COASTAL PROTECTION AND BLUE CARBON: MARYLAND

Duke NICHOLAS INSTITUTE FOR ENVIRONMENTAL POLICY SOLUTIONS

UNITED STATES CLIMATE ALLIANCE

OVERVIEW

Coastal habitats provide many benefits to people, including protecting shorelines from storm damage and storing carbon that would otherwise be released into the atmosphere. States, communities, and other decision-makers need information about the location and magnitude of these benefits, as well as how they may change in the future, so that their planning efforts can support the continued provision of all these benefits.

This project, led by the Nicholas Institute in collaboration with six mid-Atlantic states, involved spatial modeling that considers both the current status of coastal habitats and potential future changes due to sea level rise to assess habitats' ability to store carbon long-term and protect vulnerable ecological and human communities into the future. Adapting existing InVEST models developed by the Natural Capital Project kept the amount of data and computing power required relatively small, so that this work can easily be updated or extended to new areas.

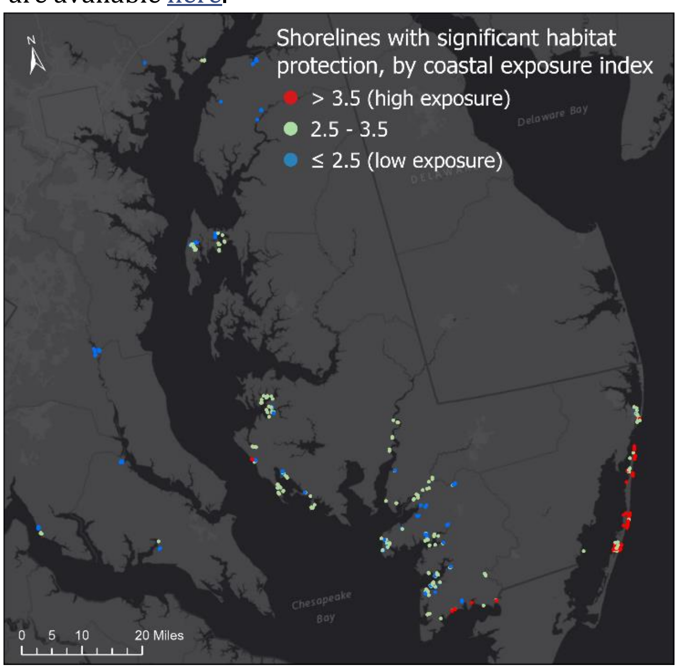
COASTAL PROTECTION

The InVEST coastal vulnerability model (Sharp et al. 2018) calculates the coastal exposure index, a relative index of coastal areas' exposure to flooding and erosion caused by storms, based on seven factors (listed to the right) that influence coastal processes leading to flooding and erosion. Coastal habitats are included in the model as a mitigating influence on coastal hazards (the presence of coastal habitats lowers the coastal exposure index). The coastal exposure index is calculated twice, once with coastal habitats included, and once as if there were no coastal habitats present, to assess the impact of coastal habitats on exposure to coastal hazards.

Coastal vulnerability factors

- Wave exposure
- Wind exposure
- Storm surge
- Sea level rise
- Geomorphology
- Relief
- Coastal habitats

With input from the state team, we adjusted the model to account for the likelihood that wider areas of marshes and coastal forests provide better protection, and reduced the weight of the sea level rise factor due to the limited geographic scope of sea level rise projections. Additional details on the methodology and datasets used are available here.



This map shows the parts of the Maryland shoreline that benefit from strong habitat protection from hazards. These protected areas are color-coded to show how exposed to coastal hazards each part of the coastline is – higher scores (red) indicate greater exposure to threats such as storm surge and erosion, where the habitat protection is especially important. Parts of Assateague Island are particularly well-protected by their ocean-facing dunes.

You can explore the coastal protection maps for Maryland, including the scores for each individual factor and the effects of specific habitat types, here.

This table shows how much of the Maryland shoreline is receiving protection from each type of coastal habitat. The middle column includes all shoreline close enough to the habitat to get some protective benefit. The right column only counts shoreline that is significantly protected by habitat (its coastal exposure index increases by at least 20% without the existing coastal habitats). Some habitat types, like seagrass and narrow marshes, are widespread but don't have a high protective capacity, so the total length of shoreline they protect is much more than the length of shoreline with significant habitat protection that they help to protect. Other habitat types, like dunes, are concentrated in specific areas but provide strong coastal protection.

Habitat type	Total length of shoreline protected, km	Length of shoreline with significant habitat protection protected, km
Marsh 100-1000 m wide	2,783	99
Coastal forest	806	105
Marsh 10-100 m wide	2,411	93
Seagrass (moderately dense)	987	21
Seagrass (dense)	1,259	19
Low dunes	50	12
Marsh <10 m wide	19	1
High dunes	25	9
Oyster	34	0

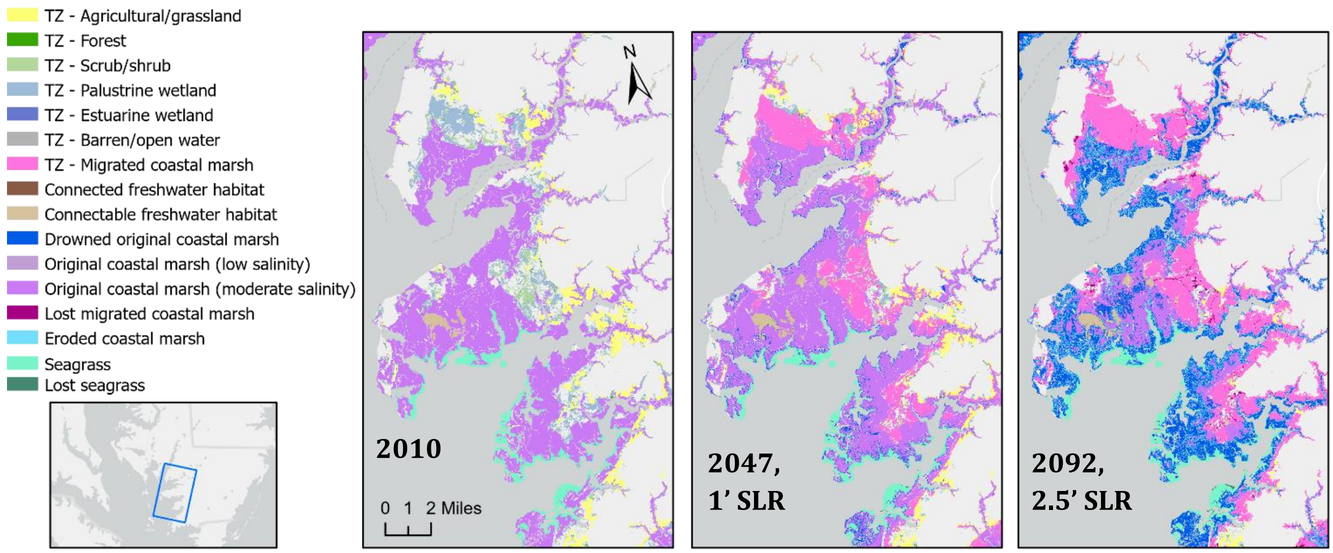
COASTAL HABITAT CHANGE WITH SEA LEVEL RISE

Climate change is causing sea level to rise globally; in Maryland, sea levels are projected to rise by 2.5 feet over 2010 levels by the end of the century (Boesch et al. 2018, RCP 8.5 scenario). The rate of sea level rise that the Maryland coast will experience is not certain. We created future coastal habitat maps for three Maryland-specific sea level rise scenarios for RCP 2.6, 4.5, and 8.5 (Boesch et al. 2018). Through the end of the century, these scenarios project 1.5 to 2.5 feet of sea level rise, respectively.

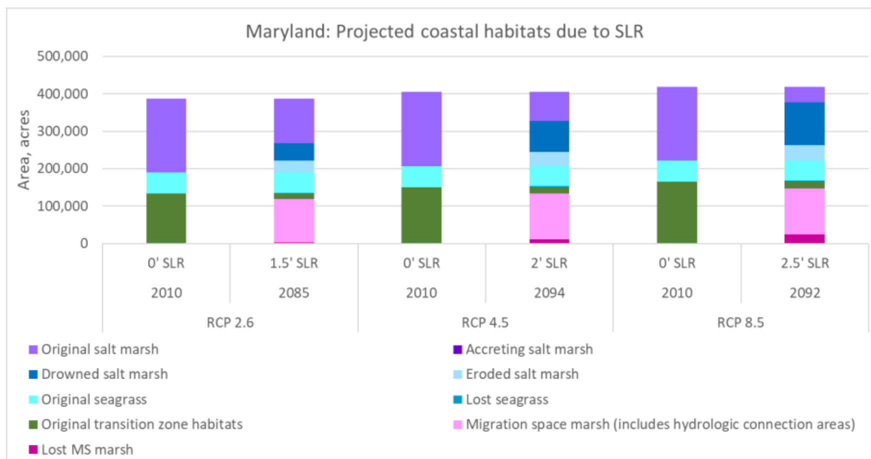
We mapped future coastal habitat extent and location under sea level rise, incorporating the three possible responses of marshes to rising seas: vertical accretion, loss via drowning or erosion, and inland migration. Seagrass loss due to increased water depth, which limits light availability, was also included in the model. Additional details on the data and methodology for this analysis are available here.

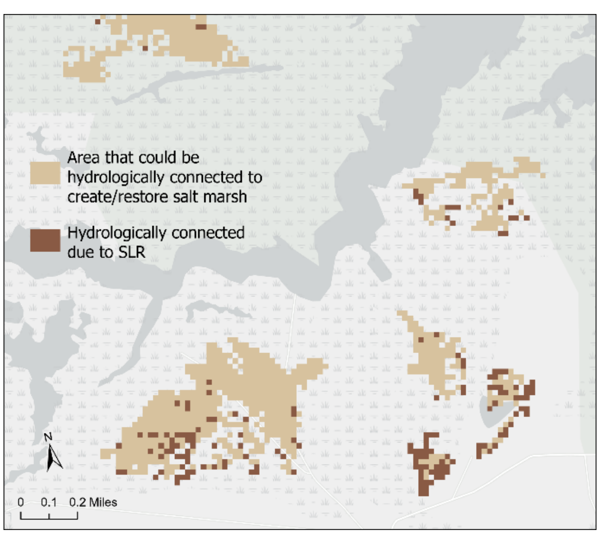
Also included in this analysis are areas that could be hydrologically connected to saline waters to restore or create salt marsh. Freshwater wetlands and open bodies of freshwater, whether they were disconnected from tidal flows by infrastructure, purposely blocked for waterfowl or mosquito management, or naturally freshwater, likely emit large amounts of methane, a potent greenhouse gas. Hydrological connection is expected to reduce methane emissions by increasing salinity; in some places, sea level rise is likely to cause this connection without additional human intervention. Some of these areas overlap with places where marsh is expected to migrate due to sea level rise; the key difference is that these areas are identified as having potential for salt marsh creation or restoration currently, even without sea level rise.

This map shows projected coastal habitat changes around Tangier Sound. You can compare future habitat maps for different sea level rise scenarios along the Maryland coast here.



Maryland's coastal marshes are vulnerable to sea level rise. Under the three modeled sea level rise scenarios, 39-79% of present-day marshes are projected to drown or erode – up to 156,000 acres of marsh loss (about 118,000 football fields) under the highest sea level rise scenario. Migration space in the coastal plain provides an opportunity to compensate for that loss under the lower two sea level rise scenarios, but is not sufficient to offset the drowned and eroded marsh in the highest sea level rise scenario. These projections include estimates of increased development over time, reducing the area available for marsh migration. In addition, Maryland is projected to lose 2.6-6.5% of present-day seagrass beds due to increased water depth from sea level rise.



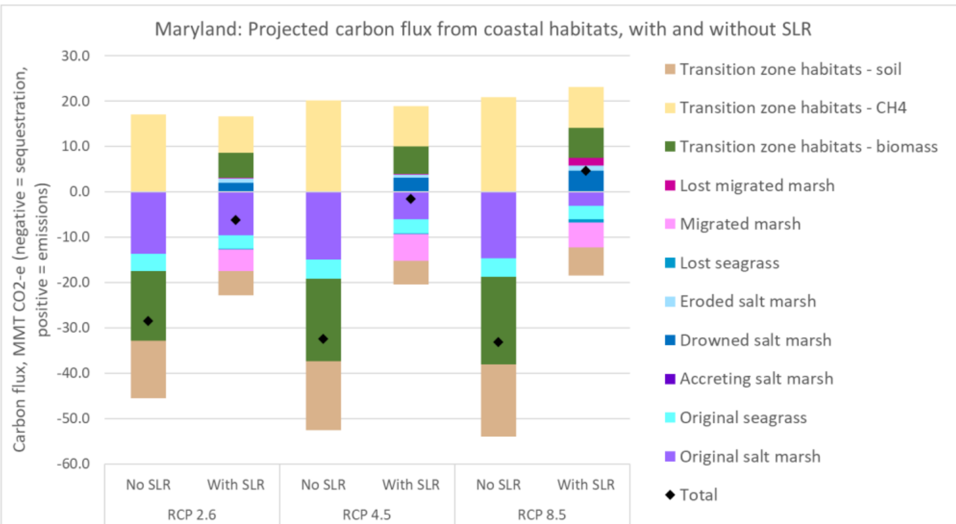


In total, we identified about 7,700 acres where hydrological connection could create or restore salt marsh. About 13% of this area is predicted to be connected by sea level rise for each of the three scenarios, leaving about 6,700 acres where connection projects could be targeted to reduce methane emissions.

This map shows hydrologic connections due to sea level rise by the end of the century, and remaining areas that could be hydrologically connected to create or restore salt marsh, in Blackwater National Wildlife Refuge.

BLUE CARBON MODELING

Coastal marshes and seagrass store large amounts of carbon in their sediment, preventing it from being released into the atmosphere and contributing to global warming. So do terrestrial and freshwater wetland habitats coastal areas. While these habitats persist, they accumulate additional carbon; the effective rate of accumulation in wetland habitats depends on their salinity, because low-salinity habitats emit much more methane than high-salinity areas. Maryland coastal marshes and seagrass currently store about 63.5 million metric tons CO_2-e and sequester an additional 140,000 metric tons each year. When marshes drown or erode, and when marshes migrate inland and replace freshwater and terrestrial habitats, a portion of the carbon stored in the original habitat type is emitted. Therefore, the projected coastal habitat changes due to sea level rise have significant implications for future blue carbon storage and emissions. We modified the InVEST coastal blue carbon model to explore these effects. Details on the data and methods are available here.



Over the next 100 years, Maryland's coastal habitats are projected to sequester up to 114% less carbon than they would if they were not affected by sea level rise. This difference is greater than 100% because the coastal habitats may become net sources of carbon, rather than net carbon sinks, under the highest sea level rise scenario, due to emissions from lost habitats. For the highest sea level rise scenario, the lost carbon sequestration potential due to sea level rise is approximately equal to the greenhouse gas emissions from 8.1 million cars driven for one year.

There is high uncertainty about how much stored carbon is lost when marshes drown or erode; the results shown here are from our primary model projection, modified with input from our Maryland partners. See the research paper for more information on key sources of uncertainty.

USING THESE DATA

The maps and data shown here are available to use in online maps and to download for further analysis. This information can be used in a variety of ways, including communication with stakeholders, building blue carbon inventories, and long-term coastal planning.

ACKNOWLEDGEMENTS

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