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Barrier Beach Systems

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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 A Focus on Our Most Vulnerable Places, a project to raise awareness and understanding about climate vulnerabilities in coastal areas and the nature-based coastal resilience measures to manage those risks. Using three reservations—a tiny sliver of the 120 miles of coastline the Trustees manage—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 highlights perspectives on the threats to Norton Point, a barrier beach and potential adaptation options available to adaptively manage this coastal landform in the face of rising sea levels and larger storm systems. Norton Point is a 2.5-mile-long barrier beach strip of sand and dunes sitting between Katama Bay to the north and the Atlantic Ocean to the south, on the Southeastern side of Martha's Vineyard. It provides vital shorebird habitat, OSV access for recreation and, when not breached, it is the only way to reach Chappaquiddick Island by land. Norton Point also provides natural storm surge protection for the homes and lands surrounding Katama Bay. However, sea level rise, wave action and storm events threaten to inundate and eliminate this fragile and dynamic sliver of sand.

Coastal Vulnerabilities and Potential Impacts to Barrier Beach Systems

The Trustees and their partners engaged individuals familiar with Norton Point's coastal environment in interviews and online workshops to understand their perspectives about coastal vulnerabilities, the changes they see occurring, and the adaptation options that could be employed to manage barrier beaches. Coastal engineers from Woods Hole Group (WHG) also assessed the vulnerabilities and potential impacts and shared their insights with stakeholders during the online workshop. Themes from stakeholder conversations and WHG analysis are summarized below:

Chronic Erosion and Sea Level Rise

Many participants commented on changes to the barrier beach caused by erosion. Several participants mentioned the 2007 breach in the barrier beach as a significant event. This breach, which formed during an April storm event, and migrated east over time until it healed itself and reformed a continuous beach in 2015. Participants commented on the acceleration of erosion of Wasque's coastal bluffs while the breach was open. A few participants said the breach and loss of vehicular access to Chappaquiddick impacted those who frequently used the OSV path to access Chappaquiddick. Several participants highlighted that the barrier beach is in constant flux, sometimes widening and other times narrowing in width, and suggested that sea level rise and stronger storm events would likely exacerbate erosion of

the barrier beach until it completely disappeared. A couple of participants also noted that sea level rise was occurring because small commercial piers on the island have been raised multiple times over the past decades to accommodate the increase in water levels. A few participants also speculated that the changes occurring on the barrier beach may impact the amount and locations of endangered species habitat and potentially cause OSV access and habitat to be squeezed together or result in limiting the extent of OSV access.

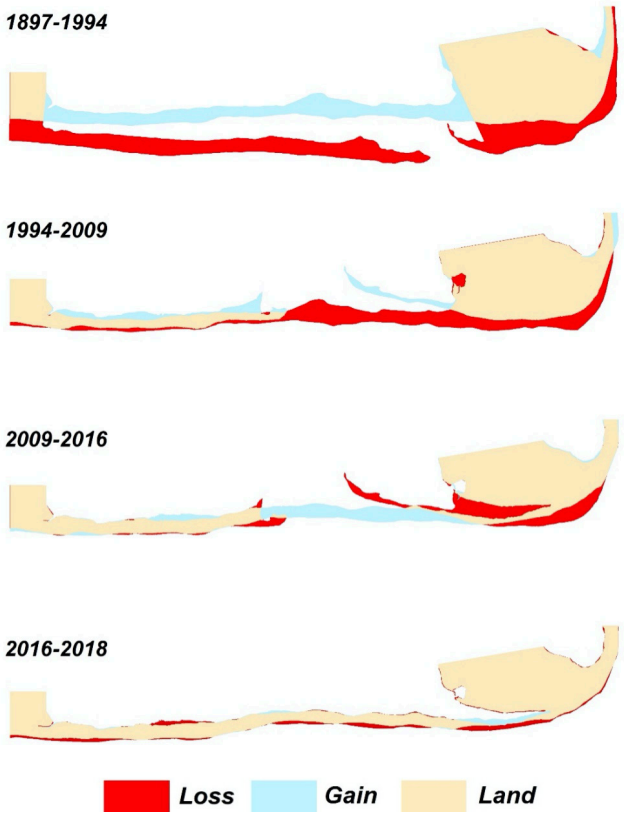
The WHG team confirmed Norton Point's highly dynamic nature, pointing out that the barrier beach has been migrating landward toward Katama Bay since at least 1897. But it is also shrinking. In the fifteen years between 1994 and 2009, the barrier beach lost 70 acres of area. Losing 70 acres in fifteen years is significant considering that 74 acres of area were lost during the 100 years prior to 1994. This suggests that coastal change is accelerating, and sea level rise and inundation is likely to exacerbate the erosion. Considering only the impacts of sea level rise (and not including the impacts of storm events or potential sediment dynamics), models predict Norton Point Beach will be increasingly inundated over time and by 2070 it may be nearly nonexistent. The area where Norton Point is today could be open ocean. The WHG team noted that breaches typically occur from the bay side when storm events create hydraulic pressure which pushes the bay water over the beach toward the ocean.

Some participants expressed concern about the erosion of the coastal dune system on the western end of Norton Point Beach. They noted that some dunes have completely eroded while other dunes are now only small hills of sand and a fraction of their former size. Participants also commented that the beach gatehouse had to be moved inland because erosion made it vulnerable. The WHG team assessment showed how two OSV pathways originally existed in this dune area, but overwash eroded the pathway nearest to the ocean and covered the inland pathway with sand. The overwash also segmented dunes near the entrance to Norton Point and in doing so created habitat that might be suitable for piping plovers. However, the natural placement of the habitat on top of the remaining OSV access pathway creates conflict between endangered species habitat and OSV access.

Shoreline Loss and Chronic Erosion

Coastal geologists from Woods Hole Group assessed the vulnerabilities and potential impacts at Norton Point and shared their insights and potential interventions with participants[1]. The WHG team confirmed Norton Point Beach's highly dynamic nature, pointing out that the barrier beach has been migrating landward toward Katama Bay since at least 1897. But it is also shrinking. In the fifteen years between 1994 and 2009, the barrier beach lost 70 acres of area. Losing 70 acres in fifteen years is significant considering that 74 acres of area were lost during the 100 years prior to 1994. This suggests that coastal change is accelerating. Sea level rise and inundation is likely to exacerbate the erosion. Considering only the impacts of sea level rise (and not including the impacts of storm events or potential sediment dynamics), models predict Norton Point Beach will be increasingly inundated over time and by 2070 it will be nearly nonexistent. The area where Norton Point is today will be open ocean. Norton Point Barrier Beach is also repeatedly breached, with the most recent breach occurring in 2007. These breaches typically occur from the bay side when storm events create hydraulic pressure that pushes the bay water over the beach toward the ocean.

[1] Assessment and Analysis of Adaptive Interventions For Coastal Martha's Vineyard Properties (of The Trustees), Woods Hole Group, May 2020



Erosion of shoreline over time

Potential Nature-Based Interventions to Reduce Vulnerability of Barrier Beach Systems

Several broad adaptation responses are available to coastal property owners to manage vulnerability along barrier beach and dune systems, 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.

Interviewees, workshop participants and coastal engineers discussed a range of site-specific adaptation options falling in the various response options above. The site-specific adaptation options could be completed independently or in combination. Decisions about which option(s) to pursue are contingent upon tradeoffs between criteria such as the net environmental impact or benefit, how long the treatment would last and how well it would perform, as well as the cost and return on investment, and the ability of the treatment to fulfill the property owner's objectives. Decisions may also require modeling or forecasting future conditions to determine the potential design life and effectiveness.

In addition to the "No Action" option, where nature takes its course and the barrier beach is eventually lost to erosion and sea level rise, a range of site-specific adaptation options could be employed to maintain access and use of the barrier beach. Some options are more suitable to certain segments of the beach system than others.

- *Planting native vegetation* – This would stabilize the beach system as a nature based solution that employs native beach grass to capture and accumulate windblown sand with its leaves and hold the sand in place with its deep root system. These relatively cost effect projects can build elevation over time while providing wildlife habitat and educational opportunities if plantings are organized with local groups.
- *Beach nourishment* – Beach nourishment is the strategic placement of sand to reshape beach systems to their natural profile. Nourishment projects are completed with sand or cobble that is consistent with size and color of sand grains or cobble stones found onsite. The result of nourishment is an immediate elevation gain which limits overwash and introduces a sediment source into the coastal system, which may provide benefits when it accretes elsewhere.
- *Combination efforts* – A nature inspired approach combining the beach nourishment with plantings takes a whole ecosystem approach to building resilience by raising the elevation and establishing vegetation that will continue to assist the beach to accumulate and retain sand.

On the western end of the beach system near the entrance of Norton Point Beach, additional site-specific adaptation options could be considered given the assets, natural features, and changes occurring in the area. Adaptation options for this stretch of Norton Point could include planting native beach grass vegetation or beach nourishment, as previously noted, and:

- *Sand fencing* – Similar to native beach grass plantings, sand fencing is used to capture wind-blown sand and trap it in place. While this would help to accumulate sand, it would create a problematic barrier between piping plover nesting sites and the wrack line where they typically feed.
- *Dune restoration* – An approach where the natural profile of a dune is recreated using imported sand. Dune restoration projects are often planted with native beach grasses to encourage the dune to accumulate sand and elevation over time. This approach would provide resilience benefits and potentially encourage dune growth over time however, if piping plovers are present, care will be required to build the dune at gradients with gentle slopes that enable easy passage over the dune.
- *Retreat and realignment of the OSV trail* – The OSV pathway could be relocated further inland, behind the dune system. This would require moving the gatehouse inland as well.

Stakeholder Perspectives on Nature-Based Measures for Norton Point Beach

Participant perspectives about these options spanned the range from taking action to not taking action. On the one hand, some participants held the perspective that the barrier beach has always been changing, man will not be able to change nature's course in this environment, and nature should rein. On the other hand, some participants suggested that reasonable, lower cost and less intrusive actions should be pursued. For example, managed retreat of OSV pathways and beach nourishment and beach grass plantings should be completed to maximize enjoyment and use by people and wildlife in the short-term while recognizing that large scale investments may not be sound given the dynamic nature of the beach, the rate of sea level rise, and expectation that sea levels will continue to rise at increasing rates through the year 2100. Several participants commented on the importance of balancing the cost of action against the ecological impacts and the value of the resource area to the public. Some participants suggested that using a light touch with adaptation options like dune reconstruction, beach nourishment, and beach grass planting, may be appropriate, but suggested that large-scale significant dune reconstruction and beach nourishment does not make sense for the site in terms of sustainability, aesthetics, and cost especially towards the east end of Norton Point Beach where it is prone to breaching. Most seemed to think that dune reconstruction at the western end made sense for protecting access in the short to medium term.

Participants also reflected on how one's relationship with the natural area, and the values one holds, can influence perspectives about adaptation option(s). For example, the generations alive today are accustomed to Norton Point as a solid, intact barrier beach that can provide OSV access to Chappaquiddick. For this reason, many people prefer to maintain the beach as it is. However, for significant periods in Norton Point's history, it was characterized by a persistent breach that connected Katama Bay to the ocean. Residents during those periods were accustomed to the breach and sought to maintain the breach because it provided them with benefits they valued.

The integrity of the barrier beach was a concern for residents with homes and properties along Katama Bay. They saw the storm protection value of the barrier beach. Without the barrier beach, there would be no protection against storm surge flooding of their homes. Residents that participated said that something should be done to maintain beach integrity. They were also concerned about the damage to Norton Point due to amount of vehicular traffic and how over-sand vehicles may be impacting the beach and making it less stable. The Trustees discussed following best management practices established in the 1994 Barrier Beach Guidelines to minimize impact to fragile barrier beach and dune systems from over-sand vehicle access.

Additional stakeholder perspectives from summer residents and Trustees who visit the beach annually were surveyed during a virtual webinar with a similar presentation format. This group of stakeholders were much more optimistic about trying a combination of nature-based measures to maintain integrity of the barrier beach system. When asked 'What adaptation options seems most realistic to you for Norton Point Beach?' most respondents (n=30) recommended a combination of dune reconstruction, beach nourishment, and beach grass planting, with another group (n=7) choosing dune reconstruction and a few (n=3) choosing beach nourishment. Only three people (n=3) chose no action.

American Oystercatcher. Courtesy: RussImages/Wikimedia

Future Choices and Summary

This 2.5-mile-long strip of sand and dunes will continue to breach periodically, rollover and move landward over time. How long this stretch of dunes can provide storm protection to both the beach, public access, the creek behind it, and the bay is in question. While the breach has currently closed, recent storms have caused significant dune loss and overwash in places. This ever-changing environment still provides a spectacular beach for beachgoers, important habitat for nesting shorebirds, and a sporting challenge for the fishermen who surfcast from this popular site.

Beach erosion will accelerate without the dunes, resulting in potential loss of access, reduced protection of the properties surrounding Katama Bay, and eventually, habitat loss. However, beaches need sand to adapt and to be more resilient to storm impacts. Without it the beach will continue to see growing shoreline loss. One short- to medium-term

solution is to trial and implement dune reconstruction and beach nourishment along with beach grass planting and sand fencing to help capture and hold sand on a new dune system. Any nature-based interventions will take a strong partnership between The Trustees, the Town of Edgartown, Dukes County, and state agencies along with continued engagement of local stakeholders and volunteers. Volunteers can be involved in beach profiling to document and share their observations and measurements of seasonal, short-term changes of the beach shoreline and dune extents and the efficacy of nature-based interventions. By doing so, local volunteers can be ambassadors and voices in the community in the broader discussion of barrier beach management and resiliency.

In the end though, these barrier beach systems will change and move based on sea level rise, upstream sediment supply, wave action, currents, and storm events. Climate change will likely accelerate these changes. However, we can intervene and trial approaches that work with nature to slow these changes so that we can preserve options for the future and the values we care about today.

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