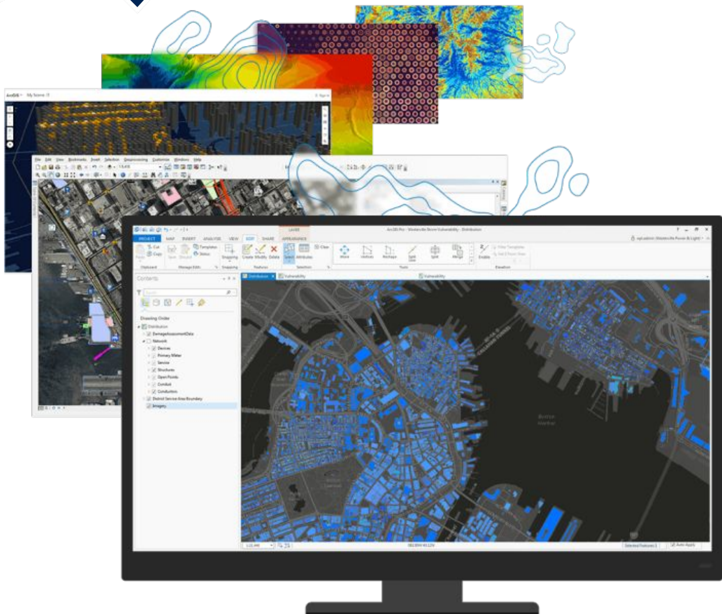
Tributary StoryMaps - Informing on Spatial and Temporal Patterns in Water Quality

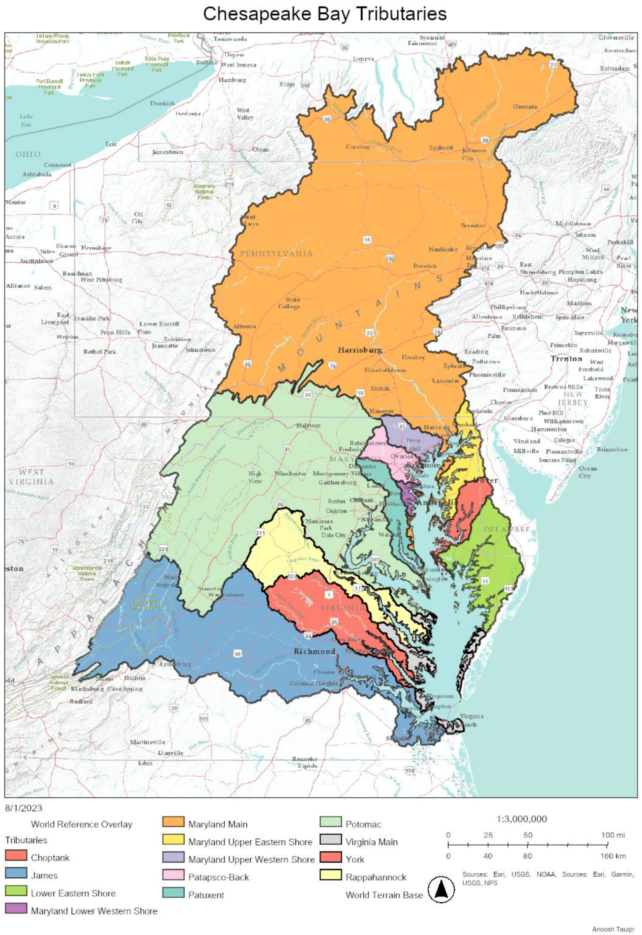
Anoosh Tauqir

Biography

- Civil and Environmental Engineering and Sustainability ‘25
- Drawn to this program because of CRC’s goals
  - Experience the intersection between the environmental and management field through supporting the restoration of the Bay and its watershed
- Interest in ArcGIS and science communication - StoryMap



Project

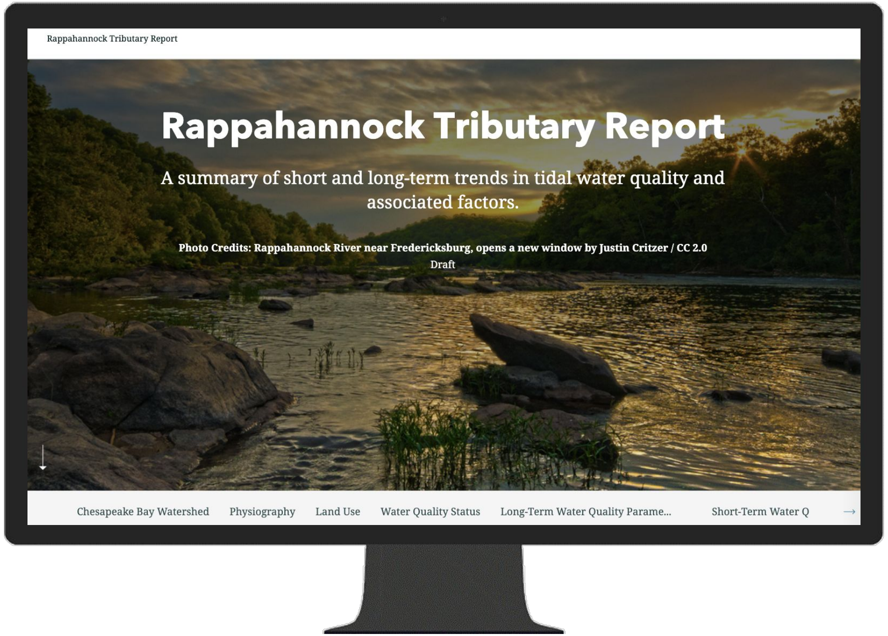


Support <u>Integrated Trends Analysis Team:</u>

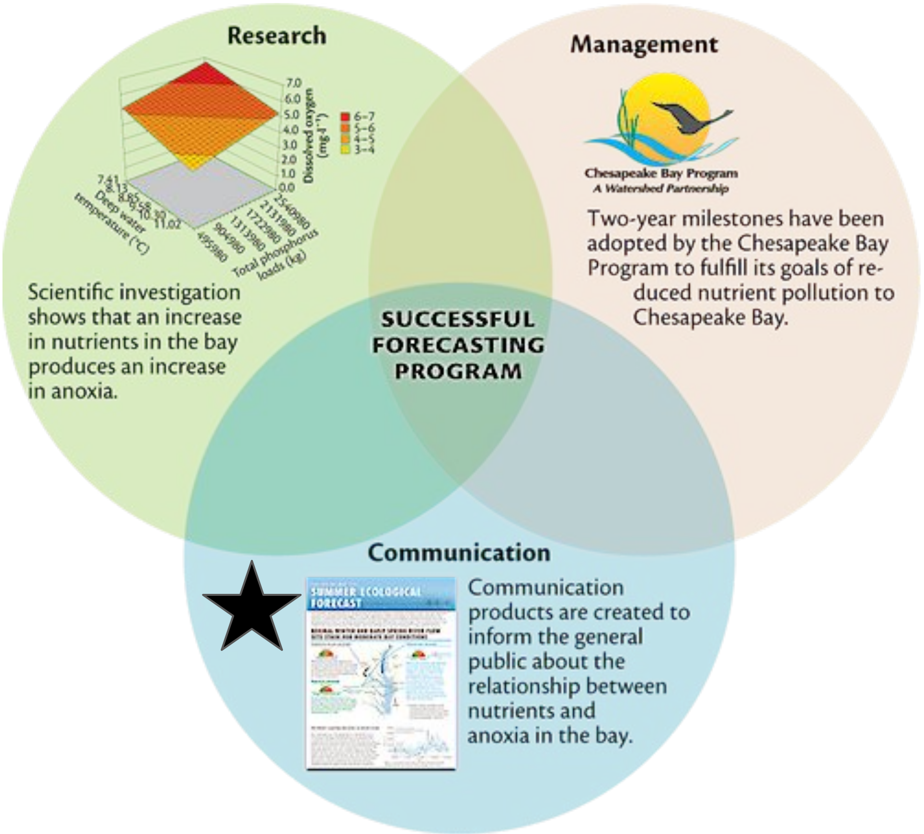
- ❑ How do we get the information in **tributary basin summary reports** to a more local level?
- ❑ How do we present the information in a new format and make it for many tributaries?

Project

- Create a template StoryMap that can easily be replicated for the 13 tributaries as the reports are updated
- StoryMap: digital webpage composed of dynamic graphics, maps, figures, and data to inform seamlessly



Purpose and Audience



Conceptual diagram illustrating the interconnectivity of research, management, and communication involved in ecological forcasting.
Diagram courtesy of the Integration and Application Network (ian.umces.edu), University of Maryland Center for Environmental Science. Source: Longstaff, B.J., T.J.B. Carruthers, W.C. Dennison, T.R. Lookingbill, J.M. Hawkey, J.E. Thomas, E.C. Wicks, and J. Woerner (eds) (2010) Integrating and applying science: A handbook for effective coastal ecosystem assessment. IAN Press, Cambridge, Maryland.

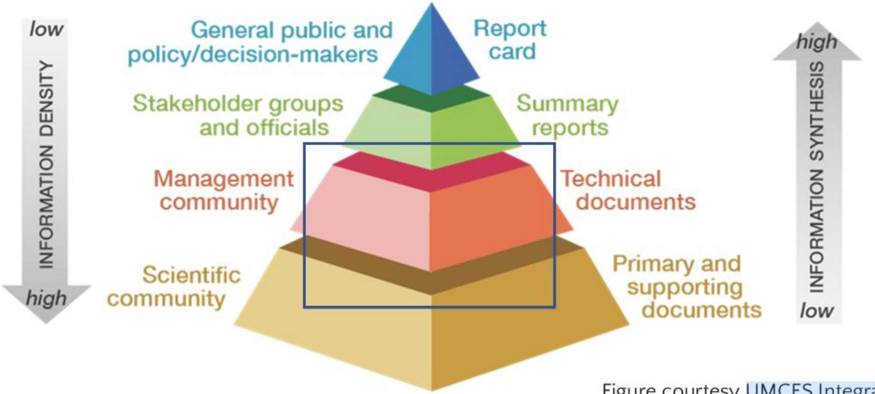
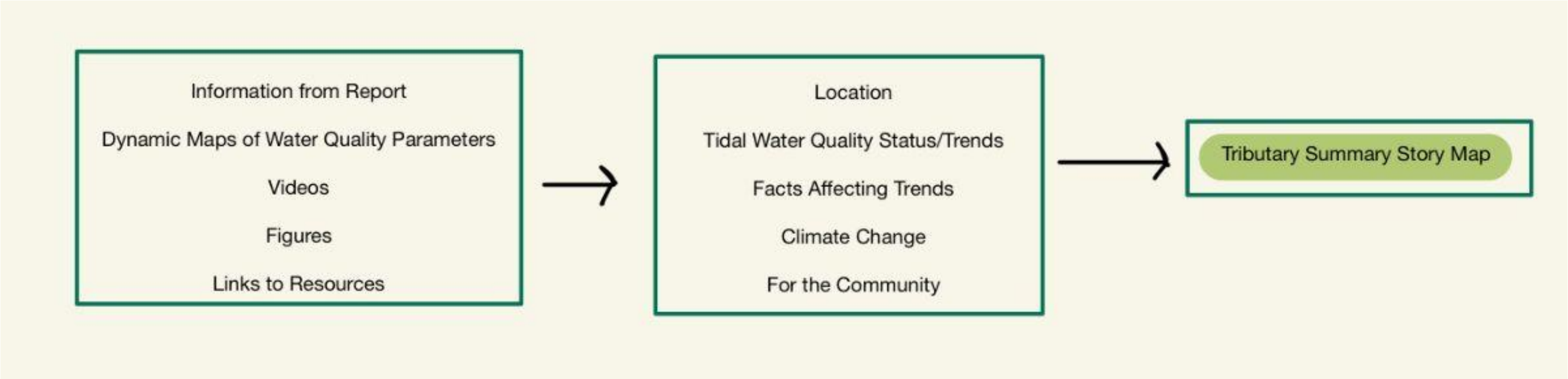


Figure courtesy UMCES Integration and Application Network, ian.umces.edu

Methods

- Outline StoryMap template



Methods

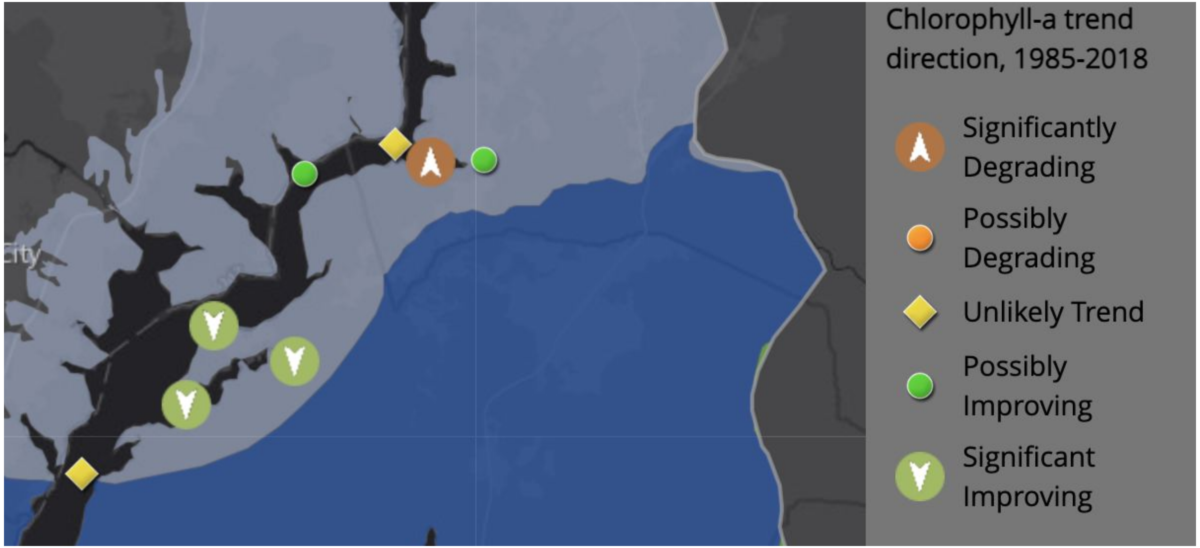
- Review other StoryMaps
- Reach out to contacts such as conservation/advocacy groups and engage to gather feedback

The StoryMap is a changing medium that informs and is informed.

Engagement with Watershed Groups

Questions asked:

1. What role could the Story Map play?
2. Do they see a place in Story Maps for data they collect in the "For the Community" section?

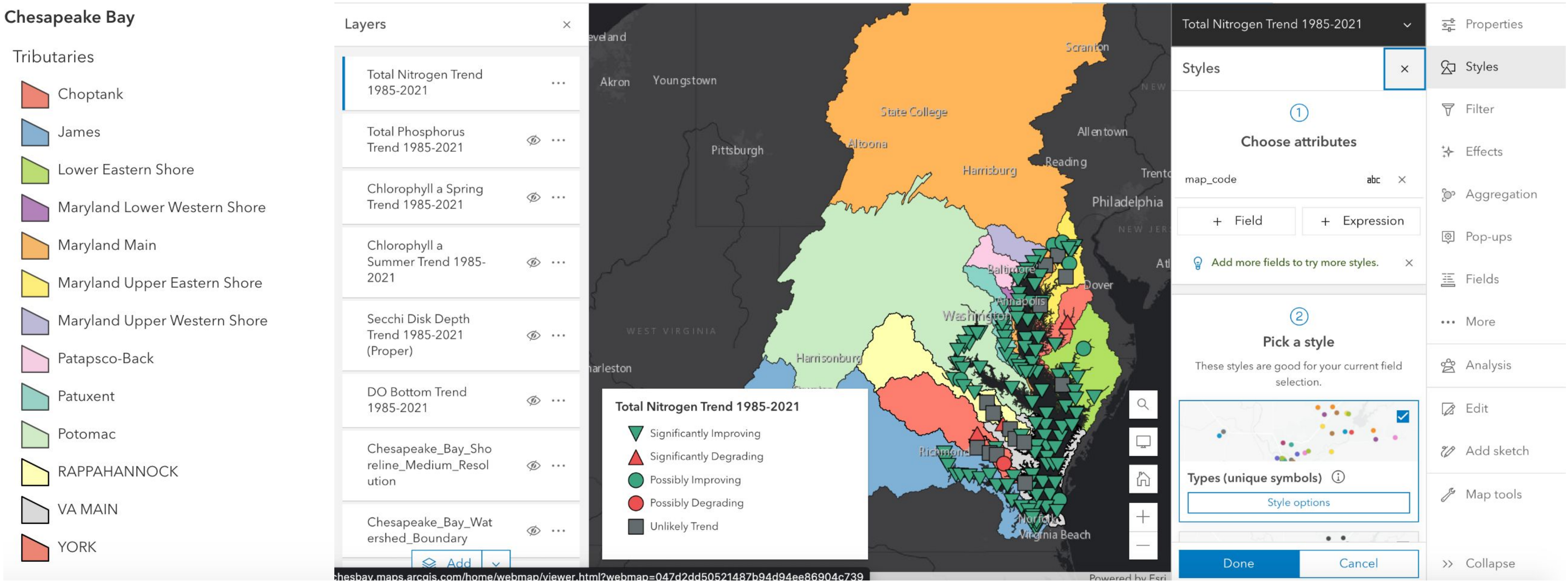


Feedback received:

Confusion about symbology.

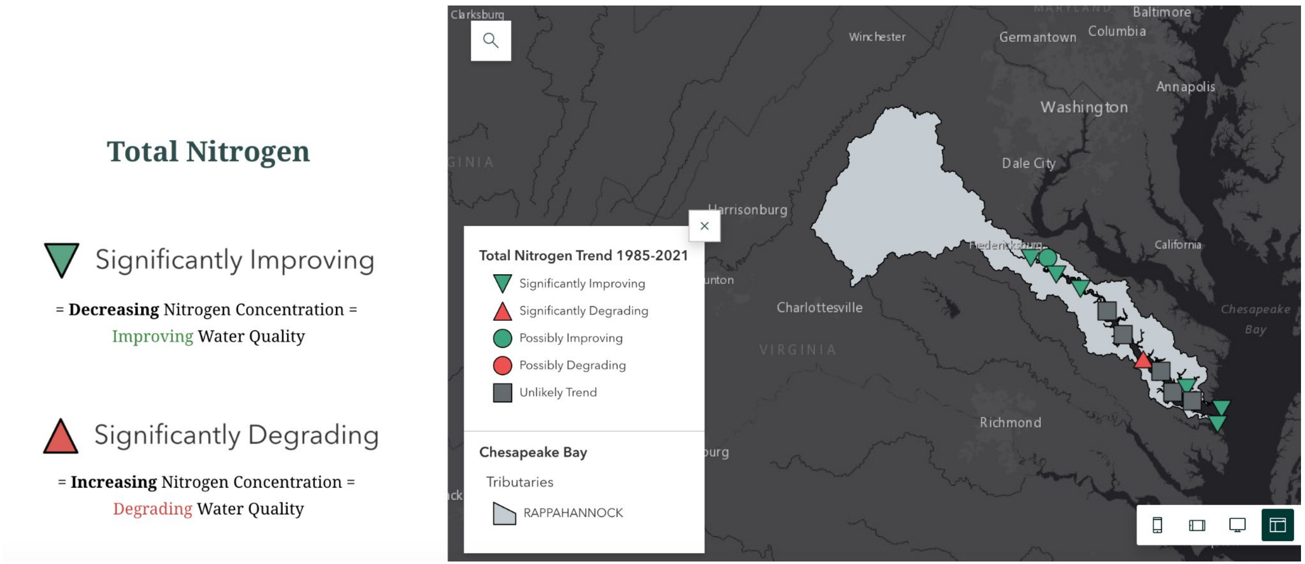
Methods

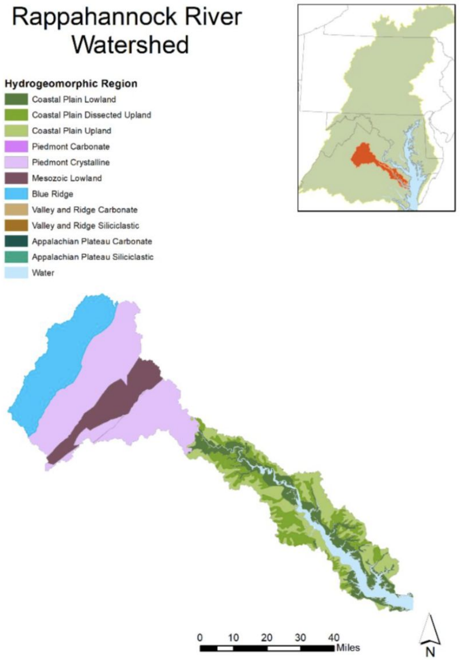
- Template of StoryMap: Use ArcGIS Online to create dynamic maps of water quality parameters



Methods

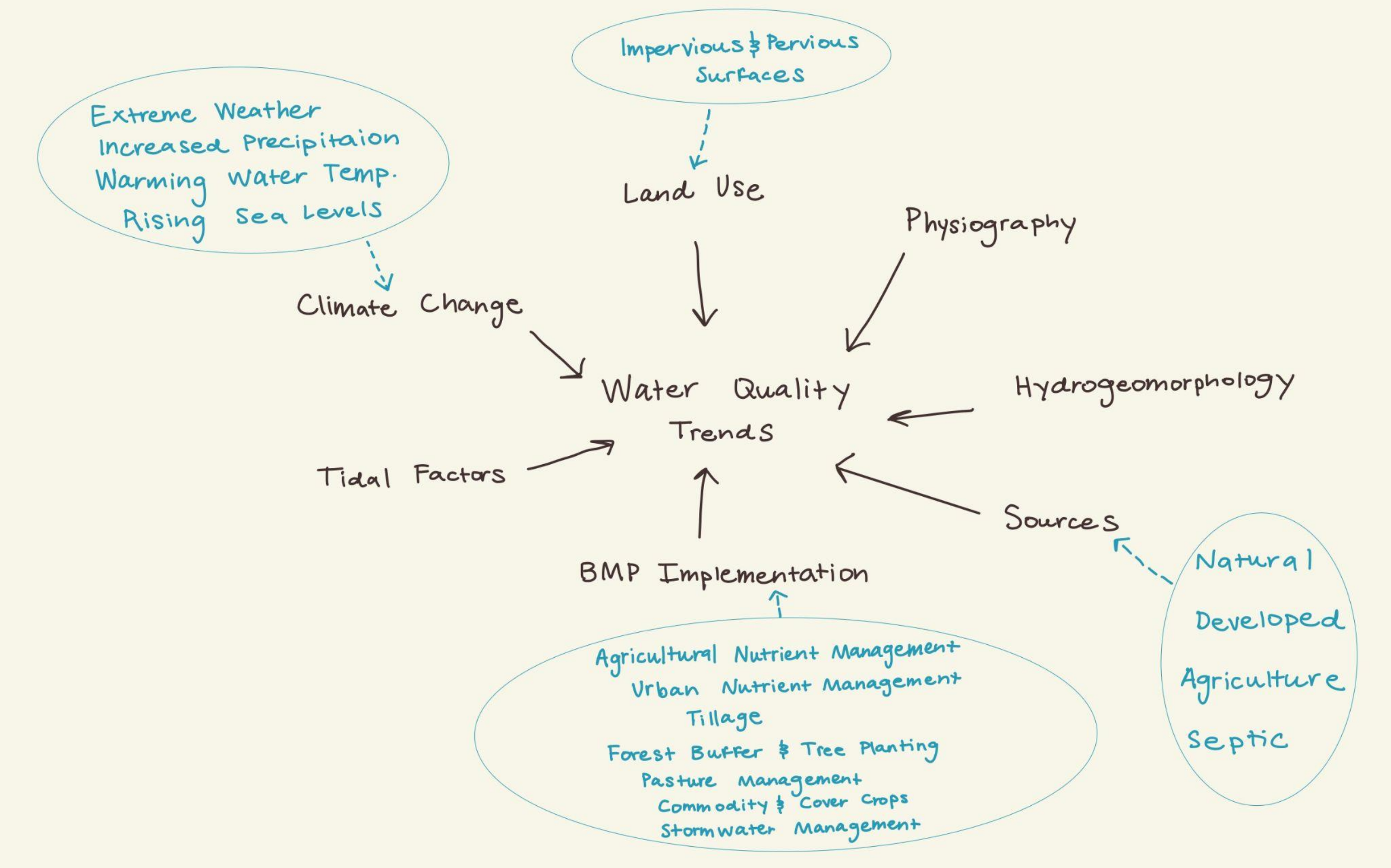
- Working example of Rappahannock StoryMap
- Create a Standard Operating Procedure document so that more examples could be made from the template





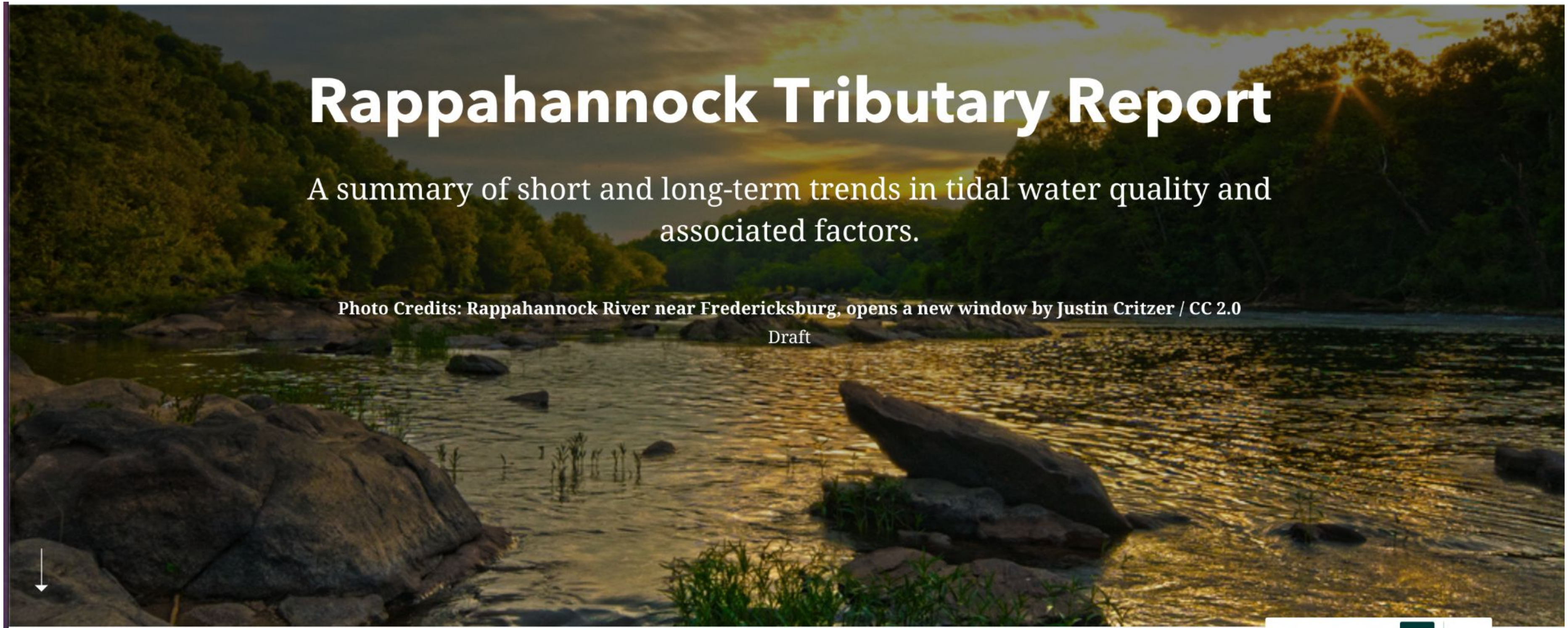
Results

Discussion: *Systems Thinking*



Thank you to Randy Rowel and my mentors, Alex Gunnerson, Breck Sullivan, and Kaylyn Gootman for teaching, mentoring, and supporting me.

C-StREAM



Rappahannock Tributary Report

A summary of short and long-term trends in tidal water quality and associated factors.

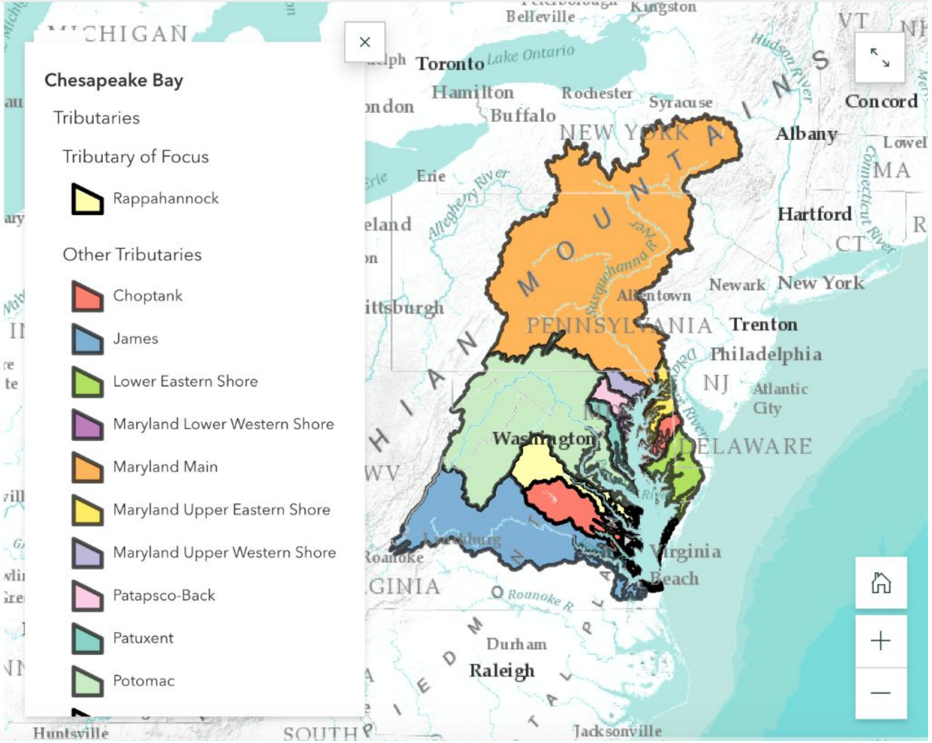
Photo Credits: Rappahannock River near Fredericksburg, opens a new window by Justin Critzer / CC 2.0

Draft

Chesapeake Bay Watershed

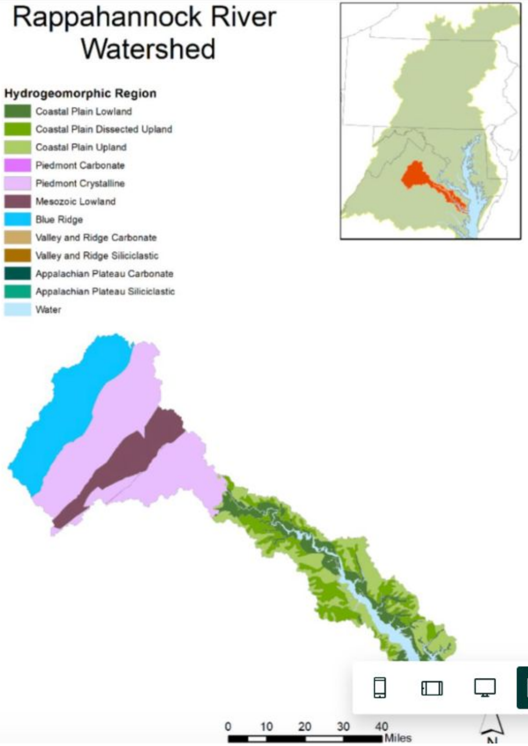
The Chesapeake Bay watershed covers more than 165,760 square kilometers over six states (Delaware, Maryland, New York, Pennsylvania, Virginia, and West Virginia) and Washington, D.C. The largest rivers that flow through the watershed are the Susquehanna River, Potomac River, James River, Rappahannock River, and York River. Over 100,000 tributaries reach across the Chesapeake Bay watershed.

More information about the Chesapeake Bay and programs for its restoration can be found on the Chesapeake Bay Program website. Technical data, such as tidal data and water quality parameters, are available through the Chesapeake Bay Watershed Data Dashboard.



Physiography

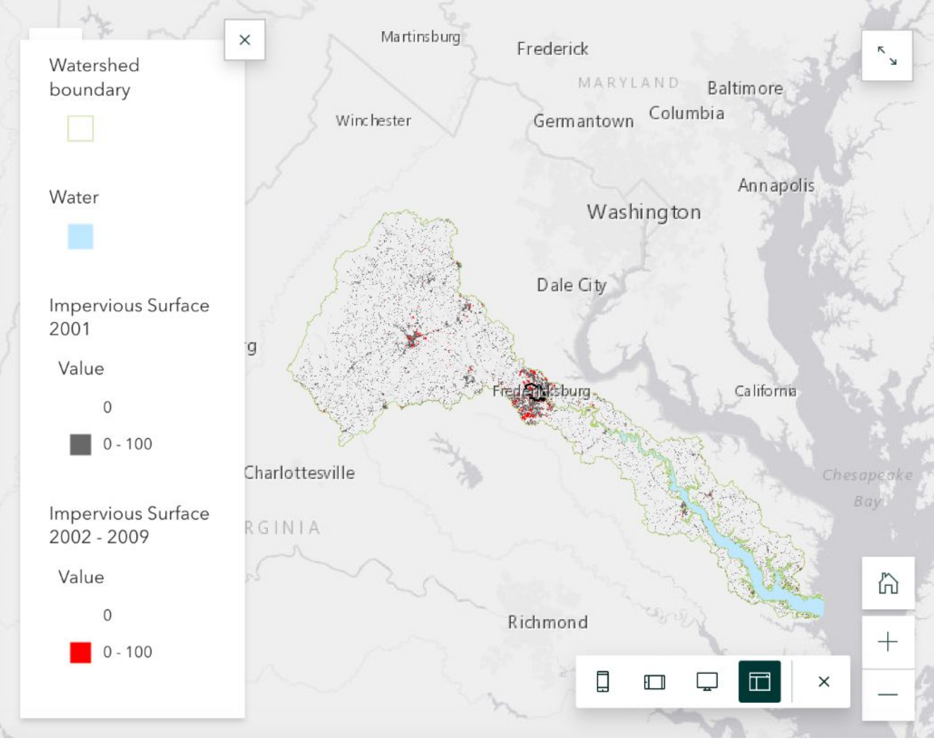
The Rappahannock River watershed stretches across four major physiographic regions, namely, Blue Ridge, Mesozoic Lowland, Piedmont Crystalline, and Coastal Plain. The Coastal Plain physiography covers lowland, dissected upland, and upland area.



Land Use

In general, developed lands in 2001 were more concentrated within towns and major metropolitan areas. Since 2001, developed and semi-developed lands have expanded around these urban areas, as well as extending into previously undeveloped regions. This is demonstrated in the map on the right which uses impervious surface coverage as a proxy for developed lands. Urban land has increased from 6 to 10% from 1985 to 2019. The impacts of land development differ depending on the use for which the land is converted.

An increase in urbanization and paved surfaces increases stormwater runoff, leading to excess nutrients and sediments entering rivers and streams.



Chesapeake Bay Watershed | Physiography | Land Use | Water Quality Status | Long-Term Water Quality Parame... | Short-Term Water Quality Param... →

Total Nitrogen

▽ Significantly Improving

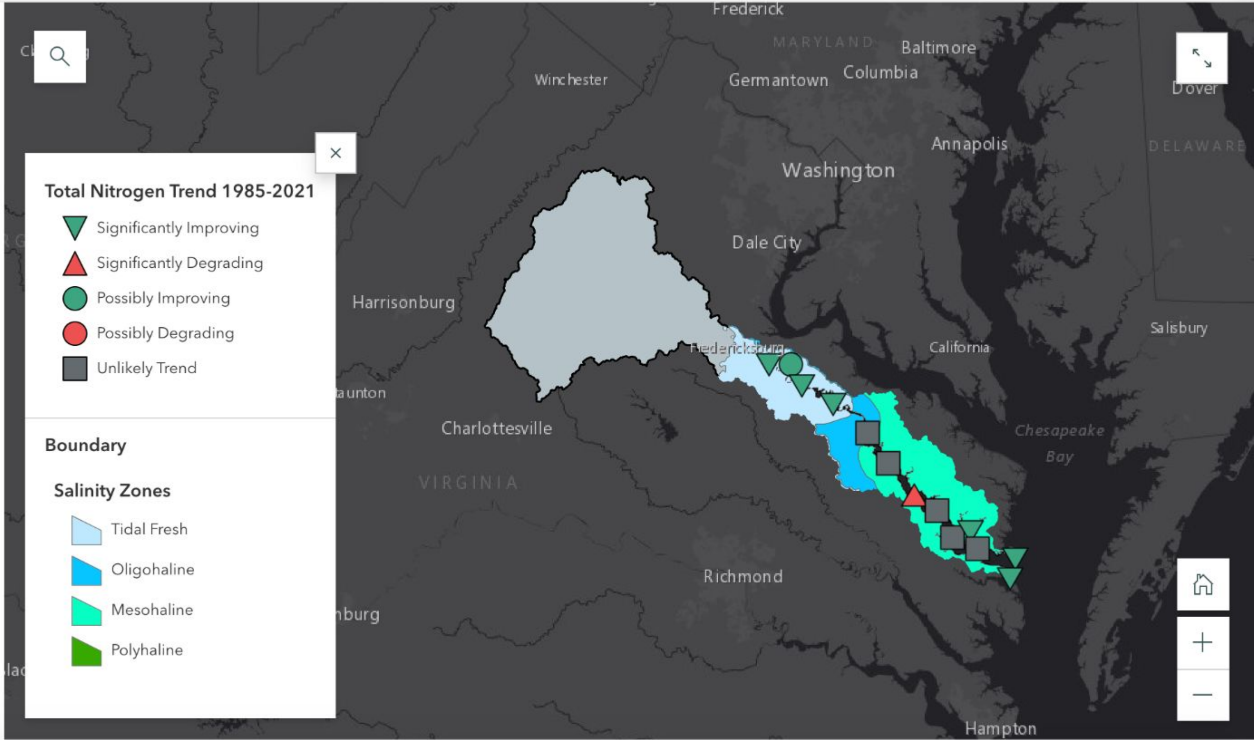
= **Decreasing** Nitrogen Concentration = Improving Water Quality

△ Significantly Degrading

= **Increasing** Nitrogen Concentration = Degrading Water Quality

01 / 06

Compared to the Rappahannock Tributary Report which covers trends



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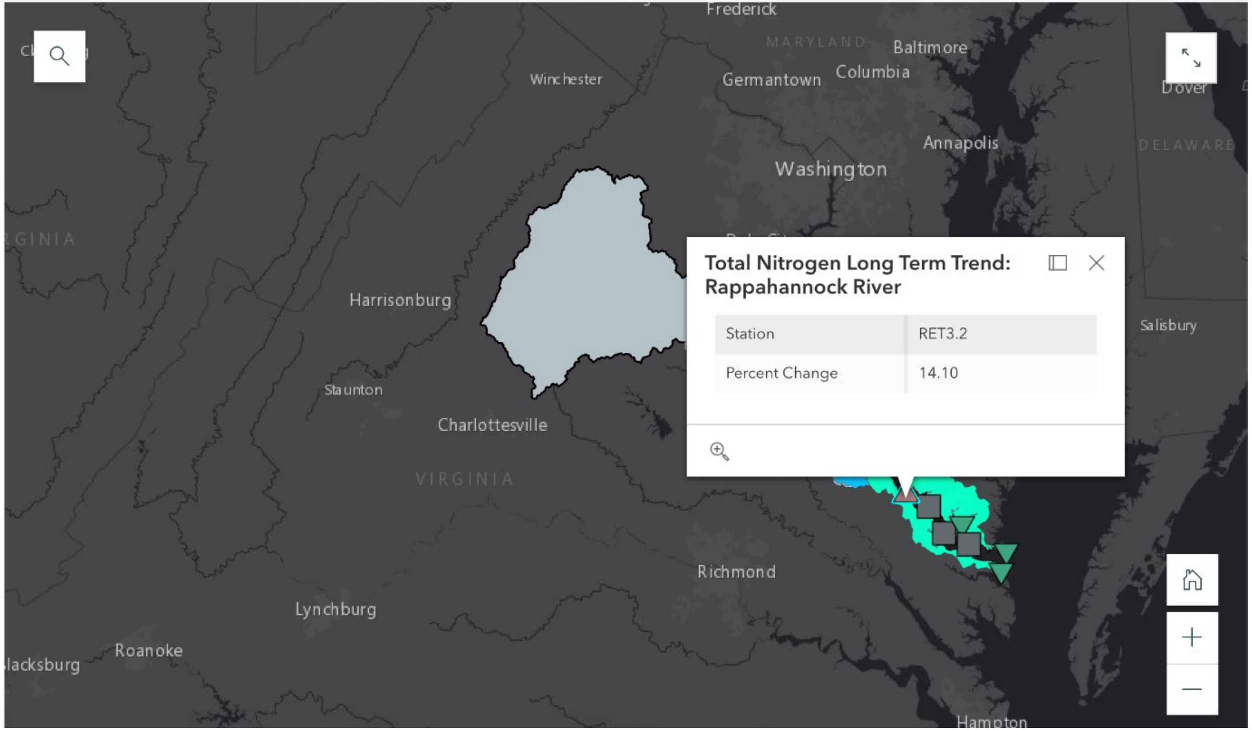


Secchi Disk Depth

Significantly Improving

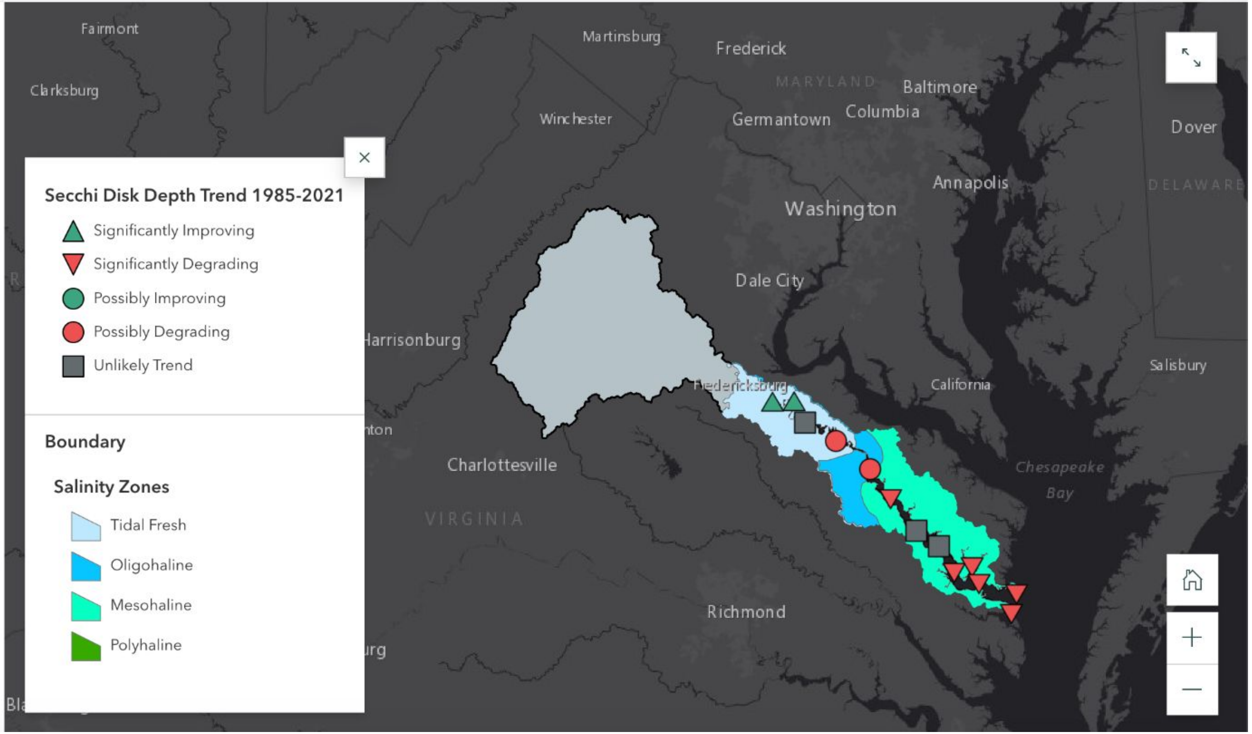
= **Increasing** Secchi Disk Depth Concentration = Improving Water Quality

Significantly Degrading

= **Decreasing** Secchi Disk Depth Concentration = Degrading Water Quality

Trends in Secchi disk depth, a measure of visibility through the water column are most significantly

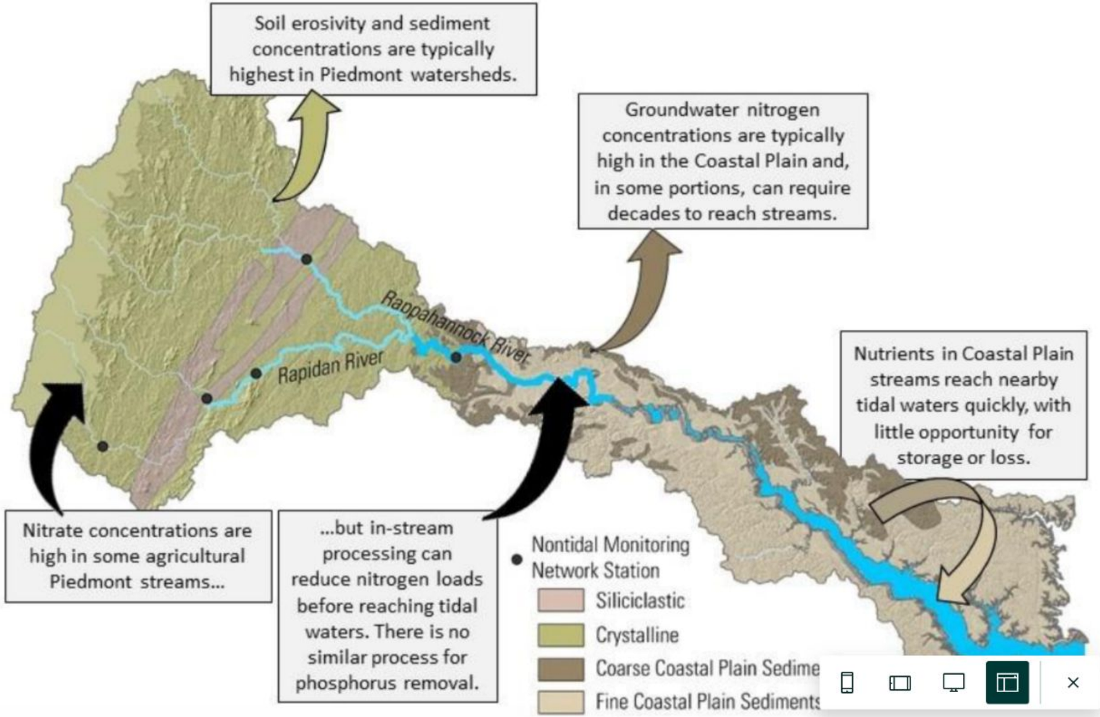
05 / 06



Hydrogeomorphology

- Hydro: water, including both surface and underground water
- Geo: ground and the landforms
- Morphology: the surface characteristics of the landforms

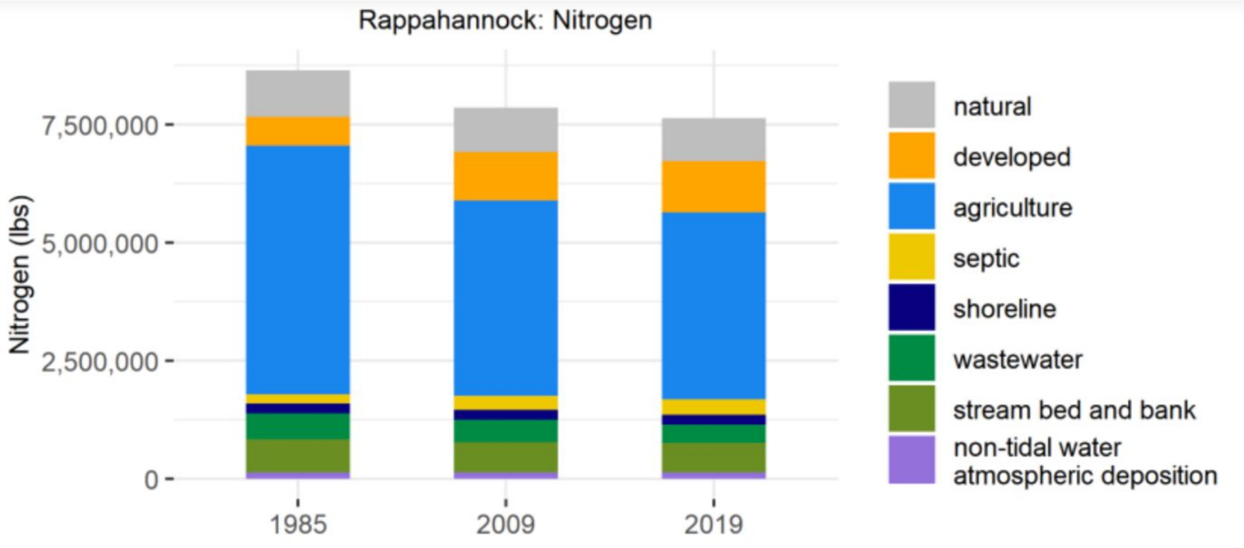
Differences in the physical characteristics of a tributary can explain in part the variability in watershed nutrient yields. The figure on the right highlights linkages between water processes and landforms on nutrient loads.



Sources

According to the Chesapeake Bay Program's Watershed Model known as the Chesapeake Assessment Scenario Tool, changes in population size, land use, and pollution management controls between 1985 and 2019 would be expected to change long-term average nitrogen, phosphorus, and sediment loads to the tidal Rappahannock River by -12%, -

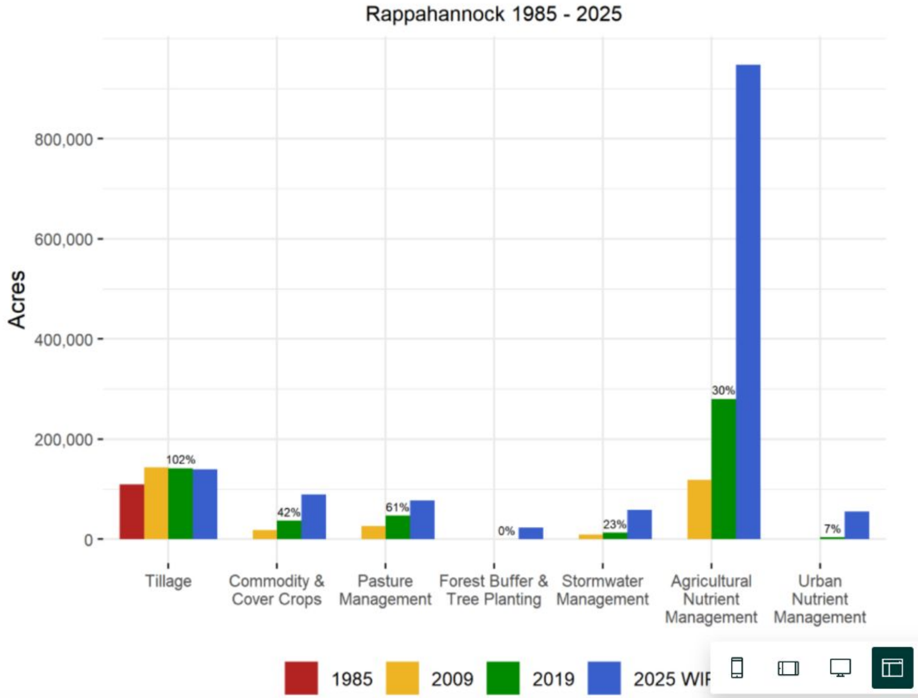
- 33%, and -13%, respectively
-
-
- Changing watershed conditions and



Management

In the graph, reported Best Management Practices (BMP) implementations on the grounds as of 1985, 2009, and 2018 are compared to planned 2025 implementation levels for a subset of major BMP groups measured in acres.

As of 2019, tillage, cover crops, pasture management, forest buffer and tree planting, stormwater management, agricultural nutrient management, and urban nutrient management were credited for 142, 37, 47, 0.1, 13, 280, and 4.1 thousand



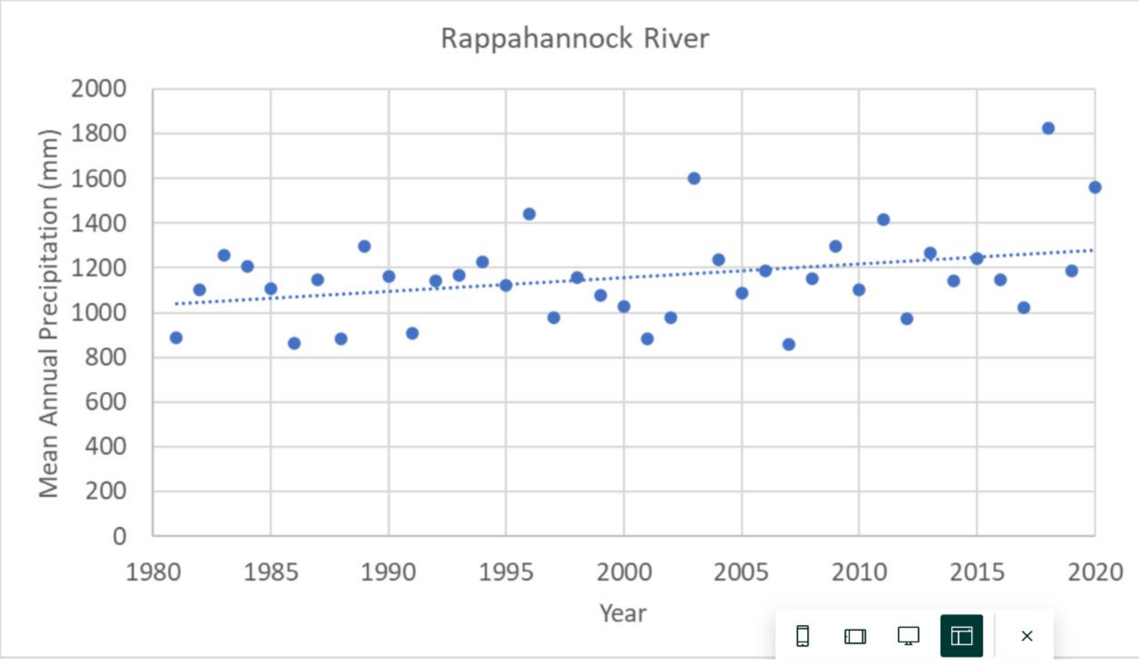
Values above the 2019 bars are the percent of the 2025 goal achieved.

Climate Change

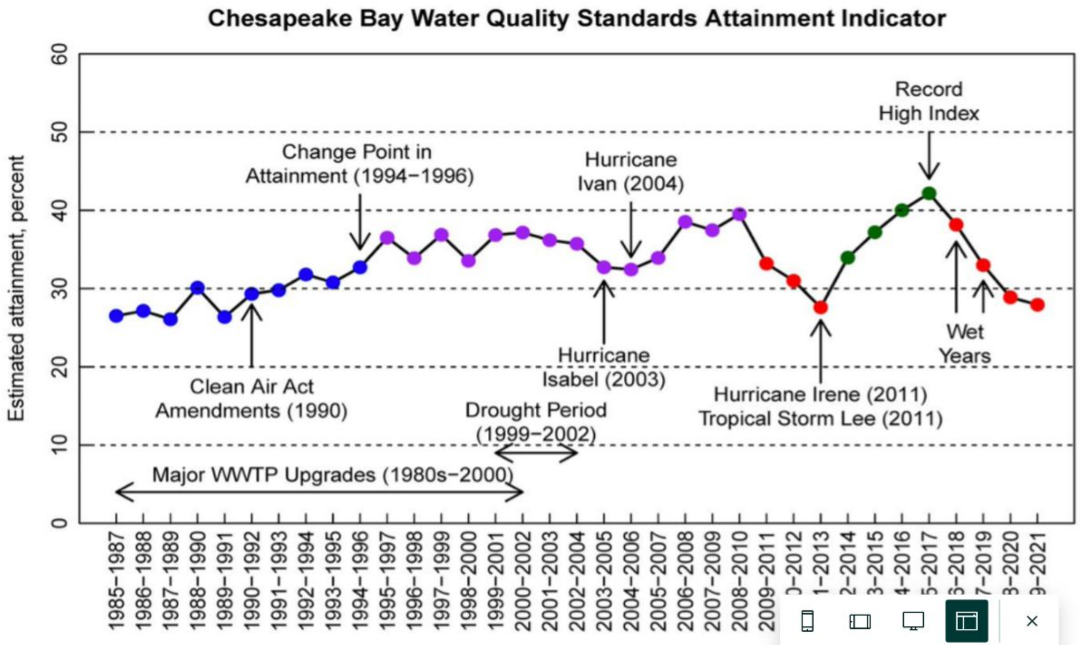
> *The watershed is experiencing an increase in precipitation, temperatures, and climate variability, which shapes Chesapeake Bay tributary recovery trends. Climate impacts are exacerbated by local non-climate stressors (e.g., land-subsidence, land use change, growth and development). Efforts aimed to increase understanding of climate change impacts on water quality patterns can help explain the actual progress gaps and transform monitoring findings into actionable information.*

Extreme Weather and Increased Precipitation

Extremes in rainfall - whether too much or too little - can have varying effects on the Bay ecosystem. During large rain events, river flow increases, delivering more fresh water into the Bay and decreasing the Bay's salinity. Stormwater runoff delivers nitrogen, phosphorus, and sediment into rivers and the Bay causing an increase in nutrientconcentrations, which create dead zones and feed algal blooms. During periods with little rainfall or extended drought, the decrease in freshwater flows results in saltier conditions, affecting habitats and aquatic species.



Dips in the long-term water quality standards show the responsiveness of the Chesapeake Bay to extreme events such as Hurricane Ivan in 2004 and Hurricane Irene in 2011. When viewed in isolation, these extreme events would lead to non-attainment. However, the Indicator also shows that estimated attainment recovers relatively quickly in the aftermath of extreme events, thus highlighting the resiliency of the Bay.

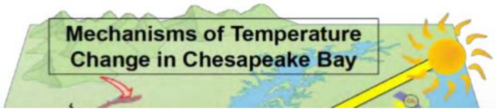


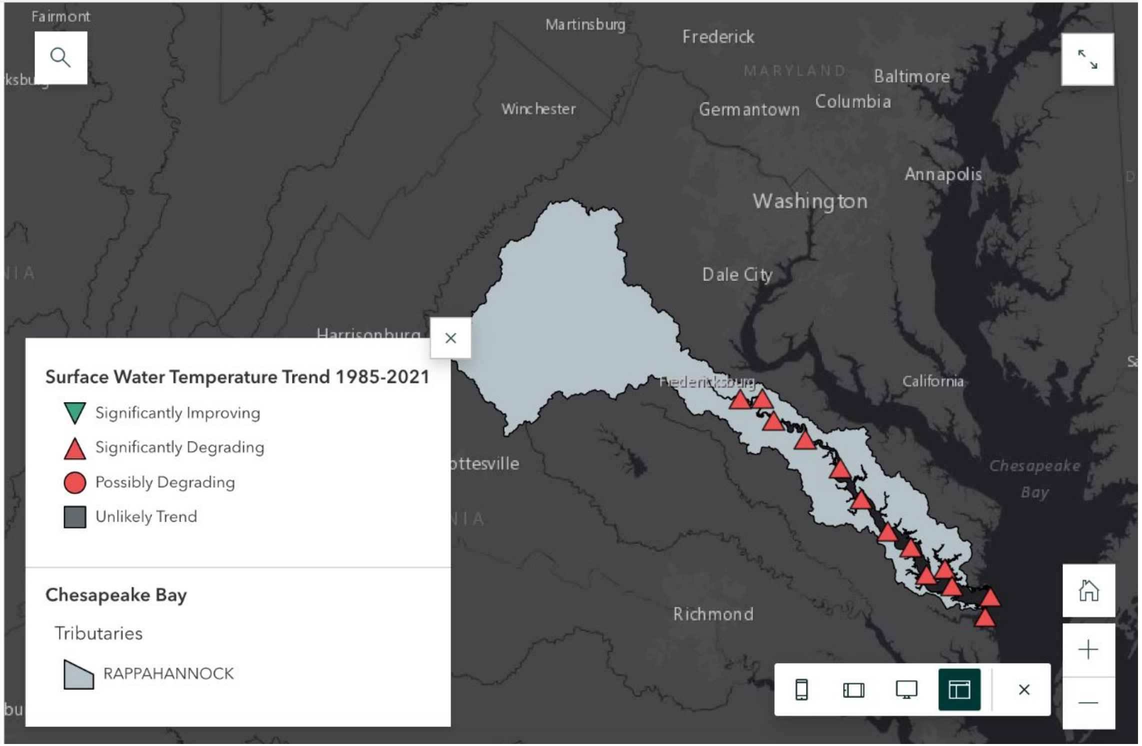
More information capturing the extreme weather events occurring in the Bay watershed:

Mid-Atlantic Regional Climate Impact...

Warming Water Temperatures

The Chesapeake Bay is shallow, with a mean depth of 6.5 m, which means that atmospheric variability greatly influences water column temperatures. Increased atmospheric temperatures are forcing factors that contribute to warmer water temperatures. Trends from resulting marine heat waves, or prolonged anomalously warm events, indicate increases in marine heat wave frequency, duration, and cumulative yearly intensity.

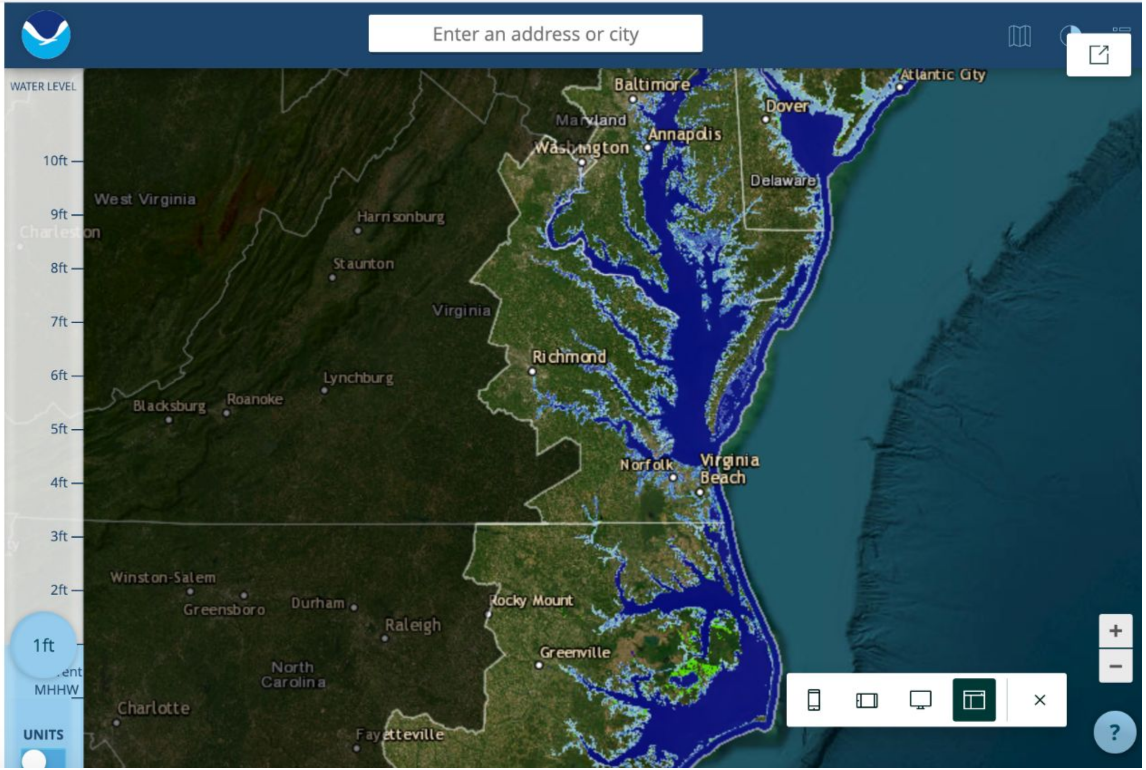




Sea Level Rise

Over the past century, Bay waters have risen by about one foot, and according to a USGS study, Bay waters are predicted to rise another 1.3 to 5.2 feet over the next 100 years. This rate is higher than the global sea level rise average because the Chesapeake Bay region is also impacted by land subsidence, or sinking of land due to removal or displacement, half of which is estimated to be from groundwater removal.

Higher water levels in the Bay can result in the loss of marshes and wetlands due to saltwater inundation. This is occurring due to erosion rates that are outpacing marsh accretion and/or



For the Community

This section serves as a resource tab that includes links to work done and data collected by smaller organizations. It can offer the state of a tributary on a smaller scale and also makes it easier to update the story map. This puts into context other aspects that are impacting water quality trends that are not consistent across all the tributaries.

Friends of the Rappahannock is a non-profit, grassroots conservation organization that works to educate everyone about the Rappahannock River and advocate for policies that will protect and restore its health.

They educate on the safety of fish consumption, have programs on river stewardship, and host recreational, community-oriented, and educational events. Their vision includes a community where citizens partake in personal stewardship over river resources and local governments manage land use and runoff to protect and enhance riparian habitats, downstream waters, scenic viewsheds, and historical resources.