



BUILDING MARSH CAPITAL

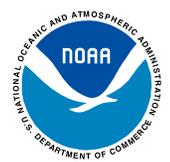
Adding sediment to help marshes face rising seas

The National Estuarine Research Reserve System (NERRS) is advancing the science and practice of thin-layer placement of sediment (TLP) as a strategy to protect tidal marshes threatened by rising seas.

Together with coastal managers from federal and state organizations and nonprofits, the NERRS team developed authoritative guidance documents on the use of TLP for enhancing marsh resilience. These include a consensus statement that advocates the testing of TLP as a restoration strategy across diverse geographies, a guide to navigating the

permitting process, and universal monitoring metrics and guidance to consider when tracking the success of TLP projects.

Eight Research Reserves in three regions also conducted coordinated restoration experiments that tested the use of TLP across diverse marsh plant communities. The team looked at the impact of elevation and sediment type and thickness on the success of this emerging wetland restoration technique. Greenhouse experiments exploring the effect of different sediment types complemented these field studies.



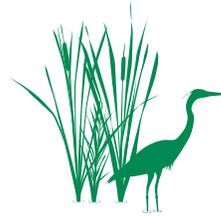
Our nation's marshes are threatened and we need science-based strategies to protect them.

Tidal marshes are valuable natural habitats that provide many benefits. They buffer against storm surge, reduce erosion, fortify upland property, and—together with other wetlands—provide an estimated \$23.2 billion in storm protection annually. Cherished for their beauty, marshes also improve water quality, create habitat for commercially-important fish and wildlife, invite outdoor recreation, and boost local economies in numerous ways.

Accelerated sea level rise poses a significant threat to tidal marshes nationwide. Marshes that can increase their elevation by trapping sediment or building peat may survive in place. Some may have the potential to migrate

to higher ground, but if this migration is blocked by steep slopes or development, the marsh must survive in place or be lost to rising seas.

To protect tidal marshes and their many benefits for future generations, we need innovative, science-based tools and strategies that are flexible enough to meet the needs of wetland managers in different regions of the country.



ACCELERATED SEA LEVEL RISE POSES A SIGNIFICANT THREAT TO TIDAL MARSHES NATIONWIDE.



Degraded marsh,
Elkhorn Slough,
California



Healthy marsh,
Narragansett Bay,
Rhode Island

Thin-layer placement of sediment is an emerging strategy to support marsh resilience.

Thin-layer placement of sediment (TLP) is a strategy to restore or maintain a tidal marsh's elevation relative to sea level.

The approach leverages a marsh's natural capacity to withstand large, storm-driven sediment deposits and the ability of its plants to grow through new sediment or to colonize patches of bare mud and sand. TLP mimics this process through the application of layers of sediment, often dredged material, to the marsh surface.

TLP has been applied in Louisiana for decades, and it is now being tested in different regions of the United States. However, there are few scientific studies on its effectiveness and the factors that influence its success or failure with regard to marsh management goals. (For more insights on TLP developed through this project, see next page.)

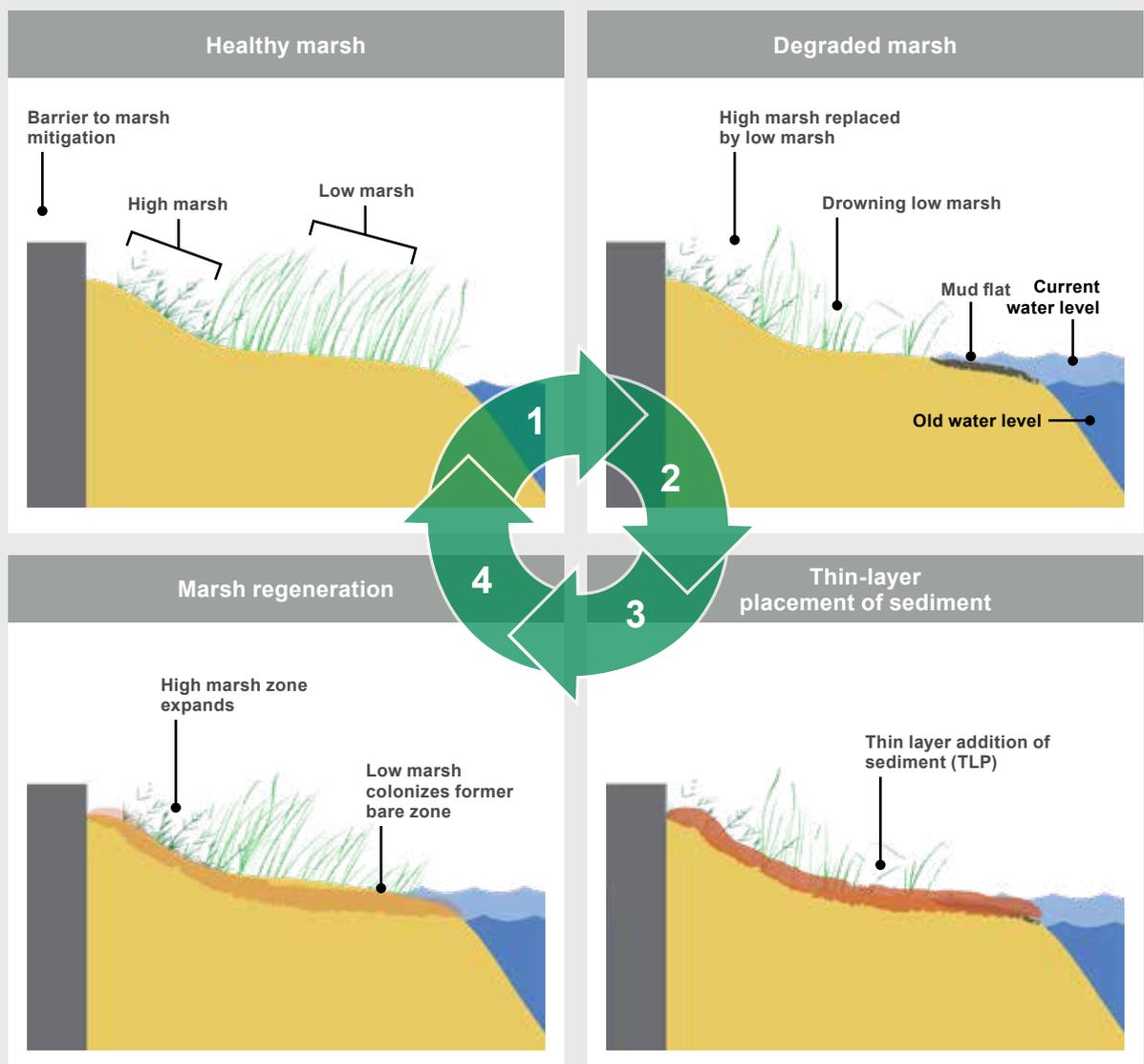
ENHANCING MARSH RESILIENCE THROUGH THIN-LAYER PLACEMENT OF SEDIMENT

1. A healthy marsh is exposed to additional inundation due to sea level rise or land subsidence.

2. In the intertidal zone, high marsh plants are replaced by those typically found in low marsh areas and the low marsh drowns and converts to mudflats.

3. A layer of sediment restores the marsh's vertical elevation relative to sea level.

4. Over time, the high marsh zone expands, low marsh plants recolonize mudflats, and the marsh thrives in place.



Original graphic courtesy of Caravan Lab and LandSea Science.

Recommendations for the use of TLP to support marsh resilience

Together with scientists and coastal managers from federal and state organizations and nonprofits across the United States, the NERRS team developed a series of documents to guide future use of TLP.

In collaboration with nine scientists and managers, the team developed a **Consensus Statement on Thin-Layer Sediment Placement in Tidal Marsh Ecosystems**. This document explores the potential risks and rewards of using TLP to enhance marsh resilience. It identifies TLP as one of only a few broadly applicable climate adaptation strategies to protect marshes in place, and as a result, calls for further restoration research to test its effectiveness across diverse geographies, salinities, and plant communities.

To support future research, the team synthesized **Thin-Layer Placement of Sediment for Tidal Marsh Resilience in the Continental United States**, a literature review on the science and practice of TLP revealed relatively few published studies in the United States. The team assembled these in an accessible table and developed three case studies that explore the use of TLP and its challenges in greater depth.

In **Recommended Monitoring for Thin-Layer Sediment Placement Projects in Tidal Marshes**, the team lays out guidelines for monitoring the success of TLP projects in diverse marshes anywhere in the world. It offers suggestions for setting quantifiable objectives for success, whether they relate to reversing degradation or enhancing ecosystem services. The document also identifies universal metrics to assess restoration success and recommends that project teams compare restoration areas to degraded control sites and high quality reference marshes.

To succeed, a TLP project requires strong, communicative relationships among land managers, permittees, funders, scientists, and community members. This is particularly critical during permitting—a long, complicated process that necessitates the coordination of diverse organizations working at different scales. In their **Guide to Navigating the Permitting Process for Thin-layer Sediment Placement Projects in Tidal Marshes**, the team recommends a flexible sequence for working through the TLP permitting process.



Photo courtesy Luciane Coletti.

NERRS research addresses key questions about TLP.

Eight National Estuarine Research Reserve (NERR) sites on the U.S. Atlantic and Pacific coasts collaborated to examine the effectiveness of TLP as a climate adaptation strategy for marshes at risk from sea level rise.

The team conducted plot-scale studies to evaluate the impact of TLP at different elevations across the marsh landscape at each Reserve. They tested the use of different thicknesses and compositions of sediment. At three Reserves, they also looked at the addition of biochar—plant-based charcoal—to improve soil and plant health.

Thus far, they have found that the impacts of TLP differ greatly across sites with some commonalities. At each site, the addition of sediment raised marsh elevation, increased sandiness, and affected soil conditions such as acidity, moisture, and oxygen levels. Vegetation recovered quickly at most sites, with plants surviving the thinner and thicker sediment addition treatments.

At low elevations, the goal of increasing cover in drowning marshes was achieved. Conversely, at high elevations, the objective of increasing cover by rarer, high marsh plants generally was not met. Biochar had a positive effect on vegetation at some sites, but not all, indicating the need for future research. An unexpected finding was that crabs burrowed more in sediment addition plots than in control plots—especially in low marsh areas. Complementary greenhouse experiments conducted by Drexel University revealed that differences in sediment can affect the outcomes of TLP.



THE ADDITION OF SEDIMENT RAISED MARSH ELEVATION, INCREASED SANDINESS, AND AFFECTED SOIL CONDITIONS SUCH AS ACIDITY AND MOISTURE.

The National Estuarine Research Reserve System: a platform for comparative research on marsh resilience

The National Estuarine Research Reserve System (NERRS) collects and shares timely environmental data on how estuarine habitats respond to a changing climate. This capacity for long-term monitoring across a national system allows Reserves to function as sentinel sites that can provide early warning signals to inform climate change adaptation and other management strategies.

It also makes Reserves ideal living laboratories for testing innovative approaches to marsh conservation and restoration—at one site or across a range of diverse tidal marshes.

As a system, the NERRS offers a rare national platform to conduct coordinated restoration experiments that apply statistical models and analyses across sites and over extended monitoring periods. While this capacity is critical to understanding trends in coastal and environmental conditions, it is extremely rare in the field of wetland restoration science.

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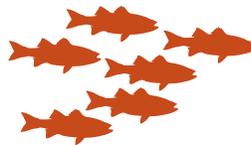
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NERRS collaborative research: local science with a national impact

This research was made possible by sustained congressional investment in the NERRS approach to collaborative science. By engaging local communities in the research process, NERRS collaborative research directly address their needs while advancing estuarine science. Through a national network dedicated to sharing tools and knowledge, local research conducted at one Reserve strengthens all 29 sites and the communities they serve, leaving them better prepared to manage our changing coasts.

More information about the NERRS approach to collaborative science is available from the project sponsor, the NERRS Science Collaborative, which is funded by NOAA and managed by the University of Michigan Water Center: nerrssciencecollaborative.org



ABOUT THE NATIONAL ESTUARINE RESEARCH RESERVE SYSTEM

Established in 1972, the National Estuarine Research Reserve System is a network of 29 special places in 24 coastal states and territories. Each Reserve is a partnership between the National Oceanic and Atmospheric Administration (NOAA) and a U.S. state or territory. NOAA provides funding and national guidance, and Reserve-based monitoring, research, education, stewardship, and training programs provide information and services that communities need to protect people and property along the coasts. Learn more at coast.noaa.gov/nerrs

The National Estuarine Research Reserve Association (NERRA) works to strengthen the Reserve network so it can better address growing challenges to our nation's estuaries, coasts, and communities. Learn what you can do to support your local Reserve at nerra.org

THE NATIONAL ESTUARINE RESEARCH RESERVE SYSTEM

