuary areas, especially around New York-New Jersey area
 - Interconnection between telecommunication - energy - transportation sector will be increasingly important
 - Flooding of superfund sites and chemical storage facilities.
 - Designing flexibility for transportation infrastructure is important.
- Gaps
 - Zillow published some research on value of housing stock losses due to sea level rise. We need same for public and commercial infrastructure.
 - Urban areas can and often are data poor (see Worcester case study from Susan J. at the Environmental Protection Agency). Local engagement with community experts and leaders is necessary to put context to limited amounts of data. This also highlights the need to collect more continuous data through monitoring.
 - There is only 1 current report from the US General Services Administration that addresses IT/telecommunications resilience
 - Need for specific guidance for working waterfront infrastructure (water dependent infrastructure)
 - We need to enhance the general understanding that simply having the location of the 1% chance floodplain is not enough information for decisions about infrastructure. We need full spectrum flood risk assessments (exceedance curves) that incorporate sea level rise and uncertainty in sea level rise.

Suggested Case Studies:

- Rebuild Rockaway Resilience is a case example for electrical microgrids
- Maine has 2 pilot projects on wastewater treatment plant infrastructure being adapted for sea level rise and storm surge.

- The Federal Highway Administration has cooperated with 19 pilot studies assessing transportation vulnerability to extreme weather events. Five are in the Northeast region (www.fhwa.dot.gov/environment/climate/adaptation/2015pilots)