COASTAL WETLANDS WILL BECOME LESS RESILIENT

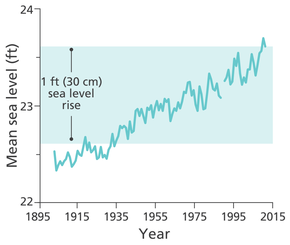
Alexandra Fries[1], Caroline Donovan[1], William Dennison[1], Heath Kesley[1]
[1]Integration & Application Network, University of Maryland Center for Environmental Science, Annapolis, Maryland

ian.umces.edu

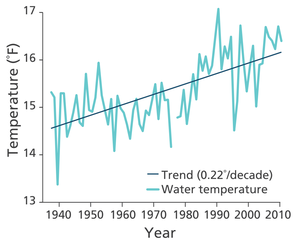
CLIMATE CHANGE IS IMPACTING CHESAPEAKE BAY

Protection and restoration of Chesapeake Bay must account for climate change impacts that we are experiencing now. Sea level rise and water temperatures are increasing. These increases cause erosion, stormwater impacts such as increased nutrients and sediments flowing into Bay waters, lower light for aquatic plants and animals, and decreased dissolved oxygen available to support life.

Mean sea level - Baltimore, MD

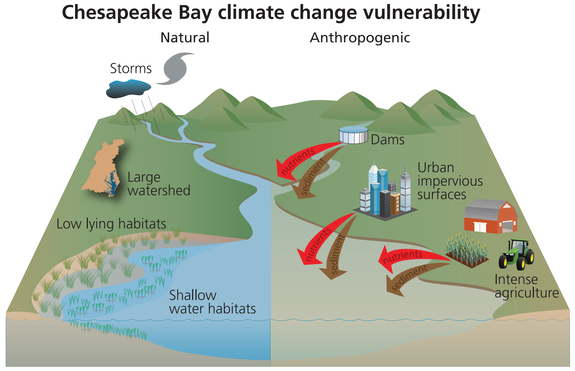


Water temperature - Solomons, MD



Climate change is already occurring in Chesapeake Bay with increasing sea level rise (left) and increasing water temperatures (right).

Chesapeake Bay climate change vulnerability



Chesapeake Bay is vulnerable to climate change impacts because of both natural conditions and anthropogenic stresses.

Coastal wetlands
Aquatic grasses
Fish
Shellfish
Pathogens

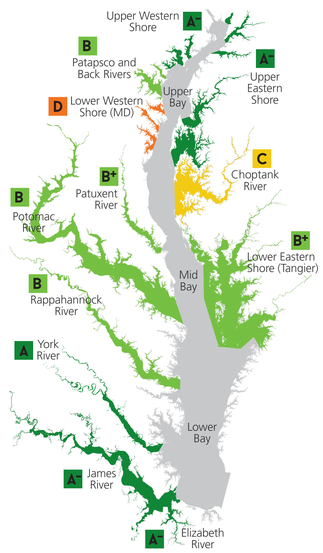
A suite of potential indicators were developed that can be used to measure resiliency to climate change. Resilience was defined as the capacity of a system to absorb change and disturbance and still retain the same function and structure. This is different to vulnerability, which usually refers to risk of negative changes.

The analysis conducted on climate change resiliency indicators in Chesapeake Bay included coastal wetlands, aquatic grasses, fisheries, pathogens in shellfish beds, and swimming beach closures.

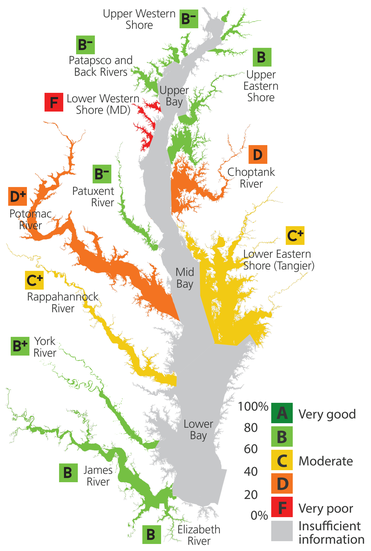
Coastal wetlands are vital habitats in Chesapeake Bay, not only for wildlife, but also to serve as buffers against storms. Healthy coastal wetlands can mitigate the effects of climate change, as long as they can keep up with rising sea level and have access to migration corridors. As sea levels continue to rise in Chesapeake Bay, marshes can accrete new marsh with adequate sediment supply. This analysis has evaluated the resilience of coastal wetlands (marshes) to sea level rise by applying a model of salt marsh accretion rates to rising sea levels in Chesapeake Bay.

COASTAL WETLANDS CURRENTLY HAVE GOOD RESILIENCE BUT UNDER FUTURE SEA LEVEL RISE RATES COASTAL WETLANDS WILL HAVE MODERATE TO VERY POOR RESILIENCE

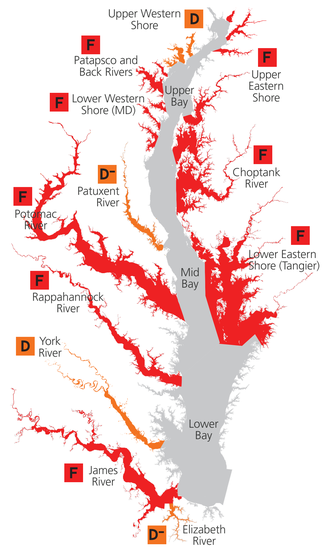
Current coastal wetlands resiliency



Near future coastal wetlands resiliency



Far future coastal wetlands resiliency



Coastal wetlands resilience under current sea level rise rates (left,) near future sea level rise rates (center), and far future sea level rise rates (right).

Coastal wetland resilience decreases as sea level rise rates increase

- **With current sea level rise rates (4 mm/year), the majority of regions in Chesapeake Bay have moderate to very good coastal wetlands resiliency scores.** The Lower Western Shore, which has a D, is the only region to have a poor score. Five regions scored A or A- and five regions scored in the B range.
- **Under near future sea level rise rates (6 mm/year), coastal wetlands will be less resilient.** There are no regions that scored an A, and seven regions scored B's. Two regions scored D's and one scored an F.
- **During far future sea level rise rates (12 mm/year), coastal wetlands will not be resilient.** All regions scored D's and F's, with failing grades predominating.

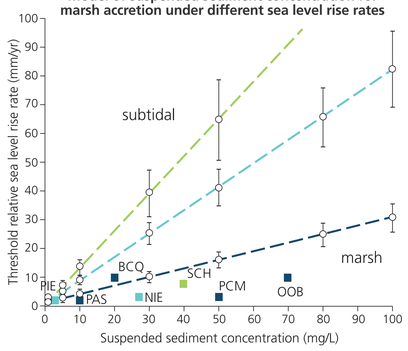
When coastal wetlands are protected from erosion, have adequate sediment supply, and have access to landward migration pathways, they will have high resilience to climate change impacts.

To evaluate coastal wetland resiliency to climate change, we examined one aspect of climate change: sea level rise. Using coastal wetland distributions throughout the Bay and the amount of sediment in the surrounding water, resilience of coastal wetlands to current, near future, and far future sea levels was determined. Total suspended solids (TSS) data from the Chesapeake Bay Program's monitoring stations and current and projected sea level rise rates from the Baltimore tide gauge were used. These parameters determine if there would be enough sediment in the water to build coastal wetlands as fast as the sea levels will be rising.

Kirwan, et al. (2010) developed a model that calculates the amount of sediment needed for marshes to accrete fast enough to keep up with sea level rise. For 4 millimeters of sea level rise per year (current rate), a TSS value of 9 mg/l is needed. For 6 mm of sea level rise per year (near future rate), a TSS value of 15.5 mg/l is needed. For 12 mm of sea level rise per year (far future rate), a TSS value of 35.5 mg/l is needed.

More analysis is needed to address the following concerns: the model used to determine thresholds is only theoretical; TSS measurements directly in coastal wetlands rather than in open water are preferable; and, the current analysis assumes TSS stays the same in future scenarios.

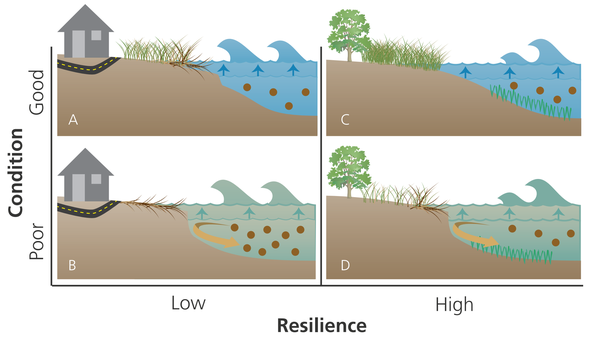
Model of suspended sediment concentration for marsh accretion under different sea level rise rates



Locations of tide gage stations in Chesapeake Bay

A graph from the model used to determine how much TSS is needed for coastal wetlands (top). Graph adapted from Kirwan et al. 2010. A map showing locations of the tide gages in Chesapeake Bay (left).

Resilience of poor and good coastal wetlands to climate change



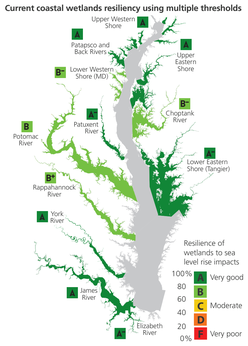
A combination of condition (health) and resilience determines the fate of coastal wetlands in Chesapeake Bay in the face of sea level rise. Coastal wetlands in good condition can have low resilience to climate change impacts, if there are no migration corridors available and no wave dampening due to a lack of aquatic grasses. Coastal wetlands in poor condition can have high resilience if resilience factors are present, such as aquatic grasses , which allow for wave dampening , and the availability of migration corridors that allow the coastal wetlands to move with sea level rise . Coastal wetlands in poor condition can be eroding which contributes to more sediments in the water.

USING MULTIPLE THRESHOLDS TO EVALUATE COASTAL WETLANDS RESILIENCY

In addition to the analysis of current, near future, and far future sea level rise rates, a multiple threshold analysis for current rates was conducted. In the Chesapeake Bay, different gage stations in various locations show that sea level is rising at slightly different rates over time. Using rates that correspond to three regions of the Bay, a more accurate detailed analysis of coastal wetland resilience under current rates was established.

The lower right map shows the three regions of the Bay that were used for the multiple threshold analysis; the upper, mid, and lower bay. The upper right map expresses the results, with A and B scores in all of the tributaries. Under current sea level rise rates, coastal wetlands will be resilient to sea level rise. These scores are similar to the single threshold scores for the current sea level rise rates.

Current coastal wetlands resiliency using multiple thresholds



Upper, middle, and lower bay threshold areas

Sea level rise rates and corresponding TSS

Upper Bay
- Baltimore tide gage
- 3.14mm/yr
- 5.4mg/l

Mid Bay
- Solomon's Island tide gage
- 3.68mm/yr
- 7.8mg/l

Lower Bay
- Gloucester Point tide gage
- 3.81mm/yr
- 8.1mg/l