

MARSHES FOR TOMORROW

A Landscape-Scale Restoration and Resiliency Plan for Maryland's Salt Marshes

David R. Curson, Henrietta A. Bellman, Brittany Panos, Zachary A. Posnik, Amanda M. Long

Audubon

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We hope this report serves as a meaningful contribution to the conservation and restoration of Maryland's salt marshes, and we remain inspired by the collective effort it represents.

EXECUTIVE SUMMARY

Maryland's salt and brackish tidal marshes cover approximately 69,606 ha (172,000 ac)[1] and constitute a unique and seemingly timeless environment at the interface of land and sea. Salt marsh is one of the most biologically productive ecosystems on Earth and is home to abundant and diverse wildlife. Salt marshes offer enormous value to society via an array of "ecosystem services." These include the following:

- Nurseries for commercially important fish species
- Community resilience and storm surge protection
- Water filtration to reduce nutrient pollution
- Outdoor recreation benefits to the local economy

Together, these services contribute millions of dollars to Maryland's economy and the well-being of its residents. In addition, salt marshes sequester carbon in the form of peat from decaying plant material, an increasingly important function in the face of climate change.

Unfortunately, Maryland's celebrated marsh landscapes are rapidly changing as climate-driven sea level rise (SLR) subjects them to increasing tidal flooding, elevation collapse, and erosion. Computer models predict that many of today's marshes will have submerged and eroded by the end of this century. Of particular concern is the high marsh zone, which is located above the reach of daily tides and provides nesting habitat for specialized bird species like the Saltmarsh Sparrow. This species breeds only in this habitat and is at risk of extinction in less than 30 years due to increased flooding of its nesting sites. Over the past decade, a number of marsh restoration projects have been completed in Maryland. However, in order to save a significant portion of the salt marsh ecosystem over the long term, restoration efforts will need to be implemented at a much larger scale and targeted strategically at the most suitable and feasible marsh sites.

MARSHES FOR TOMORROW | MEETING THE CHALLENGE

The Marshes for Tomorrow initiative was conceived in response to the issue of salt marsh loss in Maryland. Concerned about the rapid decline of Saltmarsh Sparrow populations, the U.S. Fish and Wildlife Service provided funding to Audubon to create a landscape-scale restoration plan for Chesapeake Bay salt marshes. The hope was that this bird species could inspire a strategy that could save the entire salt marsh ecosystem or at least a significant portion of it. Marshes for Tomorrow was established as a project of the Delmarva Restoration and Conservation Network (DRCN), a diverse coalition of conservation partners. A grant from the National Fish and Wildlife Foundation expanded the geographic scope of the initiative to include the Maryland Coastal Bays.

The overall goal of the Marshes for Tomorrow initiative is to create an implementation plan for salt marsh restoration on a landscape scale in Maryland.

The initiative aims to maintain a resilient and balanced salt marsh ecosystem by slowing and, where possible, reversing the conversion of high marsh to low marsh under the influence of sea level rise.

The Marshes for Tomorrow initiative's objectives include:

1. Identify at least 10,117 ha (25,000 ac) of salt marsh to be maintained long-term to conserve the high marsh ecosystem and the Saltmarsh Sparrow in Maryland despite the threats of sea level rise.
2. Determine a schedule of spatially explicit restoration actions for the priority marshes identified under Objective 1 that will maintain this acreage as high marsh over the long term.
3. Create conceptual conservation strategies at the local/county level that incorporate the restoration schedules of Objective 2 and that have the broad support of local communities.

A COLLABORATIVE APPROACH

The Marshes for Tomorrow project team opted for a broadly collaborative process, consulting a wide array of partners and stakeholders, including staff from government agencies, nonprofit organizations, academic researchers, and consultants. Project teams were established to accomplish different spheres of work within the initiative. Three distinct teams were created, including the:

- Core Analysis Team, tasked with developing models to accurately assess and prioritize marshes for restoration;
- Community Engagement Team, responsible for developing meaningful relationships, expanding participation, and gathering critical feedback; and
- Policy and Communications Team, aimed at crafting strategies to make compelling cases to legislators, funders, and partners in preparation for implementing the Marshes for Tomorrow plan.

Additional partners and stakeholders were invited to a series of workshops and focus groups in 2024, during which participants reviewed model outputs, developed methods for prioritizing marshes, and recommended appropriate restoration strategies.

In all, more than 100 people were consulted and briefed during the Marshes for Tomorrow planning process.

The Marshes for Tomorrow project team participated in parallel marsh planning efforts led by other agencies. These included Maryland's Wetland Adaptation Strategy, which is currently being developed by the Maryland Department of the Environment and the Maryland Department of Natural Resources (DNR), and the Tidal Wetlands Strategic Plan for the Chesapeake Bay Watershed, being developed by the Chesapeake Bay Trust. The Marshes for Tomorrow plan may most appropriately represent a high marsh restoration module of these broader plans.

ENGAGING LOCAL COMMUNITIES

Marshes for Tomorrow made the engagement of local communities a central feature of its planning process. Like the marshes, local communities are already being impacted by sea level rise, and they will increasingly feel the consequences of rising tides as the effects of climate change accelerate. The Community Engagement Team built awareness of the Marshes for Tomorrow initiative and provided opportunities for two-way communications with local communities about marshes and marsh

restoration. At community meetings, the project team shared draft marsh prioritization maps and restoration strategies, and welcomed feedback from attendees.

The project team also met with Indigenous leaders, local landowners, and municipal officials. We intend to continue to build relationships with landowners and local communities as restoration planning moves toward implementation.

INNOVATIVE SPATIAL ANALYSES

Spatial models were developed to identify the most suitable marshes for maintenance over the long term, and to determine what types of restoration are likely needed at each location.

The Marsh Condition Model provides a landscape-scale assessment of the ecological and geomorphic condition of the marshes and their level of resilience to sea level rise. **The primary purpose of the model is to inform the marsh prioritization process by showing where the more resilient and healthy marshes are.** It combines the two most important factors influencing the current condition and future resilience of the marsh — 1) marsh elevation in relation to tides and 2) marsh health — into a single spatial layer, representing a Marsh Condition Index.

The team used the Marsh Condition Model, along with a number of additional factors, to identify **Priority Marsh Areas (PMAs)** for long-term maintenance through restoration. These represent

- the highest-quality habitat for the Saltmarsh Sparrow,
- the areas most resilient to future sea level rise, and
- the most feasible places for implementing restoration projects.

A total of 11,792 ha (29,140 ac) of PMAs were identified and mapped across four focal areas in Dorchester, Somerset, and Worcester counties.

The majority of these PMAs are still in a healthy condition, but restoration is already needed at a number of locations to improve the health and resilience of the marsh. To determine which areas require restoration and which restoration practices are needed, Marshes for Tomorrow developed a Restoration Decision Model, which focuses on the role of marsh elevation in relation to tides and marsh health. The model provides a quantitative, geomorphic assessment, at the marsh unit scale, of restoration actions likely to be needed to restore and maintain high marsh as habitat for the Saltmarsh Sparrow.

Over the next decade (2025-2035), the restoration of hydrology, using practices such as runneling and ditch remediation, should be implemented on 4,295 ha (10,613 ac) of marsh units identified by the Restoration Decision Model. This is likely to require approximately 140 different projects over the decade and cost more than $26.5 million.

During the same time period (2025-2035), the restoration of subsided marsh, using sediment placement, should be implemented on 2,998 ha (7,409 ac) of marsh units identified by the Restoration Decision Model. This is likely to require approximately 100 different projects over the decade and to cost between $200 million and $675 million.

Considering the high cost and logistical constraints of sediment placement, it will be wise to implement low-tech, low-cost hydrological practices over the next decade, to 2035, in a timely fashion to slow the rate at which marshes lose elevation due to interior pond expansion. This points to a time-sequenced strategy beginning with the widespread use of hydrological techniques and followed by sediment placement as it becomes necessary.

STRATEGIES FOR MARSH RESTORATION

Section 8 of this report outlines recommended strategies for restoring and maintaining the marshes in the PMAs. These are organized by focal area and include spatially explicit recommendations for restoration strategies in the two major categories of hydrological repair and sediment placement, according to the Restoration Decision Model. These restoration actions are assigned priority levels to provide a recommended sequence for implementation.

The restoration strategies are intended to be implemented immediately, with a rapid increase in the number of projects in each of the four focal areas. As individual projects are planned and implemented, practitioners should follow the recommendations offered in the introduction to Section 8, which are based on restoration principles and best practices developed recently by the restoration community. In addition to the static maps presented in this report, the Marshes for Tomorrow ArcGIS Experience Builder is publicly available as a tool for exploring the spatial data used to create the models and additional data layers.

TOWARD IMPLEMENTATION

Implementing this plan will require the collaboration of a broad network of partner organizations, many of which are already working together effectively on marsh restoration in Maryland through coalitions, including the DRCN and the Maryland Coastal Restoration Alliance. New restoration projects will need to be implemented on both private and public lands, requiring sustained outreach to private landowners and government agencies. One critical agency partner is the Maryland DNR, which is the largest marsh landowner in the geographic footprint of the Marshes for Tomorrow initiative, owning approximately half of the total acreage of the PMAs.

Restoration of marshes at the scale recommended by this plan cannot be achieved without broad public support and the commitment of significant resources. To spur implementation of the Marshes for Tomorrow plan, Audubon has produced a companion summary document "Marshes for Tomorrow: Responding to Maryland's Tidal Salt Marsh Crisis", which includes a policy and funding toolkit.

Marsh restoration costs are highly variable, making it difficult to estimate costs over large geographical areas and on a decades-long timescale. However, we can be confident that the most cost-effective approach, if we wish to save the marshes prioritized in this plan, is to take action soon while lower-cost, hydrology-based restoration methods can still be effective. These methods can buy time, by maintaining the health and elevation of the marsh, thus extending the period before sediment placement, a far more expensive technique, is needed to restore marsh elevation.

The Marshes for Tomorrow initiative represents a critical step in safeguarding Maryland's salt marshes. By prioritizing restoration, implementing effective strategies, and fostering partnerships, we can protect these valuable resources for future generations. This comprehensive approach seeks to preserve Maryland's high marsh ecosystem, maintain biodiversity, and support community resilience against climate change.

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Section One: Introduction

At a Glance

- Maryland's salt marshes are globally significant, supporting unique biodiversity and vital ecosystem services, including storm protection, water filtration, carbon sequestration, and economic value through commercial fisheries and recreation.
- Salt marshes in Maryland are threatened by climate-driven sea level rise, which is resulting in increased tidal flooding of salt marshes and is predicted to drown many of today's marshes as rates of sea level rise accelerate over future decades.
- Maryland's marshes are especially vulnerable due to land subsidence and regional ocean circulation patterns, resulting in faster sea level rise than the global average.

Maryland's salt and brackish tidal marshes (hereafter "salt marshes") cover approximately 69,606 ha (172,000 ac)[1] and constitute a unique and seemingly timeless environment at the interface of land and sea. The majority of the state's salt marshes occur as extensive marsh landscapes on the Lower Eastern Shore of the Chesapeake Bay and the Maryland Coastal Bays on the Atlantic coast. One of these landscapes, covering Blackwater National Wildlife Refuge (NWR) and Fishing Bay in Dorchester County, is one of the largest contiguous salt marsh blocks in the northeastern United States.[2]

Salt marshes are one of the most biologically productive ecosystems on Earth.[3] Considered globally rare, salt marshes make up approximately 53,000-55,000 km^2 (20,463-21,235 mi^2) worldwide[4,5] and, in Maryland, support an abundance and diversity of fish and shellfish, invertebrates, waterfowl, and several bird species found in no other habitat type.[6]

Beyond their biodiversity value, salt marshes offer enormous value to society via an array of "ecosystem services." These include the following:

- **Nurseries for Commercially Important Fish Species |** Commercial fishing in the Chesapeake Bay, including the key species of blue crab, striped bass, and menhaden, contributed $1.8 billion, in 2012, in direct sales to the Maryland economy.[7]
- **Community Resilience & Storm Surge Protection |** Forests and wetlands in Dorchester, Somerset, and Worcester counties provide more than $600 million in ecosystem services that help to reduce flooding.[7] Additionally, the unique vegetation structure of salt marshes in the Chesapeake Bay region has the capacity to reduce the energy and destructiveness of storm surges that have intensified due to climate change, thus helping to decrease property loss.[8]
- **Water Filtration to Reduce Nutrient Pollution |** Wetlands and forests help to absorb and store excess nutrients from stormwater runoff, thereby reducing dead zones and improving water

quality. Statewide, this results in a benefit of $402.6 million per year, with Dorchester and Somerset counties having the highest totals and per-acre values due to the abundance of tidal wetlands.[7]

- **Outdoor Recreation Benefits to the Local Economy |** Across the state, outdoor recreation, including the fishing, birding, and photography enthusiasts who visit the Chesapeake Bay and Maryland Coastal Bays regions, generate $14 billion of consumer spending. As of 2016, the outdoor recreation industry provided 109,000 jobs, $4.4 billion in wages and salaries, and $951 million in state and local taxes.[7]

Together, these services contribute billions of dollars to Maryland's economy and the well-being of its residents. In addition, salt marshes sequester carbon in the form of peat from decaying plant material. This process, and the vast resulting store of "blue carbon" locked away beneath our marshes, is a beneficial tool in the effort to lower carbon emissions. Any loss in marshes results in increased carbon emissions from the mobilization of peat into the water column.

STUDY AREA OVERVIEW

Conservation Need

Maryland's salt marshes have faced a number of anthropogenic alterations, resulting in the loss and degradation of marsh. Historically, thousands of acres were drained and converted for agriculture and development. Throughout the Maryland Coastal Bays region and in some Chesapeake Bay marshes, grid-ditching — a process intended to alter hydrological flow and used as a mosquito control method— in the 20th century has lowered the elevation of marshes, making them more vulnerable to sea level rise (SLR).

Animals have also caused damage to the marshes. In Dorchester County, another major contributor to salt marsh degradation was herbivory by nutria (*Myocastor coypus*), an invasive South American rodent unintentionally introduced from a fur farm. Nutria became abundant through the 20th century, and their herbivory destroyed the root mat of marsh plants, causing large areas of vegetated marsh to convert to unconsolidated mudflats and ponds. Thanks to a federally funded nutria eradication campaign, started in the 1990s, led by the U.S. Fish and Wildlife Service (USFWS), and implemented by the U.S. Department of Agriculture's Animal and Plant Health Inspection Service, nutria are now absent from Maryland's marshes.[9] On Assateague Island, grazing by wild horses has had an adverse impact on salt marshes by altering the vegetation structure of the high marsh and reducing its suitability as nesting habitat for birds, including the Saltmarsh Sparrow *(Ammospiza caudacuta).*[13] In the Maryland Coastal Bays marshes, winter grazing by Snow Geese causes localized damage to marsh vegetation and has led to complete vegetation dieback in some marshes.[14,15]

In addition, invasive plants threaten salt marsh habitat. The most widespread of these is *Phragmites australis*, an introduced form of *Phragmites*, also referred to as the common reed. In many Maryland marshes, *P. australis* occupies the upland boundary and the forest-marsh transition zone, in places forming extensive monocultures. These large stands can persist as the marsh ecosystem migrates upslope under the influence of SLR, thus preempting the establishment of native salt marsh habitat in marsh migration corridors. However, *P. australis* is not currently a major problem in Maryland's more extensive, long-established salt marshes.[2]

Today, the greatest threat to Maryland's salt marshes is accelerating sea level rise driven by climate change, and scientific projections of sea level trends predict a very uncertain future for this ecosystem. For thousands of years, salt marshes in the mid-Atlantic region maintained a balance with slowly rising sea levels as the land surface subsided due to long-term geological processes. They did so by building vertically on accumulated plant remains and trapped sediments, a process known as accretion. Now, in many marshes, this vertical accretion is unable to keep pace with rapidly rising mean sea level.

Finally, rates of sea level rise are accelerating across the globe, including in Maryland, due to the warming trend of climate change, which is causing the thermal expansion of the world's oceans. During the 20th century, sea level in Maryland rose 0.3m.[13] SLR projections for Maryland are revised periodically by the Sea Level Rise Expert Group of the Maryland Commission for Climate Change.[13,14] Under the group's Current Commitments scenario, the best estimate of relative SLR in Maryland this century is 0.8 m, and sea level will likely rise between 0.6m and 1.1m.[13]

Sea level rise has already impacted Maryland's fragile salt marshes. In the Blackwater River system of Dorchester County, rates of interior ponding continue to increase each year, even after the eradication of nutria, and vestigial high marsh continues to transition to low marsh or open water. By the early 21st century, studies at Blackwater National Wildlife Refuge (NWR) indicated that the vertical development of the marsh surface, either through accretion or the accumulation of belowground biomass, was not keeping pace with rates of relative SLR.[15] Similar trends in marsh deterioration are being observed in many places in the Chesapeake Bay, including the Deal Island peninsula and the marshes of Pocomoke Sound. It is significant to note that in most of the larger marsh landscapes on Maryland's Lower Eastern Shore, the principal mechanism of marsh loss is vegetation dieback and ponding in the marsh interior rather than shoreline erosion.

Since 2010, one factor accelerating these trends is the regional acceleration in sea level rise caused by a slowdown of oceanic currents in what's known as the Atlantic Meridional Overturning Circulation system.[16] The current system includes the Gulf Stream, which lies about 200 miles offshore of Worcester County.

As sea levels continue to rise into the future, the distribution and extent of salt marshes will change over time, continuing the trends already occurring in Maryland. Many areas of low marsh are likely to convert to mudflats and open water, and areas of high marsh will likely transition to low marsh, flooded daily by tides. As the influence of tidal flooding extends farther upslope and inland, upland habitats such as forests and farm fields could potentially become salt marsh. Upslope migration of marshes into forested landscapes is now occurring in many locations on Maryland's Lower Eastern Shore, a harbinger for landowners farther inland.

Faster Pace of Marsh Loss in Maryland

Salt marsh in Maryland is more vulnerable to SLR than marshes in many other coastal regions of North America. This is because SLR in Maryland is occurring faster than the global average due to regional land subsidence and patterns of ocean circulation in the North Atlantic Ocean and the Gulf Stream off the mid-Atlantic coast in particular.[13] Historically, regional land subsidence, which is due largely to long-term geological processes, has accounted for 1.5mm (0.05 in) of relative SLR annually.[17] This constitutes 32% of the current annual rate of 4.7mm (0.2 in) of SLR.[13] Beyond the effects of land subsidence, SLR in Baltimore is projected to be 17% greater than the global average in 2100 due to ocean dynamic processes.[13]

The Sea Level Affecting Marshes Model (SLAMM) has been used to project the impacts of SLR on salt marsh distribution and extent into the future. The most recent version of SLAMM[18] predicts a variety of future trends for marsh extent depending on the SLR scenario used (Figure 1). However, all of these scenarios predict an accelerating decline in the extent of high marsh over the current century. The scenario used by the state of Maryland in its most recent wetland adaptation planning predicts the loss of more than a third of today's high marsh by 2050 and virtually all of it by 2100. Actual rates of loss of high marsh will almost certainly exceed these projections because SLAMM does not account for vegetation dieback and ponding in the marsh interior due to biogeochemical processes, which is the prevailing mechanism of high marsh loss in many of Maryland's marshes today. Thus, in many locations, high marsh is converting directly to open water, rather than to low marsh as an intermediate stage.

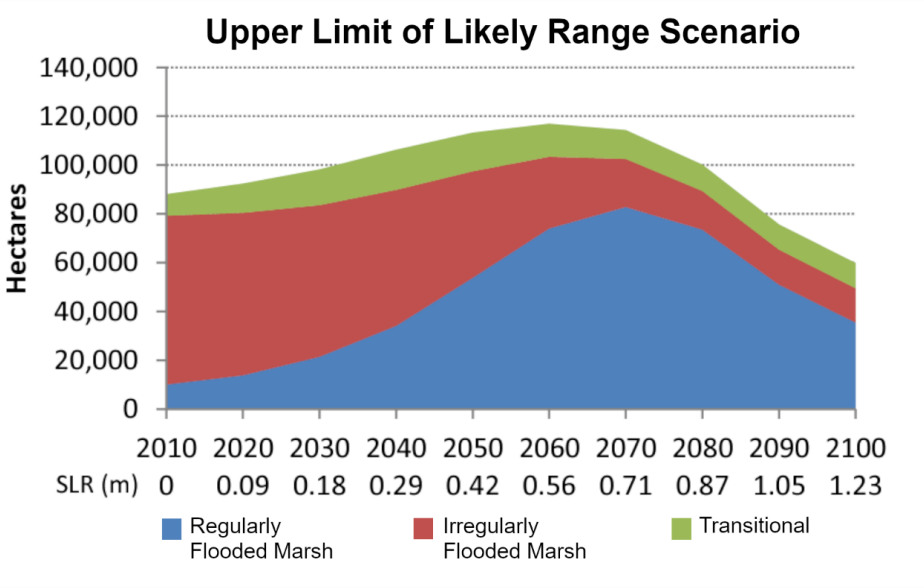


Figure 1. Marsh area graph showing total marsh area and types predicted under the "Upper Limit of Likely Range" SLR scenario. Reproduced from The Nature Conservancy, 2021.[18] Data were produced by Warren Pinnacle Consulting, Inc. under contract with The Nature Conservancy, with funding provided by NOAA's Ecological Effects of Sea Level Rise Program (award NA19- NOS4780179).

It is clear that if no action is taken to slow these trends in marsh loss, the vast salt marsh landscapes of Maryland's Lower Eastern Shore will be irreversibly changed in coming decades. Over the past 15 years, a number of restoration projects in Maryland have piloted techniques to restore subsiding marsh to a high marsh condition (see details in Section 7). However, restoration efforts will need to be rapidly scaled up to save a significant, functioning portion of the high marsh ecosystem.

Section Two: Marshes for Tomorrow

At a Glance

- Marshes for Tomorrow (MfT) is an initiative led by Audubon and funded by the U.S. Fish and Wildlife Service and the National Fish and Wildlife Foundation, with the overall goal of creating and implementing a plan for salt marsh restoration at a landscape scale in Maryland.
- The main objectives of the MfT plan are to identify at least 10,117 ha (25,000 ac) of marsh to maintain in the long term as high marsh habitat for the imperiled Saltmarsh Sparrow (*Ammospiza caudacuta*), and to determine which restoration actions are needed in each location to achieve this objective.
- The MfT planning process was designed to be broadly collaborative and to include many environmental agencies, universities, and NGOs as well as local communities.
- The MfT plan, with its focus on the high marsh zone, is intended to serve as a high marsh restoration module of more comprehensive wetland adaptation plans currently being developed by state and regional agencies.

PURPOSE AND INSTITUTIONAL BACKGROUND

The Saltmarsh Sparrow is listed in Audubon's Flight Plan as one of the 188 species used to indicate the impact of Audubon's conservation actions. The Marshes for Tomorrow (MfT) initiative was conceived after Audubon and its partners identified the need for a spatially explicit implementation plan of habitat restoration priorities to rapidly scale restoration in service to the imperiled Saltmarsh Sparrow in Maryland.

MfT is an initiative of the Delmarva Restoration and Conservation Network (DRCN). Leveraging an extensive network of partner organizations, the DRCN's mission is "to restore and conserve Delmarva's landscapes, waterways, and shorelines that are special to its people, fundamental to its economy, and vital for its native fish, wildlife, and plants." MfT is coordinated by the DRCN's Restoration and Resiliency Operating Committee.

The U.S. Fish and Wildlife Service's Ecological Services Program provided initial funding in 2022 for the MfT initiative through a cooperative agreement for Audubon to lead the planning effort. A grant from the National Fish and Wildlife Foundation's National Coastal Resilience Fund provided additional funding for the initiative.

A FOCUS ON HIGH MARSH

MfT focuses on conservation within the high marsh zone to support breeding Saltmarsh Sparrows. Salt marshes can be divided into two zones: the low marsh and the high marsh (Figure 2). Low marsh is characterized by regular tidal inundation, typically twice daily. High marsh lies above the reach of daily tidal flooding and floods only occasionally. Saltmarsh Sparrows breed almost exclusively in the high marsh zone.

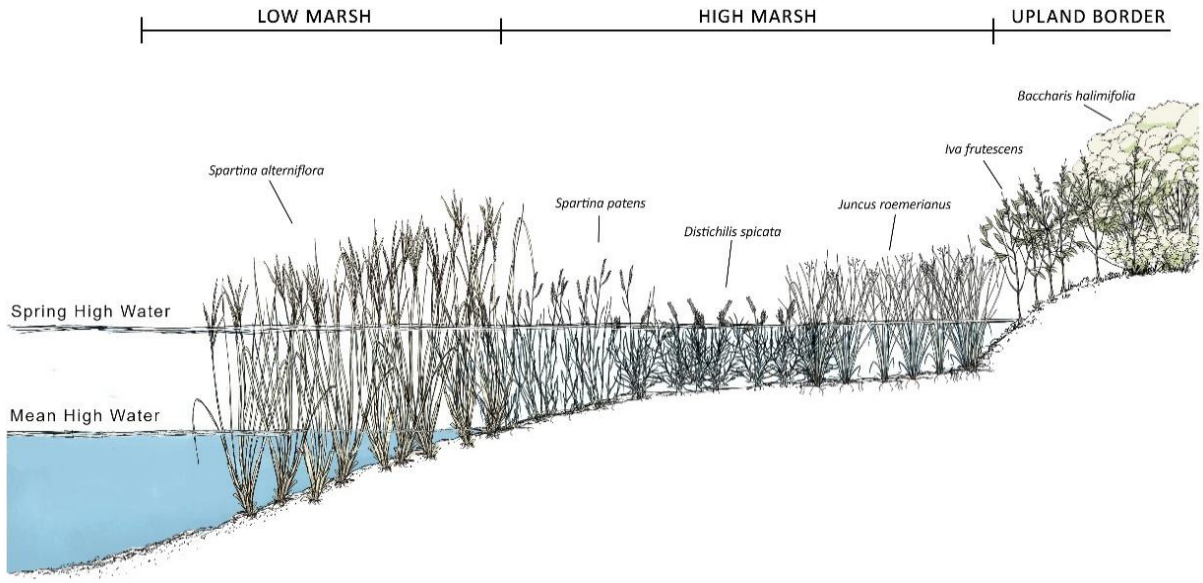


Figure 2. Schematic of salt marsh zones.

By focusing on the conservation of high marsh, MfT recognizes the unique urgency of the threat that rising sea levels pose to this particular salt marsh zone. The Atlantic Coast Joint Venture's (ACJV) Salt Marsh Bird Conservation Plan[19] states: "Within salt marshes, it is the higher-elevation marsh habitat that is facing the most serious and imminent threat, and it is expected to be the most difficult to sustain in the face of sea level rise." In contrast, projections from the Sea Level Affecting Marshes Model (SLAMM) predict that the extent of low marsh in Maryland will increase over coming decades as high marsh converts to low marsh.[18]

MfT is not intended to represent a comprehensive strategy for the entire salt marsh ecosystem in Maryland; rather, it is designed to yield a plan for spatially explicit restoration actions to guide the rapid scaling up of restoration for the most imminently threatened zone of salt marsh. Other planning initiatives for tidal wetlands that are currently being developed are more comprehensive in scope, and the MfT initiative may be best considered as representing a high marsh restoration module of these broader plans.

GOALS AND OBJECTIVES

The overall goal of the MfT initiative is to create an implementation plan for salt marsh restoration on a landscape scale in Maryland.

The implementation plan's objectives include:

1. Identify at least 10,117 ha (25,000 acres) of salt marsh to be maintained in the long term to conserve the high marsh ecosystem and the Saltmarsh Sparrow in Maryland despite the threats of sea level rise (SLR).
2. Determine a schedule of spatially explicit restoration actions for the priority marshes identified under Objective 1 that will maintain this acreage as high marsh over the long term.
3. Create conceptual conservation strategies at the local/county level that incorporate the restoration schedules of Objective 2 and have the broad approval of local communities.

The MfT initiative aims to maintain a resilient and balanced salt marsh ecosystem by slowing and, where necessary, reversing the conversion of high marsh to low marsh under the influence of SLR. This is the first time an acreage target has been set for the conservation of salt marsh in the state. The Saltmarsh Sparrow is an appropriate species on which to base the marsh restoration goal because it is a good ecological indicator of the habitat quality of high marsh and provides a biologically meaningful numerical target for marsh restoration.

The initiative's objectives build on the conservation objectives of the ACJV's Salt Marsh Bird Conservation Plan[19] and Saltmarsh Sparrow Conservation Plan,[20,21] released in 2019 and 2020, respectively. Those plans set a long-term population goal of 6,302 Saltmarsh Sparrows in Maryland and a long-term habitat goal of 10,030 ha (24,785 ac) of high marsh habitat to sustain this population. Thus, the MfT target of 10,117 ha (25,000 ac) should be sufficient, if maintained and managed appropriately, to ensure the long-term viability of Saltmarsh Sparrow in Maryland. The MfT plan aims to maintain existing high marsh habitat rather than facilitating upslope marsh migration, which is also included as a recommendation by the ACJV plans.[19,20,21] Although there is a significant extent of potential marsh migration corridor in the Chesapeake Bay, as determined by topography,[22] very few of these areas are transitioning effectively to well-functioning high salt marsh. In many places, the transition process is compromised by three factors:

1. The prevalence of large stands of invasive *Phragmites*,
2. the absence of functioning salt marsh hydrology, and
3. the collapse of the ground surface as trees die and the consequent formation of shallow basin topography, leading to ponding and loss of newly established marsh.[2]

Management techniques for overcoming these challenges are still in their infancy and must be developed. Currently, it is very difficult to estimate what proportion of potential migration corridors can be converted into functioning high marsh and thus be available as future habitat for high marsh-dependent species.

The ACJV salt marsh conservation plans[19,20] included a number of conservation strategies for salt marsh habitat, including restoration and enhancement of degraded salt marsh. The MfT initiative expands on the restoration strategies in the ACJV plans by mapping priority marshes for restoration action and making spatially explicit recommendations of the types of restoration needed in each marsh

area. In Maryland, a focus on restoration actions is essential for maintaining healthy high marsh habitat and Saltmarsh Sparrow populations into the future.

PROJECT EXTENT

The geographic scope of the plan is approximately 27,114 ha (67,000 ac) of salt marsh, which were mapped in the ACJV Salt Marsh Restoration Priorities of the Saltmarsh Sparrow.[20] These cover five distinct geographic areas across Maryland's Lower Eastern Shore. MfT adopted these as "focal areas" for the initiative (Figure 3). These focal areas are:

1. Blackwater-Fishing Bay marshes, Dorchester County
2. Deal Island Peninsula, Somerset County
3. Fairmount, Somerset County
4. Pocomoke Sound, Somerset County
5. Maryland Coastal Bays, Worcester County

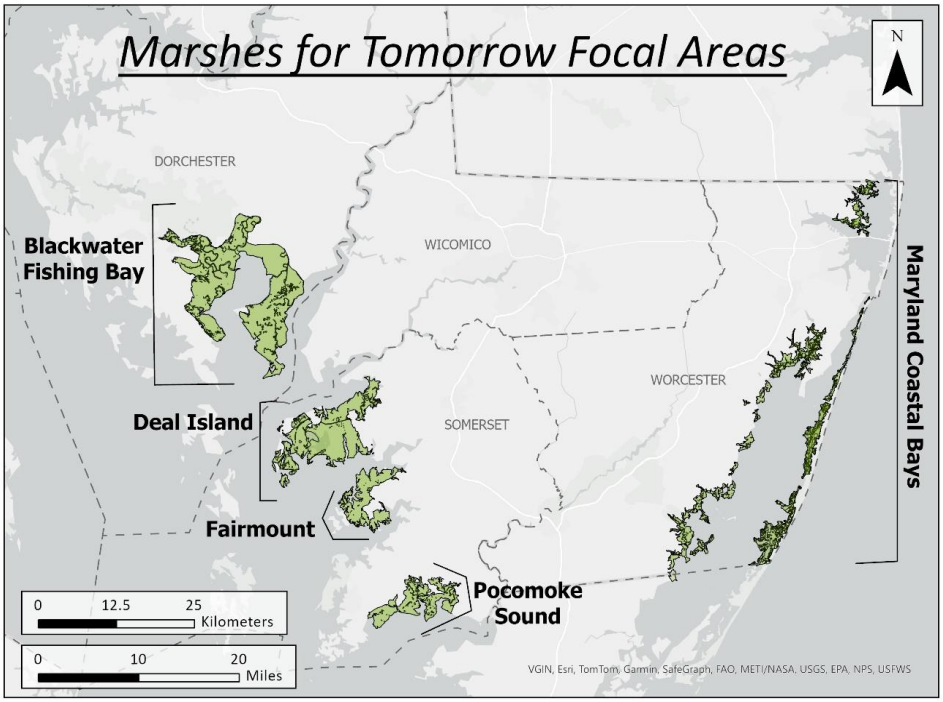
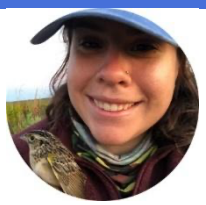


Figure 3. Map of Marshes for Tomorrow focal areas.

PLANNING & WORKFLOW

The MfT planning effort was a two-year project. Led by Audubon's Mid-Atlantic Regional Coasts Team (Table 1), the workflow was organized by creating three distinct teams: Core Analysis, Community Engagement, and Policy & Communications. A range of partners from multiple levels of government, conservation organizations, land conservancies, consultancies, and universities provided additional consultation, expertise, and support. For a complete list of the MfT team and advisory participants, see Appendix B.

Table 1. Members of Audubon's Mid-Atlantic Regional Coasts Team tasked with leading the MfT initiative.

AUDUBON'S MID-ATLANTIC REGIONAL COASTS TEAM		
		
David Curson, Ph.D. Director of Bird Conservation *Maryland*	**Henrietta "Hen" Bellman** Coastal Program Manager	**Brittany "Bri" Panos** Coastal Avian Biologist

The three teams functioned independently to deliver outputs specific to their respective objectives. The Core Analysis Team was tasked with developing models to accurately assess and prioritize marshes for restoration. The Community Engagement Team was responsible for developing meaningful relationships, expanding participation, and gathering critical feedback. The Policy & Communications Team aimed to craft strategies to make compelling cases to legislators, funders, and partners in preparation for implementing the MfT plan (Figure 4).

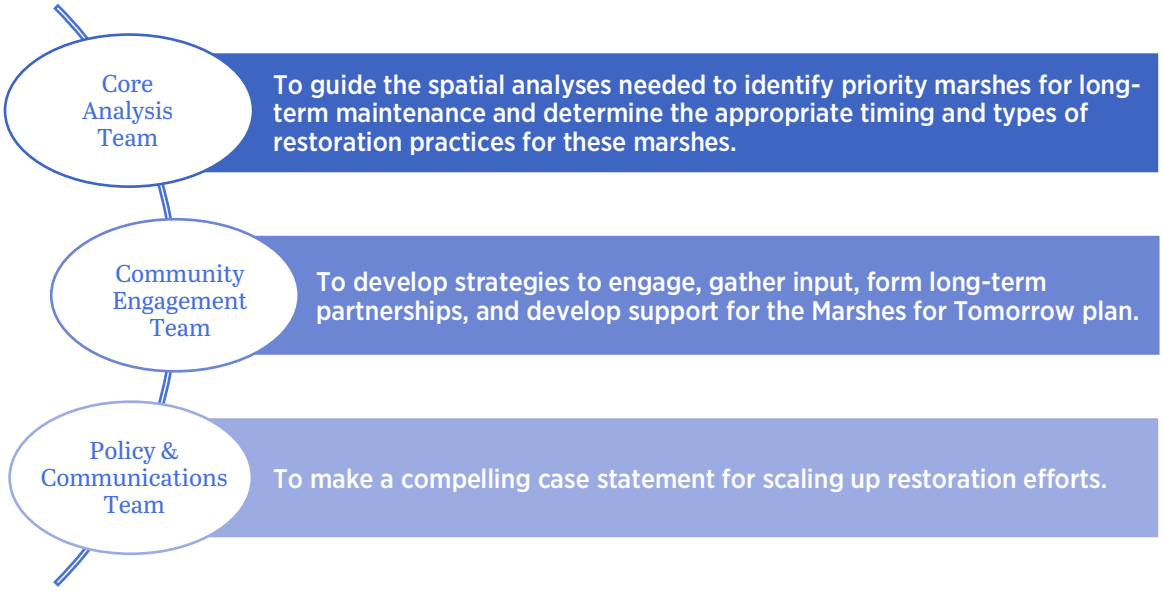


Figure 4. Collaborative planning structure of the Marshes for Tomorrow initiative.

The Audubon Mid-Atlantic Coasts Team (Table 1) provided leadership for the other teams, ensuring broad participation from a range of stakeholders and a cohesive and inclusive process to achieve the broader slate of project objectives.

The Audubon team hosted an initial meeting with agency and organizational partners to review spatial analyses and discuss criteria for marsh prioritization. Additionally, the team convened two regional

workshops, one for the Chesapeake Bay Focal Area (Figure 5) and one for the Maryland Coastal Bays Focal Area, to review and discuss model inputs and restoration prescriptions. The workshops invited feedback on the accuracy of the models, discussion of prioritization factors, and recommendations for potential project areas. Feedback from these workshops was analyzed and used to refine the models and prioritization factors for each focal area.



Figure 5. Participants at the MfT summer workshop for the Chesapeake Bay region. Photo: Kelly McGinley/Function & Flow.

The initial workshops were followed by a series of focus group meetings, which involved a smaller group of stakeholders using the revised models and prioritization factors to develop recommendations for Priority Marsh Areas (PMAs) in each focal area. The recommendations from the focus group meetings were further refined based on capacity and practical application of restoration strategies, resulting in the identification of nine PMAs across four focal areas and encompassing a restoration area of approximately 11,736 ha (29,000 ac). A complete overview of the collaborative process can be seen in Figure 6.

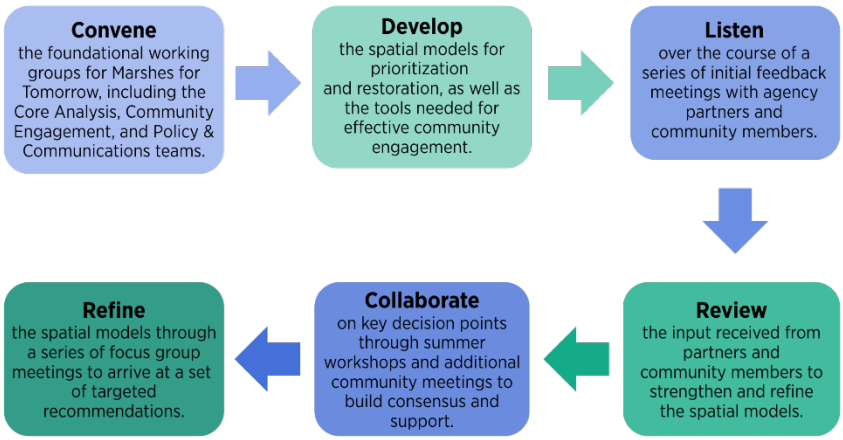


Figure 6. The Marshes for Tomorrow workflow and decision-making process.

HOW DOES MfT RELATE TO OTHER PLANNING EFFORTS?

There are a growing number of salt marsh resiliency planning efforts in Maryland and the Chesapeake Bay watershed. These cover a wide range of goals and vary in their geographic extent. The MfT initiative can inform and assist two planning efforts, in particular, which are being developed simultaneously. These are:

1. Maryland's Wetland Adaptation Strategy. The State of Maryland is creating a wetlands strategy and acreage goals for Maryland's Chesapeake Bay Program Wetlands Outcome. The strategy is being led by the Maryland Department of the Environment (MDE) and the Maryland Department of Natural Resources (DNR), with completion expected in 2025.
2. Tidal Wetlands Strategic Plan for the Chesapeake Bay Watershed. The Chesapeake Bay Program has provided funding to the Chesapeake Bay Trust to facilitate the creation of a Tidal Wetlands Strategic Plan for the Chesapeake Bay Watershed. The plan's objectives are to facilitate dialogue across practitioners and communities to establish consistent coastal marsh restoration priorities, techniques, and coastal marsh restoration siting criteria.

Additionally, MfT's narrow focus on the high marsh zone positions it well as a potential module that can be included in broader efforts underway with partners across the state.

THE POWER OF PARTNERSHIP

The MfT initiative is genuinely collaborative. This effort would not have been possible without the invaluable participation of partners in federal, state, and local governments, nonprofit organizations, local land conservancies, consultancies, and universities (Table 2).

Table 2. Agency and organization partners involved in the Marshes for Tomorrow initiative.

Atlantic Coast Joint Venture	Audubon Mid-Atlantic	Beach to Bay Heritage Area	Chesapeake Bay Program	Chesapeake Bay Trust	The Conservation Fund
Deal Island Peninsula Project	Delmarva Restoration & Conservation Network		EA Engineering, Science, and Technology, Inc., PBC	Eastern Shore Land Conservancy	EPA
The George Washington University	JBO Conservation	Lower Shore Land Trust	Maryland Coastal Bays Program	Maryland Department of the Environment	Maryland Department of Natural Resources
NOAA	National Park Service	The Nature Conservancy		Sustainable Science	Towson University
University of Delaware	University of Maryland	University of Maryland Center for Environmental Science	US Army Corps of Engineers	USDA	U.S. Fish & Wildlife Service
USGS	VIMS William & Mary				

Section Three: Marsh Ecology & Birds

At a Glance

- Maryland's salt marshes are critical habitats for a unique assemblage of bird species, including the Saltmarsh Sparrow, Eastern Black Rail, and Coastal Plain Swamp Sparrow, all of which are facing significant population declines due to habitat loss and climate change.
- Rising sea levels and increased tidal flooding are causing the degradation of high marsh habitats, which are essential for the breeding and survival of these bird species.
- Without action to restore and maintain a significant portion of the high marsh ecosystem, it is anticipated that these bird species will experience continued decline and eventual population collapse in Maryland.

BIRD ASSEMBLAGE OF MARYLAND'S SALT MARSHES

The salt marsh is home to a unique assemblage of birds, including the American Black Duck *(Anas rubripes)*, Eastern Black Rail *(Laterallus jamaicensis jamaicensis)*, Clapper Rail *(Rallus crepitans),* Coastal Plain Swamp Sparrow *(Melospiza georgiana nigrescens),* King Rail *(Rallus elegans),* Saltmarsh Sparrow *(Ammospiza caudacuta)*, Seaside Sparrow *(Ammospiza maritima),* Virginia Rail *(Rallus limicola),* Marsh Wren (*Cistothorus palustris*) and eastern Willet *(Tringa semipalmata semipalmata).* Additionally, salt marshes support migrating and wintering species, specifically shorebirds, such as Dunlin (*Calidris alpina*), Semipalmated Plover (*Charadrius semipalmatus*), Semipalmated Sandpiper (*Calidris pusilla*), and waterfowl. Many of these species evolved specific life history traits associated with salt marshes, which now face climate-driven loss or degradation resulting in population-level effects. In recent decades, the Saltmarsh Sparrow and Eastern Black Rail have experienced significant population declines (~9% per year since the 1990s[23] for Saltmarsh Sparrow and 6.5%[24] for the Eastern Black Rail). These species are predicted to experience population collapse if nothing is done to mitigate the impacts of sea level rise (SLR) on salt marsh habitat.

The Atlantic Coast Joint Venture's (ACJV) Salt Marsh Bird Conservation Plan[19] identifies a suite of three species of salt marsh obligate birds as Tier A species, or species of highest conservation priority, based on the following two criteria: 1) International Union for Conservation of Nature (IUCN) status (Near Threatened or greater) and 2) a large proportion of their global population being located within the ACJV focal area.

All three of these Tier A species — the Saltmarsh Sparrow, Eastern Black Rail, and Coastal Plain Swamp Sparrow — are found in the salt marshes of Maryland.[25] Although the Marshes for Tomorrow initiative's objectives are tailored to the needs of the Saltmarsh Sparrow, the restoration strategies recommended by the plan will also benefit the Eastern Black Rail and Coastal Plain Swamp Sparrow.

Saltmarsh Sparrow



Figure 7. Saltmarsh Sparrow (Ammospiza caudacuta) Photo: Hans Toom/Canadian Nature Visions

The breeding population of the Saltmarsh Sparrow (Figure 7) is confined to the northeastern United States, ranging from Maine to Virginia.[26] Wintering populations can be found in salt marshes across the mid-Atlantic region to Florida.[26] The Saltmarsh Sparrow is currently listed as Vulnerable on the IUCN Red List and is a candidate for listing by the U.S. Fish and Wildlife Service (USFWS) for protection under the Endangered Species Act. The Saltmarsh Sparrow is listed within Maryland's State Wildlife Action Plan as a Species of Greatest Conservation Need.[25]

Saltmarsh Sparrow populations have been monitored using the Saltmarsh Habitat and Avian Research Program (SHARP) protocol since 2011. Audubon contributed to these survey efforts in Maryland and produced mean abundance estimates using point count data collected in 2011-2012 (Figure 8) and 2021-2022 (Figure 9). The state supports 25.2% of the species' global breeding population.[27]

According to the SHARP survey data, Saltmarsh Sparrows were most abundant at Fishing Bay in Dorchester County and in the Maryland Coastal Bays; however, this species' abundance has declined since 2011, mirroring a larger trend seen throughout its range.

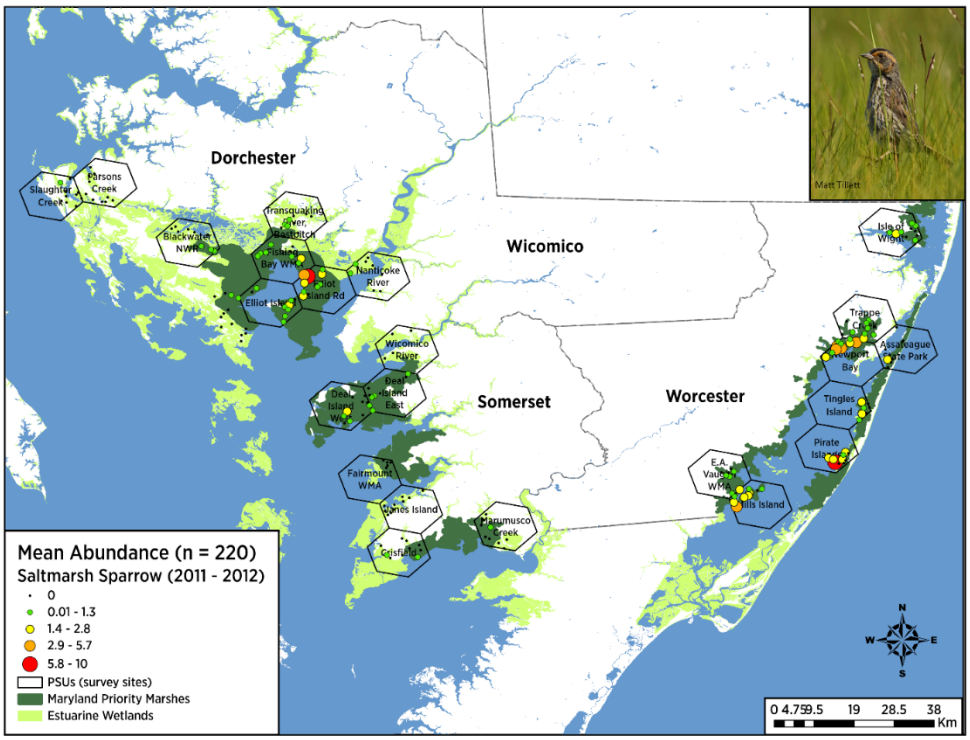


Figure 8. Mean abundance of Saltmarsh Sparrows detected per SHARP survey visit, 2011-2012.

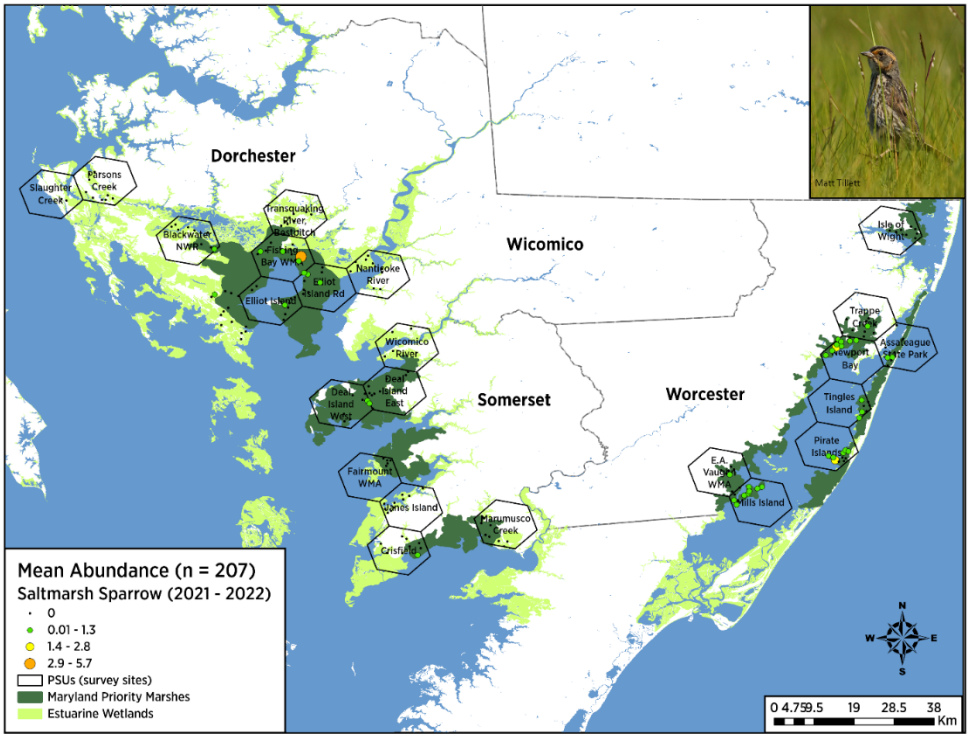


Figure 9. Mean abundance of Saltmarsh Sparrows detected per SHARP survey visit, 2021-2022.

Eastern Black Rail



Figure 10. Eastern Black Rail (Laterallus jamaicensis jamaicensis). Photo: Nick Athanas/Flickr (CC BY-NC-SA)

While the Eastern Black Rail (Figure 10) has a broad geographic range across North and South America, its distribution is very localized.[28] Typically one of the rarer species found in salt marshes, partly due to its secretive nature, recent ACJV population estimates for the Eastern Black Rail range from 255 to 815 pairs.[29] The Eastern Black Rail is currently listed as Threatened by the USFWS and Endangered within the state of Maryland, with the population estimated to be in decline and with fewer than 20 known breeding locations in the state.[30]

In the Chesapeake Bay region, most of the population of Eastern Black Rails exists on the Eastern Shore, from Dorchester County, Maryland, to Accomack County, Virginia.[28] In some Eastern Shore locations, particularly along Elliot Island Road, counts of Eastern Black Rails in the 1990s found between 30 and 47 individuals.[28] Since 2000, however, detections have dropped to 0 to 3 birds.[31] Eastern Black Rail surveys conducted at night by the Maryland Department of Natural Resources (DNR) found that the population declined more than 80% from 1991 to 2007.[32] By 2056, the ACJV hopes, through collaborative conservation efforts, to establish at least 2,500 pairs across the rail's range.[29]

Coastal Plain Swamp Sparrow



Figure 11. Coastal Plain Swamp Sparrow (Melospiza georgiana nigrescens). Photo: Middleton Evans

The Coastal Plain Swamp Sparrow (Figure 11) is a subspecies of the Swamp Sparrow that is endemic to salt marsh habitats in the mid-Atlantic region. The subspecies' breeding range is limited to the salt marshes of Maryland, Delaware, New Jersey, and New York.[33] According to the ACJV Salt Marsh Bird Conservation Plan, approximately 9,100 Coastal Plain Swamp Sparrows can be found in Maryland, making up 54% of the total breeding population.[19] In Maryland, it is listed within the State Wildlife Action Plan as a Species of Greatest Conservation Need.[25]

SALT MARSH ZONATION



Figure 12. High marsh with Spartina patens, in Dorchester County, Maryland. Photo: David Curson/Audubon

Salt marshes can be divided into distinct elevational zones according to their respective flood regimes. Different bird communities are associated with different zones.

The low marsh is characterized by frequent inundation during every tide cycle (typically twice daily), whereas the high marsh is only occasionally flooded, during the highest tides (Figure 12). In addition, the transitional zone occupies the highest elevation of the marsh adjacent to the upland boundary. Further, differentials in salinity and elevation across Maryland's salt marshes create ecological microcosms. For example, owing to its geographic position in the mesohaline middle section of the Chesapeake Bay, salt marshes in Dorchester County are typically brackish, with bay waters having an average salinity of 12-15 parts per thousand (ppt).[34] The tidal range here is narrow, 0.7m (2.3 ft.), resulting in marshes with little variation in elevation and most water level variation due to wind and precipitation. By contrast, astronomical tides within the Blackwater River system are less than 15 cm,[35] and salinity averages 5-8 ppt, reaching 19 ppt during dry periods (according to unpublished USFWS data). In the Maryland Coastal Bays, salinity is typically highest at the Ocean City inlet (30-33 ppt) and decreases with distance from the inlet. This trend is also true for the tidal range, which is greatest at the inlet (1.1-1.3m, or 3.6-4.3 ft) and decreases into the bays (0.1-0.8m, or 0.3-2.6 ft).[36]

Vegetation patterns in salt marshes are determined principally by two factors: salinity and frequency of tidal inundation. The classic model of salt marsh zonation describes a decrease in both tidal flooding and salinity upslope from the lower tidal limit, and distinct vegetation zones arranged along the elevation gradient.[37] Due to the extensive and brackish nature of the salt marshes in the Chesapeake Bay, gradients of elevation and salinity are complex and not necessarily correlated. As such, the classic

model of zonation does not always hold true across Maryland's marshes, resulting in a complex mosaic of vegetation types and some distinct zonation of plant species on a local scale.

Low Marsh

The most dominant plant species in the low marsh zone is smooth cordgrass *(Spartina alterniflora),* which grows in monotypic stands across the low marsh, ranging from mean sea level to the mean high water (MHW) mark.[1] *S. alterniflora* is the dominant vegetation type seen in the Maryland Coastal Bays salt marshes. This grass species occurs as both a tall and short form, with the tall form prevalent in the low marsh.

A dominant species of the lower parts of slightly to moderately brackish marsh, Olney threesquare (*Schoenoplectus americanus*), is particularly abundant at Blackwater National Wildlife Refuge. It is the vegetation that historically made the refuge famous as a site for wintering and foraging waterfowl. Although described as a high marsh plant by McCormick and Soames[38] and Tiner and Burke,[1] *S. americanus* tolerates regular and even permanent flooding. Other plant species common in slightly brackish marsh include narrow-leaved cattail (*Typha angustifolia*) and common threesquare (*Schoenoplectus pungens*).

High Marsh

Spartina patens, or salt hay grass, and *Distichilis spicata*, or spikegrass, are often found growing in monotypic stands or together in meadows on the high marsh. They are also found in the more saline parts of brackish marshes, where they occupy the higher elevations of the high marsh.[1,38] McCormick and Soames[38] reported that *S. patens / D. spicata* vegetation accounted for 18% of the high marsh in Dorchester County and 27% in Somerset County. The short form of *S. alterniflora* is also found in the high marsh, particularly in the Coastal Bays, where salinities are high.

Juncus roemerianus, or black needlerush, a salt marsh plant at the northern edge of its geographical range in Maryland, is highly abundant in the high marsh zone, especially in Dorchester and Somerset counties (32% cover of high marsh in Dorchester County and 46% cover of high marsh in Somerset County[38]). It can be found in large, monotypic swaths in Dorchester County and Somerset County, particularly in locations such as the Deal Island Wildlife Management Area. *J. roemerianus* occupies a wide range of elevations within the marsh and has a high tolerance for anaerobic conditions.[39] It is variably described as a high marsh plant[38,1] or a low marsh plant.[40,41]

Transitional Zone

Between the edge of the high marsh zone and the upland habitat, there is commonly a narrow but significant transitional belt buffering salt marshes and the interior landscape (Figure 13). Marsh elder (*Iva frutescens*) and Groundsel-bush (*Baccharis halimifolia*) are salt-tolerant shrub species common in the upper portions of high marshes and in transitional marsh close to the upland boundary. They generally occur over a swath of *S. patens* and *D. spicata* and can form dense stands along the upland marsh border and along levees, ditches, and small hummocks within the open marsh.

A dominant species within the transitional zone is *Phragmites australis*, or common reed, a non-native, invasive grass found throughout Maryland, including in salt marshes. This invasive species forms dense, tall, monotypic stands, often near freshwater inputs to salt marsh areas, shading out native plants. *P. australis* can spread by seed and horizontal rhizomes and thrives in disturbed soils. According to the Maryland DNR, this species is increasing in abundance and distribution, a trend observed in other states along the Atlantic Coast.[42] In Maryland, *P. australis* tends to be widespread only in the transitional zone

because it does not tolerate high salinity levels. The DNR Wildlife and Heritage Service employs various techniques to control Phragmites, which could help mitigate the threat of native marsh grasses being outcompeted.

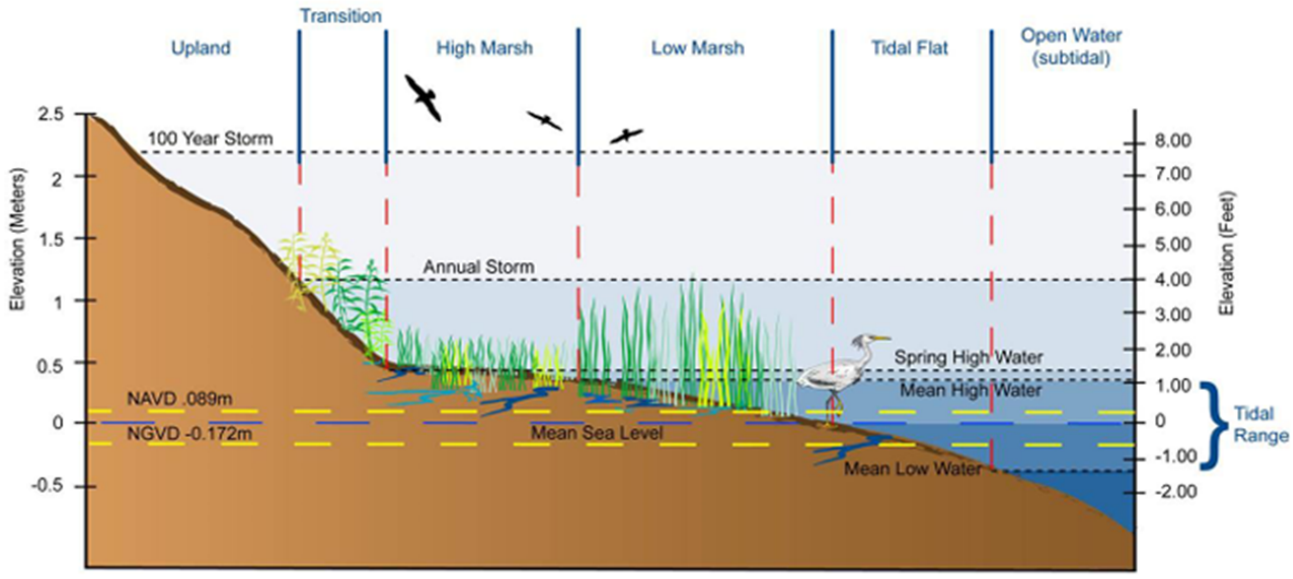


Figure 13. Relationship between tides, wetlands, and reference elevations for an example estuarine profile. Reproduced from Titus and Wang, 2008.[43]

BIRD HABITAT AND CONSERVATION NEED

Spartina patens meadows provide critical breeding habitat for the three Tier A species: the Eastern Black Rail, Coastal Plain Swamp Sparrow, and Saltmarsh Sparrow. These meadows can include the areas of short-form *S. alterniflora* and are hereafter referred to as *Spartina* grass meadows. The predicted conversion of high marsh to low marsh caused by sea level rise and regional subsidence is of particular concern for the Saltmarsh Sparrow and Eastern Black Rail. Both species select for the high marsh zone, typically with a mixture of *S. patens*, *D. spicata*, *J. roemerianus,* and/or *S. alterniflora*, and favor areas of higher elevation that are less frequently flooded[21] to maximize successful nesting.

Saltmarsh Sparrows prefer to nest low to the ground among thatches of *S. patens* on the high marsh platform. However, a proportion of them do nest in less optimal conditions dominated by *S. alterniflora,* using both short-form (~20 cm/8 in or shorter) and long-form (>20 cm/8 in) of *S. alterniflora* as long as there is a suitable thatch layer.[21,44]

In many parts of the Saltmarsh Sparrow's geographic breeding range, the high salt marsh is synonymous with suitable habitat for the Eastern Black Rail; however, in the Chesapeake Bay, not all high marsh is dominated by *Spartina* meadows. Eastern Black Rails rely heavily on plant structure versus plant species, with grassy vegetation, such as *S. patens*, as their typical dominant vegetative cover. Eastern Black Rails do not fly very often during the breeding and wintering seasons, and thus depend on dense vegetation to provide overhead cover as they use tunnels under marsh grasses to move about.[45] Eastern Black Rails are highly sensitive and known to abandon their nests if there is either too little or too much water on the platform.[29] Tidal inundation of both species' nests is more

prevalent due, in part, to SLR, leading to an increased risk of nest failure.[46,47] The primary causes for Saltmarsh Sparrow decline across its breeding range are thought to be an increase in nest flooding as a result of SLR and, regionally, increased nest predation.[47,48,49] In Maryland, although demographic studies of the Saltmarsh Sparrow have not been done, population declines are likely due to the impacts of SLR.[19]

The Coastal Plain Swamp Sparrow favors shrub vegetation, such as *I. frutescens* and *B. halimifolia*, which are widespread in the transitional zone and along creek banks in the high marsh zone.[33,50] The subspecies will even use stands of *P. australis.* With over half its breeding population found in the salt marshes of Maryland, the preservation of the high marsh and transitional marsh zones is of great importance to this subspecies.

The conservation target of the MfT initiative is acreage of Saltmarsh Sparrow breeding habitat, broadly defined as high marsh meadows dominated by *S. patens*. More specifically, the initiative will encompass high marsh patches with the lowest flooding frequency that provides a window of at least 24 days with limited flooding; extensive and dense *Spartina* grass meadows with a deep, well-developed thatch layer; and regions of minimally modified marshes.[20]

The Marshes for Tomorrow Initiative aims to protect and restore high marsh habitat to support these three Tier A species. Without immediate species protection through habitat restoration, we anticipate the continued decline and eventual collapse of these Tier A populations due to essential high marsh degradation and loss in Maryland.

Section Four: The State of the Marshes

At a Glance

- Historically, Maryland's salt marshes have comprised approximately 80% high marsh and 20% low marsh. The extent of high marsh is predicted to decline dramatically in future decades as high marsh converts to low marsh and open water under the influence of sea level rise (SLR).
- The process of high marsh loss is already well underway and is mostly occurring not along open shorelines but in the marsh interior. Here, waterlogging, plant dieback, and biogeochemical soil degradation are causing elevation collapse and ponding. The limited tidal range in the region is exacerbating this process.
- Many coastal resilience planning efforts use the Sea Level Affecting Marshes Model (SLAMM) to project future trends in marsh loss due to SLR. However, SLAMM does not account for elevation collapse and ponding, which is the prevailing mechanism of high marsh loss in many Maryland marshes. This has two important implications for coastal resilience planning.
    - First, in many places, high marsh is converting not to low marsh, as SLAMM predicts, but rather directly to open water, bypassing a vegetated low marsh stage.
    - Second, the loss of high marsh via this process will occur more rapidly than predicted by SLAMM.
- The MfT project created a spatial model, the Marsh Condition Model, to map the high marsh's current health condition and level of resilience to SLR. The model includes SLAMM outputs to represent elevation, and the unvegetated-vegetated ratio (UVVR) as a measure of vegetation loss. The purpose of this model is to help identify the most feasible marshes to maintain in the long term in the face of SLR.
- These map layers can be viewed publicly on the Marshes for Tomorrow GIS Experience Builder.

HISTORICAL CONDITIONS

In creating a restoration plan to influence the future condition of Maryland's salt marsh habitat, it is important to consider this ecosystem's current and historical condition.

In 1982's "The Coastal Wetlands of Maryland" report, prepared for the Maryland Department of Natural Resources (DNR), McCormick and Soames[38] mapped the vegetation types of all salt marshes in the state. In the Lower and middle Eastern Shore (Dorchester, Wicomico, Somerset, and Worcester

counties), they reported a proportion of high marsh to low marsh of 77.8% high marsh and 22.2% low marsh. This ratio is similar to that modeled by the Sea Level Affecting Marshes Model (SLAMM) for 2010,[18] suggesting that the ratio of high marsh to low marsh in Maryland was generally stable between the 1970s and 2010.

Maryland generally lacks the extensive areas of low marsh dominated by *Spartina alterniflora* that are commonly found in other parts of the Atlantic Coast. The SLAMM "upper limit of likely range scenario" predicts a rapid change in this ratio as high marsh transitions to low marsh under sea level rise (SLR) so that by 2050, the acreage of low marsh is expected to exceed that of high marsh.

The Marshes for Tomorrow (MfT) restoration strategy aims to slow this predicted rate of high marsh deterioration by maintaining the most suitable areas of present-day high marsh and preventing their transition to low marsh or open water. Land management agencies and the broader conservation community do not have the capacity to hold the high marsh to low marsh ratio at its current/historical levels, so the extent of low marsh will likely increase in coming decades, even if high marsh restoration is implemented according to the MfT plan. Therefore, the MfT initiative does not include an active restoration strategy for maintaining low marsh.

The conservation target of the MfT plan is Saltmarsh Sparrow breeding habitat, broadly defined as high marsh dominated by *Spartina patens*, and more specifically defined in the Atlantic Coast Joint Venture's (ACJV) Saltmarsh Restoration Priorities for the Saltmarsh Sparrow: Maryland plan,[20] as:

- High marsh patches with the lowest flooding frequency that provide a window of at least 24 days with limited flooding.
- Extensive and dense *Spartina patens* vegetation with a deep, well-developed thatch layer; short-form *S. alterniflora*, *Distichlis spicata* … also comprise high marsh areas and can support Saltmarsh Sparrow nesting.
- The highest-quality habitat is most often found in the least modified marshes, such as those without ditching, or that are downstream or free of tidal restrictions like road crossings.

In many parts of the Saltmarsh Sparrow's geographic breeding range, high salt marsh is synonymous with suitable habitat for this species; however, in the Chesapeake Bay, not all high marsh is dominated by *Spartina* grass meadows. The only comprehensive vegetation survey completed for Maryland's salt marshes was carried out in the 1970s. McCormick and Soames[38] reported that *S. patens / D. spicata* vegetation accounted for 17.5% of high marsh in Dorchester County and 27% in Somerset County. The most extensive high marsh vegetation type in these counties was *Juncus roemerianus* (31.8% cover in Dorchester County and 46% in Somerset County).

In contrast, the more saline marshes of Worcester County were dominated by suitable Saltmarsh Sparrow habitat (66.3% short-form *S. alterniflora* and 16.2% *S. patens / D. spicata*[38]).

CURRENT TRENDS ASSESSMENT

Today, Maryland's salt marshes are undergoing rapid change via erosion, open-water expansion, and elevation collapse as SLR alters the tidal flooding regime. Most of this loss occurs not along open shorelines but in the marsh interior, promoted by processes including waterlogging of the marsh surface, plant dieback, and biogeochemical soil degradation.[51,52,53] Research in the Mississippi Delta, where marshes have similar characteristics to those in the Chesapeake Bay, has explained the mechanism by which interior marsh inundation triggers pond formation in marshes influenced by SLR.[54] Vegetation dieback results in a loss of soil volume due to the loss of root turgor and the

oxidation of root organic matter, and this leads to a collapse in elevation and the formation of ponds. Although a number of factors can result in vegetation dieback, research in the Blackwater River marshes[52] and at the Deal Island Wildlife Management Area (WMA) in Somerset County[55] suggests that in Chesapeake marshes, increased flooding due to SLR is currently a leading factor. Historically, herbivory by nutria was one of the drivers of vegetation dieback in the Blackwater-Fishing Bay marshes, but this has abated due to the eradication of this invasive rodent species.[9]

In the Blackwater marshes of Dorchester County, increased tidal flooding of *S. patens* high marsh promotes the transition of vegetation to *S. alterniflora* and *Schoenoplectus americanus*. Then, as conditions continue to become wetter, these species die off, creating small openings that coalesce into ponds.[52] Similar dynamics have been described at the Deal Island WMA.[55] At both Blackwater and Deal Island, elevation collapse of the marsh interior tends to occur 75m (82 yd) or more from nearby creeks, leaving a wide rim of higher elevation around the collapsed zone.[52,55] Vegetation transitions favoring more flood-tolerant species can be used as early warning signals of interior marsh loss to ponding.[55]

Each of these mechanisms of interior marsh deterioration is exacerbated by the microtidal nature of Maryland's coast. The tidal range across most of Maryland is less than 0.8m and diminishes rapidly toward the interior of the large marsh platforms common to the Chesapeake Bay marshes in particular. This results in flat marshes with little topography, where tidal flood velocities are too low to carry sediment into the marsh interior.[56] Due to the lack of topography on the marsh platform, water can become trapped in the high marsh zone after excessively high tides or weather-driven water levels, even if the marsh has the elevation capital to drain under the local tidal regime. Waffle pools — shallow rectangular pools that form in the center of marsh "cells" in ditched marshes — are most likely to form where the tidal range is less than 0.8m, and across the mid-Atlantic region, interior marsh loss to waffle pools increases as tidal range decreases.[53]

MfT Experience Builder

The Experience Builder was created to present the spatial models developed for MfT across the Chesapeake and Coastal Bay regions in Maryland. These include:

- Marsh Condition Model | A landscape-scale assessment of the ecological and geophysical condition of marshes and their level of resilience to sea level rise
- Restoration Decision Model | An assessment of the restoration actions likely to be needed to restore and maintain high marsh as healthy habitat for Saltmarsh Sparrows
- Prioritization Model | Identifies Priority Marsh Areas within the project focal geographies, for long-term maintenance through restoration

The Experience Builder is publicly accessible here and allows users to explore these models, along with additional related data layers.

MARSH ASSESSMENT

The MfT Core Analysis Team completed an assessment of the current condition of marshes within the focal areas by examining three aspects of marsh ecological and geomorphic condition: 1) vegetation, 2) current marsh health, and 3) resilience to future SLR. This assessment was designed to provide a scientific basis for achieving Objective 1 (marsh prioritization: See p.7).

Marsh vegetation was evaluated because it is a key determinant of Saltmarsh Sparrow breeding habitat and because high marsh in the Chesapeake Bay supports multiple vegetation types, including some not used by the Saltmarsh Sparrow. No comprehensive species survey of salt marsh vegetation has been carried out since the 1970s, so no current vegetation map is available. Audubon worked with the U.S. Fish and Wildlife Service's Chesapeake Bay Field Office (CBFO) to create a simplified vegetation layer by manually digitizing marsh vegetation using visual interpretation of the 2015 National Agriculture Imagery Program. The digitization was carried out by CBFO staff with extensive field experience in Maryland's salt marshes. An initial draft of the spatial layer was validated using field data collected in 2023. The digitization identified *Spartina* grass meadows (including *S. patens* and *S. alterniflora*) with 95% accuracy and *J. roemerianus* with 89% accuracy. Other vegetation types could not be accurately identified. Accuracy for phragmites was 50%, and so was not included in the final spatial layer. We did not attempt to map *S. americanus*, a widespread vegetation type in Dorchester County, as it was difficult to distinguish on the imagery.

The final vegetation layer shows two vegetation types: *Spartina* grass meadows (*S. patens* and *S. alterniflora*) and *J. roemerianus*. All other vegetation is indicated by gaps in the data layer.

To assess current marsh health and resilience to future SLR, we developed a Marsh Condition Model that combined these two factors.

MARSH CONDITION MODEL

The Marsh Condition Model provides a landscape-scale assessment of the ecological and geomorphic condition of marshes and their level of resilience to SLR. **The primary purpose of the model is to inform the marsh prioritization process by showing where the more resilient and healthy marshes are.** It thus facilitates the conceptualization of conservation strategies at the landscape scale.

The rationale behind the Marsh Condition Model is that the two most important assets for the long-term persistence of salt marsh under accelerating SLR are 1) elevation, and 2) intact vegetation cover (lack of dieback and ponding). These qualities both indicate healthier marsh in the present day and higher resilience to future SLR. This rationale assigns low marsh to a lower condition class so that the model is in effect a high marsh condition model. This emphasis aligns not only with the high marsh focus of MfT but also with the reality that in Maryland, where low marsh has historically been limited in extent, the prevailing pattern of high marsh transition is not to healthy low marsh but instead to open water due to vegetation dieback and elevation collapse.

The Marsh Condition Model integrates marsh elevation in relation to tide, and marsh health into a single spatial layer, representing a Marsh Condition Index. This layer was calculated and mapped at the spatial scale of marsh units.[57] Marsh units delineate marsh complexes into topographically distinct units that are constrained by elevation, hydrology, or upland land use.[57]

The Marsh Condition Model uses outputs from the latest run of SLAMM in Maryland[18] as a proxy for marsh elevation in relation to tides, rather than using raw marsh elevation data. There are two reasons for this.

1. SLAMM provides outputs that correspond to the Marshes for Tomorrow target marsh types. The two SLAMM categories Irregularly Flooded Marsh and Transitional Salt Marsh represent high marsh habitat, where there is suitable breeding habitat for the Saltmarsh Sparrow.

Regularly Flooded Marsh represents low marsh, which is below the elevation range suitable as Saltmarsh Sparrow breeding habitat.

2. SLAMM incorporates data on **local tides** and **vertical accretion,** which are important in predicting current and future marsh zones. If raw elevation data were used, tide data and accretion rates would need to be incorporated independently.

SLAMM was recently rerun for Maryland by The Nature Conservancy and Warren Pinnacle Consulting, Inc. as part of a project titled: "EESLR 2019: Quantifying the benefits of natural and nature-based features in Maryland's Chesapeake and Atlantic Coastal Bays to inform conservation and management under future SLR scenarios."[18] The SLAMM rerun created outputs at decade intervals from 2010-2100 under a variety of SLR scenarios. Marshes for Tomorrow used the Upper Limit of Likely Range Scenario (see Section 1, Figure 1), which is currently being used by the Maryland DNR in wetland adaptation planning, based on recommendations in Guidance for Using Maryland's 2018 Sea Level Rise Projections.[58]

SLAMM is effective at representing wetland vegetation response to SLR[59] and includes the dominant variables influencing the vertical position of wetlands in relation to tides. However, SLAMM does not account for internal deterioration of the marsh platform, which occurs when marshes experience vegetation dieback due to waterlogging or herbivory. Unvegetated portions of marsh can deepen and expand as ponds form in the marsh interior, with a consequent loss of elevation. The deepening of surface water via biogeochemical processes can result in the rapid transition of high marsh to open water, bypassing the conversion to vegetated low marsh that is included in some models of SLR impact on marshes, such as SLAMM. It is important to account for this component of marsh health when making future projections of marsh condition under SLR scenarios.

Thus, high marsh with significant unvegetated area is vulnerable to a more rapid rate of conversion to low marsh, or directly to open water, than is predicted by SLAMM alone. To account for this, the Marsh Condition Model uses the unvegetated-vegetated ratio (UVVR) as a "horizontal, integrative indicator of marsh condition and future geomorphic trajectory."[57] The UVVR is another indicator of current marsh health and resilience to future SLR.[60,61] The UVVR has been mapped across Maryland salt marshes by hydrologically connected marsh units.[57,60] Although the UVVR is strongly correlated with marsh elevation, it provides an additional, independent measure of marsh health where high marsh deteriorates due to biogeochemical factors and consequent elevation collapse.

Data layers for SLAMM (2020-2070) and the UVVR are presented for reference purposes on a separate map viewer under the Sources tab in the MfT Experience Builder. They are located below the data source table.

The model's two constituent variables, the UVVR and SLAMM cover category, were categorized and weighted as shown in Table 3, to yield marsh condition scores that were assigned to four condition classes for mapping (defined in Table 4). Class 1 represents the healthiest and most resilient marsh, and Class 4 represents the least healthy and resilient. An example of the scoring, as displayed in the MfT Experience Builder, can be seen in Figure 14.

Table 3. Factor weightings and resilience scores for a Marsh Condition Index, consisting of the UVVR and SLAMM cover category. "Low marsh" includes the SLAMM categories Regularly Flooded Marsh, Tidal Flat, and Open Water. "High marsh" includes the SLAMM categories Irregularly Flooded Marsh and Transitional Marsh. The color scheme of the Marsh Condition Score corresponds to the mapping of Marsh Condition Class in the MfT Experience Builder.

			SLAMM Cover Category (by marsh unit)				
			Low marsh >75%	Mixed low/high marsh	High marsh >75%	Marsh Condition Score	Marsh Condition Class
		Factor weighting	1	4	9	1-7	4
UVVR	>0.15	1	1	4	9	8-14	3
	0.08-0.15	2	2	8	18	15-21	2
	<0.08	3	3	12	27	22-28	1

Table 4. Definitions of marsh classes used in the Marsh Condition Model.

1	Healthiest and most resilient marsh; limited ponding; healthy vegetation
2	Stable condition, but significant interior ponding and/or vegetation dieback
3	Degraded; extensive interior ponding and dieback; or limited ponding and dieback, but significant proportion of lower-elevation marsh
4	Extensive interior ponding and dieback; high proportion of lower-elevation marsh; submerged marsh or open water

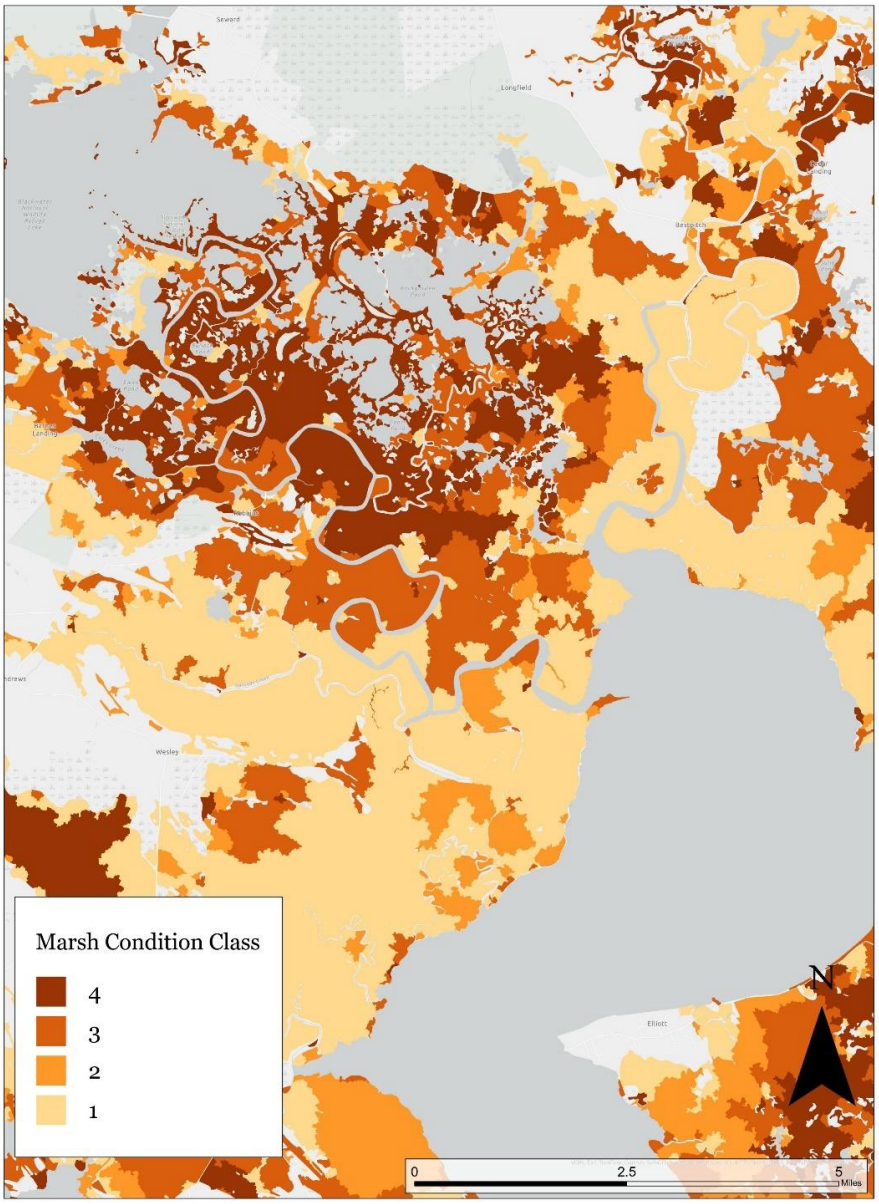


Figure 14. Section of the Blackwater-Fishing Bay Focal Area from the Marshes for Tomorrow Experience Builder, illustrating the marsh condition based on the scoring method in Table 3.

Thresholds for the three categories of the UVVR in Table 3 were set according to Ganju et al.'s statements[57] that at a UVVR value of ~0.08, the present-day sediment budget is predicted to be neutral, and the use of UVVR = 0.15 as a stability threshold.[62,63] Marshes with a UVVR of >0.15 are unstable and at risk of rapidly converting to open water.

Both the UVVR and elevation (SLAMM cover category) were divided into three categories and assigned weights from 1 to 3. The weight for elevation (SLAMM cover category) was then squared to account for the higher contribution of elevation as a factor influencing marsh response to SLR. These scores were then multiplied together to yield a Marsh Condition Score for each marsh unit so that higher scores

represent more resilient and ecologically intact marsh units. The range of the Marsh Condition Score was divided into four equal categories to yield four Marsh Condition Classes. These were mapped for all the salt marsh units in Dorchester, Wicomico, Somerset, and Worcester counties (i.e., across a more extensive geography than the Marshes for Tomorrow initiative focal areas).

Various combinations of factor weightings were investigated during the development of the Marsh Condition Model. The final version was ultimately selected because it identified high marsh in the higher-scoring Marsh Condition Classes and divided high marsh between the three highest Marsh Condition Classes according to UVVR category. The model assigns low marsh to Classes 3 and 4, regardless of its vegetated status.

MARSH ASSESSMENT RESULTS

The Marsh Condition Model results are mapped as a spatial layer and made available in the MfT Experience Builder, with a variety of accompanying spatial data layers. Several of these layers and the model were used to inform the marsh prioritization process to identify the target 10,117 ha (25,000 ac) of marsh, as described in Section 6.

The marsh assessment can be used to address the following questions:

1. What extent of healthy and resilient high marsh is present within the MfT initiative area? (Figure 15)
2. What extent of suitable Saltmarsh Sparrow breeding habitat is present within the MfT focal areas?
3. What extent of this marsh currently requires restoration?

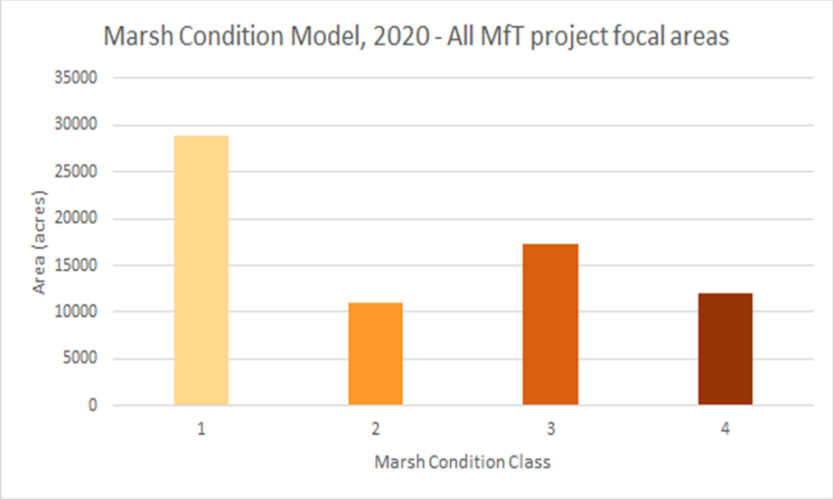


Figure 15. The extent of marsh in each of the four Marsh Condition Classes of the Marsh Condition Model (1 ac = 0.4 ha).

Not all of this high marsh supports vegetation appropriate as Saltmarsh Sparrow habitat. Table 5 shows the extent of marsh units with >25% *Spartina patens* cover and representing likely suitable Saltmarsh Sparrow habitat. This amounts to approximately 42% of marsh in all condition classes and 36% of healthy and resilient marsh (Classes 1 and 2).

Table 5. Acreage of MfT focal areas, by Marsh Condition Class and vegetation classes.

	Marsh Condition Class				Totals
Vegetation	1	2	3	4	
>25% *S. patens*	4,525 ha (11,182 ac)	1,314 ha (3,247 ac)	3,462 ha (8,554 ac)	2,389 ha (5,903 ac)	11,690 ha (28,886 ac)
<25% *S. patens*	7,178 ha (17,737 ac)	3,153 ha (7,789 ac)	3,540 ha (8,748 ac)	2,505 ha (6,191 ac)	16,376 ha (40,465 ac)
Totals	11,703 ha (28,919 ac)	4,467 ha (11,036 ac)	7,002 ha (17,302 ac)	4,894 ha (12,094 ac)	28, 066 ha (69,351 ac)

FUTURE PROJECTIONS OF MARSH CONDITION

Including SLAMM in the Marsh Condition Model allows the projection of marsh condition across future time intervals. The changes in the Marsh Condition Index between decades are based on changing ratios of "high marsh" to "low marsh" derived from SLAMM outputs. Because we were unable to include future UVVR projections, the UVVR values in each marsh unit were fixed in the Marsh Condition Model (at current values) for all time intervals and did not contribute to future projections of marsh condition. However, UVVR values generally increase over time as interior marsh deterioration proceeds.[57]

Future acreage projections for the four Marsh Condition Classes are presented at decadal intervals from 2020 to 2070 in Figure 16. The graph shows a rapid loss of marsh in the "best" two classes between 2040 and 2050 and the virtual disappearance of these classes by 2060. However, because future UVVR trends are unaccounted for, Figure 16 represents a best-case scenario in which no internal deterioration and open-water expansion occur on the vegetated marsh plain. In all likelihood, marsh internal deterioration and the loss of elevation relative to sea level will take place more rapidly than depicted in Figure 16.

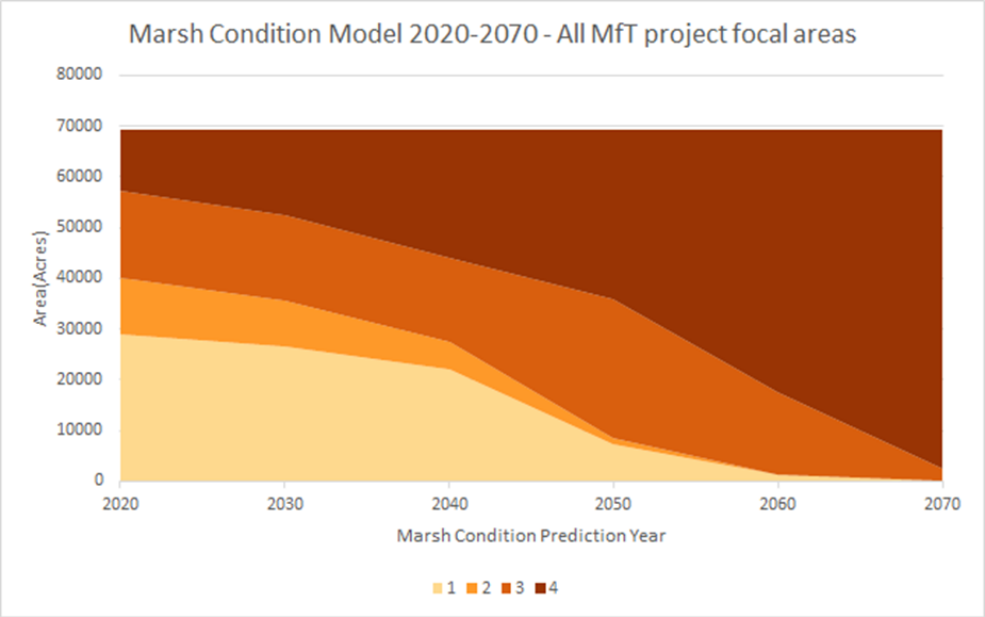


Figure 16. Future acreage projections for the four Marsh Condition Classes, presented at decadal intervals from 2020 to 2070 (1 ac = 0.4 ha).

Section Five: Community Engagement

At a Glance

- The Lower Eastern Shore holds a rich coastal culture and history. With its proximity to key trade routes, the area has developed as a hub for agriculture and aquaculture that significantly contributes to the local economy. Today, the region supports approximately 213,000 people.
- The Marshes for Tomorrow project took a multi-partner approach to identify and implement strategies for engaging with local communities. The aim was to produce a qualitative data overlay to inform the prioritization of marshes for long-term maintenance.
- Through a variety of strategies, such as personal conversations and a public survey, we heard how communities are already experiencing the impacts of sea level rise and increased storm intensity, making resiliency efforts vital for the region's future.
- We documented broad support for marsh restoration and a keen interest in being part of the process. Local knowledge, care, and advocacy of the tidal landscapes should be woven into site-specific plans as we look to future implementation.
- Successful marsh restoration is intertwined with continued active community engagement. Particular effort should be made to engage marsh user groups and underrepresented or historically excluded groups.

The coastal salt marshes of the Delmarva region are a unique and spectacular landscape that supports endemic wildlife and holds a rich history. The arrival of European settlers sparked the forced removal of Indigenous tribes and the trade of enslaved people, both resulting in profound and devastating effects on the development of local communities and cultures. The region bore witness to the Revolutionary War, the War of 1812, and the Civil War, as well as the emergence of the Underground Railroad, leaving a legacy of resilience and historical significance. According to the Maryland Department of Planning, the census population for the Lower Eastern Shore region is approximately 213,000.

Due to their location on the Eastern Seaboard and their proximity to key trade routes, the Chesapeake Bay and Maryland Coastal Bays developed as vital centers for commercial trade and tourism. The region's waterways and communities have been economic epicenters for agriculture and aquaculture, producing tobacco, soybeans, oysters, crabs, fruits, vegetables, and poultry.

Today, these tidal landscapes are seeing the effects of increased coastal sea level rise and storm intensity. We recognize that successful salt marsh habitat conservation will only be successful with the

long-term engagement and support of local coastal communities, resulting in landscapes that benefit both human and wildlife populations. The Marshes for Tomorrow (MfT) initiative is not the first to recognize the significance of such relationship building. For example, existing community-driven programs have been established at Deal Island (Deal Island Peninsula Partnership, or DIPP), and Crisfield (Environmental Protection Agency (EPA) Coastal Community Resilience Research).

COMMUNITY ENGAGEMENT TEAM

The goal of the Community Engagement Team (CE Team) was to **foster communication between local communities, relevant stakeholders, and MfT initiative team members as a means to promote the initiative's overall goal of creating an implementation plan for salt marsh restoration on a landscape scale in Maryland.**

The objectives of the CE Team included:

1. Learn how local communities relate to and utilize salt marshes, both historically and today.
2. Allow the voices of local community members to be heard on the topic of marsh restoration in general and the MfT plan specifically.
3. Demonstrate and promote the support of local communities for marsh restoration in general and the MfT plan specifically.
4. Gain the support of local county and city governments for the MfT plan through policies, planning, and logistical support for marsh restoration.
5. Facilitate participation by landowners in the restoration of their marshes.

To complete our community engagement objectives, we recognized a need to identify, select, and convene two groups of partners.

a. First, a core **CE Team comprised of local partner organizations** was assembled. It was critical to work with local partner organizations in the areas where we wanted to work that already knew and trusted one another. From July 2023 to October 2024, the CE Team met monthly to advise on and develop outreach strategies, plan and implement community engagement activities, and track the completion of the community engagement objectives. This team was co-led by Henrietta Bellman of Audubon Mid-Atlantic and Jared Parks of the Lower Shore Land Trust (LSLT).
b. Second, the CE Team **identified a network of Community Messengers**. Their role was to act as a trusted connection to local resources and perspectives, share project information and events, serve as local (county or town) community contacts, and provide support for achieving the project objectives. These individuals were identified through local partners' existing relationships or from volunteer communications during community engagement events.

METHODS

Communities on Maryland's Lower Eastern Shore are very diverse. One of our first tasks as a CE Team was to define the communities of the Lower Eastern Shore and the appropriate engagement strategies for each. Community diversity could be defined through individual identity, beliefs and values, individual and community priorities, faith or spiritual practices, and social or economic pressures. In our

process, we realized that the range of diverse perspectives and expectations across the landscape meant our salt marsh restoration objectives could be at odds with other priorities.

According to David M. Chavis and Kien Lee in the Stanford Social Innovation Review, "Community is not a place, a building, or an organization. … [It] is both a feeling and a set of relationships among people. People form and maintain communities to meet common needs. Members of a community have a sense of trust, belonging, safety, and caring for each other."[64] A community of people, such as members of a particular church congregation or hunt club, may hold shared values and social norms. Our aim was to engage with as many types of communities within the MfT focal areas as possible, to encourage input into our salt marsh restoration planning: a form of community-based planning.[65]

To do this, we pooled the CE Team's knowledge to identify Community Messengers, meeting and promotional locations, upcoming events and outreach opportunities, communication and engagement techniques, and local business partnership opportunities. During these discussions, we identified safe or neutral meeting and advertising spaces, attempting to avoid exclusion due to political or social differences. We also identified conflicting dates, such as public or local holidays and active hunting seasons.

Outreach Materials

To build awareness of the MfT initiative, the CE Team developed a suite of outreach materials that were widely distributed to Lower Eastern Shore communities by local businesses and organizations, via Audubon communication platforms, and through our partners, including the LSLT, the Maryland Coastal Bays Program (MCBP), the Eastern Shore Land Conservancy (ESLC), Bay to Beaches, DIPP, and the U.S. Fish and Wildlife Service.

In collaboration with the Delmarva Restoration and Conservation Network, we created a MfT initiative web page to serve as a central communications hub where we could share project details, announcements, educational and informational materials, and community meeting information. On the web page, we produced an online blog series from May to August 2024 to share the experiences of field biologists monitoring marsh bird populations at three restoration sites in Maryland. Two of our partner organizations, the LSLT and ESLC, also produced salt marsh articles, which they hosted on their websites. We produced and distributed two informational guides (see Appendix C) as well as promotional stickers (Figure 17).



Figure 17. Project sticker designed by Sophia Seufert, USFWS.

We created a Google account, including an email address for public communications and a shared a drive for housing team communications and resources. We used existing local media relationships to issue a press release promoting the second round of community meetings in summer 2024. Where possible, we worked with partners to attend and share outreach materials during local or existing events, such as the ESLC Waterfowl Festival (November 10-11, 2023) and the 32nd Annual Native American Festival (September 14, 2024).

Results

We estimated that the MfT initiative reached over 15,000 points of connection through a variety of strategies (Figure 18). We did not account for any overlap in participants across organization mailing lists or engagement, so it is likely that the actual number of people reached is lower.



Figure 18. A summary of outreach strategies and associated metrics from Audubon and Marshes for Tomorrow partner organizations.

Marsh Use Survey

We created a Marsh Use Survey (see Appendix D) to gather feedback on community use of and interactions with salt marshes, perspectives on salt marsh ecology and health, and habitat restoration (CE Team Objectives 1, 2, 3, and 5). The survey consisted of 17 questions, many of which were optional, and took approximately 10 minutes to complete. Participation in the survey was anonymous, unless the participant opted to share their contact information. After some discussion, the team decided not to collect demographic information from the participants.

The survey was available online via a QR code or a link on the MfT website. Because reliable internet and phone service can be variable on the Lower Eastern Shore, we created paper copies that could be completed in person during community meetings or at tabling events. For completing the survey, each participant could enter a free raffle to win one of five baskets featuring items donated by local businesses and organizations.

Results

We ran the public Marsh Use Survey from November 1, 2023, to October 3, 2024, and received 127 responses. Just over half of the respondents (56%) were local residents of either Dorchester, Somerset, Wicomico, or Worcester counties. Participants reported that they interact with salt marshes in a variety of ways, with recreation being cited by almost all participants (95%). Nearly three-quarters of participants said they interacted with salt marshes once a month or more, underscoring the local and intimate knowledge of these landscapes.

Eighty-two percent of participants reported noticing changes to the salt marsh in their lifetime. The most frequently reported changes included loss of shoreline or marsh land, flooding, property access, or changes in marsh vegetation (e.g., increased *Phragmites*). Approximately one-third indicated they had seen saltwater impacts on agricultural lands. Two participants even noted the emotional effects of

such changes in the marsh: “It’s more an emotional change. Less joy. More grief at the loss” and “[The changes] affected my mood when I’m in the marsh.”

Over 98% of survey participants (125/127) said it was important to protect the marshes (Figure 19), and the most common reasons cited for doing so included ecosystem services, wildlife habitat, and environmental stewardship and responsibility (Figure 20). Participants listed over 50 marsh-adjacent infrastructures affected by marsh migration or flooding. In one survey question, participants were asked, “Marsh restoration actions may cause local disturbances or inconveniences like ground disturbance, road closures, and dredging activity in adjacent waters. How would these activities impact your use of the marsh or adjacent areas? What concerns do you have?” Many responded that long-term protection of the marsh was worth short-term temporary disturbances.

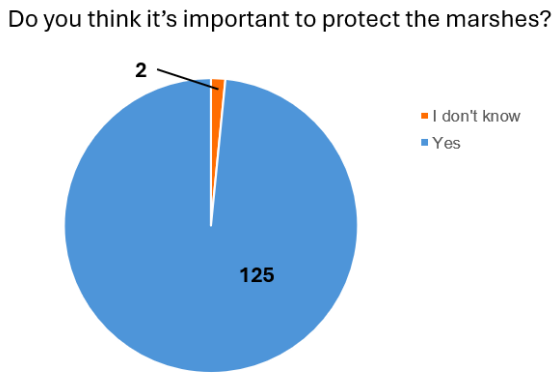


Figure 19. Survey responses from the Marsh Use Survey (n=127) regarding restoration.

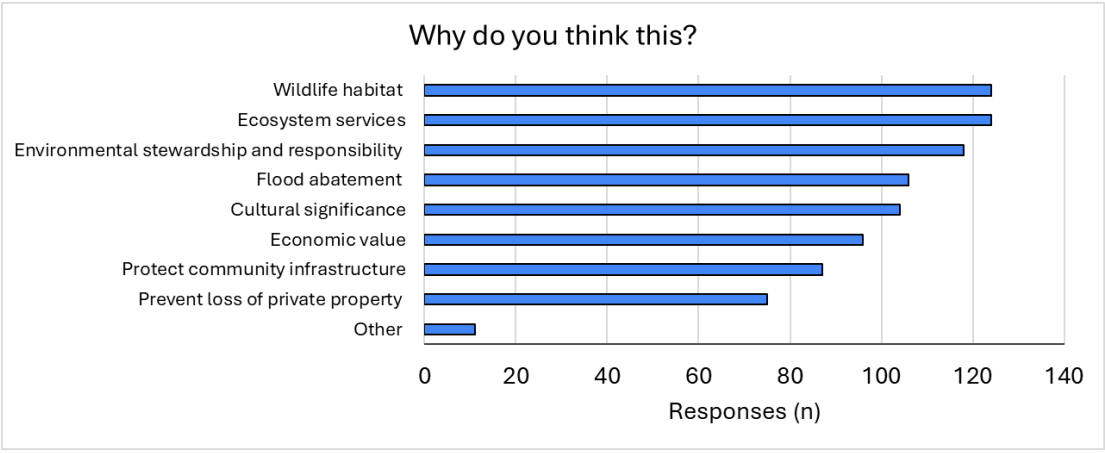


Figure 20. Survey responses from the Marsh Use Survey (n=127) regarding reasons for supporting salt marsh protection.

Twenty-two self-identified private landowners who participated in the marsh use survey indicated an interest in learning more about marsh restoration on their property.

This strategy for collecting community input was particularly useful because 30% of survey participants said they were not interested in attending an in-person community meeting.

Community Engagement Meetings

To make progress toward the CE Team Objectives 1 (learning how local communities relate to and use salt marshes), 2 (listening to community members on the topic of marsh restoration), and 3 (demonstrating local community support for marsh restoration), we organized two rounds of in-person community meetings (Figure 21) in January and August-September 2024 (Table 6).

Our goal for the January meetings was to introduce MfT, the project team, and our partners to community members in the MfT focal areas. During this first round of meetings, we held a presentation, a participatory mapping session (Figure 22), and open discussions (Objectives 1 and 2). In the second round of meetings, we employed the same type of engagement activities, with the added objectives of introducing, reviewing, and discussing the draft prioritization and restoration plans (Objective 3). At all community meetings, we encouraged questions from the public.



We'd love to meet!

Let's talk tidal marshes ...

Marshes for Tomorrow (MfT) is an ambitious project aiming to identify, protect, and restore at least 25,000 acres of the most important tidal salt marsh habitat in Maryland for Saltmarsh Sparrows. We recognize **community input** is exceptionally important for the success of this project in identifying the best locations to concentrate our conservation and restoration efforts for **birds and people**. The first round of **community meetings** is being held in January 2024 with a second round to follow in the spring. As part of our effort, we invite you to participate in a **marsh-use survey** found at www.delmarvarcn.org/marshesfortomorrow or via the QR code provided. For more information about MfT, please contact us directly via **marshes4tomorrow@gmail.com**.

Date	Time	Location (*refreshments provided!*)
January 19th 2024	4:30-6pm	Delmarva Discovery Center, Worcester County
January 20th 2024	2-3:30pm	Princess Anne library, Somerset County
January 25th 2024	5:30-7pm	Berlin library, Worcester County
January 27th 2024	2-3:30pm	Harriet Tubman Underground RR Visitor Center, Dorchester County

MfT is a coalition of partners led by Audubon Mid-Atlantic and funded through a National Fish and Wildlife Foundation's National Coastal Resilience Fund grant and U.S. Fish and Wildlife Service.

Photo credit (L to R): Saltmarsh Sparrow by Frank Lehman, Drone footage of saltmarsh by Larisa Prezioso, and Blackwater National Wildlife Refuge by Leonard Dagny.

Figure 21. Community meeting promotional poster.



Figure 22. Participants at a MfT community meeting. Photo: Sophia Seufert

We planned the meeting locations to keep driving time for those living closest to the salt marshes at less than 30 minutes, and we had a local restaurant cater each meeting (Figure 23). We decided to host some meetings in the early evening and others on weekend afternoons in an effort to accommodate different work schedules or home commitments. Approximately two to four weeks before each meeting, the CE Team placed event posters at local businesses, libraries, and other community meeting locations. Additionally, to increase attendance, team members sent personal invitations to Community Messengers, self-identified survey participants, and local elected officials, such as city/county council members and state representatives.

Table 6. The community meeting objectives, dates, and locations for each round (1 = January 2024, and 2 = August/ September 2024). The event in gray text was canceled due to inclement weather.

OBJECTIVE	DATE (2024)	MEETING LOCATION	COUNTY
ROUND 1: MFT INTRODUCTION AND INFORMATION GATHERING	Jan 19th	Delmarva Discovery Museum	Worcester (S)
	Jan 20th	Princess Anne Library	Somerset
	Jan 25th	Berlin Library	Worcester (N)
	Jan 27th	Harriet Tubman Park	Dorchester
ROUND 2: MFT UPDATE, INPUT REVIEW, AND INFORMATION SHARING	Aug 20th	Deal Island Rock Creek Church Community Room	Somerset
	Aug 27th	Berlin Library	Worcester (N)
	Sept 5th	Delmarva Discovery Museum	Worcester (S)
	Sept 7th	Blackwater National Wildlife Refuge Visitor Center	Dorchester

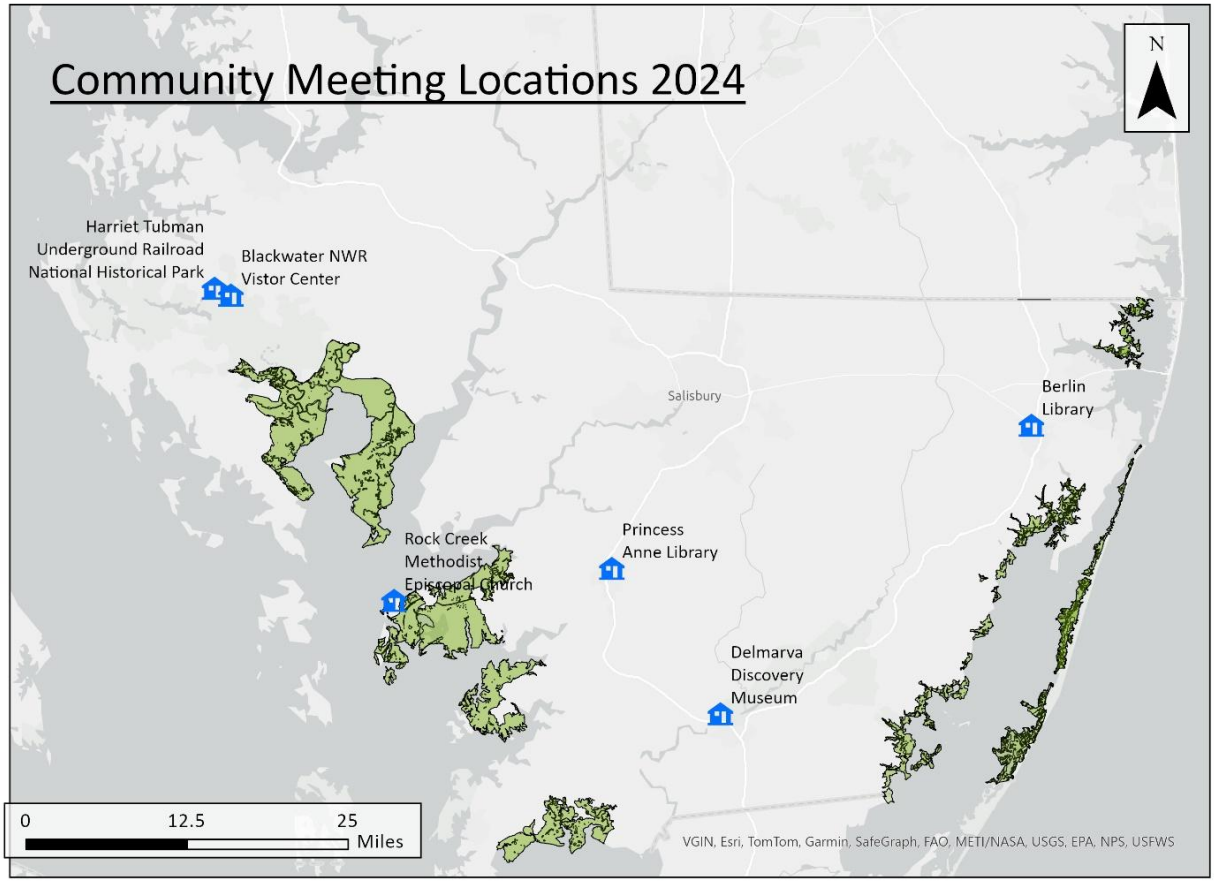


Figure 23. Map of meeting locations (blue symbols) in relation to MfT focal areas (shown in green).

After each community meeting, the CE Team held a debrief to reflect on the meeting's activities, themes, and logistics, enabling us to make adjustments prior to the next meeting. For example, we recognized that adding more instruction and familiar landmarks to the maps would help participants with the mapping exercise. These changes were incorporated into the summer meetings.

> *"Most people do not listen with the intent to understand; they listen with the intent to reply."*
>
> Stephen Covey, 2004
>
> We aimed to create an opportunity for community listening.

Results

We met with 69 people during seven in-person community meetings (Figure 24). Five of the 27 community members who participated in one of the Round 1 meetings returned during Round 2.

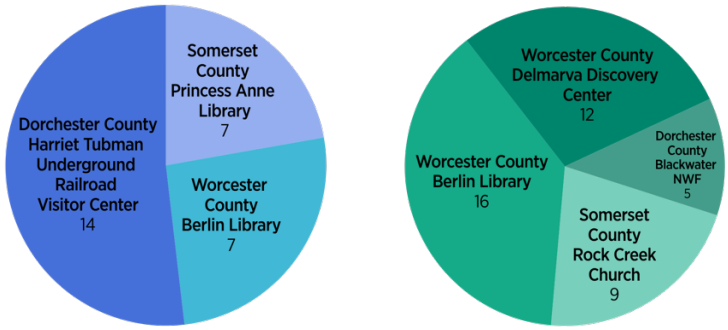


Figure 24. Attendance by location for community meetings.

The salt marshes of the Lower Eastern Shore hold a rich and diverse history of plant, animal, and human populations. The National Audubon Society acknowledges that the Marshes for Tomorrow focal areas encompass the ancestral lands of the Accohannock, Assateague, Choptank, Nanticoke (including specifically Nause-Waiwash and Wicomico), and Pocomoke Peoples, who have been forcibly displaced or removed since European colonization. Members of these tribes have historically stewarded and still actively advocate for the plants, animals, soils, and waterways essential for our ecosystem's health.

Through existing, trusted relationships, we personally connected with local tribal members from the Accohannock Indian Tribe, the Pocomoke Indian Nation, and the Nause-Waiwash Band of Indians. We extended invitations to attend community meetings, as well as the option to meet separately to share

information about the MfT initiative and offer input on our salt marsh restoration plans. Through these conversations with tribal chiefs, we received direct feedback and identified significant landscape features or practices that were incorporated into our recommendations to the MfT team.

We are humbled to build relationships through respect for culturally significant practices and values of Indigenous community members still present on the Lower Eastern Shore of the Chesapeake Bay, now and into the future.

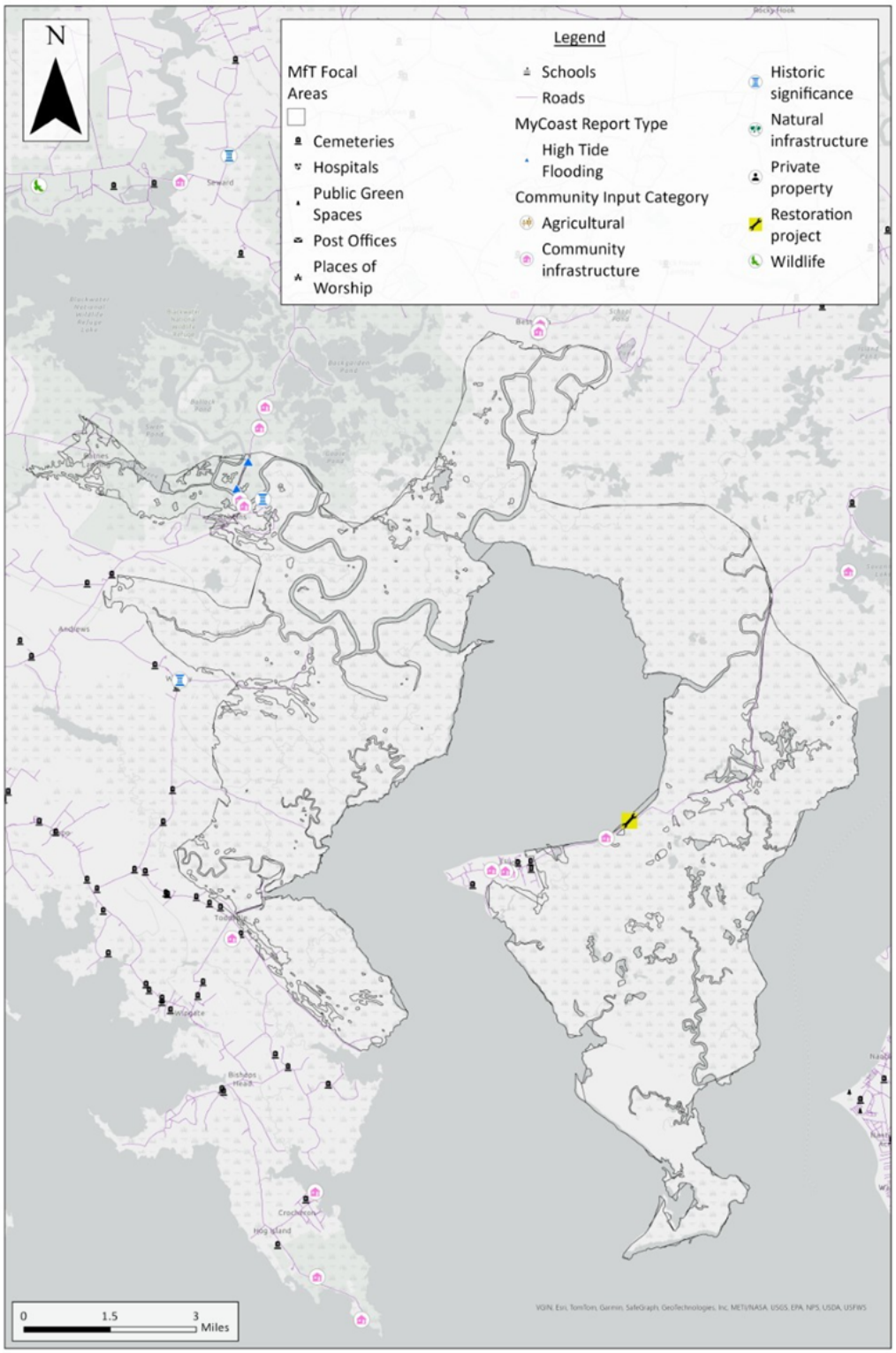
Community Input Database

We created a spatial database in ArcGIS Pro (Esri, Redlands, California) to organize community-generated input intended to inform the prioritization of marshes for restoration. The database combined results of the Marsh Use Survey and assets identified in the participatory mapping exercises. We added public records of flooding events housed in the Maryland Department of Natural Resources (DNR) MyCoast app, a community science initiative. Twenty-nine (of 418) MyCoast reports of community flooding were located within the MfT focal areas. We organized these data into seven categories: agriculture, community infrastructure, historical significance, natural infrastructure, private property, potential or ongoing restoration projects, and wildlife. For example, assets identified under the community infrastructure category included churches, access roads, and boat ramps.

The CE Team reviewed this database in spring 2024 and provided feedback on observed themes, surprising results, missing sources, and how this could inform the decision-making on salt marsh restoration prioritization. Following Round 2 of community meetings and the team's feedback, we added additional community input and baseline community infrastructure data from OpenStreet, including cemeteries, hospitals, post offices, public parks, religious areas, roads, and schools.

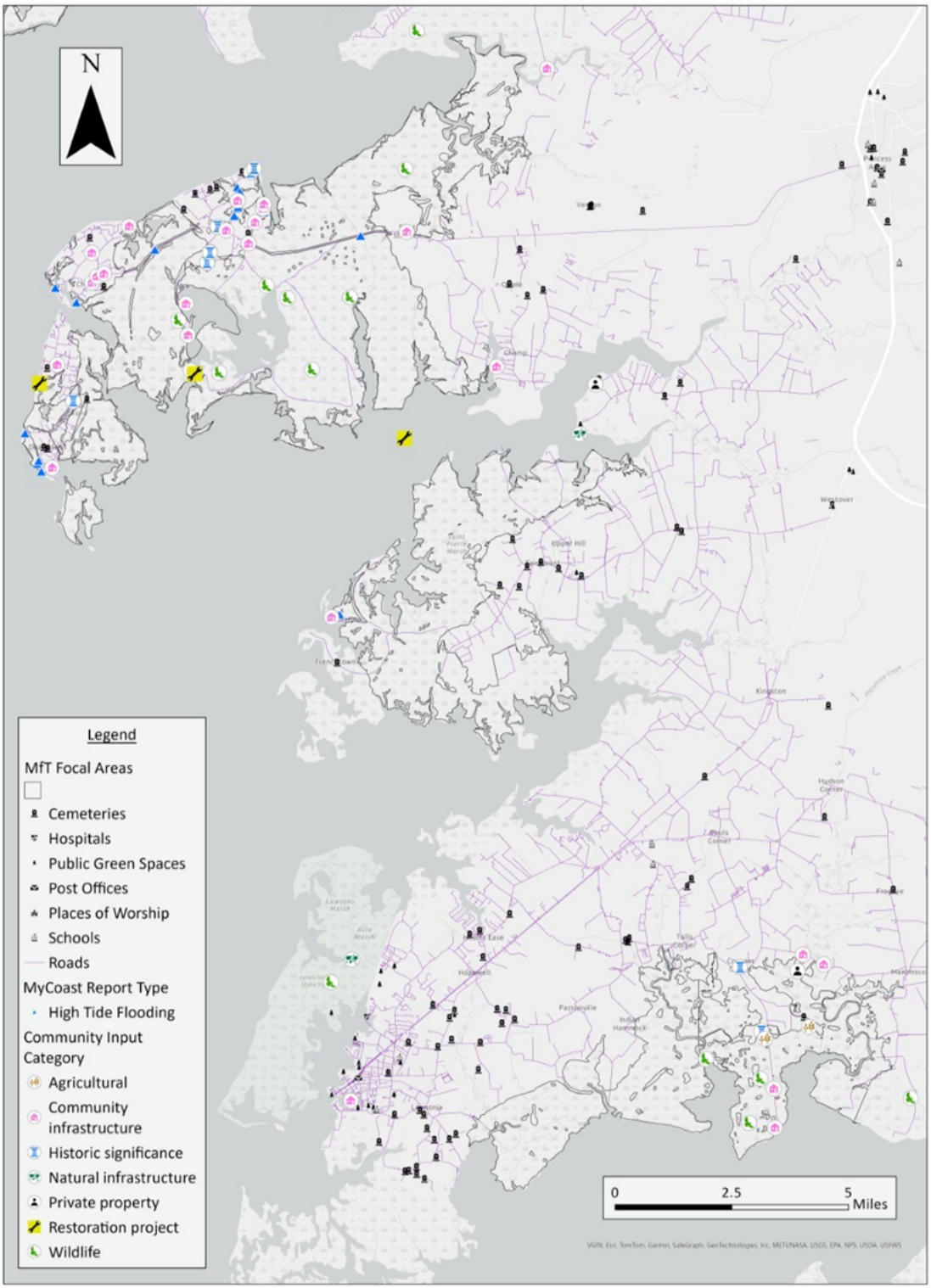
From the database, we produced a series of community infrastructure maps (Figures 25-28). We removed personal data, such as name or contact information, before adding these maps to the online MfT Experience Builder. We used the community infrastructure maps as a qualitative overlay, rather than a weighted factor, to inform the MfT marsh prioritization process (see Section 6).

Community input was one of six review criteria considered during the prioritization process. The community input often aligned with the results of the Prioritization Model, reinforcing decisions identifying Priority Marsh Areas (PMAs). Examples of locations that were prioritized using community data include southwestern Chincoteague Bay, where access from public roads was highlighted, and the Deal Island Wildlife Management Area, where wildlife viewing and public access points were identified.



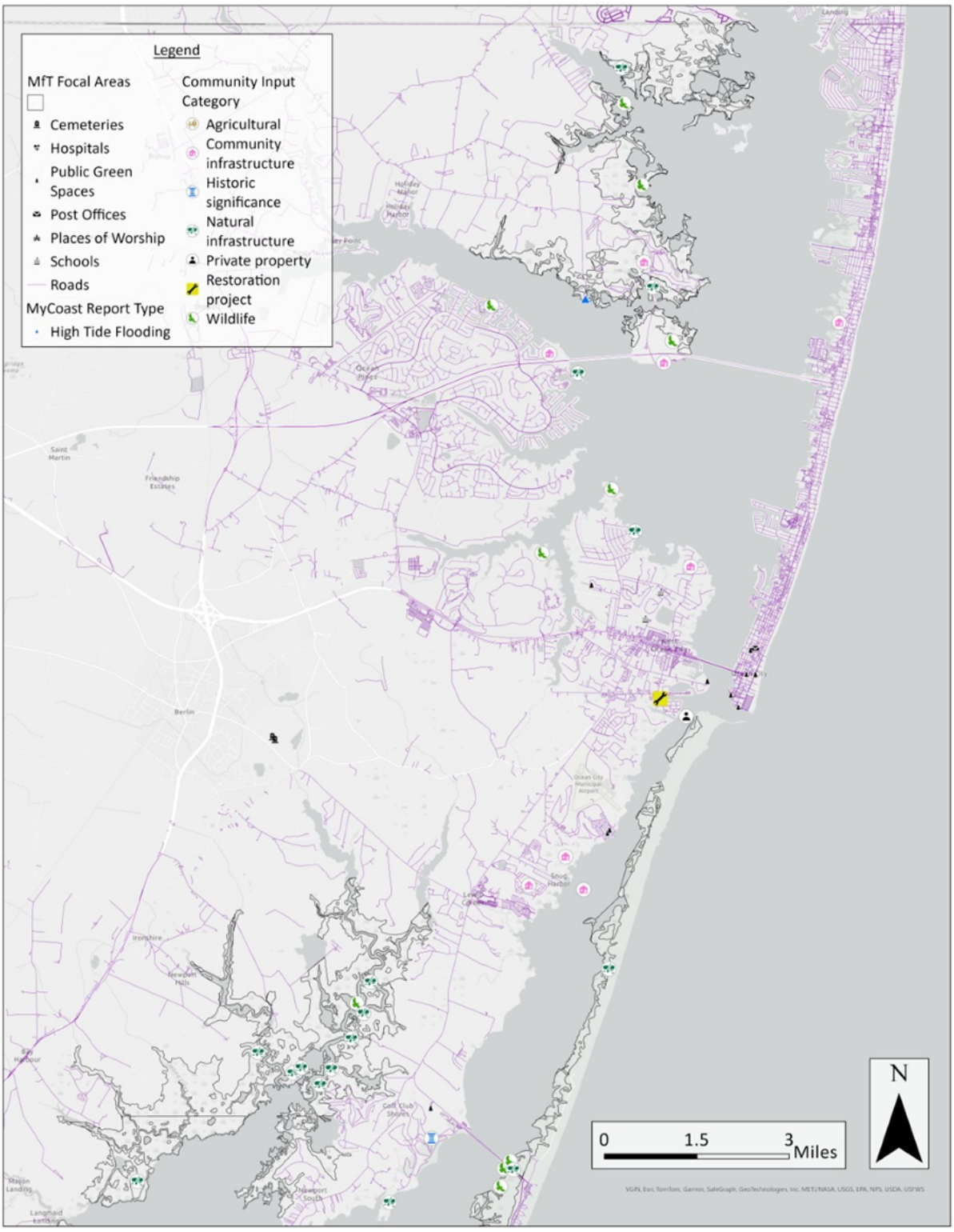
Henrietta Bellman, Audubon Mid-Atlantic.
Data: Light Gray Base Map, Maryland DNR MyCoast, Community collected input (Nov. 2023-Sept. 2024).

Figure 25. Community infrastructure and community-identified features collected through community meetings and surveys for the Blackwater NWR and Fishing Bay Focal Area.



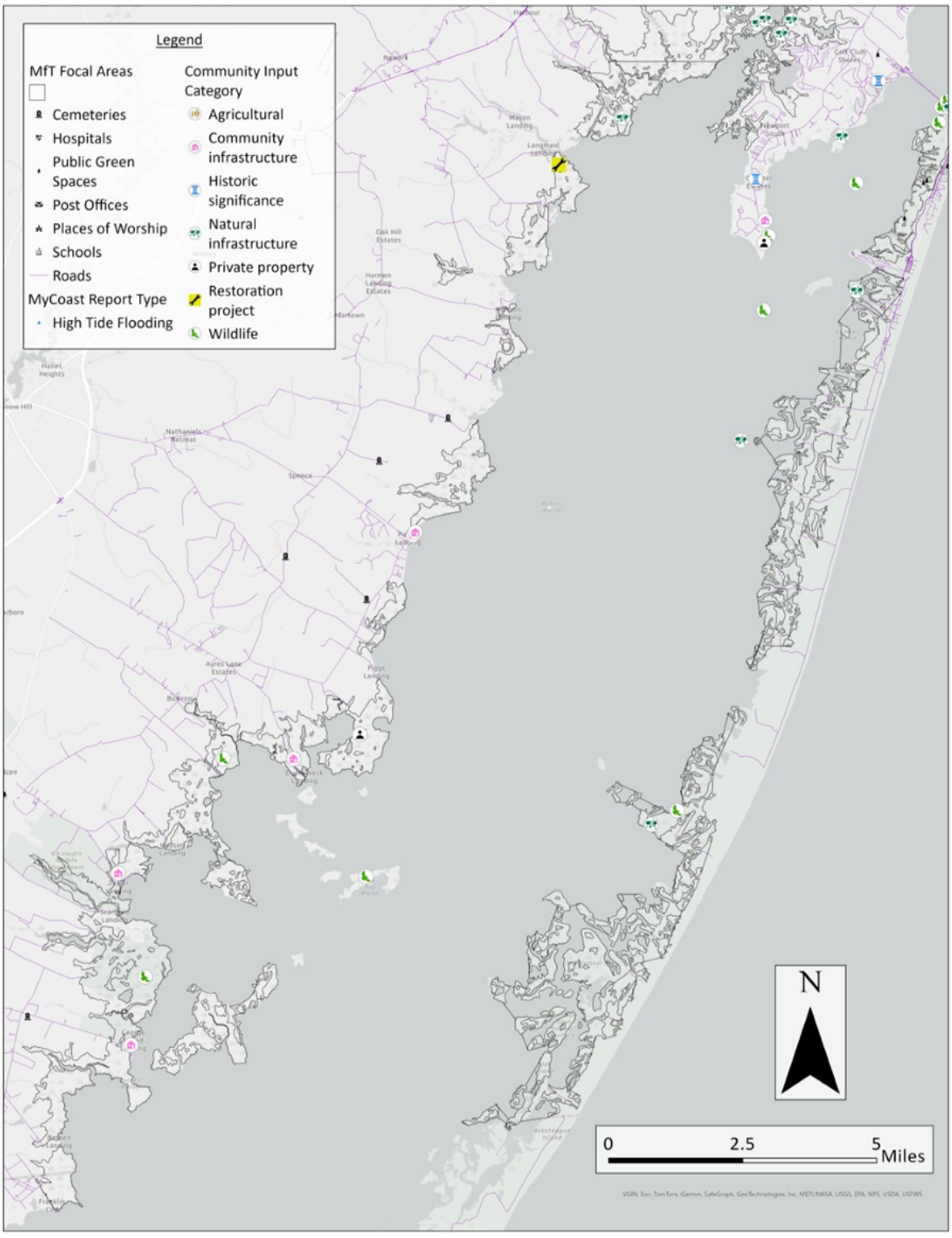
Henrietta Bellman, Audubon Mid-Atlantic.
Data: Light Gray Base Map, Maryland DNR MyCoast, OpenStree and community collected input (Nov. 2023-Sept. 2024).

Figure 26. Community infrastructure and community-identified features collected through community meetings and surveys for the Deal Island, Fairmount, and Pocomoke Sound focal areas.



Henrietta Bellman, Audubon Mid-Atlantic.
Data: Light Gray Base Map, Maryland DNR MyCoast, Community collected input (Nov. 2023-July 2024).

Figure 27. Community infrastructure and community-identified features collected through community meetings and surveys for the northern Maryland Coastal Bays Focal Area.



Henrietta Bellman, Audubon Mid-Atlantic.
Data: Light Gray Base Map, Maryland DNR MyCoast, Community collected input (Nov. 2023-Sept 2024).

Figure 28. Community infrastructure and community-identified features collected through community meetings and surveys for the southern Maryland Coastal Bays Focal Area.

LESSONS AND OPPORTUNITIES

During this phase of MfT, we focused on building long-term, respectful relationships with local communities. This effort took significant resources, genuine curiosity, and a sincere interest in building and strengthening trust through a network of local organizations.

We learned that project- and funding-related timelines do not always align with those of the communities we wish to connect with, especially if participation is not financially supported. However, when possible, adaptability and a willingness to adjust timelines can lead to full and deep conversations. A commitment to building flexibility into budgets and timelines of future engagement efforts will help to build on MfT efforts to date and strengthen mutual trust and respect.

Our community engagement relied heavily on partner organizations already working on the Lower Eastern Shore, underscoring the crucial need for collaboration in coastal restoration projects, especially those incorporating community resiliency and support.

These relationships are naturally biased toward the existing structure of on-the-ground work, which may preclude underrepresented groups from participating fully. Further, our survey intentionally excluded questions about race, age, and gender as we did not feel this was pertinent to our objectives. Overrepresented groups participating in our community meetings were predominantly white, 50 years of age or older, and environmental enthusiasts. We identified a future need to invest in groups within the community where relationships relevant to the MfT initiative still need to be created, such as local duck and deer hunting groups, farmers and watermen, and racially underrepresented African American and Hispanic or Latino communities of the Lower Eastern Shore. To do this, we must assess what additional barriers might limit participation. Recommendations include developing relationships with faith-based groups, providing gift cards or funding for participation, and providing child care or activities, as implemented during community meetings hosted by the Long Island Sound Study.

The input from community members was often rooted in personal and detailed stories unique to each participant. This qualitative data does not easily lend itself to habitat modeling exercises, but it is crucial in our decision-making because broad community approval is vital to our process. For example, by adjusting restoration timelines, we can avoid conflict during hunting or trapping seasons. The input of local communities highlighted a deep appreciation of salt marshes, which suggests that the long-term conservation of the marshes will bring tangible benefits to coastal communities.

As we elevate community input in implementing the MfT initiative, we commit to communicating and consulting with Indigenous leaders and acknowledging the importance of ongoing engagement to reach fuller representation among the underrepresented communities mentioned earlier. Additional efforts toward a more inclusive process should also involve pairing habitat restoration with community resiliency projects/objectives and consulting with landowners on projects that co-benefit private and public lands. Above all, we recognize the essential need to share and seek input on individual marsh parcels before, during, and after on-the-ground restoration projects.

Section Six: Marsh Prioritization

At a Glance

- To prioritize marshes for long-term maintenance as high marsh (called **Priority Marsh Areas, or PMAs)**, a process was developed to identify marshes that represent the highest-quality habitat for the Saltmarsh Sparrow, the areas most resilient to future sea level rise, and the most feasible places for implementing restoration projects.
- The prioritization process employed a weighted Prioritization Model, which considered marsh condition, vegetation, proximity to marsh migration corridors, and proximity to sediment sources for marsh nourishment.
- Several additional criteria were also used to inform the process, including landownership, Saltmarsh Sparrow abundance, community infrastructure, and feedback from local communities and subject matter experts.
- A total of 11,792 ha (29,140 ac) of PMAs were identified, capturing approximately 77 percent of Maryland's healthy and resilient Saltmarsh Sparrow habitat and focusing on the most feasible areas for restoration.

Objective 1 of the Marshes for Tomorrow (MfT) initiative is to "identify at least 10,117 ha (25,000 ac) of salt marsh to be maintained in the long term to conserve the high marsh ecosystem and Saltmarsh Sparrow in Maryland in the face of sea level rise." The Atlantic Coast Joint Venture (ACJV) identified approximately 27,114 ha (67,000 ac) of salt marsh as priority marsh for the Saltmarsh Sparrow in Maryland.[20] The MfT initiative used these priority marshes as a starting point to define the initiative's overall focal area and then worked to further prioritize the most appropriate subset of these marshes to select a target 10,117 ha (25,000 ac).

Our intent in selecting the target 10,117 ha (25,000 ac) was to identify marshes that represent:

- the highest-quality habitat for the Saltmarsh Sparrow,
- the areas most resilient to future sea level rise (SLR), and
- the most feasible places for implementing restoration projects.

While there is much overlap in locations satisfying these criteria, because the Saltmarsh Sparrow occupies the highest and most resilient marsh zone, there are some notable differences. For example, significant areas of high marsh in the Chesapeake Bay are dominated by *Juncus roemerianus*, which the Saltmarsh Sparrow does not use as breeding habitat. Due to this variation in high marsh vegetation types, we developed a Prioritization Model to help select the target acreage.

MARSH PRIORITIZATION PROCESS

The prioritization process utilized the following methodology:

1. **Marsh Condition Model Review |** At two online meetings in May 2024, 50 staff from environmental agencies, universities, and nongovernmental organizations (NGOs) reviewed the Marsh Condition Model and other spatial data in the MfT GIS Experience Builder. They subsequently split into small groups and ranked a list of criteria provided by the MfT initiative team for prioritizing marshes for Objective 1.
2. **Prioritization Model Development |** The ranked list of criteria was used to create a weighted Prioritization Model and a list of additional criteria to be used as spatial overlays to further inform prioritization.
3. **Prioritization Model Review |** At a Maryland Coastal Bays workshop in July 2024, 28 participants identified the most relevant prioritization criteria for the Coastal Bays Focal Area. At a Chesapeake Bay workshop in August, the weighted Prioritization Model was reviewed by 28 participants. The revised model, incorporating feedback from both workshops, was later applied to all MfT focal areas.
4. **Selection of Priority Marsh Areas |** In September 2024, small focus groups met separately for the Chesapeake Bay and Maryland Coastal Bays marshes and used the revised Prioritization Model and spatial layers for additional criteria to divide the marsh within the MfT focal areas into two classes:

    a. **Priority Marsh Areas (PMAs)** for long-term maintenance as high marsh habitat suitable for the Saltmarsh Sparrow through restoration. Resources should be focused on PMAs, and restoration projects should be implemented according to a schedule.
    b. **Opportunistic Marsh Areas,** where restoration actions can be implemented as specific partnerships arise. Such opportunities could include targeted funding, landowner intent, and the management objectives of public agencies. Projects in these areas should be evaluated during the planning phase to assess their potential to maintain or create high marsh habitat suitable for the Saltmarsh Sparrow.

At each focus group meeting, proposed PMAs were drawn by hand onto paper maps of the Prioritization Model and later refined in ArcGIS.

The complete list of criteria considered in the marsh prioritization process is provided in Table 7. Four criteria were included as weighted factors in the Prioritization Model, and the five additional criteria were displayed as visual overlays that informed our decision-making and selection process as qualitative data.

Table 7. Marsh prioritization criteria and corresponding data layers.

Marsh Prioritization Criteria	Data Layer	Included as
Marsh in the "best" condition/with best restoration potential	Marsh Condition Model	Weighted factor in Prioritization Model
High marsh habitat for the Saltmarsh Sparrow	Vegetation	Weighted factor in Prioritization Model
Proximity to upland marsh migration corridors	Marsh migration corridor	Weighted factor in Prioritization Model
Proximity to sediment sources	Dredging buffers and navigation channels	Weighted factor in Prioritization Model
Landownership	Landownership	Additional criteria
Saltmarsh Sparrow abundance	SHARP abundance 2021-2022	Additional criteria
Community feedback and infrastructure	Community-identified features and community infrastructure	Additional criteria
Landowners enthusiastic about restoration; conserved lands	Protected lands	Additional criteria
Large contiguous marsh blocks	No specific data layer	Additional criteria

The Prioritization Model was a simple additive model that included four factors for which weighted scores were developed (Table 8). These scores were based on the following rationale.

1. Marsh in the "best" condition and with the highest restoration potential. We gave this criterion the highest weighting of the four criteria and used the Marsh Condition Model output classes to represent it. Marsh Condition Class 1 received full weight (45), and the proceeding scores received less weight as they decreased in condition.
2. High marsh habitat for the Saltmarsh Sparrow. We gave this criterion the second-highest weighting of the four criteria and used the vegetation map to represent it. Marsh units with no *Spartina patens* mapped were scored low but greater than 0 because of the potential for future conversion of *J. roemerianus* to suitable sparrow habitat through fire management.
3. Proximity to sediment dredging. This criterion was given a low weighting because it is uncertain how important proximity to current dredging operations and cost will be to restoration plans in future decades, when the need for sediment placement will increase. New sources of dredged material could become available if, for example, wetland regulations are revised in the future to allow dredging specifically for the purpose of ecosystem restoration.

4. Marsh migration corridor. We used the marsh migration envelope, mapped in the MfT Experience Builder, which is defined as areas of overlap between three bay-wide marsh migration models — SLAMM 5.0, InVEST, National Oceanic and Atmospheric Administration (NOAA) SLR Viewer — based on 0.6m (2 ft) of relative SLR projections using methodology from the marsh migration data synthesis project led by the Virginia Institute of Marine Science. This criterion was given a low weighting and similar scores for locations close to and distant from marsh migration corridors. Marsh within 500m (547 yd) of an upland marsh migration corridor received a slightly higher score.

Table 8. Factor weightings and scores for the Prioritization Model.

Criteria	Weighting Score Within This Criterion (1-100)	Weighting Score of This Criterion (0-1)	Final Score
Marsh Condition Model		0.45	
Class 1	100		45
Class 2	90		40.5
Class 3	50		22.5
Class 4	20		9
Vegetation		0.3	
Spartina >25%	100		30
Spartina <25%	70		21
Spartina = 0	30		9
Beneficial Use Locations		0.125	
< 3 miles	100		12.5
3-5 miles	70		8.75
> 5 miles	30		3.75
Marsh Migration Corridor		0.125	
< 500m	100		12.5
> 500m	80		10

The Prioritization Model assigned a score from 31-100 to each marsh unit in the MfT focal area. The range of scores (31-100) was divided into five equal categories to yield five prioritization tiers for mapping, with Tier 1 representing the highest-priority marsh units.

The model was mapped and added to the MfT Experience Builder. Figure 29 shows that the majority of marshes were identified as Tier 1 or Tier 2.

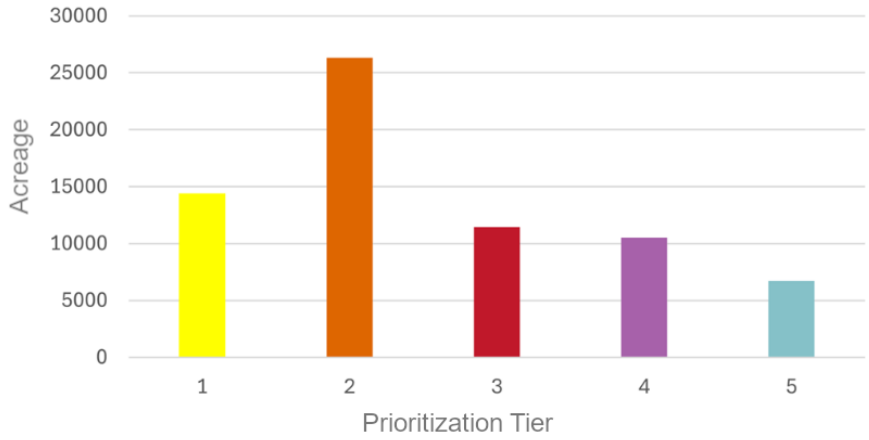


Figure 29. Distribution of prioritization tiers by acreage across all MfT focal areas (1 ac = 0.4 ha).

The totals in Figure 29 suggested that the MfT target acreage of 10,117 ha (25,000 ac) could be reached by including as much Tier 1 marsh as possible and supplementing this with marsh from Tier 2. The participants in the Chesapeake Bay focus group meetings adopted an approach of building PMAs around cores of Tier 1 marsh, expanding across Tier 2 marsh, and considering additional criteria as a guide. In the Maryland Coastal Bays, where the Prioritization Model showed very little Tier 1 marsh, focus group participants built PMAs around cores of Tier 2 marsh and considered additional criteria.

The additional criteria, which are listed above in Table 7, were used to supplement the Prioritization Model and were applied using the following guidelines.

Community input database. Although a wide selection of community features were mapped, most infrastructure types were absent from marsh habitat. A notable exception is roads, which provide a vital transport link through rural marshlands to the mainland for coastal communities and provide access to the marsh for hunting, fishing, and recreation. According to our community engagement, the most frequently reported use of marshes was recreation, and locations identified for this activity coincided with road access. Several PMAs include smaller public roads and boat ramps, and one PMA (Fishing Bay East) was extended to include marsh buffering a public road.

Geographic representation. Although PMAs were delineated independently in each of the five MfT focal areas, an effort was made to ensure representation across the focal areas as well. This approach happened to align well with the consideration of some additional criteria, namely vegetation and Saltmarsh Sparrow abundance. In the initial delineation, extensive areas of marsh mapped as Tier 2 in the Blackwater-Fishing Bay Focal Area were included in PMAs. However, *J. roemerianus*-dominated marsh was removed from these areas to allow for the inclusion of marsh in the Maryland Coastal Bays, which was mapped as Tier 2 and Tier 3 but likely supported the Saltmarsh Sparrow. No PMAs were identified in the Fairmount Focal Area because the area's acreage of Tier 1 marsh was limited, and restoration resources might be more effectively used elsewhere.

Landownership. The MfT initiative aimed to achieve a balance of landownership categories to increase the potential for taking advantage of a fuller range of future funding opportunities. For

example, in the Blackwater-Fishing Bay Focal Area, which is primarily state-owned, the PMA includes several inholdings of private land. In the Maryland Coastal Bays and Pocomoke Sound focal areas, which are predominantly privately owned, wildlife management areas (WMAs) owned by the Maryland Department of Natural Resources were included even where the marsh is in a deteriorated condition.

Large contiguous blocks. PMAs were created to include large contiguous blocks of marsh and to avoid holes within these by including patches of lower-priority marsh. Isolated fragments of Tier 1 marsh within marsh of lower priority were generally excluded.

Saltmarsh Sparrow abundance. Focus groups referred to maps of Saltmarsh Sparrow abundance from Saltmarsh Habitat and Avian Research Program (SHARP) surveys (2021-22), with the intention of favoring clusters of high abundance over clusters of low abundance. The sampling coverage of the SHARP surveys was randomized, so most marsh locations had no Saltmarsh Sparrow data. Saltmarsh Sparrow data were used only to test assumptions about marsh condition and habitat quality and not to drive the prioritization process. The assumption that clusters of high abundance would occur mostly in marsh mapped as high priority was borne out in the Chesapeake Bay marshes and also in Newport Bay, in Worcester County. Other locations in the Maryland Coastal Bays had clusters of Saltmarsh Sparrow detections in lower-priority marshes.

Vegetation. Vegetation was included as a weighted factor in the Prioritization Model, but was consulted separately to identify marsh dominated by *J. roemerianus*, which is unsuitable habitat for the Saltmarsh Sparrow. The intention was to include extensive areas of *J. roemerianus* in PMAs only if sufficient high-priority marsh was unavailable elsewhere.

MARSH PRIORITIZATION RESULTS

A total of 11,792 ha (29,140 ac) of PMAs were selected across all MfT focal areas. The PMA acreage in each focal area is given in Table 9.

Table 9. Acreages of Priority Marsh Areas for restoration in each MfT focal area.

MfT Focal Area	Acreage of Priority Marsh Area (PMA)
Blackwater-Fishing Bay	3,852 ha (9,519 ac)
Deal Island Peninsula	3,036 ha (7,502 ac)
Fairmount	0 ha (0 ac)
Pocomoke Sound	2,791 ha (6,897 ac)
Maryland Coastal Bays	2,113 ha (5,221 ac)
Total	11,792 ha (29,140 ac)

The selected PMAs contain the majority of best-quality marsh within the MfT focal area, based on the Marsh Condition Model. Table 10 gives a breakdown of the condition of this marsh in terms of the two principal criteria driving the prioritization: the Marsh Condition Model class and vegetation.

Table 10. Acreages of Priority Marsh Areas, by Marsh Condition Class and vegetation classes.

	Marsh Condition Class				Totals
Vegetation	1	2	3	4	
>25% *S. patens*	3,551 ha (8,775 ac)	933 ha (2,305 ac)	1,909 ha (4,717 ac)	752 ha (1,859 ac)	7,145 ha (17,656 ac)
<25% *S. patens*	3,068 ha (7,581 ac)	703 ha (1,736 ac)	565 ha (1,395 ac)	328 ha (810 ac)	4,664 ha (11,522 ac)
Totals	6,619 ha (16,356 ac)	1,636 ha (4,041 ac)	2,474 ha (6,112 ac)	1,080 ha (2,669 ac)	11,809 ha (29,178 ac)

Of the 5,839 ha (14,429 ac) of healthy and resilient Saltmarsh Sparrow habitat (identified as Marsh Condition Classes 1 and 2 with >25% *S. patens* cover) that exists across the MfT focal areas (see Section 4, Table 4), the PMAs capture 4,484 ha (11,080 ac), 77% of this total. These are the salt marsh areas with the greatest feasibility for ensuring the persistence of healthy high marsh, and a viable population of Saltmarsh Sparrows, in Maryland, and habitat restoration efforts should be focused on these areas.

Section Seven: Restoration Actions

At a Glance

- A variety of marsh restoration practices have been applied in Maryland, including hydrological repair, sediment placement, invasive species control, living shorelines, and facilitated marsh migration. However, the cumulative impact of restoration so far is limited, and efforts will need to be rapidly scaled up to save a significant portion of the high marsh ecosystem from sea level rise.
- The Marshes for Tomorrow (MfT) project created a spatial model, the Restoration Decision Model, based on marsh health and surface elevation, to map locations where different restoration practices are needed. The model focuses on the two most widely needed restoration practices for maintaining high marsh: hydrological repair (to enhance marsh health) and sediment placement (to return the surface elevation of subsided marsh to a high marsh condition).
- A model validation exercise found broad agreement between the Restoration Decision Model and actual project designs. However, the model does have errors associated with elevation data, failing to predict a need for sediment placement in locations where elevation data is out of date or where dense vegetation results in upward bias in elevation estimates.
- The Restoration Decision Model estimates a current need for hydrological repair on marsh units totaling 4,295-4,526 ha (10,613-11,185 ac) and a current need for sediment placement in marsh units totaling 1,704-2,998 ha (4,210-7,409 ac) within the Priority Marsh Areas identified by MfT.
- Despite the model's utility for landscape-scale planning, site-specific assessments and field verification are necessary for individual restoration project designs.

The Atlantic Coast Joint Venture (ACJV) Saltmarsh Sparrow Conservation Plan[21] includes four categories of conservation action that are necessary to maintain sufficient habitat to recover and sustain Saltmarsh Sparrow populations over the long term. These include:

1. Protect and restore salt marsh;
2. Outreach and engagement;
3. Enhance Saltmarsh Sparrow breeding populations; and
4. Non-breeding season habitat conservation strategies.

The Marshes for Tomorrow (MfT) initiative focuses on the first category of salt marsh protection and restoration. Strategies for land protection through conservation easements and other mechanisms, as well as outreach and engagement, have been developed by The Nature Conservancy and the Maryland Department of Natural Resources (DNR), among others.

Strategies for enhancing Saltmarsh Sparrow breeding populations are outlined in the ACJV Saltmarsh Sparrow Conservation Plan,[21] and include:

- Use of tide gates to dampen extreme tides, reduce storm surges, and improve nest success;
- Inclusion of microtopographic features such as hummocks in restoration design to provide areas of increased elevation that can function as flood-free nest habitat;
- Predator control; and
- Techniques to protect individual nests, where necessary.

These strategies should be employed where appropriate in Maryland marshes where Saltmarsh Sparrows nest. Not all of the strategies will apply to each site, and site-specific conditions should be assessed while considering appropriate ways to increase Saltmarsh Sparrow nest success. These techniques will need to be implemented within an experimental framework and evaluated for their effectiveness.

DEFINING RESTORATION

The Society of Ecological Restoration defines ecological restoration as "the process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed." The causes of degradation, damage, or destruction can vary from acute anthropogenic causes, such as urbanization, the introduction of invasive species, and grazing, to long-term accumulation causes, including the overexploitation of ecological resources, erosion, and climate-driven sea level rise. Both acute and long-term causes can result in a decline in native species, biodiversity, and ecological functionality, which can have implications for wildlife populations and human welfare.[66]

Ecological restoration aims to recover ecosystem conditions and reflect shared values.[67] There is intrinsic value and collective stewardship responsibility for maintaining ecosystem health for Maryland's salt marshes and the wildlife that depends on them. In Maryland, the cumulative impact of recent restoration is limited in extent and not at a sufficient scale to address the threat to Maryland's salt marshes.

The ACJV's Salt Marsh Bird Conservation Plan emphasizes that to conserve species of greatest conservation concern, including the Saltmarsh Sparrow and Eastern Black Rail, we must increase the quality and resilience of high marsh habitat through restoration, enhancement, and management efforts.[19]

SALT MARSH RESTORATION IN MARYLAND

A wide range of projects that include salt marsh restoration have been completed in Maryland. The best known are high-profile projects to rebuild islands in the Chesapeake Bay, including Hart-Miller Island, Poplar Island, and the Mid-Bay Island Ecosystem Restoration Project.

These large-scale projects have been funded by Congress, and the economic driving force behind them is the need to dispose of sediment dredged from the shipping channels approaching the Port of Baltimore. The beneficial use of these dredged materials for ecosystem restoration is widely seen as a win-win for the economy and coastal biodiversity.

A number of smaller-scale marsh restoration projects have also been implemented in the state, and the goal driving most of these has been ecosystem restoration and protection of property in coastal communities. These projects deployed restoration techniques such as sediment placement, hydrological repair through the construction of runnels and tidal creek extensions, living shorelines, and the control of invasive plants (mostly *Phragmites australis*) and introduced herbivores, including nutria and wild horses. Examples of these projects are briefly summarized below in the Salt Marsh Restoration Techniques section. So far, there is one example of a Beneficial Use of Dredged Material (BUDM) project that includes high marsh habitat creation among its objectives. The Lower Wicomico River Maintenance Dredging Project, also known as the Deal Island Marsh Restoration Project, is a diverse partnership of environmental agencies, state and governmental agencies, university researchers, and nongovernmental organizations (NGOs) working closely with the U.S. Army Corps of Engineers (USACE) to achieve habitat objectives and to implement an adaptive monitoring plan. This approach holds promise as a template for future marsh restoration in locations close to federal navigation channels.

The cumulative impact of salt marsh restoration projects in Maryland is limited to date. At Poplar Island, an impressive 461 ha (1,140 ac) of island habitat, much of it salt marsh, has been created, but beyond the large-scale, congressionally funded projects, the extent of restored marsh is probably less than 405 ha (1,000 ac). This total excludes invasive plant control and herbivore control programs. The scale and pace of restoration will need to be rapidly increased if we are to meet the challenge of marsh loss resulting from sea level rise.

SALT MARSH RESTORATION TECHNIQUES

The ACJV's salt marsh conservation plans[19,21] describe restoration practices that show promise for restoring and maintaining high marsh habitat over the long term. These practices are briefly summarized below, along with notes on their application to Maryland and examples of projects that have been implemented in the state.

Hydrological Repair: Runnels

When water becomes trapped on the marsh surface for a prolonged period, it can lead to vegetation dieback, marsh surface collapse, and ponding. One remedy is to excavate runnels, using shallow, sinuous channels that connect trapped water to existing drainage features, such as creeks or ditches, and allow the water to escape. Runnels can be constructed manually with a shovel or by using a low-pressure ground excavator and are a relatively novel, low-tech solution that has been implemented effectively in New England.[68,69] Excavated peat can be reused to create structured microtopography, such as hummocks, which can provide flood-free nesting sites for birds. This restoration practice will likely also benefit fish communities (David Bruce, National Oceanic and Atmospheric Administration (NOAA), personal communication, January 7, 2025).

Application of Runnels in Maryland

The first restoration project to use runnels in Maryland was implemented by the U.S. Fish and Wildlife Service (USFWS) at Rum Pointe in Sinepuxent Bay, Worcester County, in January 2023. Runnels were

excavated by hand to connect recently formed waffle pools to ditches at several locations across a 16-ha (40-ac) site in heavily ditched marsh. Waffle pools are shallow rectangular pools that form in the center of marsh "cells" and are thus disconnected from the ditch network.[53]



Figure 30. Runnel at Rum Pointe, Worcester County. Photo: David Curson/Audubon

A number of other projects proposing runnel construction are planned at sites in the Maryland Coastal Bays and at the Irish Grove Sanctuary in Somerset County. Despite the novelty of this technique, runnels hold considerable promise as a low-cost, low-tech action that can be implemented early on to halt the process of marsh deterioration, revitalize marsh vegetation, and potentially boost accretion rates. Thus, runnels can enhance marsh resilience to sea level rise by increasing the marsh's natural ability to gain elevation.

There are many marshes in Maryland where waterlogging and interior vegetation dieback and ponding can be mitigated by runneling, and this restoration practice should be rapidly implemented, where appropriate, to buy time by slowing down the rate of marsh deterioration. Critically, runneling should be applied only in marshes above mean sea level where there is sufficient elevation capital for trapped water to drain and there is close proximity to existing drainage features. They should be constructed in such a way as to minimize flushing action from tidal inflow and outflow, which could remove sediment from the marsh platform.

Hydrological Repair: Ditch Remediation

Marshes with a dense network of ditches dug for mosquito control and increased drainage are often degraded due to marsh subsidence, making them more vulnerable to sea level rise. Heavily ditched marshes can be mitigated to some extent by ditch remediation, in which some of the ditches are filled

with cut vegetation or sand.[70] This technique is relatively novel, and its benefits have not been effectively documented, but it may increase sheet flow on subsided marshes, which could increase sediment capture.

Application of Ditch Remediation in Maryland

Ditch remediation has been piloted at Assateague Island National Seashore where, between 2006 and 2012, ditches were filled with sand from the barrier island beach. Approximately 202 ha (500 ac) of salt marsh was successfully restored using this technique, with future plans for additional acres of restoration.

A number of planned marsh restoration projects in the Maryland Coastal Bays are incorporating ditch remediation into their designs, along with other restoration methods, including the creation of natural tidal creeks in the marsh. In 2010, a different method of ditch treatment, ditch plugging, was implemented in subsiding marsh at the E.A. Vaughn Wildlife Management Area (WMA), with the goal of restoring high marsh. Unfortunately, this method had the unintended consequence of increasing waterlogging on the marsh surface, as evidenced by the rapid conversion of high marsh vegetation to low marsh. It is unclear whether the increased waterlogging could have been avoided if the ditches had been filled rather than plugged, or if the waterlogging had occurred due to a site-specific factor. As such, ditch remediation should be carefully considered as a restoration tool where a high density of ditches is compromising marsh hydrology and where there is a comprehensive, site-specific understanding of the hydrological system. There is a high density of ditches found in salt marshes of the Maryland Coastal Bays. There are other areas of heavily ditched marsh at scattered locations in the Chesapeake Bay, including the Deal Island WMA and parts of the Fishing Bay WMA.

Hydrological Repair: Tidal Restriction Mitigation

Transportation infrastructure, such as roads or railways, can restrict tidal flow and disrupt the natural hydrology of marshes. Often, this results in excessive and prolonged flooding where water becomes trapped above some barrier. Removing tidal restrictions in such situations generally involves enlarging and/or unblocking a culvert beneath a road to restore flow.

Application of Tidal Restriction Mitigation in Maryland

Maryland's salt marshes are relatively free of transportation infrastructure compared to coastal regions in New England, where railways restrict tidal flow in many marshes. However, most large salt marsh landscapes in Maryland are traversed by one or more roads, which act as tidal restrictions. Many drainage culverts beneath these roads are undersized or blocked and are in need of enlarging or clearing. Doing so represents "low-hanging fruit" as a marsh restoration strategy because these tidal restrictions are relatively easy to locate and fix. Agencies should take a systematic approach to mapping and mitigating all such tidal restrictions, with priority given to sites within Priority Marsh Areas (PMAs) identified by the MfT initiative.

Hydrological Repair: Tidal Creek Extension

Tidal creek extension is a novel technique of hydrological management that helps facilitate the effective upslope migration of tidal marshes under the influence of sea level rise.[2,51] Salt marsh vegetation readily replaces upland vegetation once tidal flooding introduces salt water, but the establishment of stable high marsh vegetation can be compromised by the lack of a tidal creek network if ground surface collapse leads to shallow basin formation and ponding.[2] The resulting waterlogging surrounding ponds can be alleviated by excavating extensions of nearby tidal creeks into the inundated area. The principle behind this practice is similar to that of runnels, but it is implemented

on a larger scale. Tidal creek extension is just one of a suite of restoration techniques that can potentially facilitate marsh migration.



Figure 31. Excavating a tidal creek extension at Farm Creek Marsh, Dorchester County. Photo: Peter Stango/Maryland DNR

Application of Tidal Creek Extension in Maryland

Tidal creek extension is largely untested, but one project has been implemented at Farm Creek Marsh in Dorchester County.[71] In October 2018, the Maryland DNR and the Audubon Mid-Atlantic Coasts Team excavated two extensions of a tidal channel into flooded marsh. The extensions were 516 feet and 373 feet in length, respectively. Water levels and vegetation dynamics were monitored before and after construction,[72] but monitoring ceased in 2020. A publication describing this project[51] identified other locations on the Delmarva Peninsula that might benefit from this method of restoration.

Sediment Placement

Where marshes have lost elevation due to subsidence or vertical accretion not keeping pace with sea level rise, the only way to restore marsh below mean high water (MHW) to a high marsh condition is to add sediment to raise its elevation.[73] This method is often referred to as marsh nourishment to account for the fact that materials other than sediment can sometimes be used. Replanting the applied sediment with high marsh plant species is usually necessary to establish the desired marsh vegetation. Sediment placement is an expensive and high-tech restoration practice and is limited by cost and the availability of suitable material. Dredged material is the main source of sediment used in marsh restoration, and thus, sediment placement is usually limited to locations near existing dredging operations.

Application of Sediment Placement in Maryland

There are two examples of restoration projects in Maryland using sediment placement with the goal of restoring submerging, eroded marsh to a high marsh habitat condition.

1. At Shorters Wharf in Blackwater National Wildlife Refuge (NWR), Dorchester County, a sediment placement project was completed in December 2016. The project was implemented by the Blackwater 2100 partnership of the USFWS, The Conservation Fund, Audubon Maryland-DC, and Sustainable Science, LLC. Approximately 19,878m^3 (26,000 yd^3) of material was dredged from the Blackwater River adjacent to the project site for the specific purpose of marsh habitat restoration and deposited on 16 ha (40 ac) of marsh. Native vegetation (*Schoenoplectus americanus* and *Spartina alterniflora*) regenerated through the placed sediment and was supplemented with hand-planting of 217,000 plugs of *Spartina patens* and 20,700 plugs of *Distichlis spicata*. The project cost $2.1 million and was funded by a grant from the National Fish and Wildlife Foundation's (NFWF) Hurricane Sandy Coastal Resiliency Competitive Grants Program. The Shorters Wharf project was described in a technical report[74] and a peer-reviewed publication.[75] Lessons learned from the project include the following.
    - Although target elevations were achieved in 78% of the surveyed placement area, the material was not uniformly distributed, and coarser material tended to "stack up" close to the point of discharge. The resulting varied microtopography could be considered an asset in terms of potentially supporting more diverse salt marsh plant communities and providing spatial heterogeneity for wildlife.
    - The deep organic soils of the Shorters Wharf site were susceptible to compaction and rutting by the passage of heavy equipment. In future projects, it would be preferable to use an alternative method for discharge pipe relocation that minimizes the use of heavy, tracked vehicles.
    - The natural levees along the Blackwater River offered effective containment for the placed dredged material and helped reduce overall project costs.

2. At the Deal Island WMA in Somerset County, a sediment placement project was completed in December 2023. The USACE implemented the project as part of its maintenance dredging program of the Wicomico River and it is thus categorized as a beneficial use project. Approximately 123,093m^3 (161,000 yd^3) of material was dredged from the Wicomico River, pumped 11 miles through a pipe, and deposited on 30 ha (74 ac) of marsh. Some native vegetation (*Juncus roemerianus*) appears to have survived the sediment placement and is being supplemented by hand-planting plugs of *S. patens* and *Distichilis spicata* over the 2024 and 2025 growing seasons. The cost of the project's contractual work was $13.5 million for containment, dredging, and planting. The monitoring team of the USACE and NGO partners is producing a technical report to outline the key findings of this BUDM project and make recommendations for future projects in the region.



Figure 32. Dredge pipeline at Deal Island in 2023. Photo: David Curson/Audubon

Invasive Plant Control

In Maryland, a nonnative form of common reed, *Phragmites australis*, has spread aggressively through many areas of salt marsh since the early 20th century. *Phragmites australis* is particularly invasive in the upland-marsh transition zone, occupying thousands of acres in brackish areas of the Chesapeake Bay. This compromises the establishment of native salt marsh vegetation where upland is transitioning to tidal marsh.

Application of Invasive Plant Control in Maryland

Various management practices are available for controlling *P. australis*, including chemical herbicide treatment or physical removal, but this invasive plant is notoriously difficult to eradicate. In recent years, the Maryland DNR implemented a *P. australis* control program, primarily using the aerial application of herbicides. Scientists are currently conducting experimental research at Blackwater NWR to investigate the effectiveness of different *Phragmites* control treatments. Early results indicate that herbicide-only treatments may be more effective than combined treatments that include fire or salt application.[76]

Living Shorelines

In some areas, shoreline erosion can be significant due to consistent and/or high wave action. Where this is the case, the installation of living shorelines can help reduce wave energy and slow or even reverse edge erosion through sediment accretion. Living shorelines are structures designed to reduce

the impact of waves, often using a sill constructed of natural materials. Sills are used in combination with sand placement and plantings of marsh vegetation. In the Chesapeake Bay, the average rate of shoreline erosion is approximately 0.6m (2 ft) per year.

Application of Living Shorelines in Maryland

Many living shoreline projects have been installed in Maryland on both private and public land. One example is the Deal Island Shoreline Project (DISP), which was completed in 2022, stabilizing 335m (1,100 ft) of shoreline along Tangier Sound. This project stabilized the shoreline and protected a sizable tidal wetland from being breached due to erosion, which could have resulted in increased impacts on human communities situated behind the shoreline. Chesapeake Bay National Estuarine Research Reserve (CBNERR) staff are leading post-construction monitoring of vegetation and sediment for a period of five years.

Prescribed Fire

Prescribed fire has traditionally been used in Dorchester County to improve foraging habitat for wintering waterfowl and enhance access for muskrat hunters.[2] The use of fire has been widespread on private lands, as well as on public lands at Blackwater NWR and the Fishing Bay WMA. Fire management can improve plant vigor and thus marsh resiliency,[77] and can improve breeding habitat for the Seaside Sparrow.[78] Fire has also been used to promote the growth of *S. patens* and *S. americanus* and eliminate *J. roemerianus*.[38]

Application of Prescribed Fire in Maryland

The effectiveness of prescribed fire as a management technique is evident in vegetation distribution patterns around Fishing Bay. *Juncus roemerianus* is largely absent from regions where fire management is practiced but predominates in unburned marshes.[2] This suggests that fire could potentially be used as a habitat management tool in the future to convert *J. roemerianus* to *S. patens* marsh, increasing suitable Saltmarsh Sparrow habitat.

Facilitated Marsh Migration

The upslope migration of salt marsh as upland habitats come under the influence of tidal saltwater flooding can be jeopardized by a number of factors. The upland-marsh transition zone is often invaded by large stands of *P. australis*; in forested areas, the ground surface can collapse after trees die, resulting in ponding; and the absence of a tidal creek network hinders the natural drainage of such ponding.[2] Facilitated marsh migration is a term applied to a suite of management actions designed to facilitate the effective transition of upland habitats to healthy salt marsh.[19] Management actions with potential in this regard include the removal of snags in "ghost forests," elimination of invasive *P. australis*, removal of physical barriers to marsh migration, conversion of salt-damaged agricultural fields to salt marsh habitat, and tidal creek extension. Not all of these practices have been tested as ways to facilitate marsh migration.

Application of Facilitated Marsh Migration in Maryland

Maryland has hosted some of the first experimental applications of facilitated marsh migration techniques. At Blackwater NWR, 5.5 ha (13.5 ac) of "ghost forest" was removed in 2014 to test the impact on marsh birds. Documenting a measured response by birds has been challenging due to the small scale of the experiment and the low density of birds in the adjacent salt marsh. Stands of *P. australis* have been treated with herbicides in several upland-marsh transition zones, including at Farm Creek Marsh in Dorchester County and in the Nanticoke River marshes in Vienna. At both sites, *P.*

australis has reoccupied many areas where herbicide spraying showed initial success. The first tidal creek extension project in Maryland, completed at Farm Creek Marsh in 2018, is described above.

The Way Forward

Many of these restoration practices are relatively novel and need to be further tested. However, the urgent threat of marsh loss and deterioration requires testing these techniques while they're being applied to project sites of real restoration need. Ideally, then, projects should be designed within an experimental framework.

The appropriate technique, or techniques, for a particular site, depend on that site's characteristics, management history, and condition with respect to sea level rise and the management goals for the site. The restoration approach and techniques described in this report reflect MfT's goal of maintaining a target acreage of high marsh by attempting to stem an accelerating trend of high marsh deterioration and conversion to low marsh and open water.

Where marsh elevation capital is sufficient, management should focus on maintaining marsh health and resilience in order to improve the marsh's ability to keep pace with sea level rise through vertical accretion. It is important to maintain vegetative cover to ensure a stable marsh platform and avoid marsh surface collapse and ponding. Maintaining marsh health often involves restoring efficient tidal hydrology after it has become compromised by features that trap water on the marsh surface, leading to waterlogging. Hydrological repair includes practices described above, such as runnels, channel alteration, ditch filling and/or cleaning, and removing tidal restrictions to restore tidal flow. A frequent type of restriction is undersized culverts beneath roads. Where upslope migration has created new tidal marsh and ground surface collapse is causing waterlogging, it can be necessary to introduce tidal exchange by extending creeks into the impacted area.

Where there is insufficient elevation capital due to marsh subsidence and sea level rise, the only option for restoration to a high marsh condition is nourishment, typically via sediment placement to raise the marsh surface back to a sufficient elevation.

Hydrological repair and sediment placement are the two suites of restoration techniques that will be required over the largest extent of salt marsh to meet the MfT objective of maintaining 10,117 ha (25,000 acres) of high marsh habitat over the long term.

RESTORATION DECISION MODEL

To determine the extent and spatial distribution of the locations where the most critical restoration techniques will be needed, we developed a Restoration Decision Model, which provides a quantitative, geomorphic assessment, at the marsh unit scale, of restoration actions likely to be needed to restore and maintain high marsh as habitat for the Saltmarsh Sparrow.

The Restoration Decision Model focuses on the **role of marsh elevation in relation to tide and marsh health.** The two categories of restoration practice most likely to be applied are marsh elevation enhancement, through sediment placement, and hydrological repair, represented by runneling but including other practices aimed at improving hydrological function.

The model is based on the rationale that marshes with elevation above MHW (i.e., high marsh) would benefit from hydrological enhancement where values of the unvegetated-vegetated ratio (UVVR) exceed 0.08, and that marshes below MHW will likely not benefit from hydrologic enhancement.[57]

Instead, low marsh would require sediment placement to raise its elevation and return it to a high marsh condition. While these assumptions are rooted in the most up-to-date science, the limited number of on-the-ground projects and rapidly changing field conditions mean that assumptions may need to be updated in the future.

The Restoration Decision Model is constructed in a similar manner as the Marsh Condition Model, with the unvegetated-vegetated ratio (UVVR) and Sea Level Affecting Marshes Model (SLAMM) cover categories, representing marsh elevation, interacting to yield outcomes in a matrix format, with the same thresholds for the input variables. The outputs in the cells of the matrix are combinations of the two restoration practices at varying levels of required effort (Table 11). The effort levels were determined based on two assumptions: 1) marsh units that are predominantly (>75%) low marsh will require more sediment than marsh units having a more even mix of low marsh and high marsh, and 2) marsh units with a UVVR value of >0.15 will require a greater degree of hydrological restoration than those with a UVVR value of between 0.08 and 0.15.

Table 11. The Marsh Restoration Decision Model. SLAMM cover categories from 2020 and UVVR are used to evaluate the likely need for two categories of restoration practice: sediment placement and hydrological enhancement at the marsh unit scale. "Low marsh" includes SLAMM categories Regularly Flooded Marsh, Tidal Flat, and Open Water. "High marsh" includes SLAMM categories Irregularly Flooded Marsh and Transitional Marsh.

		SLAMM Cover Category		
		Low marsh >75%	Mixed low/high marsh	High marsh >75%
UVVR	>0.15	Sediment (high effort)	Hydrology (high effort) Sediment (low effort)	Hydrology (high effort)
	0.08-0.15	Sediment (high effort)	Hydrology (low effort) Sediment (low effort)	Hydrology (low effort)
	<0.08	Sediment (high effort)	Sediment (low effort)	Monitor hydrology

The model assigns high marsh with a UVVR of <0.08 (Class 1 in the Marsh Condition Model) as not requiring either sediment placement or hydrological enhancement (Table 11, bottom yellow cell in the right-hand column). This class of marsh should be monitored for localized hydrological issues, such as expanding surface water and associated vegetation die-off.

We mapped the model outputs for all of the tidal marsh units in Dorchester, Wicomico, Somerset, and Worcester counties (i.e., across a more extensive geography than the MfT initiative focal areas) so that they are available for other broad-scale planning efforts. It should be emphasized that although the restoration recommendations are mapped for each marsh unit, the Restoration Decision Model should not be used in a prescriptive way. Instead, it is intended to be used alongside site-specific data as a landscape-level planning tool.

In many marsh units, multiple restoration practices may be needed. Included in the MfT Experience Builder Restoration Model tab are the additional data layers of the Marsh Condition tab. These layers inform the likely need for other restoration practices, including all those listed in ACJV's Saltmarsh

Sparrow Conservation Plan.[21] As discussed by leading practitioners, decisions on restoration practices at the project/marsh unit level should be based on site-specific assessment and data collected on-site.[79]

One strength of the model is that it can be used as a landscape-scale planning tool to estimate the likely restoration efforts needed over time. The inclusion of SLAMM in the Restoration Decision Model allows the projection of restoration needs into the future across 10-year intervals. Future restoration needs are based on a scenario of no prior restoration action and thus depict the increasing restoration effort that will be required if we wait to act. The UVVR values in each marsh unit were fixed (at current values) for all time intervals and so do not contribute to future projections. We recommend the addition of future projections of the UVVR to the model at a later date/once available.

Model Validation

A preliminary validation of the Restoration Decision Model compared the model output for 2020 with expert-designed restoration projects.

We selected six restoration project locations in Maryland for which restoration designs were available. At each project site, we scored the percentage of marsh units in which the Restoration Decision Model agreed with the project design (Table 12.)

Table 12. Comparison of recommended restoration practices between the Restoration Decision Model and project site designs at six salt marsh restoration project sites in Maryland.

			Percentage of marsh units with agreement between Restoration Decision Model and project design	
Restoration Project Site ** Completed* *^ Design or Permitting Phase*	**Number of Marsh Units in Project Site**	**Size of Project Site**	**Hydrology**	**Sediment Placement**
Cropper Island^ Worcester County (Figure 33a-b)	16	47 ha (116 acres)	88%	56%
Bliss Happens Lane^ Worcester County	6	6 ha (14 acres)	83%	83%
Langmaid Road^ Worcester County	6	19 ha (46 acres)	100%	67%
Deal Island WMA* Somerset County (Figure 34a-b)	12	26 ha (64 acres)	17%	25%
Backgarden Creek, Blackwater NWR^ Dorchester County (Figure 35a-b)	9	40 ha (100 acres)	100%	100%
Irish Grove^ Somerset County (Figure 36a-b)	2	30 ha (75 acres)	100%	100%

The assessment showed broad agreement between the Restoration Decision Model and actual project designs (Table 12, Figures 33-36), but some differences revealed shortcomings of the model due to errors associated with Light Detection and Ranging (LiDAR) technology,[80] which was used to collect elevation data.

At three project sites in the Coastal Bays in Worcester County (Table 12), where project designs included runnels in most marsh units, the model predicted a need for runnels in the great majority of the same units. However, the model failed to predict a need for sediment in the majority of marsh units

where project designs included marsh nourishment through sediment placement. The project designs prescribe sediment placement in the deeper waffle pools, which have formed recently, and not on the marsh platform. The likely reason for this error is that the SLAMM outputs on which the model is based misclassify the ponded areas requiring sediment as high marsh. There are two sources of error: 1) the reflective nature of water yields positive bias in elevation estimates due to the inability of LiDAR beams to penetrate the surface consistently, and 2) the SLAMM run used LiDAR elevation data for Worcester County collected in 2011,[18] earlier than many of the waffle pools in the Coastal Bays formed. Averaging of data across marsh units may also have contributed to the error.

At the beneficial use project site at the Deal Island WMA (Figure 34a-b), where in 2023, 161,000 cubic yards of dredged material was placed on 26 ha (64 ac) of deteriorating marsh, the model predicted a need for sediment at only three of 12 marsh units, again because SLAMM misclassified the site as high marsh. The project design used LiDAR, as well as Real-Time Kinematic (RTK) GPS ground survey data, collected more recently than that used in SLAMM, to derive elevation estimates. The reason for the elevation misclassification is likely because the dominant vegetation at the site is *J. roemerianus*, which LiDAR beams struggle to penetrate, resulting in incorrectly higher elevation estimates. This upward bias in elevation data was also indicated by the fact that the site accommodated 25% more dredge material than expected to reach the target elevation due to the site's hummock and hollow nature and erosion between roots.

The model performed well at two other restoration project sites in the Chesapeake Bay. At Backgarden Creek in Blackwater NWR (Figure 35a-b), where sediment placement is proposed, the model predicted a need for elevation enhancement with beneficial sediment placement in all marsh units. At Irish Grove Sanctuary in Somerset County (Figure 36a-b), where a runneling project is planned, the model accurately predicted a need for hydrologic enhancement.

Example #1. Cropper Island, Worcester County

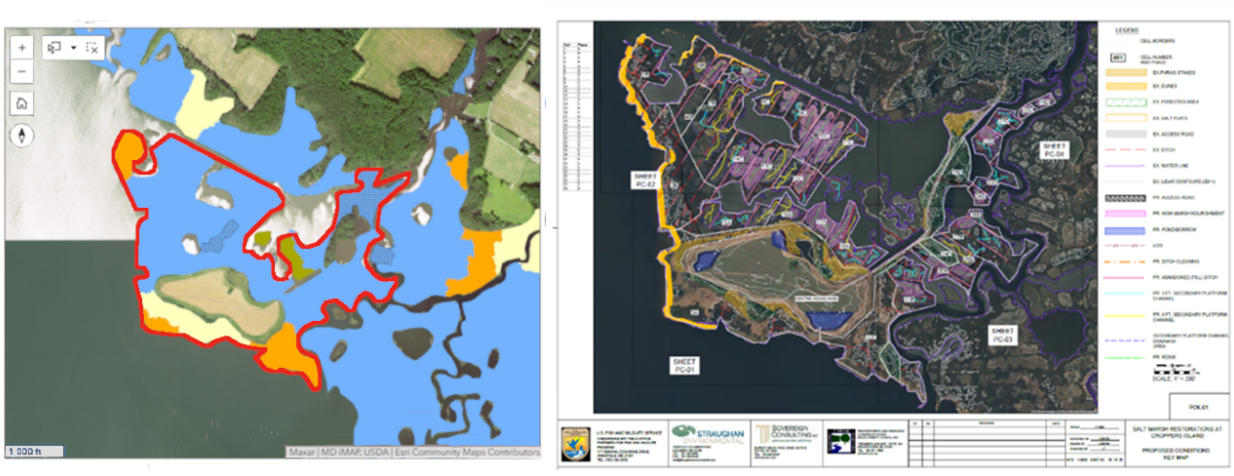


Figure 33a-b. A) Restoration Decision Model output for 2020 and b) restoration designs at 90% for Cropper Island, Worcester County. On the left, the red line delineates the proposed project area. On the right, pink shading of polygons indicates thin layer placement. The restoration project was led by the USFWS and partners.

Example #2. Deal Island, Somerset County

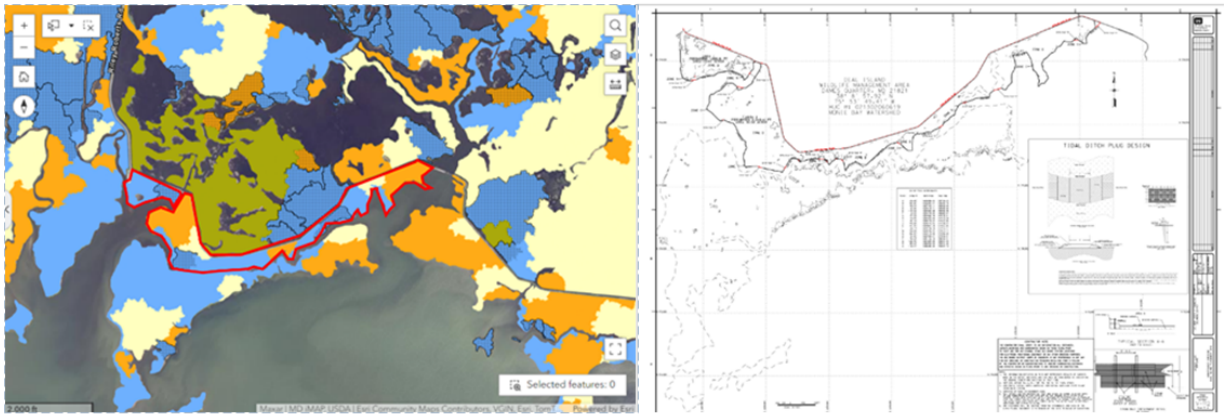


Figure 34a-b. A) Restoration Decision Model output for 2020 and b) restoration designs completed by the USACE for the Deal Island WMA, Somerset County. On the left, the red line delineates the project site.

Example #3. Backgarden Creek at Blackwater NWR, Dorchester County

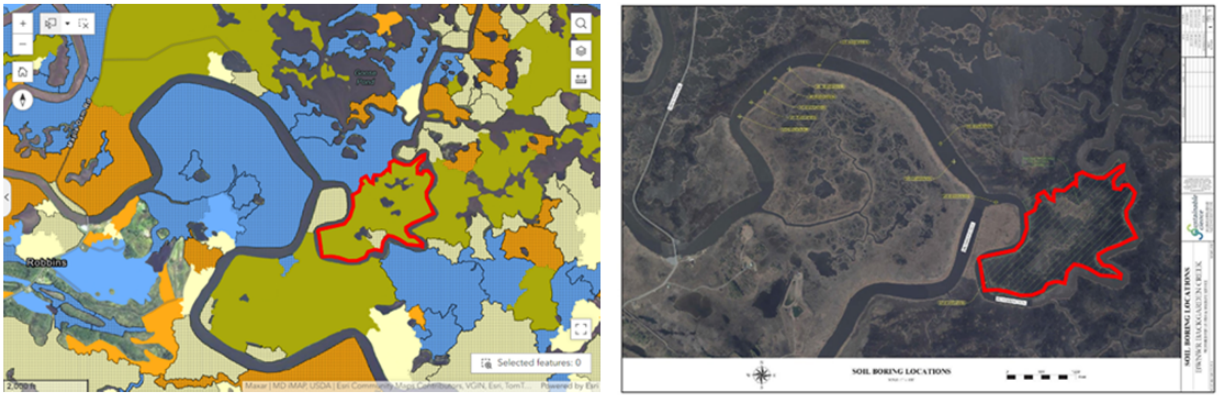


Figure 35a-b. A) Restoration Decision Model output for 2020 and b) restoration designs at 90% for Backgarden Creek, Dorchester County. The red line delineates the proposed project area. The restoration project was led by the USFWS and partners.

Example #4. Irish Grove Sanctuary, Somerset County

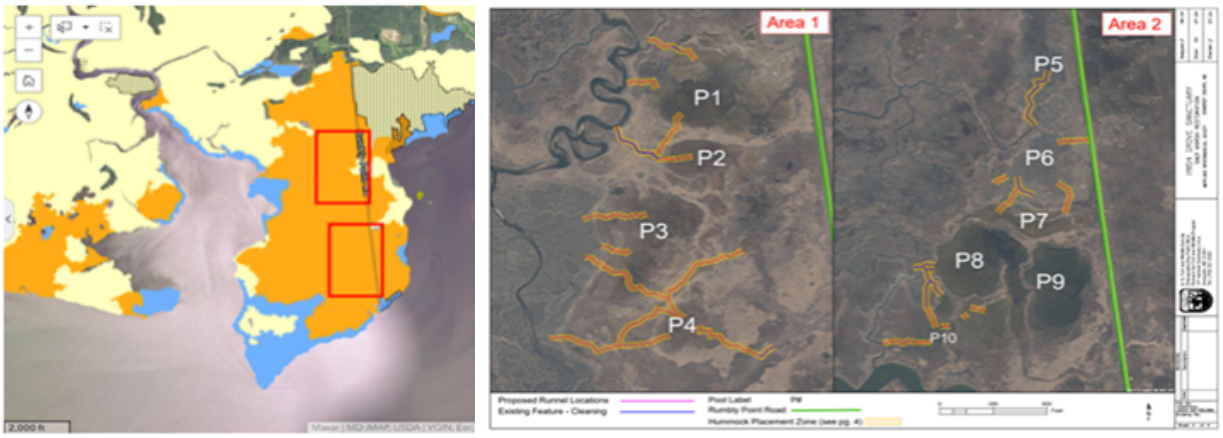


Figure 36a-b. A) Restoration Decision Model output for 2020 and b) restoration designs at 90% for Irish Grove Sanctuary, Somerset County. Restoration designs completed by the USFWS.

The results of this validation exercise suggest that the Restoration Decision Model performs well in marshes not dominated by *J. roemerianus* and where there has not been a recent increase in pond formation. In marsh where a high UVVR value predicts the need for a high-effort hydrological restoration (mapped in blue in Figures 33-36), it may be prudent to assume that localized sediment placement will be necessary to fill some pools. The site-specific restoration strategy is dependent on the existing marsh condition and the ecological degradation factors requiring resolution.



Figure 37. Measuring elevation, a key monitoring metric, with Real-Time Kinematic (RTK) global positioning system at the Deal Island WMA. Photo: David Curson/Audubon

The validation exercise reiterates that while Restoration Decision Model output is useful for landscape-scale planning, site-specific assessment and data collection should occur to determine on-the-ground decisions at the project and marsh unit level. Solutions for addressing LiDAR errors should include the use of drone sensors and locally collected RTK data (Figure 37) that can penetrate water or dense vegetation, as well as on-the-ground field verification.

The model recommendations should not be applied without multiple site visits to assess the finer-scale habitat function and needs and to design restoration solutions for each site. The Restoration Decision Model does not include all restoration techniques. For example, as seen in the project designs, appropriately cleaning or filling existing ditches to improve functional hydrological flow would not be detected at the marsh unit scale, in part because these restoration techniques were not included within our model.

Restoration Decision Model Results

The acreages of marsh units where hydrological repair or sediment placement is likely needed are shown for all of the PMAs in the MfT project area combined (Table 13). PMAs are marshes prioritized by MfT for long-term maintenance as high marsh habitat suitable for the Saltmarsh Sparrow through restoration (see Section 6). Currently, as of 2025, some 4,295-4,526 ha (10,613-11,185 ac) of marsh units are likely in need of hydrological repair, and 1,704-2,998 ha (4,210-7,409 ac) of marsh units likely require sediment placement in at least some portion of the marsh unit.

Table 13. Extent of marsh restoration needs for hydrological repair and sediment placement by marsh unit across all MfT Priority Marsh Areas, 2020-2050.

Restoration Practice	Acres Needed (by Year)			
	2020	2030	2040	2050
Repair hydrology	4,526 ha (11,185 ac)	4,295 ha (10,613 ac)	3,786 ha (9,356 ac)	2,538 ha (6,272 ac)
Sediment placement	1,704 ha (4,210 ac)	2,998 ha (7,409 ac)	5,358 ha (13,240 ac)	10,030 ha (24,785 ac)

Caution is needed in interpreting these values (Table 13). The actual extent of restoration projects needed on the ground may be less than the acreages shown because, in most cases, only part of a given marsh unit requires treatment. Some marsh units require both hydrological repair and sediment placement, but in different locations within the marsh unit. Conversely, the model likely underestimates the number of marsh units requiring sediment placement in regions where recent pond formation is not reflected in the elevation data used by SLAMM or where dense, tall marsh vegetation creates upward bias in elevation models.

Table 13 presents Restoration Decision Model results for future time periods up to 2050. Until 2030, most of the marsh acreage within the PMAs was not in need of restoration, but this situation will be reversed by 2040 as sea level rise causes continued marsh deterioration. Another notable trend is that the extent of marsh requiring sediment placement increases rapidly, nearly doubling each decade to 2050.

Considering the high cost and logistical constraints of sediment placement, it will be wise to implement low-tech, low-cost hydrological practices in a timely fashion in an attempt to slow the rate at which

marshes lose elevation due to interior pond expansion. This points to a time-sequenced strategy beginning with the widespread use of hydrological techniques and followed by sediment placement as it becomes necessary.

Each restoration project design should include a unique timeline for implementation, which is likely to include a phased approach with multiple restoration techniques, even within a single marsh unit. A phased approach is necessary, not only due to the severity of future predictions but also the permitting, financial, and logistical factors associated with restoration projects. Projects should adopt an adaptive management approach, including a continuous review process informed by robust, individualized monitoring plans.

Section Eight: Restoration Strategies

At a Glance

- The overall strategy of Marshes for Tomorrow is to maintain healthy high marsh habitat, through restoration and management, on the 11,792 ha (29,140 ac) identified as Priority Marsh Areas and representing the healthiest, most resilient marshes with the greatest feasibility for long-term conservation.
- Over the next decade (2025-2035), restoration of hydrology, using practices such as runneling and ditch remediation, should be implemented on 4,295 ha (10,613 ac) of marsh units identified by the Restoration Decision Model. This is likely to require approximately 140 different projects over the decade and cost more than $26.5 million.
- Over the next decade (2025-2035), restoration of subsided marsh, using sediment placement, should be implemented on 2,998 ha (7,409 ac) of marsh units identified by the Restoration Decision Model. This is likely to require approximately 100 different projects over the decade and cost between $200 million and $675 million.
- Implementation should begin immediately, and the first priority should be widespread hydrological repair, in order to maintain the health of high-elevation marsh. It is not feasible to implement sediment placement on a landscape scale in the short term due to the scarcity of sediment sources and other factors.
- Individual restoration projects should be implemented using an ecosystem approach that retains ecosystem elements in addition to high marsh, such as creeks, historical ponds, and areas of low marsh.
- Priority locations for restoration projects are identified in the local strategy sections of this report.
- The spatial models in this report should be used for landscape-scale planning. For project planning and design at the site level, site-based assessments need to be applied.

The strategic intent of the Marshes for Tomorrow (MfT) initiative is to ensure that a significant portion of Maryland's salt marsh ecosystem persists over the long term despite the threats posed by sea level rise (SLR). The conservation focus of the plan is the high marsh zone and the Saltmarsh Sparrow, which depends exclusively on the high marsh for breeding habitat. The marshes prioritized by MfT for long-term maintenance as high marsh are the Priority Marsh Areas (PMAs) selected by the process described in Section 6.

Some 11,792 ha (29,140 ac) of marsh were prioritized across four of the MfT project focal areas for long-term maintenance through management and restoration. No marsh was selected as a PMA in the Fairmount Focal Area. The total acreage exceeds the project's target of 10,117 ha (25,000 ac), and the "surplus" marsh should provide some flexibility in the event that the rate of restoration implementation is unable to keep pace with marsh deterioration. Although the majority of these PMAs are still in a healthy condition, restoration is already needed at many locations.

The Restoration Decision Model provides a guide to the extent of restoration needed to maintain the PMAs as healthy high marsh, both currently and over future decades to 2050. Table 14 summarizes this restoration need across all of the PMAs, by decade, over the next 30 years. An estimated 4,295 ha (10,613 ac) of marsh units will require some degree of hydrological repair over the next 10 years. Marsh restoration projects in Maryland have generally covered 20-40 ha (50-100 ac) each. If 30 ha (75 ac) is used as the average project size, 14 projects would need to be completed each year from 2025-2035 to restore the hydrology of these marshes.

The need for hydrological repair is projected to decline over future decades, to 2045-2055 (Table 14) because the Sea Level Affecting Marshes Model (SLAMM) model on which the Restoration Decision Model is based predicts a decline in the area of high marsh as these sites convert to low marsh or open water, conditions after which hydrological restoration is no longer feasible. It is important to note that the MfT spatial models do not include the impacts of restoration projects on the subsequent condition of marshes. Thus, we are unable to quantitatively predict the future benefits of marsh restoration in this plan. This may become possible in future iterations of the MfT spatial models if they include projections of future trends in the unvegetated-vegetated ratio (UVVR) and data on the effectiveness of runneling.

Table 14. Extent of marsh restoration needed to maintain all MfT Priority Marsh Areas as healthy high marsh, and the estimated number of projects needed each year, from 2025-2055. Values for the "Area of Treatment Needed" use Restoration Decision Model outputs for the midpoint of each decade.

Restoration Practice		Time Period (decade)		
		2025-2035	2035-2045	2045-2055
Repair hydrology	Area of marsh units needing treatment	4,295 ha (10,613 ac)	3,786 ha (9,356 ac)	2,538 ha (6,272 ac)
	Estimated # projects each year*	14	13	8
Sediment placement	Area of marsh units needing treatment	2,998 ha (7,409 ac)	5,358 ha (13,240 ac)	10,030 ha (24,785 ac)
	Estimated # projects each year*	10	18	33

*Estimate based on an average project size of 30 ha (75 ac).

During 2025-2035, sediment placement will be needed on some portion of an estimated 2,998 ha (7,409 acres) of marsh units across all PMAs in order to restore them to the elevation of high marsh (Table 14), and this need will only increase rapidly over coming decades. In most areas that require sediment, no source of material is readily apparent, so novel sources will have to be determined before it is possible to implement new projects.

From a strategic standpoint, it is most effective to begin landscape-scale restoration with hydrological repair, typified by runnels, since this is the less expensive practice and can be applied relatively quickly over a larger area than sediment placement. The implementation of surface hydrology projects should slow the rate of marsh deterioration and reduce the future need for sediment placement. In addition to runneling projects, mitigation of blocked and undersized culverts should be prioritized as an early action in addressing poorly functioning hydrological systems. Thus, the first priority for implementation of this plan should be widespread hydrological repair in marshes showing increased ponding and vegetation dieback.

COSTS OF THE RESTORATION PLAN

Even as it is important to know the likely cost of implementing an ambitious landscape-scale plan such as Marshes for Tomorrow, it is very difficult to produce accurate cost estimates for the restoration needs outlined above. Restoration projects are extremely variable in their costs due to high variability in factors such as the distance dredged materials must be transported to the project site, and the mobilization and demobilization of equipment. Although average cost estimates are not available, recently completed projects in Maryland (see Section 7) can provide a general idea of costs.

The sediment placement project completed at Shorters Wharf at Blackwater National Wildlife Refuge in 2016, which applied locally sourced river sediments across 40 acres, cost approximately $2.1 million, or about $52,500 per acre. The Lower Wicomico River Maintenance Dredging Project implemented at the Deal Island Wildlife Management Area during 2023-2025 cost $13.5 million for just the contractual services of containment, dredging, and vegetation planting across 74 acres, a cost of $182,432 per acre. The comparatively higher cost per acre of the Deal Island project is in part because the dredged material had to be pumped 11 miles to the project site.

By contrast, hydrological repair projects are considerably less expensive. The runneling project planned at Irish Grove Sanctuary in Somerset County is estimated to cost approximately $340,000 for all planning and construction activities needed to construct runnels and clean ditches on 73 acres of marsh, an overall cost of $4,657 per acre.

In order to extrapolate these cost estimates to the landscape scale outlined in Table 14, it is reasonable to assume that restoration treatment will be needed in only a portion of a given marsh unit, and to use 50% of the marsh unit area as the “best” estimate of this portion. Applying these assumptions, and using the cost estimates from the Shorters Wharf project and the Deal Island project as lower and upper bounds, respectively, yields an estimated cost range for the sediment placement projects needed from 2025-2035 of $200 million to $675 million. An equivalent cost estimate for the hydrological repair projects, typified by runneling, that are needed from 2025-2035 is $26.5 million. These costs will increase with inflation over the course of the decade.

The costs of sediment placement projects needed to return subsided marsh to a high marsh elevation increase sharply in the future as more and more marshes lose elevation. Using the same cost extrapolation as above, the sediment placement costs for 2035-2045 would be $348 million to $1.21 billion, and for 2045-2055 would be $650 million to $2.26 billion. Timely intervention with hydrological restoration to enhance the health of the marshes will reduce these future costs, although it is not known how much marsh this early action will save.

AN ECOSYSTEM APPROACH TO RESTORATION

A 2024 publication, "Coastal Marsh Restoration: An Ecosystem Approach for the Mid-Atlantic,"[79] calls for a "unified ecosystem-based approach" to salt marsh restoration projects and recommends prioritizing ecosystem-level restoration over single-species goals. The MfT initiative has embraced this concept by addressing the needs of a single, imperiled species through ecosystem-based methodologies. In essence, how well can MfT conserve all of the existing community types of a functional marsh ecosystem while also pursuing a regional species conservation goal?

When designing individual restoration projects, efforts should be made to maintain the existing balance of high and low marsh, along with other landscape features, such as established ponds, mudflats, and creeks. This should be achievable — historically, low marsh makes up approximately 22% of vegetated salt and brackish marsh in Maryland, with most of this distributed along the edges of creeks and mudflats rather than in large contiguous expanses.[38] Thus, each project site will likely support fringes of low marsh. Projects including the repair of surface hydrology should retain established pools and focus on revegetating only areas of recent vegetation dieback and waterlogging. This is as much a matter of practicality as principle, since older pools are likely to be deeper, and it may not be feasible or ecologically appropriate to drain them with runnels. As a guideline, Correll et al.[79] suggest that regulatory agencies might not support projects that recreate high marsh in sites that have not supported high marsh in the past 20 years.

At the larger landscape scale, it will be difficult to maintain the full zonation of the marsh ecosystem from the bay shoreline to the upland transition in the most expansive marsh platforms where much of the marsh interior has already collapsed and converted to open water. This collapse has occurred in many Chesapeake Bay marshes, as exemplified by the Blackwater-Fishing Bay system, where the marsh interior is sediment-starved. Here the more resilient marshes around the Fishing Bay shoreline, which receive sediment fluxes from Fishing Bay, will likely become islands separated from the nearest upland by several miles of water as the marsh interior continues to fragment. The MfT prioritization process selected these more resilient marshes of the Fishing Bay shoreline as PMAs, and it will likely not be feasible to prevent the loss of the adjoining interior marsh.

An immediate start to implementation of this plan and a rapid scaling-up of restoration is urgently needed. When planning individual projects, or a cluster of projects in close proximity, the following recommendations should be followed.

1. **Site-level Assessments.** Base the project design on a site-level field assessment instead of relying solely on the Restoration Decision Model or other modeling exercises and remotely collected data. Consider localized site needs and challenges in addition to the primary goal of high marsh habitat conservation.
2. **Landscape Framework.** Develop projects within a landscape framework by, for example, evaluating the local geomorphology and hydrology rather than considering an individual project site in isolation. This will also help to streamline subsequent projects.[79] An ideal approach where hydrological repair is needed would be to complete a hydrological study at an appropriate scale and then use the results to inform the design of several projects across that extent. An appropriate scale could be up to 405 ha (1,000 ac), depending on the landscape context.
3. **Address Model Biases.** Bear in mind that the Restoration Decision Model includes some demonstrated biases under certain site conditions (see Section 7). Where recent pond formation and expansion are prevalent, the Restoration Decision Model may accurately predict

the need for runneling but fail to identify a need for localized sediment placement. Similarly, in marsh dominated by dense *Juncus roemerianus*, the model may fail to identify a need for sediment placement.

4. **Diversify Restoration Approaches.** Consider a variety of restoration approaches within a single project in order to enhance benefits for the full marsh ecosystem and to address particular site-based needs. These likely include restoration techniques not in the Restoration Decision Model. For example, where the local marsh landscape includes exposed shoreline, assess the need for living shorelines or other wave attenuation devices.
5. **Contextual Review.** Review the unique set of landscape and human community characteristics that will inform project design, implementation, and communications.

The following sections of this report include local restoration strategies developed separately for each focal area. These local strategies identify locations within each PMA where restoration is needed, and prioritize them according to urgency. No local restoration strategy was developed for the Fairmount Focal Area because this no PMAs were selected within this focal area.

BLACKWATER-FISHING BAY, DORCHESTER COUNTY

Existing Conditions | Acreage and Landscape Context

Dorchester County supports more salt and brackish tidal marsh (31,137 ha/76,940 ac)[1] than any other county in Maryland, and the majority of this marsh occurs as extensive marsh platforms around Fishing Bay and along the Blackwater and Transquaking rivers. The ratio of high marsh to low marsh in Dorchester County in the 1970s was 83% to 17%, respectively, with low marsh found mostly along creeks and mudflats.[38] The Marshes for Tomorrow (MfT) spatial analyses found that the Blackwater-Fishing Bay Focal Area occupies 11,337 ha (28,015 ac) of salt and brackish marsh, about 36% of the total for Dorchester County.

The geomorphology and ecology of the Blackwater-Fishing Bay marshes have been well documented by research that explains why interior portions of this system are so vulnerable to sea level rise. Salinity and tidal range decrease away from shorelines into the marsh interior so that astronomical tides in the Blackwater River system are less than 15 cm.[81] This narrow tidal frame results in very flat marshes with little topographic variation, and these marshes are particularly vulnerable to waterlogging, vegetation dieback, and pond formation.[52] In addition, the Blackwater River marshes are a sediment-starved system, with prevailing northwesterly winds resulting in a net sediment export.[82] In contrast, the marshes at the lower end of the Transquaking River receive a net import of sediment due to their close proximity to the turbid waters of Fishing Bay. Consequently, the marshes close to the Fishing Bay shore and the larger creeks have higher vertical rates of accretion and are better able to withstand sea level rise.[82]

For this reason, the Blackwater-Fishing Bay Focal Area of MfT is centered on Fishing Bay and excludes much of the interior marshes to the north and northwest, which have been heavily eroded for decades and would require prohibitively expensive actions to restore.[83,84] Due to its intact condition and predicted longevity under sea level rise, this focal area was previously identified by the Blackwater 2100 project[2] as a Marsh Conservation Zone.

Marsh Condition

Marsh condition is mapped across the Blackwater-Fishing Bay Focal Area in Figure 38. This region currently supports 7,689 ha (19,000 ac) of high marsh in stable condition (Class 1 and 2, Figure 39), mostly around the Fishing Bay shoreline and extending into the marsh platform interior on the west and northeast sides of Fishing Bay, and along the Transquaking River corridor. The most heavily eroded marshes are in the interior of the peninsula between Fishing Bay and the Nanticoke River, particularly at Elliott Island Marsh. The marshes at the northwest edge of Fishing Bay and inland along the lower reaches of the Blackwater River are still extensively vegetated and intact but have lost elevation and are transitioning to a low marsh condition.

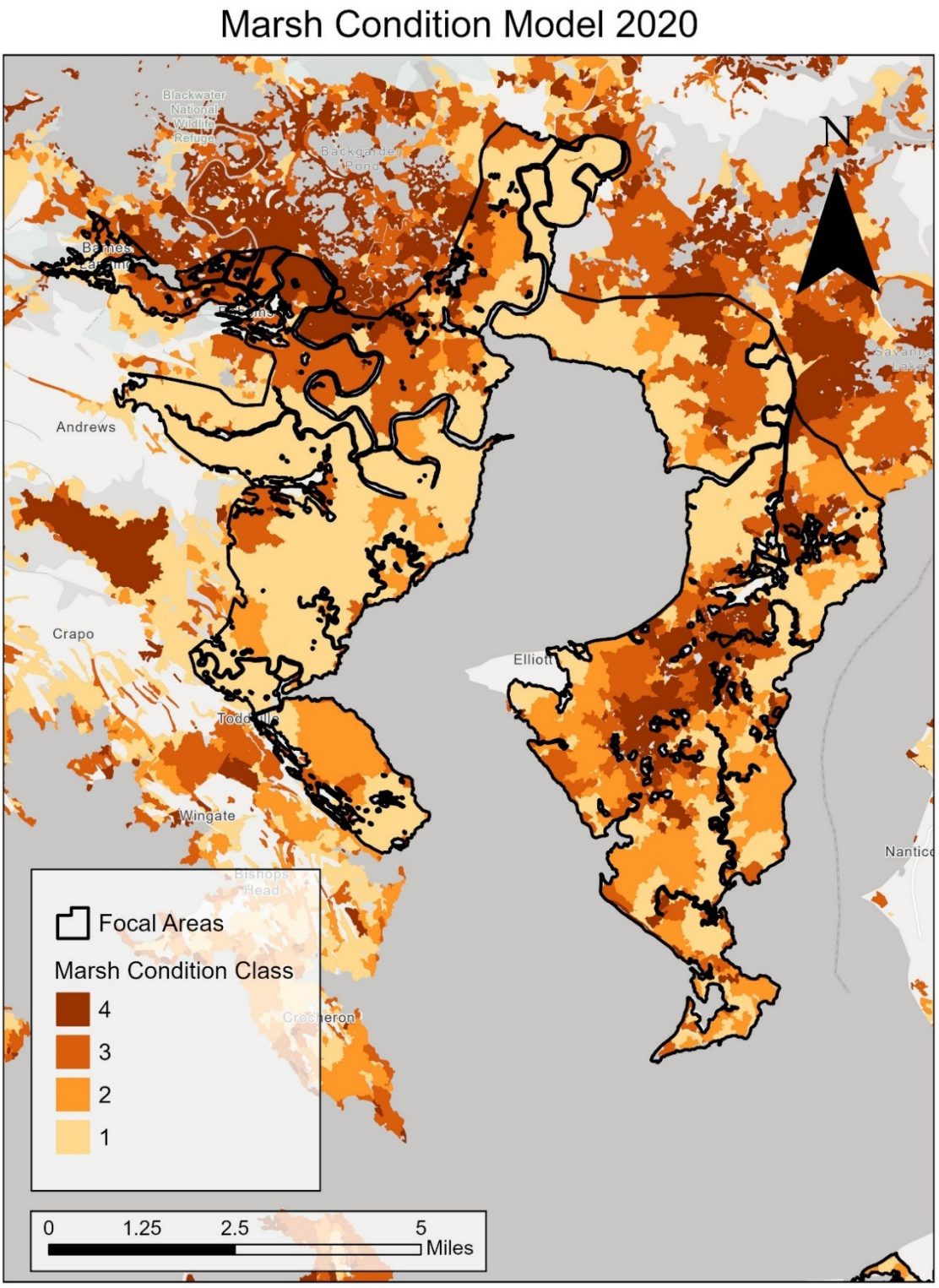
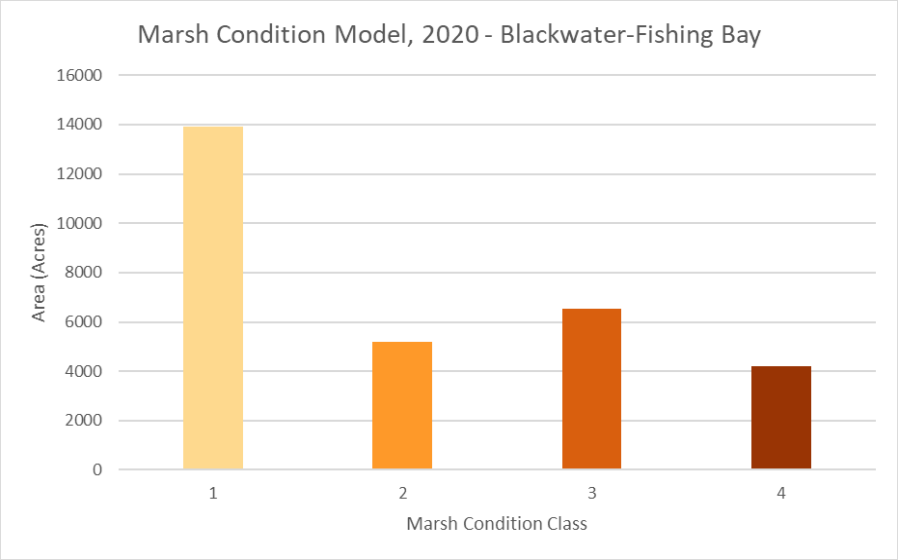


Figure 38–39. Map of Marsh Condition Model results for the Blackwater-Fishing Bay Focal Area, 2020.



Future Projections of Marsh Condition

Through 2030 and 2040, high marsh is projected to steadily convert to low marsh across most of the north and east sides of Fishing Bay and in the Transquaking River and Blackwater River corridors. Future projections of the Marsh Condition Model can be explored in the MfT Experience Builder. However, the large marshes present in 2020 to the west of Fishing Bay are projected to remain as high marsh through 2040 (Figure 40).

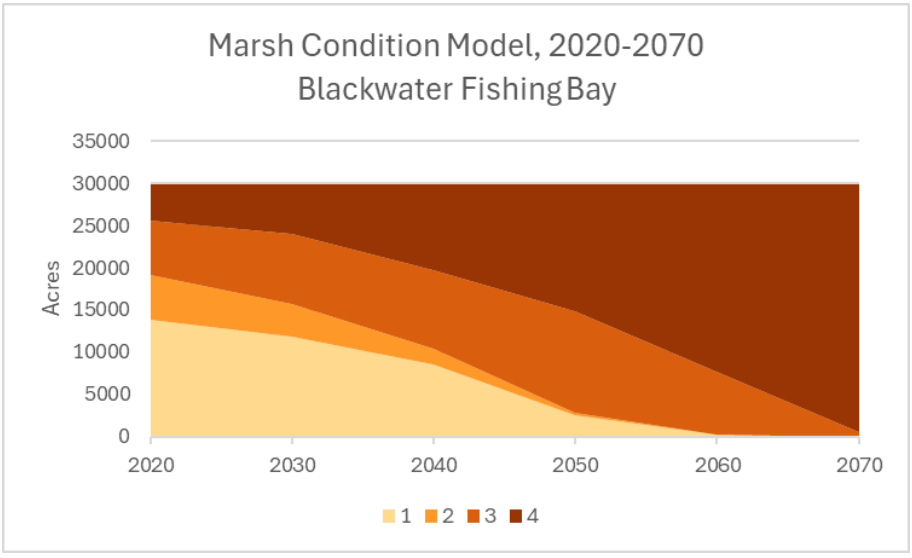


Figure 40. Future projections of the acreage of the four Marsh Condition Classes in the Blackwater-Fishing Bay Focal Area, presented at decadal intervals from 2020 to 2070 (1 ac = 0.4 ha).

By 2050, nearly all areas of current high marsh are projected to become low marsh or mudflat and open water, with the exception of the west side of Fishing Bay, where significant areas of present-day high marsh may remain (Figure 40). The marshes to the west of Fishing Bay should be considered a

potential future refuge of high marsh and the Saltmarsh Sparrow, particularly if efforts to maintain high marsh elsewhere in the Fishing Bay region are unsuccessful.

It is important to keep in mind that these projections represent best-case scenario of future marsh condition because they are based on the Sea Level Affecting Marshes Model (SLAMM), which does not account for elevation collapse that occurs due to waterlogging and vegetation dieback. A more detailed explanation of the role of vegetation dieback and ponding in the Marsh Condition Model is provided in Section 4.

Vegetation

In Dorchester County, the most widespread vegetation types of salt and brackish marsh are *J. roemerianus*, *Schoenoplectus americanus*, *Spartina patens / Distichilis spicata*, and *Spartina alterniflora*. McCormick and Soames[38] gave the proportional extent of these vegetation types in the 1970s as 32%, 20.5%, 17.5%, and 17%, respectively. Although accurate species distribution data for the present day are not available, each of these vegetation types is still widespread in the county.

The marsh within the Blackwater-Fishing Bay Focal Area is divided into two distinct vegetation zones. The northern half of the higher marsh is dominated by meadows of *S. patens / D. spicata,* and in the southern half, *J. roemerianus* predominates (Figure 41). Throughout the area, lower-lying marsh supports *S. americanus* due to the low salinity of this region of the Chesapeake Bay. The two vegetation zones correspond to spatial patterns of historical fire management. Prescribed fire is used as a management tool in the marshes north of the Blackwater River around Fishing Bay to Island Creek. In the southern areas, marsh is not regularly burned, allowing *J. roemerianus* to persist. Historically, fire was used as a management tool to convert *J. roemerianus* to meadow cordgrass in order to increase forage for cattle,[38] although the practice serves different objectives today.

The most extensive tracts of *S. patens* are around the northern and eastern edges of Fishing Bay, and these areas represent perhaps the largest patch of high-quality habitat for the Saltmarsh Sparrow in Maryland. There are also significant areas of *S. patens* in marshes flanking the Transquaking River and the Blackwater River, although the vegetation in the Blackwater marshes is transitioning to *S. americanus* and *S. alterniflora* as the marshes convert to low marsh.

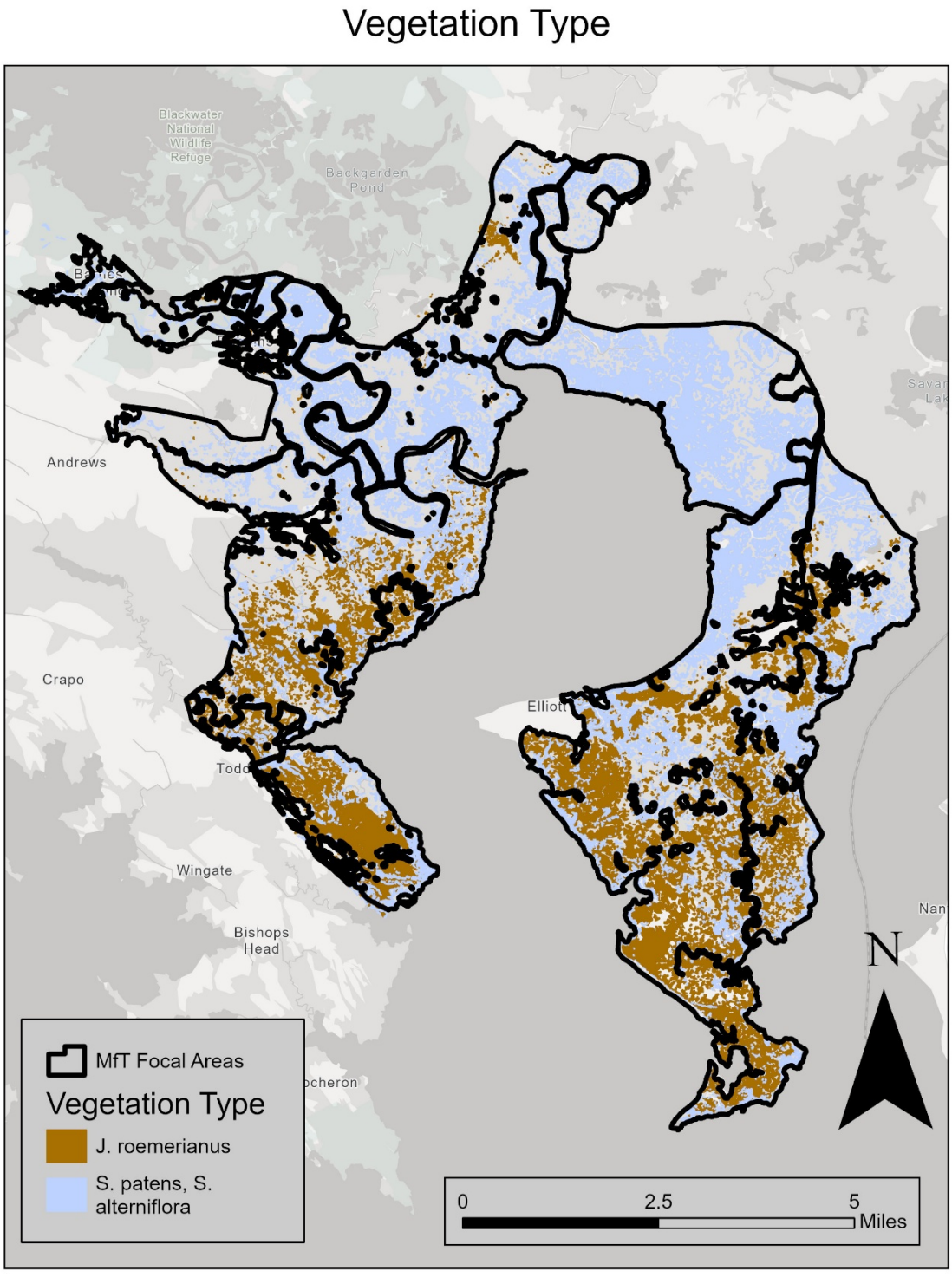


Figure 41. J. roemerianus, S. patens, and S. alterniflora distribution in the Blackwater-Fishing Bay region.

Although there are extensive areas of healthy and resilient high marsh on the west side of Fishing Bay south of the Blackwater River, this region does not support significant areas of Saltmarsh Sparrow habitat because of the prevalence of *J. roemerianus*.

Saltmarsh Sparrow Abundance

Saltmarsh Habitat and Avian Research Program (SHARP) surveys have revealed a decline in Saltmarsh Sparrow detections between 2011-12 and 2021-22, but the pattern of abundance is similar in both survey periods. Of the 31 randomized locations surveyed in this focal area, Saltmarsh Sparrows were most abundant in the large patch of *S. patens* habitat on the north side of Fishing Bay, particularly in Great Marsh and Island Creek.

Marsh Migration Corridors

The Blackwater-Fishing Bay Focal Area contains only very small scattered areas of potential marsh migration corridor, as defined by elevation alone, so there is very limited potential for upslope migration of the existing high marsh here. The reason for this is that the high marsh around Fishing Bay is separated from the nearest uplands by large expanses of collapsed marsh that have already eroded to open water and are excluded from this focal area. One exception exists on the west side of the Transquaking River near Bestpitch, where forested uplands adjoin an area of high marsh.

Sediment Sources/Dredging Locations

The Blackwater-Fishing Bay region is remote from any regular dredging operations. However, an upcoming Maryland Department of Natural Resources (DNR) dredging operation in the Nanticoke marshes near Elliott Island Road could provide sediment for a nearby nourishment project. There are several small federal navigation channels in the southern portion of Fishing Bay that may offer a potential sediment source if dredged in the near future. Additional sources of potential dredge material include Duck Point Cove, Farm Creek, Goose Creek, and McCready's Creek.

If sediment enhancement is to be used to restore subsided marshes to high marsh condition in the future, new sources of sediment will have to be identified.

Community Infrastructure and Input

The Blackwater-Fishing Bay Focal Area is in a very rural part of southern Dorchester County with low population density. Small communities, including Bestpitch, Bishops Head, Crapo, Elliott, Toddville, and Wesley, are dotted throughout the focal area. Of these, Elliott is perhaps most vulnerable to future changes in the marsh landscape, as it sits at the end of a single road, Elliott Island Road, which links it to the mainland by traversing 10 miles of open marsh, much of which has already deteriorated. There are several public boat ramps along Elliott Island Road that offer recreational and commercial access to the marsh. Other public access points in the focal area include Cedar Creek Road, which ends at a boat ramp on Cedar Creek, Maple Dam Road, and Willeys Neck Road at Wesley (see Section 5, Figure 25).

Feedback offered at community meetings indicated that the public places a high level of importance on viewing the ecological system as a whole, as well as on both short- and long-term perspectives when considering restoration efforts. Community comments included concerns about the feasibility of tidal interference on a large scale, the effectiveness of runneling versus damage resulting from ditching, and a desire for post-restoration monitoring. There was also noted interest in developing a cooperative group for landowners to discuss conservation and restoration options. There was no direct feedback during public, in-person meetings on the accuracy of the marsh condition model.

Individual discussion with the Nause-Waiwash Band of Indians indicated an observed degradation of marshes in the Blackwater-Fishing Bay Focal Area, resulting in reduced or difficult access to the marshes for muskrat hunting.

Landownership and Conservation Status

The great majority of the Blackwater-Fishing Bay Focal Area is state-owned and managed by the Maryland DNR as the Fishing Bay Wildlife Management Area (WMA). Private landholdings are scattered throughout the region. A small area along the Blackwater River in the northwest part of the focal area is part of the Blackwater National Wildlife Refuge (NWR), owned and managed by the U.S. Fish and Wildlife Service (USFWS).

One area of marsh on the west side of Fishing Bay is protected by a conservation easement held by the Maryland Environmental Trust. Another parcel (283 ha/700 ac), at Farm Creek Marsh on Wesley Church Road, is managed for conservation purposes by the Chesapeake Audubon Society and was the site of a tidal creek extension restoration project completed in 2018.

Current Habitat Management

The mission of Maryland's WMA system is "To conserve and enhance diverse wildlife populations and associated habitats while providing opportunities for public enjoyment of the State's wildlife resources through hunting and other wildlife-dependent recreation." The maintenance of marsh habitats at the Fishing Bay WMA directly supports the goals of the WMA system to:

- maintain, enhance, or protect sustainable and diverse wildlife populations;
- create, enhance, or protect appropriate habitats, natural communities, and ecologically sensitive areas;
- conserve rare, threatened, and endangered species by protecting the habitats that support them;
- provide wildlife-dependent recreation in areas with minimal capital improvements or other development, with a focused emphasis on hunting; and
- provide a venue to educate citizens on the value and needs of wildlife and plant communities through outreach, demonstration, and sound management.

Blackwater NWR is owned and managed by the U.S. Fish and Wildlife Service (USFWS). The wildlife refuge was established in 1933 to protect and manage habitat for migratory birds, threatened and endangered plants and animals, and other native species. Habitat management on the refuge follows the guidance of the latest Comprehensive Conservation Plan.[85] Specific management objectives pertaining to marshes include the restoration and management of emergent marshes for the benefit of waterfowl, nesting marsh birds, and other native fish and wildlife.

Existing Restoration Projects

Table 15. Completed and proposed restoration projects in the Blackwater-Fishing Bay Focal Area and surrounding marsh landscapes.

Name of Project/Site	Restoration Practice	Completion	Area Restored
Maple Dam Road (Blackwater NWR)	Sediment placement	2003	>0.4 ha (1 ac)
Shorters Wharf (Blackwater NWR)	Sediment placement	2018	16.1 ha (39.8 ac)
Farm Creek Marsh (Chesapeake Audubon Sanctuary)	Tidal creek extension and *Phragmites australis* control	2018	~50.6 ha (~125 ac)
Moneystump Marsh (Blackwater NWR)	Removal of dead trees (ghost forest) to facilitate native high marsh grass growth; localized *P. australis* control	2014	5.5 ha (13.5 ac)
Private Farm (Southern Dorchester County)	Replacement of row crops with native grasses	2014-15	16.1 ha (40 ac)
Backgarden Creek and Marsh	Sediment placement (planned); some replanting with native grasses where existing marsh "holes" are filled	2026-27	40.4 ha (100 ac)
Blackwater Wildlife Drive Pilot Project	Sediment placement	2002	0.4-0.8 ha (1-2 ac)
Blackwater Observation Access Road Pilot Project	Sediment placement	2002	0.4-0.8 ha (1-2 ac)
Multiple Sites Southern Dorchester County	*P. australis* eradication/control	Ongoing	Extensive area of thousands of acres
Multiple Sites Southern Dorchester County	Nutria eradication	2022	Extensive area of thousands of acres

Priority Marsh Areas (PMAs) in the Blackwater-Fishing Bay Focal Area

PMAs (Figure 42) for restoration and long-term maintenance as high marsh habitat for the Saltmarsh Sparrow were selected by a multi-stakeholder focus group, using the methodology described in Section 6.

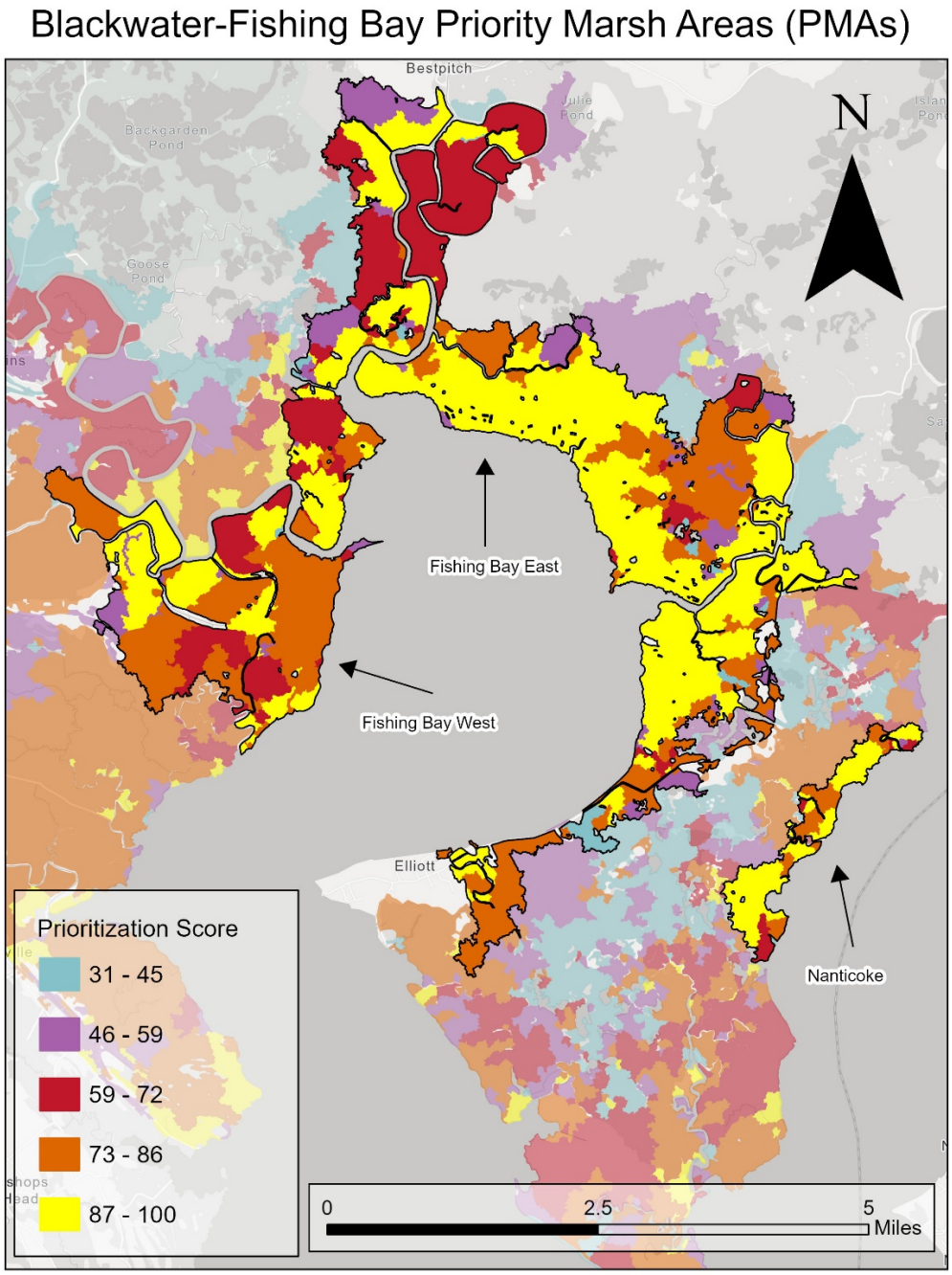


Figure 42. PMAs in the Blackwater-Fishing Bay Focal Area.

The rationale driving this selection was to maintain the habitat quality of the *S. patens* high marsh areas that are known to support the Saltmarsh Sparrow and other priority species, including marshes along the lower reaches of the Blackwater River that are converting to low marsh and will need sediment enhancement to restore them to a high marsh condition. Another intention of this prioritization process was to maintain the rim of high marsh around the Fishing Bay shoreline, since this marsh appears to be intrinsically more stable and resilient to sea level rise, in part because of sediment deposition from Fishing Bay. Three PMAs, totaling 3,852 ha (9,519 ac), were identified.

1. Fishing Bay East (2,593 ha/6,407 ac). This PMA includes extensive tracts of intact high marsh dominated by *S. patens*, encircling the eastern and northern shore of Fishing Bay and extending up the Transquaking River to Bestpitch. This is one of the largest remaining blocks of good-quality Saltmarsh Sparrow habitat in Maryland, and SHARP surveys here in 2021-22 found good numbers of this species. The PMA was extended around the Fishing Bay shoreline to Elliott Island to protect the marshes flanking Elliott Island Road and to connect the high-quality habitat of Grays Island Marsh with high-quality marsh habitat adjacent to Elliott Island. This PMA was determined to represent the highest-priority area for restoration due to its importance for the Saltmarsh Sparrow and other priority species.
2. Fishing Bay West (1,060 ha/2,620 ac). This PMA includes extensive meadow cordgrass habitat along the lower reaches of the Blackwater River and the western shore of Fishing Bay, with *J. roemerianus* habitat in the southern part. This PMA has a lower priority than Fishing Bay East for restoration.
3. Nanticoke (199 ha/492 ac). This PMA includes a narrow strip of intact high marsh dominated by meadow cordgrass habitat along the Nanticoke River. This PMA is third in priority for restoration within the Blackwater-Fishing Bay Focal Area.

The MfT team highlighted a fourth region of marsh that was not selected as a PMA but should be considered as a potential future refuge of high marsh. This region includes marshes to the west of Fishing Bay, including Cedar Creek Marsh and Farm Creek Marsh, that are projected by SLAMM to remain as high marsh until the 2040s. These marshes were not selected as a PMA for restoration because they are dominated by *J. roemerianus* and contain only small patches of Saltmarsh Sparrow habitat. However, if necessary, they could be managed in the future by fire to convert the vegetation to *S. patens*.[38]

Restoration Recommendations

The Restoration Decision Model indicates that the current restoration needs in the Blackwater-Fishing Bay PMAs are considerable (Figure 43). Table 16 summarizes these needs by restoration practice across the PMAs of the Blackwater-Fishing Bay Focal Area. It is estimated that hydrological repair, such as runneling, is likely needed on marsh units across 873 ha (2,156 acres).

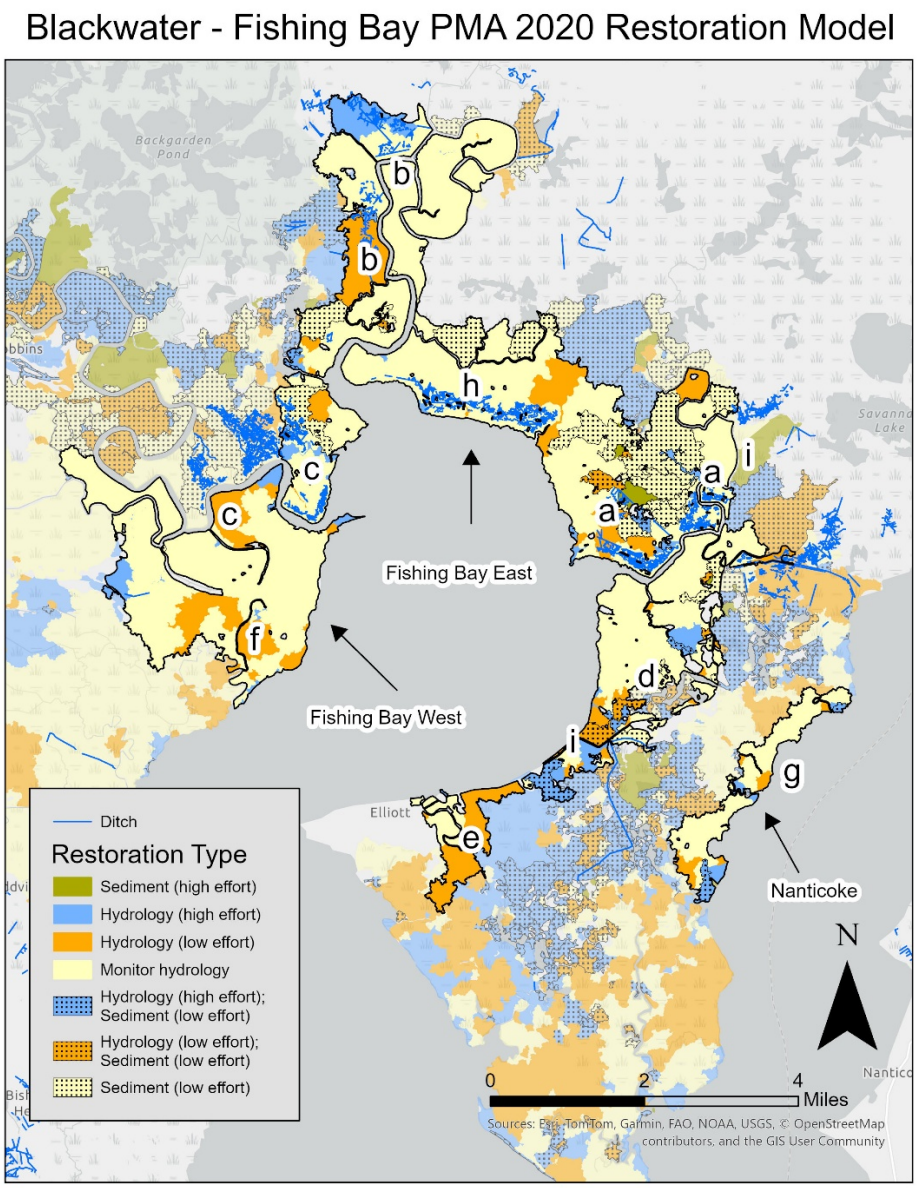


Figure 43. Recommended restoration practices for the Blackwater-Fishing Bay PMAs.

Sediment placement is likely needed on 20 ha (50 ac) of low marsh units and on portions of 550 ha (1,359 ac) of mixed high/low marsh units. These marsh units are concentrated in the interior of Great Marsh, between Island Creek and the northeast corner of Fishing Bay.

Table 16. Current marsh restoration needs in the Blackwater-Fishing Bay Focal Area. Superscript letters in the "Locations" column refer to corresponding letters on the map in Figure 43.

Restoration Practice (shown on Figure 43)	Extent Needed	Locations	Priority Level
Repair hydrology: runnels, berm modification, etc.	752 ha (1,858 ac) of high marsh; (+121 ha/ 298 ac in mixed high/low marsh)	[a]Great Marsh/Island Creek [b]Transquaking River [c]Blackwater River [d]Grays Island Marsh [e]Elliott Island Marsh [f]Thoroughfare Creek [g]Nanticoke	1 1 1 2 2 3 3
Repair hydrology: ditch remediation	Localized	[a]Great Marsh/Island Creek [b]Transquaking River [h]North shore of Fishing Bay [c]Blackwater River	1 1 1 2
Repair hydrology: tidal restriction mitigation	Extent uncertain	[i]Elliott Island Rd. Water control structures (where present)	1 1
Sediment placement	20 ha (50 ac) low marsh (+550 ha/1,359 ac mixed high/low marsh)	[a]Great Marsh [c]Blackwater River [d]Grays Island Marsh	1 2 2
Monitor hydrological condition	2,530 ha (6,252 ac) high marsh (+429 ha/1,061 ac mixed high/low marsh)	Where indicated by Restoration Model	N/A
Restoration Practice (not shown on Figure 43)	**Extent Needed**	**Locations**	**Priority Level**
Control invasive plants (*Phragmites*)	Likely limited	Scattered locations	N/A
Control herbivory	Nutria control no longer needed	Continue monitoring for nutria presence	N/A
Living shorelines (and other wave attenuation devices)	Likely limited	Identify locations of above average shoreline erosion	N/A
Prescribed fire (for vegetation conversion)	Not needed yet	Consider in marshes dominated by *J. roemerianus*	N/A

The location most urgently in need of restoration is the Great Marsh, between Island Creek and Fishing Bay, because of this area's high value to the Saltmarsh Sparrow and because of the loss of elevation and ponding occurring in the marsh interior. Restoration actions for Blackwater-Fishing Bay should begin with on-the-ground assessments in Great Marsh, where restoration action is needed through hydrological repair by runneling in order to slow high marsh deterioration. Further, the dense network of ditches in the high marsh at the southern edge of Great Marsh should be evaluated for potential ditch remediation.

There is already a need for sediment placement to restore some mixed high/low marsh areas to a high marsh condition, and this could amount to several hundred acres. Site assessments will be needed to evaluate local-scale conditions and derive accurate estimates of the effort required. Currently, there are insufficient local sources of sediment to treat this acreage of marsh. Upcoming dredging projects by Maryland DNR in the Nanticoke marshes near Elliott Island Road could provide some dredge material, although it would need to be transported two miles from the dredging site. Beyond this, novel sediment sources will have to be utilized if this marsh is to be retained. Sediment could be dredged from Island Creek or the shallow waters of Fishing Bay.

Future Restoration Needs

Over coming decades, the restoration needs of the Blackwater-Fishing Bay marshes will increase as sea level rise accelerates. Table 17 shows the projected restoration needs within the PMAs at Blackwater-Fishing Bay by decade to 2050. The acreage of marsh requiring sediment placement to restore it to a high marsh condition will increase rapidly, and less marsh will be treatable by hydrological methods as the area of high marsh diminishes. However, the degree of sediment placement needed in the future can be reduced by maintaining the health of the marshes today through targeted hydrological management.

Table 17. Projected future marsh restoration needs at Blackwater-Fishing Bay PMAs, 2020-2050.

Restoration Practice	Hectares (Acres) Needed (by Year)			
	2020	2030	2040	2050
Repair hydrology (runnels)	873 ha (2,156 ac)	867 ha (2,142 ac)	781 ha (1,929 ac)	614 ha (1,518 ac)
Sediment placement	570 ha (1,409 ac)	1,173 ha (2,898 ac)	2,159 ha (5,334 ac)	3,569 ha (8,819 ac)

Community engagement should be built into Blackwater-Fishing Bay restoration planning and timelines to ensure that thorough and clear communication is achieved regarding the proposed work, additional local input, expected impacts to local infrastructure, and outcomes of the project(s). Local tribal leaders of the Nause-Waiwash Band of Indians, as well as other local tribes with which we have not yet engaged, and the Maryland Historical Trust should be consulted to avoid any impact to sacred community assets or significant historical sites, including burial grounds.

DEAL ISLAND PENINSULA, SOMERSET COUNTY

Existing Conditions | Acreage and Landscape Context

The Deal Island peninsula is one of three Marshes for Tomorrow (MfT) focal areas in Somerset County. The Deal Island Peninsula Focal Area occupies 5,605 ha (13,850 ac) of salt and brackish marsh, about 26% of the total for Somerset County given by Tiner and Burke.[1] The ratio of high marsh to low marsh in Somerset County in the 1970s was 86% to 14%, respectively.[38] The marshes here form a peninsula extending west from Monie and Oriole to the four villages of Chance, Dames Quarter, Deal Island, and Wenona. Deal Island Road runs the length of the peninsula and provides the only road link between these villages and the mainland. A unique feature of the Deal Island marshes is a 1,133-hectare (2,800-ac) impoundment in the Deal Island Wildlife Management Area (WMA), the largest impoundment in the state of Maryland. Although water control structures largely eliminate tidal influence within the impoundment, the water is brackish and the vegetation is similar to the brackish marshes outside the impoundment.

Marsh Condition

The Marsh Condition Model is mapped across the Deal Island peninsula in Figure 44. This focal area currently supports 4,002 ha (9,889 ac) of high marsh in stable condition (Classes 1 and 2). Most of the Class 1 and 2 marsh is located north of Deal Island Road and in the southeastern quarter of the Deal Island WMA, adjacent to the Wicomico River and the forested upland boundary. In the western and central parts of the WMA, the marsh is lower in elevation, with more vegetation dieback and ponding. The marshes outside the WMA, in the vicinity of the villages from Dames Quarter to Wenona, are a patchwork of different condition classes.

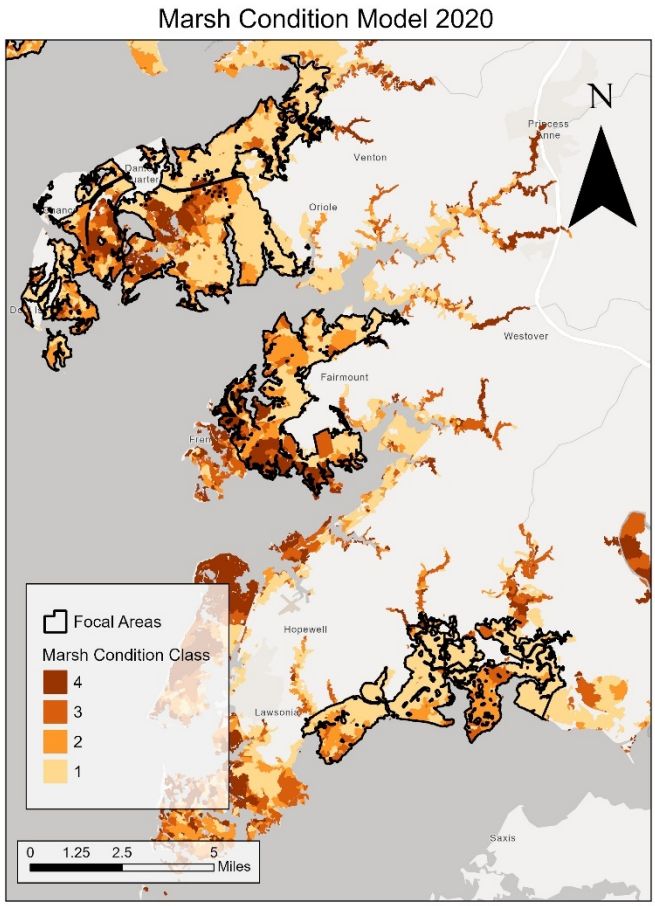


Figure 44. Marsh condition results for the Deal Island Peninsula Focal Area, 2020.

Future Projections of Marsh Condition

Through 2030 and 2040, relatively few changes in the extent of high marsh are projected by the Sea Level Affecting Marshes Model (SLAMM) in the Deal Island peninsula, and consequently, the Marsh Condition Model also shows few changes during this period. Future projections of the Marsh Condition Model can be explored in the MfT Experience Builder. However, by 2050, most of the current high marsh north of Deal Island Road is projected to become low marsh, followed by the southeastern portion of the WMA by 2060. As such, the southeastern portion of the WMA may offer a potential future refuge of high marsh and the Saltmarsh Sparrow into the 2050s. By 2070, nearly all the marshes on the Deal Island peninsula are projected to be Class 4 of the Marsh Condition Model (Figure 45).

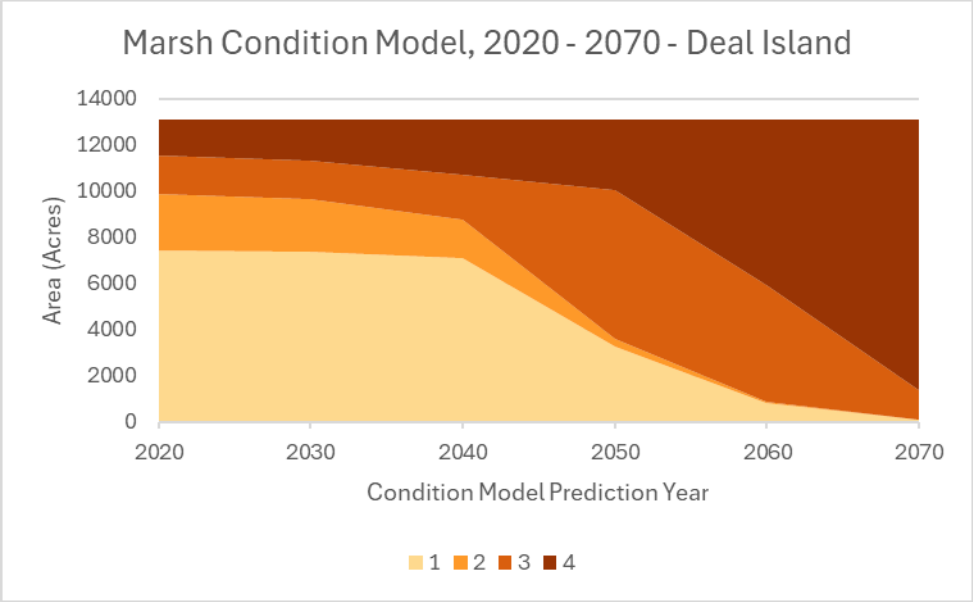


Figure 45. Future acreage projections for the four Marsh Condition Classes in the Deal Island Peninsula Focal Area, presented at decadal intervals from 2020 to 2070 (1 ac = 0.4 ha).

It is important to keep in mind that these projections represent a best-case scenario of future marsh condition because they are based on SLAMM, which does not account for the elevation collapse that occurs due to waterlogging and vegetation dieback. A more detailed explanation of the role of vegetation dieback and ponding in the Marsh Condition Model is provided in Section 4.

Vegetation

In Somerset County, the most widespread vegetation types in salt and brackish marsh are *J. roemerianus*, *S. patens / D. Spicata*, and *S. alterniflora* (Figure 46). McCormick and Soames[38] gave the proportional extent of these vegetation types in the 1970s as 46%, 27%, and 14%, respectively. Although accurate plant species distribution data for the present day are not available, each of these vegetation types is still widespread in the county.

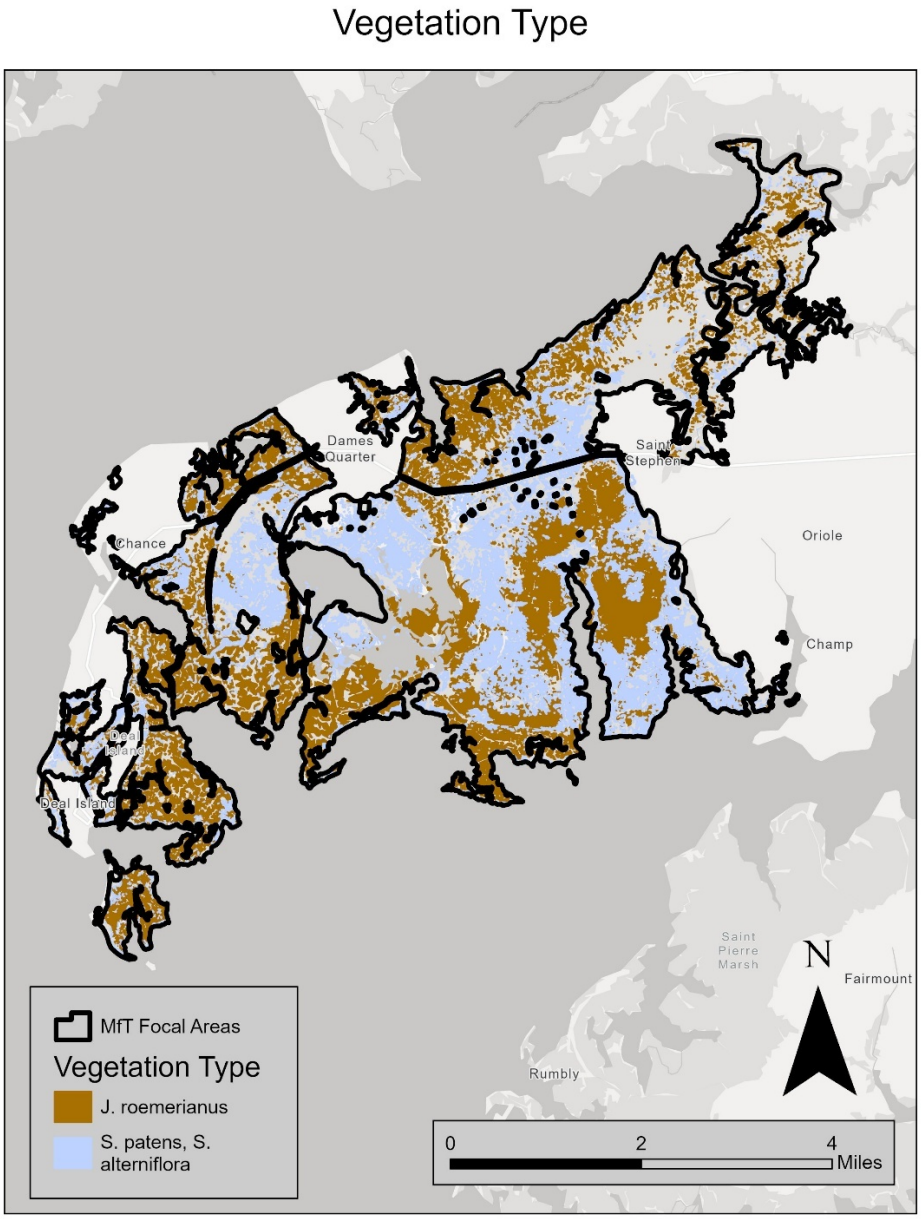


Figure 46. J. roemerianus, S. patens, and S. alterniflora distribution in the Deal Island peninsula region.

Within the Deal Island Peninsula Focal Area, *J. roemerianus* and *S. patens / D. spicata* are both widespread. Much of the lower-lying marsh in the central part of the WMA is dominated by *S. patens / D. spicata*, but this may not currently be suitable habitat for the Saltmarsh Sparrow owing to its low elevation. Extensive areas of higher-elevation *S. patens / D. spicata* marsh occur in the southeastern portion of the WMA and immediately north of Deal Island Road.

In 2024, following the placement of dredge material at the WMA, contractors planted over 300,000 native marsh plants, approximately two-thirds being *S. patens / D. spicata.*

Another vegetation type at Deal Island that has not been mapped but has significant ecological impact is *Phragmites australis*, which forms very extensive, dense stands along the upland-marsh transition zone at the eastern edge of the Deal Island Peninsula Focal Area. It occupies significant areas of high and transitional marsh that could potentially be converted to *S. patens* / *D. spicata* if the *P. australis* were successfully eliminated.

Saltmarsh Sparrow Abundance

Saltmarsh Sparrow detections appear to have declined greatly across the Deal Island marshes. Saltmarsh Habitat and Avian Research Program (SHARP) surveys during 2011-12 found this species at approximately half of 20 randomized survey points, but during the 2021-22 surveys, it was detected at only two points, both along Game Reserve Road. One area of *S. patens* / *D. spicata*-dominated high marsh that was not sampled by the SHARP surveys and rarely visited by biologists is the southeastern part of the WMA. This area should be assessed for Saltmarsh Sparrows in the future.

Marsh Migration Corridors

The marshes of the Deal Island Peninsula Focal Area are bordered by extensive areas of potential marsh migration corridor, as defined by elevation alone, in the forested uplands to the east. Because the marsh adjacent to this upland transition zone is healthy, intact high marsh, there may be potential for upslope marsh migration to occur without the issues of ground surface collapse and ponding observed in Dorchester County and other parts of Somerset County. However, the entire upland-marsh transition zone here is choked with dense stands of *P. australis*, which will compromise the habitat transition zone unless managed appropriately for its elimination. *P. australis* control is notoriously difficult to achieve with any lasting success, although it may be worth attempting at this location.

Sediment Sources/Dredging Locations

The Deal Island Peninsula is unique among the MfT focal areas in being located close to a maintenance dredging operation in the Wicomico River, which provides a material source for marsh restoration. The U.S. Army Corps of Engineers dredges the lower Wicomico River approximately every four years, and the latest round of dredging, in 2023, provided approximately 160,000 cubic yards of material for a Beneficial Use of Dredge Material (BUDM) project at the Deal Island WMA. In the 2023 project, dredge material was pumped 11 miles from the river's navigation channel to the southern edge of the WMA. Thus, it is likely that any location within the Deal Island PMA is within reach of this source of dredge material.

Additional sources of dredge material include Webster's Cove (part of the lower Wicomico), Upper Thorofare, Lower Thorofare (Deal Island), St. Peters Creek, the Manokin River, Goose Creek, Crisfield Harbor/Somers Cove/Doughtery Creek, Broad Creek, Starlings Creek and the Pocomoke River.

Community Infrastructure and Input

The Deal Island peninsula is a 26-square-mile expanse in rural Somerset County with low population density. The peninsula is home to several small communities, including Chance, Dames Quarter, Deal Island, Oriole, St. Stephens, and Wenona. The region is connected to the mainland by a single road, Maryland Route 363, which serves as the primary transportation route for residents, visitors, and commercial goods. There are multiple publicly accessible boat ramps off Deal Island Road, as well as many private water access points, marinas, and boatyards, speaking to the deep relationship these communities have with the waterways that surround them (see Section 5, Figure 26).

Two notable concerns were expressed by Somerset community members both in-person and via the Marsh Use survey. These were the current effects of road and yard flooding resulting in impaired private and public access, and the immediate need to address ditch remediation and management specifically on the Deal Island peninsula. Multiple participants had observed erosion at Little Deal Island and expressed concerns about associated impacts to the peninsula shoreline. We were asked to consider producing guidelines for private landowners (e.g., how to remove invasive *P. australis*). Feedback from community meetings included a desire for increased coordination between local, state, and federal agencies, as well as organizations leading coastal restoration and resiliency efforts in the region.

There was broad agreement between the Marsh Condition Model and local participant knowledge of the Deal Island peninsula salt marshes. We were encouraged to consult with local duck hunters, who more intimately know the vast salt marshes. Participants recognized the benefits of restoration action to wildlife and protecting recreational activities, such as wildlife watching and kayaking, while sharing their desire to find opportunities for protecting human infrastructure, too.

Landownership and Conservation Status

The great majority of the Deal Island Peninsula Bay Focal Area is state-owned. It is managed by the Maryland DNR as the Deal Island WMA and, in the northeastern portion, as the Monie Bay unit of the Chesapeake Bay National Estuarine Research Reserve (CBNERR). There are several small private landholdings around the periphery of the WMA and throughout the focal area.

Current Habitat Management

The mission of the WMA system is "To conserve and enhance diverse wildlife populations and associated habitats while providing opportunities for public enjoyment of the State's wildlife resources through hunting and other wildlife-dependent recreation." The maintenance of marsh habitats at the Deal Island WMA directly supports the goals of the WMA system to:

- maintain, enhance, or protect sustainable and diverse wildlife populations;
- create, enhance, or protect appropriate habitats, natural communities, and ecologically sensitive areas;
- conserve rare, threatened, and endangered species by protecting the habitats that support them;
- provide wildlife-dependent recreation in areas with minimal capital improvements or other development, with a focused emphasis on hunting; and
- provide a venue to educate citizens on the value and needs of wildlife and plant communities through outreach, demonstration, and sound management.

Existing Restoration Projects

Table 18. Completed and proposed restoration projects in the Deal Island Peninsula Focal Area and surrounding marsh landscapes.

Project Name/Site	Restoration Practice	Completion	Area Restored
Deal Island Shoreline Project	Shoreline stabilization, living shoreline, dune restoration	2022	335 meters (1,100 linear ft)
Lower Wicomico River Maintenance Dredging Project (Deal Island Marsh Restoration Project)	Sediment placement (Beneficial Use of Dredged Material, or BUDM)	2023	30 ha (74 ac)

Priority Marsh Areas (PMAs) in the Deal Island Peninsula Focal Area

PMAs for restoration and long-term maintenance as high marsh habitat for the Saltmarsh Sparrow were selected by a multi-stakeholder focus group using the methodology described in Section 6. Figure 47 shows the locations of the selected PMAs. The rationale driving these selections was to maintain the high marsh areas in the southeastern portion of the area and the high marsh north of Deal Island Road. In addition, the focus group sought to include areas that are in need of sediment placement and are suitable for future beneficial use projects.

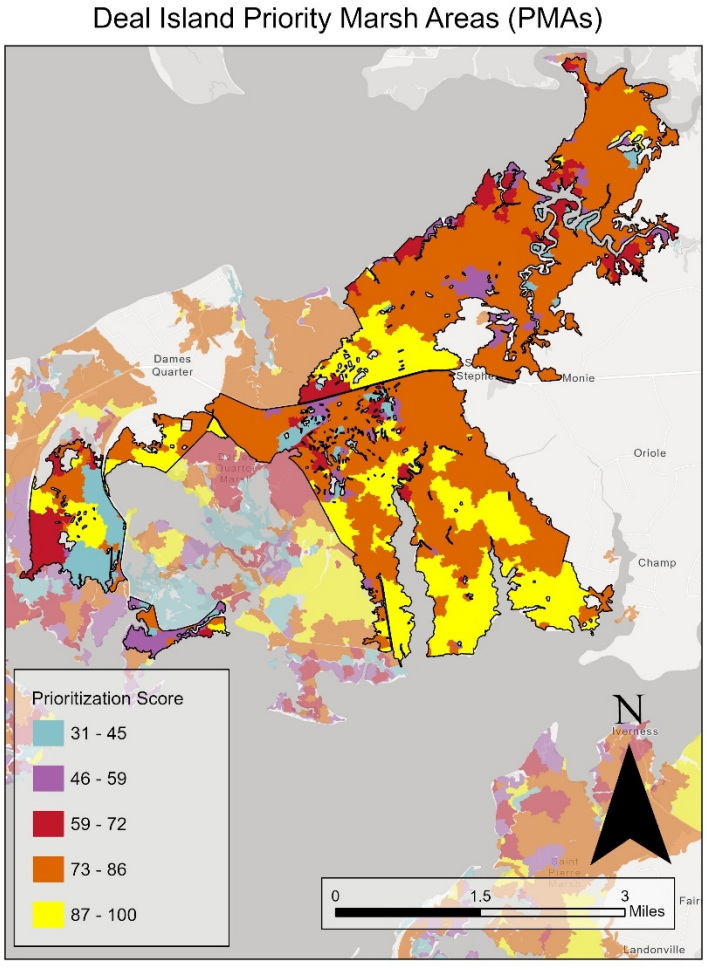


Figure 47. PMAs in the Deal Island Peninsula Focal Area.

The PMA at Deal Island occupies 3,036 ha (7,502 ac) and includes most of the marsh north of Deal Island Road and east of Dames Quarter Creek and all of the marsh east of the impoundment on the south side of Deal Island Road. The focus group also included two areas in the PMA of lower-elevation marsh as potential project sites for beneficial use, utilizing material from future dredging operations. These include the area in the vicinity of Game Reserve Road, northeast of the impoundment, and the severely ponded area of grass-dominated marsh immediately west of the impoundment. The 2023 restoration project site on the south side of the impoundment was included as

an outlying area of the PMA because of the investment already made in restoration there and the potential need for further work in the future. The acreage of the impoundment was excluded from the PMA.

Restoration Recommendations

According to the Restoration Decision Model, there are several marsh units distributed across the PMAs in need of hydrological repair by runneling, and two areas selected as potential beneficial use project sites (Figure 48). Table 19 summarizes these restoration needs across the PMAs of the Deal Island Peninsula Focal Area by restoration practice. Hydrological repair, such as runnels, is needed on 754 ha (1,862 acres) of high marsh units, with a further 266 ha (658 acres) of mixed high/low marsh units likely requiring hydrological repair where there is sufficient elevation.

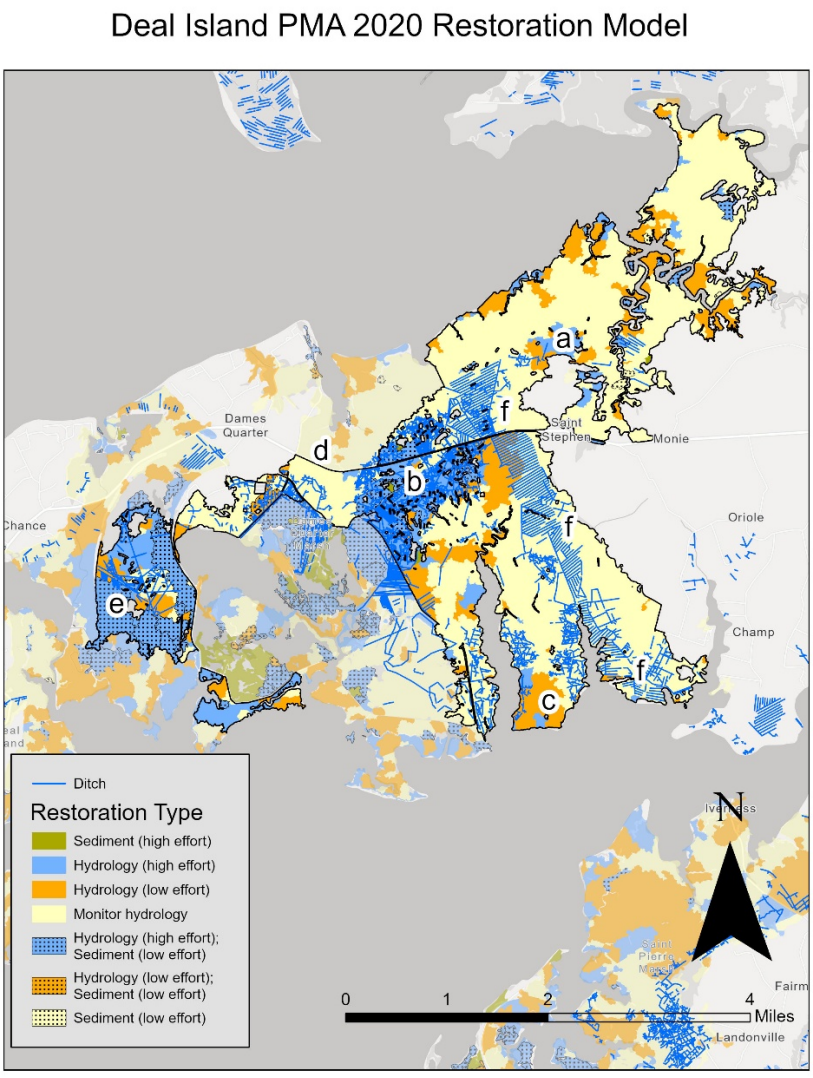


Figure 48. Restoration strategy recommendations for the Deal Island PMA.

According to the Restoration Decision Model, sediment placement is needed on at least 6 ha (15 ac) of low marsh units and likely needed on portions of 274 ha (678 ac) of mixed high/low marsh units. These marsh units are concentrated in two areas, west and north of the impoundment.

Table 19. Current marsh restoration needs in the Deal Island Peninsula Focal Area. Superscript letters in the "Locations" column refer to corresponding letters on the map in Figure 48.

Restoration Practice (shown in Figure 48)	Extent Needed	Locations	Priority Level
Repair hydrology: runnels, berm modification, etc.	754 ha (1,862 ac) of high marsh; (+266 ha/658 acres of mixed high/low marsh)	[a]North of St Stephen. [b]Game Reserve Rd [c]Mouth of Broad Creek, east side	1 2 2
Repair hydrology: ditch remediation	Widespread	[b]Game Reserve Rd.	1
Repair hydrology: tidal restriction mitigation	Extent uncertain	[d]Deal Island Rd. Water control structures (where present)	1 1
Sediment placement	6 ha (15 ac) of low marsh (+274 ha/678 ac of mixed high/low marsh)	[e]West side of impoundment [b]Game Reserve Rd	2 2
Monitor hydrological condition	2,002 ha (4,946 ac) high marsh (+8 ha/20 ac mixed high/low marsh)	Where indicated by Restoration Decision Model	N/A
Restoration Practice (not shown in Figure 48)	**Extent Needed**	**Locations**	**Priority Level**
Control invasive plants (*Phragmites*)	Extensive on eastern periphery	[f]Eastern periphery of Deal Island WMA	2
Control herbivory	Nutria control no longer needed	Continue monitoring for nutria presence	N/A
Living shorelines (and other wave attenuation devices)	Likely limited	Identify locations of above average shoreline erosion	N/A
Prescribed fire (for vegetation conversion)	Not needed yet	Consider in marshes dominated by *J. roemerianus*	N/A

Future Restoration Needs

Over coming decades, the restoration needs of the Deal Island marshes will increase as sea level rise accelerates. Table 20 shows the projected restoration needs within the PMAs at Deal Island by decade to 2050. An increasing acreage of marsh will require sediment placement to restore it to a high marsh condition, and less marsh will be treatable by hydrological methods as the area of high marsh diminishes. However, the degree of sediment placement needed in the future can be reduced by maintaining the health of the marshes today through targeted hydrological management.

Table 20. Projected future marsh restoration needs at Deal Island Peninsula PMAs, 2020-2050.

Restoration Practice	Hectares (Acres) Needed (by Year)			
	2020	2030	2040	2050
Repair hydrology (runnels)	1,020 ha (2,520 ac)	1,020 ha (2,520 ac)	1,015 ha (2,509 ac)	817 ha (2,019 ac)
Sediment placement	281 ha (694 ac)	347 ha (858 ac)	620 ha (1,532 ac)	1,999 ha (4,939 ac)

Community engagement should be built into Deal Island peninsula restoration planning and timelines to ensure that thorough and clear communication is achieved regarding the proposed work, additional local input, expected impacts to local infrastructure, and outcomes of the project(s). Representatives of Indigenous communities and the Maryland Historical Trust should be consulted to avoid any impact to sacred community assets or significant historical sites.

POCOMOKE SOUND, SOMERSET COUNTY

Existing Conditions | Acreage and Landscape Context

The Pocomoke Sound marshes comprise one of three Marshes for Tomorrow (MfT) focal areas in Somerset County. The Pocomoke Sound Focal Area occupies 2,791 ha (6,897 ac) of salt and brackish marsh, about 13% of the total for Somerset County given by Tiner and Burke.[1] The ratio of high marsh to low marsh in Somerset County in the 1970s was 86% to 14%.[38] The marshes here form a platform projecting one to two miles southward to the Pocomoke Sound shoreline between the villages of Cash Corner and Marumsco.

Marsh Condition

The Marsh Condition Model is mapped across the Pocomoke Sound marshes in Figure 49. The great majority (2,449 ha/6,051 ac) of this focal area currently supports high marsh in stable condition (Classes 1 and 2). Most of the marsh is healthy (Class 1), although there are three areas of Class 2 marsh where vegetation dieback and ponding are occurring: the Pocomoke Sound WMA, Langford Marsh, and much of Richardson Marsh at Rumbley Point Road in the Irish Grove Sanctuary. At the latter site, surface inundation and vegetation dieback expanded significantly during 2023-24. One area between Rumbley Point Road and Marumsco Creek that was grid-ditched in the past has lower elevation than surrounding marshes and is also heavily waterlogged adjacent to the road.

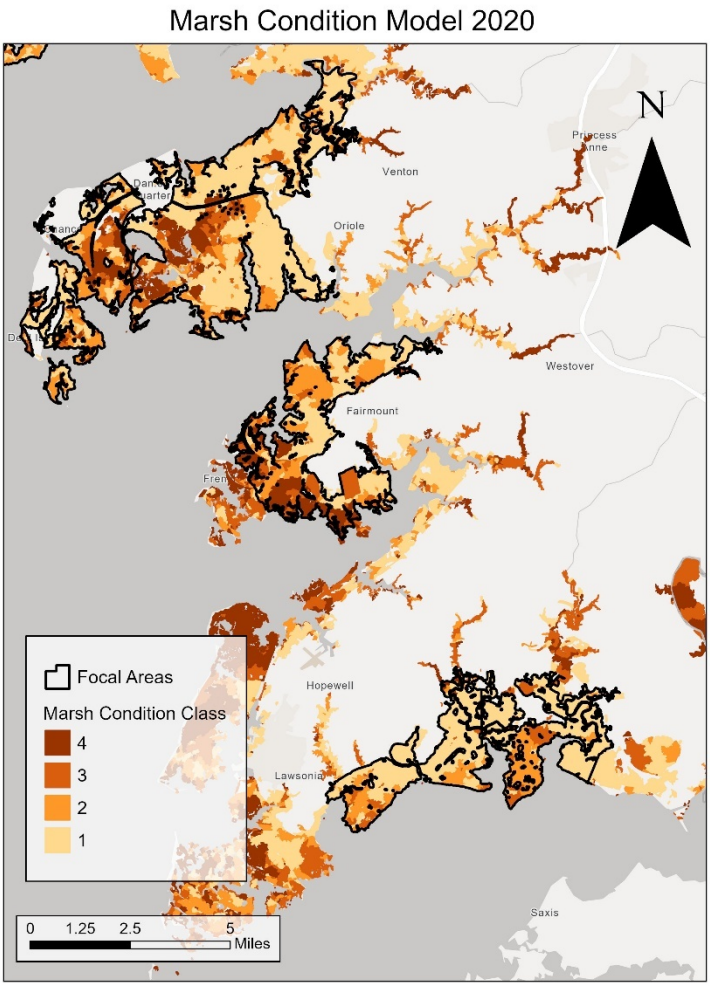


Figure 49. Marsh condition results for the Pocomoke Sound Focal Area.

Future Projections of Marsh Condition

Through 2030 and 2040, relatively few changes in the extent of high marsh in the Pocomoke Sound Focal Area are projected by the Sea Level Affecting Marshes Model (SLAMM), and consequently, the Marsh Condition Model also shows few changes during this period. However, by 2050, most marsh units are projected to become an even mix of high marsh and low marsh, and just a decade later (2060), the entire focal area is projected to be low marsh (Figure 50). Future projections of the Marsh Condition Model can be explored in the MfT Experience Builder.

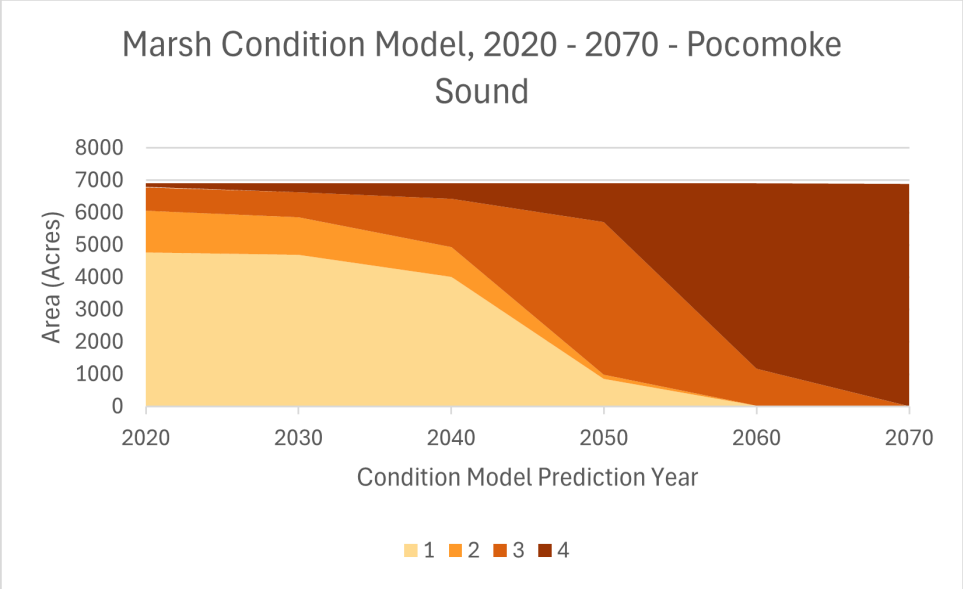


Figure 50. Future acreage projections for the four Marsh Condition Classes in the Pocomoke Sound Focal Area, presented at decadal intervals from 2020 to 2070 (1 ac = 0.4 ha).

Vegetation

The majority of the Pocomoke Sound Focal Area is dominated by extensive *S. patens* vegetation, in many places interspersed with short-form *S. alterniflora*, which constitutes high-quality Saltmarsh Sparrow habitat (Figure 51). There are large patches of *J. roemerianus* on both sides of Gunby Creek and in the northern portions of the Irish Grove Sanctuary.

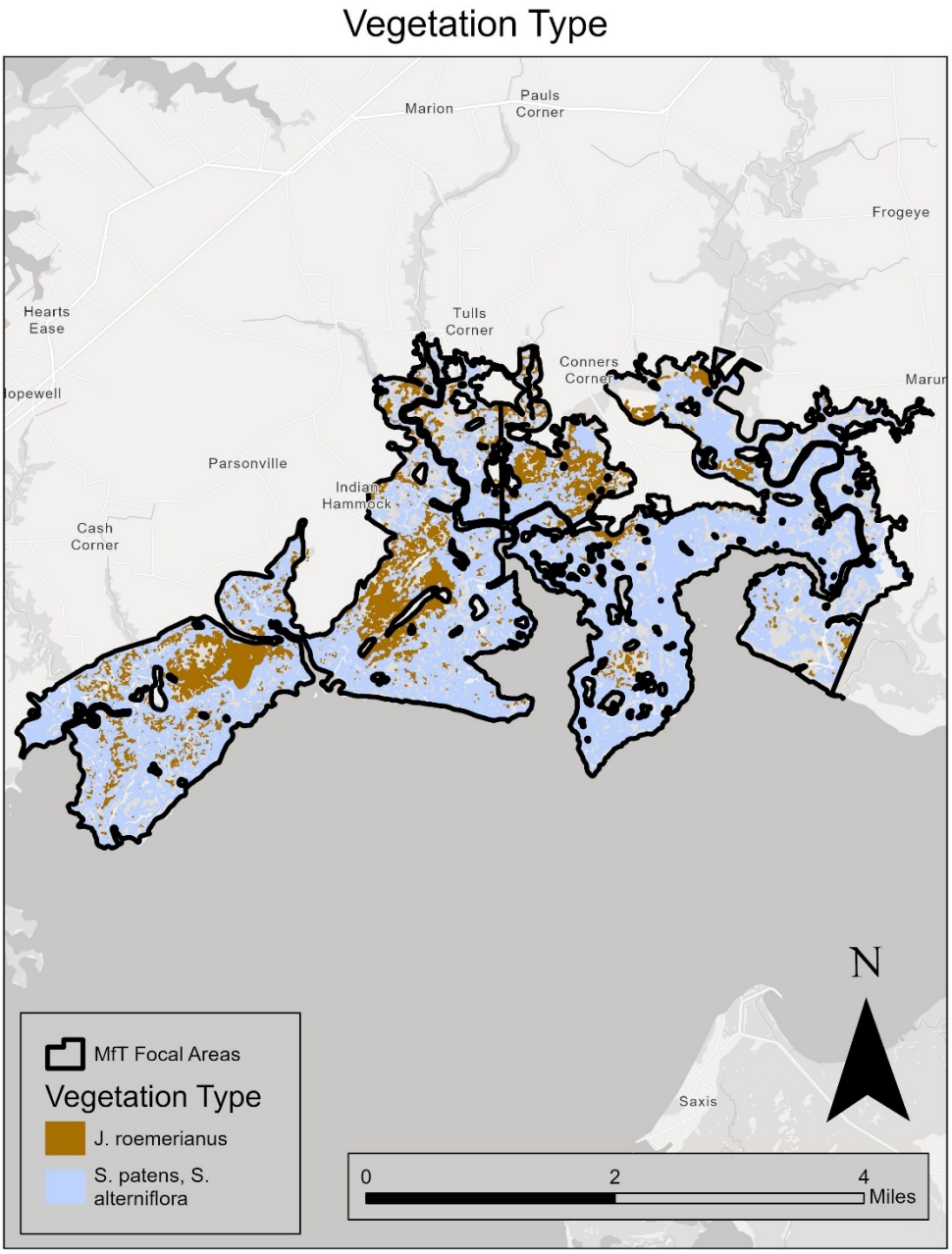


Figure 51. J. roemerianus, S. patens, and S. alterniflora distribution in the Pocomoke Sound region.

Saltmarsh Sparrow Abundance

During the 2021-22 Saltmarsh Habitat and Avian Research Program (SHARP) survey, Saltmarsh Sparrows were observed at one survey point in the Pocomoke Sound WMA but were not detected at a cluster of points east of Marumsco Creek. The SHARP survey did not sample the central part of the focal area at Irish Grove Sanctuary. However, informal surveys have found Saltmarsh Sparrows to be relatively abundant at Irish Grove. In 2022, 25 Saltmarsh Sparrows were counted along a 2.5-km (1.6-mi) transect running the length of Rumbly Point Road at Irish Grove Sanctuary. In 2024, mist netting surveys following SHARP protocol revealed two female Saltmarsh Sparrows with brood patches, confirming that they were breeding at Irish Grove. This may be one of the most important remaining breeding sites for this species in Maryland.

Marsh Migration Corridors

Extensive areas of potential marsh migration corridor, as defined by elevation alone, border the marshes of the Pocomoke Sound Focal Area. Because the marsh adjacent to this upland transition zone is healthy, intact high marsh, there may be potential for upslope marsh migration to occur without the issues of ground surface collapse and ponding that frequently accompany marsh migration in Dorchester County. Stands of *P. australis* are common in much of the upland-marsh transition zone and will require management to facilitate effective marsh migration. *P. australis* control is notoriously difficult to achieve with any lasting success, though it may be worth attempting at this location.

Sediment Sources/Dredging Locations

The Pocomoke Sound Focal Area does not currently have a significant need for sediment placement. There will likely be a need in the future, and one potential source of dredged material is a federal navigation channel in the open waters of Pocomoke Sound near the mouth of Marumsco Creek. One other dredging location is within five miles of the focal area at Janes Island State Park. Factors limiting the use of this material within the Pocomoke Sound Priority Marsh Area (PMA) might include transport costs or assignment to other locations. Other U.S. Army Corps of Engineers (USACE) navigation channels in the region, but outside the focal area, include Broad Creek and Starlings Creek.

Community Infrastructure & Input

The Pocomoke Sound Focal Area is in a very rural part of Somerset County with low population density. The small communities of Cash Corner, Indian Hammock, Marumsco, Parsonville, and Tulls Corner are located around the edges of the focal area. Two public roads traverse the marsh. Rumbly Point Road crosses Richardson Marsh in Irish Grove Sanctuary and ends at a boat ramp. This road offers public access to an extensive and wildlife-diverse marsh that is popular with birdwatchers. The road now floods frequently and is at risk of complete deterioration (see Section 5, Figure 26). Further, members of the community identified small, family grave sites within the focal area marshes that are at risk of erosion, and members of the Accohannock Indian Tribe noted the cultural significance of the marshes around East Creek.

Feedback from the community meetings indicated a strong desire for agencies and organizations to keep local communities informed of restoration plans, as well as continued protection of Irish Grove Sanctuary, Marumsco Creek, and Janes Island State Park.

There was moderate agreement between the Marsh Condition Model and local participant knowledge of Pocomoke Sound. Some participants felt the model painted a picture that was bleaker than their

experience of the existing marshes. For example, one marsh unit on Marumsco Road predicted to become Class 3 or 4 marsh was described by a participant as "at present [the marsh] remains high," and another noted that Janes Island State Park had "trees still living."

Participants recognized that restoration action could enhance fishing and hunting opportunities, improve future access to marsh habitats, and provide benefits to wildlife. Many noted that they had short-term concerns about road access during restoration actions but that the long-term benefits of such projects would support wildlife and provide continued access and activities in and around the marshes. We were asked to consider producing restoration guidelines for private landowners (e.g., how to remove invasive *P. australis*).

Landownership and Conservation Status

Most of the marsh in the Pocomoke Sound Focal Area is privately owned. However, there is one publicly owned site. The Pocomoke Sound Wildlife Management Area is owned and managed by the Maryland Department of Natural Resources and occupies approximately 364 ha (900 ac) at the western end of the focal area.

Several private properties within this PMA are protected with conservation easements. These include Irish Grove Sanctuary, which is privately owned by the Maryland Ornithological Society and includes approximately 809 ha (2,000 ac) of salt marsh. The sanctuary is managed for conservation purposes and is a popular location for wildlife watching.

Current Habitat Management

The mission of the WMA system is "To conserve and enhance diverse wildlife populations and associated habitats while providing opportunities for public enjoyment of the State's wildlife resources through hunting and other wildlife-dependent recreation." The maintenance of marsh habitats at the Pocomoke Sound WMA directly supports the goals of the WMA system to:

- maintain, enhance, or protect sustainable and diverse wildlife populations;
- create, enhance, or protect appropriate habitats, natural communities, and ecologically sensitive areas;
- conserve rare, threatened, and endangered species by protecting the habitats that support them;
- provide wildlife-dependent recreation in areas with minimal capital improvements or other development, with a focused emphasis on hunting; and
- provide a venue to educate citizens on the value and needs of wildlife and plant communities through outreach, demonstration, and sound management.

At Irish Grove Sanctuary, there is little active habitat management in the marsh. Historically *P. australis* control, by spraying with herbicide, was implemented on a small scale along some of the ditches and creeks.

Existing Restoration Projects

Table 21. Proposed restoration projects in the Pocomoke Sound Focal Area and surrounding marsh landscapes.

Project Name/Site	Restoration Practice	Completion	Area Restored
Irish Grove Sanctuary	Hydrological repair (runneling)	Permit applied for in 2024	30 ha (73 ac)

Priority Marsh Areas (PMAs) in the Pocomoke Sound Focal Area

PMAs for restoration and long-term maintenance as high marsh habitat for the Saltmarsh Sparrow were selected by a multi-stakeholder focus group using the methodology described in Section 6. The entire focal area was selected as a PMA (Figure 52) because of the healthy and resilient condition of the great majority of the marsh and the prevalence of *S. patens* vegetation. Irish Grove Sanctuary contains one of the largest remaining blocks of good-quality Saltmarsh Sparrow habitat in Maryland and supports good numbers of this species.

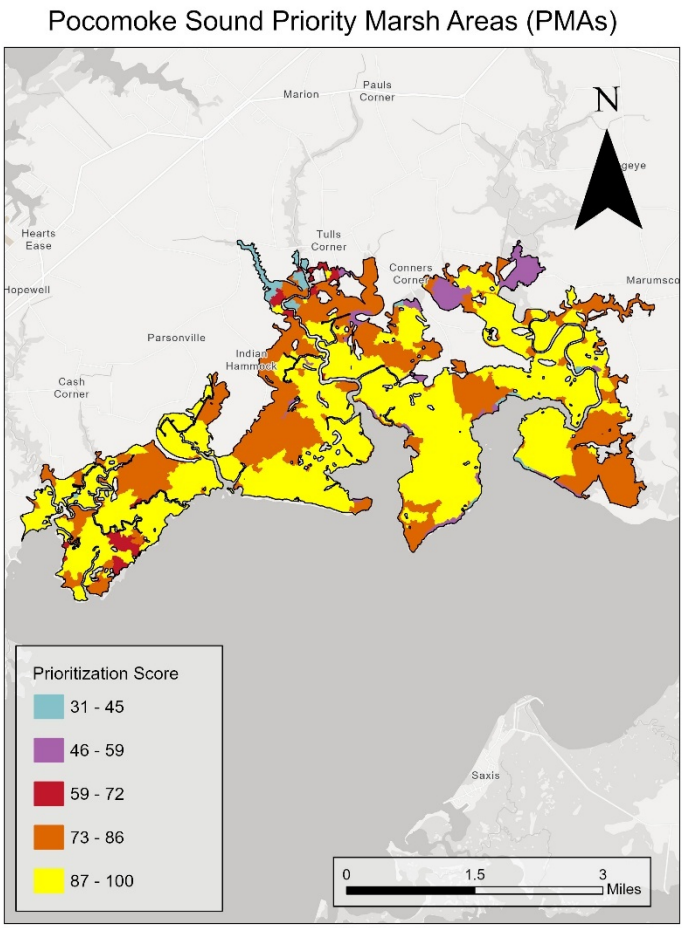


Figure 52. PMAs in the Pocomoke Sound Focal Area.

Restoration Recommendations

Although much of the Pocomoke Sound PMA is, according to the Restoration Decision Model, not currently in need of restoration, three areas of *S. patens* high marsh are becoming waterlogged and experiencing vegetation dieback and are in need of hydrological repair by runneling (Figure 53). These are at the Pocomoke Sound WMA, Langford Marsh, and much of Richardson Marsh at Rumbley Point Road in Irish Grove Sanctuary. All of these sites should be considered urgent priorities for restoration because high-quality high marsh habitat is at risk in a region known to support a significant Saltmarsh Sparrow population. Table 22 summarizes the restoration needs across the PMAs of the Pocomoke Sound Focal Area, as determined by the Restoration Decision Model.

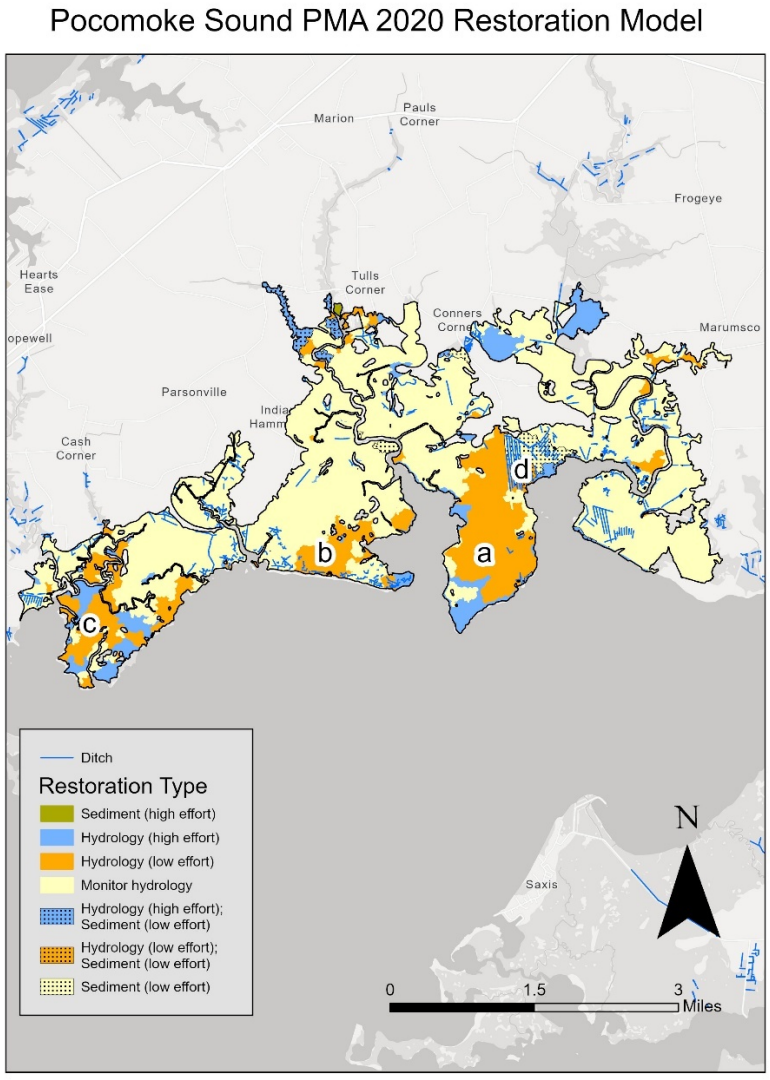


Figure 53. Marsh restoration strategy recommendations for the Pocomoke Sound region.

Table 22. Current marsh restoration needs in the Pocomoke Sound Focal Area. Superscripts in "Locations" column refer to corresponding letters on the map in Figure 53.

Restoration Practice (shown in Figure 53)	Extent Needed	Locations	Priority Level
Repair hydrology: Runnels, berm modification etc.	746 ha (1,843 ac) of high marsh; (+47 ha/116 ac of mixed high/low marsh)	[a]Rumbley Point Rd., Irish Grove Sanctuary [b]Langford Marsh [c]Pocomoke Sound WMA	1 1 1
Repair hydrology: Ditch remediation	Localized	[d]Rumbley Point Rd.-Marumsco Creek	2
Repair hydrology: Tidal restriction mitigation	Extent uncertain	[a]Rumbley Point Rd. Water control structures (where present)	1 1
Sediment placement	2 ha (6 acres) of low marsh (+67 ha/166 ac of mixed high/low marsh)	[d]Rumbley Point Rd.-Marumsco Creek	2
Monitor hydrological condition	1,929 ha (4,767 ac) of high marsh (+67 ha/166 ac of mixed high/low marsh)	Where indicated by Restoration Decision Model	NA
Restoration Practice (not shown in Figure 53)	**Extent Needed**	**Locations**	**Priority Level**
Control invasive plants (*Phragmites*)	Extent uncertain	Assess along upland boundaries	3
Control herbivory	Nutria control no longer needed	Continue monitoring for nutria presence	NA
Living shorelines (and other wave attenuation devices)	None	Identify locations of above-average shoreline erosion	NA
Prescribed fire (for vegetation conversion)	Not needed yet	Consider in marshes dominated by *J. roemerianus*	NA

Future Restoration Needs

Over coming decades, the restoration needs of the Pocomoke Sound marshes will increase as sea level rise accelerates. Table 23 shows the projected restoration needs within the Pocomoke Sound PMA by decade to 2050. An increasing acreage of marsh will require sediment placement to restore it to a high marsh condition, and less marsh will be treatable by hydrological methods as the area of high marsh diminishes. However, the degree of sediment placement needed in the future can be reduced by maintaining the health of the marshes today through targeted hydrological management.

Table 23. Projected future marsh restoration needs at Pocomoke Sound PMAs, 2020-2050.

Restoration Practice	Hectares (Acres) Needed (by Year)			
	2020	2030	2040	2050
Repair hydrology (runnels)	793 ha (1,959 ac)	791 ha (1,955 ac)	791 ha (1,955 ac)	709 ha (1,752 ac)
Sediment placement	116 ha (287 ac)	258 ha (638 ac)	708 ha (1,749 ac)	2,376 ha (5,872 ac)

Community engagement should be built into Pocomoke Sound restoration planning and timelines to ensure that thorough and clear communication is achieved regarding the proposed work, additional local input, expected impacts to local infrastructure, and outcomes of the project(s). Local tribal leaders of the Accohannock Indian Tribe and the Pocomoke Indian Nation, as well as other local tribes with which we have not yet engaged, and the Maryland Historical Trust should be consulted to avoid any impact to sacred community assets or significant historical sites, including burial grounds.

MARYLAND COASTAL BAYS AND ASSATEAGUE ISLAND, WORCESTER COUNTY

Existing Conditions | Acreage and Landscape Context

The Maryland Coastal Bays system features salt marshes along most of its shoreline except where infrastructure and housing development have converted wetlands to dry land, mostly in Isle of Wight Bay and Assawoman Bay. The marsh platform is generally 500m-1km (0.3-0.6 mi) wide, narrower than in the larger marsh blocks of the Chesapeake Bay. The largest expanses of marsh in the Maryland Coastal Bays are on shorelines protected by peninsulas or islands, as at Newport Bay and Johnson Bay. The marshes flanking the bayside of Assateague Island, a sand barrier island, are bordered by a mosaic of maritime forests, shrublands, and vegetated sand dunes. The Coastal Bays support a number of marsh islands, the largest of which are Mills Island and Tizzard Island. Some smaller marsh islands have been lost to erosion in recent decades.

Marsh Condition

The Maryland Coastal Bays marshes are, on average, lower in elevation[86] than the Chesapeake Bay marshes (Figure 54). This is likely a consequence of extensive grid-ditching that was carried out in the Maryland Coastal Bays in the 20th century, unlike in most of the marshes in the Chesapeake Bay. Nearly all of the marshes on the western side of the Maryland Coastal Bays are densely grid-ditched. On Assateague Island, there are several areas where ditching is no longer evident. Over time, natural coastal processes, such as overwash from coastal storm events, have naturally filled and obscured some former ditches, particularly along Assateague's northern six miles.[87] Another factor that has negatively impacted the Maryland Coastal Bays marshes is herbivory by geese. Large flocks of Snow Geese frequented the marshes in the 1990s and 2000s, and grazed out extensive areas of marsh vegetation, particularly in the Newport Bay region. Snow Geese no longer winter here in large numbers, but Canada Goose herbivory was reported by community members as a localized issue in 2024.

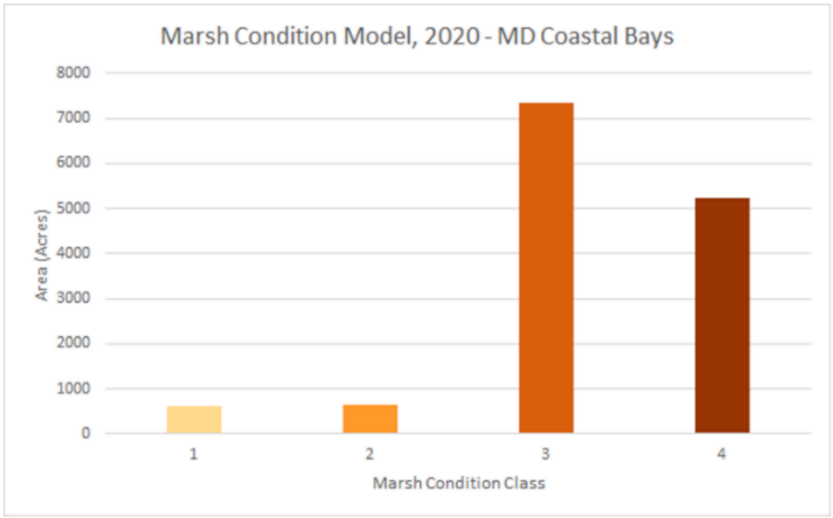


Figure 54. Marsh Condition Model results for the Maryland Coastal Bays Focal Area, 2020 (1 ac = 0.4 ha).

In many of the Maryland Coastal Bays marshes, elevation collapse and ponding has increased greatly in the past 15 years in the form of waffle pools — shallow rectangular pools that form in the center of marsh "cells" and are thus disconnected from the ditch network (Figure 55). This waffle pool phenomenon has coincided with the regional acceleration in sea level rise caused by a slowdown of oceanic currents in the Atlantic Meridional Overturning Circulation system.



Figure 55. Rum Point Waffle Pools. Photo: Roman Jesien/Maryland Coastal Bays Program

As a consequence of these factors, marsh condition in the Maryland Coastal Bays is significantly worse than in the Chesapeake Bay, having lost elevation and having been severely eroded. The Marsh Condition Model is mapped across the Maryland Coastal Bays in Figure 56. Only a small proportion (9.6%) of the marsh is in a stable condition (Classes 1 and 2). The "best" larger blocks of marshes are Class 3 marshes, and these occur in the central part of Assateague Island and the western side of Newport Bay. Just north of Newport Bay, along Trappe Creek, the marshes are lower in elevation and more severely eroded, and are rapidly converting to open water. The marsh at E.A. Vaughn Wildlife Management Area (WMA) is suffering the same fate. Of the area's two larger marsh islands, Mills Island has higher elevation than Tizzard Island, and both are severely ponded in the interior.

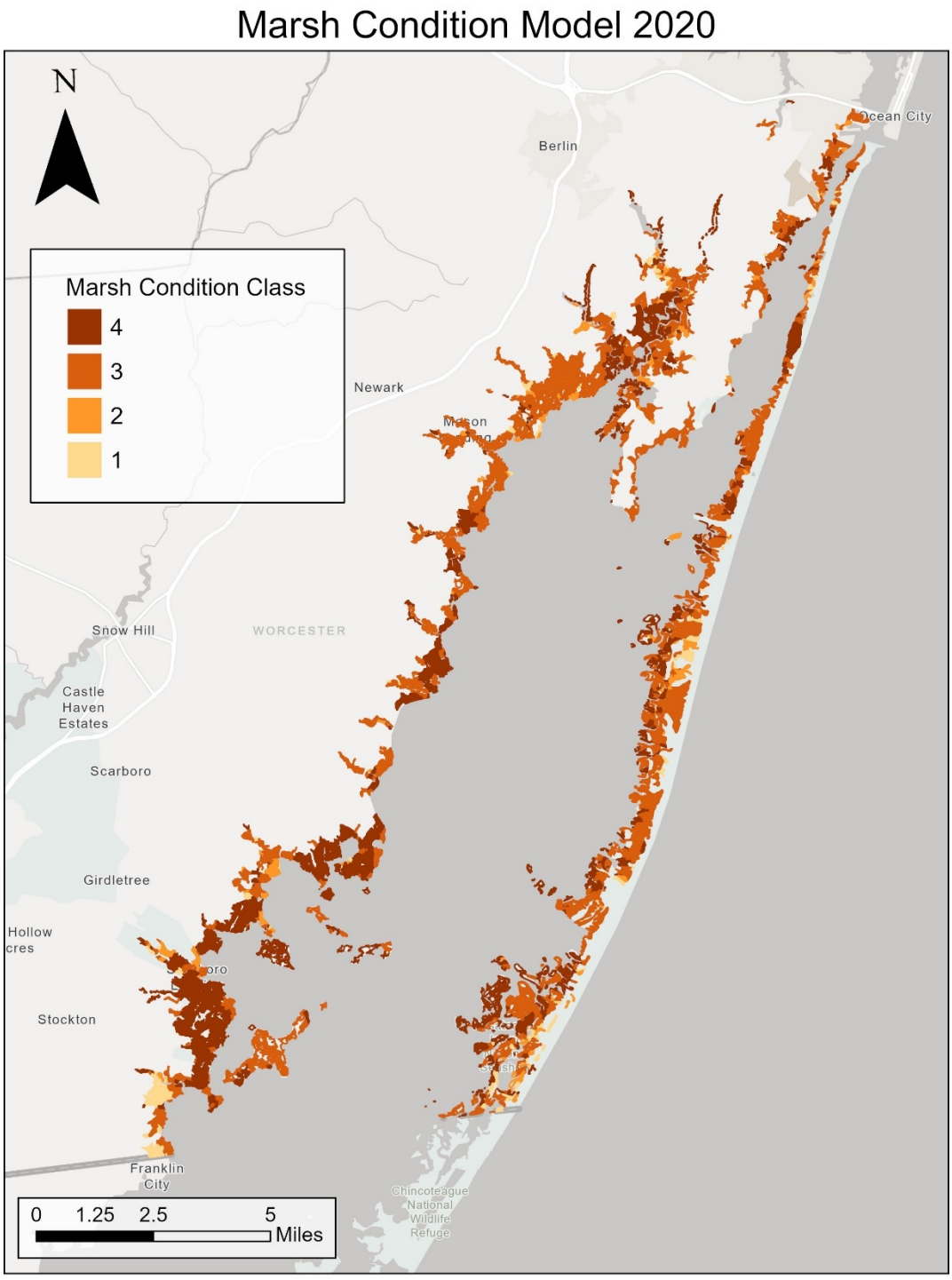


Figure 56. Marsh condition results for the Maryland Coastal Bays Focal Area, 2020.

Future Projections of Marsh Condition

The current extent of Class 1 and 2 marshes in this focal area is already significantly lower than in the Chesapeake Bay region. The Sea Level Affecting Marshes Model (SLAMM) predicts that most of the larger blocks of Class 3 marsh will deteriorate to Class 4 by 2040, which means they will become exclusively low marsh or open water. Some marsh areas close to the barrier Island dunes on Assateague Island may remain as Class 3 until 2060 (Figure 57). Future projections of the Marsh Condition Model can be explored in the MfT Experience Builder.

It is important to keep in mind that these projections represent a best-case scenario of future marsh condition because they are based on SLAMM, which does not account for the elevation collapse caused by waterlogging and vegetation dieback. A more detailed explanation of the role of vegetation dieback and ponding in the Marsh Condition Model is provided in Section 4.

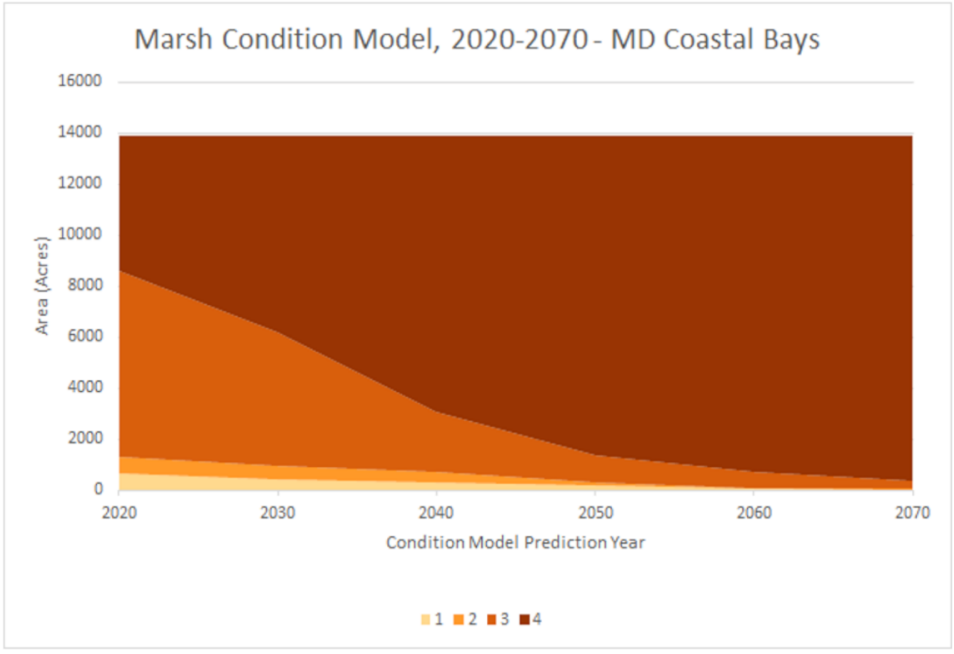


Figure 57. Future acreage projections for the four Marsh Condition Classes in the Maryland Coastal Bays Focal Area, presented at decadal intervals from 2020 to 2070 (1 ac = 0.4 ha).

Vegetation

Unlike the marshes of the Chesapeake Bay, which are brackish, the Maryland Coastal Bays marshes are saline and thus have a different composition of vegetation, which is dominated by *S. alterniflora*, *S. patens,* and *D. spicata*. *Juncus roemerianus* does occur but is confined to a few small stands on Assateague Island. *S. patens* and *D. spicata* dominate the higher marsh near the upland boundary and alongside ditches. Short-form *S. alterniflora* occupies the lower-lying areas in the marsh interior away from the ditches and is rapidly being lost as waffle pools form and expand.

Saltmarsh Sparrow Abundance

During the first round of Saltmarsh Habitat and Avian Research Program (SHARP) surveys in 2011-12, the Maryland Coastal Bays supported the highest abundance of Saltmarsh Sparrows in Maryland, with an average detection rate of one individual per survey visit. While the 2021-22 SHARP surveys found the species still present in the Maryland Coastal Bays, with approximately half of the survey points detecting a Saltmarsh Sparrow, the species has declined in this focal area. One spatial pattern at the local scale, which is evident in the 2021-22 data, is that in Newport Bay, the Saltmarsh Sparrow is more abundant in the southern marshes between Newport Creek and Cropper Island than in the marshes farther upstream on Trappe Creek.

Marsh Migration Corridors

There is less potential for upslope marsh migration in the Maryland Coastal Bays system than in the Chesapeake Bay, the result of both development and a relatively abrupt topographical shelf at the upland boundary of the marsh. However, there are some areas adjacent to agricultural fields and forests where marsh migration is possible, and it should be facilitated through techniques such as regrading slopes, sediment addition, and hydrological management.

Sediment Sources/Dredging Locations

The habitat restoration need for dredged material is considerable, and this extends beyond the mainland to islands. Some of these islands are remnant patches of marsh, and others are composed of sand. Between 1989 and 2019, 14 islands that have historically supported waterbird colonies have been lost to erosion (C. Toulan, personal communication, November 19, 2024), and there is an urgent need to rebuild at least a portion of these islands to recover populations of colonial waterbirds.[88]

A substantial amount of dredging is carried out in Isle of Wight and Sinepuxent bays, for purposes including beach replenishment and maintenance of navigation channels at the Ocean City inlet, West Ocean City harbor, and many private marinas. However, very little of the dredged material is available for habitat restoration because it is used for beach replenishment or disposed of elsewhere. Another barrier to using dredged material for habitat restoration is the coordination of project designs and the permits required with dredging operations. Stakeholder meetings in the Maryland Coastal Bays have recently been held to attempt to address this issue and hopefully will result in improved availability of sediment for conservation priorities. Even if these coordination attempts are successful, it is doubtful that sufficient material will be dredged to meet the needs of marsh-building restoration throughout the Maryland Coastal Bays. Innovative sources of materials will need to be explored in order to meet this need, including historical upland disposal sites where dredge materials have been stockpiled locally, and soil from farm fields adjacent to marsh project sites.

Our ability to save the salt marshes and colonial waterbird nesting islands of the Maryland Coastal Bays depends on changes to permitting regulations that will allow dredging specifically for the purpose of restoration. This permitting reform is urgently needed.

Community Infrastructure & Input

The Maryland Coastal Bays Focal Area spans both rural areas and urban centers of Worcester County. Areas of high population density include Ocean Pines, West Ocean City, and Berlin. The region is also home to many smaller communities, including Bishopville, Girdletree, Showell, and Stockton. The region is well connected by a network of roads, including U.S. Route 50 and State Route 113, which

serve as main thoroughfares linking the area to the rest of the state. The communities within the region have developed a robust infrastructure, including schools, hospitals, shopping centers, and recreational facilities. There is a strong focus on tourism and recreation, with a wide range of opportunities from beaches and boardwalks to fishing, boating, and nature observation (see Section 5, Figures 27 and 28).

Feedback from community meetings indicated an interest in opportunities for small-scale residential marsh protection efforts, guidance for private landowners, and the importance of both short- and long-term perspectives. There is a strong desire for consistent communication with the community, participation in future involvement, and support for existing grassroots efforts. Community members emphasized the importance of collaboration between organizations and agencies, specifically congruence with state resiliency plans and sourcing sediment. There was keen interest from community members in advocating for these landscapes and the species that depend on them. Additionally, comments addressed the negative impacts of geese herbivory on the successful establishment of native grasses and a need to plan for marsh migration.

In areas that community members were familiar with, there was broad agreement with the Marsh Condition Model output. Watermen and women familiar with Newport Bay commented on the extent of marsh loss and flooding, particularly in the bay's northern reaches. Multiple participants noted that their impression of the marsh was different around the Verrazano Bridge than the model's (both worse and better). Multiple participants commenting on the Marsh Condition Model indicated that the state of the marshes was "worse than I thought" or said they "didn't realize the bad shape."

Landownership and Conservation Status

The great majority of marshland on the western side of the Maryland Coastal Bays is privately owned.

Worcester County owns several properties with salt marsh habitat, including a publicly accessible 232-ha (574-ac) property at Greys Creek, now managed as Greys Creek Nature Park. Other Worcester County-owned properties with salt marsh include Isle of Wight Nature Park, the east side of Trappe Creek, and Langmaid Road.

The Maryland Department of Natural Resources (DNR) owns and manages salt marshes at the E.A. Vaughn WMA, Isle of Wight WMA, and Assateague State Park.

Most of Assateague Island is federally owned by the National Park Service and is managed as Assateague Island National Seashore (AINS).

Current Habitat Management

Greys Creek Nature Park in Assawoman Bay is owned by Worcester County. The scope of the Greys Creek development project is to develop the passive recreational aspects of the site, foster environmental education, promote sustainable principles, and enhance public access to an array of nature-based recreational opportunities while tangibly demonstrating a commitment to the preservation of ecosystem benefits for local communities. In 2014, Worcester County entered into a memorandum of understanding to partner with the Maryland Coastal Bays Program (MCBP). The intent of the agreement pertained to the management of Greys Creek Nature Park, where the rationale was to leverage the MCBP's expertise in site restoration and management, and to promote environmental education in a manner consistent with Worcester County's 2006 Memorandum of Understanding with the state of Maryland.

The E.A. Vaughn WMA and the Isle of Wight WMA are owned and managed by DNR. The mission of the WMA system is "To conserve and enhance diverse wildlife populations and associated habitats while providing opportunities for public enjoyment of the State's wildlife resources through hunting and other wildlife-dependent recreation." The maintenance of marsh habitats at these WMAs directly supports the goals of the WMA system to:

- maintain, enhance, or protect sustainable and diverse wildlife populations;
- create, enhance, or protect appropriate habitats, natural communities, and ecologically sensitive areas;
- conserve rare, threatened, and endangered species by protecting the habitats that support them;
- provide wildlife-dependent recreation in areas with minimal capital improvements or other development, with a focused emphasis on hunting; and
- provide a venue to educate citizens on the value and needs of wildlife and plant communities through outreach, demonstration, and sound management.

Assateague State Park is managed by the Maryland Park Service of the Maryland DNR, for the purpose of preserving the rich and diverse ecosystems of Assateague Island, including providing visitors access to two miles of Atlantic coastal beach and offering opportunities for nature-based recreation along the Atlantic coast and in Sinepuxent Bay. Monitoring and management of the marshes and Sinepuxent Bay coastal environment are undertaken in partnership with the National Park Service, the Maryland DNR Watershed and Climate Services, and the MCBP.

AINS is managed by the National Park Service (NPS) to preserve the outstanding mid-Atlantic coastal resources of Assateague Island and its adjacent waters and the natural processes upon which they depend, and to provide high-quality, resource-compatible recreational opportunities for park visitors.[89] The management of the national seashore is guided by the General Management Plan, which was updated and approved in 2016.[90] A total of 2,120 ha (5,238 ac), or 30% of the total area of Assateague Island, is salt marsh habitat.[87] These highly productive marshes provide critical habitat for fish, wildlife, and ecosystem services. The NPS characterizes salt marshes and other aquatic habitats and species of Assateague Island as "fundamental resources" because they are critical to achieving the park's purpose and, therefore, warrant primary management consideration.[87]

Existing Restoration Projects

Several marsh restoration projects are currently planned, under construction, or recently completed in the Maryland Coastal Bays system (Figure 58).

The USFWS and MCBP are coordinating a suite of 10 salt marsh restoration projects in Sinepuxent Bay, Newport Bay, and Chincoteague Bay, and all but one of them is on privately owned land. One project, a runneling project at Rum Pointe in Sinepuxent Bay, was completed in 2023. Of the remaining nine projects (Figure 58), three are under construction during 2024-25, and six are in the design or permitting phase. Most of these projects employ a combination of restoration techniques, including sediment nourishment, runneling, ditch cleaning, and ditch remediation. The project at Tizzard Island also includes a living shoreline to protect the east shore of the island from wave erosion. Most crucially, these projects also include monitoring plans. Because these techniques are relatively new at these tidal ranges and elevations, it is vital to fully measure the impacts and learn lessons from their implementation.

The entire marsh acreage included in the nine projects is 525 ha (1,297 ac), and sediment placement is needed on an estimated 387 ha (957 ac). The estimated total quantity of material needed is between 366,222-488,551m^3 (479,000-639,000 yd^3).

At AINS, past salt marsh restoration work has included ditch remediation by filling ditches with native beach sand. From 2006-2012, approximately 202 ha (500 ac) of salt marsh was successfully restored using this low-impact technique. This effort removed the ditches from the park landscape, moderated fluctuations in groundwater levels, and restored a more natural hydrologic regime to these wetlands.[87] The NPS is currently prioritizing additional salt marsh areas for restoration through a formal Structured Decision-Making process.

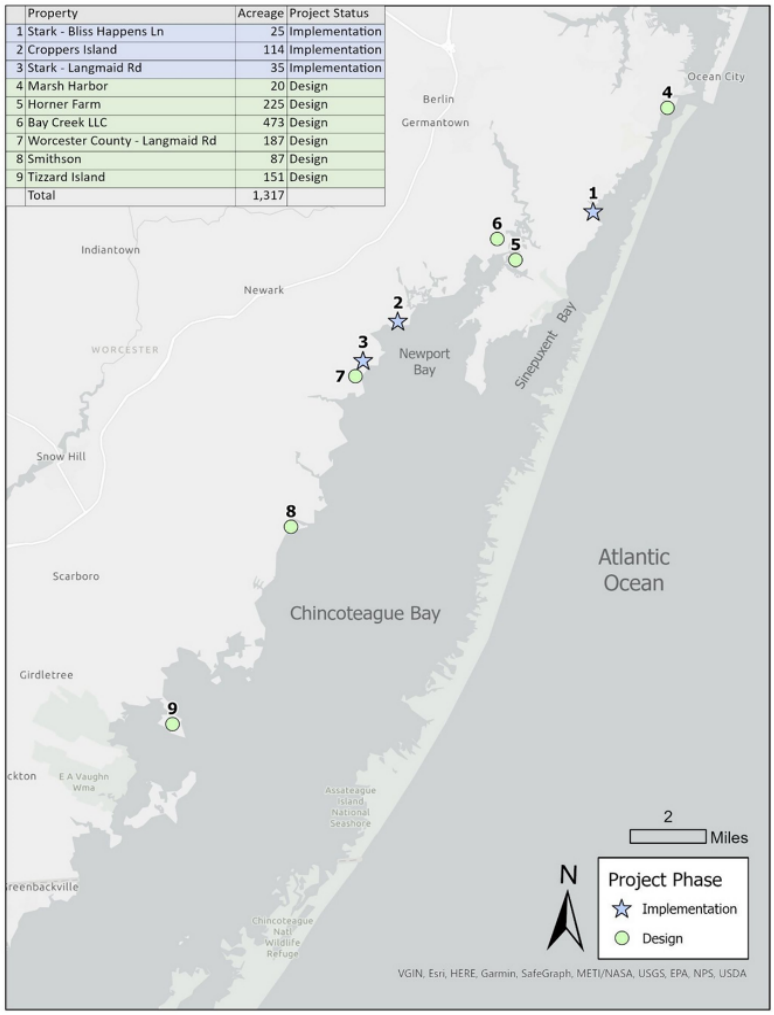


Figure 58. Current restoration projects underway in the Maryland Coastal Bays Focal Area.

Priority Marsh Areas (PMAs) in the Maryland Coastal Bays Focal Area

PMAs for restoration and long-term maintenance as high marsh habitat for the Saltmarsh Sparrow were selected by a multi-stakeholder focus group using the methodology described in Section 6 (Figure 59). The rationale driving this selection was to restore and maintain the larger areas of Class 3 marsh in Newport Bay and Assateague Island, and to establish PMAs across the three major

landownership categories (private, state, and federal) in order to utilize a range of funding streams. Due to the relative uniformity in vegetation across the region, vegetation type had little influence on the prioritization process. Similarly, Saltmarsh Sparrows occur across most of the locations surveyed in the Maryland Coastal Bays system, albeit in lower numbers than a decade ago. For this reason, PMAs were not generally selected based on sparrow occurrence. Four PMAs, totaling 2,113 ha (5,221 ac), were identified.

1. Newport Bay (664 ha/1,641 ac). This PMA includes a large block of marsh between Newport Creek and Windmill Cove categorized as Class 3 by the Marsh Condition Model. The marsh is severely degraded with waffle pools but is categorized by SLAMM as high marsh. SHARP surveys in 2021-22 detected Saltmarsh Sparrows at nine of the 12 points surveyed. Three current restoration projects are within this PMA; two will be implemented during 2024-25, at Cropper Island and Langmaid Road, and one is in the design phase.
2. Chincoteague Bay SW (843 ha/2,084 ac). This PMA includes some of the most severely degraded salt marsh in the Maryland Coastal Bays at E.A. Vaughn WMA, where much of the marsh is already categorized by SLAMM as low marsh. E.A. Vaughn WMA was included in order to prioritize marsh restoration on this state-owned property in an area where public access was highlighted through community input. It also includes Mills Island and other privately owned marsh around Purnell Bay adjacent to the Virginia state line. SHARP surveys in 2021-22 detected Saltmarsh Sparrows at five of five points surveyed on Mills Island and at lower rates of detection on the mainland marshes.
3. Assateague State Park (172 ha/425 ac). This PMA includes all of the salt marsh within Assateague State Park, and was included because the great majority of this marsh is categorized as Class 3 marsh by the Marsh Condition Model and because the Maryland DNR wishes to pursue marsh restoration here. Saltmarsh Sparrows were detected at two of four points surveyed in the 2021-22 round of SHARP. The Verrazano Bridge, which connects Assateague Island to the mainland, is located at the northern boundary of this PMA.
4. AINS (434 ha/1,072 ac). This PMA includes two blocks of salt marsh in the central portion of Assateague Island National Seashore which includes some higher and more intact marsh areas. One block is immediately south of the Assateague State Park PMA and adjacent to the popular NPS bayside campgrounds. The other block is adjacent to the Over Sand Vehicle beach extending 17-20km. The NPS is awaiting additional model results and outputs from the ongoing Structured Decision-Making process to prioritize future work areas. Saltmarsh Sparrows were detected at three of seven points surveyed in the 2021-22 round of SHARP.

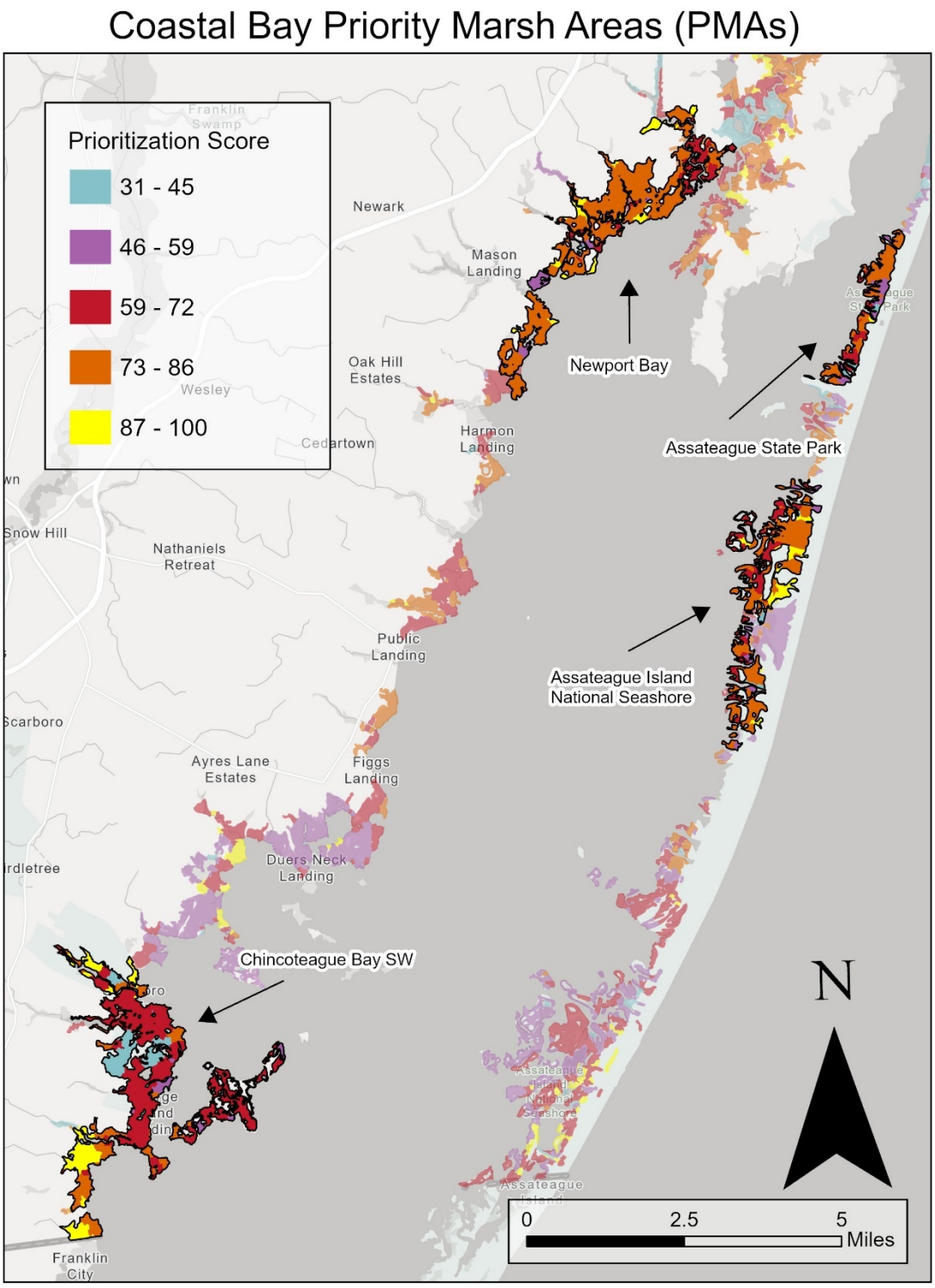


Figure 59. PMAs identified in the Maryland Coastal Bays Focal Area.

Restoration Recommendations

Most of the marshes in the Maryland Coastal Bays PMAs are in urgent need of restoration (Figure 60), according to both the Restoration Decision Model and on-site assessments from U.S. Fish and Wildlife Service and MCBP practitioners. Staff from the USFWS and MCBP voiced concern that the Restoration Decision Model may underestimate the current need for sediment nourishment on the western side of the Maryland Coastal Bays. This assertion is supported by our validation assessment (see Section 7) of the Restoration Decision Model with project designs. Table 24 summarizes these restoration needs across the PMAs of the Maryland Coastal Bays Focal Area by restoration practice.

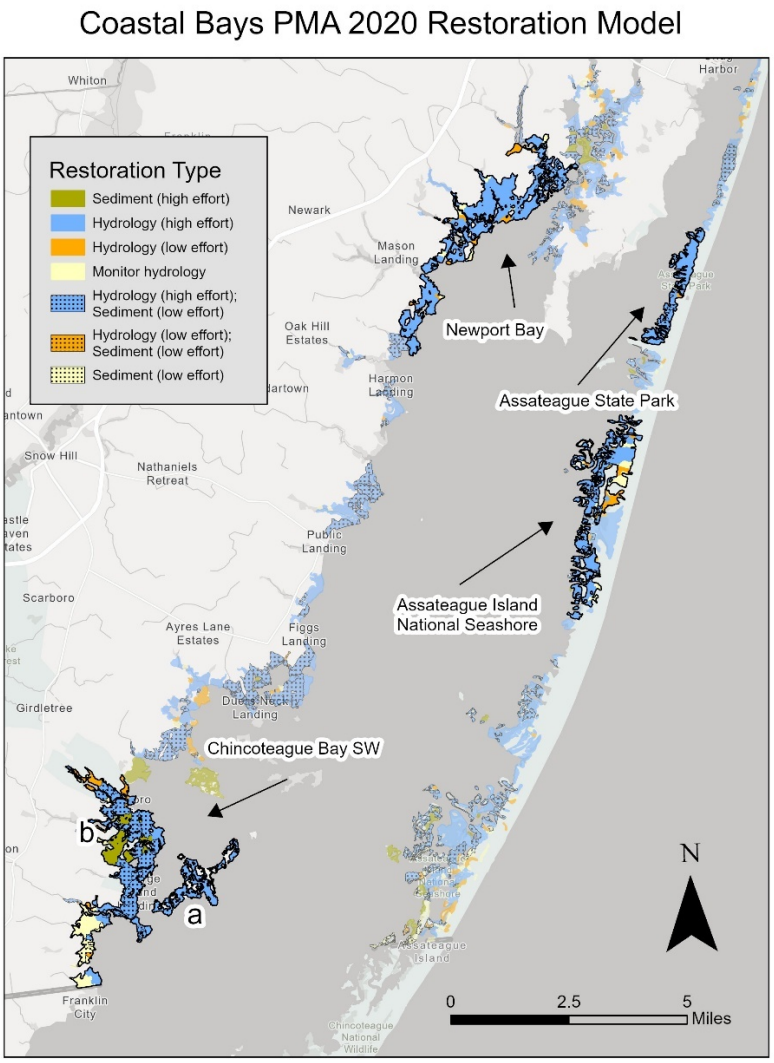


Figure 60. Restoration strategy recommendations for the Maryland Coastal Bays Focal Area.

Table 24. Current marsh restoration needs in the Maryland Coastal Bays Focal Area. Superscript letters in the "Locations" column refer to corresponding letters on the map in Figure 60.

Restoration Practice (shown in Figure 60)	Extent Needed	Locations	Priority Level
Repair hydrology: runnels, berm modification, etc.	1,233 ha (3,047 ac) of high marsh; (+608 ha/1,503 ac of mixed high/low marsh)	Newport Bay [a]Mills Island	1 2
Repair hydrology: ditch remediation	Widespread	Newport Bay Chincoteague Bay SW Assateague SP Assateague Island NS	1 1 1 1
Repair hydrology: tidal restriction mitigation	Extent uncertain	Water control structures (where present)	1
Sediment placement	701 ha (1,733 ac) (actual need could be greater)	Newport Bay [b]E.A. Vaughn WMA	1 2
Monitor hydrological condition	143 ha (354 ac) of high marsh (+35 ha/87 ac of mixed high/low marsh)	Where indicated by Restoration Decision Model	N/A
Restoration Practice (not shown in Figure 60)	**Extent Needed**	**Locations**	**Priority Level**
Control invasive plants (*Phragmites*)	Limited	Assess along upland boundaries	N/A
Control herbivory	Wild horse grazing Canada Goose herbivory	Assateague SP Assateague Island NS Newport Bay	N/A
Living shorelines (and other wave attenuation devices)	Likely limited	[a]Mills Island	2
Prescribed fire (for vegetation conversion)	Not needed	Consider in marshes dominated by *J. roemerianus*	N/A

Future Restoration Needs

Over coming decades, the restoration needs of the Maryland Coastal Bays marshes will increase as sea level rise accelerates. Table 25 shows the projected restoration needs within the PMAs of the Maryland Coastal Bays by decade to 2050. An increasing acreage of marsh will require sediment placement to restore it to a high marsh condition, and less marsh will be treatable by hydrological methods alone as the area of high marsh diminishes. As mentioned previously, the future rate of marsh deterioration may well be more rapid than is suggested in Table 25.

Table 25. Projected future marsh restoration needs in Maryland Coastal Bays PMAs, 2020-2050.

Restoration Practice	Hectares (Acres) Needed (by Year)			
	2020	2030	2040	2050
Repair hydrology (runnels)	1,841 ha (4,550 ac)	1,617 ha (3,996 ac)	1,199 ha (2,963 ac)	398 ha (983 ac)
Sediment placement	737 ha (1,820 ac)	1,220 ha (3,015 ac)	1,872 ha (4,625 ac)	2,076 ha (5,155 ac)

Community engagement should be built into restoration planning and timelines in the Maryland Coastal Bays to ensure that thorough and clear communication is achieved regarding the proposed work, additional local input, expected impacts to local infrastructure, and outcomes of the project(s). Representatives of Indigenous communities and the Maryland Historical Trust should be consulted to avoid any impact to sacred community assets or significant historical sites.

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Appendix A |

Quick Reference of Acronyms

ACJV	Atlantic Coast Joint Venture
AINS	Assateague Island National Seashore
BUDM	Beneficial Use Dredged Material
CBFO	Chesapeake Bay Field Office
CBNERR	Chesapeake Bay National Estuarine Research Reserve
DIPP	Deal Island Peninsula Partnership
DISP	Deal Island Shoreline Project
DNR	Department of Natural Resources
DRCN	Delmarva Restoration and Conservation Network
EPA	Environmental Protection Agency
ESLC	Eastern Shore Land Conservancy
FEMA	Federal Emergency Management Administration
IUCN	International Union for Conservation of Nature
LiDAR	Light Detecting and Ranging
LSLT	Lower Shore Land Trust
MCBP	Maryland Coastal Bays Program
MDE	Maryland Department of the Environment
MfT	Marshes for Tomorrow
MHW	Mean High Water
NFWF	National Fish and Wildlife Foundation
NOAA	National Oceanic & Atmospheric Administration

NPS	National Park Service
NRCS	Natural Resources Conservation Service
NWR	National Wildlife Refuge
PMAs	Priority Marsh Areas
RTK	Real-Time Kinematic
SHARP	Saltmarsh Habitat and Avian Research Program
SLAMM	Sea Levels Affecting Marshes Model
SLR	Sea Level Rise
USACE	United States Army Corps of Engineers
USDA	United States Department of Agriculture
USDOI	United States Department of the Interior
USFWS	United States Fish and Wildlife Service
UVVR	Unvegetated-Vegetated Ratio

Appendix B |

Marshes for Tomorrow Teams & Advisory Partners

Team/Mission	Team Members & Affiliations
Core Analysis Team To guide the spatial analyses needed to identify priority marshes for long-term maintenance and determine the appropriate timing and types of restoration practices for these marshes	**David Curson,*** Audubon Mid-Atlantic **Hen Bellman**, Audubon Mid-Atlantic **Alice Besterman**, Towson University **Joel Carr, Ph.D.**, U.S. Geological Survey **Mo Correll**, U.S. Fish & Wildlife Service **Neil Ganju, Ph.D.**, U.S. Geological Survey **Keryn Gedan**, George Washington University **Joanna Grand**, National Audubon Society **Matt Kirwan**, Virginia Institute of Marine Science **Amanda Long**, National Audubon Society **Rich Mason**, U.S. Fish & Wildlife Service **Al McCullough**, Sustainable Science, LLC **Dan Murphy**, U.S. Fish & Wildlife Service **Leslie Pitt**, U.S. Fish & Wildlife Service **Zach Posnik**, National Audubon Society **Sophia Seufert**, U.S. Fish & Wildlife Service **Greg Shriver**, University of Delaware **Katie Stahl**, U.S. Fish & Wildlife Service **Lorie Staver**, University of Maryland Center for Environmental Science **Bart Wilson**, U.S. Fish & Wildlife Service
Community Engagement Team To develop strategies to engage, gather input, form long-term partnerships, and develop support for the Marshes for Tomorrow plan	**Hen Bellman**,* Audubon Mid-Atlantic **Jared Parks**,* Lower Shore Land Trust **Christine Burns**, Maryland Department of Natural Resources **Lisa Challenger**, Beach to Bay Heritage **David Curson**, Audubon Mid-Atlantic **Joseph Galarraga**, The Nature Conservancy **Bri Panos**, Audubon Mid-Atlantic **Marcia Pradines**, U.S. Fish & Wildlife Service **Larisa Prezioso**, Eastern Shore Land Conservancy **Sophia Seufert**, U.S. Fish & Wildlife Service **Carly Toulan**, Maryland Coastal Bays Program
Policy and Communications Team To make a compelling case statement for scaling up restoration efforts	**David Curson**,* Audubon Mid-Atlantic **Jim Brown**,* Audubon Mid-Atlantic **Hen Bellman**, Audubon Mid-Atlantic **Bernard Devlin**, Audubon Mid-Atlantic

MfT received invaluable consultation, guidance, and support, and we thank our partners for their generosity of time and expertise, participating in meetings and workshops, providing feedback, reviewing reports, and sharing their specific talents throughout the course of this project.

Advisory Partners		
Accohannock Indian Tribe Tribe Elders	**Audubon** Suzanne Biemiller Joanna Grand Amanda Long Zach Posnik Christine Proctor Shannon Reault	**Beach to Bay Heritage** Lisa Challenger
Chesapeake Bay Trust Sarah Koser	**The Conservation Fund** Erik Meyers	**Dorchester County** Jeff Powell
EA Engineering, Science & Technology Erin McNally Danielle Szimanski	**Eastern Shore Land Conservancy** Larisa Prezioso	**Environmental Protection Agency** Matthew Robinson
George Washington University Keryn Gedan	**JBO Conservation** Emily Thorpe	**Lower Shore Land Trust** Jared Parks Kate Patton
Maryland Coastal Bays Program Kim Abplanalp Roman Jesien Kevin Smith Carly Toulan	**Maryland Department of Natural Resources** Angela Baldwin Gwen Brewer David Brinker Christine Burns Elliott Campbell Nicole Carlozo Maggie Cavey Sara Coleman Christine Conn	 Kyle Derby Sarah Hildebrand Jonathan McKnight John Moulis Meghan Rhode Jackie Specht Dylan Taillie Ryland Taylor Judd Vickers
National Oceanic & Atmospheric Administration Andrew Larkin Jessica McIntosh Julie Reichert-Nguyen Jonathan Watson	**National Park Service** Bill Hulslander Catherine Johnson	**The Nature Conservancy** Austin Bamford Joseph Galarraga Liz Van Dolah
Nause-Waiwash Band of Indians Chief Donna Wolf Mother Abbott	**Pocomoke Indian Nation** Chief Norris Howard, Sr.	**Somerset County** Catherine Skeeter

Sustainable Science, LLC Al McCullough	**Towson University** Alice Besterman	**University of Delaware** Greg Shriver Liz Tymkiw
University of Maryland Center for Environmental Science Lorie Staver	**U.S. Army Corps of Engineers** Kevin Fenyak Douglas Greene Rachel Kierzewski Charles Leasure Chris Spaur	**U.S. Department of Agriculture** Julie Devers
U.S. Fish & Wildlife Service Brian Boudan Mo Correll Leah Franzlubbers Oliver Griffin Genevieve LaRouche Kirsten Luke Rich Mason Dan Murphy	Leslie Pitt Marcia Pradines Sophia Seufert Katie Stahl Aimee Weldon Matt Whitbeck Bart Wilson	**U.S. Geological Survey** Joel Carr Neil Ganju
Upstream Alliance Veronica Vesnaver	**Virginia Institute of Marine Science** Matt Kirwan	**Worcester County** Bob Mitchell Katherine Munson Brian Soper

Appendix C |

Marshes for Tomorrow Outreach Materials

Marshes For Tomorrow

Audubon | MID-ATLANTIC



Saving Maryland's tidal salt marshes

A project of the Delmarva Restoration and Conservation Network

Stretching like vast coastal prairies, Maryland's tidal salt marshes provide a host of benefits to the Eastern Shore economy, playing a critical role in protecting coastal communities from storms and supporting fisheries and tourism. They also act as carbon storage, as a filter—removing pollutants from bay waters—and host abundant wildlife, including an assemblage of birds found nowhere else.

Marshes Under Threat

Unfortunately, salt marshes face an existential threat from climate-driven sea level rise. Maryland's tidal salt marshes are predicted to suffer an almost complete loss by the year 2100, and this process is already well underway. If nothing is done, we will lose the economic and environmental benefits of marshes.

Marsh Restoration Offers Hope

Maryland land managers and environmental organizations are beginning to implement restoration projects to slow marsh deterioration and restore submerging marshes. This work will increase climate resiliency and offer safe breeding habitat for imperiled birds such as the Saltmarsh Sparrow, the Coastal Plain Swamp Sparrow, and the Eastern Black Rail.

However, the current pace of marsh restoration projects is far slower than necessary to save our tidal marsh system. A coordinated and well-funded approach is urgently needed to scale up marsh restoration in Maryland.

DELMARVA RESTORATION & CONSERVATION NETWORK

U.S. FISH & WILDLIFE SERVICE

| 1



Saltmarsh Sparrow/Jesse Gordon

The Saltmarsh Sparrow is a rapidly declining bird species that is only found in tidal salt marshes, and scientists predict it could go extinct by 2060 . Its entire global breeding range is limited to the NE United States and 25% of its population breeds in Maryland. The Marshes for Tomorrow goal of maintaining 25,000 acres of marsh over the long term is intended to provide enough habitat to save this bird from extinction in Maryland.

A Landscape-scale Restoration Plan for Maryland's Salt Marshes

Marshes for Tomorrow is a project of the Delmarva Restoration and Conservation Network (DRCN), and is coordinated and led by Audubon Mid-Atlantic. The project will create a restoration plan for 25,000 acres of Maryland's salt marshes. Ultimately, marsh restoration at this scale will save an entire ecosystem—as well as the imperiled Saltmarsh Sparrow—and, and along with it, economic benefits to fisheries, tourism, and local communities.

The project will create a plan including three elements:

1. A marsh assessment, describing and mapping the ecological and hydrological condition along with the feasibility of restoration of the marsh across Maryland's lower eastern shore.
2. Marsh restoration strategies for each of four priority regions on Maryland's Eastern Shore. The restoration strategies will include input from local communities to capture each region's particular geographic and cultural qualities.
3. Marsh restoration prescriptions, identifying the marshes targeted for restoration and the restoration techniques appropriate for each area.

The Marshes for Tomorrow plan will provide technical and policy guidance to implement restoration work, including cost estimates.

Partnerships and Community Engagement

The planning work will include opportunities for local communities to learn more about the restoration work and provide feedback. The Marshes for Tomorrow leaders will also facilitate efforts to involve stakeholders— private landowners, municipal government, and civic leaders—in promoting an implementation plan for tidal salt marsh restoration on a landscape scale in Maryland. Assistance with community engagement is possible with the expertise of partners at Beach To Bay Heritage Area, The Conservation Fund, Eastern Shore Land Conservancy, The Lower Shore Land Trust, Maryland Coastal Bays Program, Maryland Department of Natural Resources, The Nature Conservancy, and the United States Fish and Wildlife Service.

Funding Acknowledgment

The Marshes for Tomorrow initiative has been made possible through generous support from the Partners in Fish and Wildlife Program of the United States Fish and Wildlife Service and the National Fish and Wildlife Foundation.

For More Information:
www.delmarvarcn.org/marshesfortomorrow
marshes4tomorrow@gmail.com
www.facebook.com/AudubonMidAtl
Instagram: @AudubonMidAtl

Marshes for Tomorrow

A Strategic Plan for the Restoration and Resiliency of Maryland's Salt Marshes



photo credit: Tim Tadder

What is a salt marsh?

"Salt marshes" are regularly flooded and drained by salt water with the tides.

Within a single marsh there are multiple zones including "low marsh" which is regularly flooded and "high marsh" which is only flooded on the highest tides. Unique animals and plants inhabit this "high marsh" zone, including bird species found nowhere else in the world.

Did you know? Salt marsh plants, such as salt marsh cordgrass, are important food sources for the wild horses of Assateague Island.

A cultural resource...



Hunting

Salt marshes provide many hunting opportunites for a variety of game including wintering waterfowl and deer.



Harriet Tubman

Her familiarity with the marshes of Maryland's Eastern Shore were key to Tubman's success in escaping enslavement and guiding others to freedom.



Blue Crabs

Salt marshes are vital nursery habitat (protective habitat for juveniles of a species) for the Maryland Blue Crab.

photo credit: (left to right) Kim Abplanalp (Maryland Coastal Bays Program), Jody Arneson (midtlanticdaytrip.com), Brian Henderson

...disappearing

Climate change is drowning our salt marshes.



photo credit: Eric Liner, Cornell Lab of Ornithology

75% of Maryland's high marsh will likely be lost to sea level rise by 2100.

email marshes4tomorrow@gmail.com or visit https://www.delmarvarcn.org/marshesfortomorrow

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DELMARVA RESTORATION & CONSERVATION NETWORK

What benefits do saltmarshes provide?

Coastal Protection: Healthy, elevated salt marshes protect coastal communities by buffering against wave energy and storm surge.

Healthy Fisheries: Salt marshes provide food, or habitat for more than 75% of fishery species, including shrimp, finfish, and blue crab.

Recreational Opportunity: Salt marshes provide outdoor opportunities such as fishing, kayaking, and wildlife-watching, boosting local economies.

Clean Water: Salt marshes protect water quality by naturally filtering out chemicals from agricultural runoff and breaking down excess nutrients.

Why are Maryland's marshes disappearing so quickly?

Sinking Land and Rising Seas

Sea levels across the globe are rising due to the impacts of climate change. Scientists predict that **sea level will rise about 3 feet by 2100.** Sea level is rising due to 2 primary causes:

1) Thermal expansion: As water increases in temperature it also increases in volume, due to its physical properties. This accounts for about half of measured global sea level rise.

2) Polar melting: As the atmosphere warms, glaciers at earth's poles melt, depositing ice that was previously trapped on land and increasing the amount of water in the ocean.

Additionally, the coasts of Maryland have been slowly sinking since the last ice age. This is a natural geological process, but it does mean that relative **sea level rise in Maryland is twice as fast compared to the global average.** This increased water on the marsh will lead to more vegetation die back and overall deterioration of our marshes.

Historic Ditching



photo credit: Roman Jesien, Maryland Coastal Bays Program

You may notice that salt marshes in your area, have manmade ditches. Ditching changes the way water flows on the marsh and has caused severe damage in marshes over time. It is estimated that **90% of tidal marshes from Virginia to Maine were ditched** for salt hay farming in the 1600s, and later for mosquito control in the 1900s.

email marshes4tomorrow@gmail.com or visit https://www.delmarvarcn.org/marshesfortomorrow

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DELMARVA RESTORATION & CONSERVATION NETWORK

Species Highlight



photo credit: Frank Lehman

Saltmarsh Sparrow

Ammospiza caudacuta

The Saltmarsh Sparrow is a songbird that only lives in the salt marshes of the Atlantic coast and only breeds in the Northeast United States.

The saltmarsh sparrow has experienced an 87% population decline since 1998. Maryland is home to 25% of the breeding saltmarsh sparrow population. The highest of any state.

A Delicate Nesting Strategy: The Saltmarsh Sparrow nests only in the "high marsh" zone above the reach of daily tides. Because it builds its nest on, or very close to, the ground, changes in water level have major impacts on the survival of chicks and overall breeding success.



photo credit: Rhonda Smith, USFWS

Marsh Restoration Techniques

Runnels

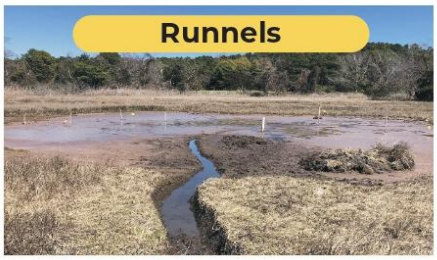


photo credit: Dave Curson, Audubon

Use When: Marsh is degrading due to water trapped on the marsh surface.

What: Shallow channels dug in the marsh to restore tidal flow and drain trapped water. Can be used to remediate impacts of historic ditching.

Sediment Placement



photo credit: Middleton Evans

Use When: Raising the marsh surface is needed for its longterm survival.

What: Placement of dredged sediment onto the marsh surface to raise its elevation above the reach of daily tides.

email marshes4tomorrow@gmail.com or visit https://www.delmarvarcn.org/marshesfortomorrow

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DELMARVA RESTORATION & CONSERVATION NETWORK

The "Marshes for Tomorrow" Initiative

Marshes for Tomorrow is an initiative, lead by Audubon Mid-Atlantic, to create a restoration plan for the tidal salt marshes of Maryland's Eastern Shore. We cannot save all of our marshes from sea level rise, but we can preserve significant areas by carefully selecting and maintaining the best examples of this precious landscape.

We have based our conservation target of 25,000 acres of marsh on the needs of the imperiled Saltmarsh Sparrow because this species is a good indicator of marsh health. Marsh restoration at this scale has the power to save the tidal salt marsh ecosystem—and along with it, economic benefits to fisheries, tourism, and local communities.

The project will:

1. **IDENTIFY** 25,000 acres of salt marsh to be maintained long-term to conserve the high marsh ecosystem and Saltmarsh Sparrow.
2. **CREATE A SCHEDULE** of restoration projects on these priority marshes which will maintain them as healthy marsh over coming decades.
3. **INCLUDE COMMUNITY FEEDBACK** by developing local/county level conservation strategies to guide restoration actions which are broadly approved by local communities.

Project Partners

Funding Acknowledgement

Marshes for Tomorrow has been made possible through generous support from the U.S. Fish and Wildlife Service and the National Fish and Wildlife Foundation (NFWF) National Coastal Reslience Fund.

Design and Artwork by Sophia Blanco Seufert, USFWS

For more information on the sources referenced in this brochure visit https://www.delmarvarcn.org/marshesfortomorrow

Appendix D |

Marsh Use Survey

Maryland Eastern Shore Marsh Use Survey

Hello! We are interested in learning about your relationship with Maryland's tidal salt marshes. Marshes for Tomorrow is an ambitious project led by Audubon Mid-Atlantic aimed at creating an implementation plan for tidal marsh restoration on a landscape scale in Maryland.

Maryland's coastal marshes are undergoing dramatic rates of loss due to erosion and sea level rise, and scientists
predict that marsh erosion will accelerate and a great majority of our
marshes will disappear by the year 2100. Restoration practices will enable us to
maintain some of these marshes over the long term but it won't be feasible to keep
all, or even most of, the marshes.
The Marshes for Tomorrow initiative will identify 25,000 acres of the
most resilient and best quality marsh on Maryland's Eastern Shore and determine which
restoration actions will be needed to prevent their loss. As part of our plan, we
recognize the essential input of communities living in or close to tidal salt marshes whose
culture, livelihoods, identities, and resources are under threat from this marsh loss.

We invite you to participate in this project by completing the following marsh use survey. This survey is made up of **17 questions**, many of which are optional, and we estimate it will take approximately **10 minutes** to complete.

Participation in this survey is **anonymous** and your personal information will not be collected unless you choose to provide it. For your participation in this survey, we'd like to offer you the opportunity to enter a free raffle to win some local goodies. At the end of the survey, we provide space for you to share your contact information if you wish to learn more or want to enter the raffle for free.

For more information about this project, please visit our webpage or reach out via marshes4tomorrow@gmail.com.

* Indicates required question

1/9

Your Identity and Tidal Salt Marsh Use

Tidal salt marshes are coastal wetlands that are flooded and drained by salt water brought in by the tides. They are marshy because the soil may be composed of deep mud and peat. According to the Virginia Institute of Marine Sciences, "the **high marsh area** is only flooded during extreme high tides and storm events. This marsh zone provides valuable storm protection and provides a buffer to intercept and filter stormwater runoff and groundwater flowing from the adjacent upland". This unique habitat holds significant value.

1. In which county(ies) do you use the tidal salt marsh? *
   [*check all that apply*]

   - [ ] Dorchester
   - [ ] Somerset
   - [ ] Wicomico
   - [ ] Worcester

2. I am a... *
   [*check all that apply*]

   - [ ] Landowner with tidal salt marsh
   - [ ] Lease holder of land with tidal salt marshes
   - [ ] Local or State government in Maryland or the counties listed above
   - [ ] Local resident
   - [ ] Public lands manager
   - [ ] Seasonal visitor (not permanent resident)

3. How do you use or interact with the tidal salt marshes?
   [*check all that apply*]

   - [ ] Farming
   - [ ] Hunting
   - [ ] Indigenous community practices
   - [ ] Live adjacent to tidal salt marsh (eg. live near the marsh but not actively engaging in marsh activities)
   - [ ] Recreation (eg. bird watching, kayaking, recreational fishing etc.) [ ] Trapping
   - [ ] Waterman or aquaculture

4. How frequently do you use or interact with these marshes?

Mark only one oval.

- ◯ Every day
- ◯ A few days a week
- ◯ Once a week
- ◯ Once a month
- ◯ Seasonally (eg. duck hunting season)
- ◯ Less than once a year

Tidal Salt Marsh Changes

5. In your lifetime, have you noticed any changes in the tidal salt marshes, such as increase in invasive species, loss of shoreline, interior marsh ponding, etc.?
Mark only one oval.

- ◯ Yes
- ◯ No
- ◯ Not sure

6. Please describe what kind(s) of change(s) you've observed on these marshes? [*check all that apply*]

- ☐ Changes in marsh vegetation (eg. increased Phragmites)
- ☐ Decline in native species including birds, insects, plants etc.
- ☐ Flooding
- ☐ Increased standing water on the salt marsh
- ☐ Loss of shoreline or marsh land
- ☐ Vegetation dieback
- ☐ I haven't noticed any changes
- ☐ Other: _____

7. Over what time scale have you noticed these changes?

8. Have these changes affected your use of the tidal salt marsh? If so, how?

Agricultural Impacts

9. Do you know of places where salt water is impacting agricultural lands? (eg. salt pannes or growth stunting in corn)

Mark only one oval.

- Yes
- No
- I don't know

10. Over what time frame have you seen this?

Mark only one oval.

- Within the last 2 years
- Over the past 5-10 years
- Over the past 10-20 years
- 20 + years

Tidal Salt Marsh Restoration

"*Coastal areas have intrinsic economic, cultural, and aesthetic value. The United States has lost more than half of its wetlands since the late 18th century. An average of 60,000 acres of wetlands were lost each year between 1986 and 1997*" (National Oceanic and Atmospheric Administration). This loss is felt in human communities through the loss or damage of infrastructure such as roads, boat landings, community cemeteries, and residual buildings.

Maryland's tidal saltmarshes support a breadth of plant, insect, mammal, and bird species. In fact, our State supports 25% of the global population of Saltmarsh Sparrow, a small bird which isn't found in any other habitat type.

Techniques in wetland restoration can help rehabilitate degraded or damaged marshes for human and wildlife populations. Marsh restoration actions might include strategies like adding sediment to the marsh platform in order to increase elevation, or release trapped water by digging shallow runnels on the marsh surface, or the removal for invasive plant species.

11. Do you think it's important to protect the marshes? *
Mark only one oval.

- ◯ Yes
- ◯ No
- ◯ I don't know

12. Why?
[*check all that apply*]

- ☐ Cultural significance (eg. historic, hunting, aesthetic value)
- ☐ Economic value (eg. prevent loss of income from sources such as fishing/crabbing)
- ☐ Ecosystem services (eg. water quality, erosion control, shoreline protection)
- ☐ Environmental stewardship and responsibility (eg. natural value) ☐ Flood abatement
- ☐ Prevent loss of private property
- ☐ Protect community infrastructure (eg. churches, roads, cemeteries)
- ☐ Wildlife habitat (eg. conserve species)
- ☐ Other: _____

13. Please list any marsh-adjacent infrastructures, such as boat ramps or access roads, that you believe are being affected by marsh migration or flooding. Be specific (eg. *which* landing).

14. Marsh restoration actions may cause local disturbances or inconveniences like ground disturbance, road closures, and dredging activity in adjacent waters. How would these activities impact your use of the marsh or adjacent areas? What concerns do you have?

Private Landowners

If you are a landowner with tidal salt marsh, Audubon and partners are interested in working with you to assess your marsh and identify potential restoration opportunities. If you're interested we'd like to talk!

15. Would you be interested in learning more about tidal salt marsh restoration practices on your property? *

Mark only one oval.

- ◯ Yes
- ◯ No
- ◯ Does not apply to me

If you are interested in learning more about tidal salt marsh restoration on your property, please provide your contact information below.
Please note, any contact information you provide will not be shared outside our Marshes for Tomorrow project.

16. Name

_____

17. Contact information (email or telephone number)

_____

Future Engagement

Audubon and its partners are currently assessing the condition of tidal salt marshes across Maryland's eastern shore. We plan to hold in-person community meetings in 2024 in Dorchester, Somerset, and Worcester counties to share details about our work and better understand *your* interest and concerns of the marsh landscape. We want to hear about your observations and give you the opportunity to comment on draft restoration plans for the tidal salt marshes we all love.

Please contact us via marshes4tomorrow@gmail.com to find out about upcoming meetings in your county.

18. Would you be interested in attending a community meeting about tidal salt marshes in your county? Mark only one oval. *

- ◯ Yes
- ◯ No

19. If you are interested in participating in a community meeting, or conversation with one of our team, please provide your contact information below (email or phone number).

    Please note, any contact information you provide will not be shared outside our Marshes For Tomorrow project.

Thank you!
As a thank you for completing this survey, we would like to offer you the chance to win some free, local prizes. If you're interested in being entered into the raffle, please provide your name and contact information below. Please note, any contact information you provide will not be shared outside our Marshes For Tomorrow project.

20. Name

21. Contact information (email or telephone number)