Activity 10 - Tidal Marshes - Richness & Diversity

PURPOSE:	To discover the many different types of plants that have adapted to life in a tidal marsh through careful observation and discovery.
TIME REQUIRED:	prep – 1 hour; field study 1-2 hours.
SUBJECTS:	Biology, Mathematics
MATERIALS NEEDED:	TIDES explorer kits* (one per team of two students), Estuary Field Study Journals, pencils, a 30m measuring tape.
VOCABULARY:	Adaptation, characteristic, community, dilution, estuarine, gradient, marine, quadrat, riverine, sampling area, species, tidal marsh, transect, uplands.

Outcomes: 1) Students will understand a simple way to test diversity within one zone of the estuary. 2) Students will gain experience making careful observations to distinguish physical differences and characteristics between species of marsh plants. 3) Students will understand how sampling a subset is used to make observations about a larger area.

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: Tidal marshes are complex communities of rooted, flowering plants adapted to flooding by the salty, sediment laden and nutrient rich waters of the estuary. Low, mid, and high elevation marshes sustain different types of plants, yet all are distinguished from species in the adjacent uplands by their ability to survive flooding waters containing some level of salt.

Marshes located near the mouth of the estuary are regularly flooded with salty tidewater that may be only slightly diluted with freshwater runoff from the uplands. In the mid estuary, salt water may be more clearly diluted by freshwater inputs yet still contain significant levels of salts. In the most riverine

parts of the estuary, freshwater heavily dilutes the flow and very low levels of salt may be detected. The most extreme reach of the seawater is called the head of tide. However, beyond this area, the influence of the ocean is still apparent as freshwater or tidal fresh marshes are formed by the flooding action of the incoming tide.

Low elevation marshes are populated by pioneer species adapted to very salty conditions that exclude most types of plants. These halophytes such as Pickleweed (*Salicornia virginica)* and Salt Grass (*Distichlis spicata)* possess unique characteristics that make them particularly interesting for study. Sparse numbers of smaller plants appear at the upper edge of the mud where currents and tides preclude more dense clusters. However, these individual plants cause the tidal waters to eddy, slowing the current and increasing the rate of deposition. As this gradually increases the elevation, more plants begin to grow, stabilizing the sediment and giving way to a mat of saltmarsh vegetation.

Mid-elevation marshes are transitional zones where saltwater inundation periods decrease and the diversity of the marshes grows. Seaside Arrowgrass (*Triglochin maritime)*, Paintbrush Owlclover (*Orthocarpus casteilloides)*, and Fleshy Jaumea (*Jaumea carnosa)* appear at the lower extent. Gradually, this community of succulent plants may transition to grasses, and sedges.

High elevation marshes are more typically meadow-like in appearance with dense communities of grasses, rushes, and sedges dominating. Seldom inundated by the salty high tides of summer, these marshes are flooded in winter with the highly diluted seawater mixing with runoff from winter storms.

In this activity, students will explore the range of diversity on the marsh by examining the structure of various plants and comparing the structure to descriptions and photographs provided in a simplified field guide. While botany, the study of plants, is a complex and expansive discipline, marshes are an accessible and excellent starting points for students to begin to appreciate the subtle diversity of structure and the purpose of adaptation. Marsh communities offer several advantages for long term study. The marsh is generally accessible without specialized footwear or boats. Marsh plants are typically low enough that the entire community of plants can be viewed and examined easily and a sampling transect and plots can be established without difficulty. The use of GPS and simple markers facilitate returning to a specific study site periodically to monitor change over time.

Preparation:

This activity may be conducted in several different ways depending on the available time and the specific objectives the teacher hopes to achieve with the class. Two methods are included here to provide clear instructions for a simple investigation of marsh diversity and a more involved study.

The TIDES Explorer Kits contain a simple, cost effective design for a sampling quadrat which is equivalent to an area of .0625 m^{-2}. The quadrat is used to introduce the concept of sampling a small area to draw inference about a population covering a larger area. Transects, a clearly defined and measurable sampling line, are used to locate random plots where the students will explore the plant community. Incidental observations such as sediment deposits on the leaves of the plants, detritus, and indirect indicators of other estuary inhabitants such as crab molts are valuable to the study and should be recorded during the course of the students work.

Each student team will need a **TIDES Explorer kit** (one per team of two students) – a small tub with lid containing two small clear plastic sample bottles with caps, a small trowel, and a quadrat (four sided sampling marker) made of pvc pipe and measuring 25cm x 25cm (.0625 m^{-2}) of a square meter.

Instructions and a detailed description of contents are included in the "resources" folder for **TIDES Activity 8 – Preparations for a Field Experience.** If a precise study of a particular area is the primary objective of the class, a 50 or 100m measuring tape is useful for establishing transects. An aerial photo with a scale is also useful in determining how much of the marsh can be sampled and where the students will focus their effort. Google Earth is a very useful, internet-based tool that is free and widely available for conducting this part of the preparation.

Several considerations are important when selecting the study site for this activity. First and foremost, permission of the land owner is essential. In the case of public lands, contacting the agency responsible for the care and management of the area is necessary unless unrestricted public access is already an accepted use in the area. Public agencies owning tidal marshes may be interested in the information your students will generate and may be able to provide important background information to assist with your study.

Many of Oregon's tidal marshes are publicly owned, however, many private in-holdings do exist and trespass is illegal unless otherwise posted by the owner. If you have a question about the owner of the study site, you may wish to contact the Oregon Department of State Lands for assistance. More information about this agency may be found at www.southsloughestuary.org .

Ease of access is important since any time taken to hike to the site will diminish the amount of time the students will have to conduct the study. Availability of restrooms and a non-tidal open area to give instructions in close proximity to the marsh is also desirable.

Activity Description:

Once the class has researched and chosen a study site and the class will locate the tidal marsh and approach it from the upper edge. If a transect method is being used, the transect locations may be chosen to cross from high elevation to low elevation to explore diversity, or along an elevation to discover variability within a zone. Since handheld GPS (Global Positioning System) units are now widely available and relatively inexpensive, the addition of such data to the location of the study can be interesting and helpful for locating transects again after the initial study. This is particularly important if a teacher intends to conduct long-term monitoring of a site.

Several key concepts should be reviewed with students prior to the conduct of the sampling. First, students should be reminded to make careful observations and look closely for differences between various plants. Teams of two typically work well for this activity since each observer may add something the other has missed. Since tidal marshes are dominated by rooted, flowering plants, a quick review of the various plant organs (roots, stems, leaves) and their functions may help the students with their observations. Secondly, describe how sampling a subset of a larger group provides data that may be used to characterize the larger community. Include a quick discussion of sampling bias and the risks involved in extrapolation using a small amount of data. Finally, remind them that each team will be responsible for a set number of sampling plots and that any gaps in the data will be apparent when it is compiled and presented.

Method 1 – marsh diversity study

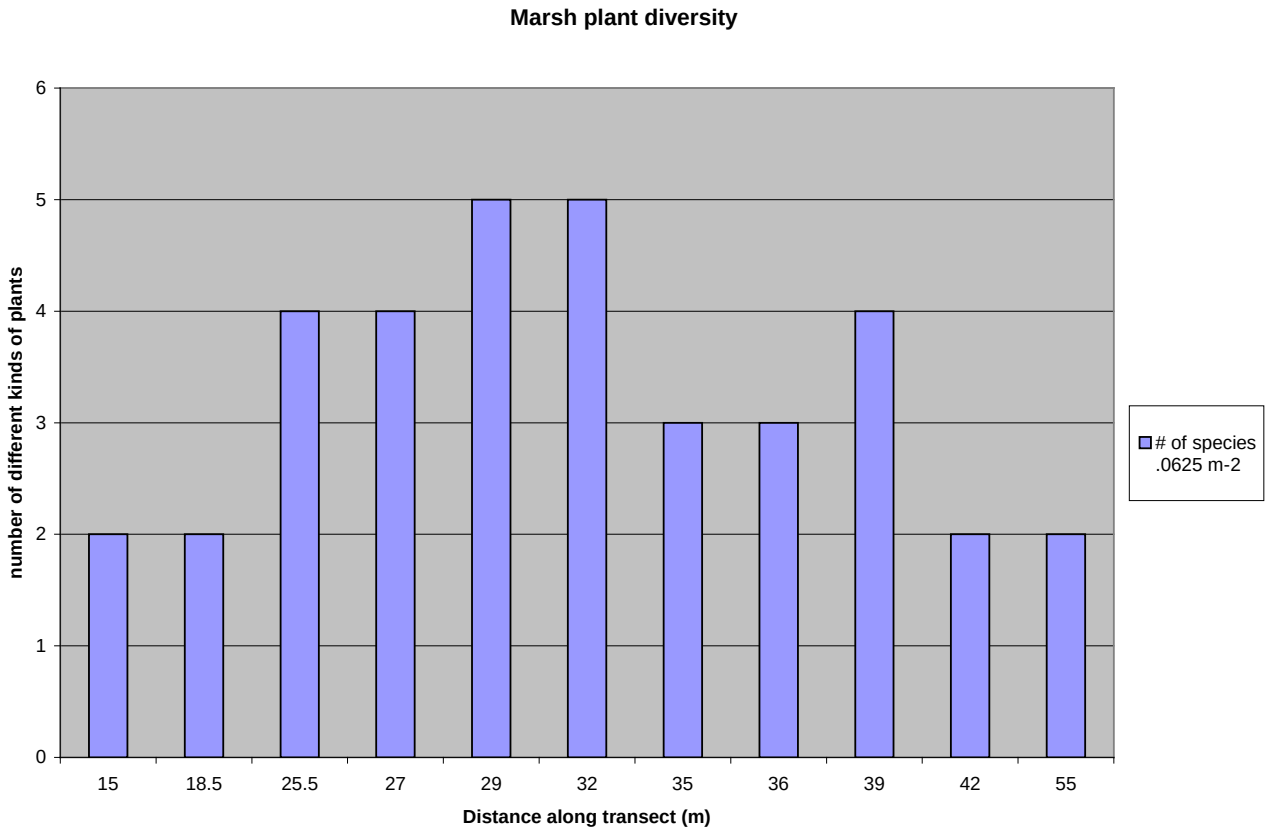
A simple study of diversity can be conducted by asking students to identify how many different kinds of plants are found in each sample plot randomly located along a transect. Ask the students to assemble in a line an arm's length from each other across the marsh along the transect line. The students will then

pair off with a partner and teams will alternate in sampling to the left or right side of the transect line. The students will then cast their quadrat out into the marsh and walk to the location where the quadrat lands without disturbing any other quadrats. Trampling the marsh plants should be avoided as much as possible, since trampled plants will be more difficult to identify.

Once the student arrives at the sample plot, ask them to record any evidence that the tide has reached the plants in their quadrat. This may include signs of accumulated sediment on the leaves of the plant, detritus left by the tide (also known as wrack), and even salt crystals evident on the leaves of some marsh plants. Then they will carefully observe and note how many different kinds of plants exist within their sample plot. You may wish to have them collect one specimen of each plant for later identification in the classroom, or alternatively, you may ask them to try to identify the plant in the field using a field guide (see discussion of field guides in "TIDES Explorer Kits assembly directions and costs" – in the Activity 8 resources folder). The students should also record the percent cover that exists within the quadrat for each species recorded. The following sample data entry page and accompanying graph represent a compilation of data. Increasing the number of plots with data will improve the accuracy of the representation of diversity. For contrast, the class may wish to collect one set of data across the marsh from high elevation to low and another set of data along the mid-elevation of the marsh. Where is the greatest diversity in the marsh plant community expressed?

The table below includes the compiled data for several teams of students, while the graph displays the data illustrating how diversity changes across the marsh with elevation.

Distance along transect	# of species
15	2
18.5	2
25.5	4
27	4
29	5
32	5
35	3
36	3
39	4
42	2
55	2



The evidence presented in this sample graph appears to indicate that marsh diversity increases along the middle of the transect line. If this transect has been laid out across the marsh elevation, then diversity may be increasing in areas where communities of plants are transitioning. In other words, as one group of plants appears less frequently, another group of plants begins to dominate. The transition zone will have plants from both communities, thus increasing diversity in this area.

Method 2 – marsh diversity and dominant species

A more involved variation of the first method presented involves the correct field identification of the most common species and estimating percent coverage for a given area. Additional study can be included using the concept of a nested quadrat and comparison of data for larger and smaller samples to identify a relationship between the size of a sample and the accuracy of predictions made with smaller sub-samples. Finally, a careful examination of marsh plants in the field can be used to improve student observations skills. The recording of distinctive characteristics for each plant along with the common and scientific name will provide the students with a deeper appreciation for the incredible adaptations these plants possess.

The procedure for this activity involves the same steps as those outlined in the first method. However, as each plant is identified, a "voucher specimen" is collected for verification back in the classroom and at least the three major plants for each quadrat must be identified. Classes may choose to develop a simple code system to make notation in the field easier. For example, Pickleweed is a plant possessing

the scientific name *Salicornia virginica*. This plant would then be coded by using the first two letters of the genus and species, i.e. - ***Sa****licornia* ***vi****rginica* = **savi** In this way, the students can build a set of codes that will become more familiar with use and will help to expedite the collection of data.

In order to test the accuracy of the small .0625 m^{-2} quadrats, a larger area should be sampled adjacent to several of the small plots. The best way to achieve this is by constructing a large 1 m^{-2} quadrat that contains divisions for .5 m^{-2} and .25 m^{-2} areas. The figure below illustrates this division.

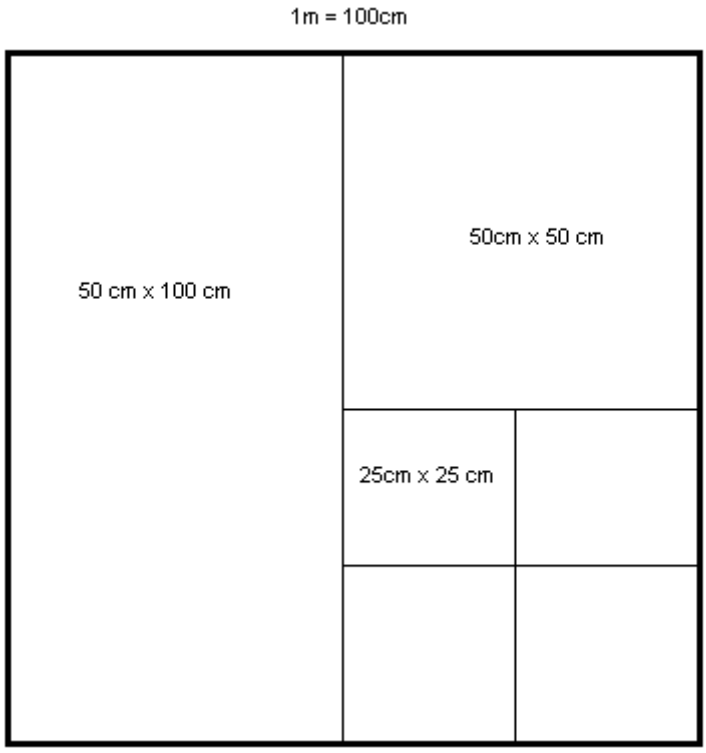


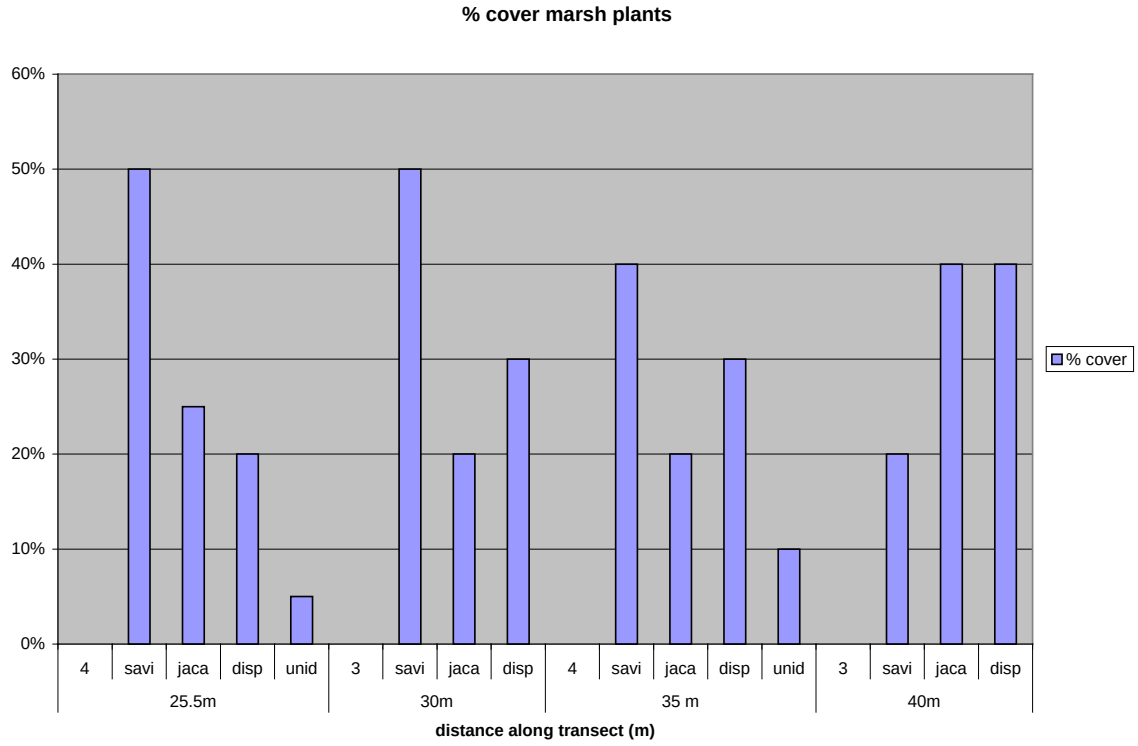
Fig. 1 – A nested quadrat

The percent cover of each type of plant for each plot can also be recorded to determine the dominant species, however this requires students to properly identify the marsh plants present in each quadrat and determine percent cover. While the determination of percent cover is subjective, the team must come to an agreement about the number they will record in the data sheet. This is a common method used by researchers monitoring change in plant communities. For an example of a standardized approach to percent cover see the % Cover Standardization Sheet included in the Resources folder for Activity 13 – Eelgrass.

Plotting and analysis of this data is a bit more involved. A sample spreadsheet and data are included in the Resources folder for this activity and below. The spreadsheet may be used as a template for the classes data. As presented, the data demonstrates the dominant species in each quadrat and the chart expresses the change in dominance as *Salicornia virginica* transitions from a low to mid-elevation marsh giving way to *Jaumea carnosa* and *Distichlis spicata*.

Method 2 - Sample data sheet and data

Quad loc. – m	# diff. plants	% cover
25.5m	4	
	savi	50%
	jaca	25%
	disp	20%
	unid	5%
30m	3	
	savi	50%
	jaca	20%
	disp	30%
35 m	4	
	savi	40%
	jaca	20%
	disp	30%
	unid	10%
40m	3	
	savi	20%
	jaca	40%
	disp	40%



Method 3 – marsh diversity and plant identification

Plant identification can often be a challenging and time consuming activity. Students may become frustrated by similarities between various different kinds of plants in the field and terminology used in field guides may overwhelm their ability to carefully observe and interpret the structure. Additionally, seasonal variation in any plants form may make absolute identification difficult or impossible. Photographs and line drawings in field guides are sometimes difficult to interpret. Yet, in spite of all these challenges, tidal marshes are still an excellent place to focus effort on plant identification. The diversity of forms and some fairly clear differences between species allow for even beginning students of botany to attain success. In addition, the practice of carefully and closely observing the structure of plants can lead to many other interesting discoveries about the marsh.

Establishing a minimum number of plants that students will be required to identify is helpful. Most classes can properly identify at least 4 different kinds of plants and the *Estuary Field Study Journal* pages for this activity include spaces for up to 9 different kinds of plants. Identifying a key characteristic for each plant is the focus of this particular method of studying the marsh. While the common names are often descriptive, asking students to go beyond the obvious and include something unique to the plant should be encouraged. In addition, the students should accurately record the scientific name. This serves two purposes. First, the scientific name is precise to that specific plant rather than a common name which may be generalized to several different plants. Secondly, the students will be introduced to scientific nomenclature and may discover clues to the unique attributes of the plant in the choice of genus and species.

If photographic documentation is possible, this can be used as an additional tool to support proper identification as an alternative or along with collection of a specimen. The worksheets included in the Resources folder for this activity may be used in the classroom or lab as part of a post field study plant identification exercise. The questions on benefits and functions of marshes are designed to be answered after students have viewed the PowerPoint presentation included in the this activity.

Post activity analysis: Depending upon the method chosen for this activity, 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: Marshes are the most highly impacted part of most estuaries because they are most like the familiar terrain that make up the habitable parts of coastal environments. In other words, marshes look like fields that flood frequently. For this reason, many marshes have been and continue to be filled or diked and drained. Improving public understanding of these extremely important and productive environments is essential if society is to gain back some of the environmental functions, values, services and benefits these wetlands provide. For that reason, sharing the results of student studies through public presentations, newspaper articles and other forms of media is vital to educate as many people as possible and community leaders in particular.

Aerial photo mapping

One possible activity which may interest teachers and students is the use of aerial photos and photogrammetry to determine wetland extent and likely areas of loss. With the advent of internet-based technologies such as Google Earth, aerial photos are becoming common place and students are increasingly familiar with the concept of remote sensing, if not the particulars of the science. More about this activity is discussed in Activity 9 – Mapping Watersheds, Habitats, and Uses. Combining student generated data about the presence of low, mid, and high marsh plant communities with aerial photos can make for a simple but effective form of GIS or Geographic Information System.

Student authored field guides

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