STATE OF THE COAST

FUTURE CLIMATE-DRIVEN RISKS—AND THEIR SOLUTIONS—ON MARTHA'S VINEYARD, NANTUCKET AND GOSNOLD (ELIZABETH ISLANDS)

trustees t ON THE COAST

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For some, coastal areas are home. For others, they are beloved places of recreation, livelihood, family, and memories. For many, they hold personal significance. We continue to be drawn to the wild beauty of the coast, even as we see these increasing impacts of our changing climate.

The Islands are on the frontlines of coastal change. Yet visiting Martha's Vineyard or Nantucket on a calm, sunny summer day can make us forget what is to come. More frequent flooding of harborfronts and downtown areas, some of the highest rates of beach erosion statewide, and billions of dollars of coastal real estate at-risk will impact an economy and a way of life that is inextricably tied to the coast.

The Trustees has witnessed accelerating changes at our special coastal places — and we have growing concern about these impacts, which threaten our natural landscapes and the way of life of the hundreds of thousands of visitors who enjoy the 17 miles of beaches that we manage on the Islands each year. At Norton Point on Martha's Vineyard, for example, we continue to lose ground: over the course of 97 years (1897-1994), 74 acres eroded. More recently, in less than 30 years (1994-2018), the beach lost 93 acres — 25% more land lost, despite the shorter timespan.

Difficult decisions lie ahead to confront a turbulent future and adapt our coastal landscapes — including beaches, coastal banks, salt marshes, habitats, and developed coasts. We know the work to confront these challenges is already underway on the Islands. But time is running out.

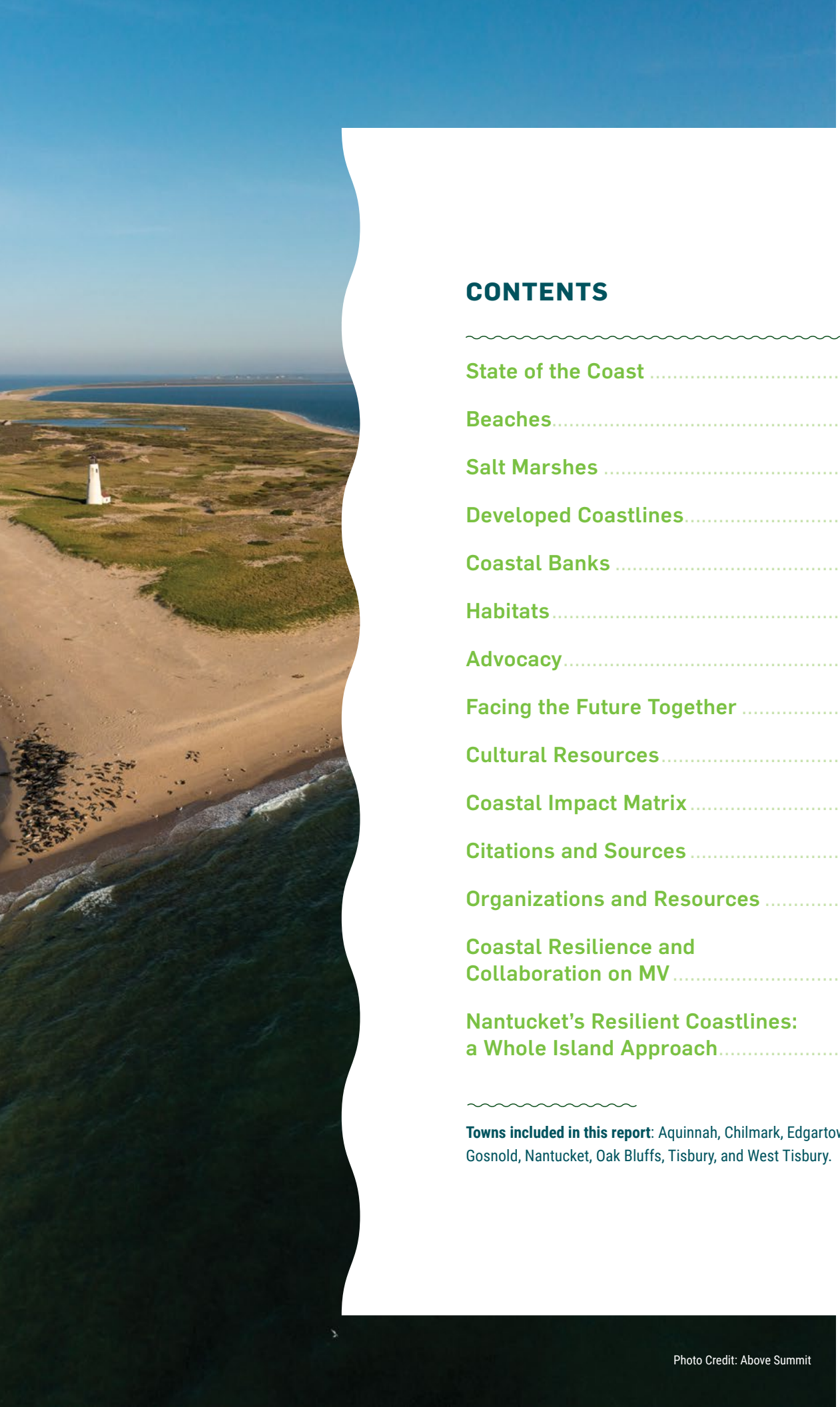
In this report, we present a timeline for actions and solutions, along with their tradeoffs, to adaptation and retreat. Each of these issues will need to be addressed in the next few decades, but we can meet these challenges together. Island-wide collaboration can be a powerful tool, helping to prioritize adaptive planning and designs as a region, and advocating as a united front for policies and funding to be brought to scale. With continued partnerships, and an urgency of action, this unique region could be a true model in leading other coastal communities forward, into a more resilient future.

Jocelyn Forbush

Acting President & CEO

Tom O'Shea

Managing Director, Resources and Planning



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Towns included in this report: Aquinnah, Chilmark, Edgartown, Gosnold, Nantucket, Oak Bluffs, Tisbury, and West Tisbury.

Photo Credit: Above Summit

State of the Coast

Generations of Martha's Vineyard, Gosnold (Elizabeth Islands), and Nantucket inhabitants understand that oceanfront landscapes are among the most dynamic, changing with winds, seasons, storms, and tides. The Islands have been buffeted for centuries by powerful tempests, from early floods that cut them off from the mainland and the Great Hurricane of 1635 to winter storm Riley (March 2018) and Tropical Storm Isaias (August 2020).

Today, these enduring and beloved places face the intensifying and accelerating impacts of climate change—ocean warming and acidification, flooding from sea level rise, and stronger storms and wave energy. These are unprecedented threats to all that exist on the shore, and they make clear that we need to make smart choices today about how to respond.

We want to continue to live, work, and play on the shoreline, as we have for years. For some people it may feel like climate change is too enormous to confront, and resources to respond to it too scarce.

And yet…

If you know the Vineyard or Nantucket, you've likely experienced downtown areas and access roads flooded, harbor areas inundated, ferries canceled, water supplies threatened, and homes damaged or lost. You've seen beaches narrow from Edgartown to Siaconset, salt marshes shrink, barrier beaches breached, and estuaries and salt ponds threatened. Consider:

- **SINCE 1887** Martha's Vineyard and Nantucket combined have lost 3,295 acres of coastal areas, or about 5.1 square miles due to erosion—roughly the size of Aquinnah, or about 2,500 football fields [CIT. 5]. Based on a review of historic maps, affected coastal areas largely appear to be beaches, dunes, and coastal banks.
- **BY 2050** Nantucket could lose nearly 569 acres of high salt marsh—an area 11 times as big as Boston Common [CIT. 2]—and 50 acres of total marsh. Menemsha docks could be underwater at high tide every 5 ½ days [CIT. 15].
- **LESS THAN 10%** of Martha's Vineyard remaining land is considered available for development, while only a reported 8.6% is available for development on Nantucket [CIT. 16], presenting a challenge for retreat from rising seas and erosion.
- **NEARLY 800 STRUCTURES**—including homes, businesses and infrastructure—are at risk of being lost by 2050 to erosion on land with a total appraised value of more than $4.6 billion, FEMA data shows. More than 44 miles of roads on both Islands are also at risk.
- **ROUGHLY 900 STRUCTURES** on Martha's Vineyard and Nantucket may experience daily flooding from tides in 2050, given an expected increase in sea level of more than 2.5 feet.

We may have only 10 to 20 years before climate change forces our hand. Do we adapt and accommodate change, or resist it? Do we avoid impacts or accept loss? Managing expectations now for the future and leveraging short-term adaptation can act as a bridge to transformational change.

WHAT IS STATE OF THE COAST?

Our annual report, now in its second year, is an analytical and qualitative assessment of coastal conditions in Massachusetts, region-by-region. This year's focus on Martha's Vineyard, Nantucket and the Elizabeth Islands (Gosnold) offers a glimpse at on-the-ground techniques and future-facing opportunities to create more resilient and healthier coasts. Most of the data used is based on High Sea Level Rise projections, to be consistent across all levels. (Please see citations for more detailed information.)

The report is a guiding resource that can stimulate discussion, action, and collaboration among public officials, conservation partners, residents, and others. Designed to be both information-rich and highly visual, graphics include a *coastal matrix* and *beach erosion chart* offering a visual comparison of community impacts, along with maps of flooding impacts and illustrations explaining coastal processes.

Readers will also find town-specific data and shoreline features along with additional information on our coastal microsite (thetrustees.org/coast).

WHY US?

As the largest private coastal landowner and conservation organization in Massachusetts, The Trustees has witnessed firsthand the widespread effects of climate change up and down the coast, with some of the highest erosion rates in the state on the Vineyard and Nantucket.

We are in a unique position to share a long-term perspective that speaks to our mission, values, and philosophy—and underscores the urgent need for new coastal strategies. We see this report as a framework for conversation, partnership building, and proactive island-wide strategies in the next 5, 10 and 20 years. Calls and meetings with local stakeholders reinforced our view that **now is the time for collaborative, forward-looking adaptations to accelerating climate change.**

↑

The Islands of Martha's Vineyard and Nantucket were formed by retreating glaciers that left mixed sediment deposits in their wake. These simplified USGS geology maps show the unique composition of each island divided into three broad categories based on the type of deposit: beach and dune, coarse stratified deposits, including glacial outwash material, and glacial moraine deposits, which contain till, and coarse stratified deposits. This graphic also shows island vulnerability to the natural processes of erosion due to the nature of their landscapes. Sandy beach and stratified glacial outwash deposits along the coastlines are extremely vulnerable to erosion through wave action and large storm events. Meanwhile, glacial moraine deposits of mostly soil and rock, which typically form the higher elevated terrain, are more stable and less prone to erosion. While many factors are at play including lack of intense development pressure and orientation to storms, and less wave exposure than south- and east-facing coasts, the west coast of Martha's Vineyard may be less vulnerable to erosion due to its glacial moraine footprint.

The report highlights two significant climate-related hazards—*sea level rise* and *coastal storms*. Both are anticipated to accelerate after 2050 with widespread effects on coastal areas. We need to start thinking now about how to transform crisis into opportunity.

FORMED BY RETREATING GLACIERS, the diverse shorelines of Martha's Vineyard and Nantucket face different impacts, and their edges are being constantly redefined. As such, they present unique opportunities for the Islands to innovate and test potential solutions. In other words, we believe **these frontline communities can be *frontrunners***, developing resiliency strategies and taking actions that may serve as models for the rest of the world.

"There are really, truly magic things that can be done if you think about what it is to live with water instead of fight against it."

CECIL BARRON JENSEN,
EXECUTIVE DIRECTOR OF REMAIN NANTUCKET

THE MAIN CHALLENGES AND OPPORTUNITIES

As Islanders know, and our latest data indicates, challenges are everywhere, including:

- **BEACH EROSION** will accelerate, with sand moving offshore and alongshore, overwashing beaches, and shorelines narrowing.
- **WITHOUT ROOM TO MIGRATE INLAND**, many salt marshes will turn into tidal flats and open water.
- **SIGNIFICANTLY ACCELERATED FLOODING** of coastal homes and businesses, transportation networks, and critical infrastructure may require short-term adaptive design and relocation.
- **COASTAL BANKS** may erode more rapidly, helping to nourish nearby shorelines with much needed sediment deposits, but also jeopardizing structures and the more hidden cultural and pre-historic resources.
- **HABITATS**, which play critical roles in sustaining island ecosystems and economies, may continue to decline and degrade unless they are restored and managed in sustainable and innovative ways.

Island communities have already begun projects on the ground, from living shorelines to elevated structures. Several partnerships between island communities have been forged, and two new island-wide, climate-focused positions filled. This is encouraging, but many climate-related projects are in the planning phase, and more needs to be done. Another challenge is that islands are finite spaces—limiting options for retreat. After all, adaptation and retreat require having somewhere to adapt or retreat to.

It will not be enough to craft solutions parcel by parcel, or town by town. Each island as a whole—and the Islands together—must be considered, from discussing whether interior uplands can serve as refuge for vulnerable areas and people to targeting the places with the greatest

chances for resiliency. Self-reliant by nature and necessity, Islanders must now look outward to one another—and beyond—to conserve and protect these fragile landscapes. What is needed now is **transformative innovation** and **broad collaboration**.

WHAT YOU CAN DO TO HELP

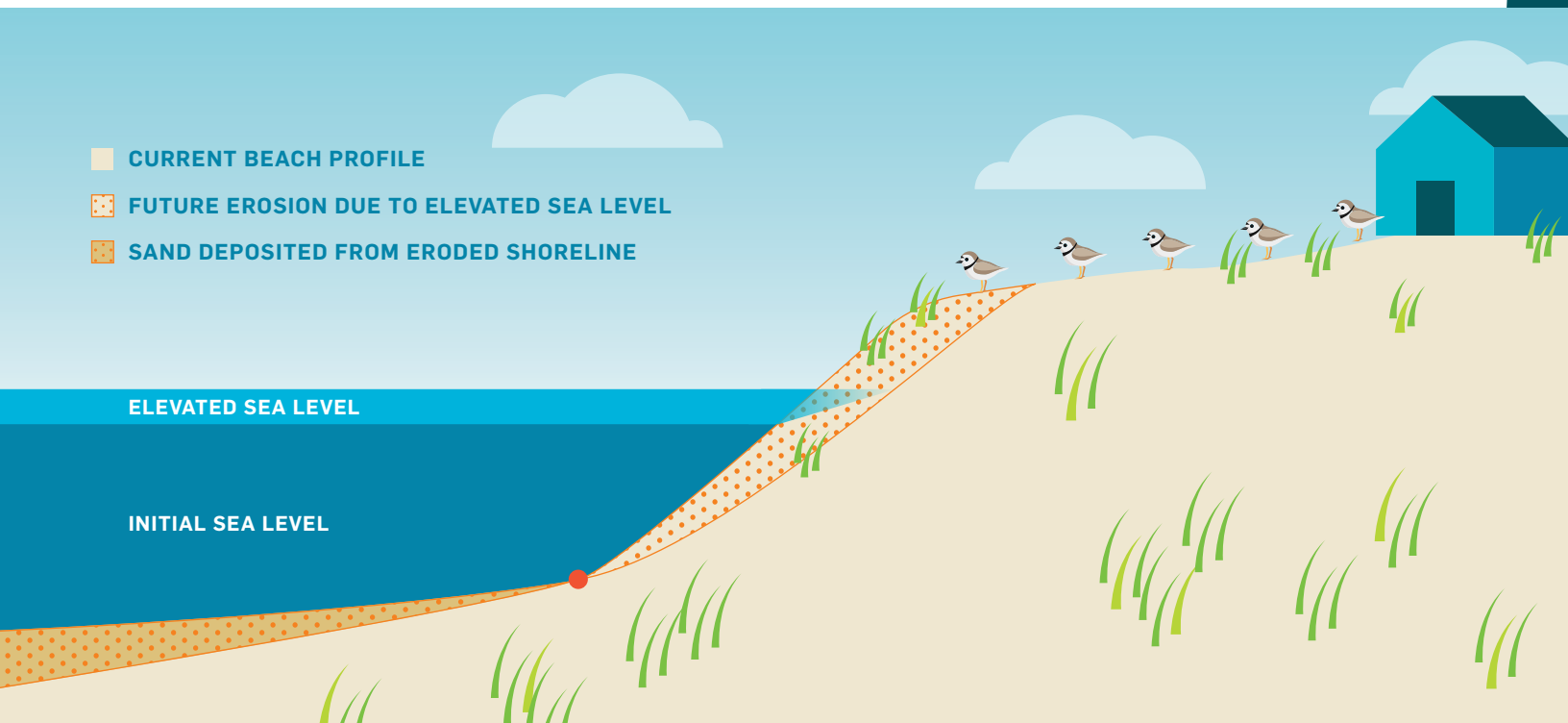
This is a call to be imaginative and forward-thinking. Making strategic choices and sacrifices, educating our communities, advocating for change, and engaging as stakeholders and volunteers will go a long way toward creating models of resiliency that other places will want to follow.

Only by acting together can Martha's Vineyard, Nantucket, and Gosnold—among the most treasured and iconic places in the world—prepare to confront the turbulence that lies ahead.

"We have to look at the common good as opposed to our individual interests in order to make this all work."

LIZ DURKEE,
CLIMATE CHANGE PLANNER FOR MARTHA'S VINEYARD

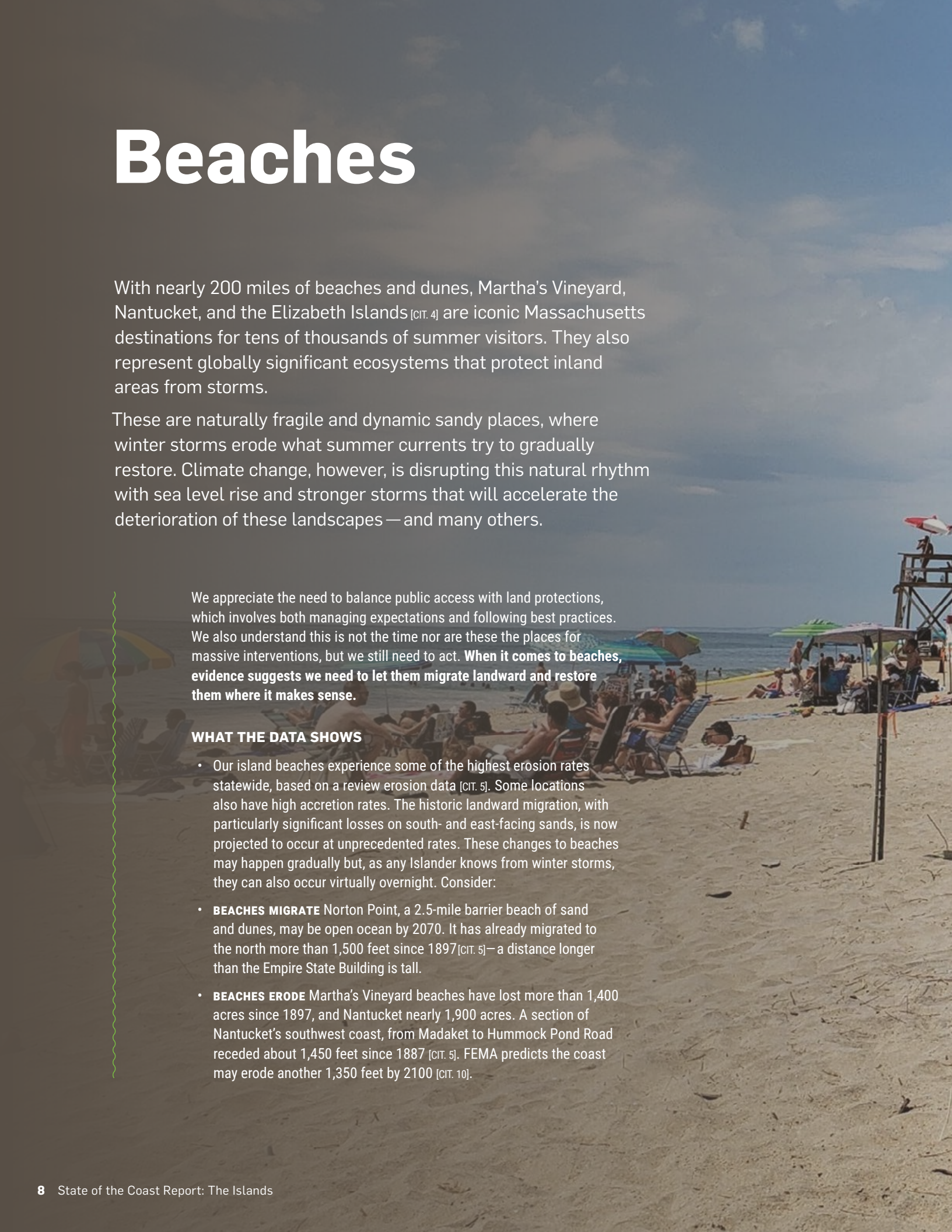
This conceptual illustration, based off the Bruun Rule, illustrates how sea level rise can result in erosion to sandy shorelines. The Bruun Rule does not include additional factors contributing to beach erosion, including but not limited to storms, changes in the wave environment, limitations on sediment supply, and the movement of sand by near-shore ocean currents.



Beaches

With nearly 200 miles of beaches and dunes, Martha's Vineyard, Nantucket, and the Elizabeth Islands [CIT. 4] are iconic Massachusetts destinations for tens of thousands of summer visitors. They also represent globally significant ecosystems that protect inland areas from storms.

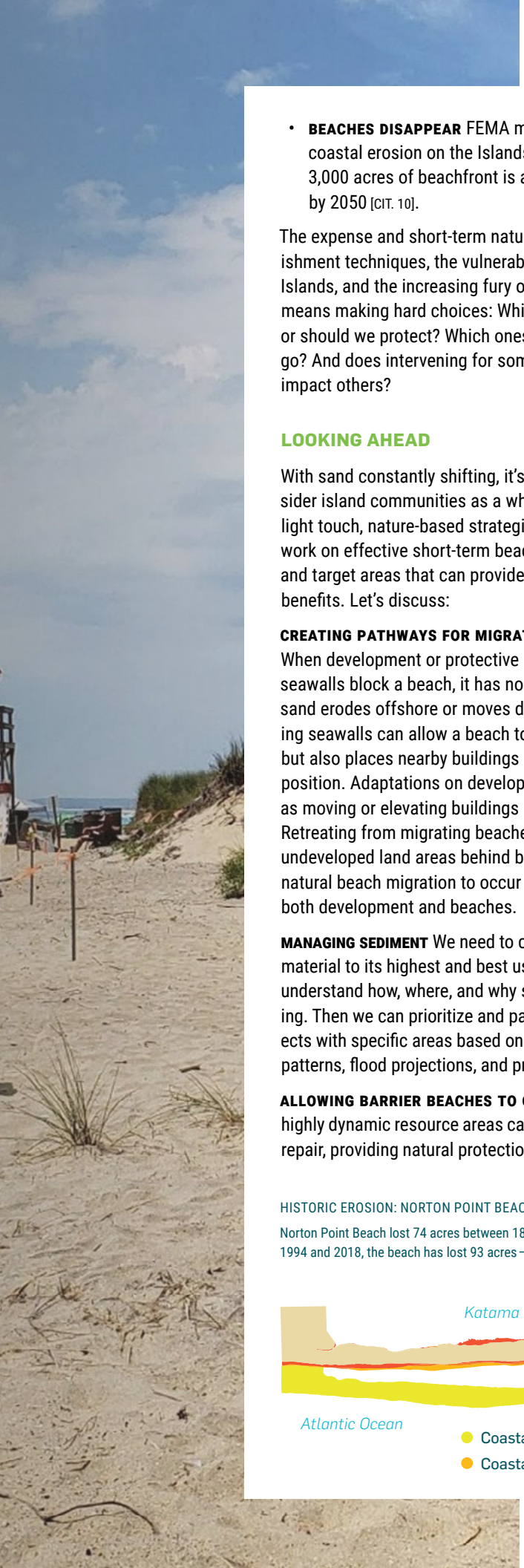
These are naturally fragile and dynamic sandy places, where winter storms erode what summer currents try to gradually restore. Climate change, however, is disrupting this natural rhythm with sea level rise and stronger storms that will accelerate the deterioration of these landscapes — and many others.



We appreciate the need to balance public access with land protections, which involves both managing expectations and following best practices. We also understand this is not the time nor are these the places for massive interventions, but we still need to act. **When it comes to beaches, evidence suggests we need to let them migrate landward and restore them where it makes sense.**

WHAT THE DATA SHOWS

- Our island beaches experience some of the highest erosion rates statewide, based on a review erosion data [CIT. 5]. Some locations also have high accretion rates. The historic landward migration, with particularly significant losses on south- and east-facing sands, is now projected to occur at unprecedented rates. These changes to beaches may happen gradually but, as any Islander knows from winter storms, they can also occur virtually overnight. Consider:
- **BEACHES MIGRATE** Norton Point, a 2.5-mile barrier beach of sand and dunes, may be open ocean by 2070. It has already migrated to the north more than 1,500 feet since 1897 [CIT. 5] — a distance longer than the Empire State Building is tall.
- **BEACHES ERODE** Martha's Vineyard beaches have lost more than 1,400 acres since 1897, and Nantucket nearly 1,900 acres. A section of Nantucket's southwest coast, from Madaket to Hummock Pond Road receded about 1,450 feet since 1887 [CIT. 5]. FEMA predicts the coast may erode another 1,350 feet by 2100 [CIT. 10].



- **BEACHES DISAPPEAR** FEMA modeling of future coastal erosion on the Islands predicts up to 3,000 acres of beachfront is at risk of eroding by 2050 [CIT. 10].

The expense and short-term nature of sand nourishment techniques, the vulnerable geology of the Islands, and the increasing fury of Mother Nature, means making hard choices: Which beaches can or should we protect? Which ones should we let go? And does intervening for some adversely impact others?

LOOKING AHEAD

With sand constantly shifting, it's critical to consider island communities as a whole in developing light touch, nature-based strategies. We need to work on effective short-term beach interventions and target areas that can provide multiple public benefits. Let's discuss:

CREATING PATHWAYS FOR MIGRATING BEACHES When development or protective barriers like seawalls block a beach, it has no place to go. The sand erodes offshore or moves downdrift. Removing seawalls can allow a beach to migrate inland, but also places nearby buildings in a vulnerable position. Adaptations on developed beaches such as moving or elevating buildings may be costly. Retreating from migrating beaches or conserving undeveloped land areas behind beaches can allow natural beach migration to occur with impacts to both development and beaches.

MANAGING SEDIMENT We need to collectively direct material to its highest and best uses once we understand how, where, and why sediment is moving. Then we can prioritize and pair dredging projects with specific areas based on that data, erosion patterns, flood projections, and priority needs.

ALLOWING BARRIER BEACHES TO CHANGE These highly dynamic resource areas can both breach and repair, providing natural protection from waves and surge. It's best to let them change without intervention, in both undeveloped and developed areas.

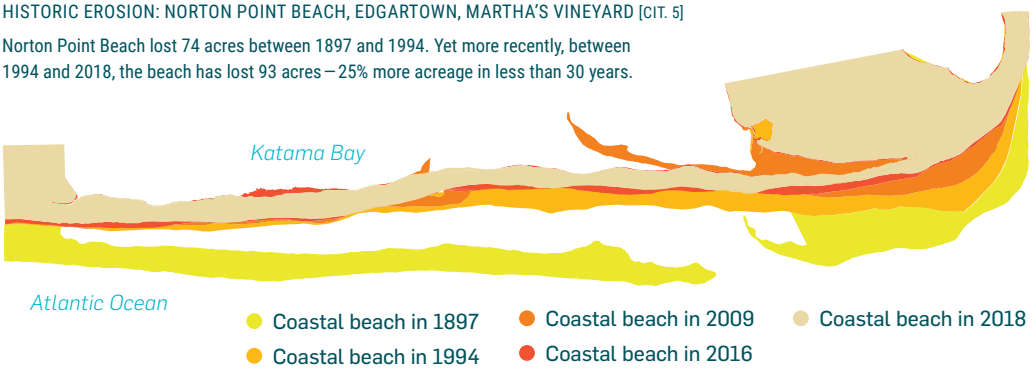
RESTORING BEACHES AND DUNES We can nourish beaches with more sand or rebuild dunes when storms damage beaches, but we need to be smart and strategic about it: Where? When? At what cost? And for how long? Do we respond reactively or think long-term? For instance, in a matter of weeks, Edgartown pulled an emergency permit for dredged sand to replenish a storm-ravaged South Beach and protect Atlantic Road. In contrast, on nearby Norton Point Beach, The Trustees, Dukes County, and Edgartown are working together on a longer-term restoration project to build overall resiliency and provide improved protection for public access, habitat, and surrounding land.

SOURCING SAND Strategies like sand renourishment may only go so far. Sand supplies are limited and expensive (about $25 per cubic yard on the Islands), and at times need to be imported. It cost more than $1 million to replenish 1,500 feet of Lobsterville Beach in Aquinnah, and restoring a small dune can cost a few hundred thousand dollars after extensive permitting and design. Offshore sand is far more plentiful, but we need to discuss on a broad, island-wide basis if that option is financially, legally, and ecologically sound—or if other options exist.

CREATING ARTIFICIAL REEFS AND LIVING SHORELINE SILLS These structures, in a variety of permutations, are being deployed worldwide to reduce wave energy, prevent beach erosion, and provide habitat for shellfish and other organisms. They have less impact on longshore processes than hard structures and may be effective for moderate wave environments. But the size of reef needed for our south-facing Island shorelines is likely not feasible or permittable. Together, we need to think about how to adapt or innovate future-facing strategies to fit our common needs.

HISTORIC EROSION: NORTON POINT BEACH, EDGARTOWN, MARTHA'S VINEYARD [CIT. 5]

Norton Point Beach lost 74 acres between 1897 and 1994. Yet more recently, between 1994 and 2018, the beach has lost 93 acres—25% more acreage in less than 30 years.



Salt Marshes

With wide open views, natural beauty, and diverse wildlife, salt marshes are one of the most productive ecosystems on the planet. Their grasses, flooded and drained by tides, accumulate captured sediment and decomposing plant matter to form peat and provide growing space for roots, allowing marsh to naturally build. They also protect our shorelines from storms and flooding, provide habitat, and help preserve water quality.

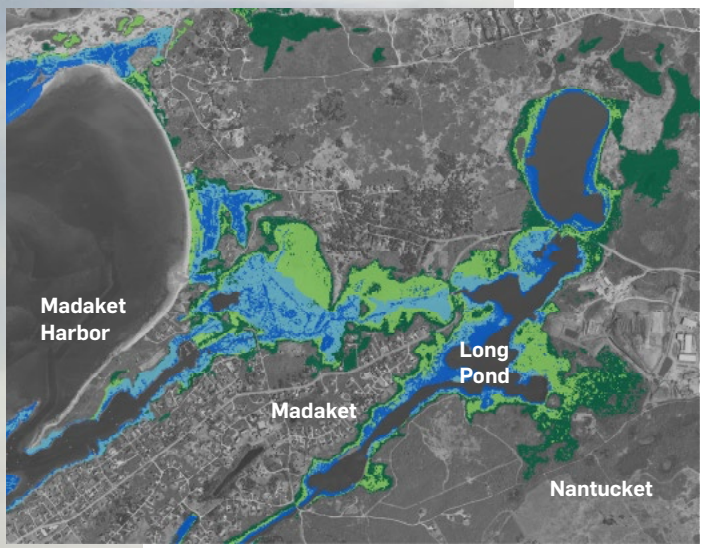
The Islands have nearly 1,800 acres of marsh [CIT. 2] that sea level rise threatens to outpace (only Gosnold appear to be spared significant marsh loss). Unlike large marshes found on the North Shore or Cape Cod, most of these island marshes fringe estuarine areas.

Some marshes may have a chance to migrate landward, and survive, where the absence of built barriers and natural topography allow. It will take concerted strategizing on an island-wide basis to determine where the best chances of restoration and protection reside. We must also educate Islanders and visitors about the importance of salt marshes to the ecosystem as a whole if we are to get everyone onboard with the value-based choices that must be made.

WHAT THE DATA SHOWS

LOSS AND GROWTH OF MARSHES Based on state data, significant marsh loss may occur on the Islands by 2050 due to sea level rise [CIT. 2]. At the same time, some locations will experience new marsh growth or expansion because with rising sea level, marsh will be able to expand to area that was previously dry land.

- Overall, total marsh loss on Martha's Vineyard may exceed 266 acres [CIT. 2]—about one-third the area of Central Park in New York City.
- On Nantucket, 568 acres (66%) of high marsh may be lost [CIT. 2].
- At the same time, more than 600 acres of new marsh growth or migration could occur where land is undeveloped, particularly in Nantucket (438 acres) and Edgartown (89 acres).
- While high marsh could recede in many areas, we may see a dramatic expansion of other coastal areas. This is good news for new shellfish habitat, even as the Islands benefit from the expansion of aquaculture.
- On Martha's Vineyard, estuarine open water may increase by 152 acres (2%) by 2050, while regularly flooded marsh may increase by 188 acres (413%). Estuarine beaches and tidal flats may increase by 240 acres (51%) in some locations [CIT. 2].



POTENTIAL MARSH MIGRATION: PRESENT-2070 [CIT. 2]

- Current marsh
- Marsh migration by 2050
- Marsh loss by 2030
- Marsh migration by 2070

Salt marshes depend on their ability to migrate with rising sea level. Some marshes may be trapped against steep landforms and drown over time, while others may have the space and time to migrate to new areas. Migration includes loss of low marsh, conversion of high marsh to low marsh, and migration of high marsh (given no barriers) as other low-lying areas experience increased or new tidal inundation. The current salt marsh system (blue) shown here in Madaket is projected to be fairly resilient to sea level rise through 2050, with some near-term losses of low marsh by 2030 (dark blue) offset by later expansion (light green). Eventually, however, accelerating sea level rise could result in a wholesale conversion of marsh to open water here in Madaket (light green), with only a modest potential for inland migration by 2070 (dark green).

- On Nantucket, estuarine open water may increase by 108 acres (2%) by 2050, while regularly flooded marsh may increase by 518.5 acres (1,066%). Estuarine beach and tidal flats may increase by 225 acres (91%) in some locations [CIT. 2].

LOOKING AHEAD

If we are to enhance the resiliency of salt marsh on the Islands, it requires **thinking more holistically beyond specific town interests and making trade-offs to ensure that we focus on the places with the best chances for success.** With limited time, resources, and funding, we need to act wisely and strategically together.

CONSERVING SALT MARSH MIGRATION PATHWAYS If new salt marsh is to migrate onto higher ground, land must be permanently and sustainably protected from development. Tools can include coastal buyouts, rolling easements, conservation and deed restrictions, and in-lieu fee programs once we identify what is protected and what is not. Examples include:

- The Martha's Vineyard Commission, Town of Oak Bluffs, and Martha's Vineyard Land Bank are considering using a District of Critical Planning Concern to protect future salt marsh migration areas around Sengekontacket Pond [see DCPC callout box on page 35].
- Elsewhere in New England, Rhode Island's Salt Marsh Conservation Project involves 1) reconciling maps showing where salt marshes will migrate landward against town data to identify the most important unprotected parcels that need to be conserved and 2) communicating these critical conservation opportunities to communities and land trusts. The project is led by the University of Rhode Island and funded using Volkswagen settlement funds awarded by the state Attorney General's office.

RESTORE EXISTING MARSHES FOR RESILIENCY AT-SCALE This involves relocating structures, where possible, and removing or adapting tidal restrictions to improve tidal flow and help marsh keep pace with sea level rise. Low-risk, nature-based techniques include ditch remediation, runneling, assisted migration, and relocation of structures. Examples are:

- Nantucket Conservation Foundation restored Medouie Creek, a high priority wetland restoration site. They installed a culvert under a lowered dike road and dredged an existing tidal creek and old ditch, allowing daily tides back into the wetland and restoring an historic salt marsh to its natural function.
- Mass Audubon, Oak Bluffs, and Edgartown shellfish departments, the University of Rhode Island, and the EPA's Atlantic Ecology Division created a living shoreline to restore a section of salt marsh habitat at Sengekontacket Pond in 2016. The project used 100% biodegradable materials including coir logs made of coconut fibers and bags of local oyster and quahog shells to dissipate wave action and reduce erosion, allowing the shoreline to establish.

More action, and more action now, is needed to preserve and protect our natural coast. Learn more and get involved at **thetrustees.org/coast**

Martha's Vineyard

The diverse landscapes of Martha's Vineyard present unique challenges, from the sturdy soil and rock ridge of glacial moraine at Gay Head Cliffs, Cedar Tree Neck, and Menemsha Hills to the shifting gravels, sands, and silts that make up the center and southern parts of the Island — places like Katama, Wasque, and Long Point Wildlife Refuge. Altogether, this one island has five Eco-Regions: the central sandplain, coastal sandplain, western and eastern moraines, and Aquinnah.

The ways in which people inhabit the island are no less varied, with a year-round population of 17,000 booming to more than 100,000 in-season. Head northeast from Alley's General Store in West Tisbury and you encounter the bustle and density of Down-Island, with its harbors, commercial districts, and critical public services. Head southwest, and you'll travel through the more rural Up-Island communities with their winding roads, undulating fields, and stone walls.

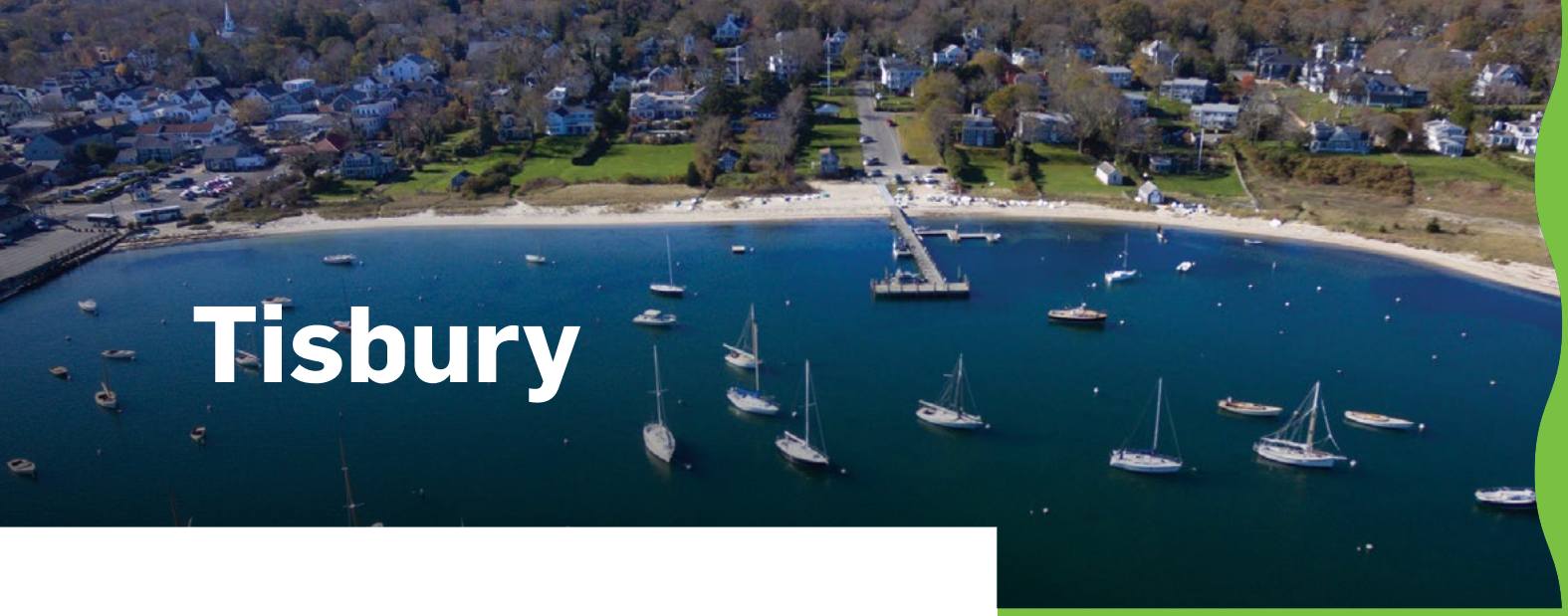
Virtually every resident and visitor may be affected by sea level rise as soon as 2050, whether it's decreased property values, flooded or eroding cultural and historic sites, ferry cancellations (more than 1,700 between 2018–2020 due to weather [CIT. 14]), fishery declines, slumping beaches and bluffs, and blocked access routes.

With 32% of the Island developed, another 40% is conserved [CIT.9], limiting retreat options for homes while providing room for coastal habitat migration.

Every Martha's Vineyard community, including the Wampanoag Tribe of Gay Head (Aquinnah), has begun the process of assessing vulnerabilities and planning, often through two state-sponsored programs — the Coastal Resilience Grant Program and the Municipal Vulnerability Preparedness Program. The Island also has town climate change committees and island-wide organizations such as the Martha's Vineyard Commission, Land Bank Commission, Climate Action Task Force, Island Climate Action Network, and Vineyard Futureworks, among others. And collaborative projects exist between towns, such as a CZM-funded project that will see Oak Bluffs partner with other island Towns to map and develop spatial datasets of low-lying areas that serve as pathways for coastal waters to flow inland, coordinating with the National Weather Service's Coastal Flood Threat and Inundation Mapping website. But **how do fragmented coalitions — six governments, the Wampanoag Tribe of Gay Head (Aquinnah), community members and organizations — reach consensus** on hard decisions that must take the whole island into account?

The MV Commission has called for support in establishing a regional climate adaptation program and a process to pursue MVP initiatives. If Island stakeholders agree and all come to the table, then technical assistance and knowledge can be shared. Decisions can also be made about where to direct island resources in the short- and mid-term to have the best chances for resiliency in the long-term.

In many cases, we may need to let nature restore itself or actively unbuild developed areas. In other cases, it will mean shoring up defenses and adapting or retrofitting structural designs in innovative, sustainable ways. That requires increasing public awareness, establishing common values, setting priorities, and making sacrifices. We need to both **reduce our exposure** and **increase our capacity** to deal with climate-driven effects. If we fail to do that now, then we may lose some of what might otherwise have been saved.



Tisbury

Impacts Projected to Occur By 2050

DEVELOPED COAST

PROPERTY DAMAGE A 10-year storm in Tisbury may flood up to 437 structures (11%), while a 100-year storm in may flood up to 501 (12%) [CIT. 3]. The ferry terminal and iconic Black Dog Bakery, which raised its floor by a foot, could be at risk.

ROAD FLOODING About 8 miles (8%) could flood in the event of a 10-year storm, and an estimated 10 miles (10%) in a 100-year storm event [CIT. 3]. Beach Road and Lagoon Pond Road are particularly vulnerable to heavy storms, flooding and sea level rise, along with the Five Corners intersection.

HARBOR AND WATERFRONT DAMAGE Navigation channels are at risk from sea level rise and flooding, and the working side of the harbor is unprotected from northerly storms. At risk is the commercial waterfront and low-lying utilities and services, such as the police station, harbormaster's office, post office, and wastewater pump station. Tisbury has received CZM funding to develop resiliency management strategies for the Vineyard Haven Harbor shoreline over the next 50 years, including dune and beach nourishment and elevation of roadways.

NATURAL COAST

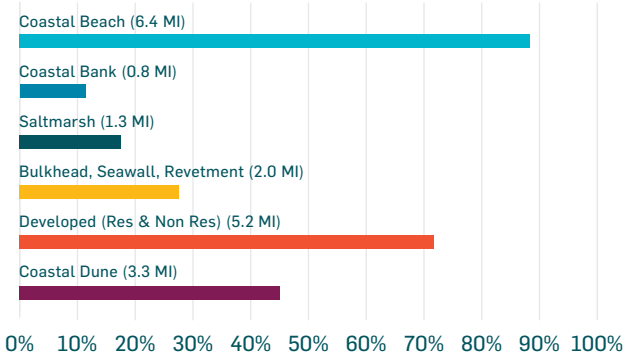
EROSION The coast of Tisbury is relatively stable, though one section of West Chop has receded almost 400 feet since 1897—its lighthouse was moved twice in the 1800s. Eastville breakwater may not be long enough to adequately protect the harbor and Beach Road.

MARSH LOSS Regular flooding may transition 31 of 43 acres (71%) of high marsh to low marsh or open water. Total marsh (high and low) may decline by 22 acres (47%) [CIT. 2], with impacts to Lake Tashmoo, Lagoon Pond, and the Mink Meadows area.

HABITAT CHANGES About 13 of 67 acres (19%) of estuarine beach/tidal flats could be lost to open water [CIT. 2]. Significant risks to fish and shellfish habitat exist in Lagoon Pond, Lake Tashmoo, the Outer Harbor, and off Eastville Beach.

OCEAN-FACING SHORELINE (7.2 MILES) [CIT. 4]

Shoreline types below can overlap, not cumulative



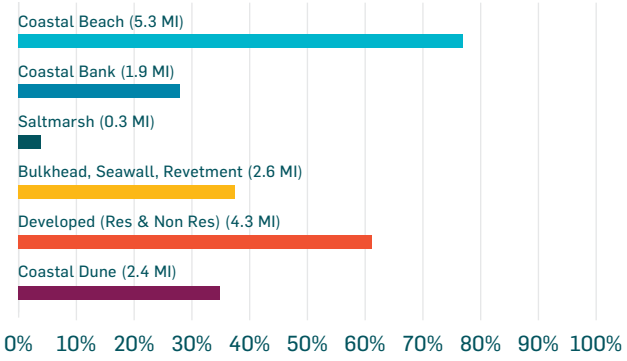
2050 STORM AND TIDAL FLOODING [CIT. 1,3]

- Roads potentially flooded by 100-year storm flooding
- Buildings potentially flooded by 100-year storm flooding
- Buildings and roads potentially affected by daily/frequent tidal flooding
- Areas potentially affected by 100-year storm flooding
- Areas potentially affected by daily or frequent tidal flooding (MHHW)
- Current Shoreline

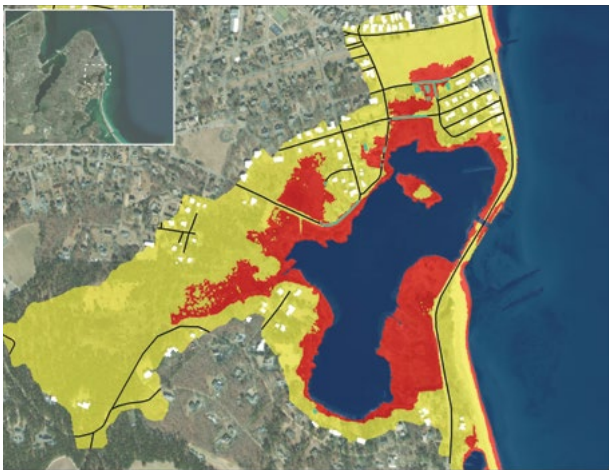
Oak Bluffs

OCEAN-FACING SHORELINE (7.0 MILES) [CIT. 4]

Shoreline types below can overlap, not cumulative



2050 STORM AND TIDAL FLOODING [CIT. 1,3]



- Roads potentially flooded by 100-year storm flooding
- Buildings potentially flooded by 100-year storm flooding
- Buildings and roads potentially affected by daily/frequent tidal flooding
- Areas potentially affected by 100-year storm flooding
- Areas potentially affected by daily or frequent tidal flooding (MHHW)
- Current Shoreline

Impacts Projected to Occur By 2050

DEVELOPED COAST

PROPERTY DAMAGE A 10-year storm in Oak Bluffs may flood up to 554 structures (10%), while a 100-year storm may flood up to 797 (15%) [CIT. 3]. The downtown area is at serious risk of flooding.

ROAD FLOODING About 11 miles (10%) could flood in a 10-year storm, and an estimated 15 miles (13%) in a 100-year storm [CIT. 3]. Roads in need of short-term infrastructure improvements or elevation include Eastville Avenue and County Road by the hospital, part of Seaview Avenue by Inkwell Beach, and County Road at Tradewinds Road. Sea level rise could inundate most of East Chop Drive, part of Beach Road on Joseph Sylvia State Beach, and areas around Farm and Sengekontacket ponds.

HARBOR AND WATERFRONT DAMAGE At risk is Oak Bluffs Harbor and critical infrastructure, including ferry terminals and low-lying utilities. Oak Bluffs has received CZM funding for an engineering study to develop options for protecting shore and coastal infrastructure in the Oak Bluffs Harbor area against existing flood and coastal erosion risks.

NATURAL COAST

EROSION Most of Oak Bluffs may remain relatively stable due to shoreline armoring. Oak Bluffs has 2.6 miles (37%) of armored shoreline, the most of any of the towns except Nantucket (with 3.5 miles of armored shoreline, but only 4%). However, one section of east-facing coast has receded more than 600 feet since the 1800s, with maximum short- and long-term annual rates of 6 and 4 feet, respectively. East Chop bluff erosion remains a concern.

MARSH LOSS Regular flooding may transition 46 of 70 acres (66%) of high marsh to low marsh, and 29 acres (38%) may be lost overall [CIT. 2].

HABITAT CHANGES Estuarine beach/tidal flats may increase from about 38 to 68 acres (30%), and estuarine open water may also increase [CIT. 2]. A causeway and herring run between saltwater Lagoon Pond and freshwater Upper Lagoon Pond is vulnerable to saltwater inundation from sea level rise.

Edgartown

Impacts Projected to Occur By 2050

DEVELOPED COAST

PROPERTY DAMAGE A 10-year storm in Edgartown may flood up to 757 structures (10%), while a 100-year storm may flood more than 1,107 (15%) [CIT. 3]. At risk commercial waterfront district areas include numerous docks, restaurants, shops, and residences, as well as Chappaquiddick Ferry infrastructure.

ROAD FLOODING An estimated 49 miles of roadway (17%) could flood in a 10-year storm, and about 71 miles (25%) in a 100-year storm [CIT. 3]. At significant risk are Atlantic Drive, Beach Road, Bend in the Road/State Beach Road, Chappaquiddick Road, Main Street, and Dock Street. A climate vulnerability assessment commissioned by The Trustees shows Dike Bridge has a 50% projected chance of flooding by 2030, jumping to 100% by 2070.

HARBOR AND WATERFRONT DAMAGE The waterfront in downtown Edgartown is the heartbeat of this historic seaside village, yet it is extremely vulnerable to flooding. For example, between Lighthouse Point and the Reading Room along Cooke Street Pier, an estimated 89 structures and one mile of roadway could flood in a 10-year storm.

NATURAL COAST

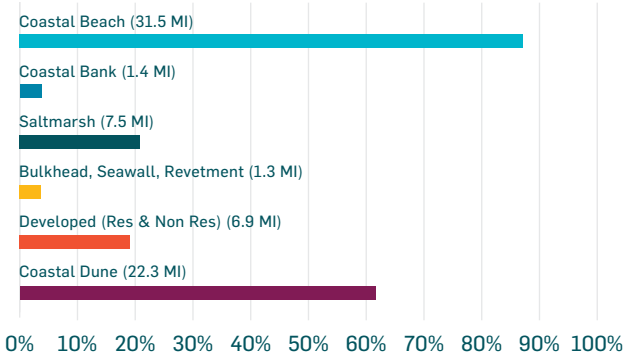
EROSION Sections of the southern coast have receded as much as 1,500 feet since 1897, with maximum short- and long-term annual rates of 54 and 27 feet, respectively [CIT. 5]. Wasque has been particularly vulnerable, and significant erosion is expected on south-facing shorelines including Norton Point Beach.

MARSH LOSS Regular flooding may reduce 331 of 508 acres (65%) of high marsh, with 227 acres (44%) of overall marsh could be lost [CIT. 2], possibly including marsh in Chappaquiddick and Felix Neck Wildlife Sanctuary.

HABITAT CHANGES Estuarine beach/tidal flats and estuarine open water may both increase by 190 acres (80%) and 105 acres (2%), respectively [CIT. 2].

OCEAN-FACING SHORELINE (36.2 MILES) [CIT. 4]

Shoreline types below can overlap, not cumulative



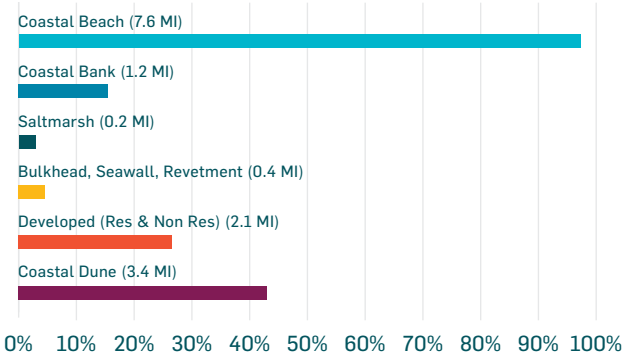
2050 STORM AND TIDAL FLOODING [CIT. 1,3]

- Roads potentially flooded by 100-year storm flooding
- Buildings potentially flooded by 100-year storm flooding
- Buildings and roads potentially affected by daily/frequent tidal flooding
- Areas potentially affected by 100-year storm flooding
- Areas potentially affected by daily or frequent tidal flooding (MHHW)
- Current Shoreline

West Tisbury

OCEAN-FACING SHORELINE (7.8 MILES) [CIT. 4]

Shoreline types below can overlap, not cumulative



2050 STORM AND TIDAL FLOODING [CIT. 1,3]

- Roads potentially flooded by 100-year storm flooding
- Buildings potentially flooded by 100-year storm flooding
- Buildings and roads potentially affected by daily/frequent tidal flooding
- Areas potentially affected by 100-year storm flooding
- Areas potentially affected by daily or frequent tidal flooding (MHHW)
- Current Shoreline

Impacts Projected to Occur By 2050

DEVELOPED COAST

PROPERTY DAMAGE A 10-year storm may flood up to 93 structures (2%), while a 100-year storm may flood up to 174 (4%) [CIT. 3].

ROAD FLOODING About 10 miles of roadway (5%) could flood in a 10-year storm. An estimated 17 miles (8%) could flood in a 100-year storm [CIT. 3], including sections of Tiah's Cove Road. Most of West Tisbury's primary roads are safely located away from vulnerable areas.

NATURAL COAST

EROSION Sections of the south coast have receded up to 800 feet since the 1800s, with maximum short- and long-term annual erosion rates of 8 and 7 feet, respectively [CIT. 5]. Beach erosion is expected to continue. The coast on Vineyard Sound may be more stable, with relatively little erosion. Lambert's Cove Beach has been relatively stable with an average long term erosion rate of less than 1 foot/year.

MARSH West Tisbury is the only town in this report that may gain more high marsh—about 5 acres (20%). Total marsh (high and low) may increase by 8 acres (19%) [CIT. 2].

HABITAT CHANGES Approximately one acre of 65 acres (2%) of estuarine beach/tidal flats could be lost to open water [CIT. 2].

Chilmark

Impacts Projected to Occur By 2050

DEVELOPED COAST

PROPERTY DAMAGE A 10-year storm in Chilmark may flood up to 164 structures (6%), while a 100-year storm may flood up to 254 buildings (10%) [CIT. 3]. Menemsha, with the largest shoreline concentration of residents and buildings, is particularly vulnerable to inundation from storms and sea level rise.

ROAD FLOODING About 12 miles (7%) could flood in a 10-year storm [CIT. 3], and an estimated 18 miles (11%) in a 100-year storm. At risk are Hariph's Creek Bridge and Chilmark's connection to other towns via South Road-State Road.

HARBOR AND WATERFRONT DAMAGE Menemsha Harbor is vulnerable to sediment deposition and storm surge, posing a risk to rescue boats, fishing vessels, tourism, and public safety.

NATURAL COAST

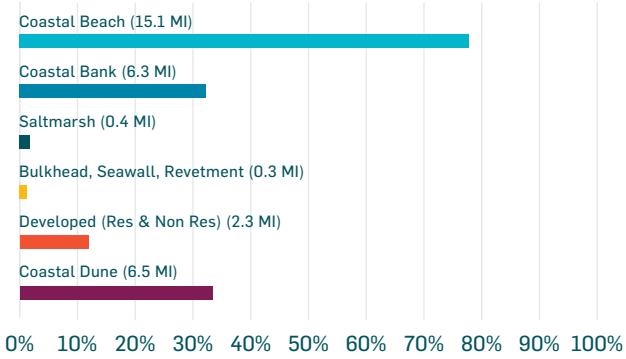
EROSION The coast near Squibnocket Pond has receded up to 1,000 feet since the 1800s. Beach erosion is expected to continue in pockets on the north side. Broad sections of the south coast have receded 500 feet or more in that time, with maximum erosion rates exceeding 6 feet per year [CIT. 5]. Significant impacts along the entire southern shoreline have affected beaches including Squibnocket and Lucy Vincent.

MARSH LOSS Regular flooding may transition about 35 of 170 acres (20%) of high marsh to low marsh, though total marsh area may stay about the same [CIT. 2]. Marsh migration may be possible at Memensha in the near future before marsh is lost to open water.

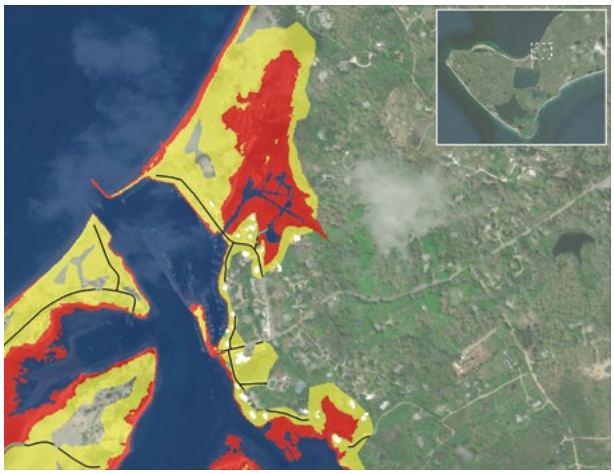
HABITAT CHANGES Estuarine beach/tidal flats will increase from 44 to 64 acres (44%) [CIT. 2].

OCEAN-FACING SHORELINE (19.5 MILES) [CIT. 4]

Shoreline types below can overlap, not cumulative



2050 STORM AND TIDAL FLOODING [CIT. 1,3]

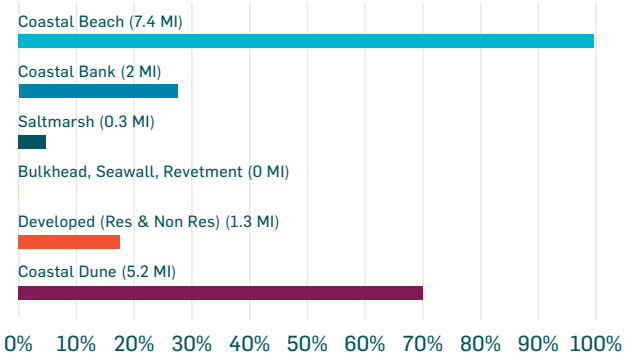


- Roads potentially flooded by 100-year storm flooding
- Buildings potentially flooded by 100-year storm flooding
- Buildings and roads potentially affected by daily/frequent tidal flooding
- Areas potentially affected by 100-year storm flooding
- Areas potentially affected by daily or frequent tidal flooding (MHHW)
- Current Shoreline

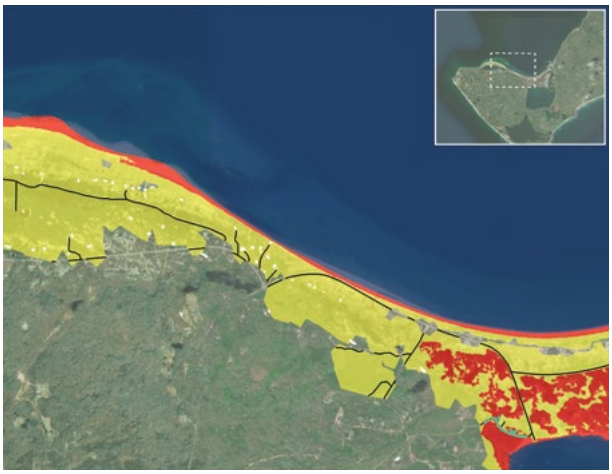
Aquinnah

OCEAN-FACING SHORELINE (7.4 MILES) [CIT. 4]

Shoreline types below can overlap, not cumulative



2050 STORM AND TIDAL FLOODING [CIT. 1,3]



- Roads potentially flooded by 100-year storm flooding
- Buildings potentially flooded by 100-year storm flooding
- Buildings and roads potentially affected by daily/frequent tidal flooding
- Areas potentially affected by 100-year storm flooding
- Areas potentially affected by daily or frequent tidal flooding (MHHW)
- Current Shoreline

Impacts Projected to Occur By 2050

DEVELOPED COAST

PROPERTY DAMAGE A 10-year storm may flood up to 39 structures (6%), while a 100-year storm may flood up to 53 structures (8%) [CIT. 3]. At risk are low-lying homes in areas such as Lobsterville and Dogfish Bar, cultural resources, food crops including cranberries, and artesian wells.

ROAD FLOODING About 4 miles (9%) of roadway could flood in a 10-year storm, and an estimated 6 miles (13%) could flood in a 100-year storm [CIT. 3]. The single route to Aquinnah over a low-lying bridge at Hariph's Creek is vulnerable to sea level rise and storm surge. Flooding could also limit access to Moshup Trail, Oxcart Road, Clay Pit Road, Lobsterville, West Basin, and East Pasture Shore.

NATURAL COAST

EROSION Sections of coast have receded up to 800 feet since the 1800s. Maximum short- and long-term beach erosion may continue at a rate of 5 feet per year on the south-facing coast [CIT. 5]. Erosion may impact beaches and dunes around Moshup Beach, Philbin Beach, and Squibnocket Pond.

MARSH LOSS Regular flooding may transition about 18 of 25 acres (72%) of high marsh to low marsh, and what little marsh exists today (high and low) may actually increase by 3 acres (12%) during this time [CIT. 2].

HABITAT CHANGES Estuarine beach/tidal flats may increase from 22 to 33 acres (54%) [CIT. 2]. Menemsha Pond and Squibnocket Pond, among other places, are vulnerable to storms and sea level rise.

Gosnold*

Impacts Projected to Occur By 2050

DEVELOPED COAST

PROPERTY DAMAGE A 10-year storm in Gosnold may flood up to 81 structures (24%), while a 100-year storm may flood up to 100 (29%) [CIT. 3].

ROAD FLOODING About 9 miles of roadway (11%) could flood in a 10-year storm, and 12 miles (15%) in a 100-year storm [CIT. 3], including a water supply control route. On Naushon, critical access between Upper Wharf and downtown is vulnerable to rainstorm washout.

HARBOR AND WATERFRONT DAMAGE The main channel to Cuttyhunk is vulnerable to overwash. Disruption of navigation and water transport is among the most serious concerns. Sea level rise and storms threaten the entrance channel to Cuttyhunk and the waterfront infrastructure of both Cuttyhunk and Naushon. Copicut Neck and Church's Beach are vulnerable to storms, along with the increasingly overwashed causeway between Naushon and Nonamesset.

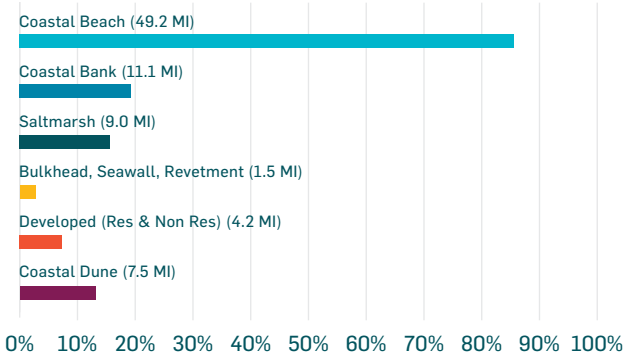
NATURAL COAST

EROSION Sections of the largely rocky or moraine coast have experienced relatively little erosion, though one portion of Barges beach on Cuttyhunk has seen up to 300 feet of erosion since the 1800s [CIT. 5].

HABITAT CHANGES About 2 of 40 acres (5%) of estuarine beach/tidal flats could be lost to open water [CIT. 2].

OCEAN-FACING SHORELINE (57.5 MILES) [CIT. 4]

Shoreline types below can overlap, not cumulative



2050 STORM AND TIDAL FLOODING [CIT. 1,3]

- Roads potentially flooded by 100-year storm flooding
- Buildings potentially flooded by 100-year storm flooding
- Buildings and roads potentially affected by daily/frequent tidal flooding
- Areas potentially affected by 100-year storm flooding
- Areas potentially affected by daily or frequent tidal flooding (MHHW)
- Current Shoreline

* Gosnold, once part of Chilmark but an independent Town since 1863, is part of Duke's County. The Town is made up of the Elizabeth Islands: Nonamesset, Uncatena, Weepecket, Gull, Naushon, Pasque, Nashawena, Penikese and Cutty hunk, with the Town's government based on Cuttyhunk.

Nantucket

Winter storm Grayson might have had a genteel name, but it packed a punch in the winter of 2018. Floodwaters approaching three feet deep roiled Nantucket's downtown streets, totaling cars, swamping homes and businesses, and surrounding Brant Point lighthouse.

FAST FORWARD TO JUNE 2021, and all signs indicate that the island heeded the wake-up call. A year after Grayson, the community gathered for its first official resilience building workshop, which led to acceptance of an MVP and Hazard Mitigation Plan in 2019, and hosted a two-day workshop on *Keeping History Above Water*. Nantucket has since hired a full-time Coastal Resilience Coordinator and contracted an engineering firm to develop a comprehensive coastal resilience plan, expected to be finalized this fall. An updated harbor management plan and a sediment transport study for both harbors is planned to be undertaken in the next few years, among other initiatives.

Organizations across the island — from the Nantucket Conservation Foundation, Land Bank, Land Council, and Preservation Trust to the Nantucket Shellfish Association, ACKlimate, and ReMain Nantucket, among others — are increasingly galvanized to raise public awareness and find ways to accommodate, protect or retreat. In a recent survey (Envision Resilience Nantucket Challenge Survey Report), more than 70% of residents and regular visitors said they are "very worried" about climate impacts. They know the challenges are great.

TO LIVE ON NANTUCKET is essentially to live on a boomerang-shaped beach, the dynamic remnants of a glacier's retreat thousands of years ago. It makes for 81 miles of wondrous sandy shoreline, visited by thousands each summer. And yet the island's greatest asset — a low-lying pristine coast, with glorious beaches — may also be its greatest liability.

With a population of about 11,000 that swells more than fourfold in-season, the median home value is about $1.08 million and median household income more than $107,000, 2019 census data shows. But wealth is no match for water. Since the tide gauge was installed in 1965, the mean sea level in Nantucket Harbor has risen by approximately 8 inches [CIT. 20]. Seas may rise 2.62 feet around Nantucket by 2050, and 4.42 feet by 2070 [CIT. 1]. The highest point of the island is a mere 111 feet above sea level, just south of Sankaty Head Light.

CLIMATE CHANGE, OR EVEN A SUDDEN SEVERE STORM, could dramatically impact the island's natural and developed coast and its historic character as well as the outposts of Tuckernuck and Muskeget, which experience severe erosion. High tide flooding already impacts low-lying areas and downtown streets, even on sunny days. Roads have closed, and beaches have eroded along the south-facing shore, which is losing up to 15 feet per year [CIT. 5].

For a mere 48 square miles, Nantucket has much to protect and more critical infrastructure than most towns its size. At stake is its access to the mainland by multiple harbors, ferries, and an airport. At risk by 2050 is $2.6 billion in parcel values, according to FEMA data, plus historic resources, uniquely preserved architecture, and an economy reliant on global tourism and outdoors recreation. The island also harbors one of the greatest concentrations of rare and endangered species in Massachusetts [CIT. 17], from the New England blazing star to the Nantucket moth and northern long-eared bat.

Over 50% of the County (including Tuckernuck and Muskeget) is protected and preserved, which leaves limited opportunities for retreat and requires a strategic realignment of resources among a wide range of landowners — as well as a leap of imagination. ReMain Nantucket's Envision Resilience Challenge in June provided a sweeping exercise in what creative adaptation might look like: Floating piers and canals. Artificial reefs and barrier islands. Boardwalks as deployable barriers. Front lawns as detention basins. Sponge parks and marine gardens. And modular, mobile structures and vertical spaces that share space with nature, and let the waters in.

As one of the event speakers noted, "It's not one big fix, and we all go home happy. It's a new way of thinking and living that will be with us and our children for a long time to come."

Town of Nantucket

Impacts Projected to Occur By 2050

DEVELOPED COAST

PROPERTY DAMAGE A 10-year storm in Nantucket may flood up to 1,436 (10%) structures, and a 100-year storm up to 1,932 (13%) [CIT. 3]. At significant risk is the town's historic downtown district, Brant Point, and Madaket.

ROAD FLOODING About 69 miles (15%) of roadway may flood in a 10-year storm and an estimated 95 miles (21%) in a 100-year storm. Washington and Easy Streets, among others, already see high tide flooding [CIT. 3].

HARBOR AND WATERFRONT DAMAGE This area is at extreme risk of future flooding and storm damage. The Steamship Authority terminal, Hy-Line terminal, and shipping channel have been cited as critical vulnerabilities. Downtown street flooding significantly disrupts travel and commerce, including routes to the ferry terminals and between commercial docks and the rest of the Island.

NATURAL COAST

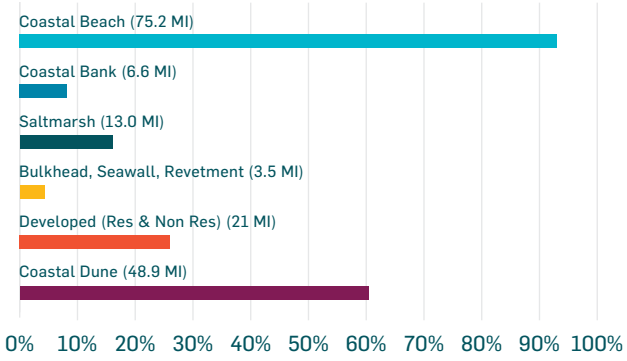
EROSION Parts of the south coast have receded up to 1,800 feet since the 1800s, with maximum short- and long- term annual rates of 17 and 11 feet, respectively [CIT. 5]. Beach erosion could be particularly severe along the south shore, potentially affecting one wastewater treatment plant and the airport. Great Point is migrating west, while erosion impacts Siasconset and Jetties Beach.

MARSH LOSS Regular flooding may transition 569 of 863 acres (66%) of high marsh to low marsh, while total marsh (high and low) may lose 50 acres (5%) [CIT. 2].

HABITAT CHANGES Estuarine beach/tidal flats and estuarine open water may increase by 225 acres (91%), and 108 acres (2%), respectively [CIT. 2].

OCEAN-FACING SHORELINE (80.9 MILES) [CIT. 4]

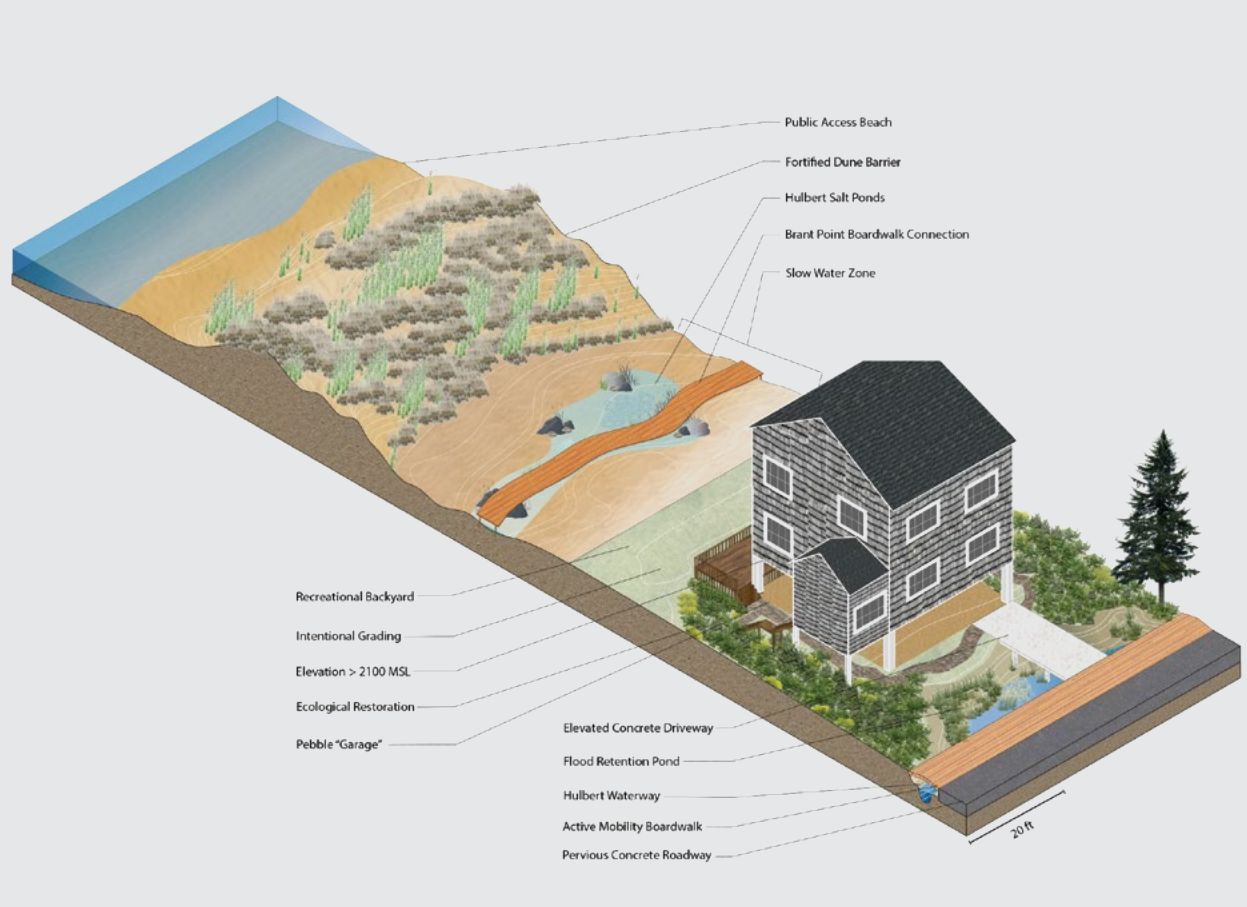
Shoreline types below can overlap, not cumulative



2050 STORM AND TIDAL FLOODING [CIT. 1,3]

- Roads potentially flooded by 100-year storm flooding
- Buildings potentially flooded by 100-year storm flooding
- Buildings and roads potentially affected by daily/frequent tidal flooding
- Areas potentially affected by 100-year storm flooding
- Areas potentially affected by daily or frequent tidal flooding (MHHW)
- Current Shoreline

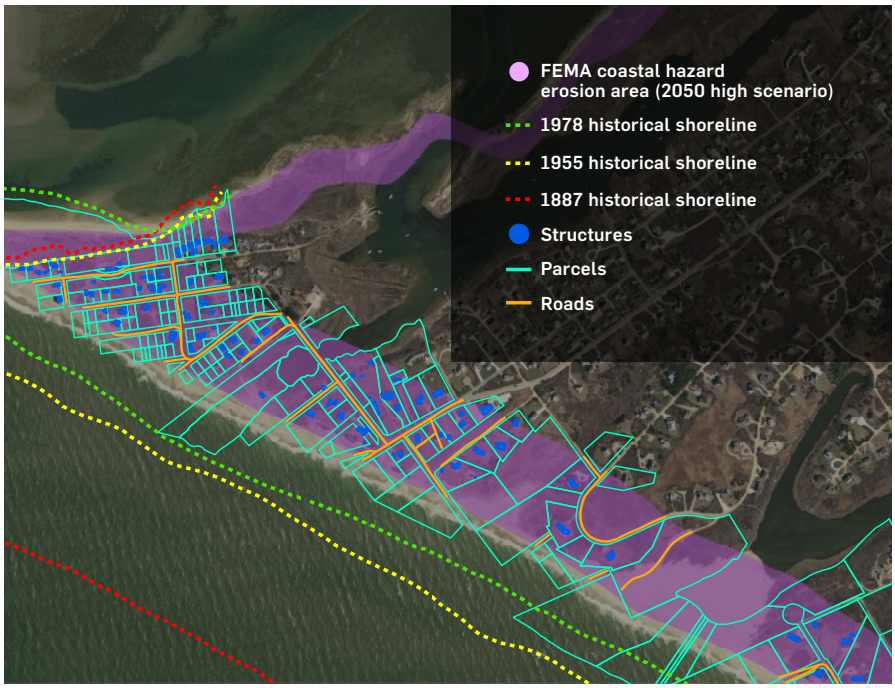
ENVISION RESILIENCE NANTUCKET: "LIVING WITH WATER"



THE ENVISION RESILIENCE NANTUCKET CHALLENGE, a spring 2021 design studio run by non-profit organization ReMain Nantucket, tasked teams from design programs at five leading universities to reimagine the Nantucket harborfront using the latest sea level rise projections. Led by Carolyn Cox of the Florida Climate Institute, students worked with 24 local and regional advisors with expertise in a wide range of disciplines, from conservation and architecture to civil engineering and historic preservation, to identify threats, research solutions and propose adaptive designs. Their innovative models, presented to a jury in late April and the public in June, featured flip-up boardwalks, permeable surfaces, vertical buildings, and absorptive parks. One team's "Living with Water" proposal for a model residence along Brant Point's Hubert Avenue creates an interconnected living and mobility network by using a layered system of shoreline hydro-ecology, dune restoration, elevated boardwalks, and yard space transformed into a retention pond circled by dense native plantings.

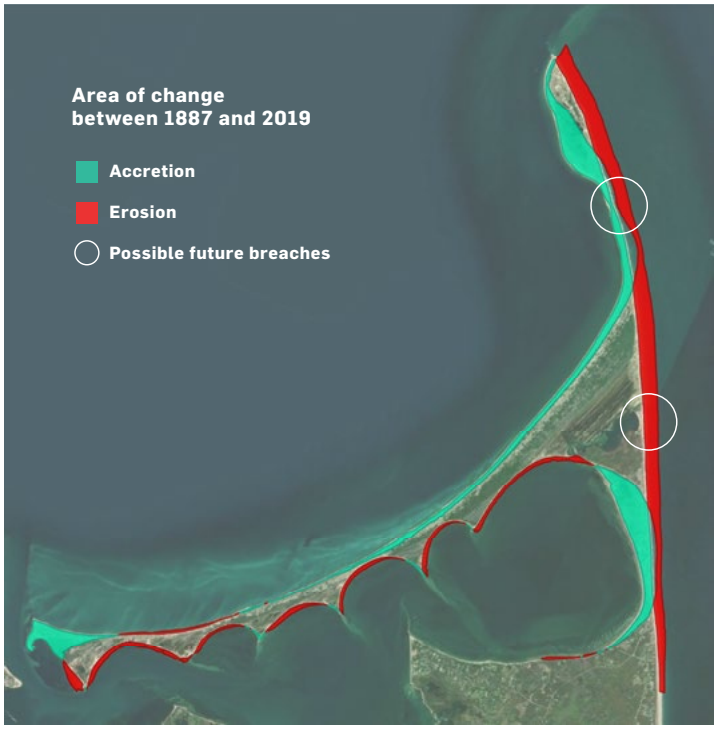
Credit: Alex Renaud, Environmental Engineering & Landscape Architecture, Northeastern University '23. "Living with Water" by Alex Renaud was developed for the Envision Resilience Nantucket Challenge

FEMA COASTAL HAZARD EROSION AREA (2050 HIGH SCENARIO): MADAKET, NANTUCKET [CIT. 5 AND 10]



THIS COASTAL AREA IN MADAKET, and other portions of the Nantucket southern coastline, have experienced significant shoreline erosion and retreat since 1887 (red dashed line). Continued erosion between 1978 (green dashed line) and present day, has had a high impact on several coastal properties and land parcels. By 2050, considering the modeled high sea level rise scenario, FEMA projects the area in purple will be under a significant erosion threat due to climate change and sea level rise.

COSKATA-COATUE, NANTUCKET: AREA OF CHANGE BETWEEN 1887 AND 2019 [CIT. 5]

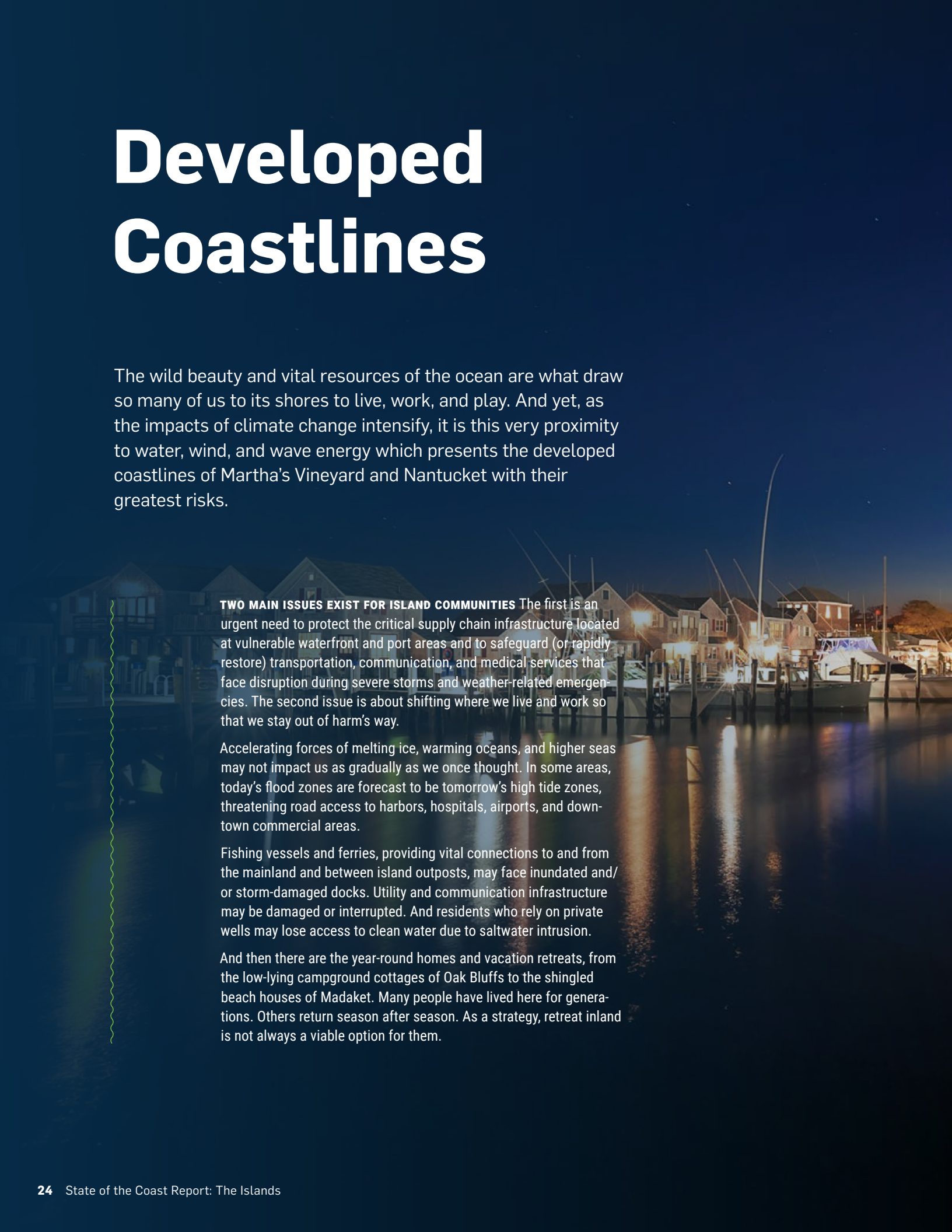


THE COSKATA-COATUE WILDLIFE REFUGE is a dynamic barrier beach system that has experienced natural erosion and accretion events over the last century. However, over the last century, the beach has experienced a net loss of 63 acres of sand and has migrated in a westerly direction because of its direct exposure to coastal processes. Looking to the future, Coskata-Coatue is likely to see continuous westward migration, overwash of dunes, and a narrowing of barrier beach in places due to sea level rise and erosion. Boston University researchers also found that breaches could occur in the future at certain locations [see circled areas on graphic] [CIT. 19].

TIME PERIOD	LOSS (ACRES)	GAIN (ACRES)	NET CHANGE (ACRES)
1887-1955	365.7	284.0	-81.7
1955-1978	85.5	144.5	59.0
1978-2009	202.9	87.9	-115.1
2009-2014	4.0	138.8	134.8
2014-2019	**73.0**	**13.1**	**-59.9**
1887-2019	**484.0**	**421.3**	**-62.7**

Developed Coastlines

The wild beauty and vital resources of the ocean are what draw so many of us to its shores to live, work, and play. And yet, as the impacts of climate change intensify, it is this very proximity to water, wind, and wave energy which presents the developed coastlines of Martha's Vineyard and Nantucket with their greatest risks.



TWO MAIN ISSUES EXIST FOR ISLAND COMMUNITIES The first is an urgent need to protect the critical supply chain infrastructure located at vulnerable waterfront and port areas and to safeguard (or rapidly restore) transportation, communication, and medical services that face disruption during severe storms and weather-related emergencies. The second issue is about shifting where we live and work so that we stay out of harm's way.

Accelerating forces of melting ice, warming oceans, and higher seas may not impact us as gradually as we once thought. In some areas, today's flood zones are forecast to be tomorrow's high tide zones, threatening road access to harbors, hospitals, airports, and downtown commercial areas.

Fishing vessels and ferries, providing vital connections to and from the mainland and between island outposts, may face inundated and/or storm-damaged docks. Utility and communication infrastructure may be damaged or interrupted. And residents who rely on private wells may lose access to clean water due to saltwater intrusion.

And then there are the year-round homes and vacation retreats, from the low-lying campground cottages of Oak Bluffs to the shingled beach houses of Madaket. Many people have lived here for generations. Others return season after season. As a strategy, retreat inland is not always a viable option for them.

WHAT THE DATA SHOWS

VULNERABILITY IS WIDESPREAD, especially on the Islands' ocean-facing southern tiers. The latest data shows:

- Erosion threatens an estimated $2 billion worth of coastal parcels on Martha's Vineyard and $2.6 billion in Nantucket, not including structures, FEMA (Massachusetts Coastal Erosion Hazard Map) data shows.
- Overall, more than 3,500 structures on the Islands may be flooded during a 10-year storm in 2050 [CIT. 3] while almost 800 structures may be threatened by erosion, FEMA data [CIT. 10] shows.
- Nantucket may experience daily tide flooding of 25 miles of roads (5%) by 2050 [CIT. 3].
- About 95 miles of roadway are projected to flood on Martha's Vineyard during a 10-year storm event [CIT. 3], including 49 miles in Edgartown — nearly twice as many miles as the Boston Marathon.
- Even Gosnold, which is relatively undeveloped with more high ground, could see nearly 8 miles of roads flooded in a 10-year storm in 2050 [CIT. 3].

LOOKING AHEAD

Our projections indicate Islanders must make hard choices now about how to avoid or reduce flood risk. It's not just a matter of looking at local infrastructure, site by site. To buy time and increase the odds of success, discussions and initiatives should focus on the best opportunities to collaborate and improve resiliency.

Based on our latest findings, we propose:

ELEVATING AND ADAPTING INFRASTRUCTURE It's urgent that buildings in current and projected flood zones are designed for adaptive reuse, with features such as breakaway walls. And while individual structures can be raised, a more comprehensive approach is also necessary to develop consistent solutions over time that respect historic character. We can look at:

- Boston's Planning & Development Agency (BPDA) has plans for a Coastal Flood Resilience Overlay District that will require new development and retrofits to limit damage and displacement due to coastal storm and sea level rise impacts.
- Amphibious buildings are designed to avoid damage when water levels rise. They range from foam-based flotation systems to sophisticated designs with terraced landscapes acting as early flood warning systems.

ENGINEERING TO ABSORB WATER "Sunny day" flooding already occurs in some downtown areas, so it's imperative to channel or redirect water away from homes, businesses, and critical infrastructure or find ways to live with it. Together, we can think outside the box and find ways to adapt urban models like "sponge cities" to the Islands, transforming hardscapes into permeable areas for water to be naturally absorbed, retained, and filtered.

WEIGHING RETREAT AGAINST OTHER PRIORITIES For some residents and business owners, retreat may be the only viable option when retrofitting or relocation to another inland area are not possible or realistic. With significant impacts forecast to occur within the lifetime of most mortgages, property owners need the Islands to determine viable retreat areas and weigh those against land conservation plans.

MITIGATING VULNERABLE TRANSPORTATION ROUTES Choices need to be made about whether to relocate piers and ports offshore as floating networks or further inland, as the shoreline recedes. We need to ask whether low-lying areas should be adapted for port areas and causeways and if harbors should be transformed into more open resilient spaces. With many places at high risk of flooding, it's also time to plan for strengthening inland routes, raising roads, and using new technology such as floating roads and bridges.

Coastal Banks

From the sunset-colored cliffs of Aquinnah to the picturesque bluffs of Siasconset, ocean-facing coastal banks are fragile environments threatened by intensifying storm events, development, and sea level rise.

Among the more than 31 miles of coastal banks on Martha's Vineyard, Gosnold (Elizabeth Islands), and Nantucket, many are anchored neither by rock nor even dense gravel. This makes them more vulnerable to erosion and also jeopardizes all that these slopes between upland areas and the sea contain—from trails, parking lots, and houses to the archaeological remains of indigenous communities and fossils of prehistory [see Cultural Resources on page 36].

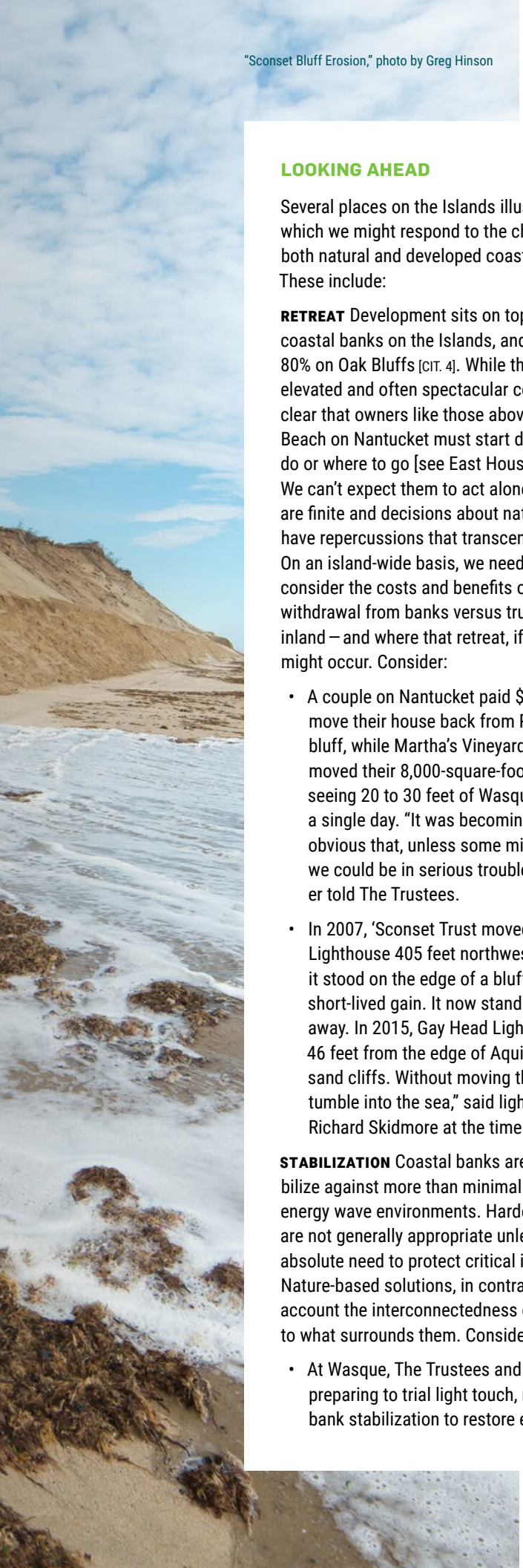
Coastal erosion is a natural process, but new mapping projections by FEMA indicate its pace is likely to accelerate with sea level rise as storms are able to attack higher and higher land elevations. The impacts are more highly episodic on bluffs than on beaches, causing sudden collapse and retreat. And unlike beaches, for which they are a critical source of sand, coastal banks are not self-healing. When they are gone, they are gone.

WHAT THE DATA SHOWS

According to our historical and recent data, coastal banks on the Islands are rapidly disappearing. Consider:

- Gay Head Cliffs has eroded as much as 70 feet between 1990 and 2014, or almost 3 feet per year [CIT. 18].
- Wasque on Chappaquiddick has receded as much as 1,500 feet since 1897—the equivalent of nearly 5 city blocks. Data shows recent erosion rates of more than 50 feet per year [CIT. 5].
- The bluffs at Siasconset have eroded over 100 feet in places between 1990 and 2014, over 4 feet per year [CIT.18]. FEMA also predicts the glacial Siasconset bluffs could erode another 300 feet or more by 2100 [CIT. 10].
- Sections of coastal banks on Tuckernuck Island have eroded more than 500 feet between 1990–2014, approximately 20 feet per year [CIT. 18].
- Gosnold has 11.1 miles of coastal bank [CIT. 4] (more than any town in our study), but they are generally more stable than elsewhere on the Islands.

WE'RE AT A PIVOTAL MOMENT TO SIGNAL HOW WE ARE GOING TO RESPOND TO CLIMATE-DRIVEN IMPACTS. It's a time when we need to begin charting a future course not just for one coastal bank in a single location, but across towns and islands—and the ecosystems to which they are tied.



"Sconset Bluff Erosion," photo by Greg Hinson

LOOKING AHEAD

Several places on the Islands illustrate the ways in which we might respond to the challenges facing both natural and developed coastal banks. These include:

RETREAT Development sits on top of 31% of coastal banks on the Islands, and as much as 80% on Oak Bluffs [CIT. 4]. While their homes offer elevated and often spectacular coastal views, it's clear that owners like those above Siasconset Beach on Nantucket must start deciding what to do or where to go [see East House callout box]. We can't expect them to act alone when resources are finite and decisions about natural resources have repercussions that transcend property lines. On an island-wide basis, we need to collaboratively consider the costs and benefits of short-term withdrawal from banks versus true retreat inland — and where that retreat, if possible, might occur. Consider:

- A couple on Nantucket paid $1.6 million to move their house back from Pocomo Head bluff, while Martha's Vineyard homeowners moved their 8,000-square-foot home after seeing 20 to 30 feet of Wasque bluff lost in a single day. "It was becoming increasingly obvious that, unless some miracle happened, we could be in serious trouble," the homeowner told The Trustees.
- In 2007, 'Sconset Trust moved Sankaty Head Lighthouse 405 feet northwest from where it stood on the edge of a bluff, but it was a short-lived gain. It now stands about 240 feet away. In 2015, Gay Head Lighthouse stood 46 feet from the edge of Aquinnah's clay and sand cliffs. Without moving that year, "it would tumble into the sea," said lighthouse keeper Richard Skidmore at the time.

STABILIZATION Coastal banks are difficult to stabilize against more than minimal erosion in high energy wave environments. Hardened structures are not generally appropriate unless there is an absolute need to protect critical infrastructure. Nature-based solutions, in contrast, take into account the interconnectedness of coastal banks to what surrounds them. Consider:

- At Wasque, The Trustees and our partners are preparing to trial light touch, nature-based bank stabilization to restore eroded areas.

Pictured here is The Trustees undeveloped Wasque Reservation, where natural coastal processes have eroded the banks and adjacent forest. Private homes adjacent on either side of this property were at risk of eroding as well. In one case after bank stabilization efforts including coir logs had failed, one homeowner moved an entire house back landward. Another homeowner, with no room to move a house, was spared when a portion of breached beach closed and the bank stopped eroding [Photo credit: Tara Marden]

We're also planning for retreat when the loss of parking lots and trails is likely.

- Wilkinson Ecological Design stabilized a severely undercut bank by a Martha's Vineyard home with a plant-focused, bioengineered approach. The design using native plants has served to protect the property, filter stormwater, and provide wildlife habitat.
- Elsewhere, the Puget Sound National Estuary Program is studying the feasibility of a Revolving Loan Fund (RLF) to help waterfront homeowners finance the removal of damaging armor and install nature-based erosion controls. Maryland's Shore Erosion Control RLF, one of the oldest in the nation, has been a blueprint for similar programs.

ADAPTIVE DESIGN: A commissioned coastal bluff study prompted the award-winning design of East House in Chilmark, perched above the coast. Peter Rose + Partners, a Boston-based architectural firm, created a 4,000-square-foot home cast as a collection of linked boxes. Each box is a structural unit with concrete floors and 10-inch-thick walls that can be individually moved (with interior finishes intact) to a location away from the bluff, should increased erosion threaten to jeopardize the structure.

FUTURE-PROOFING: While it is possible to restore a coastal bank with compatible material and native plantings, these projects are often just as vulnerable to erosion as the original natural feature. To replicate today's bank under future conditions, we can incorporate terraced, biodegradable toe protection across the entire stretch of banks to accommodate future highwater levels.

MANAGED SEDIMENT RELEASE: Erosion of the coastal bank is a natural process that feeds sediment to the beach, but accelerated slumping and the episodic nature of large erosion events add an element of uncertainty. We might consider a phased release of sediments, informed by monitoring and data that gives us predetermined thresholds to plan for stabilization and erosion over time.

REDUCED RUNOFF STORMWATER: runoff is increasingly impacting coastal banks and, with groundwater breakout, contributing to slumping. We can manage stormwater using natural vegetation and other low-development techniques to prevent more damage.

Habitats

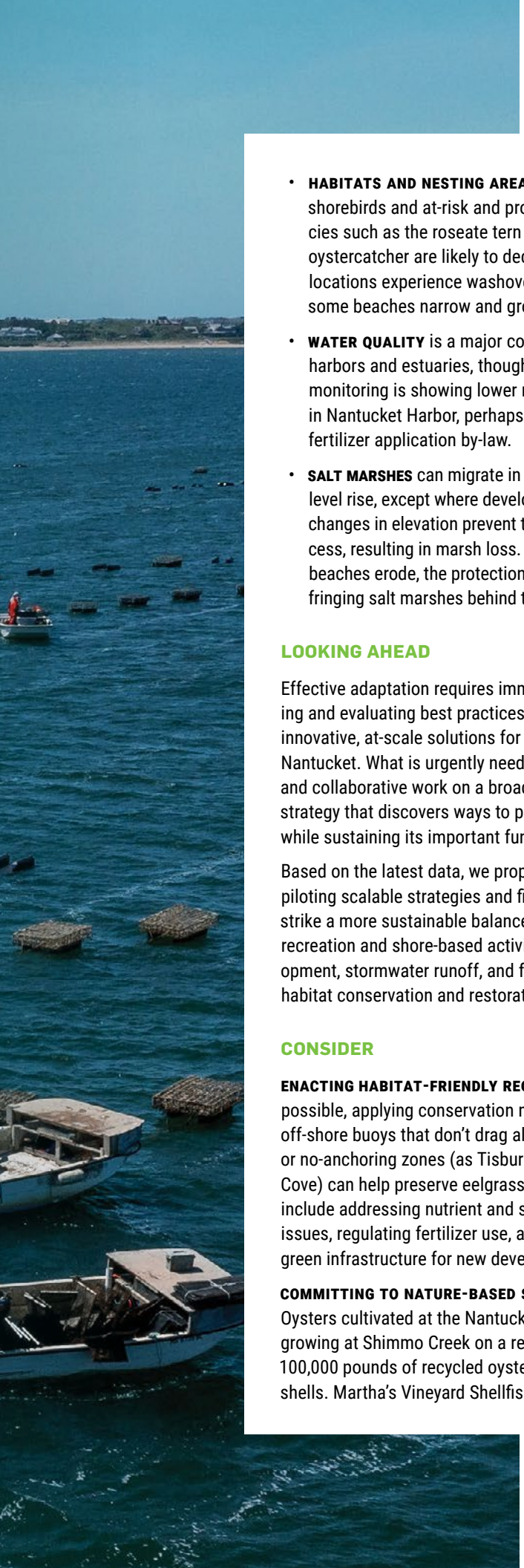
Coastal habitats on Martha's Vineyard, Gosnold (Elizabeth Islands), and Nantucket provide extraordinary ecological and economic value, with 68,600 acres that are home to many rare and threatened species. In the winter, snowy owls, mergansers, and bufflehead ducks frequent Norton Point. In the warmer months, Cape Poge Bay attracts striped bass and bluefish, and nests of piping plovers, least terns, and oystercatchers. Martha's Vineyard has one of the only nesting colonies of black skimmers in Massachusetts — one of the latest species to expand their range north with the warmer climate.

We may worry about the future of our homes amid rising seas, but climate change poses no less a threat to natural habitats. Its impacts go beyond intensified storms, erosion, and sea level rise to include the ocean's warming temperatures and acidification. These effects — compounded by pollution, disease, contamination, tidal restrictions, nutrient loading, and sedimentation — threaten to significantly degrade and destroy estuaries, including mudflats, eelgrass, shorebird nesting sites, and shellfish beds.

WHAT THE DATA SHOWS

- **THE FUTURE OF SHELLFISHING IS IN JEOPARDY**. On Nantucket, the scallop harvest is down to 8,000 bushels this year, from about 100,000 bushels in the 1980s [CIT. 13]. Wild oysters also appear to be on the decline, though there has been growth in aquaculture and oyster farming [CIT. 11].
- **TOXIC ALGAE BLOOMS ARE OCCURRING WITH INCREASING FREQUENCY**, including at the head of Nantucket Harbor [CIT. 11]. Algae can smother eelgrass, which impacts scallops.
- **EELGRASS IS UNDER STRESS FROM HUMAN IMPACTS** (scallop draggers, prop wash, and mooring scour, for example), warming waters, and decreased light due to sea level rise. The density of eelgrass meadows in Nantucket Harbor declined to 17% in 2020 from 36% in 2016 [CIT. 11], and restored eelgrass in Edgartown Great Pond continues to suffer from sedimentation. Eelgrass is critical, providing nursery habitat for commercially important shellfish (especially bay scallops) and fisheries. It also stabilizes sediments, removes pollutants, and sequesters carbon.

Photo Credit: Above Summit



- **HABITATS AND NESTING AREAS** for migrating shorebirds and at-risk and protected species such as the roseate tern and American oystercatcher are likely to decline as nesting locations experience washover events, and some beaches narrow and grow steeper.
- **WATER QUALITY** is a major concern for island harbors and estuaries, though long-term monitoring is showing lower nitrogen levels in Nantucket Harbor, perhaps due to a recent fertilizer application by-law.
- **SALT MARSHES** can migrate in response to sea level rise, except where development or abrupt changes in elevation prevent this natural process, resulting in marsh loss. Also, as barrier beaches erode, the protection they provide to fringing salt marshes behind them will be lost.

LOOKING AHEAD

Effective adaptation requires immediately developing and evaluating best practices and introducing innovative, at-scale solutions for the Vineyard and Nantucket. What is urgently needed now is active and collaborative work on a broad, Islands-wide strategy that discovers ways to provide habitat while sustaining its important functions.

Based on the latest data, we propose strategically piloting scalable strategies and finding ways to strike a more sustainable balance between human recreation and shore-based activities (e.g. development, stormwater runoff, and fertilizers) and habitat conservation and restoration.

CONSIDER

ENACTING HABITAT-FRIENDLY REGULATIONS Where possible, applying conservation moorings or off-shore buoys that don't drag along the seafloor or no-anchoring zones (as Tisbury did in Drew's Cove) can help preserve eelgrass. Other remedies include addressing nutrient and septic system issues, regulating fertilizer use, and requiring green infrastructure for new development.

COMMITTING TO NATURE-BASED SOLUTIONS Oysters cultivated at the Nantucket hatchery are growing at Shimmo Creek on a reef made from 100,000 pounds of recycled oyster and quahog shells. Martha's Vineyard Shellfish Group is also spearheading shell recycling from homes and restaurants for oyster habitat and eelgrass restoration [CIT. 12]. Techniques such as snow-fencing and grass planting can help to stabilize eroding dunes, and restore salt marsh shorelines.

MOVING OFFSHORE Coastal communities are increasingly using offshore reefs and reef-mimicking structures to provide habitat and reduce wave energy impacts on natural landscapes and harbors. Off the coast of Martha's Vineyard, Cottage City Oysters established a 3D farm to produce eco-friendly oysters, clams, and seaweed. The state Division of Marine Fisheries also created an artificial reef program to provide additional fish habitat.

GROWING BLUE ECONOMIES As threats to traditional industries grow, science and technology can help expand sustainable ocean-facing businesses. Low-cost aquaculture projects reduce reliance on fisheries and increase the diversity of food sources. For instance, Mook Sea Farm in Maine developed technology to grow microalgae for oyster larvae, among other innovations.

LOBBY FOR TARGETED FUNDING Identifying coastal habitats as natural infrastructure would allow islands to rebuild natural spaces after storms, as they do with built infrastructure. FEMA also offers insurance incentives for the preservation of open space. These should be expanded to cover natural coastal defenses that provide values beyond protecting development and infrastructure.

MANAGING PUBLIC ACCESS AND BEACH RESILIENCY The Trustees provides areas for walking and over-sand-vehicles, but limit access in areas to protect dune vegetation, intertidal shorelines, and allow natural dunes to rebuild—critical for beach resiliency.

PRESERVE HABITAT MIGRATION CORRIDORS Conservation organizations island-wide can work together to make sure that corridors have ample space across diverse elevations and habitat types.

SEEK OPPORTUNITIES What damages habitat for one species may create the right conditions for another. We don't always need to resist change; sometimes, we can be ecological opportunists and use our collective efforts to make the most of it.

Advocacy

From the massive Rotterdam sea gate and Hamburg's new floodproof HafenCity to absorptive "sponge cities" in China and floating farms in Bangladesh, projects designed to mitigate coastal climate change worldwide represent feats of imagination and logistics. Here in New England, the Islands of Martha's Vineyard, Gosnold (the Elizabeth Islands), and Nantucket deserve no less: creative, holistic, and scalable approaches to their unique needs and transformation over time.

Even more than mainland coastal communities, adapting to coastal change is integral to life on the Islands, but we can't do it all at once—or on our own. It's time to create the collaborative foundations necessary for change and learning to live with water. Without adequate resources, investments, creative solutions, and regulatory reform, our communities will experience unmitigated climate impacts—and have more difficulty recovering from disaster after it strikes. Yet by working together, we can create resiliency while preparing for retreat from migrating shorelines.

The Trustees, which owns and protects wildlife refuges, coastal upland areas and more than 17 miles of beach on the Islands, has conserved these sensitive landscapes by working with landowners, land trusts, philanthropists, elected officials, and agency experts. We create and advocate for public policies and funding, lead statewide and regional coalitions, spearhead education and outreach efforts, and negotiate passage of state and federal legislative and regulatory reforms.

Investments in climate mitigation, adaptation, and resiliency are at the core of our coastal projects. Key to that is leveraging private resources and bringing conservation, adaptation, and restoration projects to scale, but we cannot accomplish this important work alone. Lawmakers at all levels of government need to acknowledge the urgency of climate impacts and prioritize and increase investments in climate-facing policies and strategies.

The Trustees and our partners are urging the U.S. Congress and Massachusetts legislative and agency leaders to make significant investments in natural "infrastructure," especially large-scale coastal restoration projects and the creation of new, resilient waterfront parks. To adapt to climate impacts, we need to redesign and replace transportation infrastructure—roads, bridges, dams and culverts—and balance human recreational and development wants with important habitat and natural resource needs. The state also needs to enact a new Flood Risk Protection Program to acquire properties and relocate homeowners and small businesses from current and future flood-prone zones, focusing on environmental justice populations and low- and middle-income homeowners.

We need to set forth and advocate for a bold vision for the future of our Islands that goes beyond a traditional understanding of land conservation and restoration. To do that, we must consider:

- **CONSERVATION TECHNIQUES** Federal, state and local decision makers need to prioritize and increase investments in our natural coastlines and habitats, not only areas of built infrastructure. We must expand existing resiliency strategies and pilot new approaches that prioritize nature-based solutions. We can look to the innovative techniques of other coastal communities like the New Jersey Blue Acres property buyout program, which has used mostly federal funds to buy and then demolish

about 1,000 flood-prone homes from willing sellers. Land is permanently preserved as publicly accessible open space and a natural buffer against future storms and floods.

- **FUTURE-FACING DESIGNS** Communities need to collectively focus on seeking and implementing creative approaches to living with water, from deployable barriers and absorptive landscapes to floating, elevated, and amphibious infrastructure. That means engaging multiple disciplines and the next generation in thinking about how we design for the future along the lines of Nantucket's Envision Resilience and Virginia-based RISE's coastal resilience laboratory.
- **FORWARD-THINKING LEGISLATION** With our universities and research institutions, Massachusetts should drive new science and innovation and lead the country by integrating climate science into planning and development projects and making permitting for climate resiliency measures easier and less expensive through regulatory reform. The Trustees, for instance, is partnering with state agencies to streamline permitting requirements for nature-based coastal initiatives. Balancing land conservation and restoration with other priorities means revising current laws and experimenting with techniques such as the transfer of development rights or California's proposed buy-rent-retreat program, in which communities could buy vulnerable coastal properties and rent them out (to the homeowners or someone else) as long as they are safe to inhabit.
- **INNOVATIVE, CONSISTENT FINANCING** Public and private partners can coordinate to establish robust streams of dedicated revenue for climate mitigation, adaptation, and resiliency and find new ways of supporting promising pilot projects with public and private funding. The Trustees is working with a coalition of non-profit groups to identify new potential sources of dedicated funding to create $1 billion for climate resiliency programs over 10 years. Elsewhere, officials in Maryland created Resilience Authorities to help local governments flexibly fund and manage large infrastructure projects to address the effects of climate change.
- **COLLABORATIVE AND CREATIVE APPROACHES** Communities must reach out to each other and to new partner organizations that can help bring ideas and approaches to scale. Martha's Vineyard and Nantucket are increasingly finding ways to unite towns and approach climate resiliency projects from island-wide perspectives. The appointment of full-time climate change coordinators is a critical step forward. We can create more opportunities to share knowledge, assess vulnerabilities and priorities, and act with common goals in mind, inspired by local initiatives such as LA Safe in Louisiana and the international climate change alliance between Boston, Cambridge, and Copenhagen.

> "People need to remember that in the eastern U.S. the beaches where we love to swim rise at a slope of about one degree—which means that if you raise the ocean a foot, it comes in about 90 feet across that sand. Think about that for a moment."
>
> **BILL MCKIBBEN, AUTHOR, ENVIRONMENTALIST, FOUNDER OF 350.ORG, AND SCHUMANN DISTINGUISHED SCHOLAR-MIDDLEBURY COLLEGE**

Earlier this year, Miami published a draft of its $3.8 billion stormwater master plan draft. It proposes seawalls and strengthening natural resources like coral reefs but also concepts such as floating neighborhoods and streets converted into canals. "The most common question I get asked is whether Miami is going to be here in 50 years, whether it's going to be here in 100 years," said Miami Mayor Francis Suarez while announcing the plan.

We need radical thinking, too. But unlike highly developed urban centers, we don't have to wonder if the Islands, with their natural shorelines and upland areas, will still be around in 50 years. Instead, we are faced with questions of how to adapt their vulnerable edges and find places to retreat. It's important to be flexible and cooperative as we seek answers—and partners. Success depends on forging new relationships that will build the momentum, energy, and optimism we need to bolster our natural defenses and weather the changes to come.

Facing the Future Together

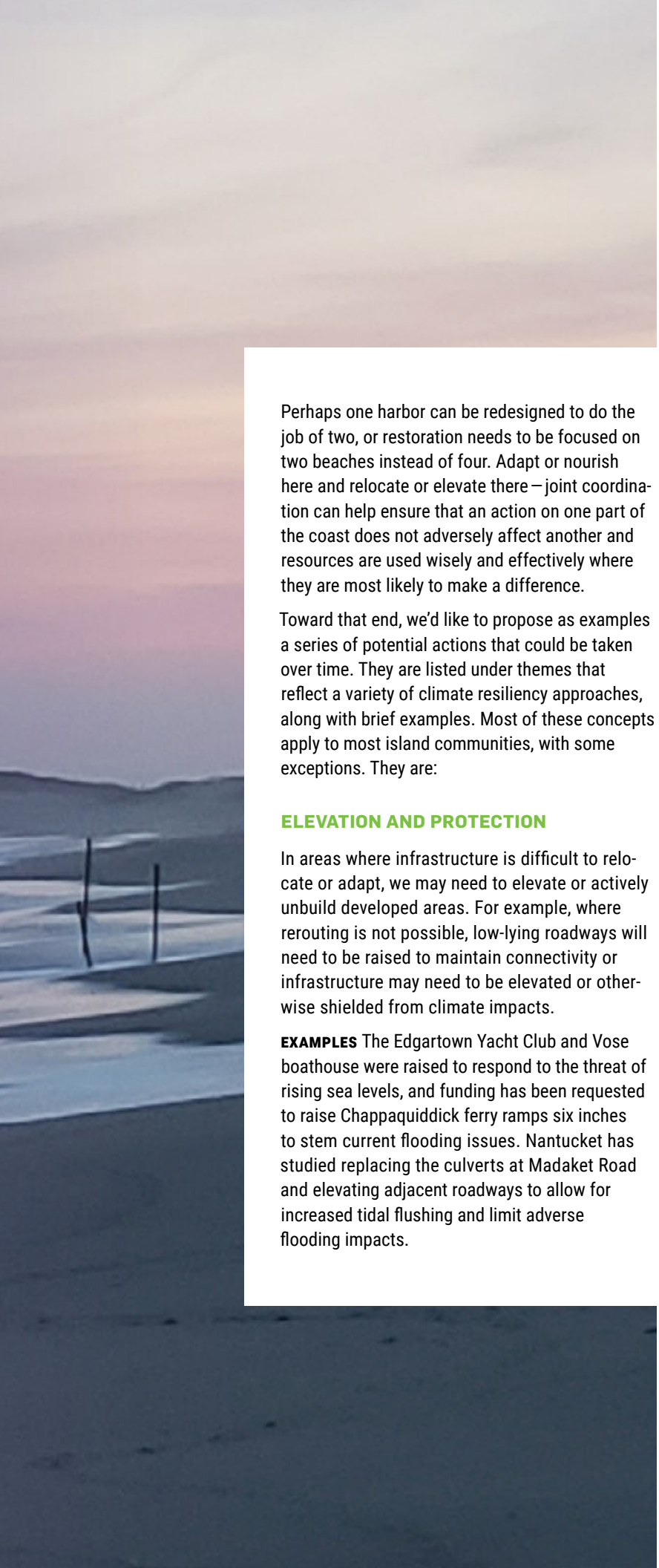
It's easy to feel overwhelmed by the extent of change that must occur for Martha's Vineyard, Nantucket, and Gosnold (the Elizabeth Islands) to thrive, and for a sustainable balance to be struck between human activity and the natural environment. From the frontlines of coastal climate change, Islanders are truly in a unique position to innovate and model leadership at a time when President Biden has called for nearly $1 trillion in climate-related investments—but we must act now.

MOVING TOWARD INTELLIGENT ADAPTATION TOGETHER

Towns on Martha's Vineyard and Nantucket are taking individual actions and weighing options such as redesigning harbors, nourishing beaches, and raising roads, yet the questions remain: How do these options fit together? And are they enough?

We applaud current efforts by the Islands to develop more comprehensive climate resiliency plans and collaborate on an increasing number of initiatives. And we want to underscore this message, shared by many Islanders: The first and foremost priority is to accept that we must live with the natural coast and its waters, allowing it to reorganize and evolve in ways that are far more resilient than we can construct ourselves.

Adapting to a new normal may mean recalibrating the definition of normal. Having shifted our mindset, we can then collaborate to design and implement a grand strategy for each island—and even the Islands together— that considers a whole greater than the sum of its parts.



Perhaps one harbor can be redesigned to do the job of two, or restoration needs to be focused on two beaches instead of four. Adapt or nourish here and relocate or elevate there—joint coordination can help ensure that an action on one part of the coast does not adversely affect another and resources are used wisely and effectively where they are most likely to make a difference.

Toward that end, we'd like to propose as examples a series of potential actions that could be taken over time. They are listed under themes that reflect a variety of climate resiliency approaches, along with brief examples. Most of these concepts apply to most island communities, with some exceptions. They are:

ELEVATION AND PROTECTION

In areas where infrastructure is difficult to relocate or adapt, we may need to elevate or actively unbuild developed areas. For example, where rerouting is not possible, low-lying roadways will need to be raised to maintain connectivity or infrastructure may need to be elevated or otherwise shielded from climate impacts.

EXAMPLES The Edgartown Yacht Club and Vose boathouse were raised to respond to the threat of rising sea levels, and funding has been requested to raise Chappaquiddick ferry ramps six inches to stem current flooding issues. Nantucket has studied replacing the culverts at Madaket Road and elevating adjacent roadways to allow for increased tidal flushing and limit adverse flooding impacts.

RESILIENT CONNECTIONS AND CONTINGENCIES

It's critical to lay the groundwork for emergency response: quick restoration of public and private road and ferry connectivity, access to medical centers and drinking water, relocation or replacement of damaged or flood-prone infrastructure, and the evacuation and protection of vulnerable or isolated Islanders.

EXAMPLES Martha's Vineyard and Nantucket jointly applied for an MVP action grant to study supply chain resilience for areas of vulnerability and improvement, and the new Nantucket Cottage Hospital was built with climate change impacts in mind, with all mechanical systems installed on the roof instead of the basement.

SEDIMENT MANAGEMENT

With limited material resources on islands, it will be critical to understand sediment supply and demand.

For example, it will be increasingly necessary to develop long-term strategies and facilitated processes to allocate sediment (sand, etc.) islandwide for beach and salt marsh restoration.

EXAMPLE The Trustees has identified priority areas, sediment volumes, and costs for dune restoration and beach nourishment across the more than 17 miles of beach we manage on the Islands. Future beach restoration trials will be monitored by volunteers for effectiveness over time.

HARBOR MANAGEMENT AND RESILIENCY

Cross-island visualization and coordination is needed to optimize harbor planning and sustain each island's constellation of access to working waterfronts and critical lifelines, not necessarily in today's configurations. The ways we adapt adjacent areas can also help to mitigate inland flooding.

EXAMPLE The Oak Bluffs adaptation plan contains design alternatives for raising and protecting infrastructure at the harbor's edge, including reconfiguring jetties and raising the harbor bulkhead.

NATURAL RESOURCE ENHANCEMENT

With island communities inextricably tied to their natural resources, we can make an environmental and economic case for investing in ecological preservation and restoration as a vehicle for climate adaptation and mitigation.

EXAMPLE At the Felix Neck Wildlife Sanctuary, a broad consortium of collaborators installed the largest living shoreline restoration project in New England to protect the marshes of Sengekontacket Pond and initiate the self-healing process for ecological restoration and wildlife benefits.

TRANSFORMATION

In some special places, projected changes will necessitate a pivot in how we live, work, and play at the water's edge. This doesn't always mean retreat, but it does mean that we need to be prepared to use crisis as an opportunity to change our relationship with rising waters.

EXAMPLE The Envision Resilience Nantucket Challenge presented inspired proposals that embraced climate change as an opportunity to leverage modularity, ecology, aquaculture, and public space in novel ways. It explored several possible futures for living with water in Brant Point, including controlling where water flows and building local resilience through a sustainable, circular (no waste) economy.

A TIMELINE FOR CHANGE

We understand the desire to maintain the integrity of the Islands and their Towns, and their distinct characters and landscapes, and we acknowledge the impossibility of achieving resiliency overnight. It would be impractical to suggest that sustainable solutions are just around the corner, and, having implemented them, we are done. Instead, we propose a multi-pronged, flexible approach that occurs in stages with island-wide collaboration.

For instance, we might decide on:

- **2021–2030** Bring policies and funding to scale. Complete island-wide planning and designs. Forge new partnerships to bring solutions to scale. Begin adaptations. Establish coastal corridors for land protection, sediment budgets for beach restoration and living shorelines, and strategies for beach interventions. Homeowners and businesses at-risk of flooding or erosion begin to plan for adaptation or relocation. Monitor local conditions.
- **2031–2040** Continue major adaptations of harborfront areas and conservation of waterfront open space for resilience and landward migrating coastline. Targeted beach resiliency and living shoreline projects are underway. At-risk business and homeowners have started adaptation or relocation. Continue monitoring local conditions and make design changes as needed.
- **2040–2050** First stages of adaptation are complete, allowing for flexibility and additional measures over time. Continue monitoring local conditions and make design changes as needed.

In its recently issued guidelines, "Resist, Accept, Direct," the U.S. National Park Service made clear it can no longer safeguard all of its resources in the face of climate change. With this report, we are recommending collective triage for our Islands, too. We cannot afford to take a siloed approach to the future. It's time to decide together what we're willing to adapt and what we're willing to sacrifice. Only then can we move forward intelligently, in step with each other and the natural world around us.

DISTRICTS OF CRITICAL PLANNING CONCERN (DCPCS) are municipal land planning designations. On Martha's Vineyard, they protect areas ranging from Oak Bluffs harbor, Cape Poge, and Lagoon Pond to Gay Head Cliffs and the entire town of Aquinnah.

In a coordinated effort between island towns, the Martha's Vineyard Commission (MVC) and MV Land Bank Commission are considering applying DCPCs to protect Sengekontacket Pond salt marsh in Oak Bluffs. This is how it would work, as explained by MVC's first climate change planner, Liz Durkee:

A row of houses is set at the landward edge of a marsh. The town board nominates these houses to be placed in a DCPC. If the MV Commission approves it, the town develops DCPC regulations. If voters give officials a green light, the town gets the right of first refusal to buy the houses at fair market value when they go up for sale. The town then transfers that right to the Land Bank, which buys the properties and takes three critical actions.

First, the Land Bank removes the houses to allow the salt marsh to migrate inland. Second, the septic systems are taken out to decrease the amount of nitrogen polluting the pond. And third, the Land Bank offers the salvaged houses to an affordable housing agency to help address the island's housing crisis. In this way, the DCPC represents managed retreat and could serve as a model for salt marsh preservation elsewhere.

Cultural Resources

Climate change threatens to submerge not just the present-day visible world—landscapes, structures, and habitat. The effects of sea level rise, intensifying storms, and flooding also pose a serious threat to culturally significant resources now protected underwater or underground. Their exposure to the elements can degrade long buried artifacts or environments, increase looting risks, and cause severe damage or destruction.

Archaeologists around the world are racing against nature, from the Arctic, where frozen archives are melting, to historic Jamestown, which rests along a sea wall and is subject to seeping groundwater. A survey of southeastern states in the U.S. by Digital Index of North American Archaeology showed that nearly 20,000 sites are at risk of destruction by a sea level rise of only three feet.

These pressures exist on Martha's Vineyard and Nantucket, where climate-driven effects are fierce, and humans have been continuously interacting with the islands' coastal environments for thousands of years. Wampanoag artifacts between 500 and 3,000 years old, for instance, were found a decade ago on the cliffs above Lucy Vincent Beach in Chilmark. Today, parts of those cliffs have crumbled. This section of coast has eroded 500 feet since 1897, and has a long-term erosion rate of about 4.5 feet/year [CIT. 5].

This means that we need to ask sooner rather than later: What visible resources exist, and what's hidden? How do we document and preserve resources, or mitigate losses. And ultimately, how do we decide? In the words of Deborah Cox, president of the Public Archaeology Laboratory (PAL) in Rhode Island: "How can we be responsible stewards?"

While Nantucket does not have a recent island-wide comprehensive archaeological inventory study, PAL have completed more than a dozen archaeological projects across the island and more than 100 individual projects on the Vineyard, including town wide archaeological reconnaissance surveys of Edgartown (2000) and Aquinnah (2002).

To prepare the islands for these cultural ramifications of climate change, we need to integrate them into resiliency planning, partner with heritage professionals and indigenous community members, and conduct sensitivity assessments of where resources are and where they might be. We also need:

- **REPORTING AND TRACKING SYSTEMS**
- **VOLUNTEER TEAMS** to take inventory and also survey damaged areas after storms
- **APPROPRIATE METHODS** of conservation, education, and preservation, when possible

South Carolina, for instance, has involved "citizen scientist" volunteers to help recover artifacts and document the shell ring sites on the barrier island of Pockoy, which is eroding at a rate of nearly 30 feet per year and will soon be gone. For guidance and inspiration, we can also look to the Carns site at the Cape Cod National Seashore, the National Park Service (which has a quarter of its properties on or near the coast), Midden Minders in Maine, Heritage Monitoring Scouts program in Florida, and Scotland's Coastal Heritage at Risk Project. And in May, Boston announced an archaeological climate action plan for the Harbor Islands.

Many of the resources we seek to preserve—from archeological sites to traditional structures and knowledge—hold valuable information on how earlier cultures responded to changing environments. They can be part of a sustainable future and help inform us about the origins of modern climate change.

This is the time to focus on cultural resources that are both significant and most at risk, and to take stock of what our most vulnerable areas might hold. We will certainly have to make some hard decisions but if we collaborate now, we stand a greater chance of preserving our cultural island heritage before it disappears.

Coastal Impact Matrix

		Gosnold	Aquinnah	Chilmark	West Tisbury	Tisbury	Oak Bluffs	Edgartown	Nantucket
Max Short Term Erosion Rates (Feet/Year) 1970–2014 [CIT. 5]	BEACH	No Data	4.6	6.6	7.8	3.1	5.5	54.5	16.6
Max Long Term Erosion Rates (Feet/Year) 1800s–2014 [CIT. 5]		No Data	4.9	6.2	6.9	3.1	4.4	27.0	11.5
Acreage Lost to Erosion 1887–2014 [CIT. 5]		No Data	40.3	520.2	238.6	21.8	37.1	579.0	1857.8
Acreage Projected to be Lost to Erosion by 2050 (FEMA) [CIT. 10]		No Data	76.7	332.0	135.1	74.0	68.3	585.0	1700.8
Acres Total Marsh Loss in 2050 [CIT. 2]	MARSH	3.6	-3.1	0.3	-8.1	21.8	28.8	227.1	50.0
Acreage of New Marsh Growth or Migration through 2050 [CIT. 2]		0.3	37.5	16.8	10.1	5.4	29.1	89.3	438.0
Structures in Area Flooded from Daily Tidal Flooding in 2050 [CIT. 3]	STRUCTURES FLOODED	10	0	34	1	92	87	76	628
Structures in Areas Flooded from 10-Year Storm in 2050 [CIT. 3]		81	39	164	93	437	554	757	1436
Miles of Road Flooded from Daily Tidal Flooding in 2050 [CIT. 1]	ROADS FLOODED	1.1	0.4	0.9	0.8	2.1	1.4	10.9	25.1
Miles of Road Flooded from 10-Year Storm in 2050 [CIT. 3]		8.7	4.1	11.9	10.5	8.1	11.0	49.4	68.6
Structures in Areas Impacted by Erosion by 2050 (FEMA) [CIT. 10]	EROSION OF STRUCTURES AND ROADS	No Data	3	27	15	108	89	44	500
Miles of Roads Impacted by Erosion in 2050 (FEMA) [CIT. 10]		No Data	0.6	3.4	1.6	1.3	2.8	10.5	24.3

We are providing this chart so that communities can gauge their specific risks and vulnerabilities in relation to each other and the region as a whole. On the left are some of the climate-driven impacts—beach erosion, marsh loss, and flooding of buildings and roads—that are projected for 2050 (high sea level rise scenario) from storms and sea level rise. The chart also shows rates of short- and long-term beach erosion, an impact that has already been experienced by most communities. For beaches in more developed areas, even small rates of erosion can be problematic because their migration may be restricted by development or armored shorelines.

Visit the thetrustees.org/coast for additional information and data.

Citations and Sources

Data used in this report came from a variety of sources. Metrics such as marsh transitions, number of buildings flooded and miles of roads impacted are based on assessments of model results by The Trustees. The models used are state-of-the-art, but they are based on a number of assumptions and various input conditions that come with inherent limitations. The Trustees used publicly available data for other metrics, including beach erosion rates, tidal restrictions, and miles of armored shoreline.

Our sources include:

1. **Massachusetts State sea level rise** projections were developed by DeConto, R.M. and R.E. Kopp (2017). Massachusetts Sea Level Assessment and Projections. Technical memorandum. More details on Massachusetts State Sea Level Rise projections can be found at *https://resilientma.org/resources/resource::2152*

   The 'high' rate of SLR is what is used in our flood risk analyses using MC-FRM (Massachusetts Coast Flood Risk Model) as recommended by the Massachusetts Office of Coastal Zone Management (CZM), MassDOT, and UMass-Boston. Assumed Mean Sea Level elevations (measured from 2000) are 1.2 ft, 2.5 ft, and 4.3 ft NAVD88 for 2030, 2050, and 2070.

2. **Marsh and coastal habitat changes** were provided by Woods Hole Group and derived from CZM's Massachusetts Sea Level Affecting Marshes Model (SLAMM) project. The high sea level rise scenario from which SLAMM results are presented is 7.1 feet of rise for Martha's Vineyard and 7.32 feet of rise for Nantucket from 2011-2100. Details on the SLAMM model can be found at *https://www.mass.gov/service-details/report-on-modeling-the-effects-of-sea-level-rise-on-coastal-wetlands*.

3. **Impact to buildings and roads from storm flooding**. Details of the Flood risk Models used for this study (Boston Harbor Flood Risk Model and the Massachusetts Coast Flood Risk Model) can be found at Bosma, K., E. Douglas, P. Kirshen, K. McArthur, S. Miller and C. Watson. 2021 (in progress). Assessing the vulnerability of MassDOT's coastal transportation systems to future sea level rise and coastal storms, and developing conceptual adaptation strategies. In publication.

4. **Shoreline Characterization Layers from CZM** were sourced from the Massachusetts Ocean Resources Information System (MORIS) at *https://www.mass.gov/service-details/massachusetts-ocean-resource-information-system-moris* and the Report of the Massachusetts Coastal Erosion Commission, Volume 1: Findings and Recommendations, and Volume 2: Working Group Reports, 2015. *https://www.mass.gov/service-details/massachusetts-coastal-erosion-commission*.

5. **Short- and long-term erosion rates, beach erosion rates, and shoreline change analyses** were derived from Massachusetts Coastal Erosion Viewer, found at *https://mass-eoeea.maps.arcgis.com/apps/MapSeries/index.html?appid=80fc0c7ef5e443a8a5bc58096d2b3dc0*.

6. **Woods Hole Group, Inc. analysis of MassGIS Data** came from NHESP Priority Habitats of Rare Species (August, 2017)

7. **Coastal Habitat** was derived from MassDEP Wetlands and regional Landcover datasets. MassDEP Wetlands Original (1:12,000) from MassGIS (January 2009) was combined with the NOAA Coastal Change Analysis Program (C-CAP) Regional Land Cover Database. Data collected 1995-present. Charleston, SC: National Oceanic and Atmospheric Administration (NOAA) Office for Coastal Management. Data accessed at *https://coast.noaa.gov/digitalcoast/tools/lca.html*.

8. SHARP 2015. "Specialist-bird survey database: 1994-2012." **Salt marsh Habitat and Avian Research Program**. *https://www.tidalmarshbirds.org*.

9. Woods Hole Group, Inc. analysis of **MassGIS Data: Protected and Recreational OpenSpace** (December 2020)

10. **Future projected scenarios for coastal erosion on Martha's Vineyard and Nantucket** were derived from the Massachusetts Coastal Erosion Hazard Map, FEMA, 2021. *https://fema.maps.arcgis.com/apps/webappviewer/index.html?id=a4aa86031a3a40be9d453d781ff210b3*. Technical details on the Coastal Erosion Hazard areas can be found at FEMA, 2019, FEMA Region I Coastal Erosion Study—Nantucket County, Compass September 3, 2019.

11. **Information on shellfish conditions and environmental issues in harbors and ponds on Nantucket** were from a discussion with Nantucket Shellfish Biologists Tara Riley and Leah Hill on May 20, 2021.

12. **Information on shellfish conditions and environmental issues in harbors and ponds on Martha's Vineyard** were from a discussion with Martha's Vineyard Shellfish Biologists Emma Green-Beach on May 14, 2021.

13. **Historic shellfish landings from Massachusetts Shellfish Initiative Assessment Report**, October 2020, by Jeff Kennedy, Sean McNally, PhD, Chris Schillaci, and Jared Silva.

14. Woods Hole, Martha's Vineyard and Nantucket Steamship Authority **monthly trip report** statistics provided by spokesperson Sean F. Driscoll.

15. Asimow, N. (2020, September 4). **Health Officials Monitor Toxic Blue-Green Algae in Chilmark Pond.** The Vineyard Gazette - Martha's Vineyard News. *https://vineyardgazette.com/news/2020/09/04/health-officials-monitor-toxic-blue-green-algae-chilmark-pond*

16. McCormick, C. (2015, June 15). **Special Series: Nantucket's rising tide of sky-high prices.** Cape Cod Times. *https://www.capecodtimes.com/article/20150615/NEWS/150619632*

17. Beattie, K. (n.d.). **Protecting Nantucket's Rare Species: What, How and Why?** Nantucket Conservation Foundation. Retrieved April 15, 2021, from *https://www.nantucketconservation.org/protecting-nantucketsrare-species-what-how-and-why/*

18. **Massachusetts Coastal Bank Erosion Hazard Mapping**, MassDEP and CZM, 2019, *https://www.arcgis.com/home/item.html?id=ae5aadccca65446495d403b60598cb0b*

19. (D. FitzGerald, **emailed PowerPoint**, March 14, 2020).

20. **Mean sea level trend data for Nantucket** was retrieved from NOAA's Nantucket Tide Gauge which can be viewed at *https://tidesandcurrents.noaa.gov/sltrends/sltrends_station.shtml?id=8449130*

Organizations and Resources

ACKLIMATE

acklimate.org

A public-private partnership supporting innovative and holistic approaches and communication addressing climate change and sea level rise for the Nantucket community and beyond.

COASTAL RESILIENCY ADVISORY COMMITTEE

www.nantucket-ma.gov/1391/Coastal-Resiliency-Advisory-Committee

The committee works with the Coastal Resiliency Coordinator in the development, oversight, and implementation of a Coastal Resiliency Plan for the Town of Nantucket to address the impact of climate change and sea level rise.

DUKES CONSERVATION DISTRICT

dukescounty.org/dukes-conservation-district

A subdivision of state government that carries out programs for the conservation and wise management of soil, water and related resources.

ISLAND CLIMATE ACTION NETWORK (ICAN)

islandclimateaction.org

A volunteer Vineyard organization that provides information about local climate activities, advocates for local climate action, and provides information on ways Islanders can help.

LINDA LORING NATURE FOUNDATION

llnf.org

A foundation that promotes environmental literacy through research, education, and stewardship, with its 275-acre property on Nantucket serving as a "living laboratory."

MARIA MITCHELL ASSOCIATION

mariamitchell.org

An association founded in 1902 to preserve the legacy of Nantucket native astronomer, naturalist, librarian, and educator Maria Mitchell. It operates two observatories, a natural science museum, an aquarium, a research center and preserves Mitchell's historic birthplace.

MARTHA'S VINEYARD COMMISSION

mvcommission.org

The regional planning agency for Martha's Vineyard Island and the Elizabeth Islands, is charged with protecting and enhancing the Islands' environment, economy, character, and social fabric.

MARTHA'S VINEYARD SHELLFISH GROUP

mvshellfishgroup.org

A non-profit organization working to restore shellfish resources since 1976.

MASS AUDUBON

massaudubon.org

The Massachusetts Audubon Society acts to protect the nature of Massachusetts and stimulate individual and institutional action through conservation, education, and advocacy.

MV LAND BANK COMMISSION

mvlandbank.com

A public organization that collects a 2% real estate transfer fee for purchasing land in order to preserve and conserver it for the public access.

NANTUCKET BIODIVERSITY INITIATIVE

nantucketbiodiversity.org

An initiative whose mission is to conserve the native biodiversity of Nantucket through collaborative research, monitoring and education.

NANTUCKET COASTAL CONSERVANCY

savenantucketbeaches.org

A non-profit organization founded in 2012 and composed of year-round Islanders and seasonal residents, as well as visitors, whose common interest is to preserve and protect Nantucket's natural beaches.

NANTUCKET CONSERVATION COMMISSION

nantucket-ma.gov/326/Conservation-Commission

The Commission must review and approve all development and proposed activities within 100 feet of a wetland.

NANTUCKET CONSERVATION FOUNDATION

nantucketconservation.org

A non-profit land trust of members, friends, and benefactors dedicated to preserving the open spaces and natural habitats of the island through conservation and active land management.

NANTUCKET LAND BANK

nantucketlandbank.org

Founded in 1983 as the first of its kind in the nation, the Land Bank works to acquire, hold, and manage key open spaces, provide waterfront access, preserve scenic views, protect ecological resources, promote local agriculture, and create outdoor recreational opportunities.

NANTUCKET LAND COUNCIL

nantucketlandcouncil.org

A non-profit dedicated to protecting Nantucket's natural world and rural character through conservation restrictions, commissioning scientific research, monitoring development proposals, engaging in legal proceedings to protect natural resources, and educating the public on local environmental issues.

NANTUCKET PRESERVATION TRUST

nantucketpreservation.org

A local non-profit with a mission to protect, promote, and preserve the island's unique architectural heritage and sense of place.

NANTUCKET SHELLFISH ASSOCIATION

nantucketshellfish.org

A non-profit association founded in 2003 by a group of concerned Islanders to protect and promote the Nantucket shell fishing industry.

REMAIN NANTUCKET & REMAIN VENTURES

remainnantucket.org/remainventures.com

An organization founded by philanthropist Wendy Schmidt to support the economic, social, and environmental vitality of Nantucket. ReMain believes that by fostering innovative thinking, expert research, and community collaborations, the evolution of a healthy year-round community can flourish from its iconic downtown and expand throughout the island.

THE MASSACHUSETTS OFFICE OF COASTAL ZONE MANAGEMENT (CZM)

www.mass.gov/orgs/massachusetts-office-of-coastal-zone-management

The lead policy, planning, and technical assistance agency on coastal and ocean issues within the Executive Office of Energy and Environmental Affairs. It implements the state's coastal program under the federal Coastal Zone Management Act.

UMASS BOSTON NANTUCKET FIELD STATION

umb.edu/nantucket

The Nantucket Field Station, one of the facilities of UMass Boston's School for the Environment, is a 107-acre field site providing education, research, and community service.

VINEYARD CONSERVATION SOCIETY

vineyardconservation.org

A non-profit membership organization founded in 1965 and dedicated to preserving the environment of Martha's Vineyard through advocacy, education, and the protection of the Island's land and water.

VINEYARD FUTUREWORKS

vineyardfutureworks.org

Vineyard FutureWorks, which began as a series of "grassroots" meetings of diverse island leaders, promotes island-wide collaboration and innovation.

VINEYARD TRUST

vineyardtrust.org

Vineyard Trust owns and maintains 20 iconic landmarks central to the community of Martha's Vineyard.

WAMPANOAG TRIBE OF GAY HEAD (AQUINNAH)

wampanoagtribe-nsn.gov

The ancestors of Wampanoag people have lived for at least 10,000 years at Aquinnah (Gay Head) and throughout the island of Noepe (Martha's Vineyard). Today, they care for 477 acres of ancestral lands, much of it set aside for common use and benefit.

Coastal Resilience and Collaboration on MV

LIZ DURKEE
MVC CLIMATE CHANGE PLANNER

mvcommission.org

In 2015, the Gay Head Lighthouse, a beacon of hope and refuge since 1865, was moved some 130 feet inland from the eroding Gay Head cliff. The move was funded in part with Community Preservation Act contributions from all six Vineyard towns. The towns pitched in because saving a historic lighthouse benefits the community-at-large.

Island-wide collaboration is essential to coastal climate resilience planning.

Climate change impacts are oblivious to town boundaries. On the coast, each Island town faces beach and bank erosion, coastal flooding, and salt marsh loss. Every town's economy is linked to the shoreline. Everyone needs safe access to the Vineyard Haven Steamship Authority port and the Martha's Vineyard Hospital.

Two critical points on coastal resilience arise from the worldview of the Wampanoag Tribe: When it comes to the natural world, everything is connected (including us) and as such it must be tended collectively.

Yet embedded in the culture of the Island's six distinct towns is concern that collaboration will dilute their independence. The encroaching sea cares not.

Climate planning, in particular, is a challenge for the towns due to:

- A lack of funding and staff for climate work
- Competition with each other for the small pot of resilience grant funding
- Planning that is town-focused and largely short-term

The Island community will benefit from collaboration between the towns and the Martha's Vineyard Commission, the regional planning agency. The Commission has:

- A professional planning staff, including a climate change planner
- A Climate Action Task Force addressing island-wide issues
- Climate change expertise
- The ability to identify shared resilience strategies for island-wide problems
- The ability to apply for regional projects as encouraged by many grant programs

THE COMMISSION IS WORKING ON A COLLABORATIVE, 20-YEAR CLIMATE ACTION PLAN. Local stakeholder groups will help identify resilience strategies. Stakeholders focusing on coastal issues will include members of the towns' climate committees, planning boards and conservation commissions, as well as Wampanoag tribal staff, non-profit land use groups, and building trade representatives. When the plan is completed, the Commission will continue to work with the towns on implementation.

ACROSS THE ISLAND LOCAL GROUPS ARE COLLABORATING WITH ONE ANOTHER. Last year, for example, the Martha's Vineyard Land Bank Commission and Sheriff's Meadow Foundation bought 304 acres of undeveloped land in Aquinnah. Preserving this ecologically rich land means that homes won't be built on the vulnerable, ever-shifting shoreline, wild-life habitat will remain intact, trees will continue to absorb carbon, and the public gains new waterfront access.

CLIMATE CHANGE AFFECTS EVERY ONE OF US. Island-wide collaboration strengthens both resilience planning and the common, collective good of the Island and its people.

Nantucket's Resilient Coastlines: a Whole Island Approach

DR. JEN KARBERG
RESEARCH PROGRAM SUPERVISOR,
NANTUCKET CONSERVATION FOUNDATION

nantucketconservation.org

Nantucket Conservation Foundation

Nantucket, the Far Away Land, is a county, a town and an island isolated ~30 miles out to sea. On this little sand spit, one is never far from the sound of the ocean! The beauty of Nantucket's natural coastline is what brings many of us to call Nantucket home for a week, a month, a season or all year long. As the impacts of climate change, erosion and sea level rise become clearer, so too does our understanding of how important these natural areas are to this little sand spit's long-term resiliency.

The Nantucket Conservation Foundation (NCF), as the Island's largest landowner, is fortunate to provide stewardship for over 9000 acres of open space; open space key to providing island-wide resiliency. NCF's science staff uses Nantucket as a living laboratory studying island ecology and, increasingly, the resilience of our shoreline. Salt marshes are natural sponges and one of our best tools to fight storm surge and rising seas. Of the ~1600 acres of salt marshes around the island, NCF is proud to own and protect ~1200 acres.

NCF is assessing salt marsh conservation: identifying open space behind salt marshes to protect, giving marshes space to migrate with rising seas or removing culverts and dike roads that restrict saltwater movement.

Intact dunes provide everyday resilience to a constantly eroding and moving shoreline. NCF and The Trustees protect the Coskata-Coatue Wildlife Refuge in partnership, where we are currently examining the resilience of this barrier beach that creates Nantucket Harbor and protects the Town. Assessing future impacts of sea level rise on the Refuge will allow us to design nature-based adaptations to sustain the beach and enhance ecological habitat. On a small island like Nantucket, collaboration will be key to our resilience.

Natural buffers are key to resilience but we will have to make hard choices about the protection of historic, cultural and economic areas. Resilience may require harder structures but they can and should be combined with natural solutions. A bulkhead with a salt marsh fronting it can hold more water and survive more intense storms. In 2021, NCF started a pilot oyster reef installation in Polpis Harbor. This oyster reef is a semi-hard structure that will reduce wave impacts to an eroding salt marsh shoreline. These innovations will help Nantucket stay ahead of projected sea level rise impacts while also maintaining the unique, natural and beautiful character of our island.

As an island, our culture is deeply connected to the ocean, the natural coasts. And Nantucket's future will be rooted in how we adapt to the pressures of climate change. NCF will continue to research protecting and enhancing our natural buffers while advocating for nature-based coastal solutions on our properties and around the island.

LONG TERM EROSION RATES (1887–2014) FOR MARTHA'S VINEYARD AND NANTUCKET BEACHES [CIT. 5]

These are long-term average rates of erosion along the beach. Erosion rates can vary from year to year, and along different sections of the same beach. Negative rates indicate erosion, and positive rates indicate accretion.

Beach Name	Town Name	Average Feet/Year
Norton Point Beach–West ocean	Edgartown	-17.4
Madaket	Nantucket	-11.2
Wasque Swim Beach*	Edgartown	-10.6
Norton Point Beach*	Edgartown	-9.3
Cisco	Nantucket	-7.0
South Beach State Park–Right fork	Edgartown	-6.4
Long Point Beach*	West Tisbury	-6.4
Coskata–East Side*	Nantucket	-5.6
Ocean at Chilmark Pond Preserve	Chilmark	-4.2
Surfside 2	Nantucket	-3.8
Dionis	Nantucket	-1.7
Tashmoo Beach	Tisbury	-1.1
Menemsha	Chilmark	-1.0
Squibnocket Beach	Chilmark	-1.0
Menemsha–Trustees*	Chilmark	-0.9
Lambert's Cove Beach–South	West Tisbury	-0.8
Moshup Beach	Aquinnah	-0.8
Wasque Swim Beach	Edgartown	-0.7
Miacomet	Nantucket	-0.7
40th Pole 1	Nantucket	-0.7
Cape Poge-West Facing*	Edgartown	-0.4
Children's (1 transect)	Nantucket	-0.3
Cape Poge-East Facing*	Edgartown	-0.2
Pay Beach	Oak Bluffs	0.1
Joseph Sylvia State Beach–South	Edgartown	0.3
Sconset 2	Nantucket	0.6
Joseph Sylvia State Beach–North	Oak Bluffs	0.6
Cuttyhunk Harbor	Gosnold	0.8
Lobsterville	Aquinnah	1.0
Owen Park	Tisbury	1.0
East Beach (Chappy)	Edgartown	1.7
Eastville Town Beach–Drawbridge	Oak Bluffs	1.7
Coskata-West Side*	Nantucket	3.6
Jettes	Nantucket	4.3

* Trustees of Reservations owned/managed beaches

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