HMSC High Tide Lesson Plan: Salinity in the Estuary

Time frame: 1 hour-long class (Can be extended to two hours with additional graph interpretation activities included in the Powerpoint)

Materials: (for each group of 4-8 students)

Part I: What is an estuary?

- **Salinity in the Estuary Powerpoint**

Part II: Collecting Water Samples

- 1 hydrometer
- 1 refractometer
- 1 small bucket
- Rope or string for bucket

Part III: Modeling a Salt Wedge

- 4 test tubes
- 1 test tube rack
- 1 box of food coloring w/4 colors in each box
- 1 cup or beaker with 50 ml of salt
- 4 empty 100 ml beakers
- 1 teaspoon measurer
- 1 stirring rod or plastic spoon
- 1 cup or 100 ml beaker with water for rinsing
- 1 graduated cylinder (50 ml)
- 4 plastic pipettes

Part IV: Identifying the Mystery Samples

- 4 saltwater solutions described in the Preparation section
- Electronic scale for measuring salt
- 4 large (1000 ml) beakers or glass jars

Objectives: Students will…

- gather and analyze data on salinity
- create a model of a salt wedge
- develop a hypothesis about how tides and location influence the salinity gradient in an estuary

Guiding Questions:

- What is an estuary?
- What is salinity and how is it measured?

- How is salinity related to density?
- What factors influence the salinity of an estuary?

Activity Links and Resources:

- Rhythms of Our Coastal Waters —This interactive NANOOS exhibit helps learners discover how salinity fluctuates in the Yaquina Bay estuary in Newport, OR. http://www.nanoos.org/products/lobo/lobo_exhibit.php
- Salt Wedge Estuaries – NOAA developed this animation to show how salt wedges develop in an estuary. http://oceanservice.noaa.gov/education/kits/estuaries/media/supp_estuar05a_wedge.html
- National Estuarine Reserve Research System – An interactive database that contains salinity data from estuaries around the country, including South Slough in Coos Bay, OR. http://cdmo.baruch.sc.edu/get/export.cfm
- Aquatex Salinity Conversion Chart – This chart converts density measurements to salinity in ppt based on the temperature of the water. This is useful information when using a hydrometer. http://www.aquatext.com/tables/hyd18-23.htm
- Salinity in the Estuary PowerPoint

Teacher Background:

Estuaries are formed where fresh water from rivers drain out into the open sea. The **Yaquina River Watershed** is drained by the Yaquina River and its major tributary, Big Elk Creek, which enter the Pacific Ocean at Yaquina Bay. The watershed contains parts of Newport (population 9,989), all of Toledo (population 3,465) and several other communities. Major economic activities include lumber, fishing, tourism, and agriculture. At the mouth of the river, **Yaquina Bay** supports an estuary with an area of 17.5 km^2, which provides critical spawning, breeding, and nesting habitat for many species, including endangered and threatened salmonids.

Estuaries are categorized by their geographic features and by their salinity. **The Yaquina Estuary is classified as a "drowned river valley".** Drowned river valleys are also known as coastal plain estuaries. In places where the sea level is rising relative to the land, sea water progressively penetrates into river valleys and the topography of the estuary remains similar to that of a river valley. This is the most common type of estuary in temperate climates.

One of the key features of the Yaquina Estuary is the presence of a salt wedge**. Salt Wedge Estuaries** occur when the mouth of a river flows directly into salt water. The circulation is controlled by the river that pushes back the seawater. This creates a sharp boundary that separates an upper less salty layer from an intruding wedge-shaped salty bottom layer.

The salinity in an estuary varies based on season, tidal influences, and location in the estuary (both depth and distance from the mouth.)

Description:
This lesson plan introduces students to the concepts of salinity and density and provides students an opportunity to create and test a hypothesis about how the distance from the mouth of an estuary influences salinity levels.

Preparation:
Prepare 4 saltwater solutions representing water samples from different locations in the estuary as follows:
Add 20 drops of food coloring and the correct amount of salt to each of the 4 containers.

- Blue: 36 grams of salt to 1000 mL of water
- Red: 24 grams of salt to 1000 mL of water
- Green: 12 grams of salt to 1000 mL of water
- Yellow: no salt

Activity Introduction:
Ask students what an estuary is. Explain that they will learn what factors influence how salty the water is in the estuary and that they'll use that information to help solve a case of missing identity.

Part 1: What is an estuary? (10 minutes)

1. Go through Slides 1 – 11 on the Salinity and Estuaries PowerPoint.
2. Discuss the following:
    a. What is an estuary?
    b. How are estuaries categorized?
    c. Why are oceans salty?
    d. What is salinity?
    e. How is salinity measured?
3. Demonstrate the use of a hydrometer and a refractometer

Part 2: Collecting water samples (30 minutes)

1. Walk to the bridge over the estuary.
2. Have students collect water samples using the buckets and ropes.
3. Have students measure and record the salinity of the samples using the hydrometers and refractometers.
4. Discuss discrepancies in measurements and brainstorm reasons why these might occur.
5. Return to the lab and input the salinity data in StreamWebs. http://www.streamwebs.org/search/projects

Part 3: Modeling a salt wedge (10 minutes)

1. Show slides 12 – 15.
2. Discuss the following:
    a. What is density and how is it calculated?

    b. How are density and salinity related?
3. Tell students they'll use what they know about density and salinity to create a model of a salt wedge in their test tubes.
4. Instruct students to use the materials at their table as follows:
    a. Add 50 ml of water to each of the 4 beakers using the graduated cylinders.
    b. Add exactly 4 drops of food coloring to each of the beakers, using a different color for each beaker.
    c. Use the measuring spoons to add *some amount* of salt to each of the beakers. (NOTE: This is an inquiry, so let students experiment. Don't specify how much salt. Don't tell them that they need to vary the amount of salt, either. Just tell them that they can add salt *if they want* but that they should pay attention to how much salt they add using the measuring spoon. Also instruct students that the only rule concerning the salt is that it needs to dissolve completely in the water. That will limit the amount of salt they add to each beaker.)
    d. Demonstrate how to add the dyed water solutions to the test tube using the pipettes. The trick is to tilt the test tube and put the tip of the pipette right above the water level. Add the water slowly. If the water is added too quickly or forcefully, mixing will occur.
    e. Instruct students to rinse their pipettes and stirring spoons in the fresh water cup each time they switch solutions.

5. Allow students enough time to create a model of a salt wedge.
6. Ask students how they used what they know about density and salinity to create their models.

Part 4: Identifying the mystery samples (10 minutes)

1. Show slide 16.
2. Tell students that their challenge is to identify 4 mystery samples that lost their labels. All 4 samples were taken at high tide on the same date at 4 different locations in the estuary:
    - At the mouth of the estuary
    - 5 miles inland
    - 10 miles inland
    - 30 miles inland
3. Have students rinse out their beakers and re-fill them with each of the 4 samples.
4. Allow students time to design and conduct an investigation to determine the relative salinity of each sample. (They can't use the hydrometer or refractometer!)

Activity Wrap Up:

Ask students to share their reasoning:

- How did they decide which location would have the highest salinity? The lowest?
- How did they determine the relative salinity of each sample?

Extended Learning:

Slides 18 – 32 show graphs of data collected in Yaquina Bay using an environmental monitoring device known as LOBO (Land/Ocean Biogeochemical Observatory). These graphs illustrate variation in salinity levels due to seasonal and tidal influences. Students can interpret these and other graphs on the interactive NANOOS website: http://www.nanoos.org/products/lobo/lobo_exhibit.php