Making and Measuring a Model of a Salt Marsh

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Students are often confused by the difference between the terms *accuracy* and *precision*. In the following activities, students explore the definitions of accuracy and precision while learning about salt marsh ecology and the methods used by scientists to assess salt marsh health. These activities are part of a larger body of work containing several interdisciplinary lessons on salt marsh ecology (Fogleman 2006; Fogleman and Curran 2006; Fogleman and Curran 2007). Both activities are appropriate for fourth- through ninth-grade life-science or biology classes and fit well with the National Science Content Standards for Life Science for students in grades 5–8 because they address populations, ecosystems, and the diversity and adaptations of organisms. The activities also address the concept that the ocean supports a great diversity of life and ecosystems, which is one of the ocean literacy principles outlined by the Ocean Literacy Network. Approximate teaching time per activity is one hour.

Activity 1: What Makes Up the Marsh?

Background information

Salt marshes are intertidal habitats that form in protected areas such as the edges of estuaries and the back sides of barrier islands. These areas are flushed by the tides as water from the ocean rises and recedes. During high tide, the marsh is flooded with salty water from the ocean. This influx of water stirs up the bottom sediments and provides nutrients for marsh plants as well as phytoplankton, which are plant-like organisms that float with the tides and currents. Incoming water during high tides can also bring larval forms of many animals, including crabs and fishes, to the estuary. When the tide goes out toward the ocean, the receding water removes debris and decaying material from the salt marsh, thereby providing food and nutrients to nearshore environments.

One species of plant that dominates many salt marshes is called *Spartina alterniflora*, or smooth cordgrass. Smooth cordgrass is a salt-tolerant plant characterized by long, narrow leaves and strong, spreading roots that help to stabilize the soggy sediment during high tides and river flooding. Cordgrass plants vary in height, with stems reaching up to two meters (Reidenbaugh 1983). Like other salt marsh plants, smooth cordgrass displays cyclical changes in height according to season, with peaks occurring during the months of September and October (Reidenbaugh 1983; Morris and Haskin 1990).

Though the salt marsh may appear to be a vast expanse of nothing but plants, mud, and water, many animals inhabit this productive area that provides abundant food and protection from predators. Organisms living in the salt marsh have adapted to survive in a tidally influenced habitat. Because of the daily tides, changes in rainfall, and seasonal changes, the plants and animals of the marsh experience cyclical fluctuations in salinity, temperature, and air exposure.

Tidal currents and the removal or deposition of sediment also lead to cyclical changes in the marsh environment.

The periwinkle, a small, grayish-white snail that reaches approximately 2 cm in length, can be found climbing the undersides of cordgrass leaves. Periwinkles shred the leaves using their radula, a tooth-like appendage, and then later feed on the fungus that grows in the shredded tissue of the leaf (Silliman and Zieman 2001). Periwinkles arrived in the United States during the 1800s by hitching a ride on the hulls of ships coming over from Europe (Ballantine 1991).

Many crabs also inhabit the salt marsh, including several species of fiddler crabs. The fiddler crab is appropriately named because of the male's larger, fiddle-like pincer and his smaller pincer that resembles a bow. Only males have the large pincer, which he waves above his head to defend his territory or attract females. Fiddler crabs feed on detritus, which is dead and decomposing material found in the marsh mud. These crabs retreat to underground, U-shaped burrows when predators are near or marsh conditions are not favorable.

Salt marshes provide numerous benefits for the coast and its inhabitants. Salt marshes filter both surface water and groundwater and protect adjacent areas from wave, storm, and flood damage. Many marine species inhabit salt marshes or frequent them to feed and reproduce, including several commercially important organisms such as blue crabs, oysters, and species of shrimp and fish.

Procedure

The background information provided with this lesson includes a general overview of salt marsh ecosystems and all or part of this information should be conveyed to students via a learning activity prior to the building of the models. One suggestion for introducing this material is to instruct students to create an informational brochure on salt marshes, including information about

What Makes Up the Marsh?

Name____

Materials (per group)

- 8" diameter disposable pie pan
- small shell macaroni (10 to 15 pieces per group)
- plastic flexible straws (approximately 20 per group)
- modeling clay or dough (two or three cans per group, each approximately 5 oz.)
- scissors
- permanent markers (green and brown)
- pencil

Procedure

1. Place modeling clay inside the pie pan. Press it down so that it covers the bottom of the pan.
2. Cut several straws to different heights and color them to represent live and dead stems using markers. Use green straws to represent live stems and brown straws to represent dead stems. Bend the straws to make the "stems" look more realistic and insert them into the clay as far as possible. Because your model should be unique, feel free to include as many or as few straws (both live and dead) in your model as you would like.

Record the number of live stems included in your model here: ____

Record the number of dead stems included in your model here: ____

3. Place shell macaroni in your model to represent periwinkle snails. Once again, you will decide how many "snails" to include in your model and where they will be placed. Often, periwinkle snails are found on blades of cordgrass. Feel free to use a bit of clay to attach them to the straws. Snails are also found on the surface of the mud.

Record the number of snails included in your model here: ____

4. Use the eraser end of the pencil to make holes representative of fiddler-crab burrows. You may make as many holes as you would like. You may decide to put several holes in a clumped pattern, or you may decide to evenly distribute them in your model. Count the number of crab holes as you make them.

Record the number of crab holes included in your model here: ____

animals and plants commonly found in this ecosystem. See Fogleman and Curran (2006) or Fogleman (2006) for a detailed explanation of this suggested activity.

All of the materials required for this activity can be purchased at a store if they are not readily available in the classroom. The teacher may want to prepare the materials prior to introducing the lesson. Each set of materials can be placed into a large bag or bin to facilitate distribution to the student groups, which should each consist of three to four students. Direct students to construct a model using the materials and procedures provided in the What Makes Up the Marsh? activity sheet. During the 15 to 20 minutes that students will need to build their models, walk around the room and monitor student progress. Encourage students to use their creativity to build a realistic model by bending the straws, cutting them at various heights, and placing "snails" both on the "mud" and on the "plants." Remind students to carefully count the number of "live stems," "dead stems," "crab holes," and "snails" used in their models and record these values on the activity sheet.

As students finish building their models, encourage them to return any extra materials and throw away any trash. Then, when all of the groups have finished the construction of their models, lead students in a discussion of the following questions:

- Why are the tides important to life in the marsh?
- Why is smooth cordgrass important to the stability of the marsh mud? How would a sudden decline in smooth cordgrass populations (or other plant populations) affect the marsh?
- Why are salt marshes important to our coastal communities?
- How do parameters for water quality, including salinity and temperature, affect organisms that live in the salt marsh?
- What are some of the features in a salt marsh ecosystem that you included in your model? Were there any features that you were unable to construct using the materials provided?
- What were some of the difficulties that you experienced while building your salt marsh model?

Assessment

The marsh model should be assessed for accuracy and completion, and the activity sheet should be collected so that the teacher will have a record of the "true" values for each student-created model. These values will be needed in the second part of this lesson, when students collect data using these models. The teacher may also want to informally assess student knowledge through observations from the post-activity discussion.

Modifications

Modifications can be made to this activity if the teacher has multiple classes and needs to keep costs to a minimum. If the teacher only teaches one or two classes but needs to save on supplies, several options are available. Homemade dough could be used instead of store-bought clay. Disposable pie pans are relatively cheap, but any container will do. An empty shoebox could be inverted and straws placed through the bottom, which would eliminate the need for store-bought clay and the disposable pie pans. If permanent markers are too expensive, students could distinguish live stems from dead stems by using two different types of straws, such as lined and unlined straws or colored and clear straws.

If the teacher has several classes and wants each class to participate in this activity, the same sets of materials could be used in each class. After constructing the model and completing the in-class discussion, each model could be disassembled and the materials returned to the bags or bins for the next group of students. It is important that the teacher save the models created by the last class of the day so that they can be used by all class periods during the second day of this lesson when students collect data using the student-created models.

Activity 2: Accuracy and Precision

Background information

When scientists collect data, they want their data to be accurate and precise. What do these terms mean? The teacher can use an example of a dart thrower and target to demonstrate the definitions of these two words to students.

Imagine that the darts were thrown and they landed on the target (see Figure 1A). The dart thrower was not precise—the darts landed in different locations on the target. Also, the dart thrower was not accurate, because the darts did not land where the dart thrower intended—that is, in the center of the target. The dart thrower was neither precise nor accurate.

Imagine that the darts were thrown again and they landed on the target (see Figure 1B). In this case, the thrower was precise, because all of the darts landed in the same location. However, the darts are not near the center of the target, which is what the thrower was attempting to hit. Therefore, the dart thrower was precise, but not accurate.

Now, pretend that our thrower tried again (see Figure 1C). In this example, the thrower was precise and accurate. The throws landed near each other (an example of precision) and the throws all landed near the center of the target (an example of accuracy).

Accuracy and Precision

Name ____

Materials: Data sheet, pencil, and ruler

Your teacher will distribute a student-created model to your group for data analysis. Please record the number of the model on your data sheet. After completing data collection for this model, your teacher will instruct you to exchange models with another group.

Procedure

1. Record the number of the model that you are measuring.
2. Count the number of live stems (green straws) in the model. Be careful to not remove or displace the straws as you count them. You may want to count the live stems two or three times to ensure that you are getting an accurate count. Record the total number of live stems in the appropriate box.
3. Count the number of dead stems (brown straws) using the same method as the live stems. Record the total number of dead stems in the appropriate box.
4. Add the number of live and dead stems to determine the total number of stems in the model.
5. Measure the three tallest live stems using the ruler, without removing or displacing the straws. Record heights to the nearest centimeter in the appropriate boxes on the data sheet. Make sure to unbend any straws that have been bent over, and return them to their original position after measuring them.
6. Count the number of snails in the model without removing or displacing any of the snails from their original location. Record the total number of snails in the appropriate box.
7. Count the number of crab holes in the model and record this number in the appropriate box.
8. When directed by your teacher, exchange models with another group and complete the data collection process again. You will assess three models by the completion of this lesson. Make sure that your group records the number for each model that you use to collect data.

Data sheet—Accuracy and Precision

Name ____________________________________

	Live	Dead	Total
Total number of stems			
Height of tallest live stem (in cm)			
Height of second tallest (in cm)			
Height of third tallest (in cm)			
Total number of snails			
Total number of crab holes			

Model number _________

	Live	Dead	Total
Total number of stems			
Height of tallest live stem (in cm)			
Height of second tallest (in cm)			
Height of third tallest (in cm)			
Total number of snails			
Total number of crab holes			

Model number _________

	Live	Dead	Total
Total number of stems			
Height of tallest live stem (in cm)			
Height of second tallest (in cm)			
Height of third tallest (in cm)			
Total number of snails			
Total number of crab holes			

Model number _________

It is important that scientists are precise when collecting data, which means that the measurements are repeatable and consistent. It is also important that scientists collect accurate data, which are data that are close to the true value being measured. In the following activity, students will measure several parameters such as plant height and the number of snails in a model of a salt marsh. It is crucial that students measure precisely, with the goal that all groups will record similar data. It is also important that the student data are accurate. For example, when measuring the plant height, students will need to record heights that are measured to the nearest centimeter. Encourage students to collect their data carefully (to be accurate) and take several measurements for each data point (to be precise) before recording each data value.

The background information provided with this lesson includes a general overview of the concepts of accuracy and precision, and all or part of this information should be conveyed to students via a learning activity prior to measuring the models. One suggestion is to provide students with a handout that includes the three examples of the targets and a brief description of each situation. For example, under the target where the three darts are distributed randomly across the dartboard, the caption could read "In this example, the dart thrower was neither precise nor accurate." These illustrations and descriptions could also be displayed on an overhead transparency or in a PowerPoint presentation. Working from these illustrations and the descriptions of each situation, students should create definitions of the terms *accuracy* and *precision*. These student-created definitions could then be shared with the entire class in a discussion at the end of which the teacher gives students the official definitions.

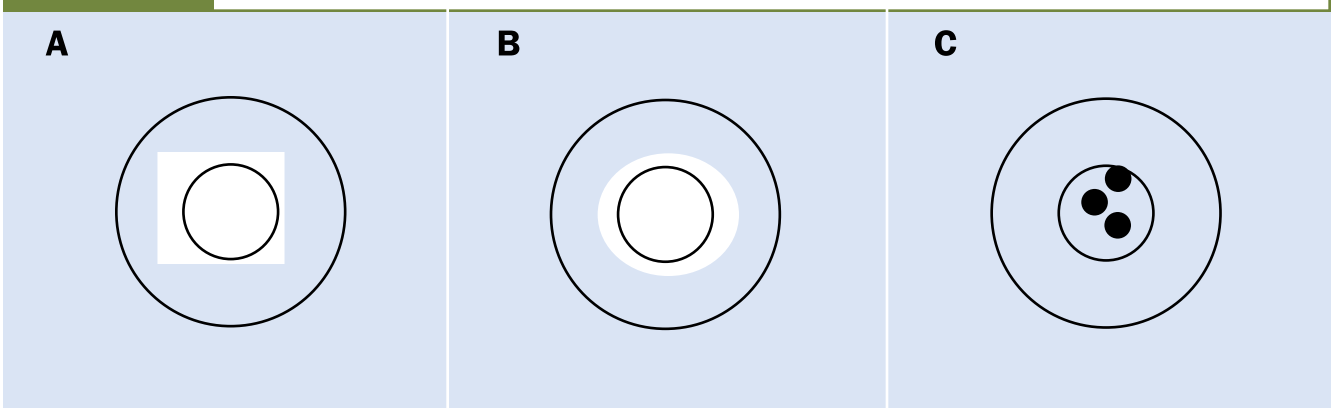
Procedure

Prior to the hands-on lesson, the teacher should assign a number to each student-created model built in the previous activity. Direct students to follow the procedures outlined in the Accuracy and Precision activity sheet to collect data for several marsh health parameters. Explain that though students are using models, the data collection techniques that they will be using are very similar to those used by scientists who monitor marsh ecosystems. These scientists must be accurate and precise when collecting data. Each group should collect data on three models in the class. Students will count the number of live and dead stems, the number of snails, the number of crab holes, and the heights of the three tallest plants. All data should be recorded on the data sheet. Students should preserve the integrity of their model by handling the models carefully and not removing or displacing any of the snails or stems.

As students complete the data sheets for each of their three models, ask them to transfer this information onto a class data chart printed on an overhead transparency. To reduce student bias, the teacher should cover up the data reported from other student groups after each group transfers their data to the class data chart. When all groups are finished, the teacher should add the "true" values for each model that were reported by the student groups. The teacher can then display all of the class data and ask students to work in their groups or individually to answer the following questions:

- What is the definition of *accuracy*?
- What is the definition of *precision*?
- Was it easier to count stems or snails? Justify your answer.

FIGURE 1 Target and darts



- Did some student groups report data that were different from other groups? Why might students get different counts for the same model?
- Which parameter had the greatest variability? The least variability?
- Which model had the greatest variability? Why?
- Based on the collected data, can you determine whether students were precise? Can you determine whether students were accurate?
- Can you be accurate but not precise? Explain.

Students should be able to provide correct definitions of accuracy and precision and relate these terms to the data collected using the marsh models. Typically, students find it easier to count objects found in fewer numbers, such as snails, than objects found in greater numbers, such as stems. Also, students typically report variable data for stem heights, most likely due to the interference caused by other straws when trying to manipulate the ruler to take a measurement. From the data reported, students can determine whether the multiple student groups were precise, and they can assess accuracy based on the true values provided on the transparency. Because the student groups did not collect values for "stem" heights while building the models, accuracy cannot be determined for this parameter.

Assessment

Ensure that data sheets have been completed correctly and grade the completed discussion questions for correct and thoughtful answers. The teacher may also want to lead a class discussion about the answers to the analysis questions that were completed individually or in groups.

Extension

Using the data collected during this activity, students could calculate averages for each of the parameters and graph these data by hand or using a program such as Microsoft Excel.

Students could create smaller or larger models of a salt marsh ecosystem and collect data to determine whether the area of the model has an effect on the accuracy of the data collected. For additional practice with using the metric system, see Curran 2003. For additional lessons related to salt marsh ecosystems, see Fogleman and Curran 2006 or Fogleman 2006. ■

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