MARIE SELBY BOTANICAL GARDENS

E³: ECOSYSTEMS, ENERGY FLOW, & EDUCATION

Where Land Meets Sea: Mangroves & Estuaries

Eco-systems, Energy Flow, and Education:

Where Land Meets Sea: Mangroves & Estuaries

CONTENT OUTLINE

Eco-systems, Energy Flow, and Education:

Where Land Meets Sea: Mangroves & Estuaries

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 within it. 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 that specifically listed and can be easily modified to meet the needs of diverse learners. For example, the bibomimicry 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?" "Why do mangrove roots look like that?
(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 you visit Selby Gardens, we have 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. Investigate the contents and benefits of estuaries and adjoining mangrove forests. 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. A mangrove leaf sorting activity will help students identify the three types of mangroves native to Florida. **(K-12)**

IN-FIELD RESOURCES (Continued):

- **Plant Parts: Flower Dissection:** Learn plant parts in a fun, engaging way. A good way to learn about the reproductive parts of a plant is by dissecting a flower. 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. The term "dichotomous" means to divide into two groups that are not alike. **(3-12)**

- **Leaf/Algae Lab:** 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/ non-vascular plants, the purpose of leaf shapes (i.e.: bo tree's drip tip), etc… Preserves samples of various Algae species are also available for investigationn and crayon rubbings. **(K-8)**

- **Soil Dissection:** By scooping distinct types of soil into two buckets, children can examine what makes up the soil while observing the types of plants that grows in either type. The bo tree on the south point of the gardens is a great place to demonstrate sandy, coastal soil vs. one with more humus and other organic matter. Have students sort through soil using toothpicks and record what they see. Components include organic matter such as dirt, leaf and plant debris, animal excrement and decaying animal bodies (insects, etc…), and humus. Inorganic matter such as shell, rock, and sand and silt can also be found. **(3-12)**

BACKGROUND INFORMATION:

(Adapted and excerpted from The United States Environmental Protection Agency http://water.epa.gov/type/oceb/nep/about.cfm and from the Reef Ball Foundation http://www.oceanoasis.org/fieldguide/mangroves.html. Additional information resources can be found in the resource & appendix sections.)

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 salt water. Although influenced by the tides, they are protected from the full force of ocean waves, winds, and storms by such land forms 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 re-fuel 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.

Eco-systems, Energy Flow, and Education:

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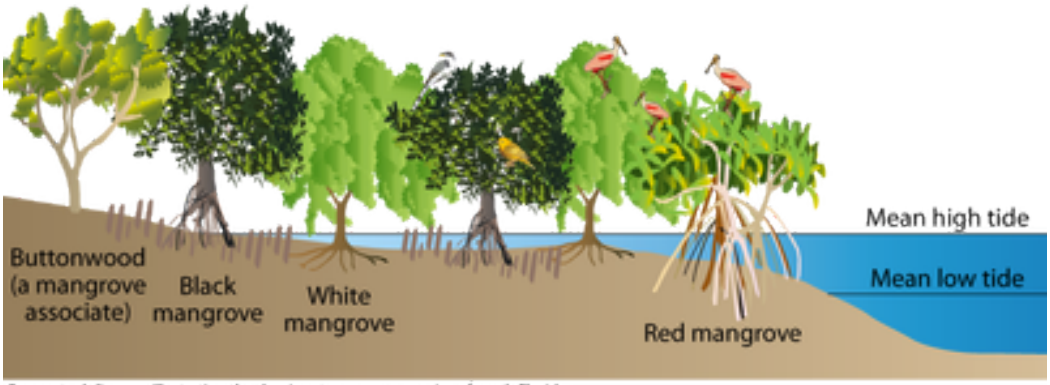
Why Protect Estuaries? The economy of many coastal areas is based primarily on the natural beauty and bounty of estuaries. When those natural resources are imperiled, so too are the livelihoods of those who live and work in estuarine watersheds. Over half the U.S. population lives in coastal areas, including along the shores of estuaries. Coastal watershed counties provided 69 million jobs and contributed $7.9 trillion to the Gross Domestic Product 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 closest to the sea and are flooded by daily tides. Red Mangrove (*Rhizophora mangle*) displays characteristic prop roots. Black (*Avicennia germinans*) and White (*Laguncularia racemosa*) Mangroves can usually be found landward of the Red Mangrove. The term “mangrove” refers to an assemblage of tropical trees and shrubs that grow in the intertidal zone. These zones are frequently inundated with salt water due to tidal activity of gulfs, seas and oceans. The term also refers to the mangrove family of plants, Rhizophoraceae, or more generally to mangrove trees of the genus Rhizophora. The relationship between mangroves and their associated marine life cannot be overemphasized.



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 Swamps (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 phosphorous, 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**, their intricate root systems provide shelter for many marine and terrestrial animals, protecting them from ocean currents and strong winds.

- **PRODUCE NUTRIENTS**, a large amount of the leaf litter is shed, being dropped and then broken down by bacteria and fungi which is made available to the food chain of aquatic animals. Therefore mangroves contribute to productivity in off shore 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 white-crowned pigeons 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 industry, 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, in 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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IMPORTANT NOTE TO THE TEACHER: *The preceding investigations are inquiry and project/lab-based. As you progress through each lesson, evoke student curiosity and wonder through hands-on experiences. Asking open-ended questions will develop their ideas and awareness about heat variations in relation to the sun. Resist the temptation to give the correct answer right away -- "thinking time" will encourage contemplation and wonder. Accept all reasonable answers and encourage students to speculate and elaborate on their responses. Allow the students' collective excitment to guide the development of the lesson. All lessons can be modified to reach many K-3 standards, regardless of the age group the lesson is listed under. While undergoing data collection, be sure to verify the accuracy of the data to ensure the validity of your investigation. If you have questions or would like additional support, contact education@selby.org.*

KINDERGARTEN - THIRD GRADE

(Habitats, Adaptations, & Biomimicry)

"Welcome to the Wetlands"

Description: This lesson encourages students to seek and understand the distribution of plant 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.

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 organisms 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 biomimcry in water filtration) *(1-LS1-1)*
- Students will apply their knowledge of how the Coastal Wetlands unique filtration ability thas inspired humans in creaton 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)*

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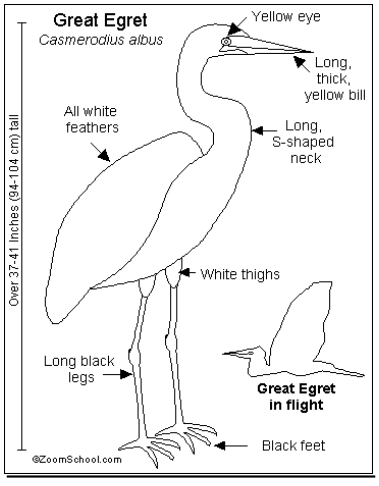
Materials:

- computer / internet access / projector
- various recycled materials like liter/ two liter plastic bottles
- sand / carbon (available at pet store) / river rocks / cotton balls
- ipad (for recording video clips)
- chart paper / paint / sponges & paintbrushes
- leaf rubbing kit: flat crayons, tracing paper, a variety of mangrove leaves (estuary tech kits including mangrove leaves available for check-out locally in Sarasota County. Contact: *Around the Bend Nature Tours* for more information)
- small piece of barbed wire, small section of thorny vine (optional)

Procedures:

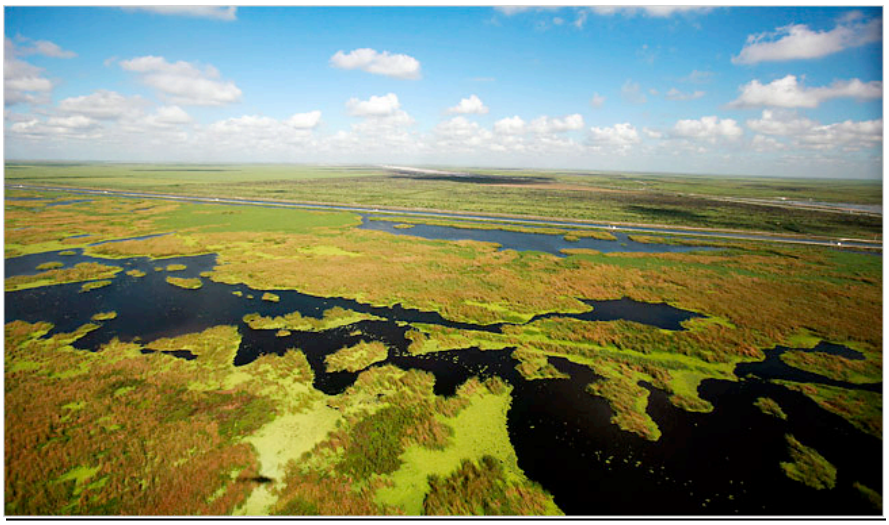
DAY ONE (HABITATS & ADAPTATIONS)

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 a discussion about habitats and that animals require unique environments in which to thrive
3. Introduce the concept of habitats/ecosystems with the following video (22min): http://www.youtube.com/watch?v=7Klscf43X4w
4. As a class, in small groups, or as individuals, have students select an animal from the video and discuss how it is uniquely adapted to it's 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 the wetlands ecosystem on chart paper. *(Consult teacher/student resources for more information)*



7. Conclude class explain that the class will be taking either a trip to visit (or will be exploring items from) the wetlands ecosystem.

DAY TWO (FIELD EXPEDITION)

1. If possible, schedule a learning expedition to visit a coastal area (like Selby Gardens) and see mangroves in person. If not possible, contact the Estuary Program and check-out their tech kit.
2. Prior to departure, reference the previous day's discussion on wetlands animals, and their unique adaptations to living there. Explain that plants are the same way and introduce the Mighty Mangrove. Discuss how the mangroves are uniquely suited to filtering the water around them. (Preview the up-coming lesson by letting the students know that these natural adaptations are so helpful, humans have even copied them!) If a field expedition is not possible, the following 5 minute video can be used: http://estuaries.noaa.gov/Teachers/mangroves.aspx
3. As part of a "Mangrove Leaf Lab" allow students compare to the different types of mangroves and their qualities *(reference background information section if needed)*
4. Students can create leaf rubbings from the various types of mangroves.
5. 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 (BIOMIMICRY)

1. Reflect on Field Expedition or kit experience.
2. Review knowledge as a class and record understanding in video clips.
3. Add paint and mangrove trees to class drawing. Draw and label each type of mangrove tree.
4. Ask if anyone can remember some of the unique/usual qualities of the mangrove tree (if filtering water isn't mentioned, remind them of this fascinating ability and tell them people have taken ideas from nature.
5. (If possible) show students one example (like how thorny vines gave us the idea for barbed wire)
6. Share photos or a slide-show featuring additional nature-inspired inventions
7. Student take-a-way: 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 themselves have inspired an invention --- can the guess what it might be?
3. Explain the way the wetlands filter water and that as a class you're going to create you very own device that can 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, carbon, recycled plastic water 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
- Make a poster declaring how nature inspires great ideas
- Pair up with 4th-8th grade students to complete additional water testing (pH, turbidity, etc.)

Related Key Terms:

- Habitat: a place where living things live
- Ecosystem: the way living things interact with eachother within a habitat
- Wetland: a type of ecosystem that is usually covered partially by water; often found near oceans/bays/rivers
- Mangrove: a type of wetlands tree that grows at the end of the sea in salty water
- Estuary: a protected wetlands habitat that provides a place for plants and birds to rest and raise their young
- Adaptations: changes you make to fit into an 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 this one: https://www.youtube.com/watch?v=ltBlCCoQ74k or http://www.youtube.com/watch?v=XHCV6b921gw
- **Geography:** Consult a world atlas to discover the ecosystems the exist in the world. Which ecosystems do the students live closest to? Furtherst? What ecosystem would that most like to visit? Which ecosystem does their favorite animal live in?

Eco-systems, Energy Flow, and Education:

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FOURTH - EIGHTH GRADE

(Adaptations & Ecosystem Energy Flow)

"A Magnificent Mangrove Maze"

Description: Students will identify the unique traits that Mangroves have made in order to survive and thrive in a wetlands environment. Additionally, they will explore how the "maze" of the mangrove root system contributes notonly to the coastal wetlands and estuary ecosystems, but to nearby ecosystems as well.

Driving Questions:

"What's so magnificent about wetlands?"
"Why do mangrove root systems look like that?"

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
- modeling clay
- long shallow pan
- a sponge
- watering can
- cup of soil
- jar of muddy water
- sponges

Procedures:

DAY ONE: INTRODUCTION

1. Introduce WetlandsBill Nye Wetlands (video) introduction (23 minutes): http://www.youtube.com/watch?v=gbYmr3D_UP8 (Consider dividing video into two classes)
2. Review with the students what they have learned about wetlands and their functional values.
    i. Have students list the three primary functions of wetlands:
        1. Control flooding (they soak up the water that flows into them) (3:33)
        2. Filter water (kinda like a natural coffee filter) (3:40)
        3. Provide a home for wildlife (3:43)
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 and preview upcoming field expedition to Selby Gardens.
4. Have the students think about the types of animals and plants that might live in each type of wetland.

DAY TWO: LAB/DEMONSTRATION

5. Present a pre-made wetland using a pan with modeling clay, representing land covering half of the pan sloping toward the bottom of the pan and nothing in the other half of the pan. This will represent a body of water such as a lake.
6. Ask the students what will happen if I pour some water (as rain) on the land (clay) what will happen to the water? (Should runoff quickly into the body of water.)
7. Now place a sponge in the pan at the base of the clay representing a wetland as a buffer zone between the land and the body of water. Pour some water on the land again and ask the students what happens with the wetland added? (The wetland slows the runoff down and it lessens the amount of water reaching the body of water because some water is trapped in the wetland.)
8. Explain that wetlands are shallow basins that collect water and slow the rate of flow down. This slowing process helps prevent flooding and soil erosion.
9. 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 industrialized world today.
10. 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? (Its 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 dirty and polluted.)
11. 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 dirty and polluted.)
12. Point out that without wetlands, tremendous amounts of silt and pollutants end up in bodies of water.
13. Introduce the role of mangrove stilt roots with pictures similar to these: http://www.mangrove.at/mangrove_roots.html. Reference the example BIll Nye gave using the marbles and the pegs.

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 inqure 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 a people? How can we prevent these undesirable events from happening?
- Wetlands model / PSA project / Hydro-detective project

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.
- Allow student to to create PSA posters/projects declaring the need to preserve wetland habitats
- Launch a biomimcry competiton where student pairs attempt to create a more effective water filtration system than their peers http://celfeducation.org/documents/MakeYourOwnWaterFilter6-8.pdf

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 Wetlands:
- 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 (prop) roots (as related to mangroves): above ground roots useful for support and additional oxygen

Extensions:

- **Language Arts**: Write a haiku about the importance of mangroves/estuaries
- **Mathematics**: Students graph the percentage of Florida that was/is wetland using the following data: http://soils.ifas.ufl.edu/wetlandextension/threats.htm
- **Just for fun**: Allow students to play "kerplunk" http://www.toysrus.com/buy/active/kerplunk-37092c-2328296 which models the role of the mangrove roots (sticks) on holding back the water (marbles)
- **Visual Arts/Advisor**y: Encourage students to explore (in writing or/sketching) 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 this one:http://www.youtube.com/watch?v=ltBlCCoQ74k or http://www.youtube.com/watch?v=XHCV6b921gw

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NINTH - TWELFTH GRADES

(Ecosystem Energy Flow & Environmental Vulnerability)

"Monitoring the Mangroves"

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)*

Eco-systems, Energy Flow, and Education:

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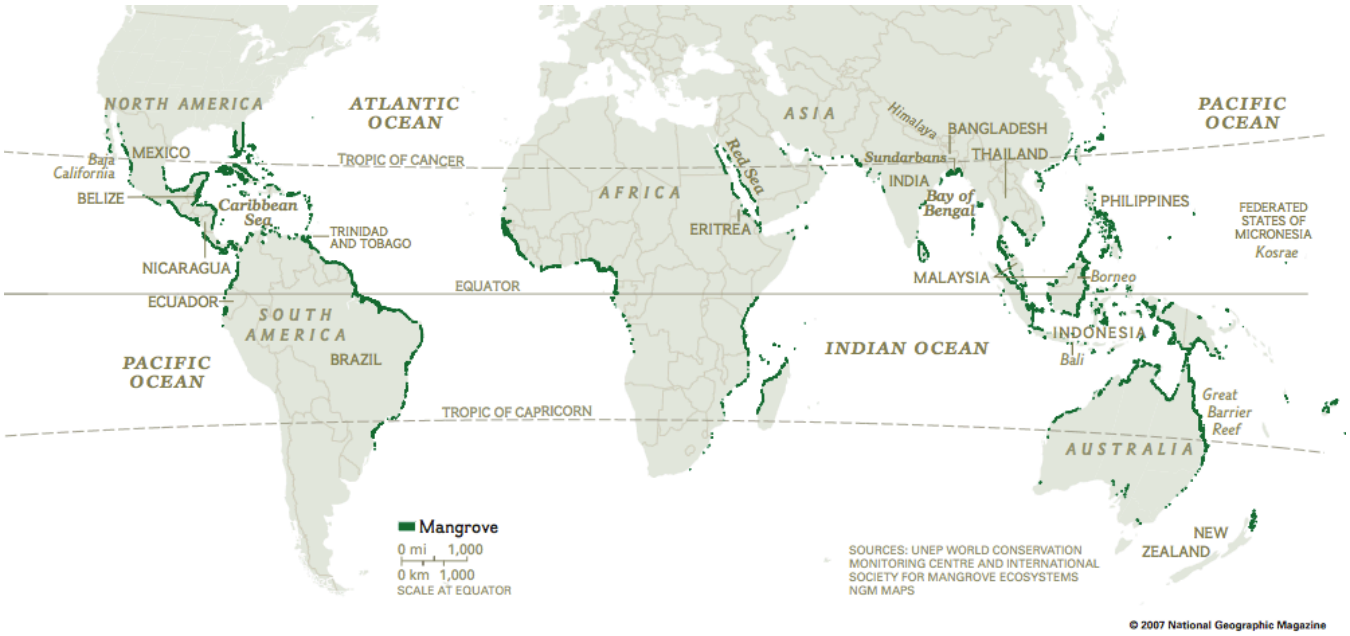
Materials:

- class set of “Mapping Mangroves” (includes student guide and maps) http://estuaries.noaa.gov/Teachers/pdf/12_Mangroves_Ex2.pdf
- several copies of the following article: http://www.bradenton.com/2013/07/28/4630381/long-bar-devlopers-say-sarasota.html
- class set of computers/ipads
- internet connection/projector
- additional materials may be needed for wetlands monitoring

Procedures:

DAY ONE:

1. Preview worldwide mangrove distribution by showing the following map:



http://mangroveactionproject.org/wp-content/uploads/2013/08/mp_download.5.pdf

2. Introduce the power and importance of the wetlands with the following video clip: http://www.blueworldtv.com/webisodes/watch/mangrove-forests
3. If possible, arrange a visit to Selby Gardens or similar coastal area with mangroves.
4. Introduce "Wetlands/Estuary Restoration and Monitoring" video clips: discuss slurry spray and kite camera monitoring in terms of effectiveness, cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts
5. 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 real-time 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:
   - Mangrove Action Project: http://mangroveactionproject.org/conservation-restoration/
   - Manual for monitoring mangroves in the South Pacific using three different levels of intensityhttp://www.sprep.org/Publications/manual-for-mangrove-monitoring-in-the-pacific-islands-region
   - Living Shorelines: http://www.habitat.noaa.gov/restoration/techniques/lsimplementation.html

DAY TWO

6. Share the following articles with the students to consider and discuss a local (and current) circumstance of mangrove endangerment at Long Bar Pointe: http://www.bradenton.com/2013/07/28/4630381/long-bar-devlopers-say-sarasota.html and http://www.bradenton.com/2014/05/04/5133991/a-review-of-major-legislation.html

7. What can we do? Explore volunteer wetlands monitoring options, using EPA guidelines:
   f. http://water.epa.gov/type/wetlands/assessment/upload/volmonitor-intro.pdf
   g. http://water.epa.gov/type/oceb/nep/monitor_index.cfm

8. Team with Selby Gardens in organizing a wetlands monitoring plan. Begin and continue on-going mangrove health monitoring in terms of general conditions, hydrology, soil, vegetation, and animal life, similar to the one below: http://www.a2skyline.org/skyline.home/files/wetland_monitoring_2006_report_final.pdf

Assessment / Learning on Display:

- Analyze data regarding wetlands importance, preservation, and monitoring techniqes
- Share prepared research/graphs/data with school community / community organizers

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” and “Urban Estuaries: Home to Native Peoples” http://estuaries.noaa.gov/Estuarylive/VideoGallery.aspx?ID=45
- **Social Studies**: Explore the history of wetlands in the U.S. http://www.fws.gov/wetlands/Documents/History-of-Wetlands-in-the-Conterminous-United-States.pdf
- **Language Arts**: Students approach wetlands life/conservation from a plant/animal perspective in a short story or limerick
- **Mathematics**: Graphing wetland loss trends: http://www.wetland.org/101/WET101C.pdf

Eco-systems, Energy Flow, and Education:

Where Land Meets Sea: Mangroves & Estuaries

Outstanding K-12 Educator Resources:

TEACHER INFO. RESOURCES

Wetlands Specific:

- Understanding Salt Marshes, Estuaries,and Mangrove Forests: http://marinebio.org/oceans/estuaries-salt-marshes-mangroves.asp
- "Wetlands Live" Comprensive Lesson Plans : http://wetlandslive.pwnet.org/resource/lesson_plans.php

Mangrove Specific:

- Mangrove introduction video (5 min., K-12) http://www.blueworldtv.com/webisodes/watch/mangrove-forests
- Fascinating Mangrove curriculum (K-5) http://www.meaningfulvolunteer.org/userfiles/file/mangrove_elem.pdf
- Smithsonian Mangrove Information (also accessable 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
- Mangrove/Wetlands Presentation prepared by UAE (6-12) http://edu.environmentalatlas.ae/downloads/Lesson%20Plan_Mangove%20Forests.pdf

Estuary Specific:

- Estuary Information & Activites: http://water.epa.gov/type/oceb/nep/about.cfm
- Estuary Resource and Lesson Plans: http://www.tbep.org/teacher/classroom_lessons.html#elemschool
- NOAA Estuary Education Resources: http://estuaries.noaa.gov/About/Home.aspx
- HIE Estuaries: http://oceanservice.noaa.gov/education/kits/estuaries/estuaries09_humandisturb.html
- HIE Estuaries: http://wps.prenhall.com/esm_thurman_introocean_9/5/1360/348196.cw/index.html
- NOAA Sponsored Estuary Resources "An Ocean of Free Teacher-Approved Marine Education Resources": http://www2.vims.edu/bridge/search/bridge1output_menu.cfm?q=estuary

Outstanding K-12 Educator Resources:

TEACHER INFO. RESOURCES (CONTINUED)

Additional Resources:

- Middle School Salinity Activity http://www.blueworldtv.com/images/uploads/lesson-plans/Lesson_Plan_Webisode24Mangroves.pdf
- Biomimicry: Filter Water Like the Wetlands: http://biomimicry.info/wetlandwater
- DIY Water filter instructions: http://pbskids.org/zoom/activities/sci/waterfilter.html
- Estuary Food Web Unit (6-12): http://teachoceanscience.net/pdfs/Aquatic%20Microbes%20Food%20Webs.pdf
- Barrier Island LP (K-12): http://www.nwrc.usgs.gov/fringe/barriers.html
- Introduction to Habitats LP (3-5): http://school.discoveryeducation.com/lessonplans/programs/habitats/
- Differentiating between wetlands: http://www.pngwima.com/?page_id=29

STUDENT INFO. RESOURCES

Wetlands Specific:

- Wetlands video (Bill Nye): http://www.youtube.com/watch?v=gbYmr3D_UP8
- Wetlands information (5-12): http://floridaswater.com/waterbodies/wetlands.html
- Wetlands brochure: http://sarasotabay.org/documents/wetlandsbrochure.pdf
- Florida's Wetlands: http://www.swfwmd.state.fl.us/publications/files/waterweb_wetlands.pdf

Mangrove Specific:

- Concise breakdown of importance of mangroves (4-8) http://www.mangrovesolutions.com/whyimportant.php
- Mangrove Information (6-12): http://www.oceanoasis.org/fieldguide/mangroves.html
- Adaptations of Mangrove Trees (3-12) http://oceanservice.noaa.gov/education/kits/estuaries/media/supp_estuar07d_mangrove.html

Estuary Specific:

- HIE Estuaries: http://www.clas.ufl.edu/users/jmjaeger/estuaries.htm
- Estuaries & You. Find out here: http://estuaries.noaa.gov/About/Default.aspx?ID=243

Eco-systems, Energy Flow, and Education:

Where Land Meets Sea: Mangroves & Estuaries

Outstanding K-12 Educator Resources:

STUDENT ACTIVITY RESOURCES

Elementary:

- Interactive wetlands animal game (K-3): http://www.greenwing.org/greenwings/fun/fun5.html
- Plum Landing Magnificent Mangroves (K-3): http://pbskids.org/plumlanding/educators/context/105_mangrove_mystery.html
- Water Filtration Lab (3-5): http://pbskids.org/zoom/activities/sci/waterfilter.html
- Bill Nye the Science Guy: Wetlands Episode: http://www.youtube.com/watch?v=gbYmr3D_UP8
- List of Estuary Animals: http://naturemappingfoundation.org/natmap/marine/estuary_animals.html

Middle/High School:

- “Hydrodesigners” Water Filtration Lab/Competition (6-12): http://celfeducation.org/documents/MakeYourOwnWaterFilter6-8.pdf
- Floridian Wetlands Research (6-12): http://soils.ifas.ufl.edu/wetlandextension/research.htm
- Mapping the Mangroves: http://mappingthemangroves.org/