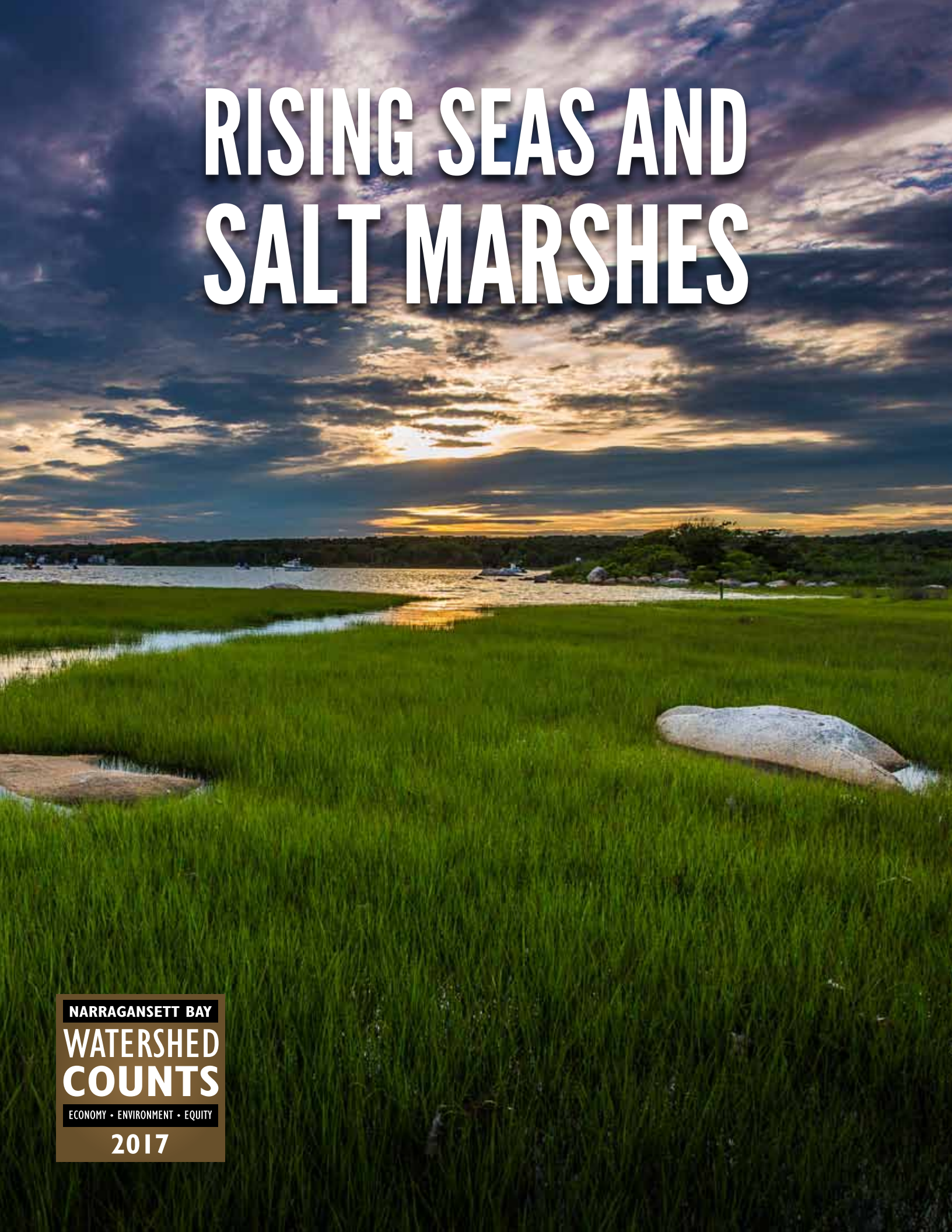
RISING SEAS AND SALT MARSHES



NARRAGANSETT BAY
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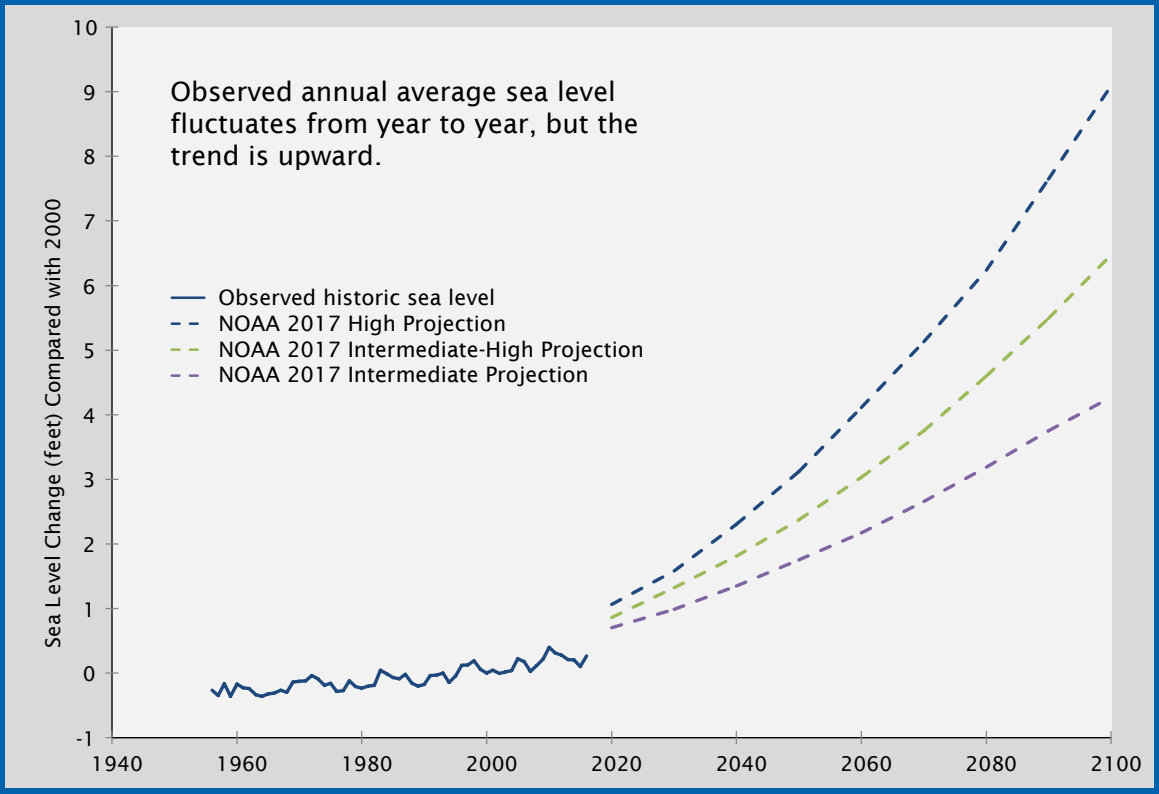


New projections from the National Oceanic and Atmospheric Administration demonstrate accelerating rates of sea level rise. NOAA predicts that by 2100 Rhode Island could experience 4 feet (intermediate scenario) to 6.5 feet (intermediate-high scenario) to over 9 feet (high scenario) of sea level rise. NOAA 2017 sea level rise projections are based on the Newport, RI, tide gauge and calculated with the U.S. Army Corps of Engineers Sea-Level Change Curve Calculator.

Sea level has risen in Narragansett Bay and will continue to accelerate.

- ~0.1 inch per year since 1931; more than 10 inches in the last century.
- More sea level rise than global average, which is ~8 inches since 1880.
- Rate of sea level rise is accelerating, so it is rising faster than it has in the past.
- 4 feet by 2100 is an intermediate projection.
- 9 feet by 2100 is a high projection.

Rising Seas and Salt Marshes

Bluff Hill Cove, Galilee, RI
Lori Jeremiah — www.lorijeremiah.com

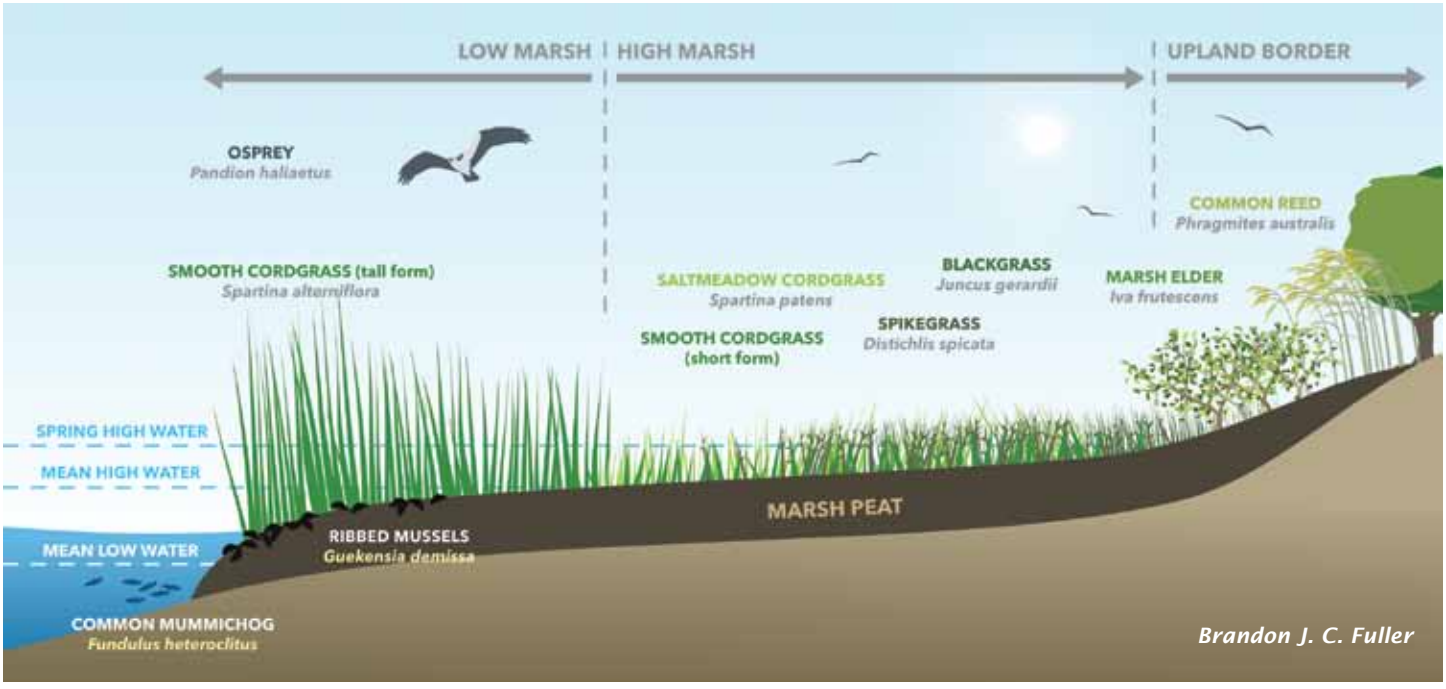
"To describe our growing up in the low country of South Carolina, I would have to take you to the marsh on a spring day, flush the great blue heron from its silent occupation, scatter marsh hens as we sink to our knees in mud, open you an oyster with a pocketknife and feed it to you from the shell and say, 'There. That taste. That's the taste of my childhood.'"

—Pat Conroy, *The Prince of Tides*

Whether in the pluff mud of Conroy's South Carolina or in your Narragansett Bay backyard, salt marshes are beautiful places. Kayak down Narrow River in Narragansett to breathe in fresh air, soak up warm sunshine, and hear bird calls, all underscored by the rustle of marsh grasses that line the shore. These plants are the defining features of salt marshes, serving as an aesthetically pleasing transition between water and land. Marshes keep the water clean, provide food and shelter for shorebirds and fish, and stabilize the soil to reduce erosion from storm surge. Unfortunately, the impact of climate change on these functions puts Rhode Island's coastal communities at greater risk as salt marshes decline, largely due to the increasing rate of sea level rise associated with climate change.

Salt Marsh 101

Before we dive into how climate change is impacting our marshes, let's characterize a salt marsh. Perhaps most importantly, they are habitats defined by plants that can live in salty water. The grasses that are closest to the water—smooth cordgrass (*Spartina alterniflora*)—can tolerate the submergence of their roots during a large part of the tidal cycle—but not permanently. As you move farther from the water, the plants—saltmeadow cordgrass (*Spartina patens*) and others—tolerate shorter periods of tidal inundation. The roots and rhizomes of marsh plants, along with sediment, form peat—a spongy soil that accumulates overtime and allows water to slowly filter through.



Salt marshes in service of people

Salt marshes serve the natural ecology of the area, contribute to the economy, and add a layer of protection that helps prevent erosion in adjacent coastal communities. True to their home state moniker as The Biggest Little, the marshes around Rhode Island are much smaller than the expansive salt marshes of coastal Louisiana or closer to home in New Jersey. They occur as fringing or broader expanses along protected shores, embayments, and tidal rivers of Narragansett Bay and the coastal ponds. But their small size packs a big punch, as they are an essential habitat providing critically important ecosystem and societal services.

Ecology. An amazing 42 different species of fish, crabs, and shrimp occur in our Rhode Island and Massachusetts marshes, with the common mummichog and grass shrimp dominating, both valuable forage species for birds and recreational fisheries such as striped bass.

New England salt marshes also support 79 bird, 20 mammal, and 6 amphibian and reptile species at some point during their lives. This includes the Salt Marsh Sparrow, a US Fish and Wildlife Service species of conservation concern that nests in salt marshes, and Diamondback Terrapins, a turtle that was once heavily harvested and is now listed as endangered in Rhode Island. As marshes dwindle, so do the populations of these and other wildlife that are dependent on this critical habitat.

Economy. You may not scour Pinterest for recipes to grill up 3-inch long mummichogs that navigate the salt marsh plants at high tide, but these and other small fish of the marsh are bite-sized treats for striped bass—the same prized catch that hits your grill after a day of surf casting at the breachway. Marsh fish may not be the catch of the day for restaurants, but they help support Rhode Island's $70 million a year recreational fishing industry. Diminishing salt marshes equals loss of foraging species for valuable recreational and commercial fish.

Shoreline protection. Salt marshes serve as a natural buffer to protect adjacent coastal lands from erosion. When salt marshes are present, the waves and currents that pummel the shoreline are weakened and sturdy marsh peat resists erosion. But, when salt marshes are gone, the land where the marshes once stood takes the full brunt of erosion. Of course, no salt marsh will fully protect adjacent property during a strong hurricane or nor'easter, but the marshes do help protect against the daily wear and tear. Healthy, functioning salt marshes are ideal natural buffers for edging your property and they support the local ecosystem as well.

The Salt Marsh Sparrow lives its entire life in salt marshes, summering in areas around Narragansett Bay and wintering farther south. They lay their eggs during the summer months, building nests among the marsh plants that occur above the high tide line to avoid being flooded during the 28 days required between egg laying and hatching.

But with sea level rise the marshes are getting wetter and the available area to nest is declining. The Salt Marsh Sparrow population has declined 75% since 1998, and researchers predict that their population will decrease an additional 92% over the next 50 years, plummeting to fewer than 5000 birds.

US Fish and Wildlife Service

Aesthetic value. Next time you visit the Wickford or Scituate Art Festivals or wander through a local gallery, take notice of how often salt marsh landscapes are the focus of captivating photos and paintings. Birdwatchers and nature enthusiasts are fond of salt marshes for observing breeding marsh birds and Great Blue Herons and egrets catching their favorite fish. Exploring calm marsh creeks by kayak or paddle board are activities enjoyed by many.

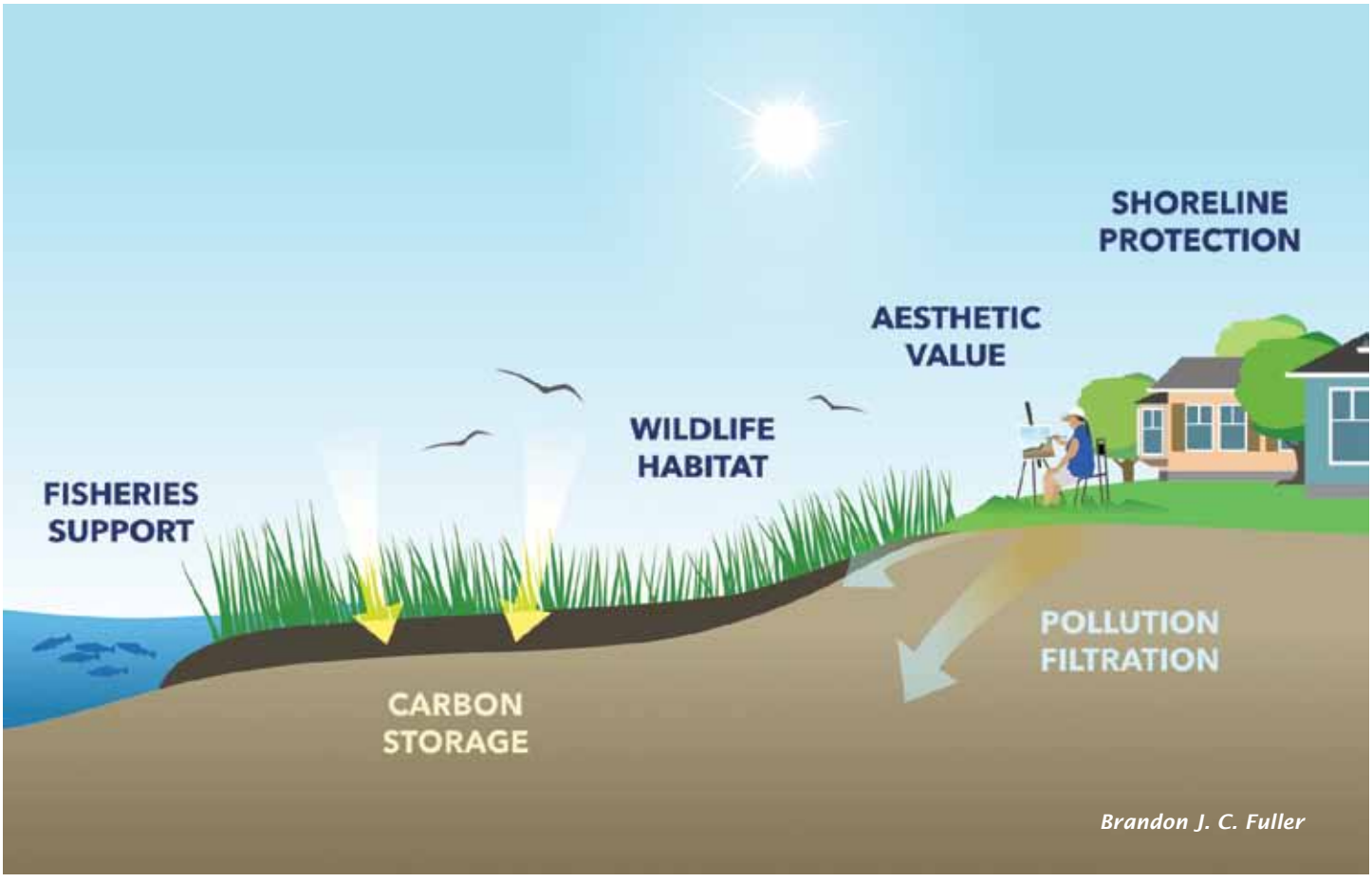
Water quality. Salt marshes remove nitrogen, a nutrient that at high levels can trigger massive algal blooms and subsequent hypoxia (low oxygen), killing hundreds to thousands to millions of fish, such as occurred in Greenwich Bay in summer 2003. As stormwater and groundwater travels from developed areas and through marshes that fringe Narragansett Bay, some of the nitrogen is removed from the water through a process called denitrification, which benefits water quality overall.

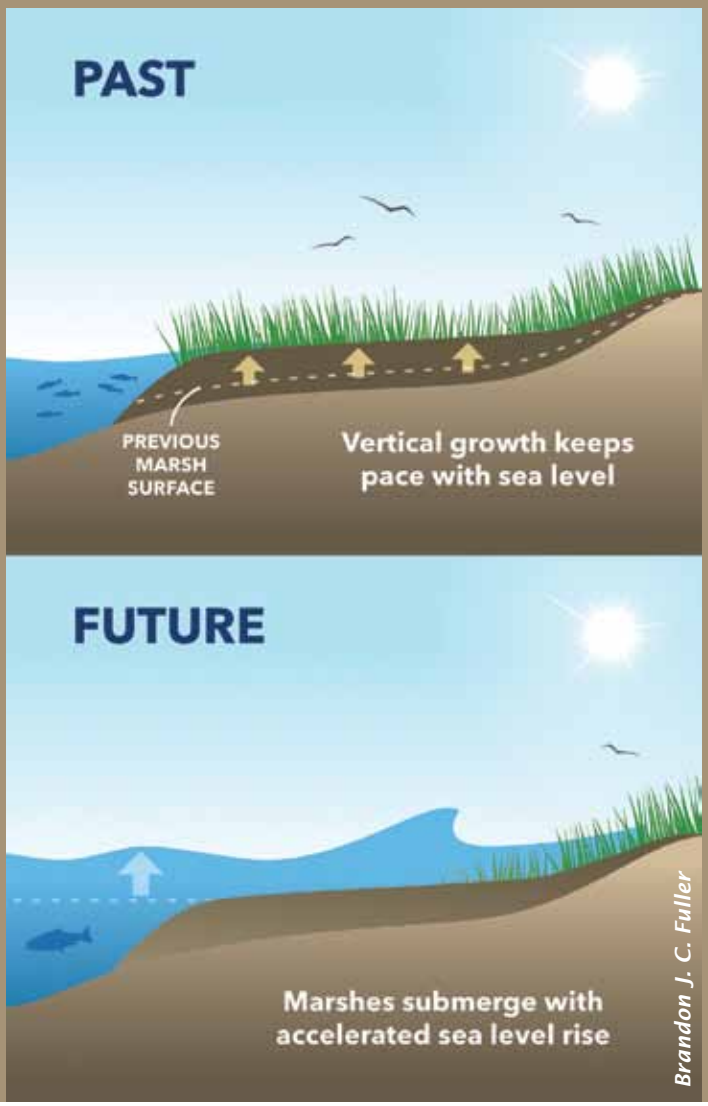
Carbon Storage. Through photosynthesis, salt marsh vegetation takes up carbon dioxide—a major contributor to global warming—and stores much (not all) of this carbon in salt marsh peat. Salt marshes serve a valuable role in storing carbon for hundreds to thousands of years. As wetlands are lost, their role in sequestering and storing greenhouse gases is diminished, countering efforts to decrease carbon emissions.

Changing perceptions, but continuing loss

Since the early 1800s, Narragansett Bay has lost an alarming 53% of its salt marshes. These losses are attributable to a number of factors, the most notable being a history of filling marshes to support industry growth and urban expansion. Consider that portions of downtown Providence were once thriving salt marsh habitat. At that time, the full value of salt marshes was not understood, and consequently these lands were deemed more valuable when filled and stabilized to support factories, warehouses, and housing at the expense of services to the ecosystem.

Since the 1970s, the value of salt marshes was recognized, leading to federal and state legislation that protects the remaining salt marshes from destructive filling activities. Even though filling is now strictly regulated, these valued habitats continue to be threatened. Perhaps the most significant threat confronting our salt marshes today and well into the future is the increasing rate of sea level rise.





Rising to new heights

Salt marshes naturally accommodate increases in sea level through a process called accretion—the buildup of peat to a height that allows the marsh to drain for part of the tidal cycle. As tides and storms flood the salt marsh—a natural and important process—marsh plants trap sediment suspended in the water, which settles to the marsh peat surface. As the plants grow there is accumulation of roots and rhizomes below the marsh surface, combining with sediment settled from the water column, to form more peat. This accretion is virtually unnoticeable on a day-to-day basis, but year-after-year this process builds elevation to support healthy marsh functioning—a process that has been ongoing for thousands of years. But now there is evidence that our southern New England marshes cannot keep up with an increasing rate of sea level rise.

From 1999 to 2015, Narragansett Bay marshes have been increasing in elevation at an average rate of about 1/16 of an inch (less than 2mm per year), or a total of 1-1/8 inch since 1999. The problem is that over this same time interval the rate of sea level rise has been over 3 inches, more than double the elevation increase of many Narragansett Bay marshes. The accelerating rate of sea level rise that we have experienced in the last several decades, which climate change will render even more extreme, outpaces the ability of salt marsh plants to keep their heads above water.

Drowning marshes as sea level rises too fast

Today, some Narragansett Bay marshes are becoming wetter or fully submerged—early signs of losing the battle to keep pace with sea level rise. Smooth cordgrass, found in the low marsh and most tolerant of flooding, is marching inland with the rising waters, invading high marsh plants such as saltmeadow cordgrass, the nesting habitat for the saltmarsh sparrow. Some areas of marshes that once supported lush plant growth are now shallow open water ponds or mudflats. While the shift of these grasses is not necessarily the death knell for marshes, it is an indicator that waters are rising and marshes are struggling to survive.

We know that historic marsh loss was due to filling, but now research reveals that over the past four decades a 17% loss of vegetated marsh has occurred in Rhode Island—260 acres, the equivalent of 196 football fields. Let's look at individual marshes in the state. At Succotash Marsh, which you cross when driving to East Matunuck State Beach in South Kingstown, 41% of vegetated marsh has converted to open water. A 22% loss of fringing marsh has occurred around Hundred Acre Cove along the Wampanoag Trail in Barrington. These recent declines in salt marsh are not unique to Narragansett Bay and coastal Rhode Island; this trend is occurring throughout southern New England, including Cape Cod and Long Island. As marshes drown, we not only lose the plants and the animals that live there, but we lose the economic and community value of the marshes.

Without broad-scale intervention, marshes cannot accommodate accelerating sea level rise. The Sea Level Affecting Marshes Model (SLAMM), a mapping and planning tool developed by the RI Coastal Resources Management Council, suggests that Rhode Island could lose up to 87% of existing marshes under a 5-foot rise in sea level. When compounding stressors are considered—such as nutrient input, hydrologic alterations, and warming temperatures—the sustainability of these iconic coastal features is bleak. Marshes could become a nostalgic memory seen only in museums.

Management options—fielder's choice

Over the next 30 years and beyond, salt marshes will be jeopardized as these lush meadows get wetter and potentially convert to mudflats and open water, leaving narrow fringes of marsh as remnants of broader expanses that once thrived. The most effective solution is to adopt rigorous efforts to curb greenhouse gas emissions on a global scale, thereby decreasing the rise in temperature and dampening the rate of sea level rise. This is not a feasible immediate solution; it requires continued advancement of technological, societal, and political innovation. And, even if emissions were halted today, it could be at least a hundred years for ocean temperatures and sea level rise to change course. So as the global community strives to find a solution, there are actions that are being taken at the local level to help our salt marshes adapt to rising seas.

Build marsh elevation. Rhode Island is experimenting with thin-layer deposition—the addition of sand to the marsh, building up elevation to help keep pace with accelerating sea level rise. The sand comes from clean dredge materials that are removed to maintain navigation channels and breachways, in a beneficial use of dredge materials.

Local efforts are underway at Sachuest Point National Wildlife Refuge in Middletown, John H. Chafee National Wildlife Refuge on the Narrow River, and Ninigret Pond along the south shore, to add up to a foot of sediment to the marsh surface. Marsh plants naturally regrow on the bare sandy sediment, while volunteers do plantings to help speed the process. These are costly projects that require the collaboration of numerous partners, including the US Fish and Wildlife Service, RI Coastal Resources Management Council, RI Department of Environmental Management, the Narragansett Bay National Estuarine Research Reserve, Save The Bay, local towns, contractors, volunteers, and others.

Thin-layer deposition gives the salt marsh a one-time boost and is successful at increasing the life expectancy of the marsh, but it is not a permanent solution. The elevation-enhanced salt marshes will continue to be at the mercy of accelerating sea level rise unless more sediment is periodically added, or another solution introduced.

Protect marsh migration corridors. In addition to building peat, as sea level rises marshes have the natural capacity to migrate landward as new lands are inundated with saltwater and become suitable habitat for marsh plants. Gradual upland slopes are most accommodating to landward marsh migration, however, steep slopes and shore-protection structures (such as bulkheads and road embankments) impede this natural migration. SLAMM identifies corridors where marshes could hypothetically migrate landward under future sea level rise scenarios. Local communities, in concert with land trusts, Save The Bay, The Nature Conservancy, and others, are actively seeking opportunities to preserve these corridors through land acquisition, conservation easements, and other strategies. In addition, it will become increasingly critical to identify shore-protection barriers to marsh migration that have outlived their use, and then recommend removal. As the slope of adjacent upland has allowed, marshes have been migrating landward for millenia, but under a regime of accelerating sea level rise the capacity for landward movement of marshes is not well understood. Additional research and modeling will help us better understand marsh migration to inform management decisions and migration corridor preservation efforts.

Enhance marsh drainage. As marshes get wetter in response to sea level rise, efforts are underway at sites throughout Rhode Island (Narrow River and Prudence Island as examples) to establish shallow channels or runnels to relieve waterlogging. Monitoring is ongoing, but early results are encouraging with marsh plants responding positively to improved drainage.

Time and tides: rising to the occasion

Management agencies, conservation organizations, and research groups throughout Rhode Island and the Narragansett Bay region are working together to address the challenges associated with maintaining our salt marshes; however, the future sustainability of our marshes is uncertain unless global efforts are developed and implemented to reduce greenhouse gas emissions and slow the projected rapid rise in sea level.

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