Unintended Consequences of Uncontrolled Public Access to a Fragile Shoreline

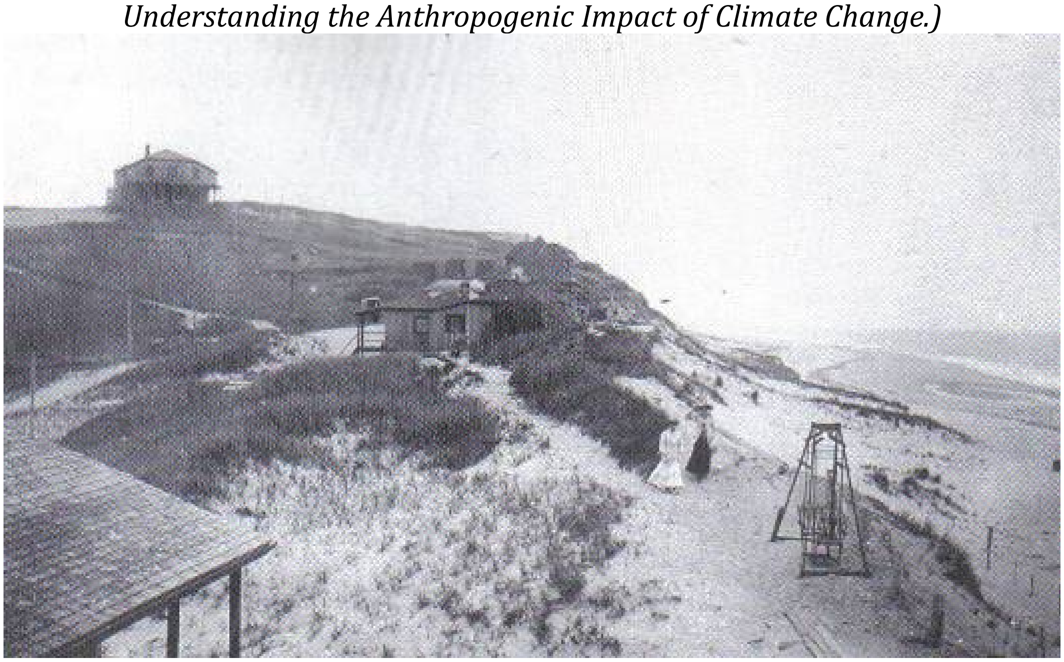
Safe Harbor

Gordon Peabody & Jacalyn Gorczynski, July, 2010

Ballston Beach is located in Truro on the oceanside of Cape Cod at 42°N and 70°W. It is a historically and continually popular beach and receives thousands of visitors each summer that access the beach via pathways from a parking lot to the South and a trail to the North. Behind the coastal bank and barrier dune that abuts Ballston Beach are the headwaters of the Pamet River, which runs east/west across Cape Cod and empties into Cape Cod Bay. The Pamet River is diked in three locations. It was first diked in 1869 when a culvert and clapper valve where placed in the river underneath Route 6A, was later diked in 1873 when the railroad passed through Truro, and was lastly diked in 1952 with the construction of a concrete culvert underneath Route 6. These dikes changed the marsh system of Pamet River from a marsh that was entirely salt to one that is fresh on the oceanside and salt on the bayside. As such, over the years, vegetation that is indicative of these two environments has taken root.

Ballston Beach aerial satellite photograph (Google Maps).

Photograph from above of Pamet River, running east/west from the headwaters behind Ballston Beach (at the bottom of the photograph) to Cape Cod Bay (at the top of the photograph). ("The Perfect Storm, Ballston Beach, Truro." *Changing Coastline: Understanding the Anthropogenic Impact of Climate Change.)*

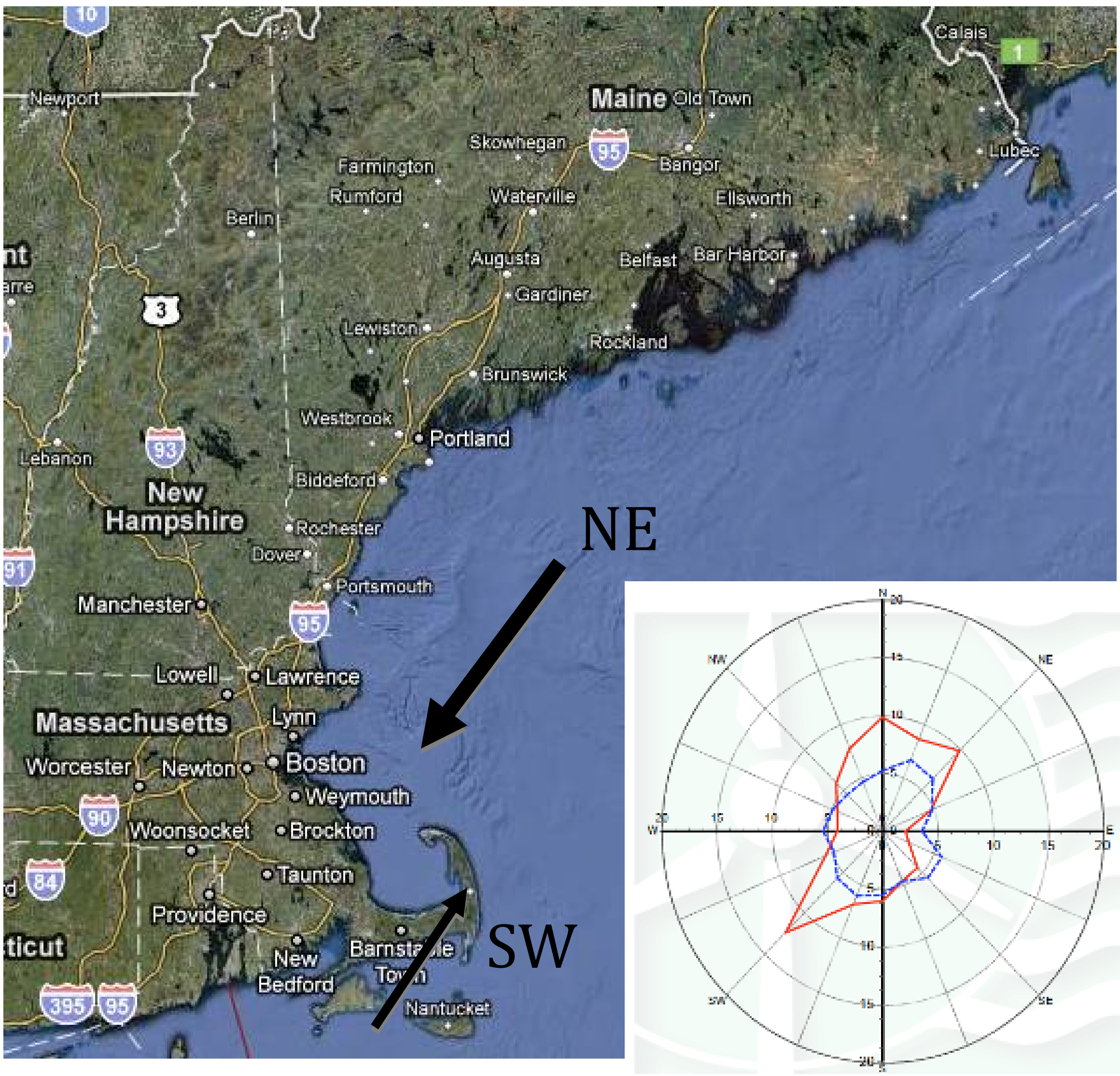


1909 photograph of Ballston resort looking north. Note connected barrier dune. (Brennan, Susan W. and Diana Worthington, *Images of America: Truro,* Arcadia Publishing, Charleston, SC, 2002, pg. 91)

Ballston Beach cottages in 1932 (Truro's Tercentennial Committee History Booklet, 2010).

Ballston Beach today from behind what remains of the barrier dune in the previous photograph, again looking north.

Located on the oceanside of Cape Cod, Ballston Beach is subject to prevailing northeast winds in the winter and southwest winds in the summer. Both can be strong, but the northeast winds occur at a higher frequency, gathering strength across the long fetch of the Gulf of Maine before impacting the Cape Cod coast, where they can have considerable impact on the shoreline. Protective bars, a component of the coastal process, along the outer Cape's oceanside help protect beaches from the large waves that these northeast winds can produce. However, there is a gap in this protection of bars directly off of Ballston Beach. This gap provides a channel for storm waves and wind to impact the beach and cause erosion.



Gulf of Maine and the predominant winds impacting Cape Cod. Wind rose in corner depicts predominant wind directions in percent time (red) and mean wind speed (blue). (Google Maps & Wind Data Report)

The results of this can be plainly seen on Ballston Beach, which has suffered from one of the highest rates of erosion on Cape Cod over the past several years. Nearly 25 feet of land was lost to the ocean over the past year at Ballston Beach, where the public access area was breached, breaking through the barrier dune and creating a large overwash fan of sand and debris. *Overwash fans are a natural part of the coastal system, as is erosion, but the amount of change caused by these fans and the frequency of overwash occurrences is something that should be looked at more closely*.

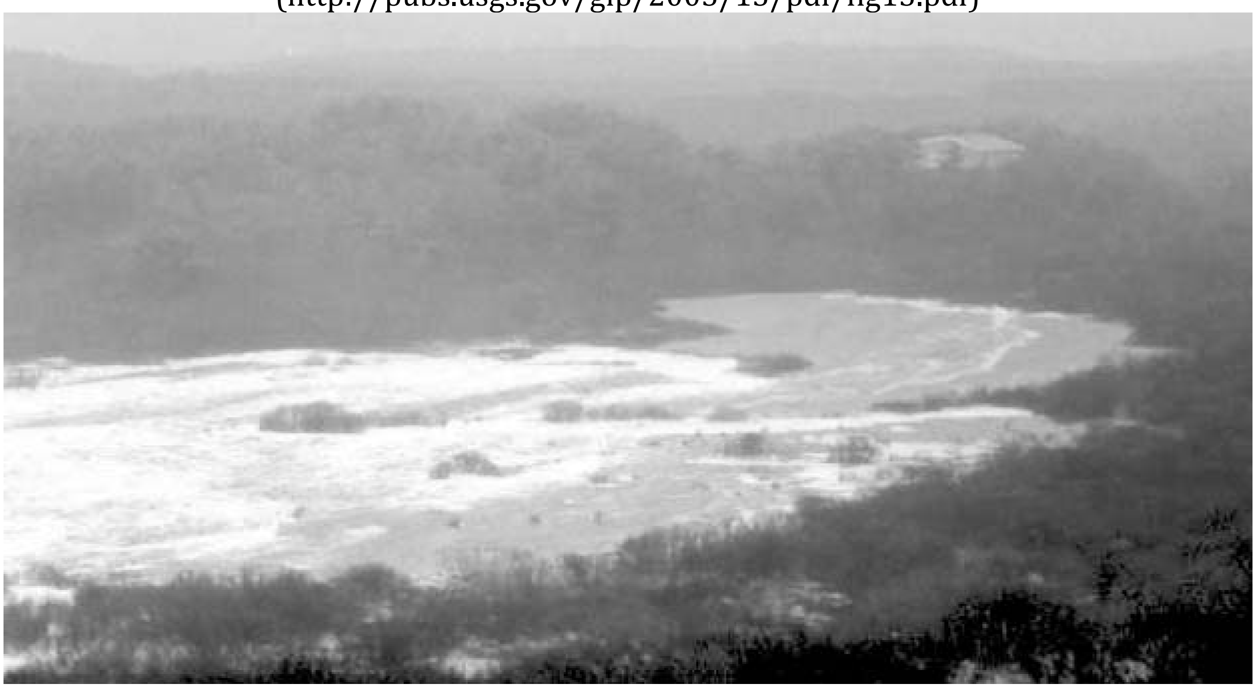
Ballston beach in 2009 looking southeast from atop the coastal bank. ("The Perfect Storm, Ballston Beach, Truro." *Changing Coastline: Understanding the Anthropogenic Impact of Climate Change,)*

Ballston beach in 2010 after having lost 25 ft of coastal bank over the winter, again looking southeast from the coastal bank. ("The Perfect Storm, Ballston Beach, Truro." *Changing Coastline: Understanding the Anthropogenic Impact of Climate Change,)*


Close up of house on the edge of 25-foot loss (Photo courtesy of Kim Deane).

There are three recent examples of large overwash events on Ballston Beach. The first occurred on October 31, 1991 during “The Perfect Storm”, as popularized by Sebastian Junger’s book, which began as a low-pressure system in Indiana, absorbed a hurricane (Hurricane Grace), and evolved into an extratropical system that was very unique. The barrier dune of Ballston beach was breached during this powerful storm and several feet of seawater were deposited on the floodplain behind it. This floodplain contains the headwaters of the Pamet River, as well as a freshwater marsh. The introduction of such a large amount of seawater caused a wide scale die-out of the salt-intolerant species found there. Breaches of similar magnitude and with similar consequences occurred in 2005 and 2009, once again killing a great deal of the marsh and introducing Phragmities to the system, which is an invasive, aggressive plant species which has contributed to habitat degradation. In all three overwash events, the river and associated marsh could not return to equilibrium because of the restrictions placed on the river that divide it into separate sections, essentially trapping the saltwater in the freshwater environment. Minimal, existing protective fencing that had been placed along the overwash breach in past years had been impacted by beach access and proved ineffective in protecting the resource.

Overwash of Ballston Beach's barrier dune during the "Perfect Storm" of October 31, 1991 looking southeast from atop the coastal bank.
(http://pubs.usgs.gov/gip/2005/13/pdf/fig13.pdf)



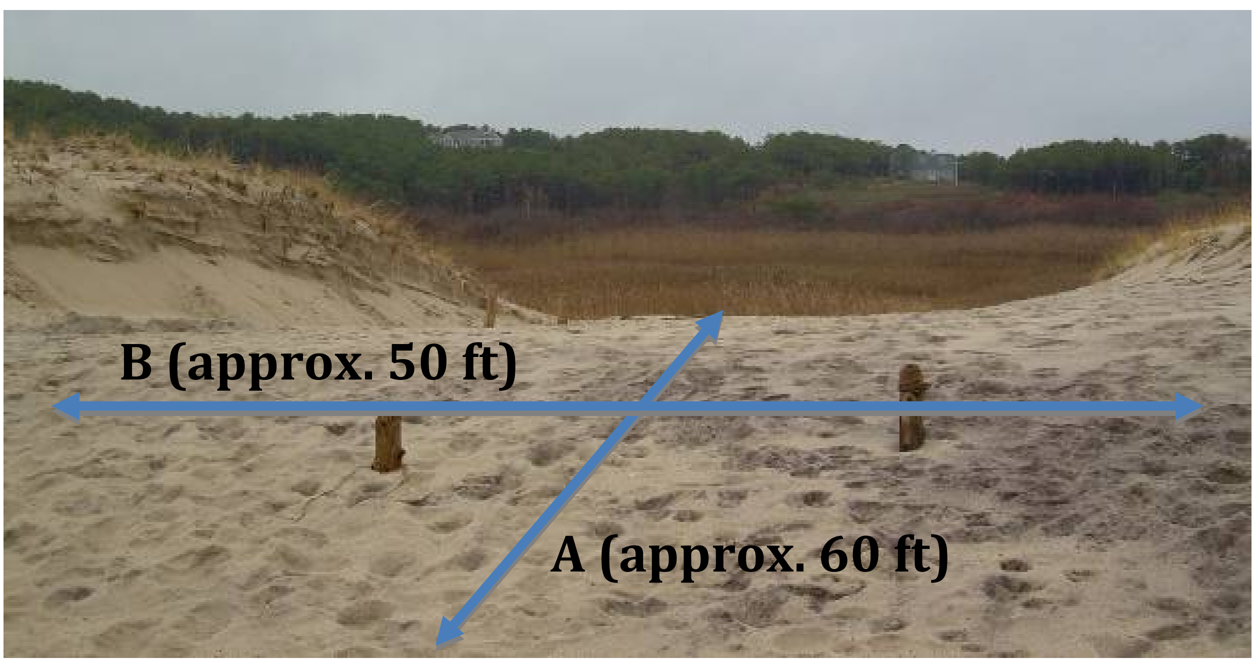
Seawater on the floodplain behind Ballston Beach's barrier dune that maintained a depth of several feet for approximately a week, looking southwest from atop the coastal bank.
(http://pubs.usgs.gov/gip/2005/13/pdf/fig13.pdf)


Overwash of 2005 looking west towards the marsh into which sand has been washed.

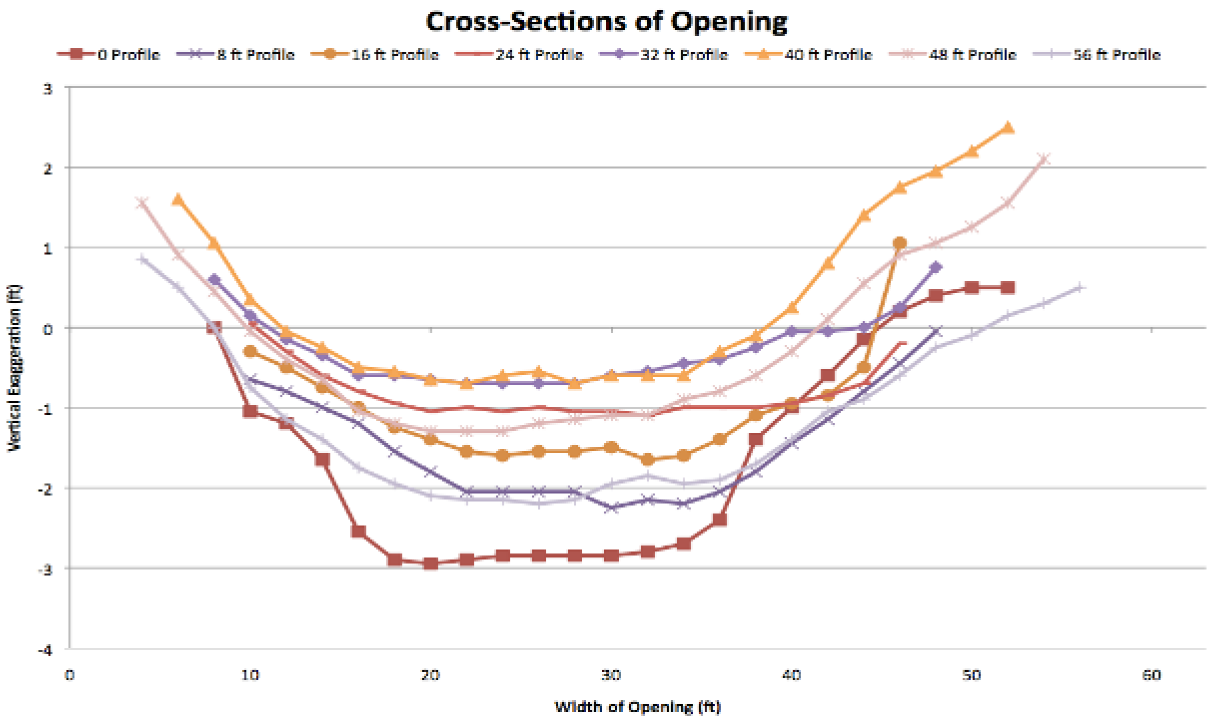

Storm of 2009, that again broke through the barrier dune and created an overwash fan (looking southeast). Ineffective fencing system visible on left edge of overwash area.

These breakthroughs in the barrier dune of Ballston Beach reduce the effectiveness of its protective abilities. While breakthroughs are a normal part of barrier beach migration in coastal systems, the weakening of this barrier dune may have been exacerbated by anthropogenic causes. The thousands of visitors to Ballston Beach each season walk directly over the barrier dune in question and subsequently weaken it. Most native dune grass species die when stepped on and the unprotected geomass becomes vulnerable to wind erosion and subsequent loss of elevation. By establishing pathways having zig zag angles to avoid potential "shotgun blow outs" and by educating visitors with signage as to what is occurring to their beach, these anthropogenic impacts can be reduced. With the use of 4' high pedestrian control fencing and 24" sand capture fencing, along with the replanting of native plant species on the barrier dune, this system can be returned to it's natural functions.

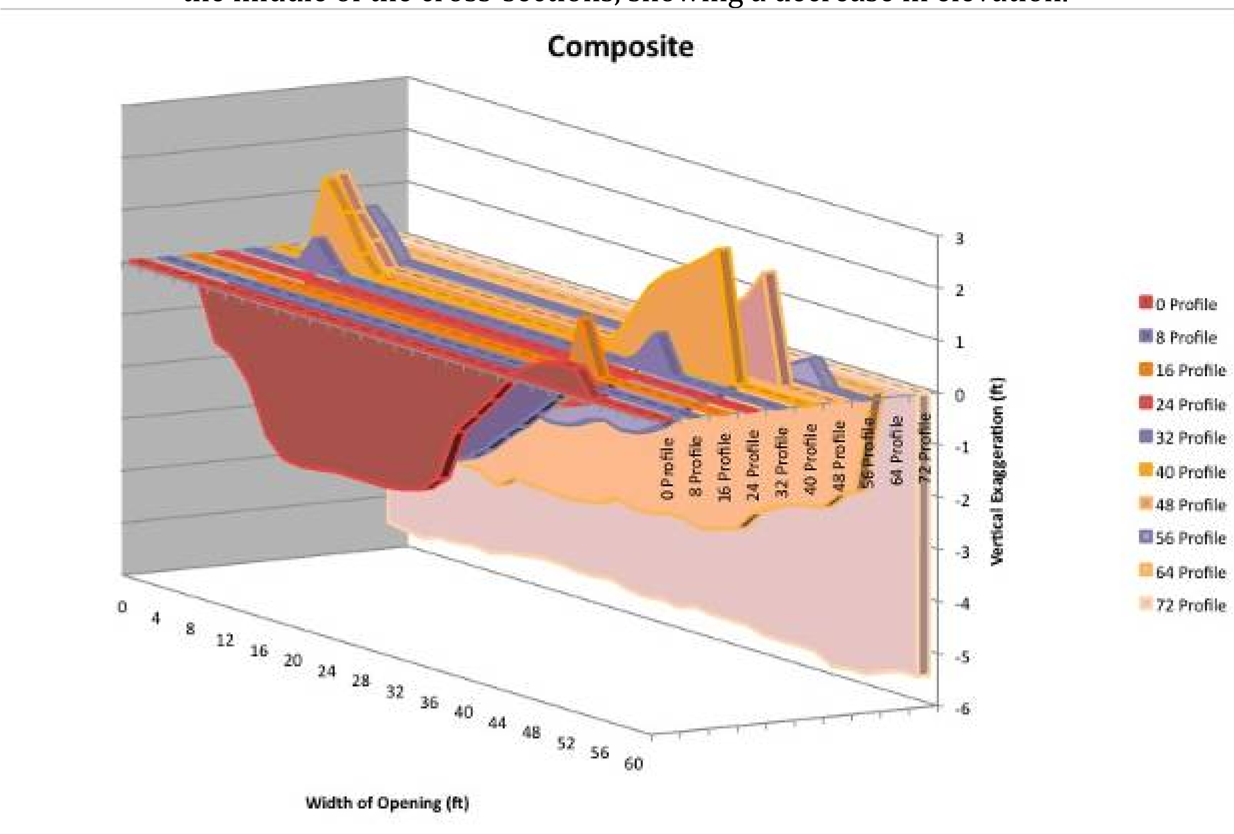
The opening in the barrier dune at the overwash area would be the focus of this restoration proposal. Profiles of the opening were taken and can be seen below. In all, about 400 ft^3 of sand is missing between the two outcrops of the barrier dune seen in the image below, which are also represented on either side of the cross-sections presented below (using the equation for the volume of a cylinder ($V=\pi r^2 h$) the volume of sand missing was approximated by cutting the cylinder in half). This is the volume of sand that would ideally be restored, though space would still be left available for a pedestrian access way to the beach. In the image below, cross-sections orientated like line B where taken along line A at 8 ft intervals. Eight cross-sections were taken resulting in a study area that is 56 ft long. On average the cross-sections are 50 ft in length, resulting in an approximately 50 x 60 ft area where restoration is proposed.

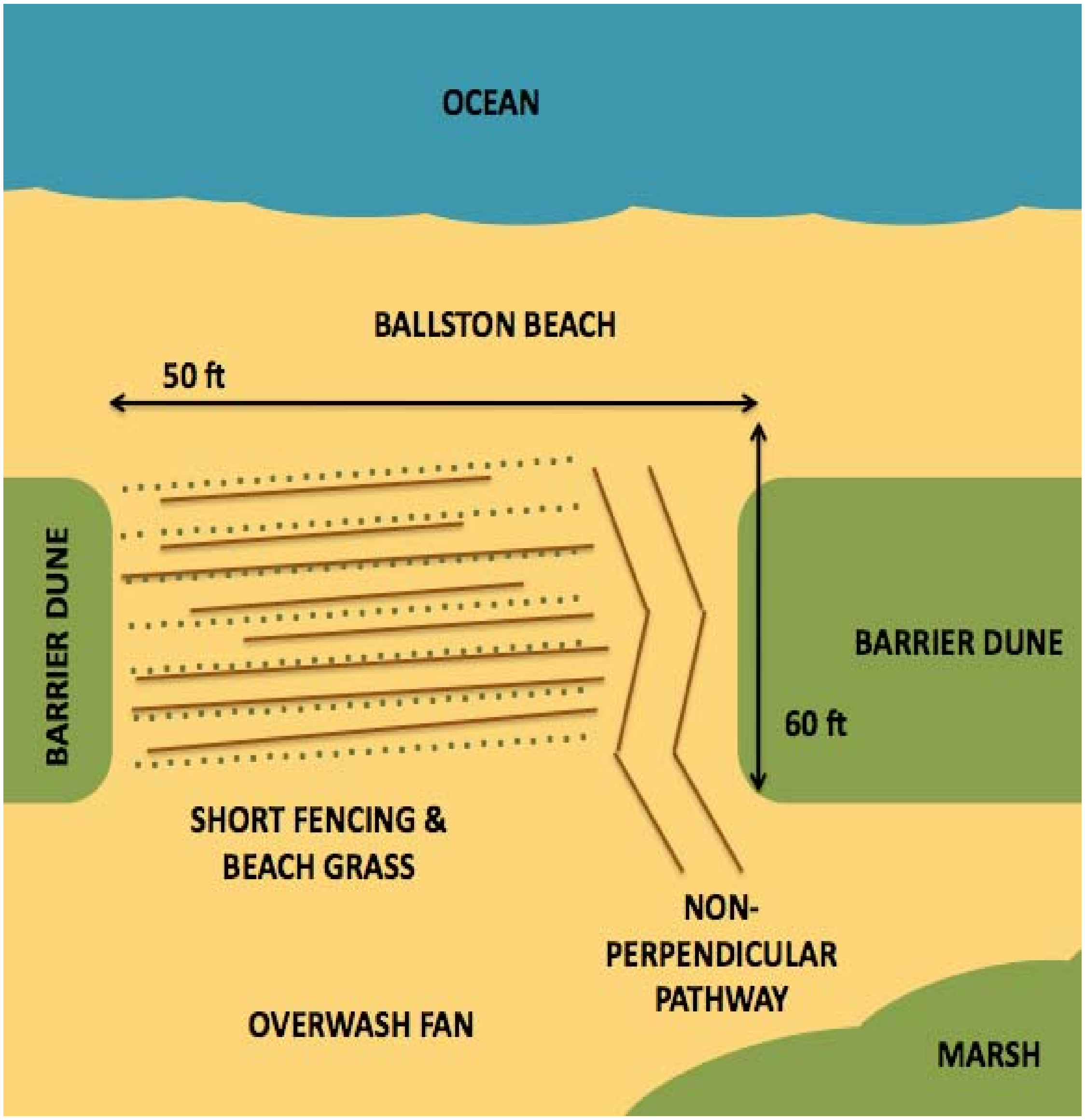


Area of proposed restoration, which is 60 ft long and 50 ft wide and is missing 400 ft^3 of sand. In the proposed restoration, this area would be built back up by storm winds sand capture systems, with a zig zag walkway to strictly control pedestrian access.



This graph depicts the elevation differences across the opening at the eight different cross-section locations. In all cases, a difference in elevation can be seen between the edges and the middle of the cross-sections, showing a decrease in elevation.





Schematic (not to scale) of proposed restoration project.

Alternatives: This area has three options: 1) Nothing can be done. Anthropogenic impacts with subsequent overwash will continue; 2) Pedestrian access can be restricted completely. Pedestrians will continue to access this beach, removing barriers. Subsequent overwash will continue; or 3) Integrate strictly controlled pedestrian access with restoration of the resource area, utilizing winter storm force wind energy to restore sand elevations.

Rationale: While overwash is a natural occurrence, the unrestricted pedestrian access has disabled natural defenses against overwash. The increased frequency of overwash events have impacted a once freshwater marsh that is now struggling to keep pace with its new salt environment. The restoration concept presented here utilizes natural forces within this habitat area to restore the resource area while allowing public beach access.

Proposal: The use of *non-perpendicular pathways* reduces possible funneling of both wind and waves. (Traditional perpendicular pathways increase the erosion of the dune, providing access for wind and water transport water of sand into the marsh system). A zig-zag pathway would allow foot traffic but with strict controls. *Signage* (see below) would be used to incorporate visitor stewardship through education. The use of *native plant species* and *short fencing*, on both sides of the pedestrian access, would collect new geo mass by catching sand and reconnecting the dune. Seventeen rolls of fencing would be required (at approximately $60 a roll, this would be $1,020). The 24 " fencing is created by chain sawing full rolls in half. Beginning at the fore dune and ending just past the crest, 25,000 to 30,000 stems of beach grass would be planted that would begin sustainable habitat restoration to the dune (at 1,000 stems for approximately $100, this would be $2,500). Labor and monitoring would be supplied by Safe harbor, at no cost to any parties. The implementation of this system could add 2 ft of sand each winter, trapped by the short fencing initially and gradually, over 3 years, by the beach grass. Case study photo documentation of this system's successful history are available.

Example of Stewardship Signage

Coastal Dune Restoration

This restoration site has been configured to accommodate beach access. Vegetation collects and holds sand, creating dunes which protect us from coastal flooding. Plants can survive 80 mile per hour winds, but will die if walked on. This restoration is a partnership, between The National Parks Service, the Truro Department of Public Works, Conservation Commission, and Safe Harbor. For photos & more information, contact Cape Cod National Seashore or SafeHarborEnv.com.

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Ballston Beach Flickr Photo. <http://www.flickr.com/photos/vivren/1525757053/>.

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