BACK BAY SCIENCE CENTER

Wetlands Soil

ACTIVITY: SOIL STORY

TIME: 35-50 minutes
GRADE LEVEL: 7th-12th
GROUP SIZE: 8-10 students

Theme: **Wetland soil is the foundation for estuaries. Students will sample wetland soil, learn about its characteristics, and classify the different soil types.**

NEXT GENERATION SCIENCE STANDARDS:

PERFORMANCE EXPECTATIONS

MS-ESS2-1. Develop a model to describe the cycling of Earth's materials and the flow of energy that drives this process.
HS-ESS2-2. Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems.
HS-ESS2-5. Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models • Develop and use a model to describe phenomena (MS-ESS2-1) **Analyzing and Interpreting Data** • Analyze data using tools, technologies, and/or models in order to make valid and reliable scientific claims or determine an optimal design solution (HS-ESS2-2) **Planning and Carrying Out Investigations** • Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data and refine the design accordingly (HS-ESS2-5)	**ESS2.A: Earth's Materials and Systems** • All Earth processes are the result of energy flowing and matter cycling within and among the planet's systems. This energy is derived from the sun and Earth's hot interior. The energy that flows and the matter that cycles produce chemical and physical changes in Earth's materials and living organisms. (MS-ESS2-1) • Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes (HS-ESS2-2) **ESS2.C: The Roles of Water in Earth's Surface Processes** • The abundance of liquid water on Earth's surface and its unique combination of physical and chemical properties are central to the planet's dynamics. These properties include water's exceptional capacity to absorb, store, and release large amounts of energy, transmit sunlight, expand upon freezing, dissolve and transport materials, and lower the viscosities and melting points of rocks (HS-ESS2-5)	**Stability and Change** • Explanations of stability and change in natural or designed systems can be constructed by examining the changes over time and processes at different scales, including the atomic scale (MS-ESS2-1). • Feedback (negative or positive) can stabilize or destabilize a system (HS-ESS2-2) **Structure and Function** • The functions and properties of natural and designed objects and systems can be inferred from their overall structure, the way their components are shaped and used, and the molecular sub-structures of their various materials (HS-ESS2-5)

Ocean Literacy Principle 5: The ocean supports a great diversity of life and ecosystems
Ocean life ranges in size from the smallest living things, microbes, to the largest animal on Earth, blue whales.
E- The ocean provides a vast living space with diverse and unique ecosystems from the surface through the water column and down to, and below, the seafloor. Most of the living space on Earth is in the ocean.

BACKGROUND INFORMATION

Mudflats are the foundation of an estuary. They are the habitat for photosynthetic organisms that supply oxygen and food for higher trophic levels. While the surface level is an aerobic environment, the deeper mud with its tightly packed fine silt is host to anaerobic organisms. Although invisible, the anaerobic bacteria process some of the toxic pollutants out of the water. It's important to monitor the health of an estuary, and keep track of as well as limit the threats that human activities present.

Mudflats are a key component to the estuarine ecosystem. They support a wide biodiversity of plants, animals, and bacteria. While the tightly packed mud excludes larger plants, eelgrass thrives here. Along with diatoms and algae, eelgrass is a primary producer and is responsible for creating most of the ecosystem's oxygen through photosynthesis. It also provides food for herbivores and shelter for larvae, juvenile species including fish, birds, and a diverse array of invertebrates . Because there is such a multiplicity of species to be found here, migratory birds, larger fish and marine mammals also come to the estuary to feed.

During low tides, a variety of invertebrates can be seen on the surface layer of the mudflats. Assorted crustaceans such as crabs and shrimp try to find shelter. The smaller copepods, ostracods and isopods can float with the moving waters or hide in the tiny pools around rocks and grasses. Mollusks such as clams burrow deeper into the mud to avoid dessication, while mussels close up. Looking closer, one can see the holes of the annelid worms.

The mudflats are formed by the sediments deposited from the watershed. The seasonal storms and off-season waterings bring rocks, trash and chemicals from upstream communities. As they travel downhill they are bounced against rocks in the riverbed and gradually eroded into smaller bits. An estuary with a long and meandering path offers many areas for slower moving waters to deposit their smaller and light weight sediments. Because the settling sediments are tiny, they can pack together tightly with little to no pore space between them. This lack of pore space creates an anoxic or anaerobic

environment. While this would be a hostile environment for most organisms, there is a group of bacteria that thrive here by metabolizing chemicals other than oxygen. It is precisely this ability to process chemicals that makes these microorganisms such a vital part of the ecosystem.

A careful look at worm holes in the deeper levels of mud reveals brown color, the sign that some oxygen is present. Digging deeper into a core of estuary mud, the black color and smell of rotten eggs is apparent. Bacteria living in the anoxic conditions of tightly packed mud metabolize alternate chemicals such as sulfates (producing the characteristic color and smell of Hydrogen sulfide), liberating energy for organisms at higher trophic levels. The bacteria occupy the important niche of decomposers. They make nutrients bound up in dead tissue available for larger organisms. Given this amazing task accomplished by microorganisms invisible to the naked eye, it's imperative to remember that there is a critical carrying capacity beyond which they cannot operate. When there are too many contaminants in the system, they cannot be processed and bioaccumulate in the plants of the estuary. As the herbivores eat many plants, and the carnivores eat multiple herbivores, the toxins biomagnify up the higher trophic levels, becoming increasingly more concentrated.

Realizing the importance of the overall estuarine biome, we are researching ways to safeguard it. As the foundation of the ecosystem, it is imperative to pay specific attention to the mudflats. Several factors recur in the literature as being critical: Dredging the channel which destroys the habitat and alters the pattern of sediment movement (which can smother eelgrass beds and benthic species); construction of marinas or docks that disturb sediments and block eelgrass access to sunlight as well as increasing possibilities for spilled gasoline and propeller wash; Increased force of water from impervious surfaces in channels and streets which carry more pollutants as well as creating more erosion; Increased erosion upstream from construction; Excessive nutrients from sewage or fertilizers; and Invasive species that can hitchhike on boats or are released upstream. Most of these are human-created, but all of them can be monitored through soil assessments, population counts and tracking channel depth. With human attention, advocacy and action we can hopefully mitigate the deleterious impacts and reclaim and secure this habitat.

Resources:http://nerrs.noaa.gov/ - national estuarine research reserve system
http://www.backbaysciencecenter.org/marinelife.html - monthly inventories going back to 2007
http://spoutingoff.wordpress.com/2011/04/13/contamination-is-forever/

TEACHER GUIDE – WETLANDS SOIL

ACTIVITY: Soil Study

OBJECTIVES:

Students will be able to:

1. Develop a model to describe how the flow of energy and cycling of matter produce change in the sediment and substrate of the mudflat environment
2. Analyze data to make the claim that changes that take place on land can cause changes in the wetland ecosystem
3. Plan and conduct an investigation to observe how properties of water can have an effect on processes that take place in a mudflat

MATERIALS:

Soil Probes (3-4)
Wetland Soils Handout
Wetland Soils Color Chart
Field-Based Soil Sample Data Chart
Analyzing Soil Samples Worksheet

KEY TERMS:

Aerobic Anaerobic Annelid worms Anoxic Bacteria Bioaccumulate Biodiversity Biomagnify Carrying Capacity Chordate Crustacea Decomposer Dessication Echinoderm Environment Ecosystem Estuarine Estuary Habitat Herbivore Invertebrate Isopods Metabolize Microhabitat Microorganism Mollusk Mudflat Niche Organism Ostracod Photosynthesis Pore space Sediment Silt Toxic Trophic level Watershed