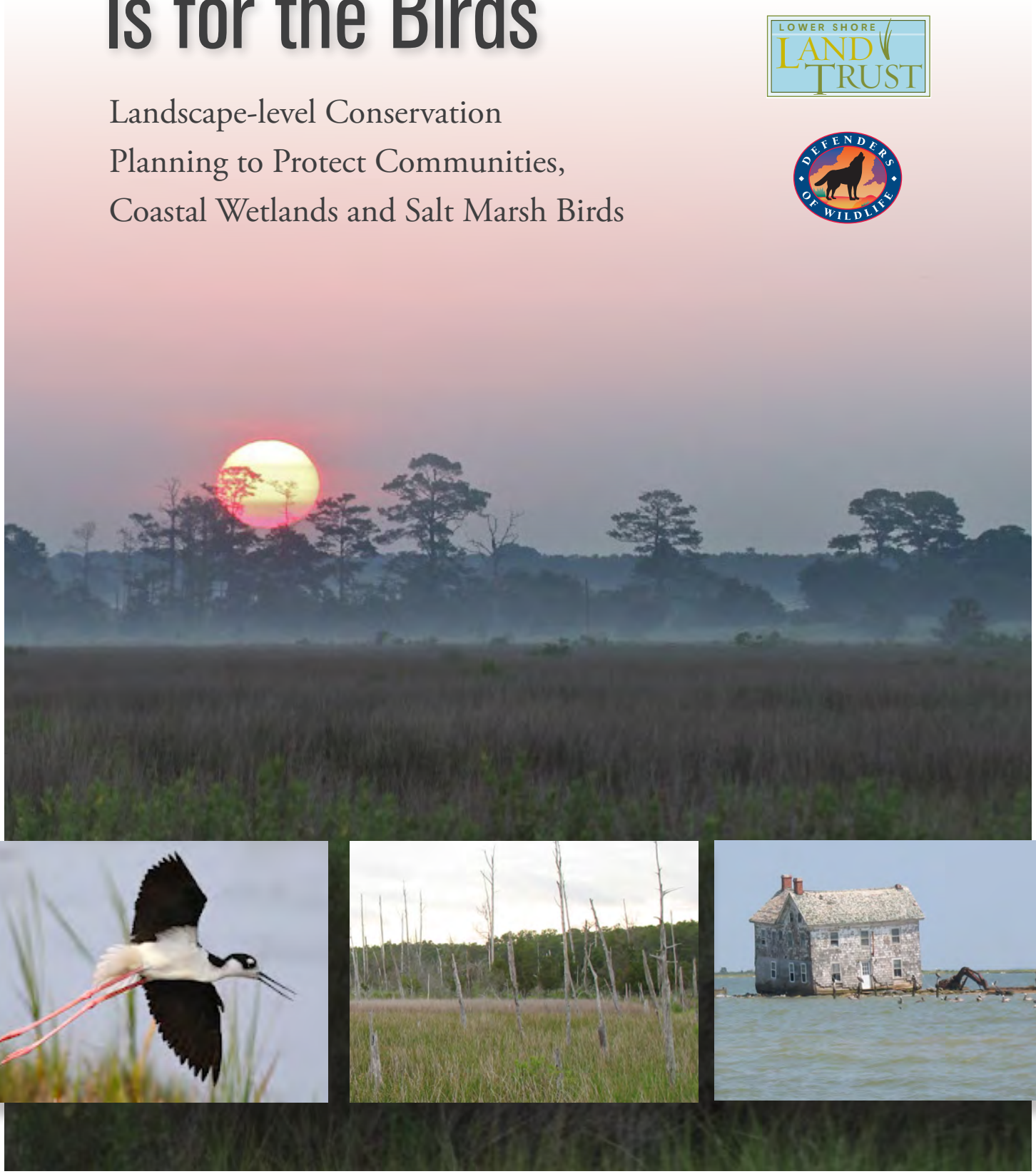
Sea-level Rise Is for the Birds

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. In addition to the partners listed below, this project is intended to leverage additional partnerships to assist the state of Maryland in implementing its adaptation strategy for this ecosystem.

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 has worked with land trusts and other conservation partners in the Chesapeake Bay watershed to enhance their capacity to improve strategic conservation planning and protect biodiversity in the face of climate change.

Audubon Maryland-DC is a state office of the National Audubon Society. It 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. 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. Also available for download at www.defenders.org/climatechange/mdwildlife.

Cover photos: sunrise on needlerush/Neil Pearson; Black-necked Stilt/Neil Pearson; dead pine trees at Irish Grove Sanctuary/David Curson; house stranded by rising sea level, Holland Island, Maryland/David Curson)

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Summary

The coastal wetlands of Maryland's Lower Eastern Shore are one of the most extensive tidal marsh landscapes along the entire Atlantic Coast. Not only do they provide essential habitat for unique plants and animals (including the saltmarsh sparrow, which lives only in this region), but they also perform economically valuable services such as storm surge protection, water filtration and serving as a nursery grounds for the Chesapeake Bay's commercial fisheries. However, these marshes are eminently threatened by sea-level rise.

The Chesapeake Bay is the third most vulnerable region in the nation, behind only Louisiana and southern Florida, when it comes to sea-level rise. In 2011, the Maryland Department of Natural Resources projected that a 3.4-foot rise in sea level (a conservative estimate for the end of the century) could inundate more than 95 percent of existing tidal marsh.

Defenders of Wildlife partnered with Audubon Maryland-DC and the Lower Shore Land Trust to establish priorities and strategies for the conservation of the region's tidal marsh ecosystem. We used computer modeling to identify areas that may support tidal marsh in the future as sea level rises, and to prioritize these locations according to their likely ecological value as future tidal marshes. We focused especially on marsh "migration corridors," or the regions that can serve as connectors between marsh habitat today and marsh habitat in the future. By combining spatial models of marsh ecological value, priority marsh bird habitat, marsh migration corridors and future development risk, we were able to produce a map for a two-county area of the Lower Eastern Shore that identifies the highest priority areas for tidal marsh conservation and facilitated adaptation in response to climate change.

Of course, simple identification of these conservation priorities is not enough. There are limited resources for preserving these lands, and protection of the highest priority areas is by no means assured. So our team also developed a set of conservation tools and targeted outreach and communications strategies to reach the audiences that must be engaged to successfully conserve, manage and maintain viable tidal marsh habitat. Commitment from public agencies, landowners and other conservation partners will be critical to the successful conservation of this exceptional ecosystem.

The decision-support tools and maps, combined with the conservation and outreach strategies from this study, can go a long way toward ensuring conservation of the Chesapeake Bay's iconic marsh landscapes. However, this region is not alone in facing the extreme challenges posed by climate change and rising sea level. It is our hope that other coastal areas will adapt this study's conceptual frameworks, methods, strategies and tools and use them to model marsh migration over time to better plan for the strategic conservation of salt marsh ecosystems.

Salt marsh off Box Iron Road, Somerset County, Maryland. Photo by Cropper Truitts.

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 United States, 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. Naturally occurring land subsidence exacerbates 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 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.[4] Increasingly, communities and their partners are recognizing the need to look ahead in their approaches to management and conservation to ensure protection of their valued resources.

The natural ecosystems most at risk from rising sea-level in the Chesapeake 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, that evolved in this tidal environment and are found only in salt marsh habitats along the U.S. Atlantic Coast.

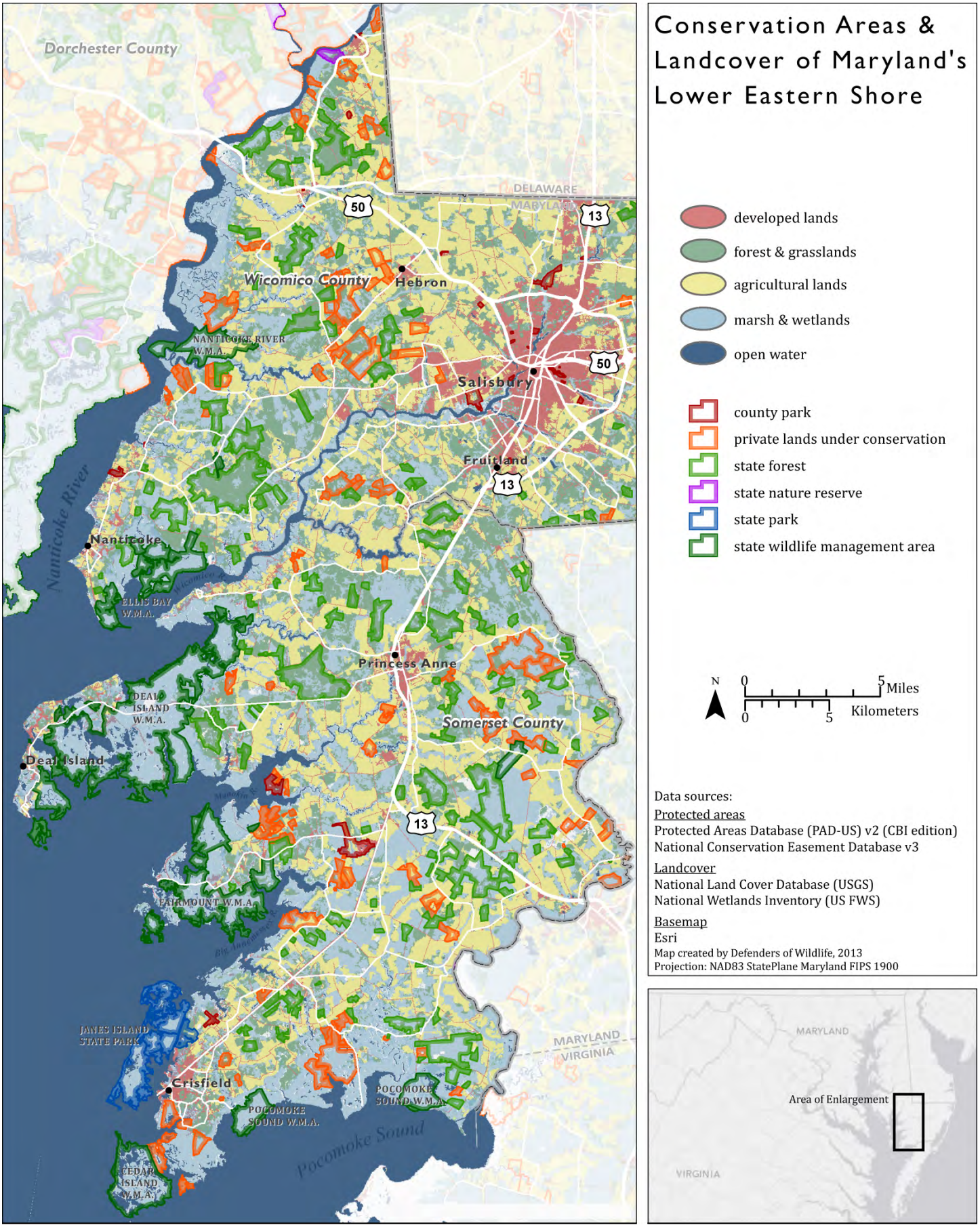
Maryland's Lower Eastern Shore (Map 1) includes an interwoven network of natural areas, agricultural areas, transportation links and settlements. Compared to the more urbanized counties in the mid-Atlantic region, much of the Lower Eastern Shore has remained sparsely populated and rural. It is also a low-lying area with significant vulnerability to flooding. Nearly 60 percent of Somerset and Wicomico counties are in the 100-year flood plain, and 24 percent occur below an elevation of 3.7 feet.[5] In these low-lying areas, more than 76,000 acres of coastal wetlands provide shoreline protection as well as habitat for numerous plants and animals.

In 2011, the Maryland Department of Natural Resources (DNR) used a tool called Sea Level Rise Affecting Marshes 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 percent of current extent) and more than 5,000 acres of tidal swamp (78 percent of current extent). However, about the same amount of currently dry land could 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 been doing 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.[6] In some coastal areas tidal wetlands will only persist if they can move upslope and inland as sea level rises. 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.

Over the past decade a number of reports have been published on the vulnerability of the Middle Atlantic coastal region to climate change, and strategy concepts for climate change adaptation.[6,7] 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 also 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 has, the Dorchester County Climate Adaptation Project, produced a set of adaptation actions for tidal marshes in southern Dorchester County, Maryland.[9] These actions include land protection within spatially defined marsh migration corridors, habitat management



Map 1. Maryland's Lower Eastern Shore, the region of interest for this study. This region is largely rural and agricultural with extensive marsh lands lining much of its western waterfront.

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 over time.

Biodiversity Values: Tidal Marshes and Salt Marsh Birds

Tidal marshes are an iconic landscape of Maryland's Lower Eastern Shore and cover approximately 69,000 acres (15 percent) of Somerset and Wicomico counties. These tidal marshes are part of a large marsh complex in the southeastern quadrant of the Chesapeake Bay extending from Dorchester County, Maryland, to Accomack County, Virginia, and represent one of the most extensive tidal marsh landscapes in the northeastern 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 "Salt Marsh Types").

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:

- American black duck
- Black rail
- Clapper rail
- Coastal Plain swamp sparrow
- Saltmarsh sparrow
- Seaside sparrow
- Willet

Surveys and vegetation data were collected for all seven focal bird species and used to characterize marsh habitat suitability (see box on pg. 4 "Characterizing Habitat Suitability for Saltmarsh Sparrow"). This information was used to identify the characteristics and location of the highest priority tidal marsh and to target these areas for land protection or restoration. The seven focal species are conservation priorities at the national, regional or state level. 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 considered "highly vulnerable" to climate change by the DNR, largely due to sea-level rise and the species' distributions in relation to barriers to the migration of marsh habitat.

Salt Marsh Types

Low marsh is flooded twice daily by tides. In Somerset and Wicomico counties low marsh 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, it is usually dominated by the tall form of a single grass species, smooth cordgrass.

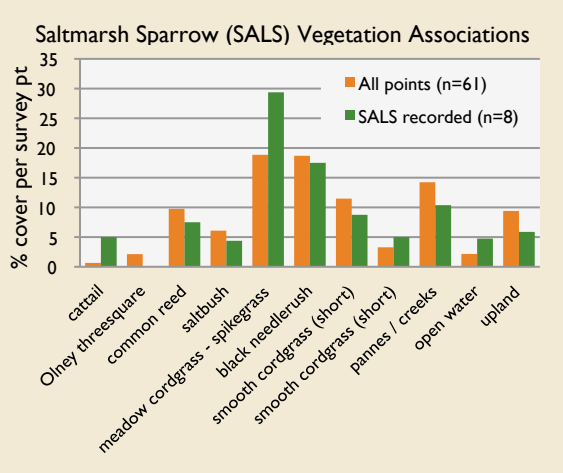
High marsh is flooded less than daily and constitutes the great majority of estuarine emergent marsh in Somerset and Wicomico counties. High marsh supports more diverse vegetation than low marsh, but is still restricted to a handful of dominant plant species, such as black needlerush, meadow cordgrass, smooth 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 typically consists 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 level rises and salt marsh shifts to higher ground.

High marsh with meadow cordgrass *(Spartina patens)* and smooth cordgrass *(Spartina alterniflora)*. Photo by David Curson.

Characterizing Habitat Suitability for Saltmarsh Sparrows

Somerset and Wicomico counties are near the southern limit of the saltmarsh sparrow's breeding range. The species is endemic to tidal marsh, and in Maryland prefers interior tracts of high marsh habitat dominated by meadow cordgrass and spikegrass. Nationally, the saltmarsh sparrow is listed by the U.S. Fish and Wildlife Service as a "Bird of Conservation Concern," and it is a "red" species (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".




Saltmarsh sparrow. Photo by David Curson

Bird data and vegetation data for this and six other focal bird species 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 its conservation status, the saltmarsh sparrow is relatively rare in the region and was found in only four of the eight primary sampling units, with a mean detection rate of only 0.08 sparrows per survey visit.

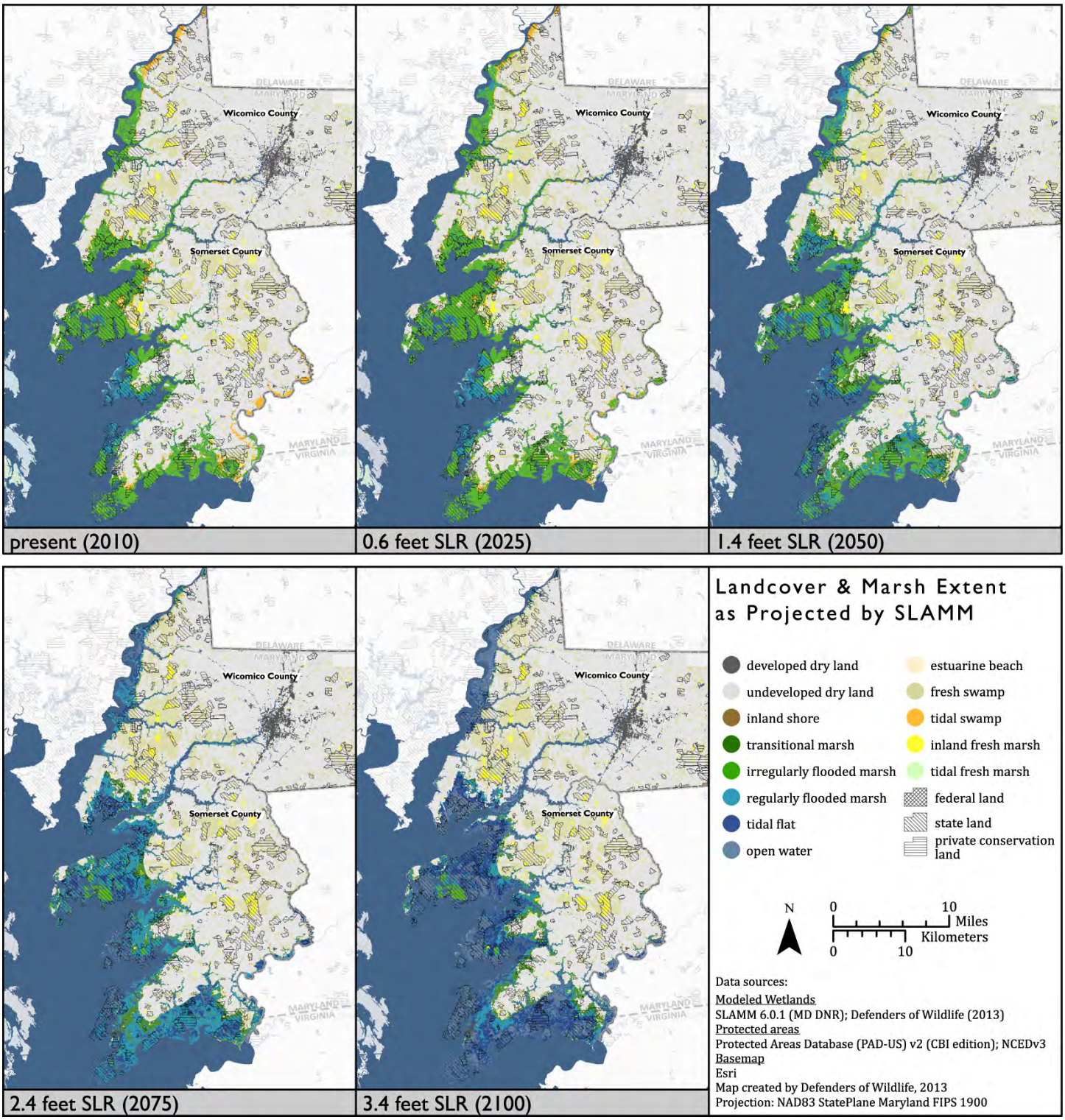
Climate Adaptation Analysis

We used computer modeling to project 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:

1) Selection of an appropriate sea-level rise model and identification of the subset of salt marsh types on which to run the analyses.
2) Modeling a series of time steps with increasing levels of sea-level rise and mapping the extent and distribution of salt marsh habitat patches for each.
3) Identification of marsh "migration" corridors—chains of salt marsh habitat that are spatially linked across time.
4) Identification of high-priority areas for marsh conservation based on salt marsh ecological value, modeled core bird habitat, risk of future development, and land cover conversion suitability.
5) Application of prioritization results to land ownership units to identify priority parcels and areas for land conservation.

SLAMM, the model used by the DNR in 2011 to project the 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.[10] Climate change parameters were based on reports 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 can be lost, maintained or improved. In other words, salt marsh may disappear, persist or migrate to new areas on the landscape. We took the marsh extent projections 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 used in this analysis. Map 2 on the next page shows the results of these SLAMM projections, highlighting the effects of sea-level rise (SLR) on high and transitional marsh on the Lower Shore in Somerset and Wicomico counties over the next century. The individual trend lines for high marsh and transitional marsh acreages differ greatly over this time period (Figure 1). Transitional marsh shows a net gain in area over the century, while nearly all (94.8 percent) high marsh is lost. This disparity illustrates the importance of future management of transitional marsh zones to facilitate the shift to open high marsh habitat, a technique recently coined as "Managed Marsh Transition."[11]



Map 2. Sea Level Affecting Marshes Model (SLAMM) output maps for Somerset and Wicomico counties in Maryland. These maps show stages of land cover and marsh extent from present conditions to 3.4 feet of sea-level rise at the end of the century.

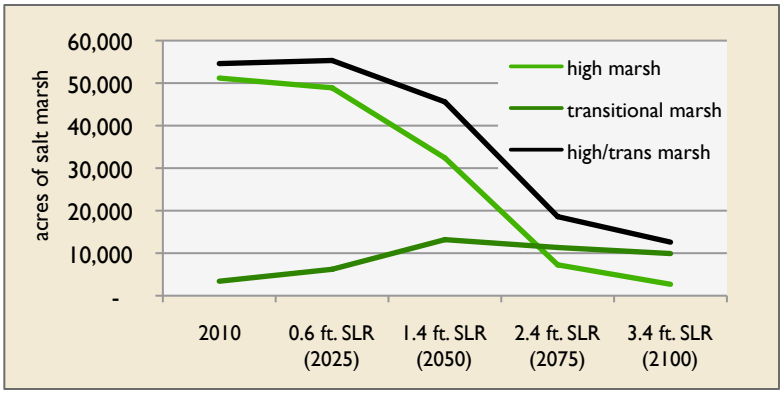
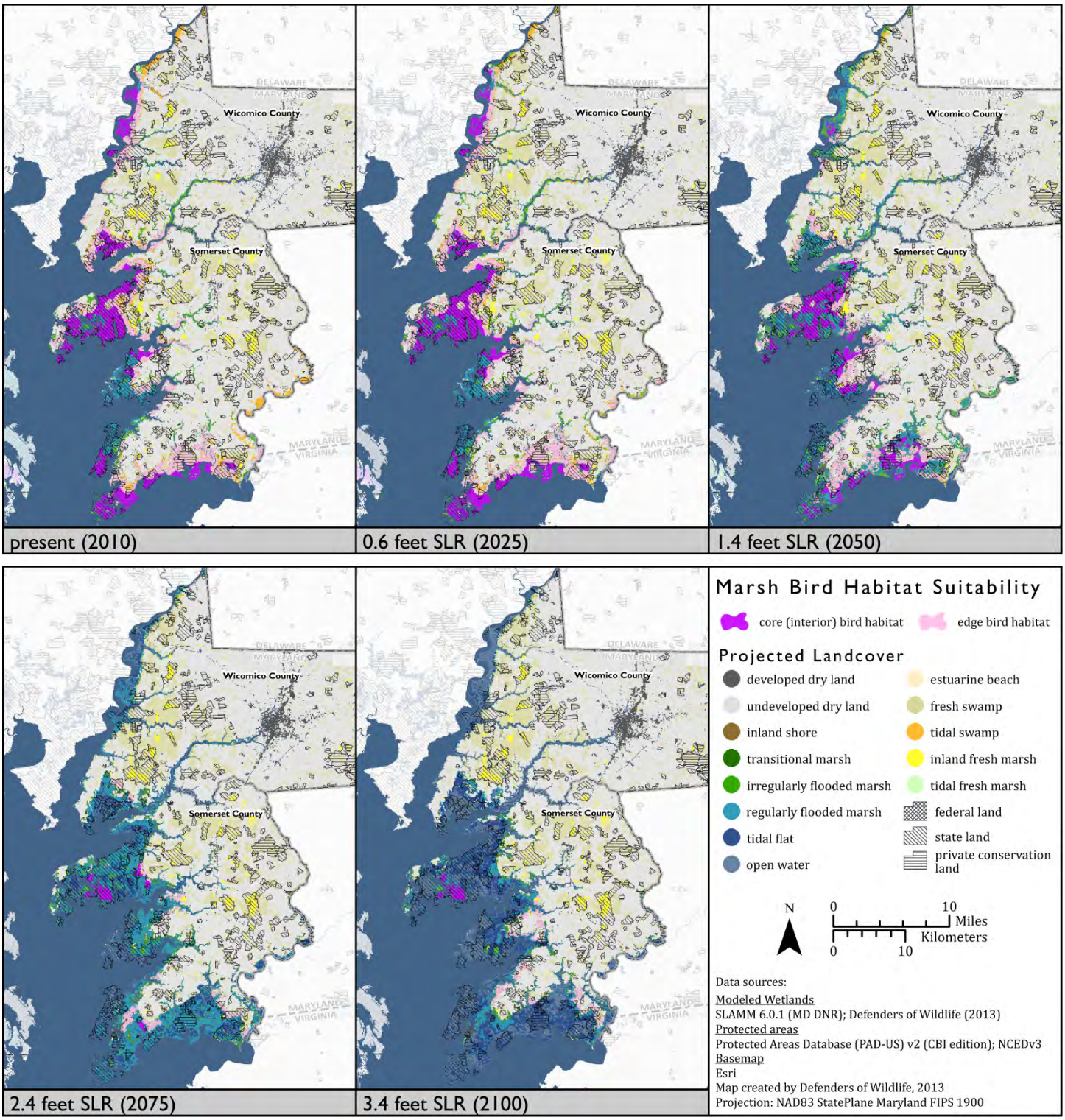


Figure 1. This graph depicts the acreage in Somerset and Wicomico counties of high marsh, transitional marsh and the two combined, from present conditions to 3.4 feet of sea-level rise at the end of the century. Note the increase in transitional marsh up to mid-century, but then the overall dramatic loss of all salt marsh acres by the end of the century.



Map 3. Land cover and projected habitat suitability for salt marsh birds over the next century in Somerset and Wicomico counties, Maryland. (See map reference on page 8).

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 will 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 that remain in the project area will be 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. All areas of new marsh that appear in 2050 as a result of marsh migration will have themselves been lost by the end of the century due 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 was to identify land-conservation priorities based on the likely ecological value of tidal marshes that will occupy Maryland's Lower Eastern Shore in the future. One factor contributing to the overall ecological value of marshlands is their potential to be quality habitat for birds. To measure this, we identified marsh habitat patches in each time step from the SLAMM models and then selected those patches meeting known 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] Results from the 2011 and 2012 Saltmarsh Habitat Avian Research Project (SHARP) bird surveys showed that salt marsh specialist birds have a strong preference for high-quality interior habitat (500 meters or more from the upland edge). Map 3 on the preceding page shows how these habitat requirements and sea-level rise are projected to interact over time, resulting in very little high quality salt marsh bird habitat by the end of the century.

The Ecological Value of Salt Marshes Over Time

The locations of present-day salt marshes are well-known and generally well-protected. Tools like SLAMM can help predict where salt marshes will be in the future, but with limited resources it is impractical to protect those areas in their entirety. To address this challenge, we modeled and combined three marsh ecosystem characteristics: patch size, relative extent and habitat connectivity (Map 4), to identify areas of current and future salt marsh that contribute the most to the greater tidal wetlands ecosystem over time.

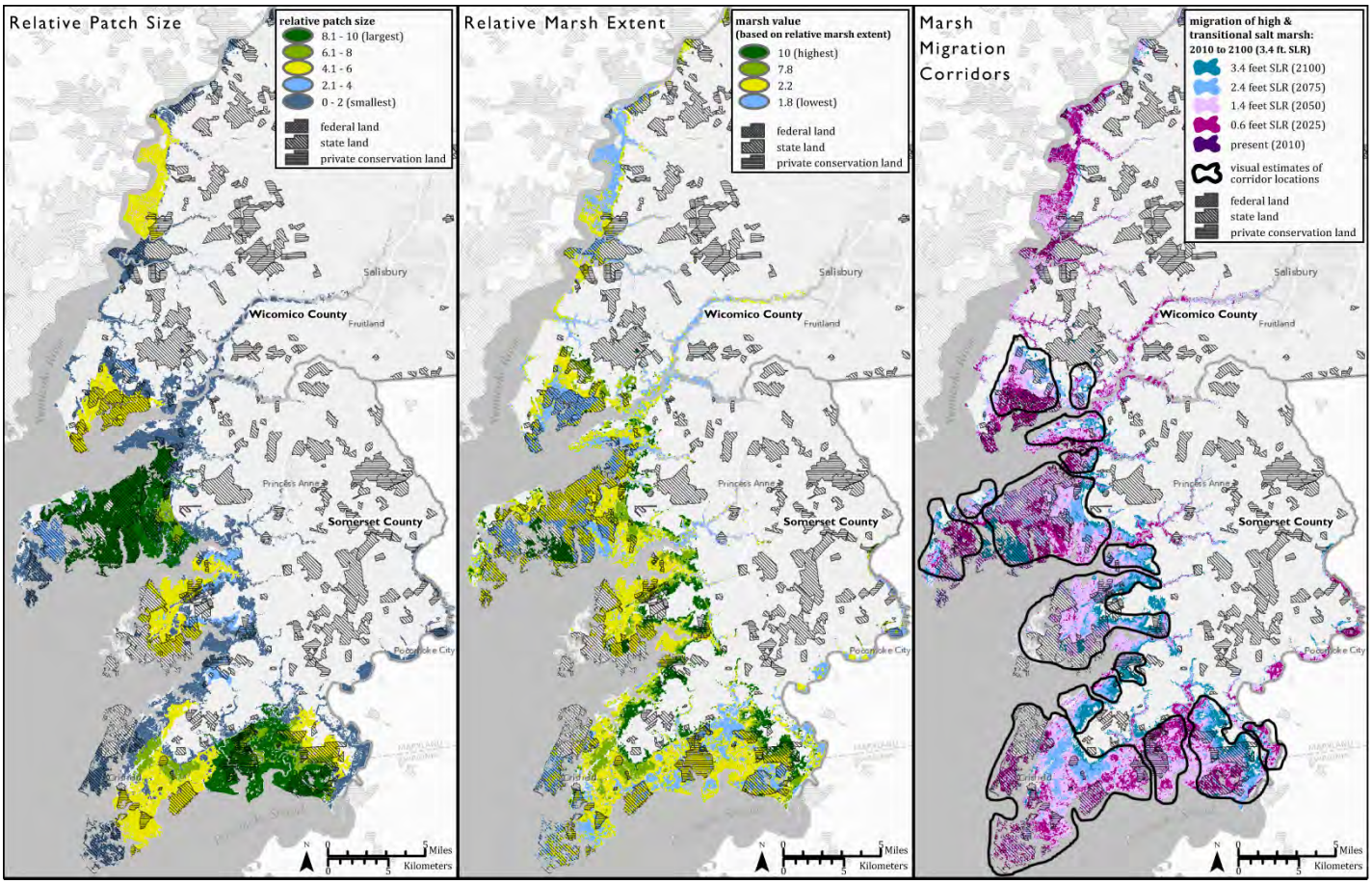
To measure the ecological value of the salt marsh landscape, we first assumed that larger patches of habitat are better at supporting bird populations and other ecological functions. This assumption was verified by the marsh bird habitat suitability analyses conducted as part of the SHARP surveys. Next we looked at the relative extent of salt marsh on the landscape at each time step. This measure of relative extent addresses the idea that there

High marsh ecosystem off of Rumbly Point Road, Somerset County, Maryland. Photo by David Curson.

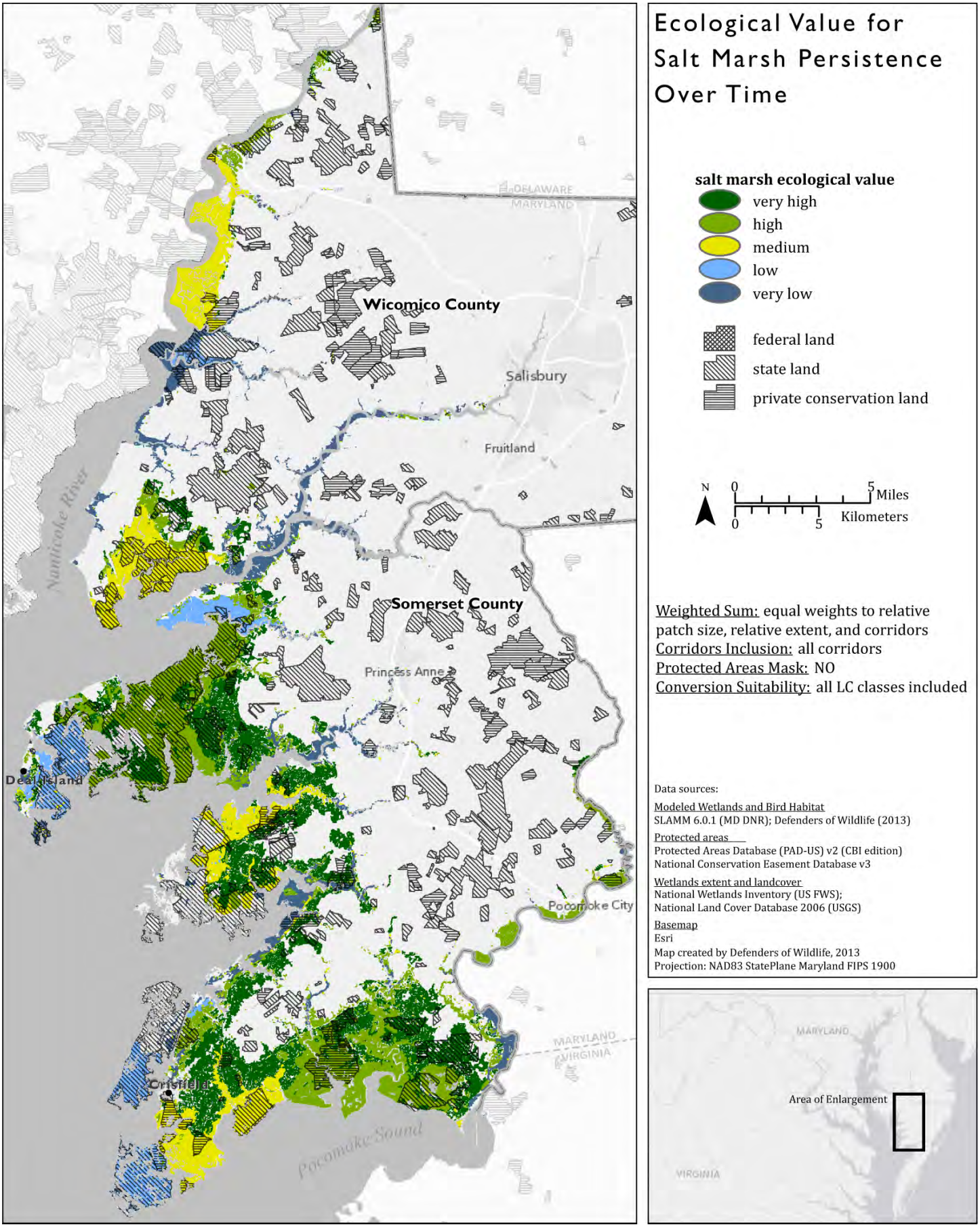
is value in scarcity. That is, during times when there is less marsh on the landscape (e.g., at the end of the century as projected by SLAMM), those areas of marsh are of higher relative value than areas of marsh that exist during times when marsh is more abundant on the landscape (in the present). In practical terms, however, this high relative value trades off against the declining predictability of habitat transitions modeled over such a long period of time.

Finally, to model habitat connectivity we investigated the concept of marsh "migration" corridors. A corridor can be visualized as a chain of salt marsh habitat that is linked across time and space. We considered patches of marsh that are part of an identified migration corridor to be more valuable than patches that stand alone or are not fully connected across time. Identification and conservation of these corridors is important to facilitate salt marsh movement to newly suitable inland locations as sea-level rises.

By weighting and combining these three marsh ecosystem characteristics we produced an overall metric capturing the ecological value of marsh lands across time in the Lower Eastern Shore of Maryland. The resulting map (Map 5, next page) identifies the Deal Island peninsula and the marshes east of Crisfield along the Pocomoke Sound as the largest landscapes having high and very high modeled ecological value over the next century. These areas also 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 the breeding season. Marsh persistence to 2050 (Map 2, page 6) is greater for these areas than elsewhere in the project area. These factors suggest that conservation efforts should be focused on these areas.



Map 4. Components of the salt marsh ecological value model. Relative patch size (left) was assessed first for each individual time step, with pixels/cells in larger patches being of higher value than those in smaller patches. The individual maps for each time step were then combined by assigning each cell the value for the maximum size patch that it experienced across all five time steps. Relative marsh extent (center) was calculated as the ratio of the maximum marsh extent across all five time steps to the marsh extent at any one time step. The calculation gives high value to cells of marsh when marsh is relatively rare on the landscape, and lower value to cells when marsh is relatively abundant. The individual maps for each time step were then combined by assigning each cell the value for the maximum relative extent value that it experienced across all five time steps. Habitat connectivity (right) was assessed by modeling marsh migration corridors. These are chains of salt marsh habitat that are linked across time and space. In our model, patches of marsh that were part of an identified migration corridor were considered more valuable than patches that stood alone or were not fully connected across time. The image above is a conceptual representation of these corridors on a composite map showing salt marsh transgression across the landscape over time; for our salt marsh ecological value model we derived these corridors quantitatively.



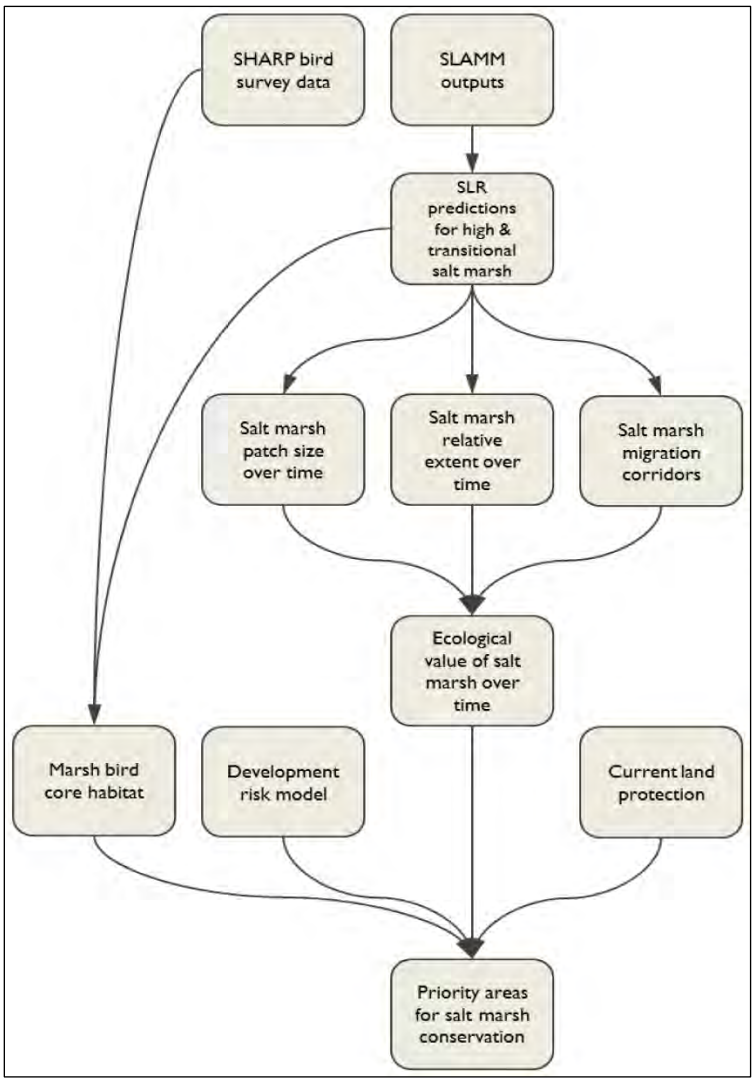
Map 5. Modeled ecological value of land for salt marsh persistence over time. The ecological value of marsh over time is calculated based on patch size, relative marsh extent and presence of marsh migration corridors. For this model's parameters, all identified marsh migration corridors were included; we did not mask-out areas that are already protected and we assumed all current land cover (LC) types are suitable to convert to marsh.

Determining Priority Areas for Salt Marsh Persistence Over Time

Many areas of high value for salt marsh persistence—areas currently occupied by marsh or projected to be marsh in the future—are already under one form of protection or another, reflecting the success of communities and conservation partners in protecting these important resources. However, to ensure the continued persistence of these ecosystems given the pressures of sea-level rise, the portfolio of conservation lands must be expanded inland.

Model projections for where marsh is likely to occur in the future (SLAMM) incorporate a number of parameters, including land cover. However, land cover 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] (Map 6, pg. 12). This model uses a combination of zoning, land ownership and land use to qualitatively assess future development potential. As illustrated in Figures 2a and 2b, this development risk layer was combined with the ecological value map (Map 5, pg. 10) and the marsh bird core habitat maps (Map 7, pg. 12) to produce a map identifying the highest priority areas for current and future salt marsh conservation (Map 8, pg. 13).



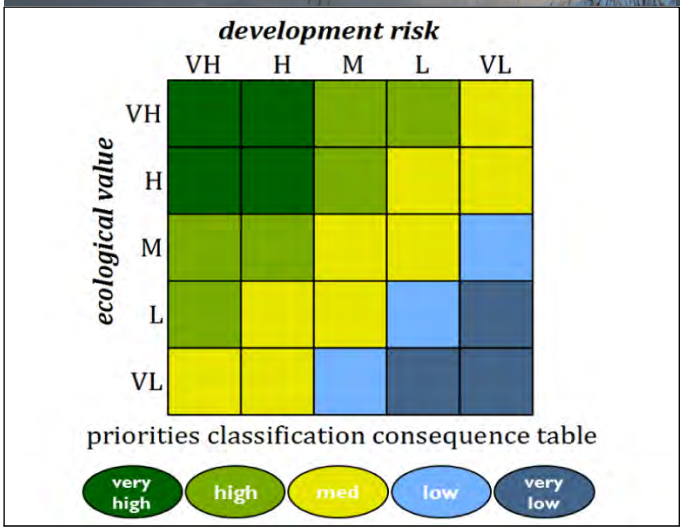
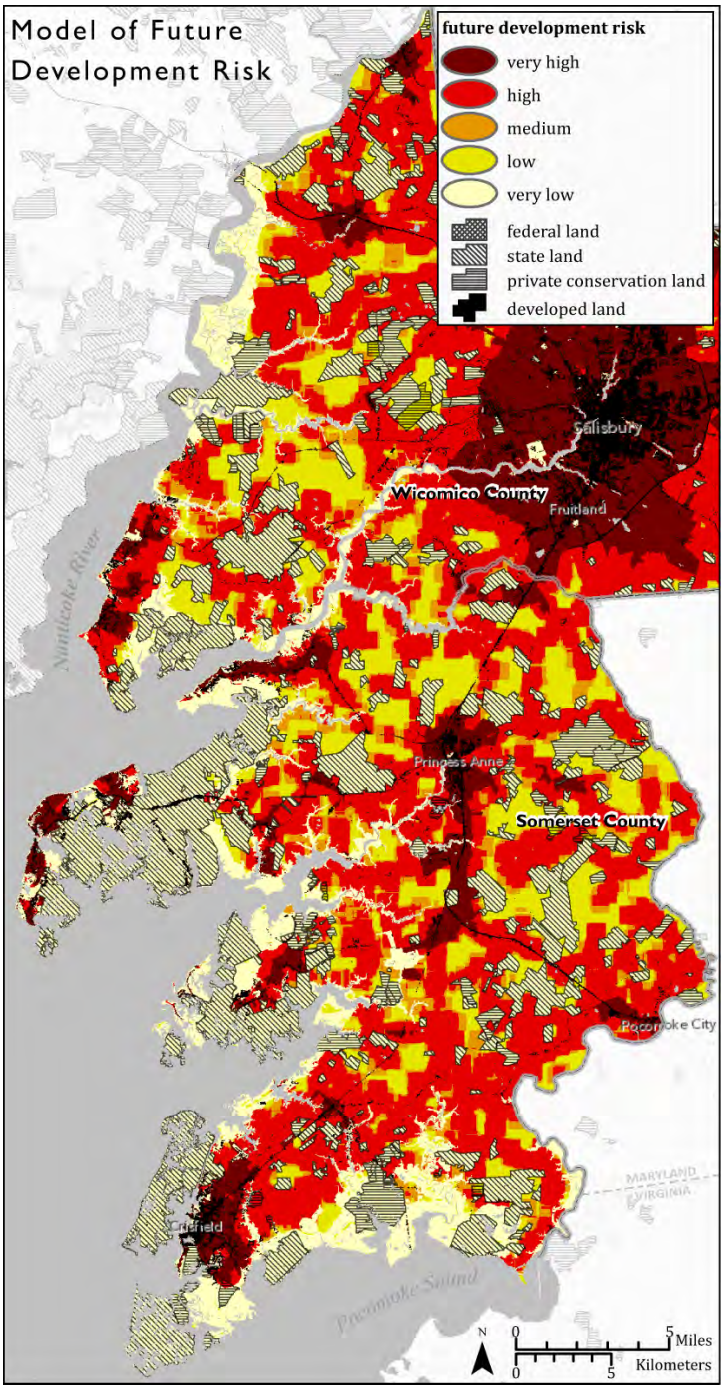
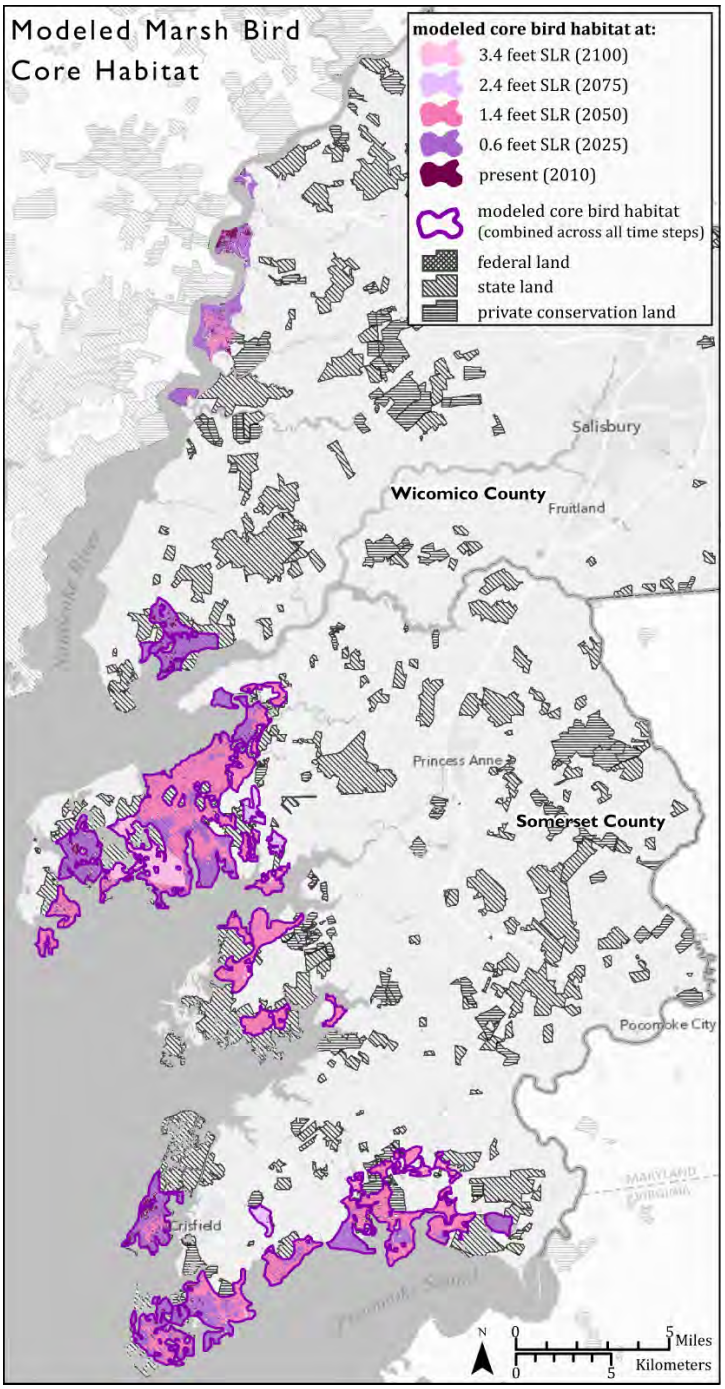


Figure 2a (left). Conceptual model showing the inputs, intermediate outputs and final outputs of this conservation planning and spatial analysis.

Figure 2b (right). This consequence table depicts the rules that were followed when combining the ecological value layer with the development risk layer to yield the priority conservation areas layer. These rules are subjective and can be modified depending of the needs and interests of the user. In this scenario, we assumed that an area with "very high" (VH) ecological value and "very high" development risk would yield a "very high" conservation priority, whereas a "very high" ecological value and a "medium" (M) development risk would only yield a "high" (H) conservation priority, and so on.

Photograph of evening clouds over a Maryland salt marsh creek. Photo by Neil Pearson.

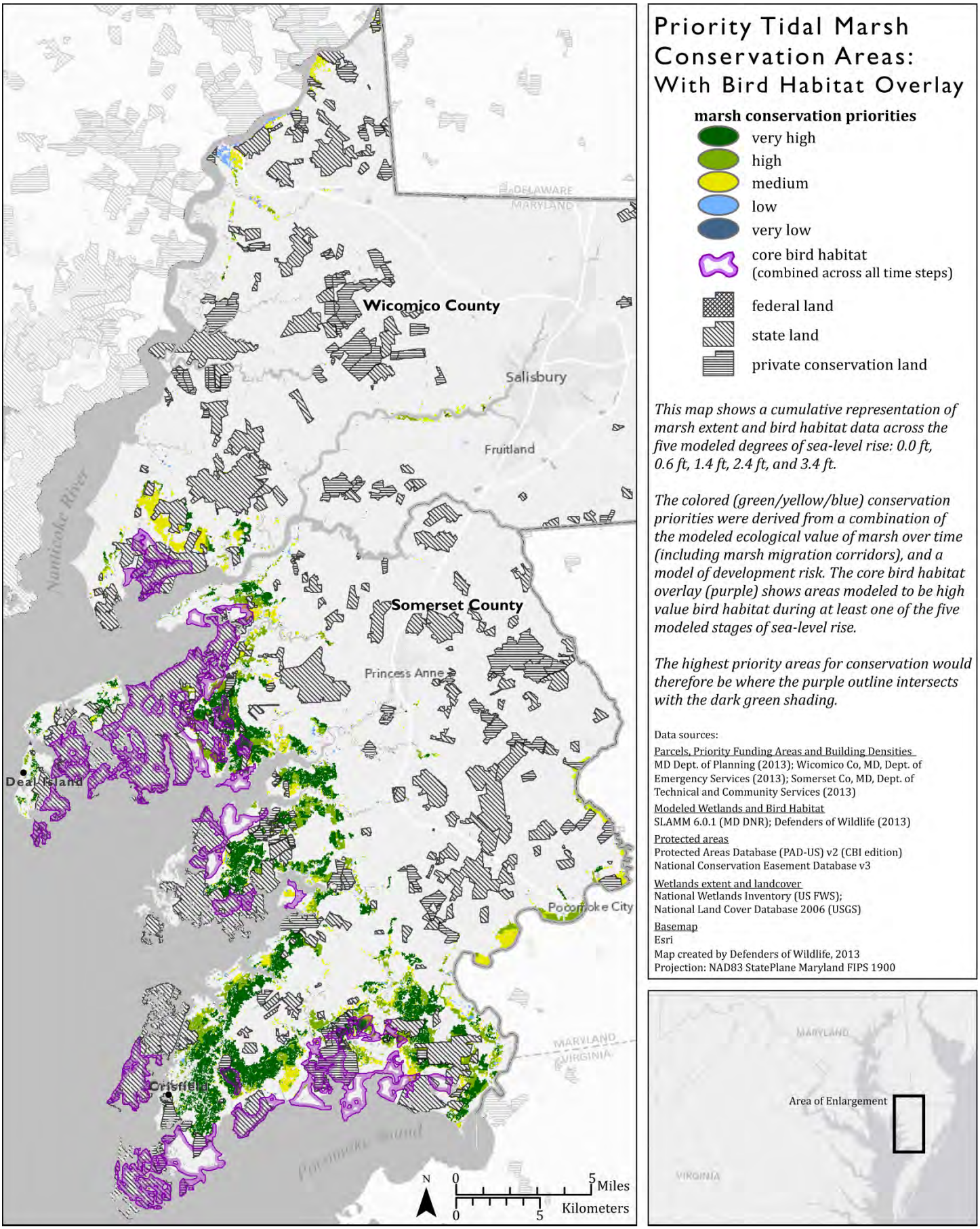




Map 6 (left). Model of future development risk for Somerset and Wicomico counties, Maryland. This model incorporates zoning, land ownership and land use to qualitatively assess future development potential. "Very high" risk areas are those that are unprotected, undeveloped and zoned as a "priority funding area" (PFA); "high" risk areas are those that are unprotected, undeveloped, zoned as a PFA and have greater than 10 buildings/km^2; "medium" risk areas are those that are unprotected, undeveloped, zoned as a PFA and have between 5 and 10 buildings/km^2; "low" risk areas are those that are unprotected, undeveloped, zoned as a PFA and have fewer than 5 buildings/km^2; "very low" risk areas include unprotected wetlands, private lands under permanent easement and protected public lands.

Map 7 (right). Composite map of salt marsh bird core habitat over time. Core bird habitat was modeled for each sea-level rise scenario/level. These identified core habitat areas are layered on top of one another with the present on the bottom and the 3.4 ft. SLR (2100) scenario on the top. For the conservation priorities map, we use the resulting composite outline, which highlights as important any area modeled as core bird habitat from the present day until the end of century sea-level rise scenario.

As seen in Map 8 (page 13), the regions with some of the highest modeled conservation priority over the next century lie on the peninsulas east of Deal Island and Crisfield. Note that the majority of these high-priority areas for conservation are inland and upslope of the highest value core bird habitat. That is largely because much of that habitat is already protected. However, there are a handful of sites that show very high conservation priority and are also identified as important core bird habitat. These areas especially should be targeted for future conservation.



Map 8. Priority areas for salt marsh conservation. 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. All currently protected federal, state and private lands (hatch marks) are excluded from these conservation priority (green/yellow/blue) designations.

Stakeholder Outreach Strategies and Land Conservation Tools

A parallel focus of this project was 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. 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 audiences that must be engaged 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, water quality, commercial 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 on Virginia's eastern shore.[14] The group consists 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 can communicate 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. A multitude of outreach strategies and actions can stem from such stakeholder cooperation, organization and preparedness, as shown in the table below.

Stakeholder Outreach Strategies

Outreach Activities	Target Audience	Messaging/Purpose
Working group	Health and safety, natural resources; agriculture, fisheries, planners and emergency medical services agencies	Develop standards for preparedness and 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	Educate on available programs and funding
Personal letters	Landowners	Communicate significance of coastal flooding and expected impacts to coastal areas from sea-level rise
One-on-one meetings and/or workshops with landowners	Potential easement grantors	Communicate that best management practices and restoration options will promote resiliency
Newspaper articles/editorials; radio interviews	Public	Focus on coastal resiliency and preparedness
Website message development	Conservation partners	Focus on coastal resiliency, preparedness and programs for restoration and land protection
Information about best management practices	Land trusts and partners	Maintain list of completed projects and interested landowners
Workshop and tour	Landowners and partners	Highlight preparedness, major storms, floods, benefits, etc.
Meet with county planners	County government	Promote resources

In addition to these strategies, numerous land conservation tools and programs are already in place in Maryland and nationally, to provide funding and other aid for the conservation of important natural lands. These include:

- 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 outlined 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.
- Do not 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 how 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.

Egrets and marsh. Photo by Hall Truitts.

Photo by Cropper Truitts.

Conclusion

Forward thinking is essential when combating threats such as sea-level rise. The results of this project address these conservation challenges in a changing landscape, first by identifying important biodiversity values such as marsh birds and modeling the trajectory of conservation threats such as sea-level rise, then mapping the areas with the highest potential conservation value and devising strategies to mobilize partners and build conservation coalitions—all through the lens of consideration for what the next 50 to 100 years are likely to hold.

The model results and conservation priority maps from this study, combined with dedicated working groups, targeted stakeholder outreach and other strategies can go a long way toward ensuring conservation of the important salt marsh landscapes of the Lower Eastern Shore of Maryland.

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 level 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 can adapt the methods, strategies and tools described here and apply them elsewhere. Similarly, while our study focused on salt marsh birds as a measure of biodiversity value, there are numerous other species, groups and systems that may be applicable in other contexts. The technical tools and strategies developed in this project will help ensure that ecologically significant coastal wetlands can persist and remain viable despite the looming threat of sea-level rise and thereby maintain the ecological services they provide.

End Notes

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