WATERSHED MANAGEMENT

CONSERVATION IN A CHANGING CLIMATE

The Chesapeake Bay is the largest estuary in the United States, fed by a watershed that stretches from mountains to sea, across 64,000 square miles. The Chesapeake Bay, along with Maryland's streams and coastal bays, provides a multitude of benefits to Maryland's citizens, including economic and natural resource benefits. Maryland's extensive aquatic ecosystems range from freshwater swamps and bogs to freshwater rivers and marshes to coastal bays and salt marshes. These ecosystems are influenced by precipitation, temperature, tropical storms, and human activity. Human development and pollution have degraded their natural resilience, leaving them more vulnerable to climate change and extreme events.

Why Adapt?

One hundred years of data show that Maryland is getting warmer on average by 1.8°F but by as much as 3.6°F in the winter. Warmer air holds more moisture, so we should expect changes in our rainfall. Over the last century, Maryland has become wetter in March and autumn and drier in July and August. For aquatic ecosystems this may alter salinity in the Bay and impact streamflow and stream temperature, all of which could shift where species live and affect watershed restoration projects.

Who should Adapt?

A changing climate will mean we all have to plan for more uncertainty. For example, ***local governments*** will need to evaluate positive and negative impacts of a changing climate on eco-tourism, natural resources stability, watershed restoration, and evaluate land protection strategies. ***Resource managers*** may need to consider the impacts of rising temperatures, changes in precipitation patterns (including wetter winters and drier summers) and more extreme events on the species they manage. ***Businesses, individuals, and community organizations*** should implement and advocate for improved sustainability measures and protection of their homes and ecosystems. Those communities that prepare now for expected changes will be better adapted to those changes and better positioned to benefit from actions needed to prepare for climate change.

Maryland's watersheds and the Chesapeake Bay are already experiencing climate change effects, such as hotter summers, more intense storms, and changes in water temperature, pH, and erosion levels (due to rising sea level). Stressors, such as development, will make it more difficult for ecosystems to be resilient to climate change. Planting urban trees and using green roofs will reduce heat stress, while planting wide riparian buffers will protect cold water habitat. Intact landscapes (no loss or fragmentation) also make watersheds more resilient to climate change.

IMPENDING RISKS TO WATERSHEDS

Freshwater

Temperatures in streams and rivers are increasing and likely to worsen, causing heat stress, decreased water quality, or changes in food availability. In freshwater habitats, temperature increases particularly affect coldwater stream species, such as brook trout, which will exacerbate the negative influences of urbanization.

Increasing need for water withdrawal because of population growth and drought will result in reduced summer streamflow. This will affect most fish species by reducing habitat and food, decreasing dissolved oxygen, and increasing toxin concentrations. Finding the balance between human and ecological water needs will be an important goal in a changing climate.

Warmer winters and wetter autumns and early springs could create mismatches between species such as trout and mayflies and send more sediment and nutrients downstream. Earlier snowmelt can cause vegetation seed stranding and aquatic insect and fish life history cycles to be out of sync with critical river flows. Increased flooding due to heavy rains combined with already elevated stormwater volumes may increase soil erosion and degrade water quality.

High temperatures and fast-moving, larger volumes of stormwater running off roads and other impervious surfaces will likely carry increased loads of sediments and pollutants into waterways, clouding the water and negatively impacting aquatic species, and smothering aquatic plant beds.

Upstream migration of fish and benthics, away from higher temperatures and runoff, may be impaired by the 700+ existing blockages to fish passage (dams and other obstructions) in Maryland.

Restoring streams using resiliency principles

Risk management is critical in any restoration project. Risks include those associated with climate patterns, such as more intense storms, as well as those associated with land use change and reliability of the designer. These risks will need to be evaluated in light of recent and expected increases in precipitation intensity, storms, and sea level rise. Risk reduction measures may include:

- Enhancing stream connectivity for aquatic animals to migrate to more favorable habitats, often further upstream, as temperatures warm and sea level rises.
- Allowing for variations in channel morphology and position to account for increases in the intensity and frequency of 100-year floods and sea level rise.
- Enhancing the resiliency of floodplains through: (1) wide riparian corridors to reduce the impacts of high flows, (2) high diversity of native vegetation to resist the impacts of invasive species, pests, and fire, and (3) diverse habitat features such as deep pools, complex woody debris, and strong connections with shallow groundwater mixing zone.

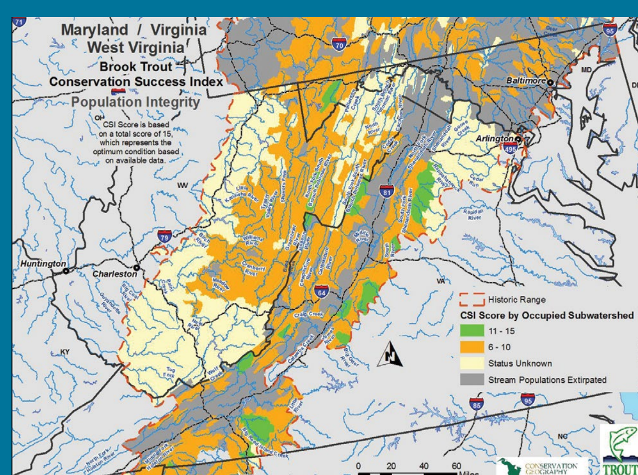
Kirk Mantay

The Savage River Watershed Association restored a headwater stream of the Savage River in western Maryland. One thousand linear feet of native brook trout headwaters and over an acre of floodplain wetland and buffers were restored in this 18-month-long effort.

Brook trout habitat is at risk

Brook trout populations have declined across the eastern seaboard of the United States, and Maryland populations are no exception. Brook trout survive in streams with cold water and little pollution (including sediment pollution). Higher temperatures and increased sediment will imperil brook trout as Maryland's climate changes. These fish may become restricted to the far reaches of western Maryland's high-elevation streams and find fewer deep, cool pools in which to seek refuge. A strategy for protection from a changing climate should include:

- Protect existing riparian buffers and add more and wider buffers
- Use artificial fishing lures rather than bait to reduce fishing mortality from swallowed hooks
- Maximize forested area and minimize impervious surfaces in watersheds with brook trout



This map shows watersheds where brook trout live in Maryland (and surrounding states). The areas in green and orange have the healthiest populations and have the best chance of persisting if protected from additional climate change impacts and other stressors. Data: Trout Unlimited.

IMPENDING RISKS TO WATERSHEDS

Estuaries

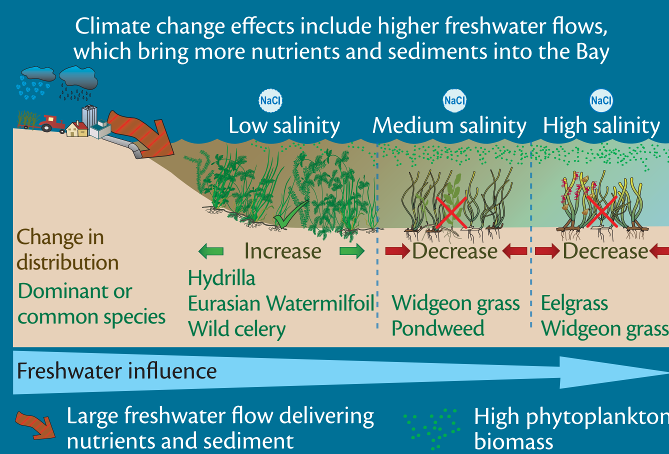
Due to their dynamic nature, estuaries are particularly sensitive to changes in sea level rise, precipitation, and temperature. Sea level rise and increasing storm frequency are expected to both positively and negatively impact estuaries. If sea level rises more rapidly than accretion rates for salt marshes, sub-tidal systems and beaches may increase in area. Greater inundation and increased storm surge will increase shoreline retreat and erosion. A direct effect of this process is a siltier substrate and more turbid water, inhibiting the growth of aquatic grasses and limiting habitat for species, such as hard clams and terrapins.

Estuarine salinity fluctuates in response to a number of factors such as changes in river flow, tides, winds, and water circulation. As a result of sea level rise and changes in precipitation, future salinity levels in coastal waters are uncertain. Although many aquatic organisms are able to either avoid or adapt to minor salinity changes, they may be unable to handle a longer duration of such changes. In fresh, brackish, and saline waters, fish parasites associated with warmer waters can also be expected to increase, threatening native fish populations.

Tidal freshwater marshes may experience losses due to saltwater intrusion. To keep pace with sea level rise, coastal marshes will need room to migrate inland. Blockages to migration, such as pavement, bulkheads, and riprap, can slow or stop wetland retreat to higher ground. Some bird species dependent on marshes for nesting, such as the salt marsh sparrow, could become threatened as a result. A loss of marshes will negatively affect stream, river, and bay water quality, as marshes act as a sponge, absorbing, filtering, and cleaning polluted runoff.

Submerged Aquatic Vegetation at risk

Submerged aquatic vegetation is a key element of a healthy Chesapeake Bay, but currently covers only a small portion of its historical distribution. It is sensitive to changes in water temperature, light availability, substrate, and water depth. Submerged aquatic vegetation provide a refuge for fish and shellfish, as well as more specialized animals such as seahorses and pipefish. Climate threats will affect different species in different ways (see conceptual diagram). Rising temperatures, deeper water from sea level rise, and increasing siltation and anoxia from higher flows will affect all aquatic vegetation. Further loss of this habitat could negatively affect crab population and threaten other fisheries dependent on this important resource.

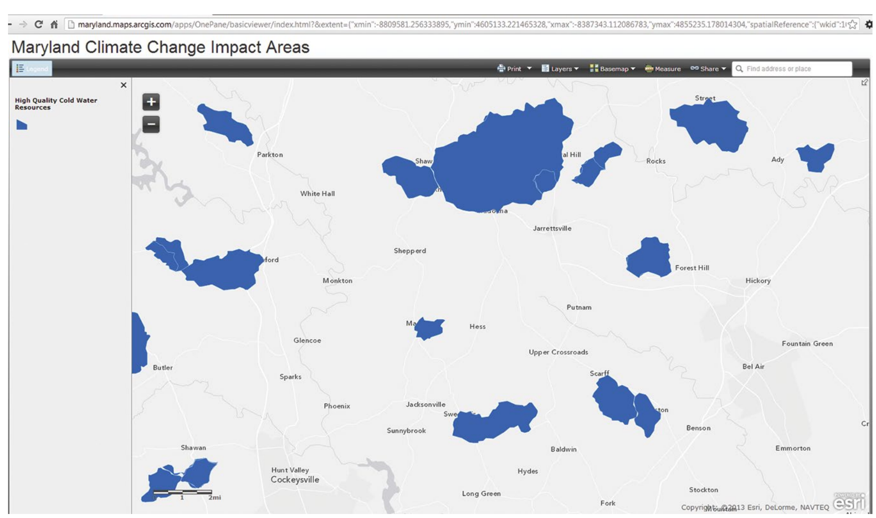


WE MUST TAKE ACTION NOW TO PREPARE FOR THE IMPACTS OF A CHANGING CLIMATE

Adaptation Toolbox: Climate Change Impact Area Mapper

The Climate Change Impact Area Mapper is an online tool provided by the Maryland Department of Natural Resources for management decision-making, planning, and education purposes. The Climate Change Impact Area Mapper brings together multiple data layers from different sources to illustrate land areas in Maryland that are projected to be the most sensitive to anticipated changes in climate. The layers include areas vulnerable to sea level rise, storm surge, flooding, drought, and rising temperatures.

http://bit.ly/UIX4Hw



The Climate Change Impact Mapper includes several different layers related to watershed management. High quality coldwater habitats that native fish species are dependent on are shown in blue.

PLANNING GUIDELINES

The patterns of water flow from mountain to sea depends on the topography and land use as well as variations in rainfall patterns and temperature. The general guidelines below provide the concepts to incorporate climate change into watershed management plans, land use planning and conservation, and restoration practices.

Management practices	Freshwater	Estuarine	Coldwater conservation areas
Enhance and protect riparian buffers and groundwater recharge zones.	✓	✓	✓
Focus restoration on impervious surface removal, floodplain connection, and reducing fine sediment input to streams.	✓	✓	✓
Restore streams to account for increasing storm intensity and sea level rise.	✓	✓	✓
Enhance fishery protection in brook trout streams by using lures instead of bait.			✓
Protect wetland and habitat migration corridors.		✓	
Develop strategies to enhance carbon storage in wetlands and forests.	✓	✓	✓
Enhance land management to protect sensitive species from higher temperatures, intense storms, and drought.	✓	✓	✓
Conduct habitat vulnerability assessments to gain a better understanding of regional impacts and potential adaptation strategies.	✓	✓	✓
Improve stream connectivity for aquatic animals to migrate to more favorable habitats, often further upstream, as temperatures warm and sea level rises.	✓	✓	✓
Implement zoning practices and conservation to enhance migration of climate sensitive species.	✓	✓	✓
Increase emergency response efforts and preparedness for flooding and drought impacts	✓	✓	

FOR ADDITIONAL INFORMATION

Department of Natural Resources' Climate Change Website: www.dnr.maryland.gov/climatechange
Department of Natural Resources' River and Streams website: www.dnr.maryland.gov/streams
Department of Natural Resources' Streams Monitoring website: www.dnr.maryland.gov/streams/monitoring.asp
Maryland's Coastal Atlas: http://www.dnr.maryland.gov/ccp/coastalatlas/
Northeast Regional Climate Center: http://www.nrcc.cornell.edu/

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