



*Photo by Stephanie Zollshan*

# Publicly Accessible Shorelines



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Crane Estate, Ipswich, MA (Courtesy Above Summit)

## Background

Like all coastal properties along the Commonwealth's shorelines, the Trustees of Reservations coastal reservations inhabit an ever-changing environment where storm events and sea level rise threaten the existence of the built and natural environments. With support from the Massachusetts Office of Coastal Zone Management (CZM), the Trustees and their partners launched the project, A Focus on Our Most Vulnerable Places, to raise awareness and understanding about climate vulnerabilities in coastal areas and the nature-based coastal resilience measures that could manage those risks. Using three reservations—a tiny sliver of the 120 miles of coastline managed by the Trustees—the Trustees engaged local community members and coastal engineers

to understand their perspectives about coastal change, the inherent risk associated with dynamic coastal areas, and adaptation options for barrier beaches, coastal banks, and publicly accessible shorelines.

This case study on publicly accessible shorelines highlights the vulnerabilities and adaptation approaches under consideration at Crane Beach in Ipswich, MA, where Argilla Road is the only way in and out, and the parking lots, visitor gatehouse, dune boardwalks, trail system, a service road, and a yet-to-be constructed coastal education center will be increasingly vulnerable to the impacts of climate change.

## Vulnerabilities and Potential Impacts on Publicly Accessible Shorelines

While models and scientific data help us to better understand current conditions and consider future scenarios, visitors who frequent a coastline often notice changes over time. To learn about the changes that visitors see happening, or expect to see in the future, and to understand their concerns about impacts to public access at Crane Beach, the Trustees and their partners engaged visitors in a set of interviews and an online workshop. Highlights of the visitor perspectives follow.

### Chronic Tidal Flooding

All of the visitors to Crane Beach knew that flooding already is a risk to Argilla Road. Several visitors commented that inundation of the road seems to occur more frequently than in the past. In fact, data collected by The Trustees confirm this observation: during the monthly astronomical high tide and during some storm events, water emerges from the

surrounding marsh and tops Argilla Road. These flood events provide clues for what the future holds and prompted the Trustees to begin planning how to maintain access to the precious resources at Crane Beach and the Crane Estate.



Argilla Road flooding

Many interrelated processes cause the flooding, including legacy marsh ditching that altered hydrology and sediment accretion, sea level rise (SLR) outpacing the rate of marsh accretion, too much or too little salt water inundation which causes marsh vegetation to die, and occasional storm events. Models integrating water flow pathways, sea level rise, tide cycles, and storm events confirm the visitors' expectations of more regular flooding in the future: after 2030, Argilla Road, the beach gatehouse and the service road to Choate Island are expected to flood on a daily basis during high tide. Chronic flooding will be the "new normal" along the road to Crane Beach.

The "new normal" daily high tides also will impact the surrounding marsh ecosystem. Since marsh vegetation has adapted to tolerate precise durations of salt water inundation, more frequent inundation of the vegetation will cause it to die-off and convert to mudflat. By 2070, sizeable areas of the marsh surrounding Argilla Road will convert to open water, and with the conversion we will lose the flood buffering, water filtration, and critical habitat that the marsh ecosystem provides to us. In some locations, where marsh currently meets the upland, marsh vegetation may migrate upslope and convert the upland into marsh.

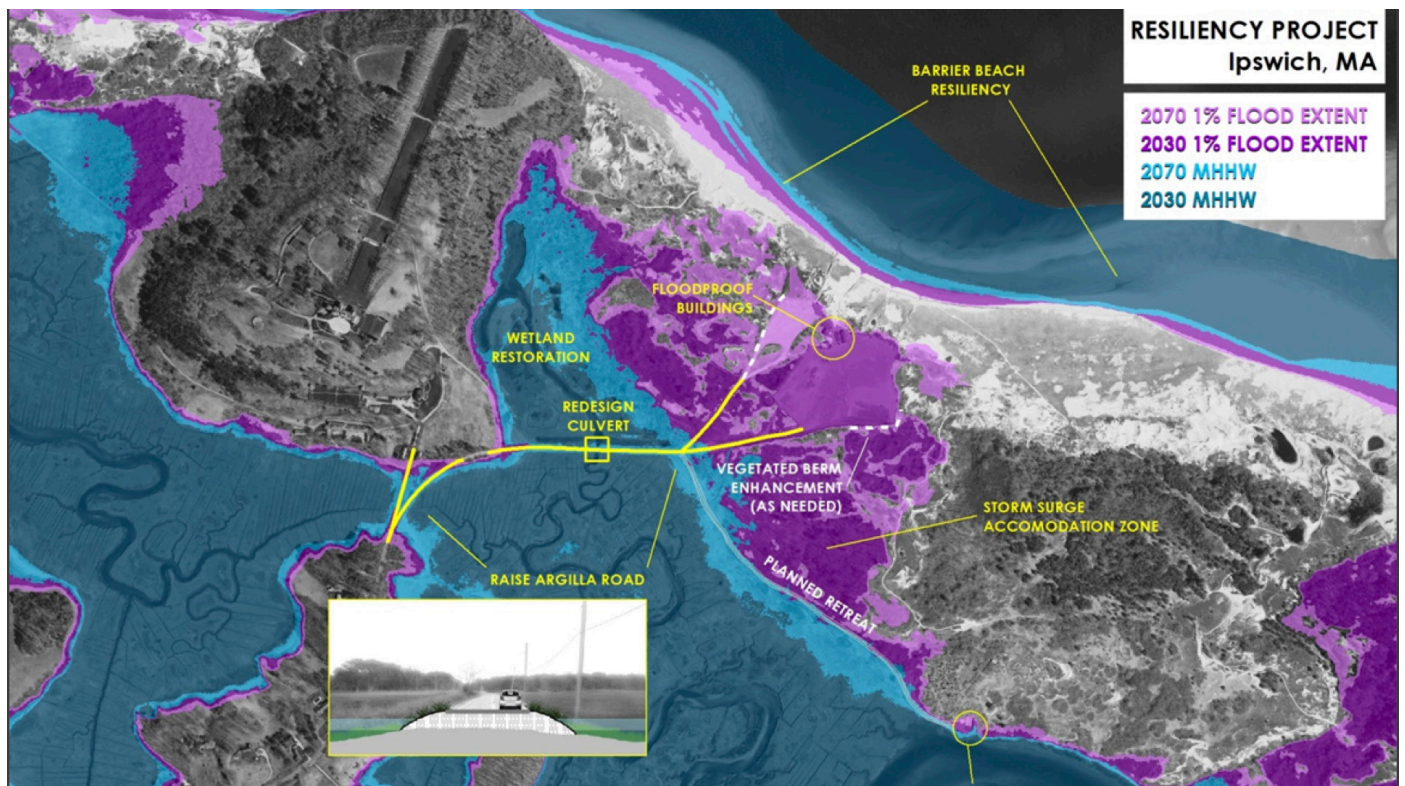
### Episodic Storm Driven Flooding

Fewer visitors had considered the impacts to the Crane

Beach parking lots, which seem protected by the dune system sitting between the parking lot and the ocean. But risk in the parking lot is deceptive. Flood waters will most likely enter the parking lots from the marsh flanking Argilla Road; however a perfect storm could cause dune overwash. While Argilla Road is expected to flood with the daily tides after 2030, only a portion of the parking lots are expected to flood and, even then, only during storm events. However, sometime between 2030 and 2050, the combination of SLR and storm events may flood larger areas of the parking lots. By 2050, modeling predicts the parking lots and buildings will have an 80% chance of storm flooding. A 10-year storm in 2050 could see storm surge flood depths of 1.6 feet across this area.

### Erosion

Visitors also noted significant coastal erosion along Crane Beach. Several visitors commented on erosion along portions of Cedar Point Trail and some visitors shared photo documentation of the dune erosion. Trustee's monitoring confirms the visitors' observations--approximately 115 acres of coastline have been lost on the southeastern section of Crane Beach since the 1950s. Visitors also noted that storm events sometimes cover the boardwalks in sand and, at other times, erode the sand from around the boardwalks. Visitors expect these impacts to continue in the future as sea levels rise and storm events increase in size.



Courtesy Woods Hole Group

Coastal communities and private property owners like The Trustees must assess climate risk in relation to their goals and determine the level of risk they can accept when deciding when and how to respond to the threat of SLR and storm events. To prioritize and focus their adaptation actions, The Trustees' completed a coastal vulnerability assessment (CVA). The CVA produced risk scores for individual assets by evaluating the probability that an asset would flood and the

estimated consequence (or impact) of the flooding on the Trustees' ability to achieve their mission. Argilla Road was identified as a critical asset to further the Trustees' mission and highlighted the need to consider interventions that would sustain public access to Crane Beach and Castle Hill, despite the monthly astronomical high tide flooding, the occasional storm-driven flooding that occurs now and the chronic daily flooding expected after 2030.

## Potential Responses and Interventions to Reduce Vulnerability

Several broad adaptation responses are available to coastal property owners to manage vulnerability, including:

- » *Avoid* – When planning future investments, locate assets out of harm's way.
- » *Protect* – Construct barriers to protect assets and sustain operations in vulnerable locations.
- » *Accommodate* – New assets, if installed in vulnerable locations, will be designed to adapt to changing environmental conditions; assets currently in vulnerable locations could be retrofitted to adapt to changing environmental conditions. Plan use over time and transition uses to take advantage of opportunities presented by the new conditions.
- » *Retreat* – Move currently vulnerable assets and associated programming out of harm's way and continue operations in a new, safe location.
- » *Accept loss* – Remove assets from the risk zone and discontinue associated operations.
- » *Do nothing* – Taking no action and allowing nature and time to take its course.

Within the adaptation responses are a variety of potential site-specific options that span the spectrum from traditional engineered “gray” solutions to nature-based solutions. Factors such as environmental benefit/impact, asset value, effectiveness, finances, construction feasibility, design life, maintenance, and adaptability influence decisions about which option(s) to pursue.

Traditionally, gray infrastructure (e.g. seawalls and rock revetments) has been used to fortify coastal assets; however, these projects are not preferable because they disrupt the ecosystem processes that both provide natural resilience and support local economies (recreation, fishing, tourism, restaurants, etc.). Additionally, these projects often transfer the problem they were intended to solve to adjacent properties.

Nature-based projects present an alternative to gray infrastructure. Nature-based projects use, enhance, or create natural processes that provide hazard reduction benefits and habitat to sustain plant and animal populations and the

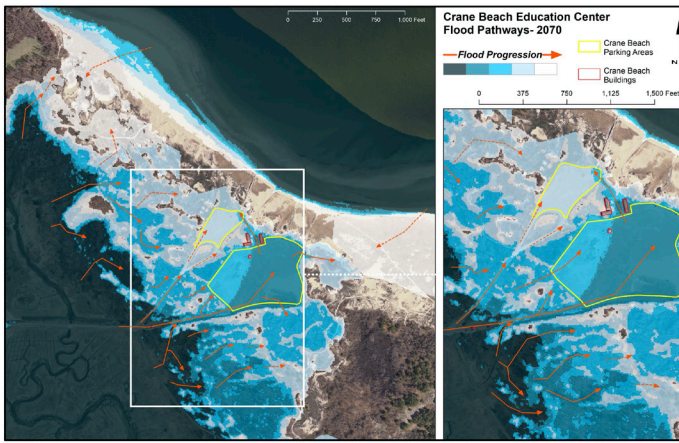
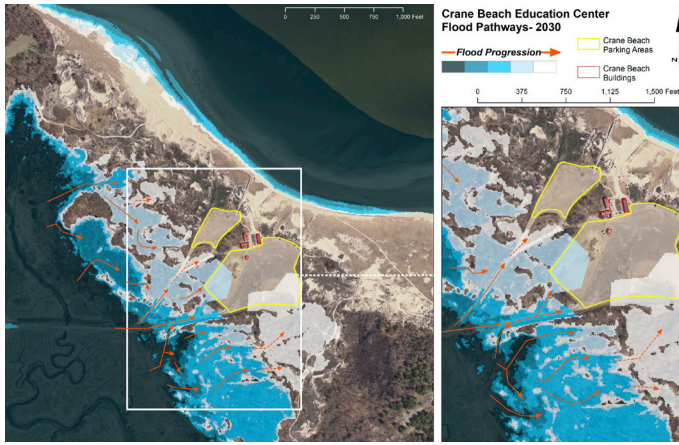
industries that rely on them.

Interviewees and workshop participants indicated a preference for nature-based approaches over the traditional gray infrastructure approaches; however questions remain about the effectiveness of nature-based approaches. Several interviewees commented that traditional gray infrastructure would not be acceptable because it would not be aesthetically pleasing in the natural environment. Interviewees suggested that the traditional infrastructure may cause more problems than it solves. A similar theme came from those in favor of nature-based solutions; they indicated that human involvement in natural processes usually causes more problems than the original issue, even in the case of nature-based solutions. To this end, they suggested allowing natural processes to continue untrammelled. However, if action must be taken, visitors seem to prefer nature-based approaches that work with nature rather than against it. Although several interviewees questioned how well nature-based approaches would perform in the face of sea level rise and storms of greater intensity.

Interviewees and workshop participants shared their perspectives on a range of nature-based adaptation strategies and interventions to manage vulnerability and maintain access to Crane Beach. Some of the interventions are actively being studied and others remain in the concept stage. The following section summarizes perspectives by asset (e.g. road, parking lot, etc.).



*Crane Beach, Ipswich, MA. Photo by Stephanie Zollshan; courtesy The Trustees*



Flood pathways from the marsh to the Crane Beach parking lot and buildings.

### Road Adaptations

The Trustees and the Town of Ipswich are exploring opportunities to elevate Argilla Road and to replace existing and add new culverts to maintain access to Crane Beach and Castle Hill for the next 50 years. One consequence of elevating a road is that the slope of the banks extend further out - which means filling in marsh on either side of the roadbed, especially to accommodate more gradual and resilient slopes. This is a tradeoff for resiliency, however, the larger culvert size will allow for more tidal flow and is therefore projected to allow marsh migration upstream with a potential net gain of 1.2 acres of new salt marsh. The 2:1 slope would impact less marsh area, but the steeper slope is more vulnerable to erosion and growing vegetation on the slope will be more difficult. The 3:1 slope will impact more salt marsh vegetation, but it would be easier to grow vegetation on the gentle slope and the combination of vegetation and a gentle slope would be more resilient to erosion. Increasing the size of the existing culvert and adding new high marsh culverts would aid in restoring a more natural flow of the tide waters, be responsive to projected SLR, and may create a net gain of 1.2 acres of new marsh habitat as sea levels rise and marsh vegetation migrates upslope.

Participants were very concerned about the current and anticipated impacts to Argilla Road and seemed generally supportive of the proposed improvements to maintain access. Several participants noted that maintaining access via Argilla Road is the most critical, given that it is the only road to access the beach and other amenities, and that the beach generates significant revenue for the Town and The Trustees. However, participants suggested that The Trustees should reevaluate the frequency with which access should be provided and consider alternative methods of access in the future. For example, reevaluating the frequency of access and temporarily restricting the use of the roadway when it is unsafe could mean that instead of providing access 100 percent of the time, access to the beach may only be provided 80 percent of the time while flooding prevents access 20 percent of the time. Recognizing that less access is inconvenient, a participant suggested that accommodating and managing 3-4 hours of high tide flooding is much easier than most people fear and should be an option on the table. Participants also suggested considering alternative, non-vehicular options (e.g. bicycle, walking trails, etc.) to access the beach.

Boathouse Road, the access road to the boathouse where visitors launch to reach Choate Island, faces threats of chronic tidal flooding storm driven flood impacts similar to Argilla Road. Potential nature-based solutions for the access road include cobble berm banks and roadway elevation, temporarily restricting use during unsafe times, or restoring the road and finding a new location for a boathouse. A participant noted that the cobble berm banks worked well in a similar situation at Duxbury Beach Reservation; however, the approach may impede marsh migration at Crane Beach. Other participants expressed interest in accepting loss, restoring the road, and retreating the boathouse to a new location given the length of roadway and potential environmental impacts of protecting it from flooding.

### Parking Lot Adaptations

Participants shared the following perspectives on a range of options to address projected impacts on the parking lots from do nothing to constructing vegetative berms to restoring the parking lot and retreating to another location. Participants suggested that the parking lots should be protected for as long as Argilla Road is expected to provide access. Earthen berms planted with native vegetation could be appropriate given the infrequent nature of the expected storm-driven flooding, although the berms would not prevent groundwater from pooling the parking lots as salt water pushes groundwater to the surface. Participants advised that the option of restoring the parking lot and creating satellite parking elsewhere could be a realistic long-term option; it might prevent some of the costs of maintaining the parking

lots, but also might decrease the number of visitors (and the associated revenue) while simultaneously causing visitor pressure to increase at other public beach access points.

### **Designing Resilient and Adaptable Infrastructure**

The Trustees have a long history of adapting to and accommodating nature at Crane Beach. To facilitate continued beach access, The Trustees build boardwalks upon boardwalks as dunes migrate and cover previous boardwalks with sand. The Trustees also are designing assets with changing conditions in mind. The beach gate house has extendable legs and wheels, which allow it to be elevated out of harm's way when high tides or storm events are predicted or hitched to a truck and relocated if the projected water depth is too great. A yet-to-be-constructed coastal education center will be designed with nature's movement in mind. It will accommodate the shifting sands of the dune and, as flooding becomes more frequent, wet-proofing and adaptable reuse will withstand flood impacts and enable new phases of building use to emerge as environmental conditions change.

### **Future Choices and Summary**

Local stakeholders are already witnessing changes in the frequency and intensity of flooding at the Crane Beach area. People recognize that changes are happening, and in some cases, are unprecedented. However, the projections of future flooding events and their likelihood was new and surprising for many of the stakeholders. In this case study, local officials and conservation professionals were already aware and engaged in the Argilla Road project. This case study is an example of how public-private partnerships are essential to ensuring public access to shorelines as well as designing models that can be shared with other communities.

Overall, the consensus at Crane Beach was to plan for and implement accommodation strategies that employ nature-based or hybrid engineering approaches to ensure public access to these coastal properties. Nature-based measures were a focus of this case study because they hold promise and options for accommodation approaches that are both more sustainable and resilient. However, some stakeholders thought retreat was the best approach in the long-run.

Participants shared the following perspectives on adaptable infrastructure options and retreat strategies related to a proposed coastal education center: To some extent, low cost investments in flood prone areas are more appropriate than high value investments. High value investments will make retreat strategies more expensive and less likely in the long-term due to an investor's interest in achieving a sound return on investment. Participants suggested taking a long-term view and, if retreat is a likely strategy in 50 years, consider the following questions: How much would a property owner gain from 50 years of property use? How much would a property owner be willing to invest and eventually give up? Is the estimated number of years of expected property use able to offset the cost of investment based on future climate impact scenarios? Alternatively, if a central design feature of the center is its ability to be relocated, then this adaptation feature would mitigate the need for more complex and protracted planning and decision-making processes.

Adapting to climate change will involve tradeoffs. There will always be a question of time frame, cost-benefits, impacts to the environment, lifespan of the adaptation, the values at stake, and who will benefit. No one coastal landowner or community can do this alone. Engaging stakeholders in the process of evaluating adaptation options and tradeoffs benefits everyone in the long run to inform our choices and response to sea level rise and storm impacts in the future. The Trustees and the Town of Ipswich will continue to engage stakeholders as we respond to coastal change. We know that the choices we make over the next decade will offer the next generation a chance to enjoy access to the coastal shorelines we love today.



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*Design by Erin Connolly*