

Visiting the Estuarium

For the Teacher of Grades 9-12

Before your visit:

1. First-timers:

Teachers may want to preview the Estuarium before bringing students. Contact Denise Keaton at (251) 861-7511 or dkeaton@disl.org for a free teacher's pass.

2. Student Activities:

- **Mobile Bay Map (attached)**

Use the provided map of Mobile Bay to familiarize your students with the Mobile Bay estuary and surrounding areas. Label it according to the instructions.

- **Trace Your Watershed (attached)**

This activity will help students understand the connection between a creek in their backyard, a river across town, a coastal estuary, and the Gulf of Mexico. If you do not live in this area, then map your own watershed. Discuss with students the impacts of upstream activities on waters downstream.

3. Student Vocabulary:

watershed, delta, wetland, salt marsh, estuary, brackish, salinity, sargassum, mollusk, arthropod, sessile, filter feeder, benthic, plankton

4. Handouts:

Make copies of the attached activity for your students to complete while visiting the Estuarium. Bring pencils and crayons (for rubbings).

5. Other ideas:

- Discuss different ways that humans have used coastal environments through activities such as fishing, shrimping, natural gas exploration, dredging, shipping, and development. En route to the Estuarium, look for examples or evidences of each. Have each student select one of these topics to research.
- Create a "Watershed in a Box." You can find instructions on our website under Teacher and Student Resources.

During your visit:

Complete handout.



After your visit:

1. Have each student write a research paper on the invertebrate he/she chose from the Invertebrate Trail. Alternately, have students choose a local plant or animal.
2. Assign each student to one side or another of local issues. Have them research the issue, focusing on their assigned interest. Have them write a position paper. Then have students from the different sides debate the issue.
3. "Take a Watershed Approach" role-playing activity: Identify (or make up) a planned development project that would have a potential impact on a local watershed. Find interest groups including resource and regulatory agencies (there may be many different agencies with different roles in the same building project - for example: the State's Department of Natural Resources, the State's Department of Environmental Quality, the U.S. Fish and Wildlife Service, the U.S. Army Corps of Engineers, the Environmental Protection Agency, etc.), citizens, and other interested parties (for example - the owner of the land and proposed building project, the builder, the State's Bureau of Economic Development, local non-profit non-government agencies, potential beneficiaries of proposed project, neighbors to the land, area residents, environmental consultant). Give these roles to different students, and have them research ways they can protect their interests. Have the owner submit a proposal to the panel of resource and regulatory agencies, and, after a public hearing, have the students representing these agencies decide whether to grant or deny permits for the project, perhaps making suggestions. Have the owner resubmit modified proposals until one is accepted by all regulatory agencies, or until you run out of time.

Aquascience Elective

- 1.) Differentiate among freshwater, brackish water, and saltwater ecosystems.
 - Identifying chemical, geological, and physical features of aquatic ecosystems
- 2.) Relate geological and hydrological phenomena and fluid dynamics to aquatic systems.
- 6.) Describe adaptations that allow organisms to exist in specific aquatic environments.
- 7.) Describe processes and environmental characteristics that affect growth rates of aquatic animals.
 - Examples: reproductive habits, feeding habits, interdependence of organisms, overcrowding, seasonal changes
- 8.) Determine effects of the fishing industry on the aquatic environment.
 - Examples: aquaculture, overfishing
 - Explaining harvesting techniques and methods of transporting fish to market

Biology

- 11.) Classify animals according to type of skeletal structure, method of fertilization and reproduction, body symmetry, body coverings, and locomotion.
 - Examples:
 - skeletal structure-vertebrates, invertebrates;
 - fertilization-external, internal;
 - reproduction-sexual, asexual;
 - body symmetry-bilateral, radial, asymmetrical;
 - body coverings-feathers, scales, fur;
 - locomotion-cilia, flagella, pseudopodia
- 2.) Describe protective adaptations of animals, including, camouflage, beak type, migration, and hibernation.

Environmental Elective

- 1.) Identify the influence of human population, technology, and cultural and industrial changes on the environment.
- 7.) Identify reasons coastal waters serve as an important resource.
 - Examples: economic stability, biodiversity, recreation
 - Classifying biota of estuaries, marshes, tidal pools, wetlands, beaches, and inlets
 - Comparing components of marine water to components of inland bodies of water
- 8.) Identify major contaminants in water resulting from natural phenomena, homes, industry, and agriculture.
- 9.) Describe land-use practices that promote sustainability and economic growth.

- Defining various types and sources of waste and their impact on the soil

Examples:

- types - bio-degradable, non-biodegradable, organic
- sources - pesticides, herbicides

- Identifying ways to manage waste, including composting, recycling, reusing, and reclaiming

10.) Describe the composition of soil.

- Identifying various processes and activities that promote soil formation

Examples: weathering, decomposition, deposition

1.) Describe agents of erosion, including moving water, gravity, glaciers, and wind.

- Describing methods for preventing soil erosion

Examples: planting vegetation, constructing terraces, providing barriers

12.) Identify positive and negative effects of human activities on biodiversity.

- Identifying endangered and extinct species locally, regionally, and worldwide

- Identifying causes for species extinction locally, regionally, and worldwide

Geology Elective

3.) Explain natural phenomena that shape the surface of Earth, including rock cycles, erosion and deposition, weathering, and tides.

6.) Explain the concept of geological time within the framework of the geologic time scale.

- Describing how sedimentary rocks provide a record of evolutionary change
- Describing the role of fossils in determining the age of strata

8.) Explain interactions among topography, climate, organic activity, time, and parent material through which soils are created.

9.) Describe the movement and storage of water in terms of watersheds, rainfall, surface runoff, aquifers, and surface water reservoirs.

- Identifying major regional and national watersheds

13.) Describe the formation and characteristics of river systems.

- Explaining the formation of alluvial fans
- Identifying natural events and man-made structures that affect rivers

Examples:

- natural events-weather, construction of dams by beavers;
- man-made structures-levees, dams

14.) Explain the interaction of the continuous processes of waves, tides, and winds with the coastal environment.

- Identifying the impact of periodic weather phenomena on coastal regions

Examples: hurricanes destroying sand dunes, El Niño or La Niña redefining shorelines

- Identifying the positive and negative impact of humans on coastal regions

Examples:

- positive - shoreline protection,
- negative - buildings replacing protective dunes and barriers

Marine Biology Elective

- 2.) Differentiate among freshwater, brackish water, and saltwater.
- 3.) Describe physical characteristics of oceans, including topography of the ocean floor, wave motion, depth, and pressure.
- 5.) Discuss physical and chemical properties of saltwater.

Examples:

- physical - turbidity, temperature, density
- chemical - salinity, pH, dissolved gases

- 6.) Describe components of major marine ecosystems, including estuaries.
- 7.) Identify patterns and interrelationships among producers, consumers, scavengers, and decomposers in a marine ecosystem.
- 9.) Arrange various forms of marine life from most simple to most complex.

- Classifying marine organisms using binomial nomenclature
- Identifying characteristics of ocean-drifting organisms

Examples: phytoplankton, zooplankton

- Identifying characteristics of marine invertebrates

Examples: Protozoa, Porifera, Coelenterata, Arthropoda

- Identifying characteristics of marine vertebrates

Examples: fishes, reptiles, birds, mammals

- Identifying characteristics of marine plants

Examples: algae, seaweed

- Describing adaptations in the marine environment

- 11.) Describe positive and negative effects of human influence on marine environments.

Examples:

- positive - reef restoration, protection of endangered species
- negative - pollution, over-fishing

- 12.) Identify various careers related to marine science.

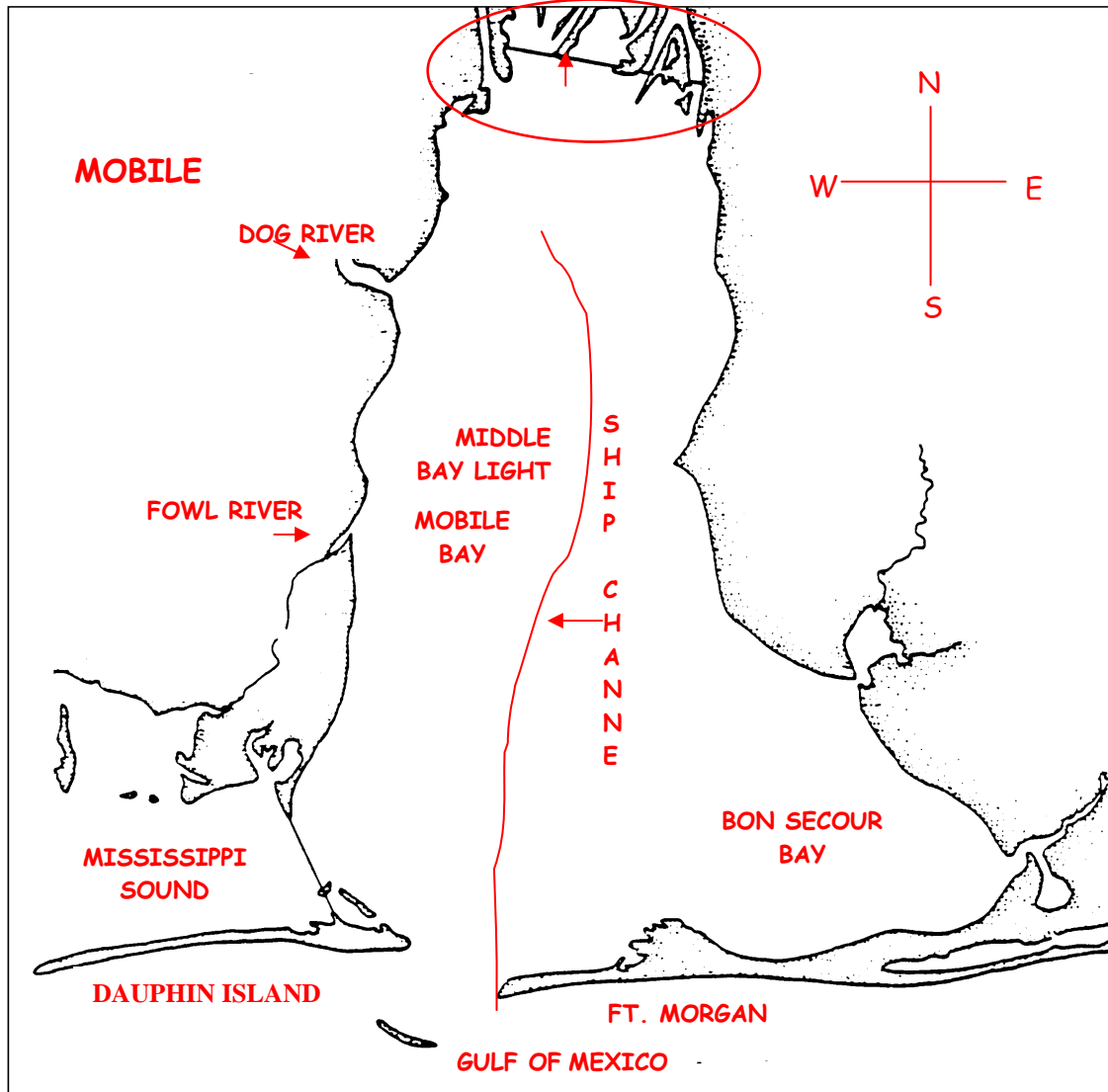
Zoology Elective

- 1.) Define basic anatomical terminology associated with the study of animals.

Examples: dorsal, caudal, aboral

MAP OF MOBILE BAY

To be completed *BEFORE* your visit.



Using the map of Mobile Bay above, label the following areas around Mobile Bay:

- | | | | |
|------------------|-------|-----------------------|-------------------|
| Dauphin Island | South | Gulf of Mexico | Bon Secour Bay |
| Mobile Bay | East | Dog River | Fowl River |
| Ship Channel | West | Mobile | Mississippi Sound |
| Middle Bay Light | North | Fort Morgan Peninsula | |

Draw a circle around the Mobile Delta area.

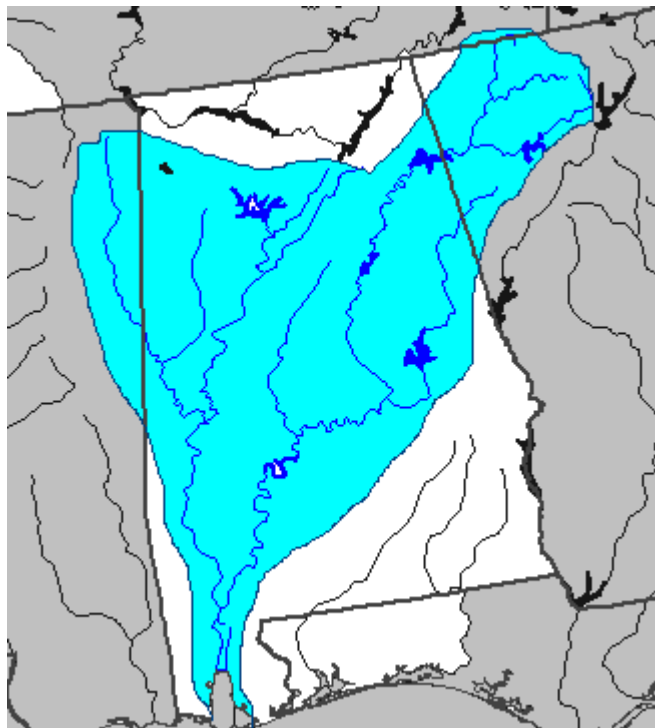
MOBILE BAY WATERSHED

To be completed *BEFORE* your visit.

A watershed is an area of land that drains to a particular body of water. Watersheds are complex systems of rivers, lakes, streams, groundwater, and wetlands that eventually drain into the same body of water.

Using the map provided (www.nationalatlas.gov), begin at Mobile Bay, and trace the rivers and streams that are connected to the bay. Draw a line to encompass these rivers and streams, being careful not to cross rivers that don't connect to the bay. This will outline the watershed of Mobile Bay. Shade the area.

Do you live in the Mobile Bay watershed? _____



Water from more than two-thirds of the state of Alabama, and parts of Mississippi, Tennessee, and Georgia eventually flows into Mobile Bay, which drains into the Gulf of Mexico. Upstream activities in a watershed can impact the quality of waters downstream. If your town is within the large Mobile Bay watershed, your activities that affect a creek in your backyard or a river in your town can directly affect the Mobile Bay estuary and the Gulf of Mexico many miles away.

At the Estuarium

9th -12th Grade Activity Answer Sheet

The titles of panels where answers are found are in italics.

Answers are in bold.

9th – 12th Grade Activity

Name: _____

What is the Estuarium?

The Estuarium is an aquarium exhibiting plants, animals, and habitats of coastal Alabama. An *estuary* is a place where fresh water from land mixes with salt water from an ocean. Your visit through the facility will take you from the fresh water *delta* to the salty Gulf waters.

This worksheet is divided into the galleries that you will find as you tour the Estuarium. Read the panels, observe the tanks, and ask docents and staff to help you find the answers.

Mobile Delta Gallery

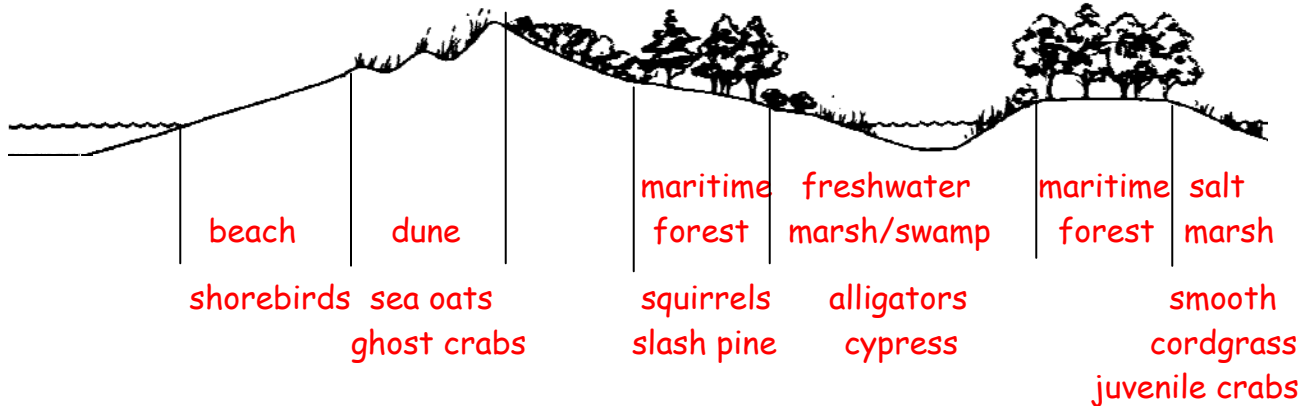
1. **Before the Delta:** Describe how our continent looked different 75 million years ago, during the late Cretaceous Period, when mosasaurs lived on earth. *Mosasaur* **What is now North America was then divided into three parts by a great inland sea that covered much of what is now the Great Plains region and parts of Canada**
2. How big is the Mobile-Tensaw Delta (measured in acres)? *Up in the Delta (D1)* **115,000 acres**
3. What is Alabama's state reptile? *A Limited Range (free-standing triple panel)* **Alabama red-belly** What specific range in Alabama does it occupy? **It is found only in the lower parts of the Mobile and Tensaw rivers.**
4. What are Streamside Management Zones (SMZs)? *Banking on Trees (D18)* **Strips of land immediately adjacent to a body of water, where soils, organic matter, and vegetation are preserved to filter surface and subsurface waters.** Name three benefits of using SMZs. **The tree canopy prevents water temperature from rising (rising temperatures can be harmful to stream organisms). Roots absorb nutrients, preventing them from throwing off the ecological balance in a stream. SMZs slow the acceleration of erosion caused by clear-cutting. And they help maintain a large diversity of plants and animals.**
5. Name two photosynthetic, carnivorous organisms in this gallery. *Bog Plants (D12)* **Pitcher plants and sundews** They can be found in what ecosystem? **Bogs** What are two threats to this ecosystem? **Draining and development**
6. What are invasive species? *Alien Species (D12)* **Invasive species are those that outcompete native species for food and/or habitat.** What invasive species plagued the Mississippian Indian societies? (*Hint: this is not spelled out in so many words on any sign*) *3,000 Years Ago (D20)* **European humans and diseases**

Mobile Bay Gallery

1. By volume of water, Mobile Bay is the **fourth** largest drainage basin (watershed) in the United States. *A Drowned River Valley (B2)*
2. How does the present-day coastline of Alabama differ from Alabama's coastline of 15,000 years ago? *A Drowned River Valley (B2)* **The coastline is 60 miles north of where it was then. Why was it different? At the end of the last ice age, large ice sheets melted, raising sea level, flooding the ancient Mobile River.**
3. What animal did people avoid eating in summer months? *Nature's Filter (B15)* **Oysters** How do these animals feed? **They are filter feeders.** How can these two factors (summer months, and their manner of feeding) contribute to making people sick when they consume these organisms? *What's for dinner?* **Typically, the higher the water temperature, the higher the Vp (a harmful bacteria) density in the water and potentially, in oysters. Because an oyster feeds by filtering seawater, when waters are warm, it can accumulate enough Vp to cause illness in consumers.**
4. How does water's ability to dissolve particles affect *our* food web? *The Buck Stops Here (B23)* **Pollution is dissolved and carried by rivers. When it reaches saltwater, particles settle to the bottom of the bay because saltwater doesn't dissolve things as well. Animals we eat may feed on these particles directly or indirectly.**
5. Explain three problems caused by piers and bulkheads along shorelines. *Pier Pressure (B7)* **Piers shade plants, reducing their growth rates and causing a loss of suitable habitat for native animals. Bulkheads reflect wave energy, removing beach and deepening water. This deeper water also allows stronger currents next to bulkheads, speeding up the removal of plants and sediments. Bulkheads along rivers prevent gradual change from water to shoreline habitats.**

Barrier Island Gallery

1. Name two important benefits of barrier islands to mainland coastal areas. *Sands of Time (BI1)* **They protect the mainland from storms, and they form a physical barrier that traps fresh water, forming estuaries.**
2. What was the capital of French Louisiana, from 1701-1717? *Massacre Island (BI4)* **Isle Dauphine (Dauphin Island)** What caused the French to move their capital? **Damage to the port from a hurricane**
3. Below is a cross section of a barrier island. Label the following habitats: *An Army of Grains (BI9), Island Forest (BI8), The Other Shoreline (BI7)*
beach fresh water marsh/swamp dune maritime forest salt marsh



For each habitat, label one plant or one animal found there. Explain why the sand dunes can be a harsh environment for plants and animals. Give at least three examples. Explain at least three adaptations that allow some plants and animals to survive these challenges. **Conditions are desert-like, with salt spray, shifting sands, and intense heat. Some animals, such as ghost crabs dig deep burrows to escape the heat. Dune plants stabilize the sand grains with their roots, which trap sand and slow wind. Dune plants can tolerate salt spray and sand burial. Intertidal animals "hide or ride" in the waves.**

Gulf of Mexico Gallery

1. Name an invasive jellyfish sometimes spotted in Mobile Bay and the northern Gulf of Mexico. *(jellyfish kiosk)* **The Australian spotted jellyfish**
2. Name four types of structures that have been sunk in Alabama waters to create artificial reefs. *Rigs to Reefs (G4), Reef Madness ((G13)* **Oil and gas rigs, junk cars, culverts, liberty ships, and army tanks** Why have people created these artificial reefs? **They provide reef habitat that is otherwise not present here, and people like to fish for the reef fish that colonize them.**
3. Explain the environmental problems caused by paving surfaces. *A Better Way to Grow (DISL1)* **By preventing rainfall from soaking into the ground, these hard surfaces increase runoff volume and rates, and the filtering capacity of the soil and vegetation is lost. This causes flash flooding and increases the pollution carried into waterways.**
4. **Underwater Exploration:** What value is there to exploring the deep ocean? **Answers will vary. They might include the following: There is value to knowing about the biology, the geology, the chemistry, etc. of this vast unknown part of our planet. Besides the intrinsic value of that knowledge, we might learn something of material value to us. For example, there are potential medical applications of deep-sea organisms. Or we might use the mineral resources of the deep sea. The deep sea might one day be an eco-tourism destination.**
1. **Oil Spill:** What do dispersants do? **Dispersants speed the rate of decomposition for oil by creating the smallest particle possible.**
What were two concerns some people had about the dispersants being put on the Deep Water Horizon oil spill? **Dispersants had never been used before at the extreme cold and high pressures at the depth (~ 5,000 ft.) of the leaking well. Corexit (the dispersant used) has its own level of toxicity.**

1. **The Weather Station:** Record these current weather conditions: **Answers will vary.**

Air Temperature	_____	Wind Speed	_____
Water Temperature	_____	Wind Direction	_____
Dissolved Oxygen mg/L	_____	Salinity	_____

* Don't forget to include units of measure.

Would the amount of dissolved oxygen usually increase, decrease, or stay the same with increased depth through the water column? *Hint: you will not find the answer written on a sign; you will have to think about it.* **Dissolved oxygen would usually decrease with increased depth.** Some of the contributing factors are listed below. Give brief explanations of how they relate to water depth and dissolved oxygen.

Pressure: **Pressure increases with increased water depth. This "squeezes" dissolved oxygen upward toward an area of less pressure.**

Air-water interface: **The air-water interface is at the water's surface. Oxygen gets mixed into the water here.**

Temperature: **Temperature generally decreases with increased depth. Warmer water molecules expand, and don't hold as much dissolved oxygen among them as cooler water molecules do. This factor is generally not enough to outweigh other factors in a dissolved oxygen profile. * However, when water heats up to very high temperatures at the surface, dissolved oxygen may be lower at the very surface, increase just below the surface, and then decrease with depth.**

Photosynthesis: **Photosynthesis produces oxygen. Photosynthesis requires light, so it generally takes place near the surface where light can penetrate. This generally contributes to lower oxygen with increased depth. * However, in cases of very high surface heat, and sometimes because of other factors, photosynthetic organisms may be present in higher numbers just below the surface instead of right at the surface.**

*** Students may not infer the exception in temperature's role in the dissolved oxygen profile.**

Living Marsh Boardwalk

The Living Marsh Boardwalk is located outside the Estuarium. This area was once the site of a septic tank used by the Air Force. In 1993 the Dauphin Island Sea Lab removed the sewage-septic tank and rebuilt the marsh. Use the panels and audio kiosks on the boardwalk and your own observations to answer the following questions.

1. Plants that live in or near salt-water have means of resisting the harmful effects of salt. Name two of these techniques. *Growing on the Dunes* **Some plants have thick, fleshy leaves to help conserve water. Some have deeply buried root systems, underground stems, or grow low to the ground to avoid salt spray.**
2. On average, how deep is Mobile Bay? *Where am I? or Ladner Pavilion Audio Kiosk* **3 meters (10 feet)** How long is Mobile bay? **53 kilometers (35 miles)** How wide is Mobile Bay? **16 kilometers (10 miles)**
3. How real is the threat of an oil spill from the rigs you see just offshore? *Energy from the Sands of Time* **Because the rigs off the Alabama coast are not pumping oil, the threat of an oil spill is nonexistent.**
4. Compare the form and function of the existing Estuarium parking lot to a hypothetical, typical, paved parking lot in the same place. *Permeable Parking Lot Audio Kiosk* **A typical, paved parking lot collects motor oil and other fluids that leak out of cars, as well as other pollutants that might be left there. When it rains, the rainwater picks up these pollutants as it flows over the parking lot. This polluted water is usually collected in storm drains and directed right into a local stream or water body. Unlike most paved parking lots, the Estuarium parking lot is permeable. Holes in the blocks that form the permeable parking lot are filled with sand and gravel packed three feet deep. When it rains, the rain water, carrying pollutants, percolates through the layer of sand and gravel, which acts as a filter for the pollutants. There is a plastic sheet under the sand and gravel. The plastic sheet directs the water to the end of the parking lot where there are two filters to further clean the water. Then the water flows into a settling pond, where it is cleaned even more by plants and sand. In case the settling pond fills during a storm, excess water flows through the tall plants on the edge of the parking lot, and they too act as a biological filter before the water returns to the bay.**

Invertebrate Trail

On the Invertebrate Trail, locate animals that represent the phylum Arthropoda (which means jointed legs). Use a crayon (or pencil) to make a rubbing of one of these animals.

Trilobite, Horseshoe Crab, Anomalocaris, Blue Crab