APPENDIX 2

PODCAST SERIES COMPANION MATERIALS

WEBSITE

SPOTIFY

NERR or Far :

The Reserves Are Where You Are

GLOSSARY

Advocacy - acts of an individual or organization with the aim to influence decisions within particular institutions.

Aerate- to supply air.

Anaerobic- having no free oxygen.

Aquaculture - the controlled “farming” of aquatic organisms.

Ballast water- water taken up and stored in tanks and cargo holds of ships to help balance the ship and make it more stable during voyages. They take up or empty this water out in ports based on the amount of cargo they are receiving or offloading at that stop.

Barometric pressure- the pressure within Earth’s atmosphere

Barrier island- a ridge of sand that sits parallel to a coast. A lagoon or bay separates the island from the mainland.

Bay- a coastal body of water that directly connects to a larger body of water, typically an ocean.

Beach renourishment- sand is moved from areas offshore to resupply eroded beach areas.

Biodiversity - the variety of life in a certain habitat or ecosystem.

Biological oxygen demand (BOD) - the amount of dissolved oxygen demanded by aerobic bacteria to break down organic material in the water.

Biosphere regions - special places that are set aside by national governments to preserve biodiversity, culture, and economic value. There is both a U.S. Biosphere Network and a UNESCO (United Nations Educational, Scientific and Cultural Organization) World Network of Biosphere Regions.

Birding- a hobby in which you observe birds in their natural habitat.

Black skimmers- medium-sized seabirds with long wings and a unique bill that is longer on the bottom half than the upper half.

Brackish - slightly salty.

Buffer zone- an area that lessens the impact of something.

Bulkhead- a vertical wall parallel to the shoreline often used in areas highly vulnerable to storm surge and powerful waves to hold soil in place. This is considered a coastal structure, not a living shoreline.

Calcareous - containing calcium carbonate.

Calusa - Native American people who lived on the coast of southwest Florida. The group is believed to have gone extinct around the end of the 18th century.

"Canary in the coal mine"- a phrase that refers to something that serves as an early warning of danger. It comes from the old practice of using a canary in the mines to tell if the air was safe for people to breathe. If it became sick or died, they knew the mine was unsafe.

Carbon dioxide (CO_2) - a transparent gas in Earth's atmosphere. It absorbs infrared radiation, which means it acts as a greenhouse gas.

Carbon sink - anything natural or unnatural that collects and stores some carbon containing compounds for an indefinite period of time.

Catch and release- releasing a fish caught for recreation back into the water where it was captured.

Chlorophyll- plant pigment that absorbs light energy and helps with photosynthesis. It gives plant life a green color. Chlorophyll-a is the predominant type.

Citizen science - collecting and analyzing environmental data for a collaborative scientific project as a member of the general public.

Coastal decision-maker - anyone who has influence and makes decisions that can impact the future of estuarine and coastal communities.

Controlled burn - a management tool that helps prevent destructive wildfires by ridding the forest floor of flammable debris like dead leaves in a more controlled, monitored setting. These burns can also destroy invasive plant species, return nutrients to the soil through the ashes of vegetation, help certain cones germinate, clear space to give young trees more sunlight for growth and reduce insect populations.

Cornerstone - (figurative language) an important feature on which something depends upon. When building a structure of stone, the cornerstone is the first stone that is set, and all other stones are placed in reference to it.

Correlated- one thing depends on the other or affects it. Two things are connected in some way.

CTP - an acronym that stands for the coastal training program. The CTP works to promote scientific understanding amongst a variety of different decision-making audiences in coastal communities.

Cultural resources - Anything that serves as an indicator or reminder of past human activity and culture. Examples include anything from archaeological artifacts to buildings or structures, a particular landscape, or an object that has importance to a specific community for religious reasons, traditional reasons, etc.

CZMA - an acronym that stands for the Coastal Zone Management Act. It was passed by Congress in 1972 and was designed "to preserve, protect, develop, enhance and restore the nation's coastal resources". It created three new national programs, one of them being the NERRS.

Data sondes- computerized devices that take water quality readings.

Database- a structured dataset that a computer holds.

Detritivores- these organisms obtain nutrition by feeding on detritus.

Detritus- organic matter made up of dead plant and animal material.

Discrete- distinct or separate.

Disseminate - to spread widely.

Distribution- the way a population is spaced across a given area, typically driven by the availability of resources.

Doubling time- the time it takes for a population of organisms to double in size.

Ebb - movement away from land/ when a tide recedes.

eBird- a program that helps you identify bird species and log your bird sightings. This is a useful tool because it also gives scientists an understanding of how birds are using a variety of habitats and how that use may be changing over time.

eDNA- nuclear or mitochondrial DNA that an organism releases into the environment.

Estuarine - a word used to describe an environment where freshwater meets saltwater, most often an area where a river meets the sea (an estuary). When fresh water and sea water combine, the water becomes brackish, or slightly salty.

Estuary - an area where a freshwater river or stream meets the ocean.

Female courtship- this refers to a behavior carried out by males of a species in the hopes that it will result in mating and reproduction.

Fiddler crab- a type of crab that can be seen commonly in slightly salty or brackish intertidal mudflats in salt marshes, as well as various other types of brackish or saltwater wetlands. They're called fiddler crabs because the male crabs have one claw much larger than the other that they hold somewhat like a violin.

Fluoresce- emit light.

Forage- to search a wide area for food or other resources.

Gastropod - a mollusk in the class Gastropoda, a big class that is made up of slugs, snails and whelks.

Germinate- when seeds begin to grow and put out shoots after being dormant

Ghost forest- a forest of gray, decaying trees created as a result of saltwater intrusion from increased storms and sea level rise.

GIS - an acronym that stands for geographic information system. It is a system that helps you create, manage, analyze, and map a wide variety of data.

Gray shorelines- shorelines that are less natural, designed using “harder” techniques.

Great Florida Birding and Wildlife Trail - a 2000-mile-long trail that promotes birdwatching, environmental education and ecotourism.

Green shorelines- shorelines designed using more natural, “softer” techniques.

Gullah-Geechee - descendants of enslaved West African people who worked on coastal plantations from North Carolina to northern Florida. The Geechee people still maintain many unique West African traditions and elements of their language and culture.

Hammocks - groups of trees that form an ecological “island”. They typically grow in elevated areas and are surrounded by a contrasting environment like a wetland.

Harmful algal bloom- when toxin-producing algae grow out of control in a body of water. Commonly abbreviated HAB.

Hatchling- a newly hatched bird.

Hog Hammock - a historic community on Sapelo Island in Georgia that is believed to be one of the last intact island-based Geechee communities in America.

Hydrogen sulfide (H_2S) - a colorless gas with the odor of rotten eggs. Some bacteria use it to create energy through chemosynthesis, others like sulfate-reducing bacteria produce it.

Hydrophone- a type of microphone that detects sound waves underwater.

Hypoxia - a state where oxygen levels are low.

Impervious- not allowing fluids to move through it.

iNaturalist- a program where people can not only record and identify birds, but they can also record reptiles, amphibians, plants, bugs, all sorts of life

Incubation- warming eggs to an ideal temperature in order to hatch them.

Initiative - a new plan or action to solve a problem or achieve a desired result.

Intensive agriculture- a type of farming that involves putting in high levels of labor and supplies relative to land area.

Intern- to complete/ do work as a part of an internship. An internship is an opportunity to gain work experience as a student or trainee.

Intertidal zone - the space between the reach of high and low tide.

Invasive species - Any type of organism that is not native to a particular environment and can cause harm to this area. Their introduction can be accidental or purposeful, and unchecked they can outcompete native organisms for resources amongst other things.

Keystone species- any organism, whether it be an animal, bacteria or fungi, or a plant that serves as the glue holding the habitat together. If it were to disappear or be removed, the biodiversity and structure of that habitat could completely change.

Learned behavior- a behavior that an animal learns by watching another animal or by being directly taught (it is not innate/present at birth).

“Leave no trace”- this phrase means that whenever you're out in nature, all you should be leaving is your footprints! Take trash with you, put out fires that you start if you're camping, and don’t take any natural objects that you find with you, snag a photo instead.

Living shorelines- a management technique used to connect the land and water to stabilize shorelines, reduce erosion, and provide valuable habitat that enhances coastal resilience. They utilize natural elements like plants, rocks and sand to stabilize estuarine environments, sometimes in combination with existing harder shoreline structures.

Maintenance- the process of preserving the state of something.

Mangroves- a hardy type of tropical tree or shrub with intricate root systems that live in the coastal intertidal zone. The group tolerates brackish to salty coastal waters.

Maritime forest- a type of shoreline estuary along coastal barrier islands. These forests are typically surrounded by a layer of dunes on one side and salt marsh on the other, but don't completely escape the impacts of ocean winds and salt spray.

Microbial load- living microorganisms that have contaminated an object.

Migratory species- species that move throughout the year from one habitat to another in order to meet food, temperature, or other needs.

Misconception - an incorrect or mistaken view or opinion.

National Audubon Society- a non-profit environmental organization in the U.S. focused on conserving bird species and their habitats.

NERRA - an acronym that stands for the National Estuarine Research Reserve Association. NERRA was created to advance the work and mission of the reserves and to raise the profile of the NERRS.

NERRS - an acronym that stands for National Estuarine Research Reserve System. It is a system of 30 coastal sites, spanning 1.4 million acres in 24 states and Puerto Rico, created to protect and study estuarine ecosystems.

NOAA - an acronym that stands for the National Oceanic and Atmospheric Administration. This U.S. government agency is responsible for monitoring our climate and environment and making sure that we are working to preserve them.

Oyster reef - an estuarine habitat where oysters cluster on hard submerged surfaces and then fuse together as they grow, forming hard, rock-like reefs that can provide habitat for other organisms.

Peat - a very thick, spongy material that is made of a decomposing plant matter that can be hypoxic.

Petrochemicals- chemicals from petroleum and natural gas.

pH- a measure of how acidic or basic a solution is.

Pollinators- organisms that help plant fertilization by moving pollen from one flower to another. Some examples are butterflies, moths, wasps, hummingbirds, bees, etc.

Productive - having high rates of biomass (biological material, living organisms) generation.

Proliferate- to increase rapidly.

Resilience- the ability to recover quickly or bounce back from disturbances like human impacts, extreme weather events, etc.

Salinity - a measure of the amount of saltiness.

Salt marshes - a type of coastal wetland that is flooded and drained by saltwater that comes from tides. The soil within salt marshes is made up of deep mud and peat, and the dominant marsh grass in the southeast is Spartina.

Saltwater intrusion - the movement / encroachment of saltwater into freshwater.

Scrapes- a type of bird nest for species that like open habitats without a lot of trees. It is a simple depression made by the bird in the ground where they can lay their eggs.

Seawall- a protective structure made typically of concrete that extends from the shore to prevent beach erosion.

Sexual dimorphism- a difference in appearance between males and females of the same species, whether it's color, shape, size, or a unique structure

Shell mounds- prehistoric mounds consisting mainly of edible shells that serve as evidence for human occupancy.

Shorebird- a bird that is found on beaches or inland mudflats. Some examples include American Oystercatchers, plovers, and sandpipers.

Sills- a hybrid type of living shoreline where a structure made of rock, concrete or oyster shell lies parallel against an existing vegetated shoreline. This technique reduces wave energy and prevents erosion in areas that don't commonly receive high wave energy.

Slough - a type of wetland with slow-moving or even stagnant water during certain seasons.

Spartina alterniflora- the scientific name for a dominant species of marsh grass in the southeast. Its common name is smooth cordgrass.

Speciose- rich in species.

Steward- someone entrusted with caring for and being responsible for something that doesn’t necessarily belong to them.

Stewardship - careful and responsible management of something that has been entrusted in your care.

Storm surge- the unusual rise of sea level during a storm caused primarily by a storm’s winds pushing water onshore.

Stormwater ponds- ponds that collect runoff in residential areas.

Strand feeding- a learned behavior in which dolphins herd and trap fish by forcing them up onto mud banks, shorelines, or sandbars. It's called "strand" feeding because of the way dolphins beach themselves momentarily, pushing prey ashore before sliding back into the water.

SWMP - an acronym for the System-Wide Monitoring Program. It is a national NERR program and network that helps us understand how water quality and weather conditions change over time, and how these changes impact the environment.

Tides - when the sea rises and falls due to the attraction of the sun and moon.

Trust - a document that allows you to transfer ownership of your assets (in this case, property) to another third party.

Vegetation-only shoreline- a type of green shoreline that would be useful in low wave energy environments to provide a buffer to upland areas. This type is considered a non-structural method and a type of living shoreline.

***Vibrio vulnificus*-** a climate - sensitive bacteria that lives in marine environments that you can get from eating affected seafood, most commonly raw or undercooked oysters

Volatility- tendency to change rapidly and/or unpredictably.

Wrack- marine debris made up of coastal vegetation.

Yields- what is produced.

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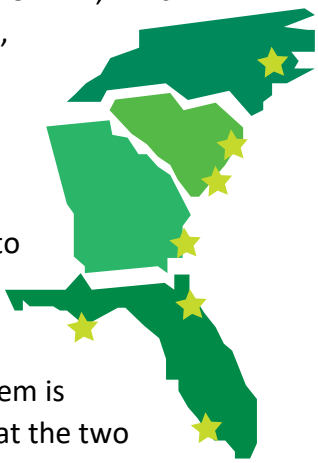
NERR or Far :

The Reserves Are Where You Are

Episode 1: Welcome to the NERRS

The **National Estuarine Research Reserve System (NERRS)** is a system of 30 coastal sites, spanning 1.4 million acres in 24 states and Puerto Rico, created to protect and study estuarine ecosystems. The word **estuarine** describes an environment where freshwater meets saltwater, most often an area where a river meets the sea. Administered by the **National Oceanic and Atmospheric Administration (NOAA)** under the **Coastal Zone Management Act (CZMA)**, these sites are living laboratories where scientists and stakeholders collaborate to develop place-based solutions to understand, conserve, and restore coastal areas so they can benefit local communities for generations. They do this through various projects and initiatives related to research, education, coastal training, and **stewardship**. These are the four pillars, or focuses, of the reserve system.

In this series, we will be looking at 7 NERR sites in the southeastern U.S. located across 4 states: North Carolina, South Carolina, Georgia, and Florida. The first site is the NCNERR, which consists of four separate NERR sites: Currituck Banks, the Rachel Carson Reserve, Masonboro Island, and Zeke's Island. It also hosts six other state-protected sites across North Carolina's coastline. The next two sites are located in South Carolina: the North Inlet - Winyah Bay NERR in Georgetown, SC, and the ACE Basin NERR in Charleston, SC. Georgia hosts the Sapelo Island NERR, and Florida has three NERR sites: the Apalachicola NERR in Eastpoint, FL, the Guana Tolomato Matanzas (GTM) NERR close to St. Augustine, FL, and the Rookery Bay NERR in Naples, FL.



Two common **misconceptions** about the NERRS are that the reserve system is the same as the National Park Service, and on the other end of the spectrum, that the two are so different that the reserves don't want the public visiting reserve lands on their own. These are both untrue! According to the NERRS Science Collaborative, the mission of the

Name: _____ Date: _____

National Estuarine Research Reserve System is "to practice and promote stewardship of coasts and estuaries through innovative research, education and training using a place-based system of protected areas". The mission of the National Park Service is "to preserve unimpaired the natural and cultural resources and values of the national park system for the enjoyment, education and inspiration of this and future generations".

Though they may seem similar, what sets the NERRS apart from parks at the national and state level is this focus on “place” and the idea of a strong working relationship with the local community. There isn't as much of a focus on preserving the sites exactly as they are. Instead, these reserves are a sort of living laboratory where scientists can study and monitor estuarine systems, students and visitors can learn hands-on, and all kinds of coastal decision makers can discover ways to better manage coastal resources through various trainings. You can even use reserve lands recreationally to get out into the estuary and go kayaking, bird watching, fishing; the options are seemingly endless. Both parks and the NERRs have numerous programs to help foster environmental stewardship and to manage protected lands. When it comes to the NERRs though, goals and initiatives, whether they be stewardship related or more research-focused, are crafted specifically with coastal areas and estuaries in mind, as well as the associated local economies. The NERRS truly earns the title "locally significant, nationally impactful" through its work to address priority issues unique to the reserve coastal communities as well as common threats across the NERRS. Some of these threats include coastal development, a changing climate, managing **invasive species** and changes in **biodiversity**.

So what do staff within each of the reserve pillars (stewardship, research, coastal training, education) do to address reserve priority issues and to help ensure happy, healthy estuaries on our southeastern coast? Stewardship staff at the reserves focus on **initiatives** that will help keep the estuary in its best shape, like invasive species monitoring, overseeing **controlled burns** at the reserve, performing trail maintenance, and coordinating volunteer days. Research staff at the reserve study estuarine species, from small plankton to large mammals, monitor water quality and weather, create data-rich reserve maps, and more. The information they collect can be used to help improve conservation and resource management locally and nationally!

Coastal training staff works to promote scientific understanding amongst a variety of different decision-making audiences in coastal communities. They present data from the reserve to a wide range of **decision-makers**: elected officials, city and local planners, people from the water management district, people who issue permits, realtors, even ecotour operators. By hosting programs at the reserves, the coastal training program is able to get information in professionals' hands that will help them better understand how they also have the ability to protect our coastline. Last but not least, educational staff serve both children and adult visitors through hands-on lab and field experiences, create virtual educational materials, and lead other various environmental outreach initiatives in coastal communities! Through

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stewardship, research, coastal training, and education, the NERRs are working to create more resilient and better-informed communities on our coasts in the face of a changing world and climate.

QUESTION TIME

1. What are some of the issues that NERRs in the southeast are working to address?

2. What is one difference between the NERRs and the National Park Service? A similarity?

3. The mission of the NERRS is "to practice and promote stewardship of coasts and estuaries through innovative research, education and training using a place-based system of protected areas". How do each of the reserve's pillars practice and promote stewardship?

4. There are a number of recreational opportunities at the NERRS and chances for hands-on learning. How do you think experiencing the outdoors for yourself impacts your feelings of stewardship towards it?

5. What are some examples of coastal decision-makers?

6. What NERR sites are closest to you? Research a reserve of your choice. What are some specific things that this reserve studies or programs that they provide to visitors that you find interesting?

7. **Match the projects below with the reserve pillar that would likely be responsible for it!**

Carefully removing kudzu and other non-native plants found on reserve lands	Stewardship
Leading a class for commercial seafood dealers on shell recycling and other sustainable practices	Education
Leading guided exploration hikes for all ages at the reserve	Research
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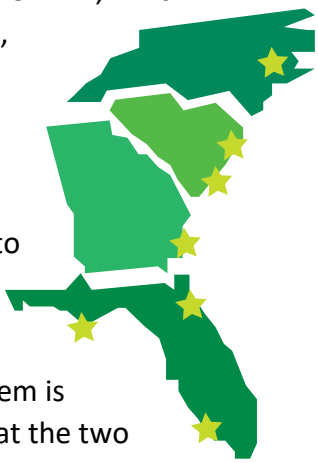

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Instead, these reserves are a sort of living laboratory where scientists can study and monitor estuarine systems, students and visitors can learn hands-on, and all kinds of coastal decision makers can discover ways to better manage coastal resources through various trainings. You can even use reserve lands recreationally to get out into the estuary and go kayaking, bird watching, fishing; the options are seemingly endless. Both parks and the NERRs have numerous programs to help foster environmental stewardship and to manage protected lands. When it comes to the NERRs though, goals and initiatives, whether they be stewardship related or more research-focused, are crafted specifically with coastal areas and estuaries in mind, as well as the associated local economies. The NERRS truly earns the title "locally significant, nationally impactful" through its work to address priority issues unique to the reserve coastal communities as well as common threats across the NERRS. Some of these threats include coastal development, a changing climate, managing **invasive species** and changes in **biodiversity**.

So what do staff within each of the reserve pillars (stewardship, research, coastal training, education) do to address reserve priority issues and to help ensure happy, healthy estuaries on our southeastern coast? Stewardship staff at the reserves focus on **initiatives** that will help keep the estuary in its best shape, like invasive species monitoring, overseeing **controlled burns** at the reserve, performing trail maintenance, and coordinating volunteer days. Research staff at the reserve study estuarine species, from small plankton to large mammals, monitor water quality and weather, create data-rich reserve maps, and more. The information they collect can be used to help improve conservation and resource management locally and nationally!

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resilient and better-informed communities on our coasts in the face of a changing world and climate.

QUESTION TIME

1. What are some of the issues that NERRs in the southeast are working to address?

coastal development, a changing climate, managing invasive species and changes in biodiversity

2. What is one difference between the NERRs and the National Park Service? A similarity?

Difference: 1) with the NERRS, there isn't as much of a focus on preserving the sites exactly as they are, 2) the reserve is a “living laboratory”, 3) the NERRS are very place-based / goals and initiatives, whether they be stewardship related or more research-focused, are crafted specifically with coastal areas and estuaries in mind, as well as the associated local economies.

Similarity: 1) both parks and the NERRs have numerous programs to help foster environmental stewardship and to manage protected lands, 2) you can use their lands for recreation.

3. The mission of the NERRS is "to practice and promote stewardship of coasts and estuaries through innovative research, education and training using a place-based system of protected areas". How do each of the reserve’s pillars practice and promote stewardship?

Stewardship staff - focus on initiatives that will help keep the estuary in its best shape, like invasive species monitoring, overseeing controlled burns at the reserve, performing trail maintenance, and coordinating volunteer days.

Research staff - study estuarine species, from small plankton to large mammals, monitor water quality and weather, create data-rich reserve maps, and more.

Coastal training staff - works to promote scientific understanding amongst a variety of different decision-making audiences in coastal communities.

Educational staff - serve both children and adult visitors through hands-on lab and field experiences, create virtual educational materials, and lead other various environmental outreach initiatives in coastal communities

4. There are a number of recreational opportunities at the NERRS and chances for hands-on learning. How do you think experiencing the outdoors for yourself impacts your feelings of stewardship towards it?

No right answer. Hopefully after being outdoors, they want to be better environmental stewards!

5. What are some examples of coastal decision-makers?

elected officials, city and local planners, people from the water management district, people who issue permits, realtors, ecotour operators, etc.

6. What NERR sites are closest to you? Research a reserve of your choice. What are some specific things that this reserve studies or programs that they provide to visitors that you find interesting?

Depends upon where you're at and student preferences! Selected reserve sites and locations are listed at the beginning of the article.

7. **Match the projects below with the reserve pillar that would likely be responsible for it!**

Carefully removing kudzu and other non-native plants found on reserve lands	Stewardship
Leading a class for commercial seafood dealers on shell recycling and other sustainable practices	Education
Leading guided exploration hikes for all ages at the reserve	Research
Completing a vegetation survey twice per year to observe changes in the dominant salt marsh plant species	Coastal Training

ACTIVITIES

- Your class has been recently employed as NERR staff!
  - Groups can be assigned a NERR pillar to represent and brainstorm a project they could do as that pillar to address the reserve threats mentioned in this article.
  - Groups are assigned one of the issues and have to come up with an example for each pillar on how to potentially address it.

- Students create short presentations on one of the 7 NERR sites either with a partner/group or individually. At the minimum, students should share where the

reserve is, an interesting fact about the region, and a detail about their stewardship, research, coastal training, and education programs. This builds upon question 6.

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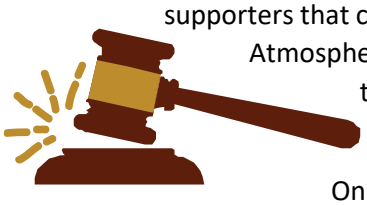
Episode 2: Effectively Communicating Science

The **National Estuarine Research Reserve System (NERRS)** is a system of 30 coastal sites, spanning 1.4 million acres in 24 states and Puerto Rico, created to protect and study estuarine ecosystems. The word **estuarine** describes an environment where freshwater meets saltwater, most often an area where a river meets the sea. Through stewardship, research, coastal training and education, the NERRs are working to create more resilient and better informed communities on our coasts in the face of a changing world and climate. The NERRs have adopted the motto "locally significant, nationally impactful", and together, the entire system is moving the needle on national science and policy needs.

An important group that supports the success of the research reserves is **NERRA**, the National Estuarine Research Reserve Association. NERRA was created to advance the work and mission of the reserves and to raise the profile of this system. NERRA is a collective voice of reserve staff and supporters that can speak to Congress, speak to NOAA (the National Oceanic and Atmospheric Administration), as well as speak to partners all over the country on the important work that the reserves are doing, raising the bar in **advocacy**.



One very important thing that NERRA advocates to protect is the Coastal Zone Management Act, or **CZMA**. The CZMA was passed by the US Congress in 1972, and is an act administered by NOAA. According to NOAA's Office for Coastal Management, the CZMA is designed "to preserve, protect, develop, enhance and restore the nation's coastal resources". The Coastal Zone Management Act outlines three national programs: the National Coastal Zone Management Program, the Coastal and Estuarine Land Conservation Program, and the National Estuarine Research Reserve System. 2022 is the 50th anniversary of the Coastal Zone Management Act, an important milestone for the **cornerstone** legislation of the NERRS.

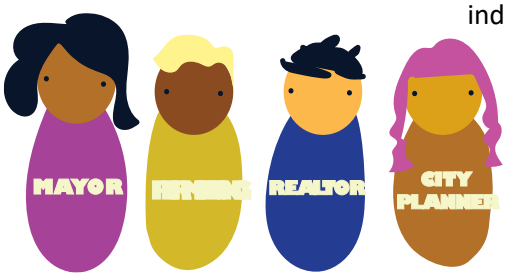
NERRA has been supporting and helping celebrate the CZMA on social media, but more importantly, they've been working with members of Congress to advance the reauthorization of the CZMA itself. Some of the challenges that NERRA president Keith Laakkonen says the organization is facing around the nation: "the country needs a stronger CZMA, one that enhances successful programs like the NERRs, delivers effective coastal management, improves community resilience in a changing

climate, and benefits communities and economic sectors dependent on these healthy natural resources".

Beyond the Coastal Zone Management Act, there have been a number of other efforts, both globally and within the United States, to protect valuable ecosystems like estuaries. An example of this is the US Biosphere Network and the UNESCO (United Nations Educational, Scientific and Cultural Organization) World Network of Biosphere Regions. **Biosphere regions** are special places that are set aside to preserve biodiversity, culture, and economic value. There are 28 biospheres throughout the United States, and scientists are currently working together to build the biosphere network within the country and make it more well-known. The Apalachicola NERR in Eastpoint, FL, is within the Apalachicola Biosphere region, designated in 1983!

Biosphere regions are nominated and maintained by national governments, but the great thing about them and what connects them to their purpose is that they're run by local organizations. Through the designation of these regions and partnerships between community members and public land managers to come up with practical solutions, the U.S. and World Networks are achieving great strides towards a more harmonious relationship between humans and the natural environment. Biosphere regions aim to: 1) promote biodiversity and healthy ecosystems, 2) inform local decision-making through a combination of education, research and open dialogue with the community, 3) create a balance between the needs of people and nature, taking local culture and economies into consideration and 4) truly work as a network where regions globally can share knowledge and learn from the experiences of other regions. Getting back to the NERRs, let's talk about one of the reserve focuses: coastal training.

The **coastal training program (CTP)** offers diverse training opportunities to the community, including courses as unique as "An Introduction to Shorebirds for Ecotour Guides". The program works to promote scientific understanding amongst a variety of different decision-making audiences in coastal communities. The term "decision-makers" includes anyone who has influence and makes decisions that can impact the future of estuarine and coastal communities. Some examples include elected officials, city and local planners, people from the water management district, people who issue permits, realtors, even ecotour operators, as mentioned earlier. By attending programs hosted by the CTP, these individuals are learning valuable new skills and the reserves are able to get information in professionals' hands that will help them better understand how they also have the ability to protect places like estuaries.



Effective science translation and communication are central to what the reserves do. Doing research, training students, publishing papers and getting information out into the scientific literature is important, but as North Inlet-Winyah Bay NERR reserve manager Erik Smith says, "science in a vacuum, science just published in those journals that only scientists read is not enough. We need to get that scientific knowledge and understanding into the hands of the public, into the hands of the decision-makers so that they can use the best available information to make decisions on coastal management issues". Reserves don't push one position or another, but it is really important

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QUESTION TIME

1. What would NERRA like to see change in relation to the CZMA going forward?

2. What is the advantage of biosphere regions and the NERRs being networks? What might these places be like if they were independent?

3. How do the aims of biosphere reserves relate to those of the NERRS?

4. In your own words, what is the goal of the coastal training program?

5. What is the importance of scientists also being good communicators? What is the advantage of being able to effectively share findings with those beyond the field?

6. How are the NERRs "locally significant, nationally impactful"?

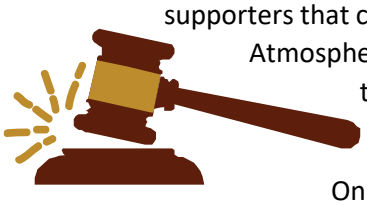
NERR or Far :

The Reserves Are Where You Are

Episode 2: Effectively Communicating Science

The **National Estuarine Research Reserve System (NERRS)** is a system of 30 coastal sites, spanning 1.4 million acres in 24 states and Puerto Rico, created to protect and study estuarine ecosystems. The word **estuarine** describes an environment where freshwater meets saltwater, most often an area where a river meets the sea. Through stewardship, research, coastal training and education, the NERRs are working to create more resilient and better informed communities on our coasts in the face of a changing world and climate. The NERRs have adopted the motto "locally significant, nationally impactful", and together, the entire system is moving the needle on national science and policy needs.

An important group that supports the success of the research reserves is **NERRA**, the National Estuarine Research Reserve Association. NERRA was created to advance the work and mission of the reserves and to raise the profile of this system. NERRA is a collective voice of reserve staff and supporters that can speak to Congress, speak to NOAA (the National Oceanic and Atmospheric Administration), as well as speak to partners all over the country on the important work that the reserves are doing, raising the bar in **advocacy**.



One very important thing that NERRA advocates to protect is the Coastal Zone Management Act, or **CZMA**. The CZMA was passed by the US Congress in 1972, and is an act administered by NOAA. According to NOAA's Office for Coastal Management, the CZMA is designed "to preserve, protect, develop, enhance and restore the nation's coastal resources". The Coastal Zone Management Act outlines three national programs: the National Coastal Zone Management Program, the Coastal and Estuarine Land Conservation Program, and the National Estuarine Research Reserve System. 2022 is the 50th anniversary of the Coastal Zone Management Act, an important milestone for the **cornerstone** legislation of the NERRS.

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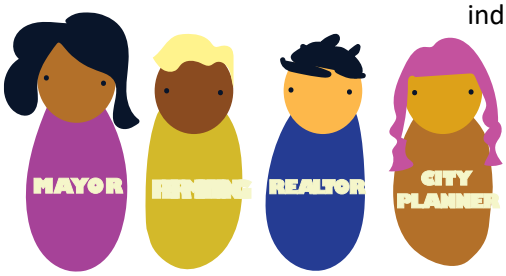

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"a stronger CZMA, one that enhances successful programs like the NERRs, delivers effective coastal management, improves community resilience in a changing climate, and benefits communities and economic sectors dependent on these healthy natural resources."

2. What is the advantage of biosphere regions and the NERRs being networks? What might these places be like if they were independent?

Biosphere regions in the U.S. and globally can share knowledge and learn from the experiences of other regions, and the same goes for the relationship between NERR sites nationally. Students might also mention it being easier to communicate and collaborate, it helps when it comes to standardizing data and protocol/procedures, etc. If these two systems were not setup like networks, their sites would not be able to share information as easily and have the collaborative relationship they do now. They might not be as successful or productive. It might also be difficult to pass legislation related to these systems because their rules and regulations might differ based on location.

3. How do the aims of biosphere reserves relate to those of the NERRS?

Both promote biodiversity and healthy ecosystems, both inform local decision-making through a combination of education, research and open dialogue with the community, and both create a balance between the needs of people and nature, taking local culture and economies into consideration. The aims of the biosphere reserves are nearly identical to the focuses of the

NERRS, which are stewardship, coastal training, education, and research. The NERRs also work closely with the local community and economy, helping support sustainable aquaculture amongst other industries.

4. In your own words, what is the goal of the coastal training program?

The given definition in this article is: “the coastal training program (CTP) offers diverse training opportunities to the community, including courses as unique as "An Introduction to Shorebirds for Ecotour Guides". The program works to promote scientific understanding amongst a variety of different decision-making audiences in coastal communities.” Any version of this should be acceptable! Further details related to the program are in the article.

5. What is the importance of scientists also being good communicators? What is the advantage of being able to effectively share findings with those beyond the field?

Being a good communicator is key to showing people why they should care about your research. It is important to get scientific knowledge and understanding into the hands of the public and into the hands of the decision-makers so that they can use the best available information to make decisions on coastal management issues. Communicating estuarine science to a diverse audience of visitors is also a valuable skill because it can help foster stewardship and a love for the environment in others.

6. How are the NERRs "locally significant, nationally impactful"?

The NERRs work closely with the local community to make change and address issues unique to their estuarine environment as well as with other reserves nationwide to achieve their goals of preserving, protecting, developing, enhancing and restoring the nation's coastal resources. Their coastal training programs help inform local coastal decision-makers while also being supported as a system by NERRA, which can talk to NOAA and Congress about the NERRs and coastal issues.

ACTIVITIES

- Lead a coastal training program! Students brainstorm an issue, whether it be in their local community or on the coast, that they are passionate about and then determine what decision-makers could benefit from attending their program (at least 2 different occupations/positions). The students will also explain the types of information that they would need to provide their audience. Remember, reserves don’t push one position or another, it is about making sure that the decisions that affect everyone who lives in the coastal zone are informed by the best available information.

- Students research different biosphere reserves and select one that stands out to them to create a short presentation about! They will share the designation date, some characteristics of the region, why it is important ecologically, how humans play a role in this system, and why they chose the site.
    - https://en.unesco.org/biosphere/eu-na

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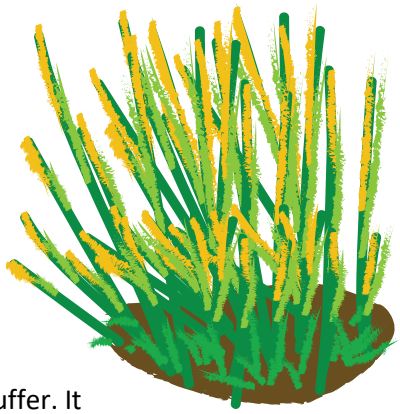
NERR or Far :

The Reserves Are Where You Are

Episode 3: Exploring Estuarine Habitats

First things first, what is an **estuary**? According to National Geographic, an estuary is "an area where a freshwater river or stream meets the ocean". When freshwater and seawater combine, the water becomes **brackish** or slightly salty. The saltiness, or **salinity**, of these estuaries can vary from season to season. In a rainy season, there's more freshwater, so it'll be less salty, also known as less saline. In a dry season, when there's less freshwater, it will be more salty. There are a number of estuarine habitats on our southeastern coast. A few that we'll be focusing on in this article are salt marshes, oyster reefs, maritime forests, and mangroves. Before we dig deeper into the benefits of estuaries, let's look at the differences between each of these individual estuarine habitats.

Salt marshes are a type of coastal wetland that is flooded and drained by saltwater that comes from **tides**. The soil within salt marshes is made up of a deep mud and **peat**. Now, peat is a very thick, spongy material that is made of a decomposing plant matter. Because the peat in marshes is usually underwater and decomposition is taking place, the amount of oxygen in this material can be super low. This state is known as **hypoxia**. "Hypo-" meaning under or beneath, and "-oxia" connects the word to oxygen. There are certain types of bacteria that love these hypoxic conditions, so they grow within the marsh soil. These bacteria produce **hydrogen sulfide**, which gives salt marshes a characteristic rotten egg smell. Now, there are a lot of different types of marsh grasses and different foliage that you can find in the salt marsh, but the most common salt marsh plant species in the southeast is Spartina (specifically, ***Spartina alterniflora***, or smooth cordgrass). Spartina helps with erosion control, acting as a stabilizer as well as a wind and wave buffer. It can also help remove pollutants, and when it dies, it forms what is called "**wrack**" and decomposes, returning nutrients to the system. This is a big reason why salt marshes are the second most **productive** ecosystem on the planet.



Another important habitat in estuaries is an **oyster reef**. Oysters like to live in brackish to salty coastal waters, making estuaries a perfect place to call home. Oysters often cluster on hard submerged surfaces and then fuse together as they grow, forming hard, rock-like reefs that can get to be 6 to 8 feet high! They'll make reefs on anything from piers to old discarded shells. That reef can then become a

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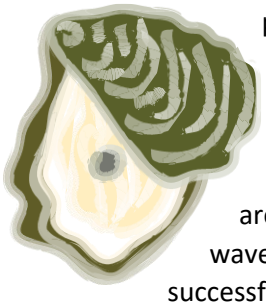
habitat for a wide range of other marine species. These structures are like little apartment complexes! Oysters are considered a keystone species, and a main reason for this designation is their role in providing habitat and shelter for crabs, worms, and all sorts of marine creatures.



It's quite an interrelated, connected ecosystem. A **keystone species** is any organism, whether it be an animal, bacteria or fungi, or a plant that serves as the glue holding the habitat together. If it were to disappear or be removed, the **biodiversity** and structure of that habitat could completely change. Oyster reefs are also great protectors. When waves get churned up in the bay, they buffer those waves so that when they hit the shoreline, they're not as strong and they won't be as successful in eroding away the shoreline. One way that **National Estuarine Research Reserves (NERRs)** in the southeast are supporting these reefs is through shell recycling programs. Reserve staff go to local restaurants that serve the oysters and recover the shell, clean it, dry it and then put it back out into the estuary!

Next up is the **maritime forest**. Maritime forests, a type of shoreline estuary along coastal barrier islands, are constantly changing and moving with a changing shoreline. These forests are typically surrounded by a layer of dunes on one side and salt marsh on the other, but don't completely escape the impacts of ocean winds and salt spray. For this reason, there's a canopy of shrub-like foliage to protect less tolerant interior trees. One state in the southeast that has a lot of maritime forest habitat is North Carolina.

Speaking of less tolerant trees, there is currently concern over an increase in what is known as "ghost forests" where once green, healthy woodlands and maritime forests used to exist. Sea level rise and an increased frequency of storms as a result of climate change is causing an excess of saltwater to advance and take over freshwater that deciduous trees need to survive along coastlines. Without the freshwater that they need to thrive, these trees die and remain in the brackish water, creating a spooky, soggy forest of gray, decaying trees. **Ghost forests** are not healthy forests, and because of this, they are unable to support the variety of life that they did before the impacts of **saltwater intrusion.** This also negatively impacts the forest's ability to store carbon, which can further fuel changes in our climate.

Lastly, **mangroves** are a type of tropical tree or shrub that live in the coastal **intertidal zone**. They're able to survive and thrive in conditions that many other trees could not. This hardy group tolerates brackish to salty coastal waters, and the never-ending **ebb** and flow of ocean tides. Their roots even create incredible underwater nursing environments for many marine species.

Storm protection, filtration and nursery are the three main benefits or ecosystem services of estuarine habitats. Let's look at storm protection. Estuaries have an incredible ability to serve as important **buffer zones**. These habitats soak up excess water during flooding and stabilize shorelines, absorbing wave energy, protecting streams and shores from excessive erosion. In the event of a hurricane or tropical storm, estuaries are a line of defense for inland habitats and communities. And it's not just flooding from hurricanes that estuaries can help control, they can help with any kind of flooding! If rivers flood their banks, the water can empty out onto the floodplain and spread out, flowing into **sloughs**, swamps and marshes before being absorbed. This process also demonstrates how

Name: _____ Date: _____

estuarine habitats are incredible carbon sinks! A **carbon sink** is anything natural or unnatural that collects and stores some carbon containing compounds for an indefinite period of time. By doing this, they remove **carbon dioxide** from the atmosphere!

Our next benefit is filtration. Salt marshes and mangroves, with their spongy peat and marsh grasses or complex matrices of tree roots, are like the Brita filters of coastal communities. They filter out all sorts of things, from herbicides and pesticides, heavy metals from industry, to excess sediments and nutrients from runoff. This is an incredible benefit, but not something to be taken advantage of. Declines in estuarine water quality can endanger aquatic life and impact human health. The NERRs do an incredible job of monitoring water quality through their **System-Wide Monitoring Program** (also known as SWMP).

Lastly, estuaries serve as a nursery for many species, creating a unique space for reproduction and early life. The mud and food particles brought in by the tide settle in some parts of estuaries where the water is more still, and hard structures like mangrove roots provide a degree of protection. These safe conditions are ideal for organisms to grow, feed and have young. Estuaries provide such great benefits to our coastal communities and because of this, it's important to study and protect these habitats. That's the purpose of the NERRs, and it's something that we can also help out with. Our activities on land can have a big impact on the health of our estuaries, so let's be good environmental **stewards**!

QUESTION TIME

1. Why do salt marshes smell like rotten eggs?

2. Name a benefit of *Spartina*.

3. What is a keystone species? Can you name any other organisms that may be considered a keystone species?

4. Define carbon sink in your own words.

5. What structures serve as the main "filter" of salt marshes and mangroves?

6. What creates a ghost forest?

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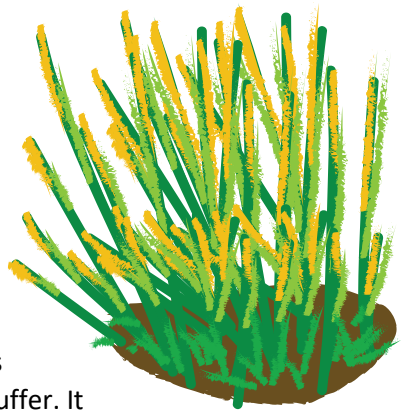

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QUESTION TIME

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Peat in marshes creates hypoxic conditions, which bacteria that produce hydrogen sulfide love. Hydrogen sulfide is a colorless gas with a strong odor of rotten eggs.

2. Name a benefit of *Spartina*.

Spartina helps with erosion control, acting as a stabilizer as well as a wind and wave buffer. It can also help remove pollutants, and when it dies, it forms what is called "wrack" and decomposes, returning nutrients to the system.

3. What is a keystone species? Can you name any other organisms that may be considered a keystone species?

A keystone species is any organism, whether it be an animal, bacteria or fungi, or a plant that serves as the glue holding the habitat together. If it were to disappear or be removed, the biodiversity and structure of that habitat could completely change. Some examples in North America are sea otters, grizzly bears, gray wolves, sharks, and hummingbirds. The site below has further details on why these species are considered keystone species: https://wildlifeinformer.com/keystone-species-examples/

4. Define carbon sink in your own words.

The definition provided in the article is: “a carbon sink is anything natural or unnatural that collects and stores some carbon containing compounds for an indefinite period of time. By doing this, they remove carbon dioxide from the atmosphere!”

5. What structures serve as the main "filter" of salt marshes and mangroves?

Salt marshes = spongy peat and marsh grasses, mangroves = complex matrices of tree roots

6. What creates a ghost forest?

Sea level rise and an increased frequency of storms as a result of climate change is causing an excess of saltwater to advance and take over freshwater that deciduous trees need to survive along coastlines. Without the freshwater that they need to thrive, these trees die and remain in the brackish water, creating a spooky, soggy forest of gray, decaying trees.

ACTIVITIES

- A developer wants to clear the area where your selected habitat (salt marsh, oyster reef, maritime forest, mangrove) exists. What would happen if they did this? What sorts of organisms live there and how would they be impacted? In your own words discuss the benefits that this habitat provides to both the marine environment and communities on land.
- Artist time! Draw an estuarine habitat of your choosing and include and label distinguishing features. Each habitat should contain at least 3 animals and at least one kind of structural component, whether it be a hard structure or plants! Show your art off to the group!

Name: _____ Date: _____

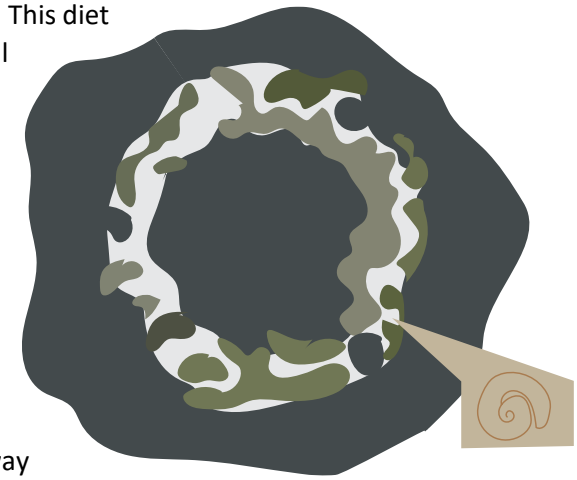
NERR or Far :

The Reserves Are Where You Are

Episode 4: Protecting Cultural Resources

People have been living along our coastlines and in estuaries for a very, very long time. Estuaries have always provided their inhabitants with protection and valuable resources that create ideal conditions for settlement. Because of this, **the National Estuarine Research Reserves, or the NERRs**, have an important role in protecting archaeological sites and other **cultural resources** on their lands. The Rookery Bay NERR in Naples, Florida, is one site in particular that has a lot of history to help protect.

People have been part of the story of Rookery Bay going back over 4000 years, going back to the Late Archaic period. People have lived with the environment in this area for a long time, and you can see evidence of this through the numerous **shell mounds** that dot the landscape. The mounds are a little more hidden now than they once were, covered with tropical **hardwood hammocks** and other plant species that researchers have confidence would not exist anywhere else except for these shell mounds. This creates a unique environment for study. One of the reasons that these sites exist is because the **Calusa** Native Americans (a tribe that unfortunately no longer exists) ate a diet that was very high in protein and left evidence of this where they once lived and worked. This diet included things like clams, **gastropods** and various species of fish, all species with **calcareous** shells or hard, bony structures, which preserve well. Their diet was actually so good that the average Calusa male in the 16-1700s, at the time of contact with Europeans, was about six feet tall. Unfortunately, European diets back then weren't as good, and so the Spanish when they came over described the Calusa as being tall, towering giants.

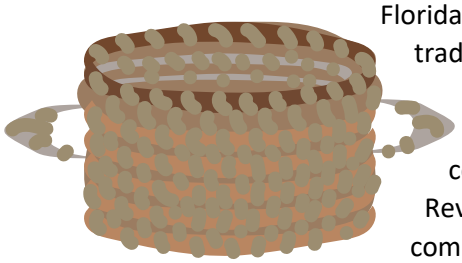


It was because of the bountifulness and richness of the estuary that the Calusa were able to exist- not only exist, but do successfully. They were actually one of the few non-agricultural Native American tribes in America, and they were able to live this way because they had enough from fishing and **aquaculture** that they didn't need to farm on land as a supplemental food source. There's also a lot of other history at the reserve, including that of the first people who settled Rookery Bay after the Calusa were gone, the veterans of the Civil War period. These people came out into the estuaries in the 1800s and settled onto Rookery Bay and surrounding areas for the same reason that the Calusas existed so successfully for so long: the bountifulness of the estuary.

Name: _____ Date: _____

We can travel nearly 500 miles from the Rookery Bay NERR to the ACE Basin NERR in the Charleston, South Carolina area, and we will still find Native American shell mounds and rings in the estuaries. One thing that these sites across the southeast have in common is that they're currently threatened by storms and sea level rise. The ACE Basin NERR has done a lot of work with state archaeologists to better understand their Native American sites. Working as quickly as they can, they have been trying to learn about and document the shell rings and other types of evidence of human settlements at the reserve that are severely eroding due to threats tied to our changing climate. Through studying these sites, researchers at the reserve have learned a lot about the abundance of oyster populations 4000 years ago and the variety of species that were used by estuary inhabitants for food. They can also tell how people moved around based on the availability of different resources, how they really lived in connection with the environment, used it to their advantage, and were resilient in the face of the different environmental threats that we face on our coasts even today. Native American archaeological sites give us a glimpse into the history of estuaries and coastal communities in the southeast. Sadly, as our planet warms, sea level rises, and storms become a greater issue, scientists and archaeologists are in a race against time to study and gather all that they can from these incredible cultural resources.

Two priority issues that the NERRs of the southeast are working to address are a changing climate and determining the impacts of coastal development. Another community that has had a big role in the history of our southeastern estuaries and a community that is dealing with the impacts of coastal development is the **Gullah-Geechee** community. The Gullah-Geechee are descendants of enslaved West African people who worked on coastal plantations from North Carolina to northern Florida. The Geechee people still maintain many unique West African traditions and elements of their language and culture. Some historians believe that the historic **Hog Hammock** community on Sapelo Island in Georgia is one of the last intact island-based Geechee communities in America. According to the island's Cultural and Revitalization Society, about 96% of the island surrounding the community is owned by the state of Georgia and cannot be purchased for development. This, in tandem with the fact that the island can only be accessed by ferry or private boat, creates an environment that makes those who have called Sapelo home for generations subject to stress and fracturing from land loss, speculative developers, a lack of job opportunities and racism.



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More cultural resources and reminders of the history of our southeastern estuaries are the horses at the Rachel Carson and Currituck sites of the North Carolina NERR. Long ago in the 1920s and 30s around Beaufort, NC, the body of water that separates town proper and what is now known as the Rachel Carson reserve was really shallow. Because of this, people from the town would bring their animals over there to take advantage of the opportunity for free grazing. One gentleman who brought his horses over there to graze ended up passing away, and without an owner they became feral. When the state of North Carolina eventually took over the management of the reserve, they decided to leave the horses on the reserve's land because they viewed the horses as a cultural resource to the community and reminder of the region's history.

The creation of many of the NERRs in the southeast was made possible by a number of conservation organizations and government agencies. But in the case of the North Inlet-Winyah Bay Reserve in South Carolina, there was an important environmental steward who paved the way: Belle W Baruch. Belle was the daughter of Bernard Baruch, a wealthy New York City financier who bought the now reserve property shortly after the Civil War and the collapse of the rice plantations. He bought it as a hunting property and enjoyed it as a winter retreat. When Belle came down to visit, however, she realized what an amazing and unique piece of property it was. Seeing how the other plantations along the SC coastline in the late 60s were being developed, she realized she needed to help leave this property intact. She set up a **trust** that would make this property available for research and education, an act that is very much in line with the current mission of the reserve, which is "protecting and wise coastal stewardship of the estuaries through research and education". Belle unfortunately died young of cancer and never got to see the creation of the reserve, but her generosity had an incredible impact on conservation and estuarine science in the southeast.

The National Estuarine Research Reserve System doesn't just study and protect our natural resources on the coast, they also play a role in protecting cultural resources and keeping the rich history of southeastern coastal communities alive. Whether it's an archaeological site, herds of feral horses, a community teeming with important culture and tradition, or hunting land turned living laboratory, reserves are committed to lending a hand and learning more. There's a lot that we can learn from these people and these sites. Storms, sea level rise, coastal development, and a number of other threats have created a race against time for those studying at the reserves, but hopefully we can learn more about the history of our estuaries before it's too late.

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QUESTION TIME

1. How did living on the estuary impact the lifestyle of the Calusa Native Americans?
2. What types of information can we gather about the past from shell rings and mounds today?
3. What challenges are archaeologists currently facing related to these sites?
4. What is unique about the Hog Hammock community on Sapelo Island? Name a challenge that this group is currently facing.
5. What is the story of the horses at the NCNERR? Why leave them on reserve land?
6. Who was Belle W. Baruch and how is she tied to the NERRS?

NERR or Far :

The Reserves Are Where You Are

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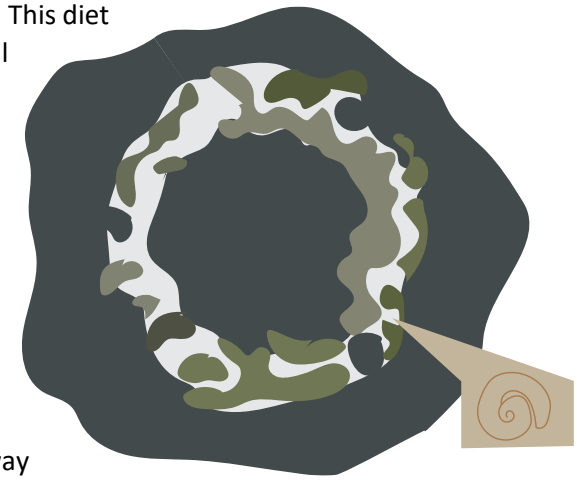

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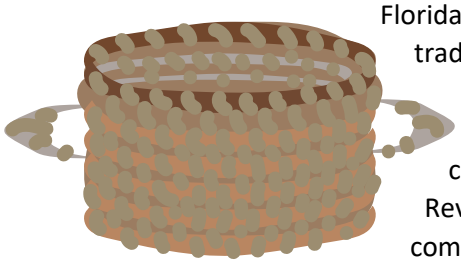

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QUESTION TIME

1. How did living on the estuary impact the lifestyle of the Calusa Native Americans?

They ate a very protein-rich diet made up of clams, gastropods, and fish from the estuary, and because of the bountifulness of the area, they didn't need to farm on land to supplement their fishing and aquaculture efforts.

2. What types of information can we gather about the past from shell rings and mounds today?

We can learn about the abundance of oyster populations 4000 years ago, the variety of species that were used by estuary inhabitants for food, how people moved around based on the availability of different resources, how they lived in connection with the environment and used it to their advantage, and how they were resilient in the face of the different environmental threats that we face on our coasts even today. Students can also guess other things like the size of these settlements, when they might have been abandoned or wiped out, tools used by these groups to build, fish, and culture aquatic species, etc.

3. What challenges are archaeologists currently facing related to these sites?

As our planet warms, sea level rises, and storms become a greater issue, scientists and archaeologists are in a race against time to study and gather all that they can from these incredible cultural resources before they're eroded and/or underwater.

4. What is unique about the Hog Hammock community on Sapelo Island? Name a challenge that this group is currently facing.

Some historians believe that the historic Hog Hammock community on Sapelo Island in Georgia is one of the last intact island-based Geechee communities in America. They are currently facing a lot of pressure from developers to sell their land as the island becomes a popular vacation destination. The fact that about 96% of the island surrounding the Hog Hammock community is owned by the state of Georgia and cannot be purchased for development and the island can only be accessed by ferry or private boat creates an environment that makes those who have called Sapelo home for generations subject to a lot of stress. They have experienced stress from land loss, speculative developers, a lack of job opportunities and racism, amongst other things. The Geechee population on Sapelo has gone from 700 members in the 1910s to now closer to 30.

5. What is the story of the horses at the NCNERR? Why leave them on reserve land?

Long ago in the 1920s and 30s around Beaufort, NC, the body of water that separates town proper and what is now known as the Rachel Carson reserve was really shallow. Because of this, people from the town would bring their animals over there to take advantage of the opportunity for free grazing. One gentleman who brought his horses over there to graze ended up passing away, and without an owner they became feral. When the state of North Carolina eventually took over the management of the reserve, they decided to leave the horses on the reserve's land because they viewed the horses as a cultural resource to the community and reminder of the region's history.

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- How are your acting skills? Students choose an inhabitant of the estuaries discussed in this article and create a short skit to explain the history of this group in this environment, as well any threats to the preservation of their history.
- Students create a short journal entry from someone who lived or is living in the estuaries and coastal communities using what they know from this article. What obstacles may they have faced? What did the estuary provide them?

Name: _____ Date: _____

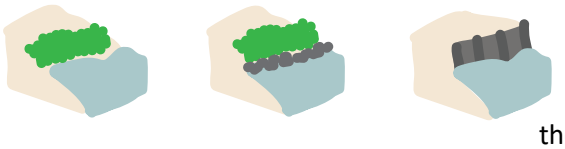
NERR or Far :

The Reserves Are Where You Are

Episode 5: A Glimpse Inside the Reserve Toolbelt

National Estuarine Research Reserves (NERRs) utilize a wide variety of techniques and tools to manage their lands and help foster healthy ecosystems on our coastline. One of these techniques is installing **living shorelines**. So what are living shorelines? **NOAA**, the National Oceanic and Atmospheric Administration, says that living shorelines "connect the land and water to stabilize shorelines, reduce erosion, and provide valuable habitat that enhances coastal resilience". Living shorelines utilize natural elements like plants, rocks and sand to stabilize estuarine coasts, sometimes in combination with existing harder shoreline structures, like **bulkheads** or **seawalls**. These shorelines are a creative and cost-effective way to add **resilience** to communities on the water as well as provide valuable habitat for wildlife. They are also beautiful green space! Living shorelines can replace aging structures like old boat launches or docks. Another benefit is that they will grow over time, unlike hard structures, which may end up hindering the growth of aquatic life.

Shoreline treatments lie on the spectrum from green to gray. **Green shorelines** are designed using more natural, softer techniques, whereas **gray shorelines** are less natural, using what's considered harder techniques. An example of a more green shoreline is a **vegetation-only shoreline**. This type of shoreline would be useful in low wave energy environments to provide a buffer to upland areas. This type is considered a non-structural method and a type of living shoreline. An example of a gray shoreline technique would be installing a bulkhead: a vertical wall parallel to the shoreline. Areas highly vulnerable to storm surge and powerful waves use bulkheads to hold soil in place. This is considered a coastal structure, not a living shoreline. A technique in the middle of the spectrum is **sills**. Sills are a hybrid type of living shoreline where a structure made of rock, concrete or oyster shell lies parallel against an existing vegetated shoreline. This technique reduces wave energy and prevents erosion in areas that don't commonly receive high wave energy. NOAA encourages using the softest, or greenest, approaches to shoreline stabilization that are feasible based on site conditions. Studies have found that during major storms, living natural shorelines perform better than a hardened shoreline and are less costly. The NERRs are doing a lot of neat work with living shorelines.



The ACE Basin NERR in South Carolina has been working on living shorelines for years. The reserve's researchers have investigated different materials and methods that are the most effective to

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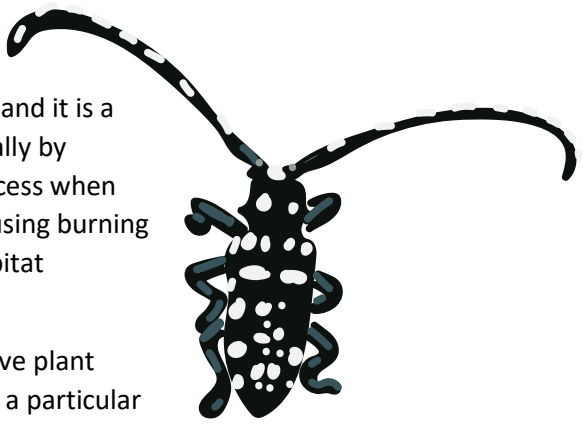
build living shorelines, experimenting with combinations of **oyster reefs** and marsh grass planting, as well as other natural materials based upon what the specific site looks like. They've done extensive testing and monitoring of living shorelines to determine the best methods for different areas along the coast. Other ACE Basin staff have worked with community members who live on the marsh to help inform them on how to go about installing a living shoreline instead of a seawall to help prevent erosion, and how that mechanism would work. Reserve partners and permitting agencies are also involved, helping determine where it would be possible to build more living shorelines on the SC coast. The reserve's education section has even gotten involved through a school-based program, "From Seeds to Shoreline'', where kids can grow marsh grass at school and then plant it in the community as living shorelines. The reserve stewardship sector leads a similar program with adult groups and different community organizations!

Another living shoreline project is in the works at the Apalachicola NERR in Florida. There is an important highway between Apalachicola and Carabelle, two towns in the county that are right against the water, and during hurricanes and winter storms the water is now consistently reaching the edge of the highway due to nearby shoreline erosion. Because of this, every time there is a large storm, it takes out little chunks of the road, forcing drivers to take a detour. So what the reserve is planning to do is plant ***Spartina*** and other plants in the water and recreate a marsh in front of the highway, hoping to create an effective wave **buffer** that prevents further erosion of the pavement. The Federal Highway Administration and the Florida Highway Department of Transportation have even given a grant to support the project. The route out of town for Apalachicola residents will hopefully be preserved by the area's new living shoreline!

The **stewardship** staff at the NERRs oversee land management at the reserves, which is an important role considering what we do on land can impact the health of our waters. Reserve land managers work on public access, developing kiosks and maps that people can use to hike reserve lands, maintain trails and places where you can get out and leave your car safely, perform prescribed / controlled burning, and manage invasive species. **Controlled burns**, as ironic as it sounds, help prevent destructive wildfires by ridding the forest floor of flammable debris like dead leaves in a more controlled, monitored setting. Additional benefits include returning nutrients to the soil through the ashes of vegetation, clearing space to give young trees more sunlight for growth and reducing insect populations. Some species of pine even have cones that need fire to **germinate**, or to begin growing the seeds within them. These burns can also destroy invasive plant species.



We have a long history of controlled burning in this part of the country. Pine forests in the southeast have become adapted to fire, and it is a very natural occurrence for these trees. Fires are typically caused naturally by lightning; reserve staff use controlled burning to mimic that natural process when needed. We also have evidence of some of our Native American tribes using burning to flush game, to clear the landscape, and to perform other types of habitat management a lot in the way that biologists do now.

One important benefit of controlled burning is destroying invasive plant species. An **invasive species** is any type of organism that is not native to a particular environment, and can cause harm to this area. Some invasive species are brought to a new area on

Name: _____ Date: _____

purpose to serve as a method of pest control or as pets, but in many cases, their introduction is actually accidental. Maybe they traveled in the **ballast water** of ships, or they were transported cross country with a crop harvest, or they were even just a bug that hitched a ride in a car. Since these species are not native to their new environment, there are often no predators to hunt them, and they can even outcompete many native species for food. Unchecked, these organisms can cause a lot of harm to the environment, as well as to the economy, damaging property and hurting **yields** from a variety of industries.

Another management technique is **beach renourishment**. In beach renourishment, sand is moved from areas offshore to resupply eroded beach areas. But where does the sand move over time? Where does it go after a storm? These are questions that the North Carolina NERR and partners at the University of North Carolina at Wilmington are investigating. Andrea Hawks and Joe Long have been investigating long-term effects from Hurricane Florence on Masonboro Island, as well as the impacts of beach renourishment in this area. Sand was deposited along portions of the southern end of the island, and since then, they have been tracking changes to the beach profile and sediment composition. The goal is to develop long-term predictive models to help folks understand how the sand will move and what the island might look like in the future. The NERRs do an incredible job of managing reserve lands through a variety of management techniques, from living shorelines to controlled burns. Through careful stewardship of our estuaries and coasts, reserves of the southeast are helping to improve coastal resiliency and preserve biodiversity. What a nifty toolbelt!

QUESTION TIME

1. Name some benefits of living shorelines

2. If you lived in an area that doesn't **typically** receive high wave energy, what type of shoreline technique would you use? Why?

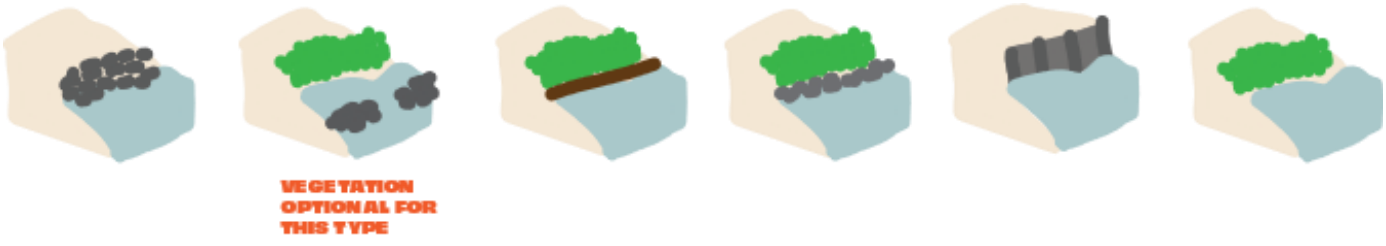
3. What are some ways that reserve land managers help foster sustainable natural ecosystems in the southeast?

4. Why are invasive species harmful? Do you know any invasive species in your state?

5. Why do reserves perform controlled burning? What might happen if they didn't do this?

6. What is the importance of creating long-term predictive models for beach renourishment?

7. Put these shorelines in order from green to gray (1 is the greenest, 6 is the grayest)



NERR or Far :

The Reserves Are Where You Are

Episode 5: A Glimpse Inside the Reserve Toolbelt

National Estuarine Research Reserves (NERRs) utilize a wide variety of techniques and tools to manage their lands and help foster healthy ecosystems on our coastline. One of these techniques is installing **living shorelines**. So what are living shorelines? **NOAA**, the National Oceanic and Atmospheric Administration, says that living shorelines "connect the land and water to stabilize shorelines, reduce erosion, and provide valuable habitat that enhances coastal resilience". Living shorelines utilize natural elements like plants, rocks and sand to stabilize estuarine coasts, sometimes in combination with existing harder shoreline structures, like **bulkheads** or **seawalls**. These shorelines are a creative and cost-effective way to add **resilience** to communities on the water as well as provide valuable habitat for wildlife. They are also beautiful green space! Living shorelines can replace aging structures like old boat launches or docks. Another benefit is that they will grow over time, unlike hard structures, which may end up hindering the growth of aquatic life.

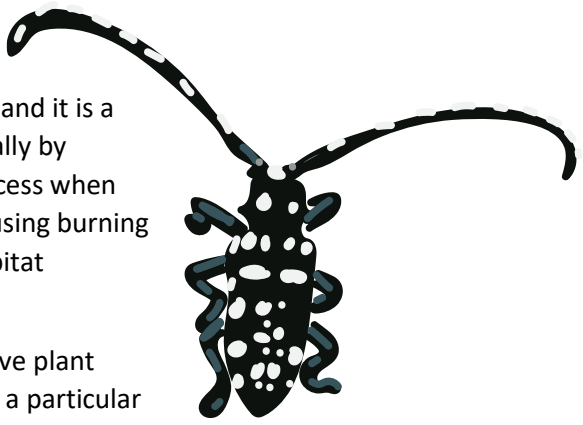
Shoreline treatments lie on the spectrum from green to gray. **Green shorelines** are designed using more natural, softer techniques, whereas **gray shorelines** are less natural, using what's considered harder techniques. An example of a more green shoreline is a **vegetation-only shoreline**. This type of shoreline would be useful in low wave energy environments to provide a buffer to upland areas. This type is considered a non-structural method and a type of living shoreline. An example of a gray shoreline technique would be installing a bulkhead: a vertical wall parallel to the shoreline. Areas highly vulnerable to storm surge and powerful waves use bulkheads to hold soil in place. This is considered a coastal structure, not a living shoreline. A technique in the middle of the spectrum is **sills**. Sills are a hybrid type of living shoreline where a structure made of rock, concrete or oyster shell lies parallel against an existing vegetated shoreline. This technique reduces wave energy and prevents erosion in areas that don't commonly receive high wave energy. NOAA encourages using the softest, or greenest, approaches to shoreline stabilization that are feasible based on site conditions. Studies have found that during major storms, living natural shorelines perform better than a hardened shoreline and are less costly. The NERRs are doing a lot of neat work with living shorelines.

The ACE Basin NERR in South Carolina has been working on living shorelines for years. The reserve's researchers have investigated different materials and methods that are the most effective to build living shorelines, experimenting with combinations of **oyster reefs** and marsh grass planting, as

well as other natural materials based upon what the specific site looks like. They've done extensive testing and monitoring of living shorelines to determine the best methods for different areas along the coast. Other ACE Basin staff have worked with community members who live on the marsh to help inform them on how to go about installing a living shoreline instead of a seawall to help prevent erosion, and how that mechanism would work. Reserve partners and permitting agencies are also involved, helping determine where it would be possible to build more living shorelines on the SC coast. The reserve's education section has even gotten involved through a school-based program, "From Seeds to Shoreline'', where kids can grow marsh grass at school and then plant it in the community as living shorelines. The reserve stewardship sector leads a similar program with adult groups and different community organizations!

Another living shoreline project is in the works at the Apalachicola NERR in Florida. There is an important highway between Apalachicola and Carabelle, two towns in the county that are right against the water, and during hurricanes and winter storms the water is now consistently reaching the edge of the highway due to nearby shoreline erosion. Because of this, every time there is a large storm, it takes out little chunks of the road, forcing drivers to take a detour. So what the reserve is planning to do is plant ***Spartina*** and other plants in the water and recreate a marsh in front of the highway, hoping to create an effective wave **buffer** that prevents further erosion of the pavement. The Federal Highway Administration and the Florida Highway Department of Transportation have even given a grant to support the project. The route out of town for Apalachicola residents will hopefully be preserved by the area's new living shoreline!

The **stewardship** staff at the NERRs oversee land management at the reserves, which is an important role considering what we do on land can impact the health of our waters. Reserve land managers work on public access, developing kiosks and maps that people can use to hike reserve lands, maintain trails and places where you can get out and leave your car safely, perform prescribed / controlled burning, and manage invasive species. **Controlled burns**, as ironic as it sounds, help prevent destructive wildfires by ridding the forest floor of flammable debris like dead leaves in a more controlled, monitored setting. Additional benefits include returning nutrients to the soil through the ashes of vegetation, clearing space to give young trees more sunlight for growth and reducing insect populations. Some species of pine even have cones that need fire to **germinate**, or to begin growing the seeds within them. These burns can also destroy invasive plant species.



We have a long history of controlled burning in this part of the country. Pine forests in the southeast have become adapted to fire, and it is a very natural occurrence for these trees. Fires are typically caused naturally by lightning; reserve staff use controlled burning to mimic that natural process when needed. We also have evidence of some of our Native American tribes using burning to flush game, to clear the landscape, and to perform other types of habitat management a lot in the way that biologists do now.

One important benefit of controlled burning is destroying invasive plant species. An **invasive species** is any type of organism that is not native to a particular environment, and can cause harm to this area. Some invasive species are brought to a new area on purpose to serve as a method of pest control or as pets, but in many cases, their introduction is actually

accidental. Maybe they traveled in the **ballast water** of ships, or they were transported cross country with a crop harvest, or they were even just a bug that hitched a ride in a car. Since these species are not native to their new environment, there are often no predators to hunt them, and they can even outcompete many native species for food. Unchecked, these organisms can cause a lot of harm to the environment, as well as to the economy, damaging property and hurting **yields** from a variety of industries.

Another management technique is **beach renourishment**. In beach renourishment, sand is moved from areas offshore to resupply eroded beach areas. But where does the sand move over time? Where does it go after a storm? These are questions that the North Carolina NERR and partners at the University of North Carolina at Wilmington are investigating. Andrea Hawks and Joe Long have been investigating long-term effects from Hurricane Florence on Masonboro Island, as well as the impacts of beach renourishment in this area. Sand was deposited along portions of the southern end of the island, and since then, they have been tracking changes to the beach profile and sediment composition. The goal is to develop long-term predictive models to help folks understand how the sand will move and what the island might look like in the future. The NERRs do an incredible job of managing reserve lands through a variety of management techniques, from living shorelines to controlled burns. Through careful stewardship of our estuaries and coasts, reserves of the southeast are helping to improve coastal resiliency and preserve biodiversity. What a nifty toolbelt!

QUESTION TIME

1. Name some benefits of living shorelines.

Living shorelines connect the land and water to stabilize shorelines, reduce erosion, and provide valuable habitat that enhances coastal resilience. They are also beautiful green space, low-cost, can replace aging structures like old boat launches or docks, and will grow over time, unlike hard structures, which may end up hindering the growth of aquatic life.

2. If you lived in an area that doesn't **typically** receive high wave energy, what type of shoreline technique would you use? Why?

The best type to use in this case would be a sill, a hybrid type of living shoreline where a structure made of rock, concrete or oyster shell lies parallel against an existing vegetated shoreline. This technique reduces wave energy and prevents erosion in areas that don't commonly receive high wave energy. A vegetation-only shoreline could also work, but considering it is most effective in low wave energy environments, a sill could ensure better protection in case there is a storm event in this area.

3. What are some ways that reserve land managers help foster sustainable natural ecosystems in the southeast?

Reserve land managers work on public access, developing kiosks and maps that people can use to hike reserve lands, maintain trails and places where you can get out and leave your car safely, perform prescribed / controlled burning, manage invasive species, and occasionally do beach renourishment.

4. Why are invasive species harmful? Do you know any invasive species in your state?

Since these species are not native to their new environment, there are often no predators to hunt them, and they can even outcompete many native species for food. Unchecked, these organisms can cause a lot of harm to the environment, as well as to the economy, damaging property and hurting yields from a variety of industries. Some examples of invasive species in the southeast include:

NC: spotted lanternfly, emerald ash borer, red sorrel, freshwater golden clam, spongy moth

SC: Chinese wisteria, kudzu bug, sugarcane aphid, spotted-wing drosophila

GA: tropical soda apple, Japanese stiltgrass, feral pigs

FL: torpedograss, old world climbing fern, Cuban treefrog, green iguana, veiled chameleon

Great site to find lists of invasive species: https://www.eddmaps.org/tools/choosedistrict.cfm

(From UGA Center for Invasive Species and Ecosystem Health)

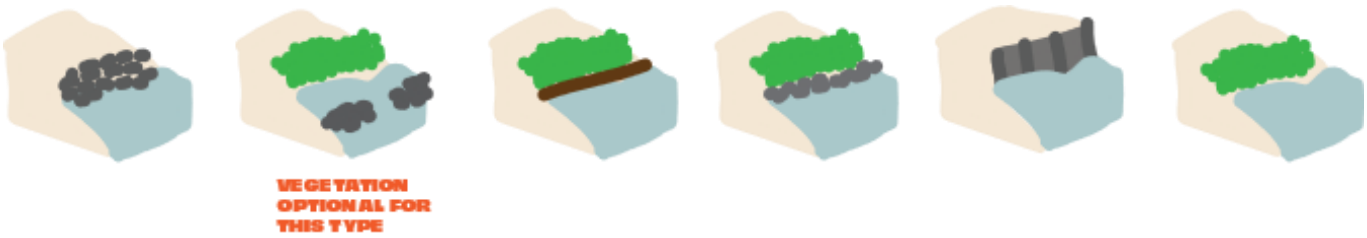
5. Why do reserves perform controlled burning? What might happen if they didn't do this?

Controlled burns help prevent destructive wildfires by ridding the forest floor of flammable debris like dead leaves in a more controlled, monitored setting. Additional benefits include returning nutrients to the soil through the ashes of vegetation, clearing space to give young trees more sunlight for growth and reducing insect populations. Some species of pine even have cones that need fire to germinate, or to begin growing the seeds within them. These burns can also destroy invasive plant species. If they didn’t do this, destructive wildfires could catch and spread uncontrollably in coastal communities. Relying upon natural fires via lightning strike could also mean less control over insect and invasive species populations and limited ability for new trees to spring up in dense areas.

6. What is the importance of creating long-term predictive models for beach renourishment?

Predictive models help scientists and the public understand how the sand will move and what the island might look like in the future. It helps ensure that reserves and their communities are making the best-informed decisions.

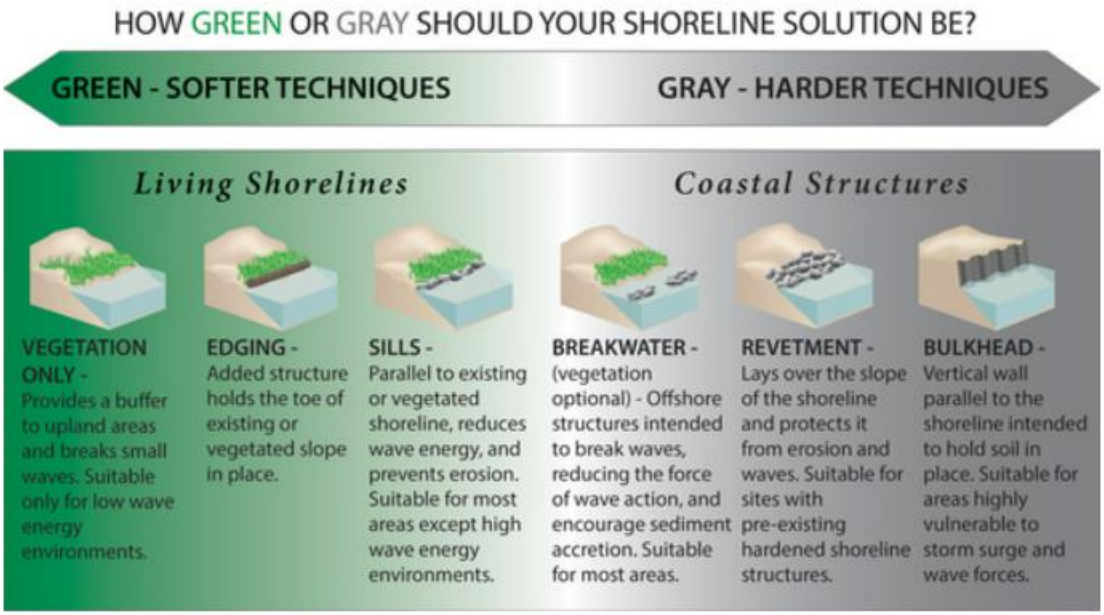
7. Put these shorelines in order from green to gray (1 is the greenest, 6 is the grayest)



5	4	2	3	6	1
Revetment	Breakwater	Edging	Sill	Bulkhead	Vegetation -Only

ACTIVITIES

- Take part in the seeds to shoreline program! More info here: https://www.scseagrant.org/from-seeds-to-shoreline/
- Have a class discussion on question 7, what are the advantages and disadvantages of these different options, and where they might be used?



NOAA Fisheries (2023). Coastal Shoreline Continuum and Typical Living Shorelines Treatments [Photograph]. https://www.fisheries.noaa.gov/insight/understanding-living-shorelines#:~:text=A%20living%20shoreline%20is%20a%20protected%2C%20stabilized%20coastal,plants%20and%20animals%2C%20living%20shorelines%20grow%20over%20time.

- Students in groups create short presentations on different management tools, what they're used for, and how they are used in other areas of the country as well.
- Students create presentations on a southeastern invasive species and how they got here! *The beetle illustrated in this article is an Asian Longhorned Beetle, an invasive species that threatens hardwood trees in Massachusetts, New York, and Ohio. It was first detected in eastern U.S. ports in 1992.*

Name: _____ Date: _____

NERR or Far :

The Reserves Are Where You Are

Episode 6: Environmental Stewardship 101

So what does it mean to be an environmental steward? Erik Smith, reserve manager of the North Inlet - Winyah Bay **National Estuarine Research Reserve (NERR)** in South Carolina, says that **stewardship** is probably the most important thing that the NERRs do, and it embodies every aspect of what a reserve does. There are a lot of different definitions of stewardship, but his favorite embodies the notion of careful and responsible management of something that has been entrusted in your care. The coastal zone has been entrusted to us, and we need to responsibly care for and manage it because it is so very important!

You don't need to work at a reserve to be a steward of the coastal zone. We can all be caretakers of our environment! Some ways to be good environmental stewards at the reserves and also in your own community are by planting native plants in your yard, making sure that you're putting down the proper and appropriate amount of fertilizer at the right time, exercising proper catch and release when you're fishing, and respecting the space of wildlife. Native plants are very important for **pollinators**, for migratory birds, and for many species of wildlife moving through the area and your landscape. Native gardens use less water, require less **maintenance**, reduce the spread of **invasive species**, and create a diverse, ideal habitat for native wildlife.

Fertilizer is great for yards, but if it washes off, it can be very harmful for the estuary and local waterways. Too much of a good thing can be a bad thing, and in this case, too many nutrients entering waterways from fertilizer runoff can lead to harmful algal blooms and negative impacts on local water quality. Definitely feed and take care of gardens, lawns and outdoor plants, but ensure that you do not use more fertilizer than you need and refrain from putting fertilizer down before or soon after it rains.

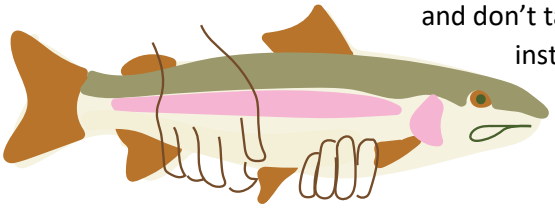
The coastal training program at the Apalachicola NERR in Florida offers a program called the “Stewardship Series”, an ecosystem studies program for residents and visitors to the reserve. One of their courses is focused on **bay**-friendly landscaping, an important topic for people who have recently moved to Florida. The state can be an entirely different world when it comes to caring for your yard. In many parts of Florida there isn’t soil, there’s sand, so this course is aimed at helping people understand

Name: _____ Date: _____

the very different environment they've come to and the value of it. A big part of the discussion is grass. Typical lawn grasses are difficult to grow in the Florida heat, especially on sand, and as a result it takes a lot of water. A lawn of native grasses and dollar weed is a more sustainable option. A lot of people enjoy the look of manicured lawns and end up spraying and fertilizing to keep the lawns, which if not done properly and thoughtfully can impact the bay. Many parts of Florida are trying to discourage these kinds of lawns so that it's more of a natural environment, especially when the state has many **migratory species** landing there, looking for sources of food and places to rest.

When you're fishing at reserves or locally where fishing may be regulated, make sure that you know how to exercise proper **catch and release** and protect the fish you reel in. You have an opportunity to engage with these animals for just a short time, and you don't want to harm them after they're released. This sort of ties into the overall idea of respecting the space of wildlife. If you see birds that are nesting or sitting on a beach, they're conserving their energy, and if people are disturbing them or impacting them in any way, it's going to affect their health and their fitness. Don't go past the **shorebird** signs if there are any posted, and if there are signs that say "no dogs", make sure to take your canine pal elsewhere. The presence of dogs can cause nesting birds to stress, reducing their willingness to **forage** or foraging efficiency, and some off-leash dogs may trample nests or even catch and try to eat birds, chicks, or eggs.

The NERRs are trying to balance people being on and enjoying reserve land while also allowing a safe space for wildlife and nice healthy habitat. So if there are signs or rules, please make sure you're following them! All reserve rules are easily displayed and easy to find on their websites, and they just ask that people minimize their impact and **"leave no trace"** when you're enjoying these beautiful places. What does it mean to "leave no trace"? This phrase means that whenever you're out in nature, all you should be leaving is your footprints! Take trash with you, put out fires that you start if you're camping, and don't take any natural objects that you find with you, snag a photo instead. Taking responsibility and being aware of the impacts that your actions can have on the environment is important to the health and future of these systems.



Another way to get involved and make a difference no matter where you are is by participating in **citizen science** projects. If you're near a reserve, you can help out with projects like the oyster monitoring and butterfly monitoring network at the GTM NERR in Florida, the new saltwater Adopt-a-Stream program at the North Inlet-Winyah Bay NERR in South Carolina, or volunteer or **intern** any of these reserves sites in the southeast. More information on the different site opportunities can be found on the NERR or Far podcast web page or the websites of any of these reserves. There's a ton of other citizen science programs out there. Even literal programs such as apps you can get on your phone!

Name: _____ Date: _____

eBird is a program that helps you identify bird species and log your bird sightings. This is a useful tool because it also gives scientists an understanding of how birds are using a variety of habitats and how that use may be changing over time. There's also **iNaturalist**, a program where people can not only record and identify birds, but they can also record reptiles, amphibians, plants, bugs, all sorts of life! Apps like iNaturalist and eBird are great because they build a huge **database** that then becomes very powerful in understanding the **distributions** and the timing of different species at broad scales. This data is super useful for scientists not only at the NERRs, but also scientists across the country. In addition to actively collecting data that will help us better understand plant and wildlife distributions, you are also becoming more familiar with identifying species, which is a great skill and fun experience!

The NERRs of the southeast are incredible stewards of the coastal zone. You too can be an environmental steward at the reserves and in your communities. Get involved in conservation outreach if you're interested, and always remember to "leave no trace" when you're out in nature!

QUESTION TIME

1. What are some ways that you can plan or modify your landscape so that it is better for wildlife and water quality?

2. How can human disturbance impact nesting birds on beaches?

3. Why is it important to obey "no dogs" signs at the reserves?

4. In your own words, what does it mean to "leave no trace"?

5. How can where you live impact the best ways to care for a lawn?

6. What are the benefits of citizen science programs and apps like iNaturalist and eBird?

7. Good environmental steward or not?

Derrick spots a group of birds resting along the shoreline during his family's beach day. He decides to run at them, causing the birds to flush (fly away).

Emiah uses circle hooks when she goes fishing, making it easier to remove hooks and increasing survival chances of her catch.

Eloise and her family plant a garden of native plants in their backyard.

Kate sprays fertilizer on her lawn in the evening before she heads to the dentist. The sky looks particularly cloudy.

Marcus and his friend Gabe go on a weekend hike. Before leaving the trail, they decide to carve their initials into a large tree to commemorate the trip.

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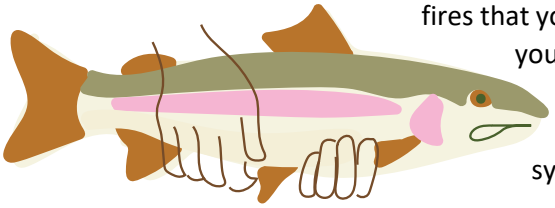

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QUESTION TIME

1. What are some ways that you can plan or modify your landscape so that it is better for wildlife and water quality?

By planting native plants and grasses in your yard and making sure that you're putting down the proper and appropriate amount of fertilizer at the right time!

2. How can human disturbance impact nesting birds on beaches?

If you see birds that are nesting or sitting on a beach, they're conserving their energy, and if people are disturbing them or impacting them in any way, it's going to affect their health and their fitness.

3. Why is it important to obey "no dogs" signs at the reserves?

The presence of dogs can cause nesting birds to stress, reducing their willingness to forage or foraging efficiency, and some off-leash dogs may trample nests or even catch and try to eat birds, chicks, or eggs.

4. In your own words, what does it mean to "leave no trace"?

The definition given in the article is: "leave no trace means that whenever you're out in nature, all you should be leaving is your footprints! Take trash with you, put out fires that you start if you're camping, and don't take any natural objects that you find with you, snag a photo instead."

5. How can where you live impact the best ways to care for a lawn?

Typical lawn grasses are difficult to grow in the heat and especially on sandy soil, so if you live in a place that has this sort of environment (like Florida), it can take a lot of water and fertilizer to maintain a traditional lawn.

6. What are the benefits of citizen science programs and apps like iNaturalist and eBird?

In addition to actively collecting data that will help scientists better understand plant and wildlife distributions, you are also becoming more familiar with identifying species, which is a great skill and fun experience!

7. Good environmental steward or not?

Derrick spots a group of birds resting along the shoreline during his family's beach day. He decides to run at them, causing the birds to flush (fly away).

Emiah uses circle hooks when she goes fishing, making it easier to remove hooks and increasing survival chances of her catch.

Eloise and her family plant a garden of native plants in their backyard.

Kate sprays fertilizer on her lawn in the evening before she heads to the dentist. The sky looks particularly cloudy.

Marcus and his friend Gabe go on a weekend hike. Before leaving the trail, they decide to carve their initials into a large tree to commemorate the trip.

Answers: **not** (not giving wildlife space, threatening shorebird health and fitness), **good steward** (proper catch and release), **good steward** (planting native plants for pollinators and native wildlife), **not** (the rain will wash the fertilizer into local waterways, potentially causing a harmful algal bloom or at least impacting water quality), **not** (they did not "leave no trace")

ACTIVITIES

- Students design a flyer, sign, or piece of virtual media that tells others how to be good environmental stewards at the reserves or in their community.
- Service opportunity! Students research local citizen science projects and/or ways to get involved at a local reserve and plan a class volunteer day!

Name: _____ Date: _____

NERR or Far :

The Reserves Are Where You Are

Episode 7: Estuarine Creature Feature

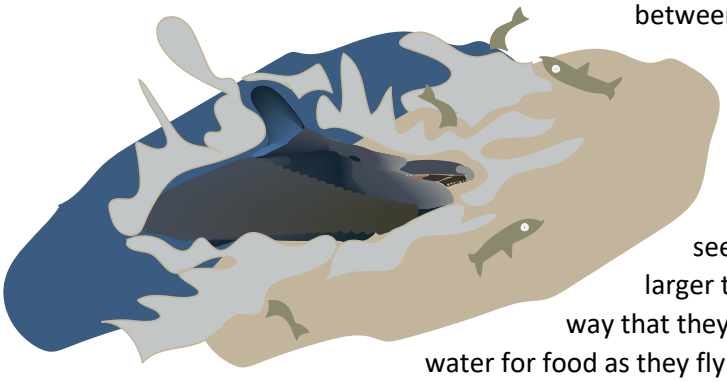
Estuaries are teeming with life! One type of animal that is particularly **speciose** in these types of environments is crabs. An important crab you might see in the southeastern estuaries in particular is the **fiddler crab**. Fiddler crabs can be seen commonly in slightly salty or **brackish** intertidal mudflats in salt marshes, as well as various other types of brackish or saltwater wetlands. They're called fiddler crabs because the male crabs have one claw much larger than the other that they hold somewhat like a violin. This is a sexually dimorphic trait. **Sexual dimorphism** is a difference in appearance between males and females of the same species, whether it's color, shape, size, or a unique structure. My favorite example is lions. Males have manes while females do not. In fiddler crabs, the males have a major claw that is much larger than their minor claw and females have claws of equal size. Males will wave this big claw in a display as a form of **female courtship**. Females choose mates not only based on class size, they also note the quality of the waving display. Research suggests that claw size is **correlated** with burrow width, which influences **incubation** temperature. This means that females will choose a male mate whose class size will provide the best environment for her eggs, and the vigorous waving display will show that he is a strong, healthy crab. Males also fight with this large claw. If they lose it, the lost claw will become the new small claw and his minor claw will grow bigger!

Fiddler crabs are **detritivores**, which means that they obtain nutrition by feeding on organic matter made up of dead plant and animal material or **detritus**. They obtain this by using their mouth to sift through chunks of sand. Anything they can't use, they roll up into a little ball and replace what they took from the ground. This feeding habit plays a very important role in preserving coastal wetlands like salt marshes. By sifting through the sand, fiddler crabs **aerate** the substrate and prevent **anaerobic** conditions. It's kind of like how worms help plants grow by aerating and breaking up the soil. Fiddler crabs have a pretty cool name that they earn for the way they look and how they move. Some other creatures in the estuary are named for how they sound! One way to listen to animals in the estuary is by using a **hydrophone**. A hydrophone is a type of microphone that detects sound waves underwater. Fish make some really awesome sounds across a range of pitches, manatees and dolphins make little squeaks and whistles, and you might even be able to hear right whales if they aren't too far offshore.

Name: _____ Date: _____

One thing you might notice while listening is that lots of fish are given common names by the sounds they emit. Toadfish, croakers, drums, all sorts of species make sense after you hear them on a hydrophone or on a recording.

You don't need to use a hydrophone to hear dolphins strand feed, you'll definitely see it! What is **strand feeding**? During strand feeding, dolphins herd and trap fish by forcing them up onto mud banks, shorelines or sandbars. It's called "strand" feeding because of the way dolphins beach themselves momentarily, pushing prey ashore before sliding back into the water. Strand feeding is a **learned behavior** passed down from mother to calf, which means that not all dolphins are able to perform this behavior. Learning strand feeding typically occurs in the calf stage, so many dolphins learn somewhere between six to eight years old. Another coastal species with a unique feeding strategy is the black skimmer. Let's talk about this incredible seabird!



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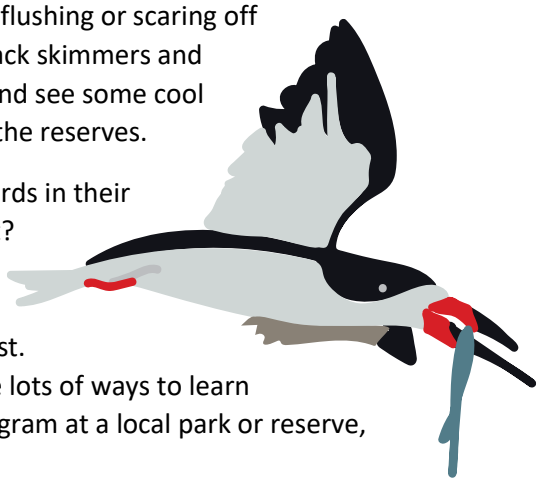
Black skimmers lay their eggs directly in the sand and shells of beaches and the higher parts of some salt marshes in what are called **scrapes**. They make these cone-like depressions themselves using their beaks and feet to carve away at the sand. Do you like sandy beaches? Me too. I mean, who doesn't? Sadly though, because of the popularity of suitable seabird nesting habitat, skimmers are threatened by development and can experience a lot of human disturbance. Skimmer nests can be hard to spot by beachgoers and can be destroyed by anything from roaming dogs to vehicles driving on the beach. Storms and sea level rise also threaten black skimmer nests, as high waters can swamp and wash out eggs and **hatchlings.** Because of these factors and the declining skimmer population, black skimmers are listed as a species of high concern. You can help do your part by keeping your distance around seabird nesting colonies, obeying shorebird signs and refraining from flushing or scaring off birds that you see in coastal areas. Together we can help conserve black skimmers and other bird species on our southeastern coast. If you want to get out and see some cool coastal birds and learn more, there are lots of places to go birding at the reserves.



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There are a multitude of unique and interesting creatures in our estuaries, from crabs, to dolphins, to seabirds and beyond. The National Estuarine Research Reserves are working to better understand and protect these species through research, stewardship, coastal training and education. You too can learn more about these species by visiting a reserve near you. You never know what you might find and experience in one of the world's most productive ecosystems.

QUESTION TIME

1. What is sexual dimorphism? Can you think of another example of a species that exhibits this?

2. What does the fiddler crab mating display tell female crabs?

3. How do fiddler crabs help improve the health of coastal environments?

4. What types of aquatic animals make sounds detectable by hydrophones? What is a hydrophone?

5. What is the meaning of the term learned behavior?

6. What are some ways that you can learn more about birding?

7. What are some threats to black skimmers? How can we help?

NERR or Far :

The Reserves Are Where You Are

Episode 7: Estuarine Creature Feature

Estuaries are teeming with life! One type of animal that is particularly **speciose** in these types of environments is crabs. An important crab you might see in the southeastern estuaries in particular is the **fiddler crab**. Fiddler crabs can be seen commonly in slightly salty or **brackish** intertidal mudflats in salt marshes, as well as various other types of brackish or saltwater wetlands. They're called fiddler crabs because the male crabs have one claw much larger than the other that they hold somewhat like a violin. This is a sexually dimorphic trait. **Sexual dimorphism** is a difference in appearance between males and females of the same species, whether it's color, shape, size, or a unique structure. My favorite example is lions. Males have manes while females do not. In fiddler crabs, the males have a major claw that is much larger than their minor claw and females have claws of equal size. Males will wave this big claw in a display as a form of **female courtship**. Females choose mates not only based on class size, they also note the quality of the waving display. Research suggests that claw size is **correlated** with burrow width, which influences **incubation** temperature. This means that females will choose a male mate whose class size will provide the best environment for her eggs, and the vigorous waving display will show that he is a strong, healthy crab. Males also fight with this large claw. If they lose it, the lost claw will become the new small claw and his minor claw will grow bigger!

Fiddler crabs are **detritivores**, which means that they obtain nutrition by feeding on organic matter made up of dead plant and animal material or **detritus**. They obtain this by using their mouth to sift through chunks of sand. Anything they can't use, they roll up into a little ball and replace what they took from the ground. This feeding habit plays a very important role in preserving coastal wetlands like salt marshes. By sifting through the sand, fiddler crabs **aerate** the substrate and prevent **anaerobic** conditions. It's kind of like how worms help plants grow by aerating and breaking up the soil. Fiddler crabs have a pretty cool name that they earn for the way they look and how they move. Some other creatures in the estuary are named for how they sound! One way to listen to animals in the estuary is by using a **hydrophone**. A hydrophone is a type of microphone that detects sound waves underwater. Fish make some really awesome sounds across a range of pitches, manatees and dolphins make little squeaks and whistles, and you might even be able to hear right whales if they aren’t too far offshore.

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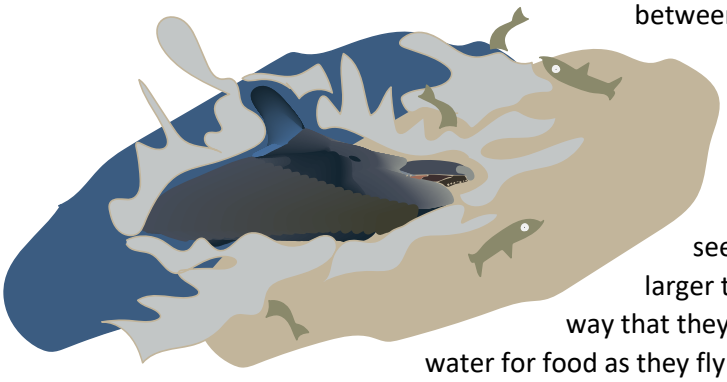

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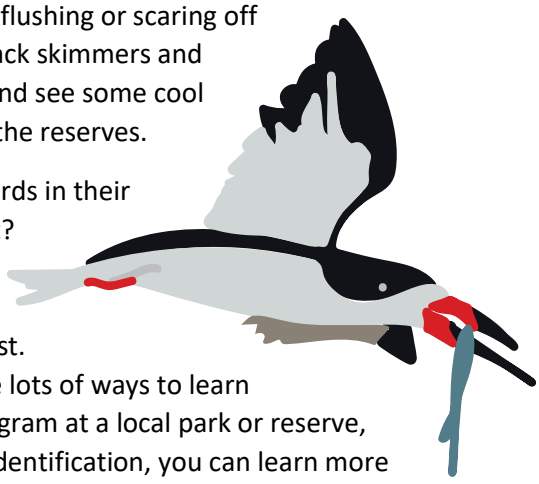

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QUESTION TIME

1. What is sexual dimorphism? Can you think of another example of a species that exhibits this?

Sexual dimorphism is a difference in appearance between males and females of the same species, whether it's color, shape, size, or a unique structure. Some examples include **cardinals** (males are a vibrant red, while females are sort of brownish and muted-looking), **peacocks** (males have the dramatic tail feathers while females do not), **elephant seals** (males have the funny nose/trunk while females do not, and males can be up to 10x larger than females), deep sea **anglerfish** (females are much bigger than the males, who attach themselves to the female).

2. What does the fiddler crab mating display tell female crabs?

Research suggests that claw size is correlated with burrow width, which influences incubation temperature. This means that females will choose a male mate whose class size will provide the best environment for her eggs, and the vigorous waving display will show that he is a strong, healthy crab.

3. How do fiddler crabs help improve the health of coastal environments?

By sifting through the sand, fiddler crabs aerate the substrate and prevent anaerobic conditions. It's kind of like how worms help plants grow by aerating and breaking up the soil.

4. What types of aquatic animals make sounds detectable by hydrophones? What is a hydrophone?

Fish, manatees, dolphins, and right whales, amongst other species. A hydrophone is a type of microphone that detects sound waves underwater.

5. What is the meaning of the term learned behavior?

A learned behavior is a behavior that an animal learns by watching another animal or by being directly taught (it is not innate/present at birth).

6. What are some ways that you can learn more about birding?

You can join a club or attend a program at a local park or reserve, you can download mobile apps like iNaturalist or eBird to help with identification, you can learn more about your local birds from sites and organizations like the National Audubon Society, or you can simply sit in nature and familiarize yourself with the calls and behaviors of different local species.

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ACTIVITIES

- Estuarine Frankenstein! Take features from each of the animals we discussed (and even add some extra options of your own) and have the students create a make-believe creature. They will explain to their group how the animal parts/behaviors dictate their lifestyle!
- Students research bird species they might see in their state and present on one that they're interested in. What habitat do they prefer? What do they eat? Do the males of

the species look like the females? What does their call sound like? How big are they? What kind of beak do they have and how does this help them eat their specific diet?

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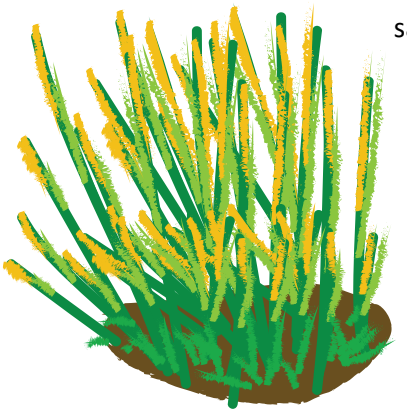
NERR or Far :

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

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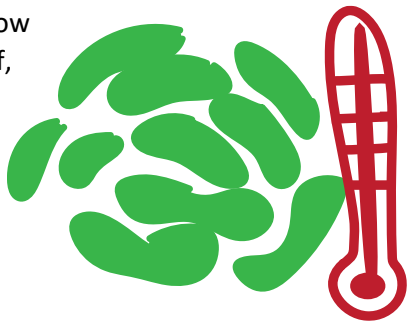
surges and floodwaters change salinity can inform the medical community when and where increases in ***Vibrio vulnificus*** infections are likely to increase. *V. vulnificus* is a climate - sensitive bacteria that lives in marine environments that you can get from eating affected seafood, most commonly 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.

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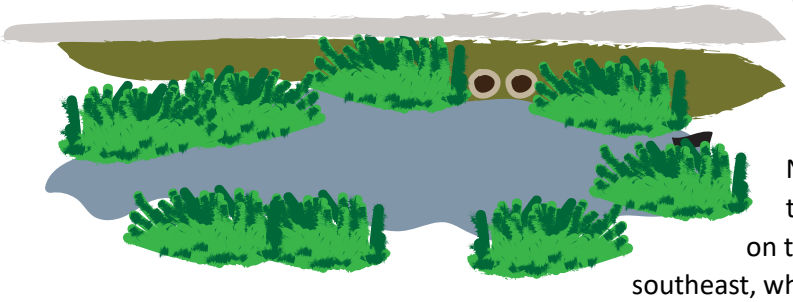
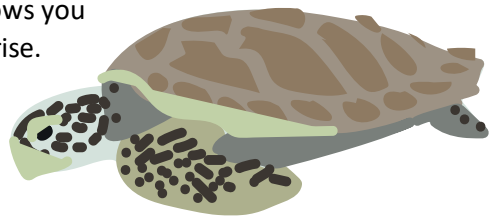
Another study going on at the GTM NERR related to water sampling is an eDNA project. **eDNA**, or environmental DNA, is nuclear or mitochondrial DNA that organisms release into the environment. We can detect species, even invasive and **cryptic** or rare species, in water or terrestrial habitats using 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,



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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?

2. Discuss some beneficial uses of SWMP.

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

4. What is eDNA?

5. Why is it important to study stormwater ponds?

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

NERR or Far :

The Reserves Are Where You Are

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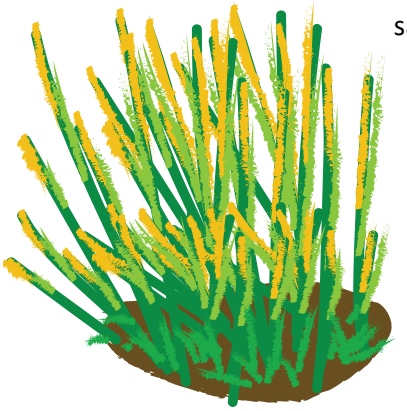
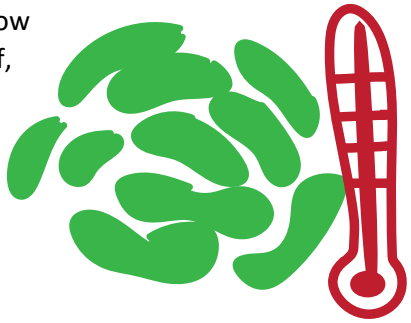


The ACE Basin reserve has been working recently with a group of other reserves to create an educational product called "Storm Stories"! This tool allows the user to observe reserve data before, during and after certain large storm events that affected the local area and see what changes throughout and 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.

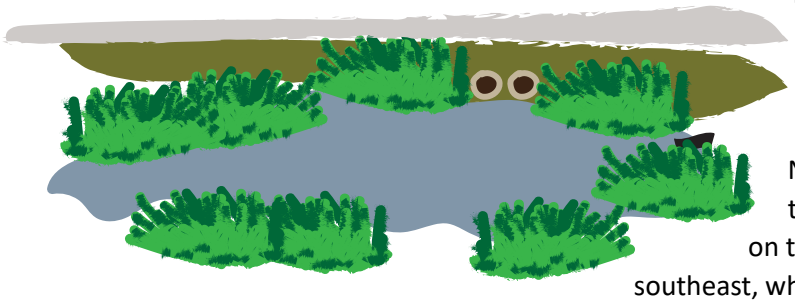


Changes in coastal land use can also change how stormwater moves through coastal watersheds. Increases in **impervious** surface area that go with urbanization, for example, sidewalks and roads, typically drive stormwater runoff into waterways faster, rather than percolating through soils. This can bring 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.

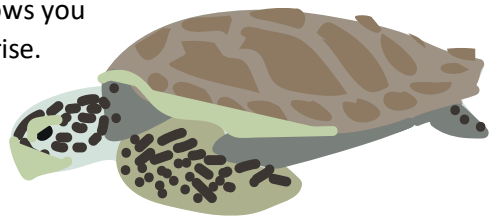
Another study going on at the GTM NERR related to water sampling is an eDNA project. **eDNA**, or environmental DNA, is nuclear or mitochondrial DNA that organisms release into the environment. We can detect species, even invasive and **cryptic** or rare species, in water or terrestrial habitats using 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!