Activity 11 – Tidal flats - A Hidden World Revealed by the Tides

PURPOSE:	To provide a structured experience for students to investigate the life of the tidal flats of the estuary and explore the relationship between sediments, elevation, and the life beneath surface.
TIME REQUIRED:	Two – three class periods (~45 minutes each) for field experience
SUBJECTS:	Science, English, Math
MATERIALS NEEDED:	TIDES Estuary study Backpack – Tidal Flats TIDES Explorer kits (one per team of two students) Estuary Field Study Journal for each student; 50 m (or 150 foot) tape measure
VOCABULARY:	Benthic, burrow, organism, sediment, substrate, tidal flat.

Outcomes: 1) Students will understand that the tide flats are covered twice a day by salty estuary water.
2) Students will understand that the tideflats are made of sediment which may be sand, mud, or gravel.
3) Students will understand that the type of sediment and the elevation determine what lives where.
4) Students will understand that most animals burrow below the mud to stay wet, protected, and to feed on the tidewater.
5) Students will understand that different animals have different types of adaptations for life in the mud.

Life Science
- Organism structure & functions
- Traits of an organism passed on
- Population change in the environment

History and Nature of Science
- How scientists investigate

Scientific Inquiry
- Ask questions to support scientific inquiry
- Design scientific investigation
- Collect data
- Analyze data

Science in Personal and Social Perspectives
- Acting on personal and social issues.

Background: Natural communities of organisms that live in and on the tide flats of the estuary depend upon the flooding tidewater to bring them food and dissolved oxygen. Animals like clams, shrimp, worms, and some crabs burrow beneath the surface to receive protection from predators and regulate their body temperature. While many of these animals live beneath the surface of the mud, some live in the algae growing upon the surface and on driftwood, shell and rock that is deposited on the tide flats. The tide flats themselves may be made up of sand, mud, clay, gravel, or even cobble. In some areas of the estuary, rock may be exposed with features very similar to the rocky shores of the outer Oregon coast.

Eelgrass beds, concentrations of the rooted, flowering plant Zostera marina are often rich with burrows and tide flat life. However, these extremely productive areas are also prone to disturbance and damage from trampling and digging. **They should be avoided for this activity.**

The tide flats near the mouth of the estuary are often made up of coarse, sandy mud which is more stable to walk on than the fine, silty mud found in the upper reaches of the bay. The waters that wash over these areas with the incoming tide are often nearly full strength seawater (32-34 ppt) and the life found in these sediments is often larger than the small organisms found mid-estuary. Strong currents move these sediments more frequently and recreational clam diggers also use these areas extensively. In general, the lower estuary is more suitable for tide flat exploration than the mid and upper reaches.

The purpose of this activity is to learn about the diversity of intertidal life in the estuary, not to disrupt as much life as possible. Counting burrows is an effective means of estimating life beneath the surface without destroying animals and damaging there habitat. While clam beds do recover, the disturbance should be minimized while the educational value is maximized.

Preparation: Carefully selecting a location for your field study in advance is very important and a bit of planning will lead to a much more successful field experience for you and your students.

Considerations may include the following:

- Where will the students get off and on the bus? Is there enough safe space for the whole class to organize equipment, have lunch, view organisms, etc.
- Are rest room facilities available including an outdoor area and hose for cleaning up after the field trip and before getting on the bus?
- Are the students going to be exposed to strong winds, super sticky mud, deep channels, and strong currents? If so, then plan to avoid these areas if possible.
- What is the diversity of organisms like at the given location? Sometimes this is not really known until you study the area, but an area with a nice mix of sediment types, elevation change, and tidal channels can make the investigation more interesting.
- Consult the clamming regulations which govern intertidal harvest in estuaries. http://www.dfw.state.or.us/MRP/regulations/sport_shellfish/
- Determine what, if anything, you are going to collect for later study in the classroom. The Oregon sport shellfish regulations dictate what can be taken legally from Oregon's waters and should be strictly observed. A recommended approach is to designate one or two students as photographers for the trip and bring a digital camera or two. Assign the students to collect images of all organisms collected for later identification. Make every effort to return all organisms in good, living condition to the estuary so that they can continue to support a rich and diverse community of life for future study.

Activity Description:

Introduction to tidal flats – The lead instructor gathers the students together in a close group at the shoreline in sight of the tide flats and reviews the following key concepts to introduce the activities.

- Tidal flats are made of sediment which is not always mud, sometimes it is sand or gravel and most often it is a mixture of different sediment types.
- These areas are covered by the tides twice each day.
- As we venture across the tidal flats to our study area, we will look for signs of life such as burrows which are signs of animals living below the surface.
- As you walk look for signs of life including burrows, but also shells, algae, molts of crabs.

Hand out Estuary Field Study Journals (one for each student) and pencils. Quickly read and review the guidelines on the back cover (see below). You may wish to only read the bolded statements and then paraphrase.

GUIDELINES TO FOLLOW ON YOUR FIELD STUDY:

• **Use your senses** - sight, smell, touch, hearing, but no tasting unless a qualified guide has approved the plant you want to taste.
• **Slow down and work quietly** - you will see, hear, and experience much more if you do.
• **Follow your teacher's instructions** - they are designed for your safety and to help you get the most out of the experience.
• **Respect the site** - please leave the plants, animals, and non-living parts of South Slough as you found them so that others may enjoy this special place.
• **Leave No Trace** - take what you have brought with you including garbage, recyclables, and compost.
• **Enjoy and Explore** - Estuaries are unique places with much to offer those such as yourself who work to understand them.

Distribute the TIDES explorer kits (one per team of two students) and ask them to carry the kits but not to begin opening them or digging until they are told to.

Activity 1 – Signs of life (~ 15 minutes)

Students will then proceed as teams of two to follow the lead instructor out onto the tidal flats to a sample location where they will begin Activity 2 – Sediment shakers. Students should be observing along the way and stopping to make notes or drawings. Once the students have arrived at the first study site, review the findings of the various teams as a group by having each team report out. As the teams name things, if someone repeats, ask if anyone has seen anything different.

Activity 2 – Sediment shakers (~ 20 minutes)

Explain that signs of life are a good start, but the tides may have moved those signs of life from where they once lived. Our next investigation will be to study the sediment to see how long it takes for the sediment to settle out once the tide has moved it.

For this activity each team will use the sediment shaker bottle. Have a volunteer assistant take one end of the 50 m tape measure and stretch it across the tidal flats from near the low tide mark up towards the high tide. Keep all the students on one side of the tape.

Now explain to the students that they will each have 3 meters of distance to collect 6 samples of sediment .5 meters apart. They will be assigned a location and they will go to that location and collect a capful of mud, place it in their bottle and then add water until the bottle is full. They will then shake the bottle for a few seconds, then hold it still and observe. They will count how many seconds it takes for the sediment to settle (the lead instructor decides how clear the sample to needs to be) and then record this number in the "Sediment Shaker" table of their Estuary Field Study Journal next to the first location. They will also record the location in the book. They will repeat this six times. (See example below.)

Sample location in meters	*Trial 1 - # of seconds for sediment to settle out*	*Trial 2 - # of seconds for sediment to settle out*
5m	35 seconds	33 seconds
5.5m	60 seconds	65 seconds
6m	25 seconds	15 seconds
6.5m	33 seconds	37 seconds
7m	47 seconds	49 seconds
7.5m	40 seconds	44 seconds

When this is completed, the students will walk further along on the tidal flat for an undisturbed location for the next activity. Pick a location that has plenty of burrows if possible.

Option *– Stay in the same location for the next activity, but the students will need to be very careful about keeping the burrows intact, so you may want to move the transect over a meter or so to avoid the area they disturbed with their sampling. If you choose to do this all in the same location, be sure you pick a location with plenty of burrows.*

Have all of the students stand on one side of the tape (transect or sample line) and then lift it and walk to the new location. This way they will understand that they are not to cross the line in the new location.

Activity 3 – Counting burrows (~20 minutes)

At the new location, lay down the tape and explain that this now represents your sample line and that they will now be investigating how many burrowing animals live within a specific square area (a quadrat or sampling marker). To do this, they will use the same distance locations that they used for the "Sediment Shakers" activity. They will use the next page in their Estuary Field Study Journal labeled Counting Burrows. They will place the quadrat next to the tape at the exact location and count the number of burrows they see, looking carefully to make sure they count very small as well as large

burrows. They will record this number in the chart and then move the quadrat to the next location and repeat the procedure. (See example on next page.)

Counting Burrows

Sample location in meters	*# of burrows in sample area*
5m	12
5.5m	5
6m	7
6.5m	10
7m	17
7.5m	3

Once the students have finished counting the burrows in all five sample areas, they may get some water for their tub and then begin digging carefully in the last sample plot looking for animals. While this is going on, one of the instructors may dig selectively to bring back a few sample specimens of interesting worms, clams, or ghost shrimp.

Option - *When the students have finished digging at their 6th sample site, the lead instructor may choose to allow them to be selective and dig at a burrow of particular interest to them. This should be limited to avoid disturbing too much of the area.*

When they have completed collecting, the students should bring their tubs and equipment to an area higher up along the shoreline where they will make observations and prepare their tidal flat museum display.

Once they have found their location, ask them as a group to discuss with you their findings with their burrow counts by asking each team to report out their highest and lowest number of burrows. Ask the group what they think the relationship might be between the sediment shakers and the number of burrows. To do this, the students should review their data and look for relationships. (Fine sediment takes a long time to settle out, prevents oxygen from penetrating the sediment very far, and tends to result in smaller and fewer burrows – but not always fewer...)

Option – Graph the student's data as a relationship between the number of burrows and the time it takes the sediment to settle out. The x – axis will be the distance along the transect and the y - axis will be the number of burrows or time in seconds.

Activity 4 – Tide Flat Museums - Collecting animals and making your tide flat museum (~45 minutes)

Explain to the students that each team now has a museum in front of them and that a museum is a place for collecting and displaying objects having scientific or historical or artistic value. They will now have time to study their collection, make drawings and observations, and work on answering the three questions in their Estuary Field Study Journal on the page marked "Tidal Flat Museums".

Student questions – For the sake of time, each team should work to develop one answer per team. This is a collaborative approach.

What do you like best in your museum?

What do you want others to know about your museum?

What question do you have about your museum?

Once the students have completed their observations and answered or developed their questions, ask each team to report out to the group.

Post activity analysis: Depending upon the method and activities chosen to explore the tide flats, evaluation will take a variety of forms. Collection and charting of data, preparation of a PowerPoint presentation and/or a written report where various sections are developed by different teams of students are all possible outcomes.

The *Estuary Field Study Journal* is designed to be used by the students to document their field experience and as a method for teachers to evaluate what the students have learned. Rather than depending solely upon what the students have recorded in the field, providing time in the classroom after the field study for reflection is recommended. In addition, a facilitated discussion where the students are encouraged to read from their journals may contribute to an overall sense of accomplishment for the class and inspire other students to add notes and additional observations to their journals.

Follow up ideas: Many different studies of the tide flats are possible and the diversity of animals is great depending on the type of substrate or bottom. One way to explore diversity within a population is to ask the students to collect clams of a distinct species and measure the size of the shells and the depth at which the clams are found. The data can then be graphed and a size distribution chart can be generated. This activity illustrates for students the concept of size variability within a population. Age in clams is sometimes visible by looking closely at the surface of the shell to observe rings which roughly correspond to annual growth. Clams feed on plankton and accumulate the calcium from the shells of microscopic diatoms and other types of phytoplankton as they digest the plants. Food availability varies with the growing season, so clams accumulate more calcium in summer and fall than they do in winter and early spring. This means that their shells may show thick and thin rings for each year of growth, similar to a tree's annual growth rings.

Another possible study might include charting relationships between presence of a particular organism and settlement times for sediment found in the same location where the organisms are collected. This can be done for two different groups of organisms such as soft shell clams and ghost shrimp to try to discover how their habitat requirements vary.

Student authored field guides

Another possible class activity is the development of a student authored field guide to the tide flats. Photos of properly identified animals and plants of tide flats, a brief listing of key characteristics and statistics such as color, appearance and a few points of interest can be developed for the ten or fifteen

most common creatures and plants. If students are interested in illustration, colored pencils and simple line drawings can accompany or take the place of photos. This can be approached with each student being responsible for one organism or with teams of students taking responsibility for areas where they feel most comfortable: photography, illustration, text development, graphic design, or fabrication. Color photo copying and lamination are much more affordable than they once were and make for a nice finished product that can be placed in ring binders for use by future classes.