LOWER BUZZARDS BAY SEDIMENTATION AND GOOSEBERRY CAUSEWAY IMPACT STUDY

PART ONE: **Westport Coastline**

MAY 2025

STUDY OVERVIEW

A little over a hundred years ago, a sandbar that was walkable at low tide joined Gooseberry Island to the Westport mainland. In 1922, a simple causeway was built that was destroyed in the Hurricane of 1938. In 1943, the US Army established a WWII installation on the island and built a fortified causeway of boulders and concrete that remains to this day. Now referred to as Gooseberry Neck, the combined causeway and island extend approximately one mile into Buzzards Bay.

The timing of the Gooseberry Causeway construction coincides with the beginning of dramatic changes to this stretch of coastline, leading government officials, coastal scientists and residents to question whether this manmade structure may be contributing to some or all of these changes.

The Buzzards Bay Coalition convened a research team with partners from Boston University, Woods Hole Group, and the Virginia Institute of Marine Science who set out to study a series of scientific questions that focused on the Gooseberry Causeway and its effects on the beaches and water quality of Buzzards Bay between the Westport and Slocums Rivers.

To do this, a dynamic area of coastline stretching from Little Compton to Mishaum Point would need to be assessed using the most up to date oceanographic science and models.

The primary aim was to improve the understanding of how the causeway interacts with the land and water around it and whether changes to the shoreline are due to the causeway.

In Part One of the release of these study findings, we answer the first three questions here:

- **Does Gooseberry Causeway negatively affect the flow of water in to the Westport River and thus its water quality?**
- **Is the Gooseberry Causeway causing or accelerating the erosion of East Beach?**
- **What is the impact of climate change on these questions?**

Part Two will focus on changes to the beaches and estuaries in Dartmouth.

Ground photograph looking southward to Gooseberry Island in 1913 (pbase.com/clamflats/gooseberry_bar_rock)

STUDY AREA

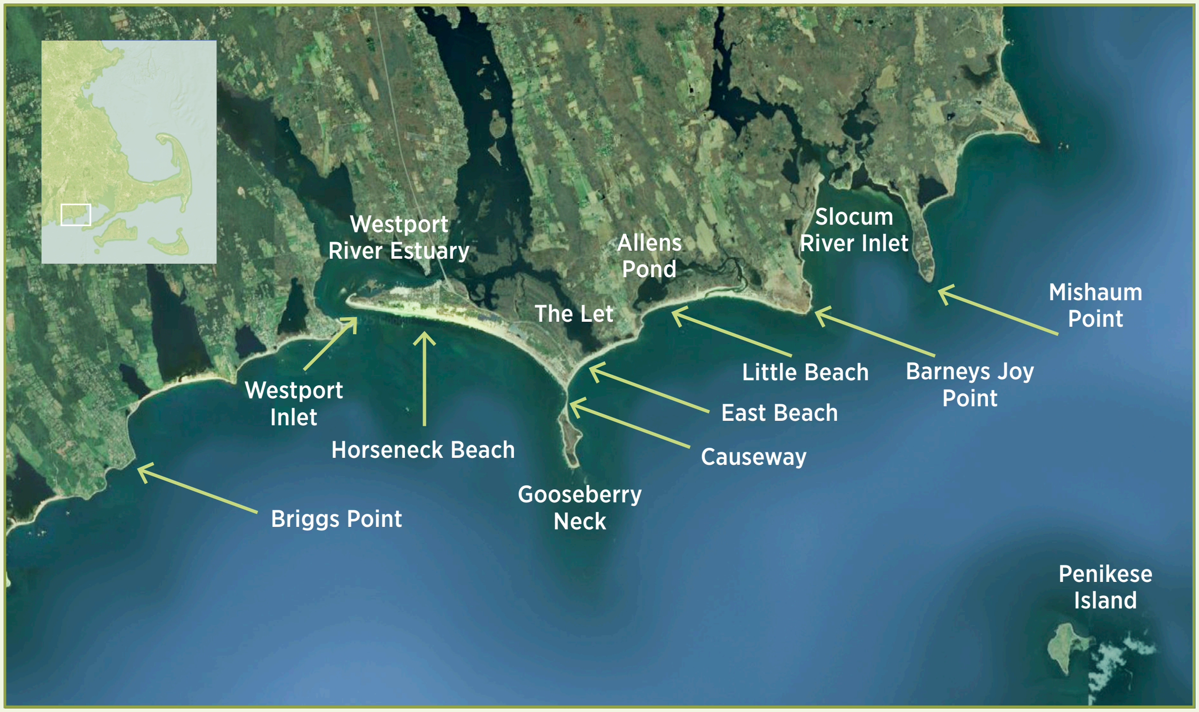

FIGURE 1 *Location of sites of interest in study region from Briggs Point in Little Compton to Mishaum Point in Dartmouth*

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Ground photograph looking southward to Gooseberry Island in 2023 (Danghan Xie, August 2023)

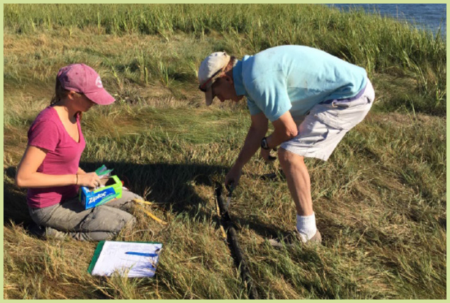
The Science Behind the Study

The Buzzards Bay Coalition assembled a top-tier team of researchers to evaluate the questions. The team had significant experience in studying the Massachusetts coastline and was composed of scientists from Boston University, the Virginia Institute of Marine Science, and the Woods Hole Group. The United States Geological Survey provided technical guidance during project formulation and during periodic discussions over the course of the study.

The research team used a multi-pronged approach beginning in 2022. First, they compiled information from previous scientific work around Gooseberry, including high resolution ground surface elevation surveys collected with laser instruments (LiDAR).

The researchers conducted a rigorous field campaign during the summers of 2022 and 2023. They collected data along coastal sand dunes and interior marshes using techniques including ground penetrating radar and radioisotopic dating. In the waters offshore, currents and wave conditions were measured using acoustic doppler current profilers, high frequency wave sensors, and conductivity and temperature sensors. Underwater sediments were collected from the seafloor using grab samplers. Their measurements updated previous studies on changes in shoreline position, bathymetry, and water flow. Finally, they paired the physical measurements with sophisticated computer models that simulated how sand and water move under different conditions, including if the causeway did not exist.

The highest standard of scientific research evaluation is independent peer-review by technical experts. Through the scientific journal publication process, independent peer-review of the results has occurred, and two scientific papers are published that can be viewed via the QR code at the end of this report.



View of Ponar Grab sampler after being lifted to the surface (top). ***Researchers examine a marsh sediment core*** (bottom).

The field campaign was designed to:

1. **Understand how the coastline of the region has been shaped over time since the retreat of the glaciers,**
2. **Provide inputs to the modeling effort (underwater terrain data, sediment data, water levels, wind and current measurements), and**
3. **Calibrate and test the model to ensure the model accurately represents reality.**

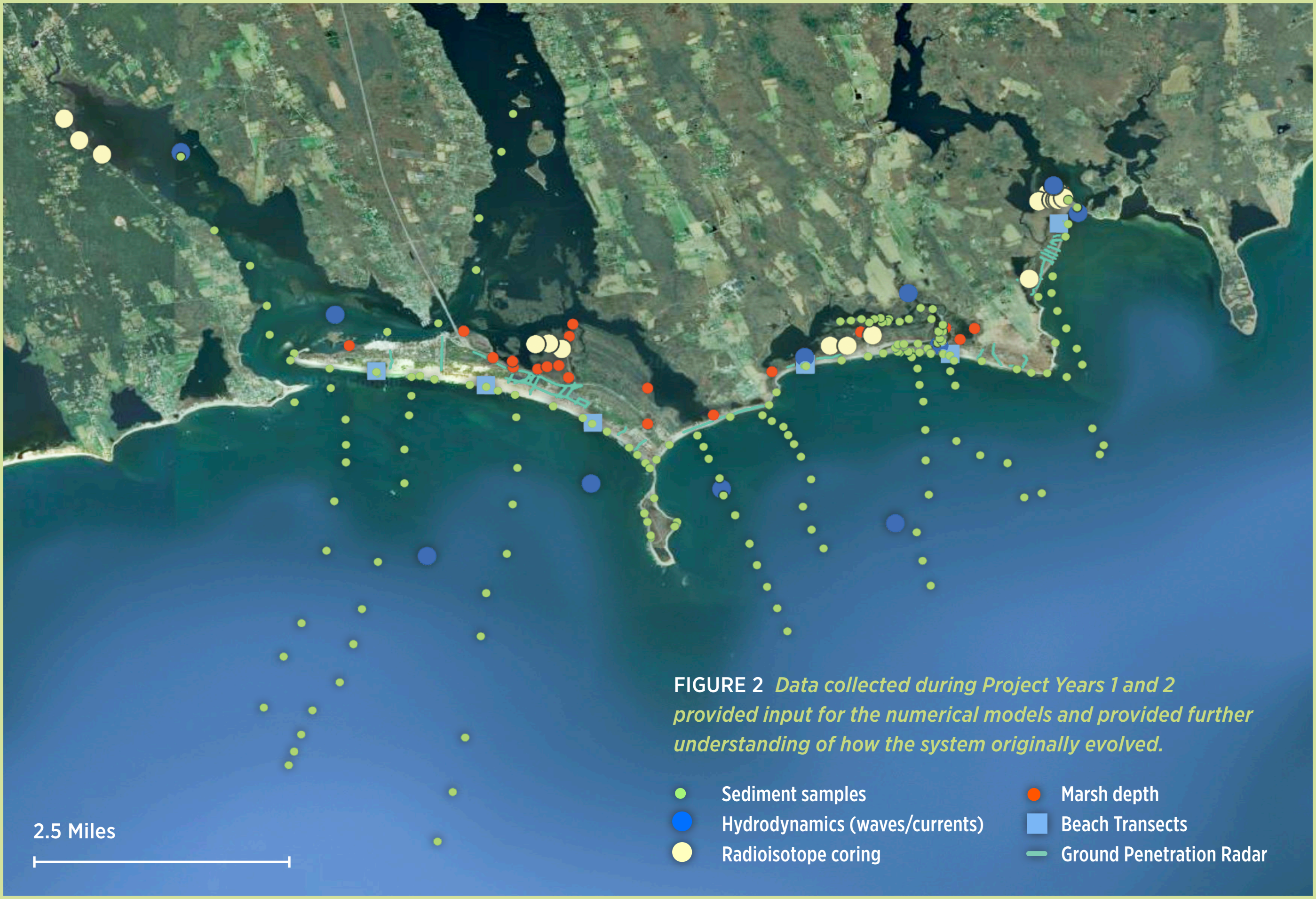


FIGURE 2 *Data collected during Project Years 1 and 2 provided input for the numerical models and provided further understanding of how the system originally evolved.*

Field and historic data were assessed geospatially using Geographic Information System (GIS) techniques. This allowed the scientists to view spatial patterns including shoreline evolution and the effects of major storms.

It was crucial to consider how storm and high-wave activity affect the area because storm conditions can cause dramatic changes to the coastline. Storm waves (~10 ft) expend much greater energy along the shore compared to normal conditions (2-3 ft waves), which is why storms cause dramatic changes.

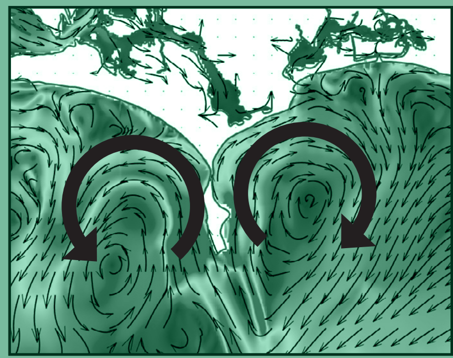
Storm surges create deep water close to shore, allowing large storm waves to break further up on the beach and impact human structures. Additionally, the greater wave energy during storms means that sand moves at exponentially higher rates than under normal conditions. Examining how much sand moves to different areas during different types of storms is, therefore, critical for understanding the long-term evolution of the shoreline.

The researchers used paired models that simulate currents from tides and meteorology (Delft3D-FLOW) and waves (Delft3D-WAVE) in concert, which allowed the examination of the complex interactions of waves and currents over small distances. The models have been widely used in scientific studies of sediment transport by the study team and by the world scientific community.

Does Gooseberry Causeway negatively affect the flow of water in and out of the Westport River and thus its water quality?

Short answer: It is Gooseberry Island — not the man-made causeway — that creates the anti-clockwise circulation pattern that affects the flow of water in to the Westport River. The circulation pattern would be the same with or without the Causeway.

The "Back Eddy" is real!
The circulation cells create a back eddy, a circular current of water that flows in a direction opposite to the main current.



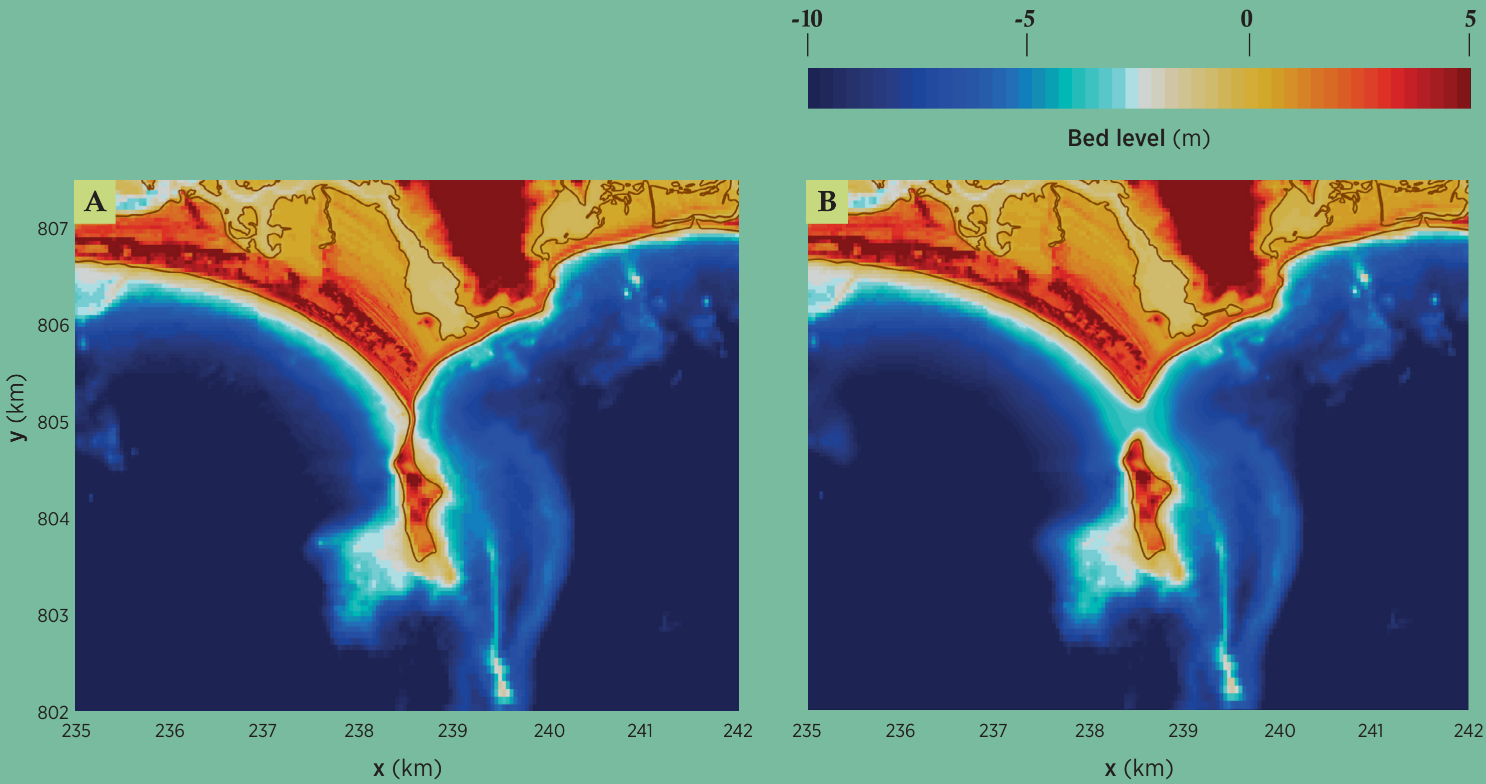


FIGURE 3 *The researchers developed a hypothetical coastline where Gooseberry Island is no longer connected to the mainland. To test the impact of the causeway on water and sediment movement, the results of model runs using current conditions* (A) *were compared to model runs using the hypothetical no causeway condition* (B).

The Westport River is severely degraded with excess nitrogen pollution. We studied whether the removal or alteration of the Gooseberry Causeway would increase flushing to the river and thereby aid water quality recovery.

The science showed that the circulation patterns on the west side of the causeway would be the same with or without the Causeway. See Figure 4. Under most conditions, the flow of water near the inlet is controlled by the tides moving water into and out of the Westport River. The Causeway causes no impact to the tidal movement of water.

Storms that impact the Westport shoreline approach mainly from the southwest. Storm waves push a lot of water to the shore, that needs to flow back offshore. The water gets pushed northwest along the shore before looping back around, creating an anti-clockwise circulation. The presence or absence of the Causeway has little impact on the creation of the circulation cell, rather it results from the presence of Gooseberry Island itself.

That anti-clockwise pattern does deposit sediment at the mouth of the river growing the spit at the west end of Horseneck Beach, but the sand deposits do not overwhelm the tidal power that flushes water in and out of the inlet.

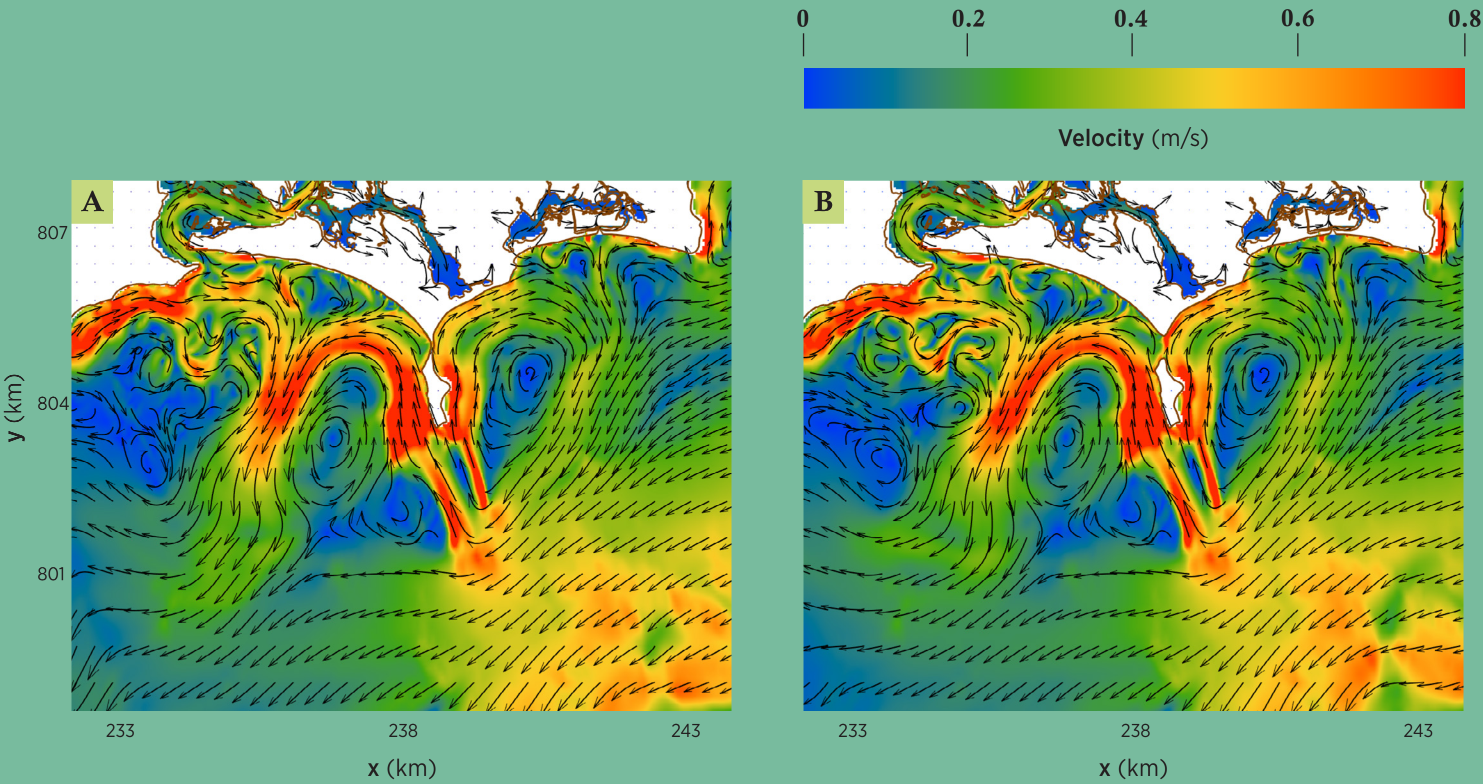


FIGURE 4 *The images show how the water moves in lower Buzzards Bay during a typical storm either in the presence* (A) *or absence* (B) *of the causeway. The arrows indicate the direction of water movement, and the colors indicate the speed of water movement with warmer colors indicating faster water movement and cooler colors indicating slower water movement.*

Is the Gooseberry Causeway causing or accelerating the erosion of East Beach?

Short answer: East Beach erosion would be occurring with or without the presence of the Causeway.

Similar to the circulation patterns to the west of the Island, the island itself sets up a circulation pattern to the east. To the east of the island, the circulation is clockwise as opposed to the anti-clockwise circulation pattern that develops to the west of the island.

This circulation pattern drives the loss of sand primarily to deeper waters offshore. In the absence of the Causeway, sand would not move across the sandbar in normal conditions.

In the case of a major storm, some sand might spill across the sandbar, but that would pale in comparison to the sand lost to areas further offshore. The combined loss from East Beach to the offshore and to Little Beach to the east in Dartmouth exceed any gains from sand transported across the sandbar. See Figure 5. Moreover, if the causeway were absent, intensified longshore currents could further accelerate erosion on the western end of East Beach, exacerbating sediment loss beyond current levels.

In all scenarios, more sand moves offshore than onto East Beach, with or without the causeway present.

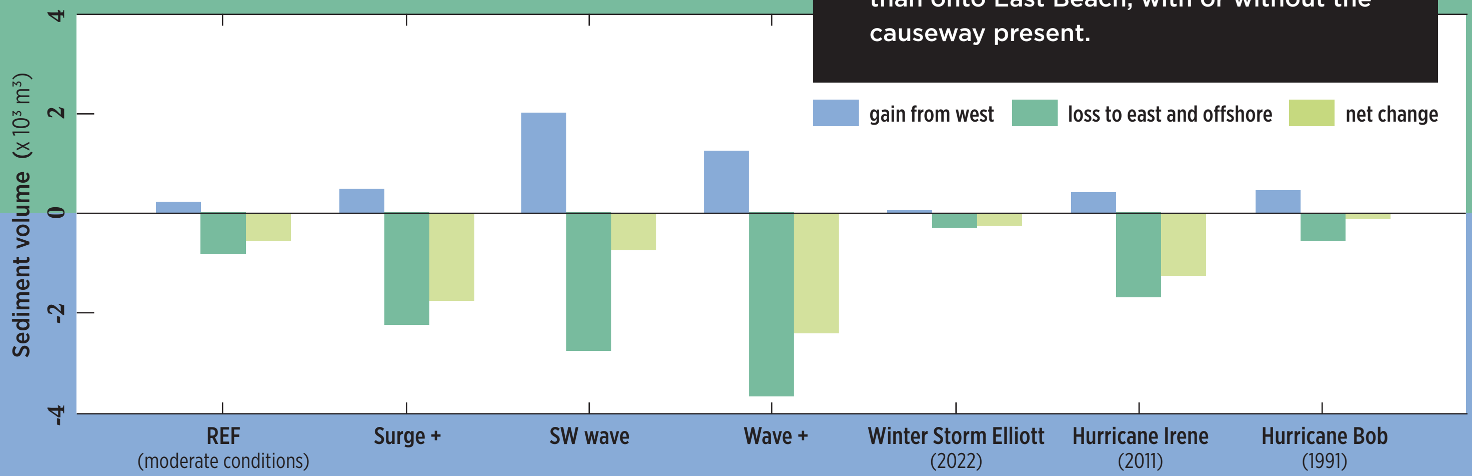
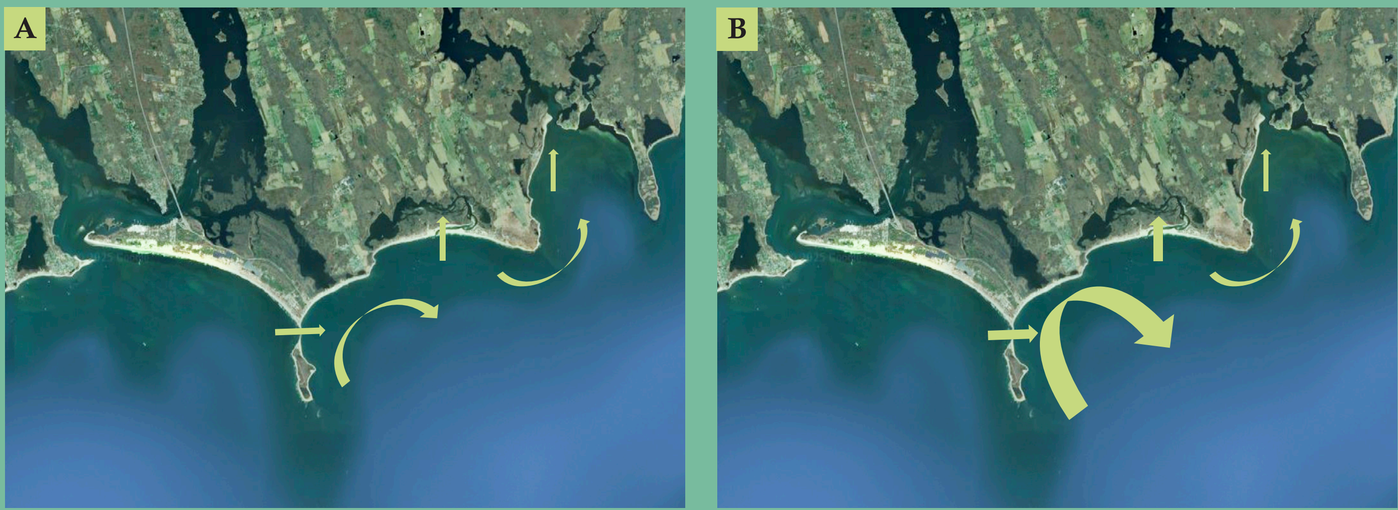


FIGURE 5 *Model results showing how total sediment thickness at East Beach changes in the absence of the causeway under different storm conditions. Gains of sediment transported across the sandbar from the west* (blue) *and losses of sediment to the east and offshore* (green) *are combined to show net change* (pale green)*. REF is a moderate storm condition based on an assessment of historical storms.* ***Surge +*** *represents conditions with a higher storm surge than REF, with other conditions held the same.* ***SW wave*** *represents a more southwesterly wave than the normal storm conditions in REF.* ***Wave +*** *represents higher wave conditions (8.5 m) than REF with other conditions held the same.*

The model showed that in the absence of a causeway, there would not have been enough sediment movement onto East Beach to have maintained a sandy beach, nor would recovery to a sandy beach occur if the causeway was removed now.

It is worth noting that the historic source of sand for East Beach (from underwater) has been depleted over time. Deepening water due to sea level rise is exacerbating the problem because it prevents sand in deeper offshore areas from moving onshore.



Small Storm **Large Storm**

FIGURE 6 *Bigger storms generate larger waves that are able to move more sand and sediment. Under the hypothetical no causeway scenario, during a small storm (of the size that typically occur every year) a small amount of sediment moves across the sandbar* (A)*. During a large storm (that typically occur only every 7-10 years), more sediment moves across the sandbar* (B)*. However, the expected volume of sediment moved across the sandbar is small in either case. Using very optimistic assumptions, it is estimated that the sediment moving across the sandbar from a small storm would equal an addition of only 0.1 inches of sand when spread across about 100 yards along East Beach, and of 1.1 inches of sand for a large storm. As described on the previous page, this sand would not stay on East Beach but be transported offshore and to the east.*

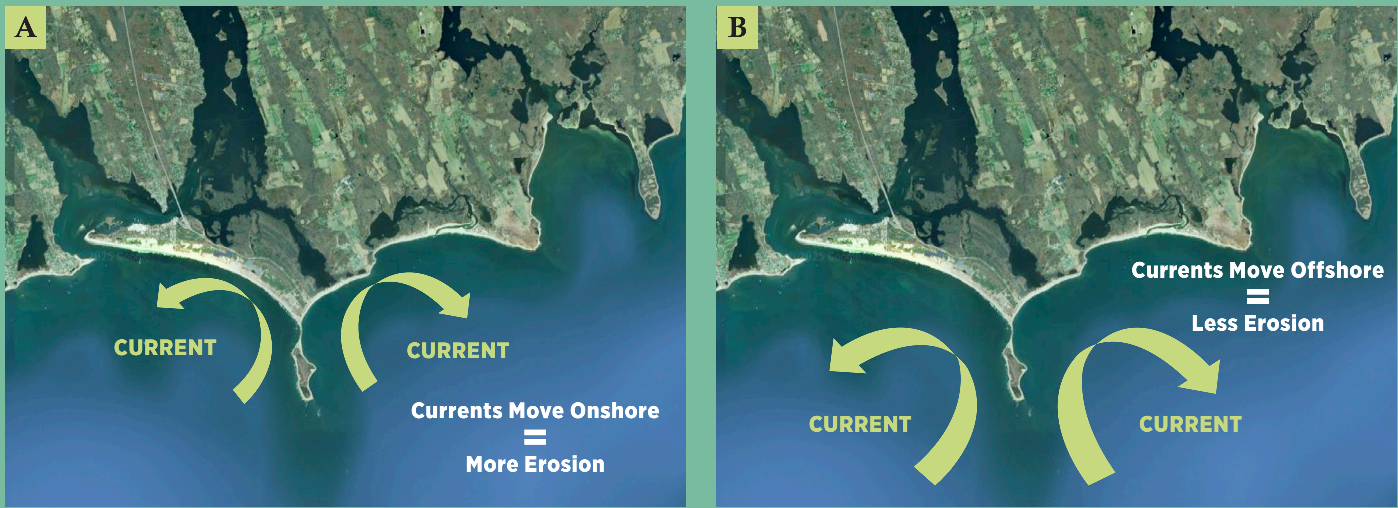
How will things change with rising sea levels and more intense storms and will the Causeway exacerbate future effects of climate change?

The model shows that deeper water due to sea level rise will move the water circulation cells closer to the beach resulting in more erosion throughout lower Buzzards Bay.

Under climate change scenarios, the causeway does not strongly influence sand and water movement in the region. Gooseberry Island and its sandbar and the shape of the shore control the movement of water and sediments, not the causeway.

Examination of marsh sediment cores indicate that Westport salt marshes are not building sediment height as fast as sea levels are rising, so they are susceptible to drowning as sea level rises.

More storms mean more frequent events when the waves are big enough to move large amounts of sand.



Sea Level Rise

Strong Storm (e.g., Hurricanes)

FIGURE 7 *Panels show how the direction of water currents are affected by two climate change impacts: sea level rise* (A) *and more frequent larger storms* (B). *Sea level rise causes the circulation cells to move closer to shore, resulting in more erosion. During very large storms that will occur more frequently as a result of climate change, the circulation cells will move offshore, causing less erosion and sediment movement during those storms.*

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This was prepared as a general summary of the Final Report of the Lower Buzzards Bay Sedimentation & Gooseberry Causeway Study. For the full report and published scientific literature, go to **savebuzzardsbay.org/Gooseberry**

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MORE TO COME

In connection with this study, the research team also addressed three additional questions. *Part Two: Dartmouth Estuaries* will be released later this year and cover:

- **The declining stability of the inlet to Allens Pond and the vulnerability of its salt marshes.**
- **Sand movement to the mouth of the Slocums River and its effect on reduced tidal flushing there.**
- **How will climate change affect the answers to these questions?**

Buzzards Bay Coalition | Boston University | VIMS William & Mary Virginia Institute of Marine Science | Woods Hole Group, a CLS company

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