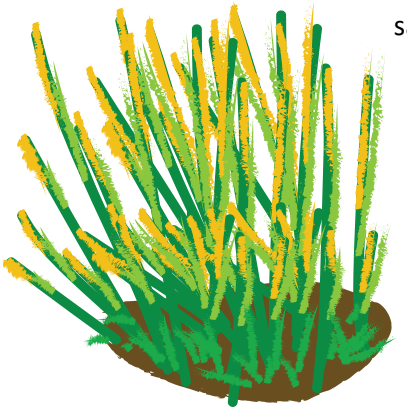
NERR or Far :

The Reserves Are Where You Are

Episode 8: SWMP(Y) Science

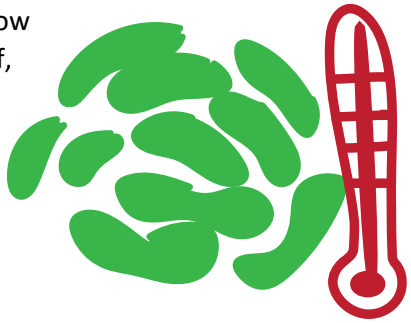
SWMP, or the System-Wide Monitoring Program, is a national network and program that helps the **National Estuarine Research Reserves (NERRs)** understand how water quality and weather conditions change over time, and how these changes can and are impacting the environment. The reserves use **data sondes**, which are computerized devices that take water quality readings every 15 minutes, 24/7. The water quality sites / data sondes are stationed at different locations throughout the reserves, and having wide coverage of the estuary helps best monitor how the saltwater - freshwater interaction is moving with tides, storms and other types of variations in weather. Water quality stations also measure water temperature, **salinity, pH**, dissolved oxygen, as well as nutrients in the water. Some are even connected to satellites so that anyone on their computer can see with a small delay what's going on in the water! Reserve weather stations supplement water quality by collecting basic meteorological data like air temperature, wind speed, **barometric pressure**, and precipitation. Because these are all long-term sites, they're great to observe trends over time in our weather and in our water quality, especially as storms come.



The ACE Basin reserve has been working recently with a group of other reserves to create an educational product called "Storm Stories"! This tool allows the user to observe reserve data before, during and after certain large storm events that affected the local area and see what changes throughout and directly after the storm in the water and weather. SWMP data allows us to look at how our environment is changing over time both over long periods of time as well as with **discrete** incidents. Other researchers that the reserves partner with, like the Department of Natural Resource biologists, can look at SWMP data in relation to their species data to see how those factors impact all different kinds of marine species. For this reason, many NERR staff members call the program a useful **"canary in the coal mine"**, which is a phrase that means it serves as an early warning of danger. It helps us see changes in our environment through data before we see noticeable, potentially irreversible changes to our coastal communities.

There are a variety of ways that SWMP data can be used. The North Carolina NERR has been collecting standardized water quality and climate data on the coast since 2002 as a part of this program. This data proved invaluable in the wake of Hurricane Florence when used to assess public health risks related to a climate-sensitive bacteria. So how can long-term environmental data be used to inform decisions related to public health? According to researchers at the reserve, understanding how storm

surges and floodwaters change salinity can inform the medical community when and where increases in ***Vibrio vulnificus*** infections are likely to increase. *V. vulnificus* is a climate - sensitive bacteria that lives in marine environments that you can get from eating affected seafood, most commonly raw or undercooked oysters. The SWMP data allowed researchers to see how long salinities were changed by **surge waters** and stormwater runoff, important drivers behind broadening the area where Vibrio **proliferates**, or multiplies. The bacteria can double every 20 minutes and thus adapt to rapidly changing conditions. Warming temperatures also increased the speed with which microbes can multiply (their **doubling time**). Using SWMP data, we can see where areas are warming and how much or for how long.

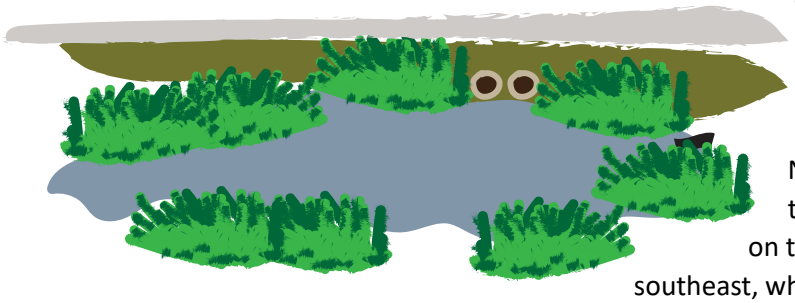


Changes in coastal land use can also change how stormwater moves through coastal watersheds. Increases in **impervious** surface area that go with urbanization, for example, sidewalks and roads, typically drive stormwater runoff into waterways faster, rather than percolating through soils. This can bring with it surface pollutants like **microbial loads**, **petrochemicals** from roads, and yard debris, along with any fertilizers and pesticides. Researchers can see how this alters salinity patterns in the waterways using SWMP. Along with pollutants, it increases the **volatility** of salinity changes following storm events, which can be burdensome on habitats and their occupants. Also, increased urbanization and **intensive agriculture** increases nutrient loading in waterways, which increases the **biological oxygen demand (BOD)**, contributing to low dissolved oxygen in the water and **harmful algal blooms**. SWMP data helps capture these effects over time. Improving algal bloom detection is a focus of the GTM NERR in Florida. Making strides towards this goal, this reserve is working to create the country's most comprehensive chlorophyll monitoring network.

Chlorophyll found in plants, including algae and phytoplankton, helps plants to photosynthesize. It's what gives plant life that rich green color. Sometimes with chlorophyll though, there can be an abundance of light, and in response, the pigment will actually release light back out, or **fluoresce**. That fluorescence is key to a new method of analyzing samples for chlorophyll! Previously, scientists at the reserves would take a chlorophyll sample, they would filter out the chlorophyll and they would be limited by the amount of time it took to do that process. They would only be able to do it about once a month. Regardless of how tedious it was, it was still a very beneficial process because they could take a look at historical data, compare it and then understand long-term changes.

With the new method, a high-frequency sensor reads the amount of light emission/fluorescence. The benefits to this include that they can collect it about every 15 minutes, so a lot more frequently than once a month. Because of the efficiency, they can take a look at short-term changes, changes with tide, changes in a day versus night, seasonally and changes after a storm. Researchers at the NERRs are currently working to determine if the entire reserve system can use this method or if it needs to be done more individually, depending on the reserve. This chlorophyll monitoring data and new method of analysis can hopefully be used to help decision-makers make decisions on water quality and to inform the **aquaculture** industry. Clams, oysters and mussels that are raised on the coasts by aquaculture centers are eating plankton that have chlorophyll in it, so helping biologists understand those processes better is important to that industry.

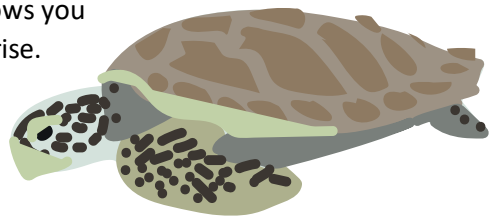
Another study going on at the GTM NERR related to water sampling is an eDNA project. **eDNA**, or environmental DNA, is nuclear or mitochondrial DNA that organisms release into the environment. We can detect species, even invasive and **cryptic** or rare species, in water or terrestrial habitats using eDNA from cellular material. Isn't that crazy? You might not see the organism but you can tell that it was there at some point because of skin, hair, or other eDNA sources that it's left behind. The GTM NERR is using this technology to build a catalog of what type of plankton is present in the reserve's waters! Let's look at some other research projects across the reserves here in the southeast. One of the current research topics at the North Inlet-Winyah Bay NERR in South Carolina is stormwater ponds and their impact on coastal water quality.



Stormwater research has been a focus of North Inlet's research outside the boundaries of the reserve for quite a while because of their focus on the impacts of coastal development. In the southeast, when developers develop the landscape to create houses and subdivisions, any sort of big residential area, they're required to manage the stormwater runoff. Stormwater runoff can be a very significant contributor of pollution to the coastal environment impacting the water quality. A current collaboration between the reserve and researchers at the University of South Carolina is looking at the role of **stormwater ponds** and working to find ways to redesign ponds using more green infrastructure to help improve the nitrogen removal efficiency of these ponds. Nitrogen is a plant nutrient and in small amounts, it's very important for growing plants, but too much of a good thing becomes a problem, and lots of nitrogen runoff into the waterways creates unhealthy growth of algae and other water quality issues. By redesigning ponds so that they capture and retain more of the nitrogen before it gets exported to the estuarine waters, hopefully the reserve can lessen the impacts of coastal development.

Another project at the reserve is aimed at using drones for saltmarsh mapping. By using drones to fly very sophisticated sensors over the marsh, the reserve is able to do a much more accurate job of mapping and measuring the growth of the marsh grasses, how they respond to storm events like hurricanes, and how they're adapting and responding to rising sea level. All of these data allows North Inlet to build better models of the vulnerability or resilience of the marshes to climate change. Speaking of models and mapping, an important mapping tool that the reserves utilize is **GIS**, short for geographic information system.

GIS is a system that helps you create, manage, analyze, and map a wide variety of data. The NERRs and their partners have used this tool to create a number of helpful sites. A few in the southeast include the Georgia Coastal Hazards Portal, where you can go to see current and predicted sea level rise and how it affects the marshes, SLAMM, the Sea Levels Affecting Marsh Model, where you can see how the vegetation changes over time with sea level and how vegetation like ***Spartina*** gets pushed up into the rivers, and the Georgia Coastal and Marine Planner, which shows you based on where you live how you could be impacted by sea level rise. This incredible visual tool can even be used for marine species! Reserve biologists can track sea turtles from GPS satellite tags, overlay aerial surveys for shrimp trawlers and stranded sea turtles, and be able to see how those factors interact graphically.



All of these projects are just a glimpse into the research happening at the National Estuarine Research Reserves. Scientists at these reserves do work with countless estuarine species, and through SWMP and other monitoring efforts are able to learn more about the impacts of a changing climate and coastal development on the health of our estuaries. We can even use SWMP data to predict public health risks. All of this information is crucial to making management and policy decisions on our southeastern coast!

QUESTION TIME

1. In your own words, what is SWMP?

The definition given in the article is: “SWMP, or the System-Wide Monitoring Program, is a national network and program that helps the National Estuarine Research Reserves (NERRs) understand how water quality and weather conditions change over time, and how these changes can and are impacting the environment.”

2. Discuss some beneficial uses of SWMP.

SWMP helps us observe trends over time in our weather and in our water quality, especially as storms come, as well as identify public health risks, perform chlorophyll monitoring, and capture the effect of urbanization/coastal development and intensive agriculture. It is a “canary in the coal mine” for estuarine waters.

3. What does increasing impervious surface area through urbanization allow?

Impervious surfaces like roads, sidewalks, and parking lots typically drive stormwater runoff into waterways faster, rather than percolating through soils. This can bring with it surface pollutants like microbial loads, petrochemicals from roads, and yard debris, along with any fertilizers and pesticides. Along with pollutants, it increases the volatility of salinity changes following storm events, which can be burdensome on habitats and their occupants.

4. What is eDNA?

eDNA, or environmental DNA, is nuclear or mitochondrial DNA that an organism releases into the environment. We can detect species, even invasive and cryptic or rare species, in water or terrestrial habitats using eDNA from cellular material.

5. Why is it important to study stormwater ponds?

In the southeast, when developers develop the landscape to create houses and subdivisions, any sort of big residential area, they're required to manage the stormwater runoff. Stormwater runoff can be a very significant contributor of pollution to the coastal environment impacting

the water quality (excess nitrogen, a plant nutrient that often gets washed into these ponds from lawns nearby, can cause unhealthy algae growth).

6. Discuss a recent technological advancement that is helping improve our understanding of estuarine environments.

They could talk about the new methods of chlorophyll monitoring, drone mapping of salt marshes, the use of GIS for creating maps and models, eDNA, etc.

ACTIVITIES

- Students visit the SWMP page below and choose a site with a group of classmates. What parameters are being measured? What might affect these parameters? What are the current conditions if they're available? What are some trends in the data that you're noticing from the graphs? If you can find different sites at the same reserve, do conditions differ from site to site?
  http://nerrscdmo.org/

  (here's a cheat sheet for water quality:
  https://coast.noaa.gov/data/estuaries/pdf/water-quality-parameters-information-sheet.pdf)

- Students in groups get assigned different parameters that SWMP measures. They research what it is, the normal range for their parameter, what can influence it, and how organisms in estuarine environments and their habitat can be affected if it is outside the desired range!