

# Meeting local needs for guidance on future coastal hazards at the New Hampshire shoreline

By

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## ABSTRACT

Following a successful bipartisan effort to legislatively establish the New Hampshire Coastal Risk and Hazards Commission (commission) and three years of dedicated work, the commission released its final report and recommendations in December 2016. The science-based recommendations provide a road map for state agencies, the state Legislature, and coastal municipalities as they prepare for and adapt to projected increases in coastal flooding from storm surge, sea-level rise, and extreme precipitation. The commission recommends strategies to protect, adapt, and sustain the coastal NH economy, built landscape, natural resources, and heritage. Three key factors enabled the commission's success: 1) a clear need demonstrated at the local level; 2) strong leadership and a commitment to real collaboration and good process; and 3) a focus on decision-making under uncertainty. By the 1 December 2016 sunset date, the commission unanimously agreed upon a summary of historical and projected coastal flood trends based on best available science and unanimously adopted a final report and set of recommendations. Within the same timeframe, commission

members supported bills that resulted in two successful pieces of state legislation, ensuring implementation of key recommendations. Finally, the commission's process created an informed and dedicated set of leaders in multiple sectors and facets of government on issues of future coastal risk and hazards in New Hampshire. Some of the most novel and challenging to implement commission recommendations emphasize understanding the ecosystem services provided by coastal natural resources and developing adaptation strategies that both protect those resources and mimic natural processes and ecosystems in order to protect the built landscape. Many municipalities are already ahead on some of the locally targeted recommendations, and in fact, their experiences helped inform the recommendation development. In one example of this municipal leadership, the town of Durham is addressing several built landscape and natural resources commission recommendations through a green infrastructure — living shoreline — design for erosion control and sea-level rise protection on a culturally-valuable public recreation and conservation property.

Traversing Wagon Hill Farm in Durham, New Hampshire, a visitor can't help but note that the property is at once a rich cultural hot spot, an ecological gem, and a recreational destination. Upon approaching the Wagon Hill Farm shoreline at the mouth of the tidal Oyster River, an old pier marks the spot where shallow-drafted cargo barges called "gundalows" docked to unload goods from Portsmouth Harbor as far back as the 1600s (Gundalow Company 2016). No matter the time of day, a visitor will meet others enjoying the scenic view of the Great Bay Estuary while their dogs enjoy a swim, and it is clear to the visitor that this property is beloved by nearby residents. And indeed, the property does officially serve multiple purposes: The 139-acre property was acquired by the town in 1989 "to preserve its scenic vistas, provide for future municipal purposes and preserve open space in order to provide for a healthful and attractive outdoor environment for work and recreation, and to conserve land, water, forest and wildlife resources" (Town of Durham 2017). But upon closer look, a visitor will

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also notice signs of stress at Wagon Hill Farm's shoreline. Meeting the multiple goals for Wagon Hill Farm has been challenging for the town, in part because the fringing salt marshes that mark the tidal shoreline have eroded into the river at an alarming rate over the past two decades (Cavendish Partnership 1995; Snyder 2009). The erosion is likely due to a series of stressors, including trampling from foot and pet traffic along the shoreline and shading from overhanging trees that prohibits marsh plant growth. The Durham Department of Public Works has moved the fence that runs along approximately 1,000 ft of the shoreline landward twice in the past few years. Recognizing

the need to come up with a resilient solution to the disappearing shoreline at Wagon Hill Farm, Durham residents allocated funds in their Fiscal Year 2016 budget for a stabilization project (Town of Durham 2015). However, designing an erosion control strategy that preserves the conservation, recreational, and historical integrity of the property while accounting for intensifying erosive forces from sea-level rise and storm surges, is quite a challenge (Stafford Regional Planning Commission 2013).

Durham is not alone in its struggle to address existing and future coastal erosion hazards while trying to preserve quality of life in coastal New Hampshire. It was precisely these types of tidal tribulations that the New Hampshire Coastal Risk and Hazards Commission was set up to investigate in January of 2013 when Senator David Waters introduced New Hampshire Senate Bill 163, "Establishing a commission to recommend legislation to prepare for projected sea-level rise and other coastal and coastal watershed hazards" (NH General Court 2013). The commission, established with bipartisan support in the

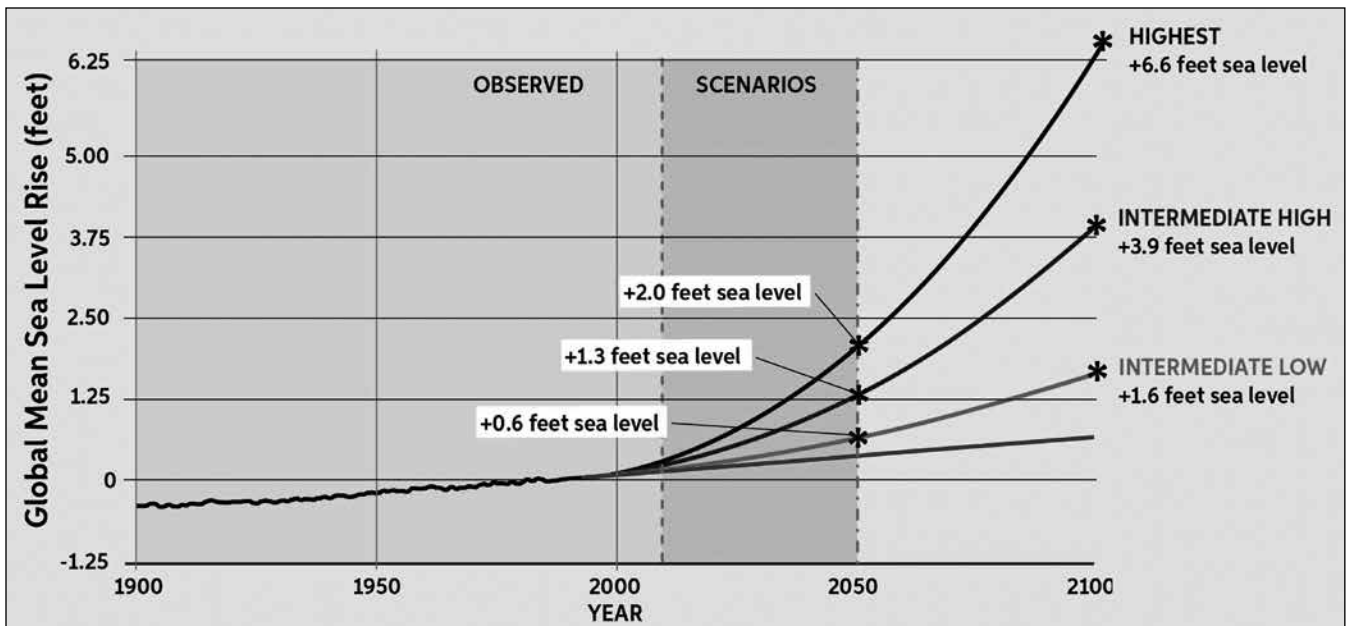


Figure 1. Coastal New Hampshire sea-level rise scenarios under different emission levels in 2050 and 2100, adapted from Kirshen *et al.* (2014).

New Hampshire legislature, was charged with two central duties in the law:

1. The commission shall recommend legislation, rules, and other actions to prepare for projected sea-level rise and other coastal and coastal watershed hazards such as storms, increased river flooding, and storm water runoff, and the risks such hazards pose to municipalities and state assets in New Hampshire.

2. The commission shall review National Oceanic and Atmospheric Administration and other scientific agency projections of coastal storm inundation, and flood risk to determine the appropriate information, data, and property risks.

The commission released its final report and recommendations in November 2016, just in time for its legislated 1 December 2016 sunset date (NH Coastal Risk and Hazards Commission 2016a). Though the commission's sunset is more accurately a starting point for the work ahead than an indication that issues have been resolved, by several measures, the 37-member commission process was extremely successful. The commission's Science and Technical Advisory Panel (STAP) Report which summarized best available science about past and future storm surge, sea level rise, and extreme precipitation, was adopted unanimously by the commission in 2014. The final report and recommendations, for which the STAP report was a foundation, were adopted unanimously by the commission

in 2016. Also in 2016, commission members passed two state laws implementing key recommendations (NH General Court 2016a, 2016b). Finally, the commission process resulted in a dedicated set of informed leaders on coastal risk and hazards issues at multiple levels of government and in multiple industry sectors that will continue working beyond the commission's lifespan. The commission's effectiveness can be attributed to a combination of many things; however, three

key enabling factors played critical roles in its success: a clear need demonstrated by municipalities, strong leadership and a commitment to real collaboration, and a focus on risk based strategies for decision-making under uncertainty.

#### MEETING THE NEEDS OF COASTAL COMMUNITIES

Prior to the commission's genesis, many coastal NH communities had been grappling with how to manage coastal



Figure 2. Waves crash on the shores of Hampton, New Hampshire. (Photo credit: Christopher Harmon.)



**Figure 3. People and dogs alike enjoy the Great Bay Estuary along the shores of Wagon Hill Farm in Durham, New Hampshire. (Photo credit: Brendan Newell.)**

risk from the immediate threat posed by storm surge flooding and extreme precipitation events as well as the long-term effects expected from accelerating sea-level rise. The Mother's Day flood of 2006 and the Patriot's Day flood of 2007 caused significant disruptions and damage in coastal NH communities, and Tropical Storm Irene and Superstorm Sandy impacted neighboring communities too close for comfort. These events precipitated local recognition that better flood planning was needed (NH Coastal Risk and Hazards Commission 2016a).

In 2009, the New Hampshire Coastal Adaptation Workgroup (NHCAW) — an informal partnership created by several regional organizations including the Piscataqua Region Estuaries Partnership, the New Hampshire Fish and Game Department Great Bay National Estuarine Research Reserve, the New Hampshire Department of Environmental Services, the New Hampshire Coastal Program, the University of New Hampshire Cooperative Extension, the National Oceanic and Atmospheric Administration, NGOs and two regional planning commissions — began providing technical assistance on storm-based flood management and sea level rise preparedness to coastal municipalities (Coastal States Organization 2016). In 2011, downscaled sea level rise scenario maps were developed for the NH coastal region, leading to vulnerability assessment and planning efforts

in the City of Portsmouth and town of Durham as well as other communities (Wake *et al.* 2011; City of Portsmouth 2013; Strafford Regional Planning Commission 2013). NHCAW members helped connect coastal communities to federal grants and resources to conduct many of these projects, such as the U.S. Environmental Protection Agency Climate-Ready Estuaries Program, the National Oceanic and Atmospheric Administration Office for Coastal Management, and the Federal Emergency Management Agency.

Through these efforts, municipal officials began recognizing that much of the preparedness actions they needed to take would require close collaboration with state agencies on permitting and construction. For example, if they wanted to raise local roads to avoid future high tides, connecting state roads would need to be aligned with higher local roadway elevations. However, a lack of clear state policy and guidance contributed to the already-significant uncertainty about the timing and magnitude of future impacts at the municipal level and made for additional hesitancy toward taking preparedness actions. In workshops and planning projects, NHCAW members consistently heard requests from municipal decision makers for clear policy and guidance from state agencies on the topic of climate change adaptation. Knowing full well that the coastal municipalities would bring valuable firsthand experience to the table

and were interested in guidance from the state, Senate Bill 163 co-sponsor Senator Nancy Stiles insisted that each of the 17 tidal municipalities have a representative on the commission.

#### **STRONG COMMITMENT TO BIPARTISAN COLLABORATION**

The broad makeup and active participation of commission membership — including the 17 municipal representatives and 20 representatives from the NH legislature, state agencies, academic institutions, and industry associations — were critical to the commission's success. Strong bipartisan leadership provided by Senators David Watters and Nancy Stiles created an expectation of respectful participation from members. Dedicated chairmanship from Rockingham Planning Commission Director Cliff Sinnott ensured meetings were well-designed and facilitated. Over the course of three years, the full commission met 24 times, the Steering Committee met 30 times, and several workgroups met regularly. Because the commission was unfunded, many commission members volunteered their time and other professional representatives prioritized their participation. State agencies and regional planning commissions dedicated staff time to clerk the meetings, conduct research, develop presentations, draft and edit report content, and plan and execute a public input process (NH Coastal Risk and Hazards Commission 2016a). This supplemental

**Figure 4. A boy plays on the eroding shoreline of Wagon Hill Farm in Durham, New Hampshire. (Photo credit: Kirsten Howard.)**



staff support was critical in the execution of a multi-pronged public input process which included facilitated discussion group meetings with municipal officials in December 2015 and a 75-day public comment period, which included public input meetings and detailed responses to each comment received (NH Coastal Risk and Hazards Commission 2016b). The thorough public input process not only resulted in an improved final product, but also solidified commission member support for the final product as it confirmed that the guidance and recommendations were desired by local officials.

#### **A FOCUS ON RISK-BASED DECISION-MAKING**

Progress by the commission relied on emphasizing risk tolerance-based approaches to decision-making in the face of uncertainty. Early in its process, the commission lay the foundation for understanding coastal hazards and flood risks by establishing a Science and Technical Advisory Panel (STAP) to review current science and analyze historic trends and projections for storm surge, sea-level rise, and extreme precipitation in coastal New Hampshire (Kirshen *et al.* 2014; NH

Coastal Risk and Hazards Commission 2016a). The STAP report, unanimously adopted by the commission in 2014, concluded that best available peer-reviewed research suggested that, compared to a baseline of 1992, sea levels would likely rise between 0.6 and 2 ft by 2050 along New Hampshire's coast, and between 1.6 and 6.6 ft by 2100. Figure 1 shows the sea-level rise scenarios presented for coastal New Hampshire. In addition to future sea levels, the STAP report concluded that annual precipitation will likely increase by as much as 20% by the end of the 21<sup>st</sup> century compared to the late 20<sup>th</sup> century. Research remained uncertain regarding coastal storm predictions; however the STAP noted that future storms will occur on top of higher sea levels, resulting in greater flooding extent. Additionally, extreme precipitation events are expected to increase in frequency and amount of precipitation produced, however model predictions remained too uncertain to predict specific increases in intensity and frequency.

While the STAP provided an important baseline summary of the science for the commission and its stakeholders, it

also illuminated a challenge for the commission: that many recommendations would need to enable action to protect against and prepare for future impacts of uncertain timing and magnitude. Recognizing the wide range of possible sea level rise outcomes and uncertainty around storm frequencies and precipitation quantities, the commission, drawing from a suggestion made by the STAP, recommended (S1) that best available peer-reviewed science be reviewed frequently and that the STAP report be updated regularly. Support for regular science updates extended beyond the commission: the recommendation was codified by Senate Bill 374 which required the STAP to be updated every five years beginning in 2019 (NH General Court 2016a). The bill passed the NH Legislature and was signed into law in March 2016.

Also drawing from STAP suggestions, one of the key guiding principles identified by the commission for municipalities and state agencies is to “incorporate risk tolerance in design.” This entails determining the capacity to tolerate damage or loss of a structure or project. If a project has a long design life and a low



**Figure 5. Existing conditions at the Wagon Hill Farm shoreline, contrasted with two conceptual options for living shoreline designs. (Photo credit: Strafford Regional Planning Commission.)**

tolerance for damage or loss, such as a newly built wastewater treatment plant, the commission recommends adopting a low-risk tolerance approach and designing the project to withstand higher sea-level rise scenarios and more extreme storms. This concept is used in everyday decision-making already but, by applying it to climate change preparedness, the commission put forward an approach that municipal and state officials could fairly easily build into existing processes.

Similar to the STAP update recommendation, many of the 35 recommendations and associated actions set forth by the commission focused on improving available information by either filling known gaps in existing science, improving the resolution and detail associated with vulnerability assessments, or evaluating existing enabling legislation to better understand legal implications of preparing for future impacts. For example, Recommendation S2 identifies specific scientific gaps to be filled including a better understanding of how sea level rise will impact saltwater intrusion and groundwater tables. Recommendation CC2 prioritizes improving vulnerability assessment information for state and municipal assets. Recommendation CC3 suggests reviewing state statutes and rules to understand whether they permit state agencies and municipalities to prepare for climate impacts or whether adjustments are needed. A law passed the NH Legislature in March 2016 requiring CC3 to be completed by specific state agencies (N.H. General Court 2016b). While those three categories of recommendations (science, assessment, and legislation) assist with decision-making under uncertainty, several recommendations do offer options for action. These recommendations, for

the most part, are in line with another guiding principle identified by the commission: to “make no regrets decisions.” They focus on strategies for building resilience in the regional economy, built landscape, natural environment, and historical and recreational resources that are likely already on the to-do list of certain municipal boards, commissions, capital improvement plans, or agency leadership teams. For example, Recommendation NR3 suggests protecting land that is resilient to changing conditions and provides benefits to people. Land protection is already a goal for many municipalities and this recommendation simply reinforces the ability of well-planned conservation to persist over time and support demand for things like recreation and clean water. The commission members recognized that actions that are already on to-do lists and provide multiple benefits to a community are often easier to prioritize. Furthermore, many existing best practices in policy-making and public resource management lead to more resilient and adaptive communities when it comes to all sorts of shocks and disruptive events, including future climate change impacts.

#### ON THE GROUND:

##### *A nature-based solution for Wagon Hill Farm’s shoreline erosion*

Wagon Hill Farm’s shoreline solution has been on Durham’s to-do list for more than 20 yrs, when a report first identified the property’s erosion problem (Cavendish Group 1995). Durham’s Climate Adaptation Hazard Mitigation Plan Chapter, which was published three years prior to the commission’s report, recognizes that sea-level rise will only exacerbate erosion issues on the Oyster River and in Little Bay (Strafford Regional Planning Commission 2013). Furthermore,

according to modeling conducted by the New Hampshire Department of Fish and Game (2014), as much as 95 percent of New Hampshire’s current salt marsh could be lost if sea levels rise by 6.6 ft or more without active restoration and protection (NHCoastal Risk and Hazards Commission 2016a). Finding a solution for the site has been elusive, in part due to a lack of funds, other priorities, and (perhaps most important) a lack of knowledge about how to design an appropriate solution that is consistent with the original conservation-focused goals for the property. A more traditional rip-rapped approach would likely result in a loss of ecological function in the short term, and complete disappearance of the salt marsh over the long term as higher seas drown them out and the rip-rapped wall keeps them from migrating upland.

Recognizing the need to explore innovative solutions to the type of challenge facing Wagon Hill Farm and other shorelines, Commission Recommendation BL5c suggests identifying shoreline sites that would work well for “nature-based approaches to shoreline stabilization.” These approaches, also known as living shorelines, use primarily organic materials and maintain the natural continuity of the land-water interface, retaining or enhancing shoreline ecological processes (NOAA 2017; U.S. Army Corps of Engineers 2017). More common in the mid-Atlantic and Gulf of Mexico states, living shorelines face challenges in the colder Northeastern climate, but also hold significant promise for preserving ecosystem function as tidal shoreline erosion becomes more common and more property owners seek protective measures. When installed under the appropriate conditions, a living shore-

line can stop or slow erosion, protect nearshore ecosystems, improve water quality, create habitat, store flood water, and sequester and store carbon. Unlike a seawall or rip-rap shoreline stabilization method, a living shoreline would allow salt marshes to migrate landward rather than drown as sea levels rise.

Leveraging municipal funds and a grant from the NOAA Office for Coastal Management in partnership with the New Hampshire Department of Environmental Services Coastal Program, Durham Department of Public Works Director Mike Lynch is working with University of New Hampshire restoration and engineering experts to evaluate erosion drivers and design a living shoreline stabilization approach that will adapt with sea level rise. If installed, the Wagon Hill Farm living shoreline will be one of the very first living shoreline projects piloted in coastal New Hampshire.

“The Town of Durham is proud to be the lead on such a cutting edge, pioneering project that could change how seacoast communities control erosion problems year-round, not only here in Durham but up and down the eastern seaboard,” Lynch said in a recent interview.

If successful, the project will serve as an important step toward implementing the commission’s recommendation to prioritize resilience strategies that protect both the people of coastal NH and the natural resources they will continue to depend on in a future with higher, more tumultuous seas.

### CONCLUSION

The commission’s efforts serve as a model of strong collaboration and commitment to meaningful discussions and local decisions necessary to prepare for future coastal risks and hazards associated with climate change. Effectiveness

depended on several factors, but most notably: 1) a need for guidance demanded by municipalities, 2) a carefully designed collaborative process with strong, bipartisan leadership and active participation, and 3) a focus on risk based decision-making in the face of uncertainty. As municipalities such as Durham struggle with intensifying shoreline erosion and more extreme flood risk, they will seek solutions that preserve the values and quality of life in coastal New Hampshire. Though time will tell whether the commission’s recommendations are implemented effectively, the process undertaken by the commission created a set of informed leaders that will continue to find innovative solutions that attempt to provide multiple benefits and enable a strong regional economy, a functional built landscape, vibrant natural resources, and a rich cultural history.

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