

## **FINAL PROJECT REPORT**

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### **SECTION 1. ADMINISTRATIVE INFORMATION**

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**Agency or Institution of the recipient:** North Atlantic Landscape Conservation Cooperative, U.S. Fish and Wildlife Service

**Project title:** Critical Thresholds and Ecosystem Services for Coastal Ecological and Human Climate Adaptation

**Agreement number:** G16PG00099

**Date of report:** July 2017

**Period of time covered by the report:** 10/14/2016 – 07/14/2017

**Actual total cost of the project:** \$48,860.05

### **SECTION 2. PUBLIC SUMMARY**

Understanding how climate change will impact natural and human communities is a crucial part of decision making and management related to the protection of our coasts. As the effects of climate change on ecological communities grow, the possibility of crossing tipping points or thresholds of viability increases the potential for rapid and possibly irreversible changes in ecosystems. Therefore, understanding thresholds related to climate change is critical for facilitating conservation and management actions, which could help to prevent more costly and possibly catastrophic effects in the future. As part of a broad effort to synthesize and deliver coastal resilience information through the Landscape Conservation Cooperatives (LCCs), Climate Science Centers, states, and other partners along the Atlantic and Gulf Coasts, we synthesized existing quantitative threshold information for 45 priority coastal fish, wildlife, and plant species and habitats in response to sea level rise and storm projections. Additional information was synthesized on climate change adaptation actions that can increase the persistence and resilience of species and their habitats and how these actions relate to human community resilience. In addition to two peer-reviewed manuscripts, results from these synthesis efforts were disseminated online through easily accessible, topic-specific web pages in the Massachusetts Wildlife Climate Action Tool ([climateactiontool.org](http://climateactiontool.org)) to make this information more easily accessible to stakeholders across the region. The compilation and dissemination of species and habitat threshold information will help to develop a more comprehensive understanding of how natural systems will respond to climate change and how land and resource management decisions could potentially help these species.

### **SECTION 3. PROJECT SUMMARY**

Through a 1-year pilot effort to increase the resilience and adaptation of communities and priority coastal resources across the coastal LCCs, a multi-LCC coastal resilience project was led by the North Atlantic LCC to compile and synthesize coastal resilience information across the Atlantic and Gulf Coasts and Caribbean regions. The overall goal was to coordinate, synthesize, and deliver coastal resilience information, activities, and lessons learned across this portion of the LCC network to have decision makers informed about the potential impacts, adaptation strategies, and management approaches that incorporate both ecological and human communities in their decisions and that provide a range of ecosystem services through nature-based approaches. To meet these goals, we conducted a comprehensive literature review using Web of Science and used expert elicitation to compile existing quantitative threshold data related to sea level rise and coastal storms for 45 priority coastal fish, wildlife, and plant species and four coastal habitats in this geography. These species were selected based on their ecological, economic, and cultural importance and have been previously identified as focal species or species of conservation concern. We further compiled alternative management and restoration strategies being used by partners that increase the persistence and resilience of these species and habitats, and that benefit human community resilience; this includes nine case studies to exemplify how ecological information can enhance adaptation strategies and inform planning. Just over half of the 45 species examined (56%,  $n = 25$ ) were found to have quantitative threshold data currently available that can be used to assess the effects of sea level rise and coastal storms during some aspect of their life history. To support more robust coastal management and decision making across spatio-temporal scales in the face of climate change, additional monitoring, modeling, and research is needed to provide multiple quantitative thresholds across species' life stages and/or latitudinal gradients.

Through a six-month extension of this multi-LCC effort funded by the DOI Northeast Climate Science Center, we further disseminated the results from this compilation and synthesis project to stakeholders interested in climate change information to help guide coastal management and decision making. The overall goal was to further compile and synthesize coastal resilience information pertaining to priority fish, plant, and wildlife species and coastal habitats important to the Northeast region and make this information easily available online through Phase II of the Massachusetts Wildlife Climate Action Tool (CAT). We cross-compared the list of 45 focal species from the initial phase of the project with those listed in the CAT to integrate relevant quantitative threshold data and management information on coastal species and habitat pages of the CAT. We expanded existing stressor pages within the CAT and created new stressor and coastal adaptation pages related to the findings of the coastal resilience synthesis effort. This included new coastal storms and drought stressor pages as well as new adaptation pages related to threshold-based adaptive management and an overview of living shoreline techniques.

### **SECTION 4. REPORT BODY**

#### **Purpose and Objectives:**

The general purpose of this project was to synthesize and deliver coastal resilience information through the Climate Science Centers, LCCs, states and other partners along the Atlantic and Gulf Coasts and make this information easily available online through Phase II of the Massachusetts Wildlife Climate Action Tool.

Specific objectives completed as part of this project included:

1. Cross walking the list of 45 species from this synthesis effort to species anticipated in the Climate Action Tool (CAT) and identifying what species and information were missing (e.g., threshold information) from existing pages that were particularly relevant for the Northeast and that had identifiable actions that could help maintain species populations (e.g., Nelson's sparrow, Diamondback Terrapin, etc.). Information on these species, habitats, and adaptation actions relevant for preserving their habitat and population status was added to relevant CAT pages.
2. Researching and synthesizing "further actions that could delay or preclude listing of species that are sensitive to sea level rise, help sustain and recover listed species, and maintain economically important fish and wildlife populations". Additional research was undertaken on more actions, their specific mitigation of sea level rise and storms as a threat, as well as on additional climate change threats, and organized into adaptation webpages. Additional case studies pertaining to these new actions and/or threats were integrated into adaptation pages.
3. Identifying additional climate change stressors and potential adaptation actions for these species, including extreme precipitation events, drought, extreme temperatures, and coastal storms.
4. Compiling additional information on "existing and planned efforts to use natural and nature-based approaches to increase [human and natural] community resilience" in the Northeast with a specific eye towards sea level rise and storm surge buffering capacity. Synthesize the range of re-vegetation and other natural and nature-based approaches that are used to mitigate these stressors but that may be vulnerable to other coastal climate change driven stressors such as summer drought (marsh vegetation die-off), increased water temperatures (oysters), high air temperatures & decreasing pH (all intertidal shellfish), increasing variability in salinity (shellfish) and runoff/erosion (marsh vegetation seedlings) due to increased extreme precipitation events.

The first objective was completed; however, we focused on stressor and adaptation pages instead of creating new species and habitat pages, which were deemed to be of higher importance and a priority for new content in the CAT. Instead, we focused on adding quantitative threshold and management information to existing coastal species and habitat pages. The second objective was completed through several tasks, including two review papers that included a summary of adaptation actions to sustain species' populations as well as case study examples; a review and modification of existing coastal adaptation pages inserted into the CAT; and several new adaptation pages added to the CAT. The list of stressors we completed from our third objective did not match exactly as scoped, since we did not want to be redundant with work planned by the Massachusetts Executive Office of Energy and Environmental Affairs (EEA) as part of an emerging effort to provide state-wide climate information as part of the municipal vulnerability preparedness program. Specifically, we created a new drought page, modified the existing extreme precipitation page, and created a new coastal storms page with expanded information. The fourth objective was completed, with this information included in the two papers (one accepted and the other in review) and new CAT pages.

#### Organization and Approach:

In the initial phase of this project, we conducted a comprehensive literature review and used expert elicitation to compile and synthesize quantitative threshold data related to sea level rise and coastal storm projections for 45 coastal fish, wildlife and plant species of conservation concern, as well as information on alternative management and restoration approaches for increasing the resilience of these species and their habitats and the ecosystem services they provide to human communities. We then cross-walked this information with information displayed on the coastal pages of the CAT to

identify opportunities to integrate this information into the CAT by reviewing and expanding on existing pages and adding new pages.

#### Project Results, Analysis and Findings:

Through the 6-month extension we greatly expanded the coastal content of the CAT, which included:

- The integration of quantitative sea level rise and storm threshold data and impacts to the following species pages on the CAT:
  - [American oystercatcher](#)
  - [Clapper rail](#)
  - [Horseshoe crab](#)
  - [Northeastern beach tiger beetle](#)
  - [Northern diamond-backed terrapin](#)
  - [Piping plover](#)
  - [Red knot](#)
  - [Saltmarsh sparrow](#)
  - [Shortnosed sturgeon](#)
  - [Willet](#)
- The integration of quantitative sea level rise and storm threshold data and impacts as well as management impacts to the following habitat pages:
  - [Coastal: Beaches and dunes](#)
  - [Coastal: Salt marsh](#)
  - [Coastal: Shellfish beds](#)
- Reviewed newly created coastal adaptation pages:
  - [Improve coastal resiliency: Conserve and create blue carbon sinks](#)
  - [Restoring affected estuaries: Manage extensive crab herbivory](#)
  - [Restoring affected estuaries: Strategies to reduce sediment pollution](#)
  - [Restoring affected estuaries: Strategies to reduce nutrient pollution](#)
- Modified and expanded existing stressor pages:
  - [Sea level rise](#)
  - [Storms and floods](#)
  - [Precipitation changes](#)
- Created new stressor pages:
  - [Coastal storms](#)
  - [Drought](#)
- Created new adaptation pages:
  - [Use threshold-based adaptive management: Incorporate ecological thresholds to guide coastal protection and restoration](#)
  - [Restore and protect natural shorelines: Use living shoreline techniques](#)

#### Conclusions and Recommendations:

During this six-month extension, we added a significant amount of content on sea level rise and coastal storm thresholds for coastal species and habitats listed in the CAT, as well as new information on climate change stressors. We further added adaptation actions that will help stakeholders better understand and identify appropriate living shoreline techniques as well as the application of threshold information to enhance management and inform decision making. This content greatly expanded and improved the coastal sections of the CAT.

Overall, the main goals and objectives of the project were met. The original scope of work pertaining to adding missing species to the CAT was modified to instead focus on adding information from the first year of this project to existing species and habitat pages on the CAT, as efforts to add new species and habitat pages were already underway. A few minor changes were made related to new stressor pages to accommodate other work being planned with EEA. We were delayed in completing a new adaptation page related to the application of sea level rise and coastal response models, which was originally scoped as a sea level rise modeling options page and an expansion to the [existing SLR stressor page](#). Multiple conference calls were held to discuss this new page and an initial outline for the page was developed. However, the completion of a new SRL adaptation page was dependent on the finalization of a paper being developed in an ongoing project with partners at the USGS Coastal and Marine Science Center. The paper was not published during the time-period of the current project thus the SLR adaptation page will be revisited at a later date.

Recommended next steps for this work include completing the sea level rise adaptation pages based on the coastal response modeling work, as well as linking the CAT to the new CDI project that is producing an interactive web tool of coastal responses based on work stemming from Lentz et al. (2016). Further next steps include developing additional adaptation pages that were not prioritized in the original scope of work but that represent important adaptation information currently missing from the CAT. These include an ecosystem service valuation page and a monitoring and performance metrics page. An assessment of stakeholder information and data needs could further inform development of new material for the CAT. Additional funds could further be directed toward greater coordination with the work being planned with EEA with content on the CAT.

The information we integrated into the CAT's species and habitat pages provide more quantitative information about the vulnerability of these species and habitats to sea level rise and coastal storms, as well as how coastal management approaches impact these species. Quantitative thresholds represent an information need among the LCCs and other partners across the region. By integrating this information into pages of the CAT, stakeholders have increased access to threshold information where available for a particular species or habitat and they may be able to transfer this information to other important species and locations where threshold data are not yet available. The addition of new coastal storms and drought stressor pages filled critical information gaps. Further, the new living shorelines and threshold-based adaptation pages represent important coastal management approaches that are increasingly considered in the protection of our coasts but where more information and guidance is often needed. The expanded coastal sections of the CAT reflects a more comprehensive set of information that is timely and that responds to the needs of natural resource managers and decision makers.

#### Outreach and Products:

- We have a review paper that has been accepted and is currently in press: A Synthesis of Thresholds for Focal Species along the U.S. Atlantic and Gulf Coasts: A Review of Research and Applications , and a second review paper currently undergoing peer review: A Review of Coastal Management Approaches to Support the Integration of Ecological and Human Community Resilience Planning.
- This work has been presented at several conferences and meetings already. Upcoming presentations of this work include a poster at the American Fisheries Society in Tampa, FL (Aug 2017).
- Additional products from this work are available online on the North Atlantic LCC coastal resiliency page (<http://northatlanticlcc.org/products/thresholds-for-coastal-species-and->

habitats; <http://northatlanticlcc.org/products/coastal-resilience-resource-list>), on the U.S. Climate Toolkit (<https://toolkit.climate.gov/tool/coastal-resilience-resource-list>), and a project page on the NE CSC site (<http://necsc.umass.edu/projects/critical-thresholds-and-ecosystem-services-coastal-ecological-and-human-climate-adaptation>).

## **References**

Lentz, Erika E., E. Thieler Robert, Plant Nathaniel G., Stippa Sawyer R., Horton Radley M., and Gesch Dean B. 2016. Evaluation of dynamic coastal response to sea-level rise modifies inundation likelihood. Nature Climate Change.