Sea-level Rise is for the Birds:

Landscape-Level Conservation Planning to Protect Communities, Coastal Wetlands, and Salt Marsh Birds




Audubon MARYLAND-DC

LOWER SHORE LAND TRUST

DEFENDERS OF WILDLIFE

The Lower Shore Tidal Marsh Climate Adaptation Project brings together partners interested in finding ways to better address the combined impacts of sea-level rise on the natural resource values of the Lower Eastern Shore of Maryland:

The Lower Shore Land Trust (LSLT) was established in 1990 with a mission to protect the natural heritage, rural character, and historic landscapes of Somerset, Wicomico, and Worcester counties. To date, LSLT has worked with interested landowners to secure permanent protection of nearly 18,000 acres of land throughout Maryland's most biologically diverse region, utilizing donated conservation easements and funding from the Rural Legacy Program, the federal Farm and Ranchlands Protection Program and the Conservation Reserve Enhancement Program.

Defenders of Wildlife's Living Lands Program has worked with land trusts and other conservation partners in the Chesapeake Bay watershed to improve strategic conservation planning and enhance their capacity to protect biodiversity in the face of climate change. In addition to these three partners, the project is intended to leverage additional partnerships to assist the state of Maryland in implementing its adaptation strategy for this ecosystem.

Audubon Maryland-DC is a state office of the National Audubon Society, and uses science, education, community engagement and advocacy to pursue its mission to conserve and restore natural ecosystems, focusing on birds and other wildlife, for the benefit of humanity and the earth's biological diversity. Within the project area, Audubon has identified 85,665 acres as the Somerset-Wicomico Marshes Important Bird Area for salt marsh obligate bird species, which are a focus of this project.

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To obtain a copy of the full project report, including technical documentation on methods, data sources, and GIS models, please contact Anderson Shepard at: ashepard@defenders.org.

Cover: Sunrise on Needlerush, photograph by Neil Pearson; Black-necked Stilt, photograph by Neil Pearson; child exploring the shore of Chesapeake Bay, photograph by Ryan Hagerty, courtesy U.S. Fish and Wildlife Service; dead pine trees at Irish Grove Sanctuary, photograph by David Curson; house stranded by rising sea levels, Holland Island, Maryland, photograph by David Curson. Back cover: Sunrise on Needlerush, photograph by Neil Pearson; Egret, photograph by Neil Pearson.

Chesapeake Bay, the largest estuary in the continental United States, includes parts of six states and is home to more than 17 million people. Once the most productive estuary in the U.S., the bay supports more than 3,400 species of plants and wildlife, including 500 species of fish and shellfish[1]. Today, the bay's health is threatened by nutrient and sediment pollution, land use conversion, and resource use[2]. The bay is also particularly vulnerable to the effects of climate change, and sea-level rise is recognized as an urgent priority. The region is the third most vulnerable in the nation to sea-level rise[3], behind Louisiana and southern Florida. Sea-level rise, coupled with naturally occurring land subsidence, contributes to the region's vulnerability. In the Chesapeake Bay, sea-level rise is not simply a problem of the future. It is already impacting low-lying coastal lands at twice the global average rate.

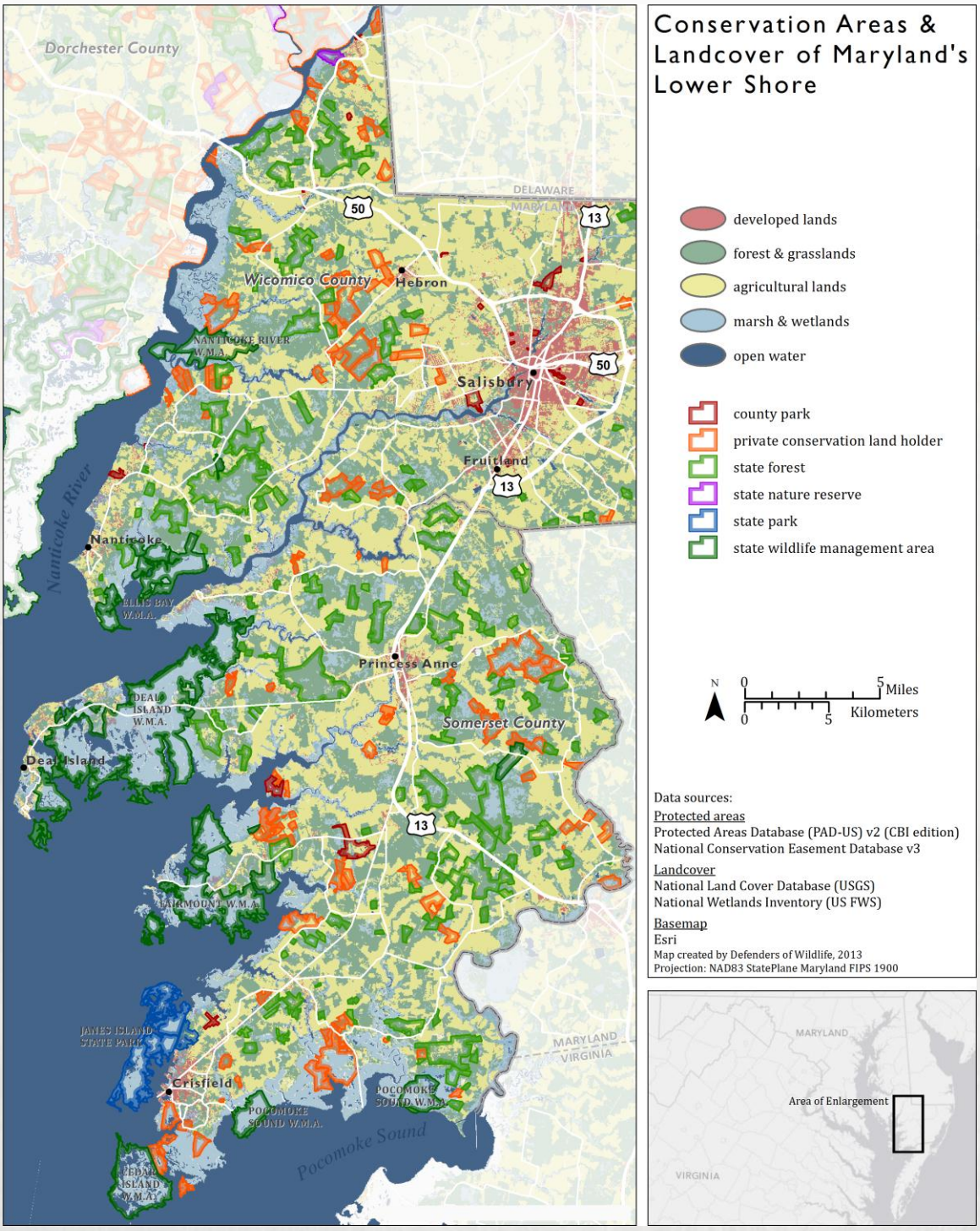
Over the past 100 years, a foot of relative sea-level rise has resulted in the disappearance of 13 islands from the Chesapeake Bay. Additional sea-level rise impacts, such as wetland erosion and saltwater intrusion, are also evident. New estimates[4] suggest that Maryland should prepare for 1.4 feet of sea-level rise by 2050 and 3.7 feet or more by 2100, with floods from storm surges rising well above these levels. Increasingly, communities and their partners are recognizing the need to look ahead in their approaches to management and conservation in order to ensure protection of their valued resources.

The natural ecosystems most at risk from rising sea-levels in the bay are coastal wetlands. These wetlands provide a range of natural benefits critical for improving water quality, providing flood and erosion control, and supporting fish and wildlife populations. They provide habitat for unique flora and fauna, including two birds, the Seaside Sparrow and the Saltmarsh Sparrow, which evolved in this tidal environment and are found only in salt marsh habitats along the U.S. Atlantic Coast.

Maryland's Lower Eastern Shore includes an interwoven network of natural areas, agricultural areas, transportation links, and settlements. Compared to the more urbanized counties in the mid-Atlantic region, much of the Lower Eastern Shore has remained sparsely populated and rural. It is also a low-lying area with significant vulnerability to flooding. Nearly 60% of Somerset and Wicomico counties are in the 100 year flood plain[5], and 24% occur below an elevation of 3.7 feet. In these low-lying areas, more than 76,000 acres of coastal wetlands provide shoreline protection as well as critical habitat for numerous plants and animals.

In 2011, the Maryland Department of Natural Resourced (MD DNR) used a tool called Sea Level Rise Affecting Marsh Model (SLAMM) to look at the potential impacts of sea-level rise on Maryland's coastal wetlands and determined that, in Somerset and Wicomico counties, a 3.4 foot rise could inundate more than 63,000 acres of existing salt marsh (92% of current extent) and more than 5,000 acres of tidal swamp (78% of current extent). However, about the same amount of currently dry land could also potentially convert to marshland under such a rise.

Tidal marshes can build, or accrete, in response to sea-level rise by depositing peat, and indeed have done so for thousands of years in the Chesapeake Bay as the land slowly subsides due to long-term geological processes. However, with the more rapid rates of sea-level rise resulting from climate change, marsh accretion will not keep pace with rising tides. In some coastal areas tidal wetlands will only persist if they can move upslope and inland as sea-level rises. In order for adjacent uplands to function as "migration corridors" for these threatened habitats, they must remain free of barriers, such as development and hardened shoreline protection.



Maryland's Lower Eastern Shore, the region of interest for this project.

Over the past decade a number of reports[6] have been published on the vulnerability of the Mid-Atlantic coastal region to climate change, as well as strategy concepts for climate change adaptation[7]. In Maryland, all of the counties in and adjacent to the Lower Eastern Shore have produced technical guidance or response strategies to sea-level rise[8]. The neighboring counties within the Delmarva Peninsula – including those in Virginia and Delaware – have all developed their own strategies for adapting to climate change. These strategies recommend changes to land use planning policies, such as the creation of floodplain planning zones with reduced permitted building densities, and the identification of areas for new wetlands in the future. Implementation of these land use recommendations will require public support and partnerships.

Few of these climate change strategies, however, have identified spatial priorities for responding to climate change. One that did, the Dorchester County Climate Adaptation Project[9], produced a set of strategies for climate adaptation of tidal marshes in Southern Dorchester County, Maryland.

These strategies include land protection within spatially defined marsh migration corridors, habitat management recommendations for current tidal marshes, and climate adaptation recommendations for agricultural and forestry sectors of the economy.

The Lower Shore Tidal Marsh Climate Adaptation Project extends this spatially explicit approach to Somerset and Wicomico Counties. This project shares the Dorchester County Project's emphasis on salt marsh birds, and focuses on identifying land protection priorities in areas of marsh with high ecological value and connectivity across time.

Biodiversity Values: Tidal Marshes & Salt Marsh Birds

Tidal marshes are an iconic landscape of Maryland's Lower Eastern Shore and cover approximately 69,000 ac (15%) of Somerset and Wicomico Counties. These tidal marshes are part of a large marsh complex in the southeastern quadrant of the Chesapeake Bay from Dorchester County, Maryland, to Accomack County, Virginia, and represent one of the most extensive tidal marsh landscapes in the northeast United States. The ecology and vegetation patterns of these marsh systems are largely determined by variations in salinity and by the frequency of tidal inundation (see side bar).

The avian species that frequent these marshes are excellent indicators of this landscape's ecological health. One of the objectives of this project was to identify and map the highest-priority areas of tidal marsh habitat for salt marsh birds within the Lower Shore region. We identified seven salt marsh specialists as focal bird species and used these to determine the characteristics and location of the highest priority tidal marsh and to target these areas for land protection or restoration:

- American Black Duck
- Black Rail
- Clapper Rail
- Coastal Plain Swamp Sparrow
- Saltmarsh Sparrow
- Seaside Sparrow
- Willet

Photo by Cropper Truitts

Low marsh is flooded twice daily by tides, and in Somerset and Wicomico Counties is confined mostly to creek banks and upper borders of tidal flats, from mean sea level to mean high water. Due to the influence of the tidal regime, low salt marsh is usually dominated by the tall form of a single grass species, smooth cordgrass.

High marsh is flooded less than daily, and constitutes the great majority of estuarine emergent marsh in Somerset and Wicomico Counties. High marsh supports more diverse vegetation than low marsh, but this is still restricted to a handful of dominant plant species, such as black needlerush, meadow cordgrass, spikegrass, and Olney threesquare. These often grow in stands dominated by a single species but form a mosaic pattern across the landscape.

Transitional marsh is very infrequently flooded and occupies the transition zone between salt marsh and the upland border. It supports estuarine intertidal scrub-shrub wetlands with broad-leaved deciduous vegetation and is typically comprised of marsh elder and groundsel tree. The current extent of transitional marsh in the region is limited, but this marsh type will play a large role in the future as sea levels rise and salt marsh shifts to higher ground.

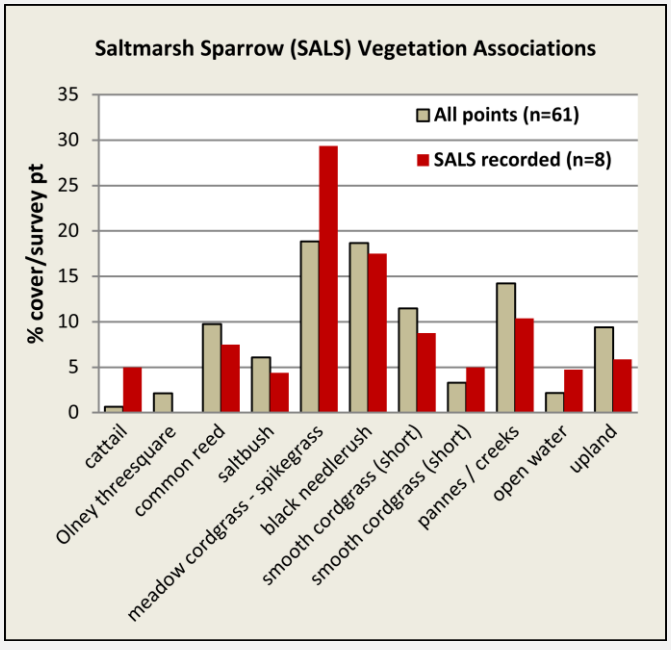
The seven focal species are all conservation priorities at the national, regional or state level, and all of them use high and transitional marsh as their principal breeding habitat in the Mid-Atlantic region. Additionally, five of the seven species are rated by the MD DNR as "Highly Vulnerable" to climate change, largely due to sea-level rise and the species' distributions in relation to barriers to the migration of marsh habitat. The surveys and data analysis described in the side bar on the next page were carried out for all seven of these focal species, not just the Saltmarsh Sparrow.

Saltmarsh Sparrow

Photo by Neil Pearson

The Saltmarsh Sparrow's breeding population is native to the northeastern United States – Somerset and Wicomico Counties are close to the southern limit of its breeding range. It is endemic to tidal marsh, and in Maryland it prefers interior tracts of high marsh habitat dominated by meadow cordgrass and spikegrass. Nationally, the Saltmarsh Sparrow is listed by the US Fish & Wildlife Service as a "Bird of Conservation Concern", and it is a "red" (highest national concern) on the Audubon Society / American Bird Conservancy's WatchList. Additionally, the State of Maryland lists the Saltmarsh Sparrow as a "species of greatest conservation need".

Bird data and vegetation data were collected during the breeding season of 2011 and 2012 as part of the Saltmarsh Habitat Avian Research Project (SHARP - www.tidalmarshbirds.org). As expected by their conservation status, Saltmarsh Sparrow relatively rare in the region. They were found in only 4 of the 8 primary sampling units, with a mean detection rate of only 0.08 sparrows per survey visit.



Climate Adaptation Analysis

We used computer modeling to predict the effects of sea-level rise on the current and future distribution of salt marsh ecosystems in Somerset and Wicomico Counties. Our objectives were to identify areas that may support tidal marsh in the future as sea level rises, and to prioritize these locations according to the likely ecological value of future tidal marshes. The analysis consisted of five principle steps:

Select an appropriate sea-level rise model and use it to identify the subset of salt marsh types on which to run the analyses;

Model a series of time steps with increasing levels of sea-level rise, and determine the extent and distribution of functional salt marsh habitat patches for each time step;

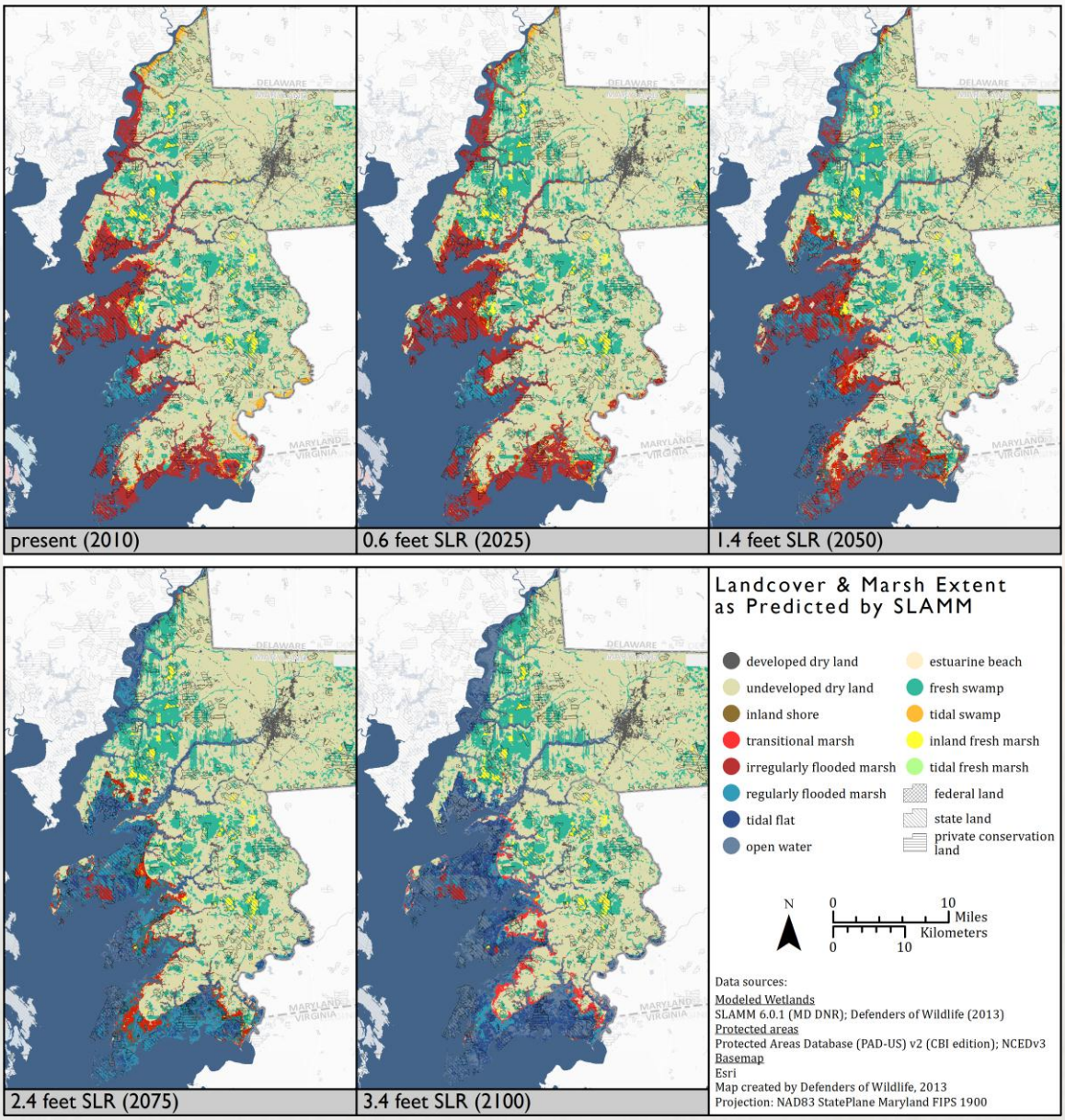
Identify marsh "migration" corridors – chains of salt marsh habitat that are spatially linked across time steps;

Identify high priority areas for marsh conservation based on salt marsh ecological value, modeled core bird habitat, risk of future development, and landcover conversion suitability;

Apply prioritization results to land ownership units to identify priority parcels and areas for land conservation.

SLAMM[10], the model used by the MD DNR in 2011 to measure the predicted effects of sea-level rise on Maryland's coastal counties, is well-tested, widely used, and incorporates a number of parameters that specifically take into account the physical processes that drive long-term changes in wetlands and shorelines. The climate change parameters it employed were adapted from the Maryland Commission on Climate Change, and assume a sea-level rise of 1.4 feet by approximately 2050 and a rise of 3.4 feet by the end of the century.

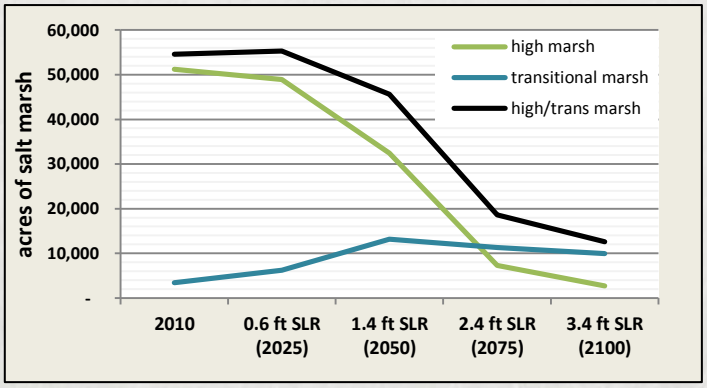
As physical conditions change over time due to sea-level rise, an area's ability to support salt marsh will be lost, maintained, or improved. In other words, salt marsh on the landscape may disappear, persist, or migrate to newly available areas. We took the marsh extent predictions made by SLAMM and specifically investigated the high (irregularly flooded) and transitional marsh types, as those are the marsh types most important to the focal bird species



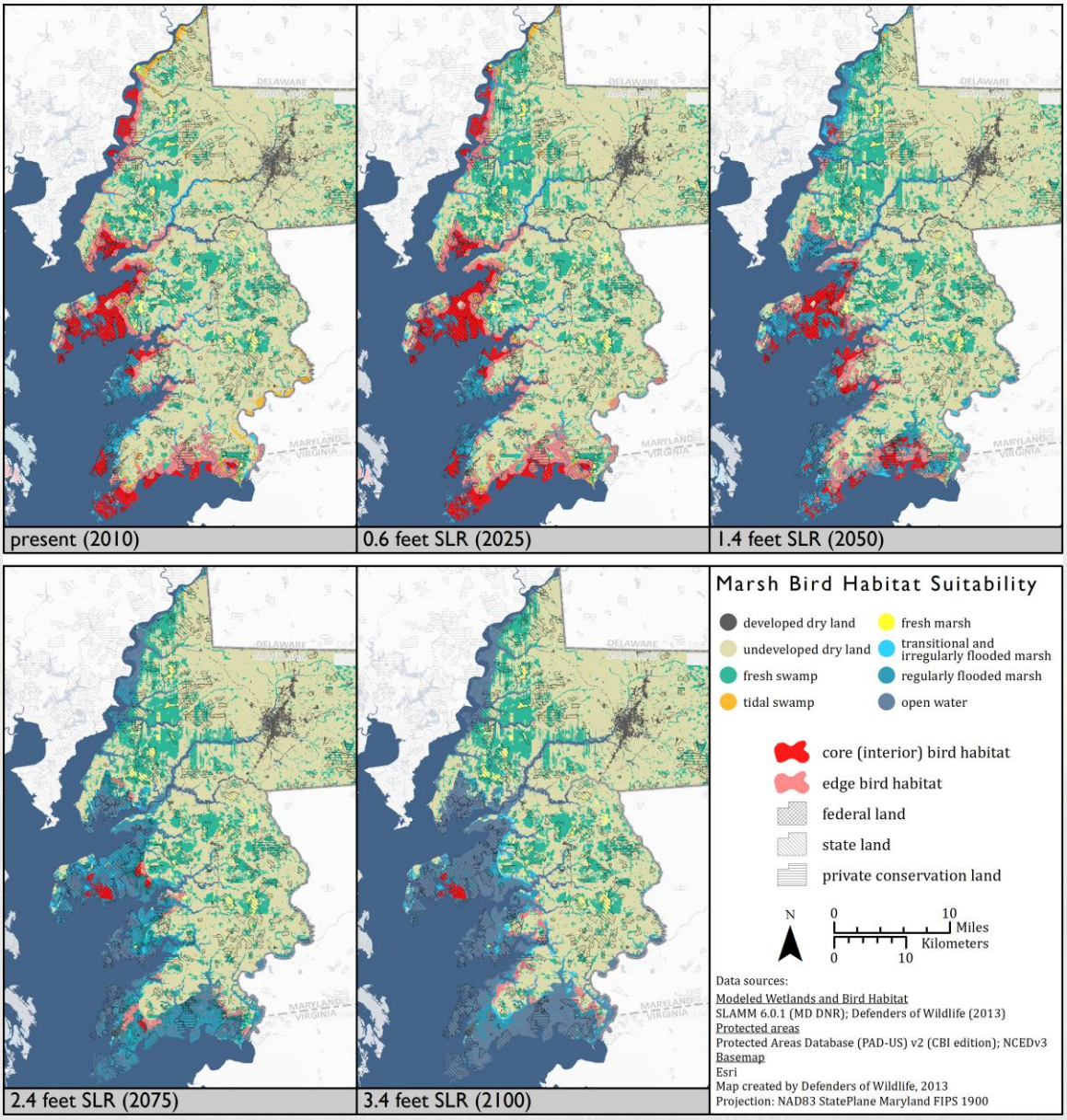
Sea Level Affecting Marshes Model (SLAMM) output maps showing stages of landcover and marsh extent from the present to a predicted 3.4 feet of sea level rise at the end of the century.

used in this analysis. The graph to the right and the map above show the results of these SLAMM predictions, highlighting the effects of sea-level rise (SLR) on high and transitional marsh on the Lower Shore over the next century.

The individual trend lines for high marsh and transitional marsh acreages differ greatly. Transitional marsh shows a net gain in area over the century, while nearly all high marsh is lost (94.8%). This disparity illustrates the importance of future management of transitional marsh zones to assist their shift to open high marsh habitat, a management process recently coined as Managed Marsh Transition[11]. The need for Managed Marsh Transition will increase through this century as high marsh acreages decrease and marsh migration expands areas of transitional marsh.



By 2050 significant areas of potential new marsh occur as a band, up to a mile wide in places, adjacent to the landward side of current marshes. By 2100, the only areas of current high and transitional marsh predicted to remain in



Predicted habitat suitability for salt marsh birds over the next century.

the project area are within impoundments at Deal Island Wildlife Management Area and Fairmount Wildlife Management Area. However, these impoundments will likely support target marsh types in the long term only if managed appropriately. At the end of the century, all areas of new marsh that appear in 2050 as a result of marsh migration will have themselves been lost to further sea-level rise. The southern half of Somerset County has the greatest potential for marsh migration late in the 21st century.

Marsh Bird Habitat Suitability

The primary objective of the spatial analysis portion of the project was to identify land conservation priorities based on the likely ecological value of tidal marshes that will occupy these areas in the future. One contributing factor to the overall ecological value of marshlands is their potential to be quality habitat for birds. To measure this, we first identified marsh habitat patches from the SLAMM models of future tidal marsh distribution and then refined those patches to reflect the habitat requirements of salt marsh specialist birds. Many salt marsh birds are area-sensitive and are absent from patches smaller than 160 acres in size[12]. Similarly, results of the 2011 and 2012 Saltmarsh Habitat Avian Research Project (SHARP) bird surveys (see side bar on page 4) showed that salt marsh specialist birds have a strong preference for high quality interior habitat (500 meters or more from the upland edge). This map shows how these habitat requirements and sea-level rise are predicted to interact over time, resulting in very little high quality salt marsh bird habitat by the end of the century.

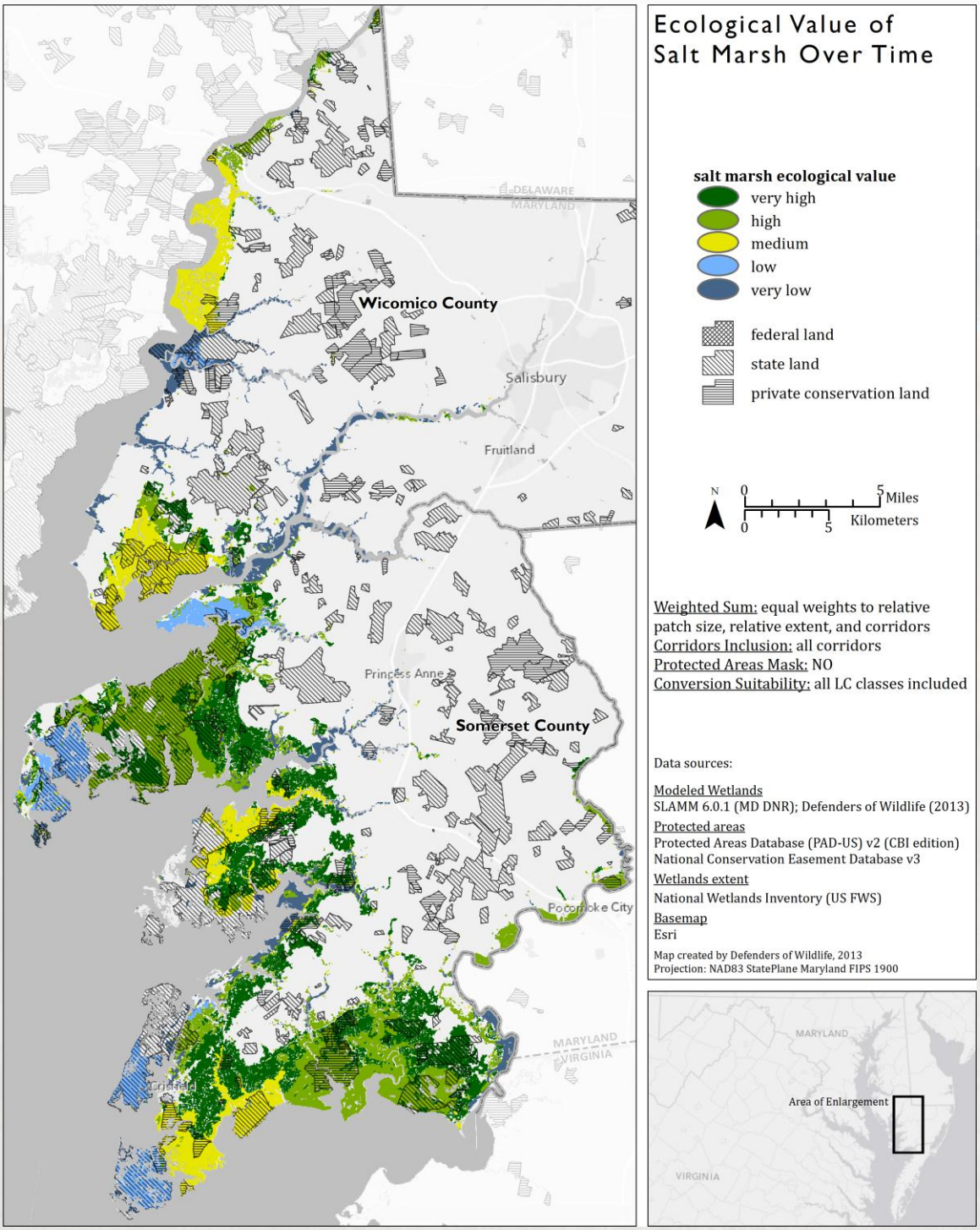
Photo by David Curson

The Ecological Value of Salt Marsh over Time

The present-day salt marshes are well-known and well protected, and tools like SLAMM can help predict where salt marshes will be in the future. However, with limited resources available to protect those areas, we will be unable to conserve current and future salt marsh in their entirety. To address this challenge, the project aimed to identify areas of current and future salt marsh that contribute the most to the greater tidal wetlands ecosystems over time. To do this, we modeled and combined three marsh ecosystem characteristics: patch size, relative extent, and habitat connectivity.

We assumed that bigger patches of conserved habitat are better, and this assumption was verified by the marsh bird habitat suitability work discussed above. Our measure of relative extent of marsh addresses the idea that there is value in scarcity. That is, when there is less marsh on the landscape (e.g. at the end of the century as predicted by SLAMM), those areas of marsh are of higher relative value than areas of marsh that exist when marsh is more abundant on the landscape (in the present). In practical terms however, this high relative value trades off against the declining predictability of events over such a long period of time.

To model habitat connectivity, we investigated the concept of marsh "migration" corridors. These are chains of salt marsh habitat that are linked across time and space. For our purposes, patches of marsh that are part of an identified migration corridor are more valuable than patches that stand alone or are not fully connected across time. Identification and conservation of these corridors is important in order to create an unobstructed environment in which salt marsh ecosystems have the freedom to move to newly suitable inland locations as sea levels rise.



Map of modeled salt marsh ecological value. The ecological value of marsh over time is calculated based on patch size, relative marsh extent, and presence of marsh migration corridors.

By weighting and combining these three marsh ecosystem characteristics we get an overall view of the ecological value of marsh lands across time in the Lower Eastern Shore of Maryland.

The resulting map identifies the Deal Island peninsula and the marshes east of Crisfield along the Pocomoke Sound as the largest landscapes having high and very high value. These areas comprise the current marshes of highest priority for salt marsh birds, including nearly all of the marshes where surveys have found Saltmarsh Sparrow and Black Rail during breeding season. Additionally, marsh persistence to 2050 is greater for these areas than elsewhere in the project area. These factors suggest that conservation efforts should be focused on these areas.

Determining Priority Salt Marsh Conservation Areas

Many of these areas of high value salt marsh are already under one form of protection or another, which reflects the great work that has been done over time by the region's conservation players. Still, in order to ensure the ability for

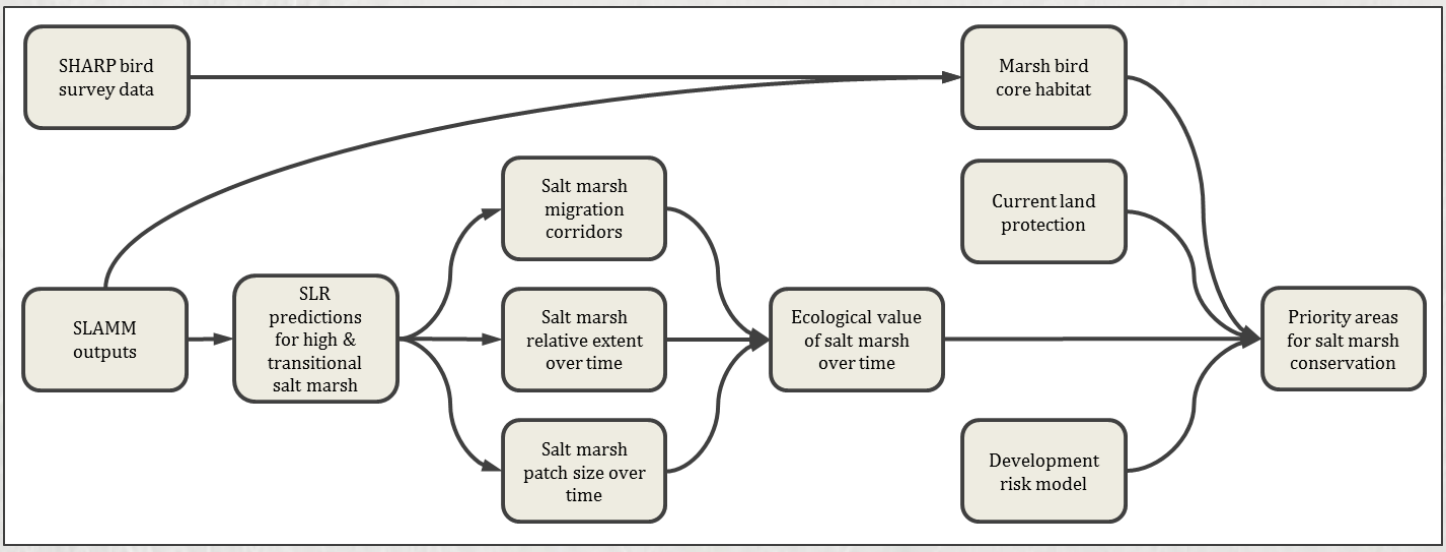
these salt marsh ecosystems to persist over time and to endure the pressures of sea-level rise, the portfolio of conservation lands must be expanded inland.

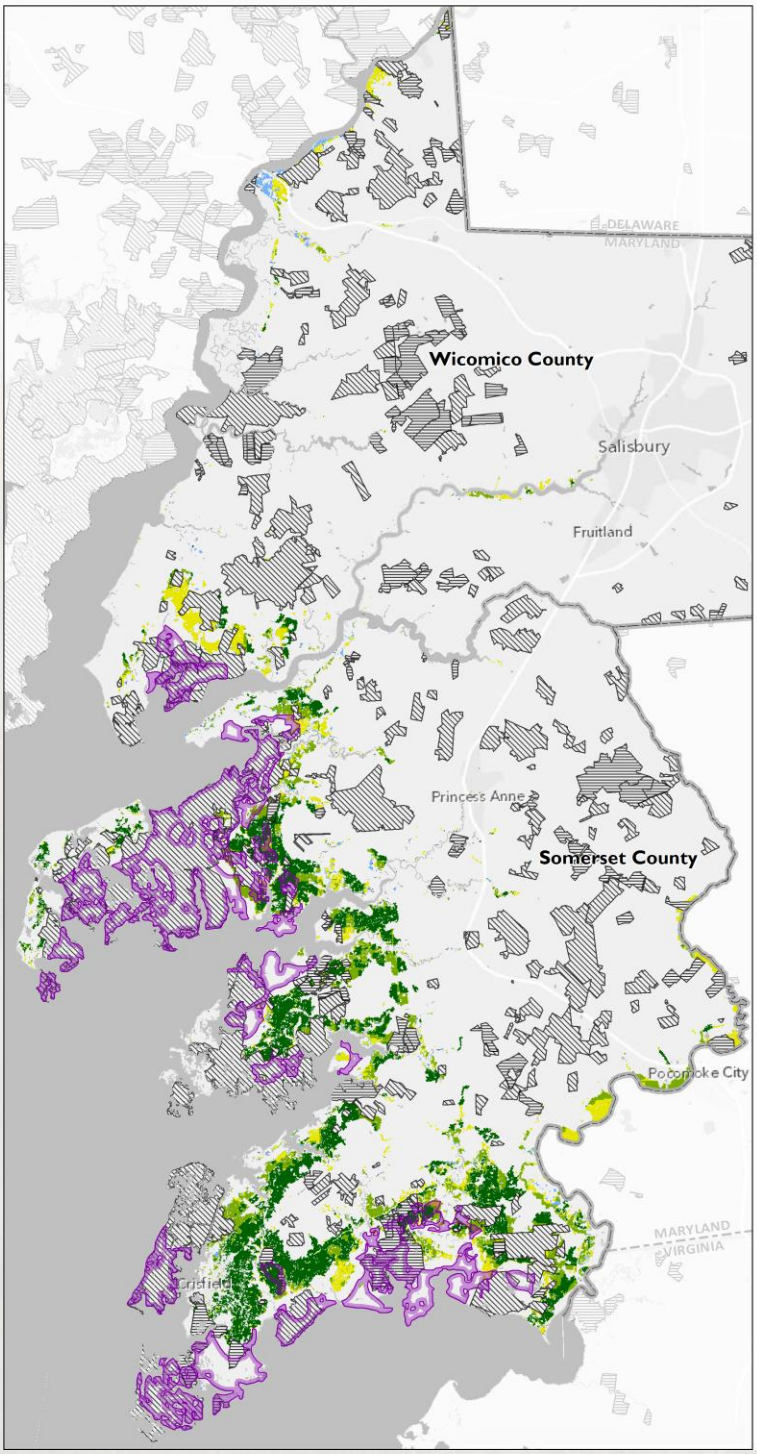
The models that predict where marsh is likely to be in the future (SLAMM) are based on several elements, including landcover. However, landcover is dynamic and can be dramatically altered by pressures such as urban development and land use change. When identifying priority areas for current and future salt marsh conservation, it is important to take into account factors such as development risk in addition to ecological value.

To do this, we incorporated a model of future development risk that was designed by the Dorchester County Climate Adaptation Project[13]. This model uses a combination of zoning, land ownership, and land use to qualitatively assess future development potential. As illustrated in the diagram to the below, this development risk layer was combined with the ecological value map and the marsh bird core habitat maps to produce a map identifying the highest priority areas for current and future salt marsh conservation.

Photo by Neil Pearson

Schematic depicting the inputs and outputs for the models of ecological value of salt marsh over time, and priority areas for salt marsh conservation.

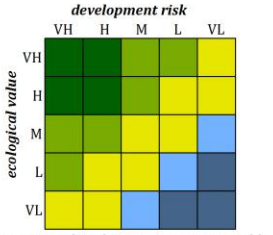




Priority Salt Marsh Conservation Areas: With Bird Habitat Overlay

marsh conservation priorities

- very high
- high
- medium
- low
- very low
- core bird habitat (combined across all time steps)
- federal land
- state land
- private conservation land



priorities classification consequence table

N 0 5 Miles
0 5 Kilometers

Data sources:

Parcels, Priority Funding Areas and Building Densities
MD Dept. of Planning (2013); Wicomico Co, MD, Dept. of Emergency Services (2013); Somerset Co, MD, Dept. of Technical and Community Services (2013)

Modeled Wetlands and Bird Habitat
SLAMM 6.0.1 (MD DNR); Defenders of Wildlife (2013)

Protected areas
Protected Areas Database (PAD-US) v2 (CBI edition)
National Conservation Easement Database v3

Wetlands extent and landcover
National Wetlands Inventory (US FWS);
National Land Cover Database 2006 (USGS)

Basemap
Esri

Map created by Defenders of Wildlife, 2013
Projection: NAD83 StatePlane Maryland FIPS 1900

Map showing modeled salt marsh conservation priorities. This model is based on the ecological value of marsh over time, the risk of future development, and the presence of core salt marsh bird habitat.

Photo by Hall Truitts

Stakeholder Outreach Strategies & Land Conservation Tools

A parallel focus of this project is to develop and refine a strategy for protecting existing and future salt marsh in Wicomico and Somerset counties. Through our climate adaptation analysis we identified those marshes with the highest conservation values and with the highest threat from sea-level rise and future development. Of course, there are limited resources for preserving these lands, and protection of the highest priority areas is by no means assured. Outreach and communications strategies are therefore needed to identify available conservation tools, as well as to reach the audience that must be engaged in order to successfully conserve, manage, and maintain viable salt marsh habitat.

Commitment from public agencies, landowners and other conservation partners is critical to the success of maintaining viable habitat for targeted bird species and other benefits including water quality and economic impacts to fisheries and other resource-based industries. One way of achieving that commitment is through broad-based community working groups that serve to monitor projects for the best possible ecological outcomes. A model for such a group is the Climate Adaptation Working Group[14] on Virginia's eastern shore, consisting of conservation partners, county planning agencies, municipalities, health agencies, emergency service providers, seafood and fisheries representatives and interested landowners and citizens.

Having an engaged body of stakeholders organized into a working group would provide a means for reviewing and conveying to local communities important information about the impacts of sea-level rise on Lower Shore counties. A broad-based group of stakeholders will serve to convey the importance of preserving and managing lands for marsh migration and resiliency, not just for wildlife benefits, but for impacts to human communities as well. Such a group could develop materials that focus on coastal resilience and preparedness but also include information about available programs, resources, priorities, and contacts pertaining to restoration and land protection. There are a multitude of outreach strategies and actions that can stem from stakeholder cooperation, organization, and preparedness, as shown in this table:

Outreach Activities	Target Audience	Messaging
Form working group	Health & Safety; Natural Resources; Ag; Fisheries, Planners, EMS, Health Agencies	Preparedness, coastal resiliency
Regional Roundtable	Conservation partners – agency, non-profit, private, etc.	Promote resources; i.e. TNC website with NOAA
Landowner Conservation Tools brochure	Landowners, partners, local government	Available programs and funding
Personal letters	Landowners	Coastal flooding and expected impacts to coastal areas form SLR
One-on-one meetings and/or workshops with landowners	Potential easement grantors	Best management practices and restoration options promote resiliency
Newspaper articles/editorials; radio interviews	Public	Stress coastal resilience; preparedness
Website message development	Conservation partners	Stress coastal resilience; preparedness; programs for restoration and land protection
Information about Best Management Practices	Land trusts, partners	Maintain list of completed projects and interested landowners
Workshop and Tour	Landowners & partners	Preparedness; major storms; floods; benefits
Meet with County Planners	County government	Promote resources

In addition to these strategies, there are numerous land conservation tools and programs that are in place both in Maryland and nationally, which exist to provide funding and other aid for the conservation of important natural lands. The following is a list of some such programs:

- Land and Water Conservation Fund (LWCF)
- Maryland's Program Open Space (POS)
- Donated Easement Program
- Maryland Environmental Trust (MET)
- Maryland Agricultural Land Preservation Foundation (MALPF)
- Wetlands Reserve Program
- Farm and Ranch Land Protection Program (FRPP)
- Conservation Reserve [Enhancement] Program (CREP/CRP)
- Readiness and Environmental Protection Initiative (REPI)
- National Coastal Wetlands Conservation Grant Program
- The North American Wetlands Conservation Act Program
- Land Owner Incentive Program (LIP)
- Mitigation Requirements
- Trading of Development Rights

Finally, with a changing climate, creating conservation easements that are perpetually enduring under uncertain future conditions is a challenge. In drafting conservation easements, land trusts have always had to anticipate likely areas of change by drafting easements that are flexible enough to accommodate change, yet enduring enough to protect conservation values in perpetuity. This difficulty is especially pertinent in regards to sea-level rise and marsh conservation. For example, some groups may wish to avoid placing an easement on land that will like be inundated in the future. Others may struggle with justifying the protection of lands that are expected to hold higher biodiversity conservation value in the future than in the present. As part of this project, we outline some pointers for drafting conservation easements when faced with changing conditions as a result of climate change[15]:

- Identify conservation values that will endure
- Provide sufficient flexibility
- Define specific terms
- Don't restrict unnecessarily
- Consider rolling easements
- Consider including discretionary approval or consent provisions and specify amendment criteria and procedures
- Provide comprehensive recitals
- Strive for clarity
- Consider performance standards
- Carefully define hoe the easement can be terminated or modified
- Utilize existing frameworks for responding to climate change
- Consider whether easement requirements that look to law should be fixed to current law

The Chesapeake Bay is a unique and special place. It is home to amazing wetlands, diverse biota, and vibrant local communities. The challenges that this region faces as a result of climate change and rising sea levels are extreme, but they are also shared by many other coastal areas. Our hope is that this study will provide a conceptual framework for modeling marsh migration across time, and that others confronting similar conservation problems will be able to adapt the methods, strategies, and tools described here and apply them elsewhere. Similarly, while our study chose to use salt marsh birds as a measure of biodiversity value, there are endless other species, groups, and systems that may be substituted in future analyses. The technical tools and strategies developed in this project will help ensure that ecologically significant coastal wetlands can persist and remain viable in light of their primary threat, sea-level rise, thereby maintaining the ecological services they provide.

Photo by Neil Pearson

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[15] See full report for detailed descriptions of these easement language suggestions.