



BACK BAY SCIENCE CENTER

Mudflats/Invertebrates Module

Activity I – Mudflats
Activity II – Mudflats Community
Structure

CALIFORNIA STATE CONTENT STANDARDS

Grades 6 – 8

6th Gr. Science:
Ecology - 5b, c, e

7th Gr Science:
Physical Principles in Living Systems - 6d
Investigation and Experimentation - 7a

Grades 9 – 12

Science:
Biology/Life Sciences –
Ecology 6a, b, d, f

Earth Science – ES 5.3

AP Science - Science Practices SP 1.1,
1.2

Life Science LS 3.1, 3.2

History/Social Science –
11th Gr 11.11.5
12th Gr 12.3.2

EEI P and C: IIa; IVb, c
Ocean Literacy Principles: 1g; 6e,g
Climate Literacy Principles: 2c, d; 6c,

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 desiccation, 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/marine/elifelife.html> - monthly inventories going back to 2007
<http://spoutingoff.wordpress.com/2011/04/13/contamination-is-forever/> Soil Pollution

Extensions:

1. Investigate local municipal policies on environmental issues that would decrease the health of the Estuarine ecosystem, such as: construction litter and waste disposal; agricultural and commercial run-off; re-cycling; green alternatives in construction and public functions.
2. Get involved by speaking up, cleaning up, joining local conservation and restoration groups.



TEACHER GUIDE – Mudflats/Invertebrates Module

ACTIVITY I: Mudflats

OBJECTIVES:

Students will be able to –

1. Identify at least three characteristics of a mudflat.
2. Explain at least 3 ways the mudflats play a significant role in Estuary biodiversity

KEY TERMS:

Aerobic Anaerobic Annelid worms
Anoxic Bacteria Bioaccumulate
Biodiversity Biomagnify Carrying
Capacity Chordate Crustacea
Decomposer Dessiccation
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

MATERIALS:

Observation Worksheet and Analysis Questions

Pencils

Non-latex gloves

Corer, Mud Boots

Hand lenses

Dissecting Microscopes

2 jars: same size, same amount of water, one with beach sand, one with estuary mud
(same amounts of each)

Trays

Probes

Tweezers



TEACHER GUIDE – Mudflats/Invertebrates Module

ACTIVITY II: Mudflats Community Structure: Playing in the Mud

OBJECTIVES:

Students will be able to –.

1. Identify 4 - 7 organisms living in the mudflats
2. Specify at least 3 ways humans have had a negative impact on mudflat microhabitats
3. Name at least 3 things humans can do to fix their negative impact and safeguard the mudflat microhabitats

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Ecosystem Estuarine Estuary
Habitat Herbivore Invertebrate
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Microorganism Mollusk Mudflat
Niche Organism Ostracod
Photosynthesis Pore space
Sediment Silt Toxic Trophic level
Watershed

MATERIALS:

Mud Grabbers
Life Vests (students under 12)
Plastic Tweezers
Mud Strainers
Mud Straining Station
Hoses
Petri Dishes / Trays
Overhead Projector
Flex Cam / Microscope Camera
Microscope
Plastic Pipettes

Organism Identification Sheets