MARIE SELBY
BOTANICAL
GARDENS

$E^{3:}$ ECOSYSTEMS, ENERGY FLOW, & EDUCATION

Where Land Meets Sea:
Mangroves & Estuaries

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Where Land Meets Sea: Mangroves & Estuaries

CONTENT OUTLINE

GRADE LEVEL: K-12

SUBJECT: Science (includes interdisciplinary Common Core connections & extension activities)

BIG IDEA/OBJECTIVE: To help students broaden their understanding of the coastal wetlands of Southwest Florida (specifically focusing on estuaries and mangroves) and our individual and societal interconnectedness with them. Through completion of these units, students will explore and compare the unique contributions and environmental vulnerability of these precious ecosystems.

UNIT TITLES/DRIVING QUESTIONS:
(Please note: many of the activities span a range of age levels beyond those specifically listed, and can be easily modified to meet the needs of diverse learners. For example, the K-3 biomimicry water filtration activity can be used with learners of all ages. Information on modification for older students can be found in the resources section under "student activities.")

(K-3) "Welcome to the Wetlands"
"Why do plants & animals live in different places?" (Habitats & Adaptations)

(4-8) "A Magnificent Mangrove Maze"
"What makes wetlands so important?"
(Adaptations, Ecosystems, & Environmental Vulnerability)

(7-12) "Monitoring the Mangroves"
"What can research and long-term monitoring reveal about changes in estuary habitats?"
(Environmental Vulnerability & Energy Flow)

IN-FIELD RESOURCES:
When your class visits Selby Gardens for a guided tour, we offer a number of interactive standards-based field opportunities to supplement your students' academic adventure, including:

- **Fantastic Florida:** Florida's Native Plants: Identify the plants and animals that live along our coast. With a focus on Florida native plants such as mangroves, sea grapes, sea grasses and other coastal plants, students will learn how these plants are connected to land and sea. Mangrove leaf sorting or bark rubbing activities will help students identify the three types of mangroves native to Florida. (K-12)

- **Plant Parts: Flower Dissection:** Identify the many parts of a flower by carefully disassembling it piece by piece with the use of high quality visuals. Add-on for middle school and above: Name that plant! Classify the plants around you with a simple dichotomous key. By looking at characteristics of a plant and using a dichotomous key, you can identify most living things to the species. (3-12)

- **Look at Those Leaves!**: By clipping a variety of leaves of all shapes, sizes and colors just before the tour, kids can see the variety of leaves throughout the garden. Using flat crayons and paper folded in half, children reveal the texture of different plants while taking a closer look. Discussions can surround leaf veins, vascular vs/ nonvascular plants, adaptations and the purpose of leaf shapes (i.e.: bo tree's drip tip), etc...(K-8)

- **Soil Dissection:** By scooping distinct types of soil into two buckets, children examine what makes up the soil while observing the types of plants that grow in either type: coastal or beach soil (sand) vs. one with more humus and other organic matter (found in the mangrove forest). Components include organic matter such as leaf and plant debris, animal excrement and decaying insects, etc., and inorganic matter such as shell, rock, sand and silt (3-12)

- **Mangrove Metaphors:** In this fun and engaging hands-on activity, common household items and other familiar objects help students discover the important functions and ecosystem services provided by mangrove forests. (5-12)

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TEACHER BACKGROUND INFORMATION:
(Adapted and excerpted from The US EPA http://water.epa.gov/type/oceb/nep/about.cfm and the Reef Ball Foundation http://www.oceanoasis.org/fieldguide/mangroves.html. Additional information can be found in the resource section.)

What is an Estuary?

An estuary is a partially enclosed body of water along the coast where freshwater from rivers and streams meets and mixes with salt water from the ocean. Estuaries and the lands surrounding them are places of transition from land to sea and freshwater to saltwater. Although influenced by the tides, they are protected from the full force of ocean waves, winds, and storms by such landforms as barrier islands or peninsulas.

Estuarine environments are among the most productive on earth, creating more organic matter each year than comparably-sized areas of forest, grassland, or agricultural land. The tidal, sheltered waters of estuaries also support unique communities of plants and animals especially adapted for life at the margin of the sea. Many different habitat types are found in and around estuaries, including shallow open waters, freshwater and salt marshes, swamps, sandy beaches, mud and sand flats, rocky shores, oyster reefs, mangrove forests, river deltas, tidal pools, and seagrasses.

Why are Estuaries Important?

Estuaries provide us with a suite of resources, benefits, and services. Some of these can be measured in dollars and cents, others cannot. Estuaries provide places for recreational activities, scientific study, and aesthetic enjoyment. Estuaries are an irreplaceable natural resource that must be managed carefully for the mutual benefit of all who enjoy and depend on them. Thousands of species of birds, mammals, fish, and other wildlife depend on estuarine habitats as places to live, feed, and reproduce. And many marine organisms, including most commercially-important species of fish, depend on estuaries at some point during their development. Because they are biologically productive, estuaries provide ideal areas for migratory birds to rest and refuel during their long journeys. Because many species of fish and wildlife rely on the sheltered waters of estuaries as protected spawning places, estuaries are often called the "nurseries of the sea." Estuaries have important commercial value and their resources provide economic benefits for tourism, fisheries, and recreational activities. The protected coastal waters of estuaries also support important public infrastructure, serving as harbors and ports vital for shipping and transportation.

Estuaries also perform other valuable services. Water draining from uplands carries sediments, nutrients, and other pollutants to estuaries. As the water flows through wetlands such as swamps and salt marshes, much of the sediments and pollutants are filtered out. This filtration process creates cleaner and clearer water, which benefits both people and marine life. Wetland plants and soils also act as natural buffers between the land and ocean, absorbing flood waters and dissipating storm surges.

This protects upland habitat as well as valuable real estate from storm and flood damage. Salt marsh grasses and other estuarine plants also help prevent erosion and stabilize shorelines.

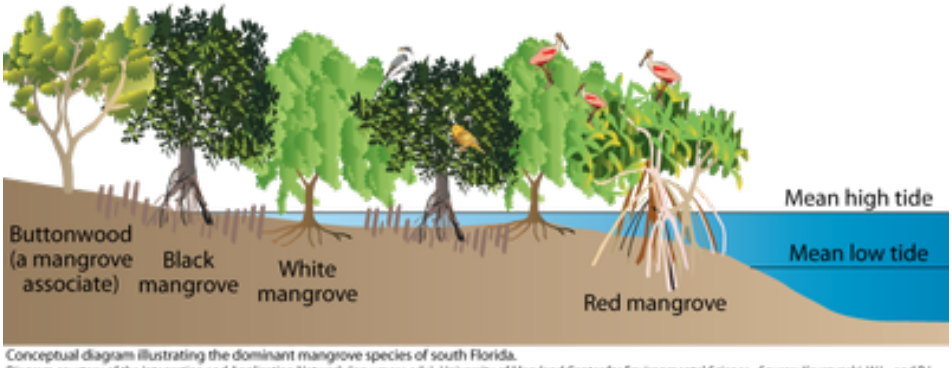
Why Protect Estuaries?

The economy of many coastal areas is based primarily on the natural beauty and bounty of estuaries. When those natural resources are imperiled, so too are the livelihoods of those who live and work in estuarine watersheds. Over half the U.S. population lives in coastal areas, including along the shores of estuaries. Coastal watershed counties provided 69 million jobs and contributed $7.9 trillion to the GDP in 2007 (National Ocean Economics Program, 2009). Coastal counties are growing three times faster than counties elsewhere in the nation. Unfortunately, this increasing concentration of people upsets the natural balance of estuarine ecosystems, threatens their integrity, and imposes increased pressures on vital natural resources like estuaries. What happens on the land affects the quality of the water and health of the organisms that live in an estuary. For example, if a river or stream flows through an agricultural area, it picks up fertilizer, manure, and pesticides from farming operations that run off the land after a rainstorm. As it passes urbanized and suburbanized areas, it gathers fertilizers or pet waste that wash off lawns, untreated sewage from failing septic tanks, wastewater discharges from industrial facilities, sediment from construction sites, and runoff from impervious surfaces like parking lots.

What are Mangrove Wetlands (Also called Mangrove Swamps/Forests)?

Mangrove wetlands are found typically along tropical coastlines of gulfs, seas and oceans. These zones are frequently inundated with salt water due to tidal activity. The term “mangrove” refers not to a particular species, but is rather a collective term for an assemblage of tropical trees and shrubs that grow in the intertidal zones. Scientifically, they are not closely related and are only grouped together based on their function within the ecological community.

There are 3 mangrove species found in Florida. Red mangrove (*Rhizophora mangle*) displays characteristic prop roots, and can often be found growing as discrete “islands” just offshore. Black (*Avicennia germinans*) and white (*Laguncularia racemosa*) mangroves can usually be found landward of the red mangrove. Black mangroves are identifiable by pencil-like projections called “pneumatophores” emerging from their root systems. White mangrove can be identified by their leaves, which are rounded at the tip. Each leaf also has two small glands at its base that produce nectar.



Conceptual diagram illustrating the dominant mangrove species of south Florida.
Diagram courtesy of the Integration and Application Network (ian.umces.edu), University of Maryland Center for Environmental Science. Source: Kruczynski, W.L., and P.J. Fletcher (eds.). 2012. Tropical Connections: South Florida's marine environment. IAN Press, University of Maryland Center for Environmental Science, Cambridge, Maryland. 492 pp.

Why are Mangrove Wetlands Important?

- ACT AS A FILTERING SYSTEM for the run-off and ground waters, clarifying adjacent open water, which facilitates photosynthesis in marine plants. Mangroves also help to control other forms of pollution, including excess amounts of nitrogen and phosphorus, petroleum products, and halogenated compounds. Mangroves stop these contaminants from polluting the ocean waters through a process called rhizofiltration.
- PROTECT COASTAL LAND by absorbing the energy of storm-driven wave and wind action - creating in effect a natural breakwater that helps stop erosion, preventing a great deal of property damage and sometimes even human death.
- TRAP DEBRIS AND SILT contributing to soil formation and stabilizing the coastline.
- SERVE AS HABITAT for many marine and terrestrial animals,.Their intricate root systems and dense canopies provide shelter from ocean currents and strong winds.
- PRODUCE NUTRIENTS through a large amount of the leaves, twigs, bark being shed and then broken down by bacteria and fungi. This detritus is a primary food source for many small organisms such as invertebrates and juvenile fish. These organisms are then made available to the food chain of aquatic animals. Mangroves thus contribute to productivity in offshore water.
- SERVE AS NURSERY AND REFUGE for many juvenile fish and invertebrates such as spiny lobster, gray snapper, jacks and barracuda. Mangroves are the nesting grounds for many water birds such as the great white heron, reddish egrets, roseate spoonbills, and frigate birds.
- IMPORTANT IN TERMS OF AESTHETICS AND TOURISM since they preserve the beauty and health of the environment around them.

Endangered Mangroves: Despite their critical importance, mangroves are disappearing at an alarming rate around the world. Human coastal development, industrial activity, climate change, and aquaculture are rapidly replacing these salt-tolerant trees and the ecosystems they support. There are a few places where mangrove cover is increasing. But, just in the last decade, at least 35 percent of the world's mangroves have been destroyed. That’s a rate of loss that exceeds the disappearance of tropical rainforests. (Taken from: http://ocean.si.edu/mangroves)

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KINDERGARTEN - THIRD GRADE

"Welcome to the Wetlands"
(Habitats, Adaptations, & Biomimicry)

Description: This 4-day lesson encourages students to seek and understand the distribution of plants and animals according to their differing needs and abilities. Students will focus on the coastal wetlands ecosystem and consider how their unique filtration system has inspired modern water purification systems. Contact Selby Gardens in advance to schedule a field trip (Day 2) to explore the mangroves and other habitats represented there.

Driving Question: "Why do plants & animals live in different places (habitats)?"

Objectives:

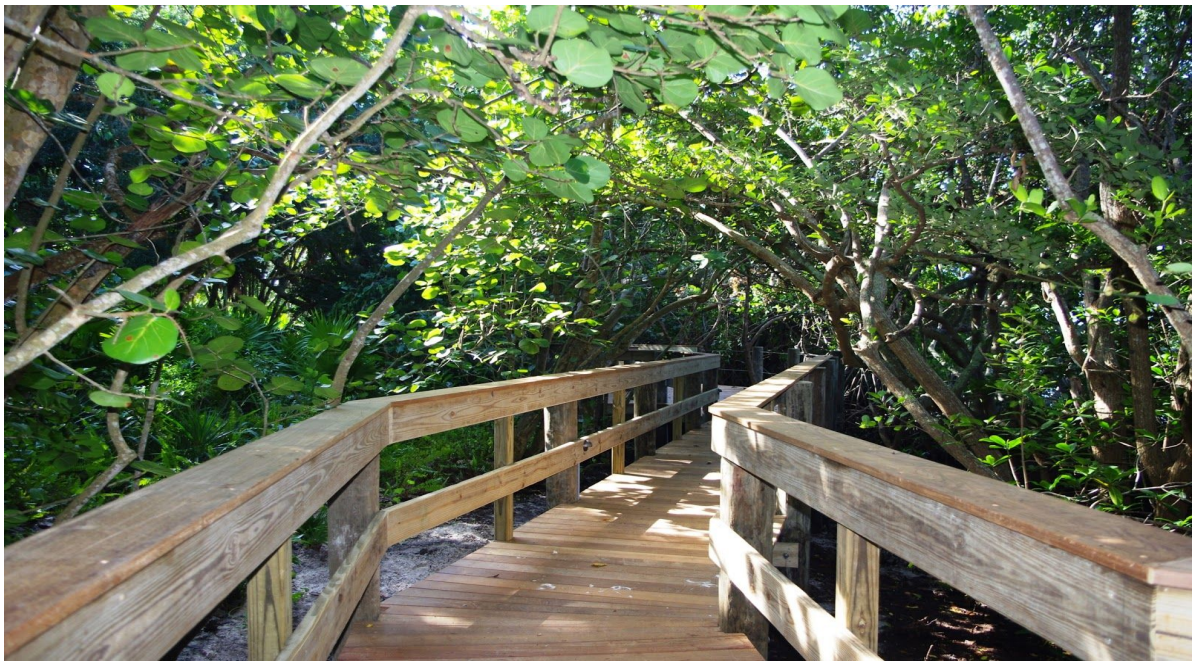
- Students will understand that Earth supports many different animal habitats, each of which has distinct features and distinct plant and animal populations. (K-ESS3-1)
- Students will create a simple sketch, drawing, or physical model to illustrate how the shape of an organism's features helps it function as needed to solve a given problem in its environment. (K-2-ETS1-2)
- Students will be able to explain how animals and plants are adapted to the conditions of the habitats in which they live and that humans get ideas from nature about how to adapt to our environments. (Wetlands, for example, have inspired biomimicry in water filtration) (1-LS1-1)
- Students will apply their knowledge of how the Coastal Wetlands unique filtration ability that inspired humans in creation of a class-made water filtration system. (1-LS1-1)
- Students will use evidence to support the explanation that traits can be influenced by the environment. (3-LS3-2)

Materials:

- computer / internet access / projector
- various recycled materials like two liter plastic bottles
- sand / charcoal (available at pet store) / river rocks / cotton balls
- mobile device with video capability for recording video clips
- chart paper / paint / sponges & paint brushes
- leaf rubbing kit: flat crayons, tracing paper, a variety of mangrove leaves
- seeds and burrs that stick to clothes, or a small section of thorny vine (optional)

DAY ONE *(HABITATS & ADAPTATIONS)*

1. Evoke interest by asking students to think of an animal, any animal. Before they share their chosen animal aloud, ask them to draw it on a piece of paper including any details they might already know about what that animal eats, where it lives, and what other animals live nearby.
2. Open up discussion about habitats and that animals require unique environments in which to thrive
3. Introduce the concept of habitats/ecosystems with the following video (11 min): https://www.generationgenius.com/videolessons/habitats-video-for-kids/?gclid=CjwKCAjw8MD7BRArEiwAGZsrBcecSqBiHbuDlnU9XqIWUQ8DgfNPH4_aGf66_BAlu5LF2DRSc3StFBoCYOoQAvD_BwE
4. As a class, in small groups, or as individuals, have students select an animal either from the video or personal experience and discuss how it is uniquely adapted to its specific habitat (i.e. egrets have long legs to be able to stand in water, and long beaks to catch their food in the water)
5. Discuss/reinforce the concept of habitat and ecosystem.
6. Sketch/draw a wetlands ecosystem on chart paper. (Consult teacher/student resources for more information)
7. Conclude class by announcing that the students will be taking a trip to visit (or will be exploring items from) the wetlands ecosystem. Play this 16-minute video tour of Selby Gardens to introduce students to what they will see. Mangrove information begins at 8:26) https://www.youtube.com/watch?v=bl2NvFrXAvY



DAY TWO *(FIELD EXPEDITION)*

1. Schedule a learning expedition in advance to visit Selby Gardens and see mangroves in person (or virtually).
2. Prior to departure, reference the previous day's discussion on wetlands animals, and the Selby Gardens video. Reinforce that plants are like animals in that they also have specific adaptations to survive in their environments and ask students to recall the Mighty Mangroves introduced in the video. Discuss how mangroves are uniquely suited to filtering the salty water around them. Preview tomorrow's (Day 3) up-coming lesson by letting the students know that these natural adaptations are so helpful, humans have even copied them!
3. At Selby Gardens, students will compare the different types of mangroves and their qualities. Students may also create leaf and bark rubbings from the various types of mangroves.
4. Student take-a-way: the mangroves in the wetlands are interesting and important parts of nature with unique features and roles in the world around us.

DAY THREE *(INTRO to BIOMIMICRY)*

1. Reflect on yesterday's Field Expedition to Selby Gardens.
2. Review knowledge as a class and record student understanding by recording video clips.
3. Add paint and mangrove trees to the class drawing begun on Day 1. Draw and label each type of mangrove tree with their unique identifying characteristics
4. Ask if anyone can remember some of the unusual qualities/ abilities of mangrove trees. If filtering water isn't mentioned, remind them of this fascinating ability and tell them that people have gotten great ideas from nature.
5. (If possible) show students an example of biomimicry, like burrs that stick to people and animals, and gave us the idea for Velcro, or a thorny vine that inspired the idea for barbed wire.
6. Share this (6:41 min.) video about biomimicry : https://www.youtube.com/watch?v=V2GvQXvjhLA
7. Student take-away: Nature is filled with great ideas!

DAY FOUR *(BIOMIMICRY - CONTINUED)*

1. Review the concept of biomimicry with the class -- can they remember any examples?
2. Share how the wetlands have inspired an important invention --- can they guess what it might be?
3. Explain the way the wetlands filter water, and that as a class you're going to create your very own device to make dirty water clean!
4. As a demonstration object, you can show students a commercially available water filter (like Brita) and show them how it works to clean water.
5. Take out water filter-building materials (sand, stones, activated charcoal, recycled plastic bottle) and slowly build each layer of the water filter. Video instructions available here: http://www.youtube.com/watch?v=j_ouCfFGIiI

Learning on Display:

- Share and display class-made water filtration system with community
- Pair up with 4th-8th grade students to perform water testing (pH, turbidity, etc.)
- Make a poster showing how nature inspires great ideas

Related Key Terms:

- Habitat: a specific place where plants and animals live because it provides all they need to survive: food, shelter, water, and space.
- Ecosystem: a community of living things things that interact with each other and the environment within a habitat
- Wetland: a type of ecosystem that is usually covered partially by water; often found near oceans, bays, lakes or rivers.
- Mangrove: trees that grow at the coastline in tropical places, and experience regular flooding by tides.
- Estuary: a body of water formed where freshwater from rivers and streams flows into the ocean, mixing with the seawater.
- Adaptations: physical, cellular or behavioral changes made by an organism over time to help it fit into its environment

Extensions:

- Community connections: Find out how the water in your home/school/city is treated. What processes do they use?

- Music/Performing Arts: Write a song about ecosystems, wetland animals and their adaptations, or choreograph one of these: : https://www.youtube.com/watch?v=ltBlCCoQ74k or http://www.youtube.com/watch?v=XHCV6b921gw

- Geography: Consult a world atlas to discover the different kinds of ecosystems that exist in the world, or rewatch the Selby Gardens video tour to sample some of the ecosystems represented there. Which ecosystems do the students live closest to? Farthest from? What ecosystem would they most like to visit? Which ecosystem does their favorite animal live in?

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FOURTH - EIGHTH GRADE

"A Magnificent Mangrove Maze"
(Adaptations & Ecosystem Energy Flow)

Description: In this 4-day lesson, students will identify the unique traits that mangroves have evolved in order to survive and thrive in a wetlands environment. Additionally, they will explore how the "maze" of the mangrove root system contributes not only to the coastal wetlands and estuary ecosystems, but to nearby ecosystems as well.

Driving Question: "What's so magnificent about wetlands?"

Objectives:

- Students will construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction. (4-LS1-1)
- Students will develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact. (5-ESS2-1)
- Students will analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem. (MS-LS2-1)
- Students will evaluate competing design solutions for maintaining biodiversity and ecosystem services. (MS-LS2-5)
- Students will construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems. (MS-LS2-2)

Materials:
- internet/projector/computer
- sand
- long shallow pan (like a roasting pan)
- a sponge
- watering can
- cup of soil

- jar of muddy water
- sponges

DAY ONE: INTRODUCTION

1. Introduce students to wetlands by showing students this classic (1989!) Bill Nye video: https://www.youtube.com/watch?v=BeUPbGWg2KU
2. Review with the students what the video presents about wetlands and their functional values.
    1. Control flooding
    2. Filter water
    3. Provide a home for wildlife
3. Show the class photos of different kinds of wetlands such as freshwater and saltwater marshes, swamps, and bogs. Show photos of the wetlands specific to Florida (Coastal tidal salt marshes, mangrove swamps, inland southern swamps, freshwater marshes and riparian wetland) and announce that the students will be taking a trip to Selby Gardens to visit an important wetlands ecosystem. Play this 16-minute video tour of Selby Gardens to introduce students to what they will see. Mangrove information begins at 8:26. https://www.youtube.com/watch?v=bl2NvFrXAvY

DAY TWO: FIELD EXPEDITION

1. Schedule a learning expedition in advance to visit Selby Gardens and see mangroves in person (or virtually).
2. Prior to departure, reference the previous day's discussion on wetlands, and the Selby Gardens video.
3. At Selby Gardens, students will compare the different types of mangroves and their qualities, and discuss the vital functions and ecosystem services performed by mangroves. Students may also create leaf and bark rubbings from the various types of mangroves.

DAY THREE: LAB/DEMONSTRATION

4. Present a pre-made wetland using a pan with sand, representing land covering half of the pan, and sloping toward the bottom of the pan. Nothing is in the other half of the pan. This will represent a body of water such as a bay.
5. Ask the students what will happen if I sprinkle some water (as rain) on the land, what will happen to the water? (Should drain quickly into the body of water.)
6. Now place a sponge or sponges to fit in the pan at the base of the sand representing a wetland as a buffer zone between the land and the body of water. Sprinkle some water on the land again and ask the students what happens with the wetland added? (The wetland slows the runoff and reduces the amount of water and sand reaching the body of water because it is trapped in the wetland.)
7. Remind students about what they saw inthe videos and at Selby Gardens. Explain that wetlands collect water and slow the rate of flow down. This slowing process helps prevent flooding and soil erosion.

8. Ask what might happen if a wetland is destroyed and houses or other developments are built in its place? Point out that this is happening a great deal in the world today, particularly in Florida.
9. Pour the water out of the pan from the last experiment and use a clean sponge. Spread soil over the land and pour a jar of muddy water onto the land to represent polluted water. Ask what happens to the runoff? (It's trapped in the sponge.) Ask the students to compare the water in the jar to the water that ends up in the body of water? (The water in the jar is much more polluted.)
10. Ask the students what they think would happen if they remove the sponge and repeat the experiment. What happens to the runoff now? (It reaches the body of water more easily and quickly, the water is a great deal more polluted.) Point out that without wetlands, tremendous amounts of silt and pollutants end up in bodies of water.
11. Have students discuss the impacts of polluted bodies of water.

DAY THREE:

14. As a class, or in pairs, have students research the different types of wetlands here in Florida: http://soils.ifas.ufl.edu/wetlandextension/types.htm
15. Have students inquire into our local wetlands (salt marshes and mangrove swamps): http://soils.ifas.ufl.edu/wetlandextension/counties/sarasota.htm

Assessment:

- Essay: How might the lack of wetlands affect us as people? How can we prevent these undesirable events from happening?
- Wetlands model / PSA project / Hydro-detective project (below)

Learning on Display:

- Have students work in groups of four to make their own wetland models and use them to explain to the class/school community/local politicians what would happen if their wetlands were destroyed.
- Have students create PSA posters/projects declaring the need to preserve wetland habitats
- Launch a biomimicry competition where student pairs attempt to create a more effective water filtration system, or erosion control system than their peers

Related Key Terms:

- Ecosystem: a biological community of interacting organisms and their physical environment.
- Wetlands: area of land that is saturated with water during at least part of the year and which supports plant life

- Estuary: An estuary is a body of water formed where freshwater from rivers and streams flows into the ocean, mixing with the seawater
- Mangrove: any of several tree species that grow in the intertidal zones, especially of estuaries. The word mangrove can also refer to the entire habitat created by the trees, which is sometimes called a mangrove forest or mangrove swamp.
- Adaptation: unique feature or behavior that helps an animal or plant survive in its environment
- Habitat: the specific environment where an animal or plant is able to survive. A suitable habitat will provide food, shelter, water and space for the organisms that live there.
- Marsh: a wetland habitat dominated by grasses or grass-like plants. A salt marsh is a marsh that is flooded by salty water, such as water from the ocean
- Endangered: a species at risk for extinction
- Bog: wet muddy ground too soft to support a heavy body
- Peat: a brown, soil-like material characteristic of boggy, acid ground, consisting of partly decomposed vegetable matter. It is widely cut and dried for use in gardening and as fuel.
- Aerial roots: above ground roots useful for support and additional oxygen

Extensions:

- Language Arts: Write a haiku about mangroves/estuaries.

- Mathematics: Students research and graph the percentage of Florida that was wetlands compared to the current amount of wetland cover.

- Just for fun: Allow students to play "kerplunk" which models the role of the mangrove roots (sticks) on holding back the water (marbles)

- Visual Arts/English Language Arts: Encourage students to explore (in writing or drawing/ painting) their own personal refuge, the importance of having one as a middle schooler, and what the ideal refuge would look like for them (See: http://www.incredibleart.org/artroom/Nicole/refuge.htm for more ideas)

- Music/Performing Arts: Write a song about ecosystems, wetland organisms and their adaptations, or choreograph one written by another student. Produce a skit or play demonstrating the interactions of the organisms in a wetland

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NINTH - TWELFTH GRADES

"Monitoring the Mangroves"
(Ecosystem Energy Flow & Environmental Vulnerability)

Description: Students will explore the on-going research of black mangrove health in Harbour Island, Texas. Next students will apply similar techniques to contribute to on-going monitoring of local mangrove activity. Through these explorations, students will understand that on-going ecosystem monitoring is needed to increase our understanding of estuaries and to improve our ability to protect and sustain them.

Driving Question: "What can research and long-term monitoring reveal about changes in estuary habitats?"

Objectives:

- Students will understand that organisms are both affected by changes in their habitat and have adaptations that allow them to live and thrive in different estuary habitats, such as salt marshes or mangrove habitats. Students will apply concepts of statistics and probability to support explanations that organisms with an advantageous heritable trait tend to increase in proportion to organisms lacking this trait. (HS-LS4-3)

- Students will understand that habitats can expand or contract due to outside changes in things that affect either the physical components of the habitat or the organisms that help define the habitat. Students will evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem. (HS-LS2-6)

- Students will use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of the coastal wetlands ecosystem at different scales. (HS-LS2-1)

- Students will understand that research on habitats and species ranges, coupled with long-term monitoring, can give clues to why estuary habitats change over time. Students will construct an explanation based on evidence for how natural selection leads to adaptation of populations. (HS-LS4-4)

- Students evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts. (HS-ETS1-3)

Materials:
- class set of computers/ipads
- internet connection/projector
- additional materials may be needed for wetlands monitoring activities

DAY ONE:

1. Preview worldwide mangrove distribution by showing the following map: https://i0.wp.com/blog.education.nationalgeographic.org/wp-content/uploads/2014/12/mangrovemap.jpg?ssl=1

2. Introduce the power and importance of mangrove wetlands with a visit to Selby Gardens or other nearby coastal area with mangroves. If a visit is not possible, show this video http://www.blueworldtv.com/webisodes/watch/mangrove-forests
3. Have students evaluate and compare some of the ways conservationists are attempting to mitigate estuary/mangrove damage. Divide students into small groups and have them investigate one of the

following mangrove/estuary conservation efforts. Ask students to consider each in terms of effectiveness, cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts:

- Monitoring Restoration of Mangroves from Space: https://www.researchgate.net/publication/319481173_Monitoring_the_Restoration_of_Mangrove_Ecosystems_from_Space
- Mangrove Action Project: https://mangroveactionproject.org/mangrove-restoration/
- Manual for monitoring mangroves in the South Pacific using three different levels of intensity http://www.sprep.org/Publications/manual-for-mangrove-monitoring-in-the-pacific-islands-region
- Living Oceans Foundation: https://www.livingoceansfoundation.org/education/mangrove-education-and-restoration/
- Living Shorelines http://floridalivingshorelines.com/

DAY TWO

4. Share the following articles with the students to consider and discuss 2 different circumstances of mangrove endangerment in Southwest Florida:
https://www.miamiherald.com/news/local/environment/article209148999.html
https://www.winknews.com/2020/02/25/mangrove-massacre-dep-investigating-mangroves-ripped-out-damaged-at-tropicana-park/

5. What can we do? Explore possible solutions to mangrove protection, restoration, and monitoring options, including policy, scientific assessment, community outreach or other options. Using the following resources as examples, have students form teams to create strategic conservation and management plans:

- http://water.epa.gov/type/wetlands/assessment/upload/volmonitor-intro.pd
- http://water.epa.gov/type/oceb/nep/monitor_index.cfm
- https://floridadep.gov/water/submerged-lands-environmental-resources-coordination/documents/mangrove-trimming-and

Assessment / Learning on Display:

- Analyze data regarding wetlands importance, preservation, and monitoring techniques
- Share prepared research/graphs/data with school community / community organizers
- Team with a local organization such as the Sarasota Bay Estuary Program https://sarasotabay.org/ to begin and continue on-going mangrove health monitoring in terms of general conditions, hydrology, soil, vegetation, and animal life, etc.

Related Key Terms:

- Ecosystem: a biological community of interacting organisms and their physical environment.
- Wetlands: area of land that is saturated with water during at least part of the year and which supports plant life
- Estuary: An estuary is a body of water formed where freshwater from rivers and streams flows into the ocean, mixing with the seawater
- Mangrove: any of several tree species that grow in non-freezing estuaries. There are about 12 species though the black, red, and white are most common. The word mangrove can also refer to the entire habitat created by the trees, which is sometimes called a mangrove forest or mangrove swamp
- Adaptation: unique feature or behavior that helps an animal or plant survive in its environment
- Habitat: the specific environment where an animal or plant is able to survive
- Marsh: a wetland habitat dominated by grasses or grass-like plants. A salt marsh is a marsh that is flooded by salty water, such as water from the ocean
- Monitoring: sampling of environment (air, water, soil, vegetation, animals) that is compared with baseline samples to see if any changes have occurred
- Range: the geographic region in which a plant or animal typically lives or grows
- Research: systematic investigation to establish facts
- Salinity: the amount of dissolved salt content of in a body of water

Extensions:

- Social Studies: Research how native peoples lived with wetlands, starting with these video clips "Estuaries and the First Peoples" https://www.youtube.com/watch?v=KsIXm_UIYEI and "Urban Estuaries: Home to Native Peoples" https://www.youtube.com/watch?v=OLa57gc65aI
- Social Studies: Explore the history of wetlands in the U.S. since European settlement: http://www.fws.gov/wetlands/Documents/History-of-Wetlands-in-the-Conterminous-United-States.pdf

MARIE SELBY BOTANICAL GARDENS

Mangroves & Estuaries

Outstanding K-12 Educator Resources:

TEACHER INFORMATION RESOURCES

Wetlands:

- "Wetlands Live" Comprehensive Lesson Plans : http://wetlandslive.pwnet.org/resource/lesson_plans.php

Mangroves:

- Mangrove introduction video (5 min., K-12) http://www.blueworldtv.com/webisodes/watch/mangrove-forests
- Smithsonian Mangrove Information (also accessible for 5-12 students) http://ocean.si.edu/mangroves
- The Mangrove Tree (with applicable lesson ideas): http://www.teachingbooks.net/tb.cgi?tid=23348&a=1

Estuaries:

- Estuary Information & Activities: http://water.epa.gov/type/oceb/nep/about.cfm
- NOAA Estuary Lessons: https://oceanservice.noaa.gov/education/tutorial_estuaries/welcome.html
- NSTA collections of Estuary Resources: https://my.nsta.org/collection/050RtC2OOoc_E

Additional Resources:

- Middle School Salinity Activity http://www.blueworldtv.com/images/uploads/lesson-plans/Lesson_Plan_Webisode24Mangroves.pdf
- DIY Water filter: https://unctv.pbslearningmedia.org/resource/ess05.sci.ess.earthsys.waterfilter/earth-water-filter/

STUDENT INFORMATION RESOURCES

Wetlands:

- Visit to the Everglades https://unctv.pbslearningmedia.org/resource/ess05.sci.ess.watcyc.everglades/an-everglades-visit/
- Wetlands video (Bill Nye): https://www.youtube.com/watch?v=BeUPbGWg2KU
- Florida's Wetlands: http://www.swfwmd.state.fl.us/publications/files/waterweb_wetlands.pdf
- Wetland Career info: https://www.chegg.com/career-center/explore/wetlands-scientist, https://www.environmentalscience.org/career/wetland-specialist

Mangroves:

- Breakdown of importance of mangroves http://www.mangrovesolutions.com/whyimportant.php
- Mangrove Identification (6-12): https://floridadep.gov/sites/default/files/fg_man.pdf
- Adaptations of Mangrove Trees (5-12) https://www.floridamuseum.ufl.edu/southflorida/habitats/mangroves/adaptations/

Estuaries:

- Human impacts on Estuaries: http://users.clas.ufl.edu/jmjaeger/estuaries.htm

STUDENT ACTIVITY RESOURCES

Elementary:

- Interactive wetlands animal game (modify as needed to represent Florida organisms) https://iowaee.org/wp-content/uploads/2016/11/MarshMunchers_29Nov2016.pdf
- Plum Landing Magnificent Mangroves (K-3): http://pbskids.org/plumlanding/educators/context/105_mangrove_mystery.html
- List of mangrove Animals: https://www.floridamuseum.ufl.edu/southflorida/habitats/mangroves/mangrove-life/

Middle/High School:

- Floridian Wetlands Research (6-12): http://soils.ifas.ufl.edu/wetlandextension/research.htm

- Mapping Mangroves: https://coast.noaa.gov/data/estuaries/pdf/mapping-mangroves-resources.pdf