A TEACHER'S GUIDE TO THE
CARPINTERIA SALT MARSH RESERVE

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About This Guide

This guide contains activities associated with the Carpinteria Salt Marsh Reserve. It includes activities for marsh field experiences, classroom lessons (for field experience preparation and follow-up), and a word search for outreach events.

These lessons are designed to let teachers know about the resources they can take advantage of at CSMR, as well as make it possible for teachers to lead some activities without direct involvement from CSMR staff. This guide may also be useful to students assisting the Reserve Director with the Reserve education and outreach programs.

Lessons are adapted to the California State Science Content Standards, and are easily adaptable for different grade levels. One lesson, Wetland Sponges, is also aligned to the upcoming Environmental Principles and Concepts of the Education and the Environment Initiative.

In the future, further lessons could be developed dealing with wetland food webs, water/soil chemistry, water quality testing, tides, the water cycle, transect monitoring, erosion control, parasites, and Science Day activities/handouts.

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CALIFORNIA STATE SCIENCE CONTENT STANDARDS

Classroom Activities

PRE & POST CSMR ACTIVITIES

What is a Watershed?

Alignment

This lesson best fits grades 3-6.

Introduction

Through this activity, students will gain a more concrete picture of the geography of a watershed. The lesson emphasizes the impact of human activities on aquatic habitats, including wetlands and oceans. Students will build a model of a watershed, including urban areas and a salt marsh, and use this model to illustrate wetland function, non-point source pollution and watershed connections. Students will learn where the water comes from, where it goes, and what kinds of choices people can make to use and conserve it responsibly.

Objectives

Students understand that:

- A watershed directs all precipitation and run off to a common body of water, in our case the ocean. Wetlands are a part of the total path of water over the land, through the ground, and eventually to the ocean.
- Oceans and wetlands can be impacted by events that take place far away in the watershed.
- Wetlands absorb and filter heavy rains.

Background

Watersheds are important to humans, plants and animals that depend on them for water, food, and homes. Everyone lives in a watershed. A watershed is the area of land that drains precipitation and runoff to a specific body of water. Ridges separate these drainage areas, or watersheds. A wetland is just a part of the total watershed, in our case a stop for water from the mountains on its way to the ocean. Salt marshes, a type of wetland, contain special plants and mud that hold and trap pollutants and excess sediment, improving water quality. Human activities along rivers and streams, such as building roads and dams, can alter a watershed. Water washes over concrete instead of percolating through the soil, overwhelming streams and wetlands. Effluents such as fertilizers, sewage, and storm drain runoff enter the water and travel to salt marshes. Left untreated or free-floating in the water, high levels of these nutrients cause eutrophication, an initial explosion of algal growth followed by a decline in plant life and dissolved oxygen. Plants from the salt marsh help to handle pollutants in several ways. Marsh vegetation can take up and filter the pollutants, while other pollutants settle into the soil and are chemically reduced over time. Otheres are processed by bacterial action. When salt marshes are filled or lost, pollutants they could have rendered harmless remain in the water, free to move all over the water system and into the ocean.

MATERIALS

- 1 Roll Paper Towels
- 5 Plastic Spray Bottles
- 10 Sponges, "Watersheds"
- 25 "Pollutants" vials
  - 5 vials "Detergent" (laundry detergent)
  - 5 vials "Dog Poop" (chocolate sprinkles)
  - 5 vials "Fertilizers" (Kool-Aid)
  - 5 vials "Car oil" (soy sauce)
  - 5 vials "Trash" (bits of paper)
- Newspaper
- 5 Large plastic garbage bags
- Chalkboard/Chalk, Poster Paper/Pens or Whiteboard/Pens
- 5 Slanted boards/notebooks and props
- Freshwater to fill Plastic Spray Bottles
- Method B
  - Watershed models can be made using modeling clay protected with household cling-wrap or wire mesh and rigid wrap
  - Homes, cars, pets…

PREPARATION

- Gather materials or restock your kit.
- Divide materials between 5 groups. Each group should have a spray bottle, two sponges, a vial of each type of pollutant, newspaper, a garbage bag, and some type of slanted board or notebook. Fill squirt bottles with water.

ACTIVITY (85 minutes)

- Invitation: (10 minutes)
  - Begin with a discussion about wetlands and watersheds. *What is a wetland? Have you ever been to one? How can you tell if some place is a wetland? Have you ever wondered where water went after it entered the storm drain in front of your house? What is a watershed?* Tell students they are going to build a model of a watershed in groups to help them better understand the concepts of wetlands and watersheds.
- Exploration: (30 minutes)
  - Split class into 5 groups.
  - Have groups create a simple watershed model by draping a large, plastic trash bag over crumpled newspaper "mountains" on a slightly slanted board or notebook. The mountains should be at the top of the board and along the sides, forming a valley down the center. At the bottom will be the ocean. Have students place sponges just before the ocean to serve as a wetland. *Ask students to describe the land formations in their models. Where do you think people would live? Where would you find farms? Who would live in the mountains?*
    - Method B: Use the model to explore the concepts of a watershed instead. This can be pre-made for a teacher demonstration or built by students during the class period. Adjust materials list and timetable accordingly.

- Have students predict what would happen if rain fell on the watershed. Use the spray bottles to sprinkle rain on the mountains to see. *Why do we concentrate the rain in the mountains? What do you observe happening?*
    - Rain runs downhill and puddles at the lowest point. The wetland slows down the water. Excess water pools at the bottom. Pick up the sponge and squeeze it to show how much water the wetland absorbed.
- Have students predict what would happen if the wetland were removed. Remove the sponge and collect water from the model. Sprinkle rain over the land again. *What do you observe happening?*
    - The water flows more quickly into the ocean. Water may eventually flood the land because it is not protected by the wetland.
- Direct students' attention to the "pollutant" materials. Discuss what each represents. *Where do you think you might find these materials in our watershed?*
    - Fertilizers-agricultural regions, front yards. Detergents-driveways, yes, water from your driveway flowing into the storm drain will run to the ocean. Feces-urban areas. Car oil-urban areas, driveways, parking lots.
- Spend some time littering materials around the watersheds and predict what will happen when it rains. Again, sprinkle rain in the mountains. Run trials with and without the sponges in the model. *What do you observe happening?*
    - All the pollutants flow toward the ocean. The sponge visibly traps pollution particles. Dirty water flowing over the land is cleaner when it reaches the ocean.

- Concept Introduction: (15 minutes)
  - *What happens to the water as it flows to the bay?*
    - The water gets dirtier, collecting pollutants along the way, washing them to the ocean.
  - *What is the wetland doing for the water?*
    - Filtering/cleaning it.
  - Discuss the vocabulary "Point and Non-Point Source Pollution" and identify possible sources in your watershed.
    - Non-point source pollution is pollution that cannot be traced back to a single source. Examples include animal waste on farm fields or on the sidewalk, lawn fertilizers and pesticides, oil and gas leaking from cars, and leaking septic systems.
- Application: (20 minutes)
  - *Ask students to provide a definition of a watershed.*
    - A watershed is all the land that drains water to the same place. Mountain ridges separate different watersheds. Discuss how this model is the same and different from a real watershed. This model cannot show groundwater movement. It cannot show the difference in water movement over vegetation vs. urbanized areas.
  - *What would happen if there were no wetlands?*
    - Silt and pollution would accumulate in large bodies of water.
  - *How might muddy water affect fish and other plants and animals?*
    - It would be harder for them to see and breathe. Silt could clog gills and possibly kill them. Settling sediments can smother bottom dwelling animals that filter feed, and block sunlight needed for plant growth and visual animals. It introduces toxins and causes rifts in the food chain.
  - *How might all of this affect your lives?*

    - Decrease in natural resources and food sources. Decline in quality of drinking water. Impacts on recreation, such and fishing and swimming. Food web alterations.
- Use a local watershed map and encourage students to find their home, school, and other noticeable landmarks. *How do these areas affect the watershed?* Think: pollutants washing over streets/parking lots, fertilizers, dog waste, farm animals/fertilizers, altered waterways…
- Discuss the impact people make on the watershed, and the types of things that could be done to lessen the impacts. Discuss the responsibility the students have to ensure the safety of the watershed and teach other to do the same. Write impacts and solutions on the board. Encourage students to explore their neighborhood and determine where a drop of water on their roof might end up.

STANDARDS

K: 3abc, 4bce
1: 2bc
2: 3e
3: 5d
4: 3a, 5c
5: 3de
6: 6b

EXTENSIONS/ADAPTATIONS

K-2: Younger children will need simplified explanations but will grasp the general concepts and will enjoy littering and making rain.

Have students draw a picture of a watershed and draw the path of a drop of water.

1: 4ab

6-12: Have deeper conversations about where people would likely live in a watershed and why. *How would human activities impact wetlands?* (Would farmers desiring flat land along the river want to drain the marshes or dike the rivers? Would industries want to dredge an estuary to create deeper ports for commerce?)

Lead an environmental ethics discussion. Pose difficult questions and write the pros and cons on the board or divide students into teams that must defend different viewpoints (possibly in debate format).

Have students write a report about issues taking place in their watershed (either currently or in the past).

Use topographic maps to build realistic models of your watershed.

6: 6f
7: 7bcde
9-12: 6ab

FUNCTIONS OF A WETLAND

ALIGNMENT
This lesson can be adapted for grades K-12, but is best for younger grades.

INTRODUCTION
In this lesson, the many functions of wetlands will be explored. Students will learn the reasons that wetlands are important and how they serve a number of functions for wildlife and humans. Students will explore metaphors for a wetland and its functions, and proceed to make their own as they learn new roles.

OBJECTIVES
Students understand that:

- Wetlands have many beneficial functions that are important to humans and wildlife.
- Wetlands have many unique habitats for plants and animals.

BACKGROUND
Wetland functions include many that are of importance to humans, including flood control, groundwater recharge, water filtration and purification, erosion control, recreation, education and research. They also have many functions that make them important to wildlife and the ecosystem. The functions that an individual wetland performs depend on its location, surrounding topography, sub-surface geology, hydrology, and the types of plants present. While each wetland may not perform all of these functions, the cumulative value of all the wetlands in a watershed makes each important.

Major functions of a wetland include: 1) flood control; 2) groundwater recharge; 3) water filtration; 4) wildlife habitat; 5) wildlife nursery; 6) erosion control; 7) recreation; and 8) education and research.

Flood Control: Wetland soil and vegetation lining streams absorb and store water, preventing downstream flooding.

Groundwater Recharge: Water that is absorbed by wetland soil and plants is gradually released (recharged) into groundwater and streams, maintaining stream flow through dry times of the year.

Water Filtration: Wetland plants trap suspended sediments within their roots. They also absorb dissolved pollutants and trap them to be used by bacteria living among their roots. By trapping sediments and pollutants, the water leaving the wetlands, either by stream or groundwater, is cleaner than when it entered.

Wildlife Habitat: Wetlands, with their variety of habitats and food sources, have a complex food web. Wetlands are also important for migratory birds that stop during long journeys to feed and rest.

Wildlife Nursery: The protected bays of a wetland are gentle nurseries for young plants and animals. Wetlands are nurseries for 75-90% of all fish and shellfish harvested in America. This natural resource accounts for $111 billion dollars in sales and provides one and a half million jobs.

Erosion control: Wetland vegetation reduces erosion by absorbing wave and current energy, and by stabilizing the soil with roots. Erosion control protects our coasts.

Recreation: Wetlands are of great value for human recreation, such as hunting, fishing, bird watching, photography, and kayaking. With this comes an economic benefit. In 1980, the U.S. Fish and Wildlife Service estimated that American spent nearly $15 billion on observing and photographing fish and wildlife.

Education and Research: Wetlands provide many opportunities for scientific research and serve as living classrooms ideal for teaching a range of ecological concepts. With physical, biological, and hydrological cycles constantly in action, wetlands are excellent sites for research and education in ecology, hydrology, botany, ornithology, and more.

MATERIALS (pictures of items will work as well)

- Sponge (soak up water, prevent flooding)
- Pillow (a resting place for migratory birds)
- Cradle (nursery for young plants and animals)
- Egg beater or whisk (mix fresh and salt water)
- Strainer or filter (filter sediments and pollution)
- Can of soup (food for wildlife and humans)
- Toy boat (recreation)
- Chalkboard/Chalk, Poster Paper/Pens or Whiteboard/Pens
- Construction Paper
- Markers

PROCEDURE (70 minutes)

- Invitation (10 minutes)
  - Begin with a discussion about the functions of a wetland. Have students brainstorm why wetlands are important. Write functions on the board.
- Exploration (20 minutes)
  - Tell students that you are going to explore metaphors that describe wetlands. Have students explain the meaning of a metaphor and give examples. A metaphor is a comparison between two things. Example: “the moon is a lantern in the sky,” “the flowers are a rainbow.”
  - One by one bring out items listed in the materials list. Have students describe the relationship between each metaphor item and a wetland. Example: “a wetland is a sponge so wetlands soak up water and prevent flooding.” List the metaphors on the large paper.
- Concept Introductions (10 minutes)
  - Give students 10 minutes to come up with their own metaphors for wetlands
  - Ask students to share their new metaphors. Add these metaphors to board. Have the class provide an explanation for the relationship.
- Application (30 minutes)
  - Have students choose a metaphor to illustrate on paper and have them do so.

EXTENSIONS

K-5: Compile the artwork into a book to be passed around and shared with each student’s family.

6-12: Have students get in groups and discuss what influences might prevent a wetland from performing its critical functions and the possible impacts. Discuss conclusions as a class and talk about whether these things are happening in your community and how to lessen the impacts.

STANDARDS

Easily adaptable.

WETLAND SPONGES

EEI ALIGNMENT
2nd Grade

INTRODUCTION

This activity emphasizes the functions of a wetland though exploration of the capacity of different substrates to retain water. Students will observe the qualities of various soil types, determine which soil holds the most water, and, from this, decide which substrate type would be best in a wetland. The lesson also reiterates the steps of scientific investigation as students develop and test hypotheses.

OBJECTIVES

2nd Grade Science Content Standards	EEI Learning Objectives
Earth Science 3.c. Students know that soil is made partly from weathered rock and partly from organic materials and that soils differ in their color, texture, capacity to retain water, and ability to support the growth of many types of plants.	Students can: • Describe the importance of soil to plants and natural systems. • Identify different soils by their color, texture, and capacity to retain water.
Investigation and Experimentation 4.a-e.	

BACKGROUND

Water plays a critical role in the wetland ecosystem. Water is present for at least some part of the year, and vegetation is typically adapted for life in saturated soils. In general, a wetland absorbs water, holds this water, and releases it slowly over time. Absorbing the water helps prevent downstream flooding, while storing the water helps alleviate drought as it is released slowly back into streams and groundwater through drier summer. Plants and substrates also trap sediments and pollution, filtering water that passes through the wetland.

The substrate plays an important role in the wetland's ability to hold water and nutrients. Scientists classify different types of soil by their particle size, or texture. Sand is the largest particle in the soil. When you rub it, it feels rough because of its sharp edges. Sand doesn't hold much water. Silt is a soil particle whose size is between sand and clay. Silt feels smooth and powdery. Clay is the smallest of particles. Clay is smooth when dry and sticky when wet. Clay also can hold a lot of nutrients, but doesn't let air and water through it well. Most soils are a mixture of these three soil types.

Human recreation and development has destroyed at least 50% of the nation's wetlands. Repair of the destruction from floods already costs the United States between $3 and $4 billion per year. Knowledge about wetland substrates could help counter our water and economic losses.

MATERIALS

- 100 mL of each:
  - Sphagnum/Peet Moss
  - Potting Soil
  - Sand
  - Gravel
  - Clay (or ground up kitty litter)
- 5 150 mL Mason Jars
- 5 Cheesecloth Squares
- 5 100 mL Graduated Cylinders
- 5 Pencils
- 1 Roll paper towels
- 1 Stopwatch
- 1 Pitcher (to carry water)
- 5 Wetland Soil Datasheets (or compile results on the board if short on time)
- 500 mL Freshwater
- Chalkboard/Chalk, Poster Paper/Pens or Whiteboard/Pens

PREPARATION

- Gather/restock supplies.
- Make 5 copies of the Wetland Soil Datasheet and draw a copy on the board.
- Divide supplies between 5 groups. Each group gets one soil type, a Wetland Soil Datasheet, a pencil, a mason jar, a cheesecloth square, and a graduated cylinder. You may choose to lay down newspaper or keep all water over a plastic shoebox. Keep the stopwatch for yourself.

ACTIVITY (65 minutes)

- Invitation: (10 minutes)
  - Begin with a discussion about the functions of a wetland and the soil types that would facilitate these functions. *Why do we need wetlands? What does a wetland do during a heavy storm? Does a wetland help nature during a dry summer? What does it do for our drinking water? What does the soil in a wetland need to be able to do (wetland functions)? What kind of soil might make a wetland?* From this question, lead into the experiment.
- Exploration: (25 minutes)
  - Break students into 5 groups. Pass out samples of each substrate to the groups. Ask them to compare and contrast the color, texture, and particle size of the substrates and make predictions about each substrate's capacity to hold water (act like a wetland). Return substrates to the supply table.
  - Assign each group to a substrate and have them gather their materials. Inform students that each group will be testing a different substrate, and that they will need to make critical observations in order to inform the other groups about what happens with theirs. They will need to work together to decide which sample makes the best wetland substrate. Walk them through the steps of the procedure so they will be clear on the instructions when it is their turn to perform the experiment.

    - Fill mason jar with 100mL of substrate, packed. (Be especially sure to pack the moss.)
    - Fill graduated cylinder with 100mL of water. Start the stopwatch and slowly pour water over the substrate and observe what happens. Record these observations on the Wetland Soil Datasheet. At this point, students should observe bubbles percolating out of the substrate. (Be sure all groups pour water at the same rate to avoid confounding. *Would the ground react differently to a short, intense storm vs. a long sprinkle?* Choose a happy medium.)
    - Cover the top of each jar with cheesecloth and screw on the lid.
    - Students should be making notes about their observations on their Wetland Soil Datasheet. After 2 minutes, discuss aloud what is taking place in each of the samples. Optional: Ask students to draw a picture of what takes place in their jar on the back of their datasheet.
    - After 5 minutes total, turn each jar upside down to pour off the remaining water. Record the amount of water left, along with any observations.
- Concept Introduction (15 minutes):
  - *Which sample absorbed the water the fastest? Why do we observe the bubbling?*
    - The bubbling illustrates how water displaces oxygen between the particles of substrate. At CSMR, the mud becomes very dark several inches beneath the surface. In this anoxic layer, organisms must cope with anaerobic conditions (no oxygen).
  - *Why were there layers in the potting soil?*
    - Density/weight differences
  - *Which sample did the water run out of the quickest? The slowest? What does the water that is poured off represent?*
    - 1) Gravel or clay (if clay formed a hardpan: an impenetrable layer on top). 2) Sphagnum Moss. 3) Water that the soil could not hold.
  - *Which substrate serves as the best wetland?*
    - Soils that allow absorption. You should find that clay and sphagnum moss make the best wetland. In Santa Barbara, our wetlands are a combination of the two. Think of the moss as the plant material. Talk about how the clay forms a hardpan during rainy conditions, forming a pool on top. Discuss how the plant material soaks up water and chemicals in the water.
- Application/Assessment: (15 minutes)
  - *How do the characteristics of each substrate we observed before the experiment affect their ability to make a good wetland?*
    - Discuss textures and space within substrates to hold or drain water. The fine particle size of the clay traps water, whereas the large grain size of the sand allows water to easily pass through. The moss absorbs water like a plant.
  - *How do wetlands prevent flooding?*
    - They absorb storm water before it can overflow.
  - *How does having a wetland along a river help to keep the stream flowing during the dry summer months?*
    - The river is constantly being recharged by water that is slowly released from the wetland.
  - *How do humans affect this balance? What is the importance of these different types of soils?*

- Reiterate the importance of wetlands and how the local ecosystem would be affected with out them. Discuss the important role the substrate plays in this balance.

EXTENSION

Emphasize the steps of the Scientific Process by having students develop the experiment they should use to test which type of substrate would make the best wetland (question, hypothesis, and simple investigation steps).

ADAPTATIONS BY GRADE

K: 1a, 3b, 4cde

Have students describe the properties of the substrates (grain size/texture). Go through the changes in a wetland from season to season and how the wetland's ability to hold water and recharge the aquifer (well) during the dry months is beneficial.

1: 3b, 4abc

Discuss changes in a wetland as the seasons change, and how a wetland's ability to hold water and recharge an aquifer during the dry months is beneficial.

3: 3c, 5acde

Discuss more in depth the ability humans have to change this environment. Repeat the experiment, look for differences and discuss the importance of repetition.

4: 2b, 6bcdef

Discuss how the loss of wetlands could affect the food web. Graph the results of the experiment. Write up the experiment's directions for students to follow.

5: 6abcfghi

Stress the scientific method (write a report, develop a hypothesis, graph the results, repeat the experiment, suggest further investigation).

6: 7abcd

Have students communicate the steps and results of the experiment in a report.

7: 7abce

Have students communicate the steps and results of the experiment in a report. Have students do background research about recorded wetland substrate composition on the internet.

8: 9ab

Have students communicate the steps and results of the experiment in a report.

WETLAND SOIL DATA

Materials	Immediate Observations	Observations at 2 mins	Observations at 5 mins	Amount of Water Collected (mL)	Best Wetland
Moss					
Potting Soil					
Clay					
Gravel					
Sand					

WETLAND SOIL DATA
ANSWER SHEET

Materials	Immediate Observations	Observations at 2 mins	Observations at 5 mins	Amount of Water Collected (mL)	Best Wetland
Moss	Bubbles	Moss expands All water absorbed	Releases water the slowest	30 mL	*
Potting Soil	Bubbles	Stratification- organics in soil float on water, three layers	Water left is dirtier	71 mL	
Clay	Bubbles	Clay expands Hardpan has formed on top Stratification, two layers	May release water quickest Water never penetrates to bottom	20 mL	*
Gravel	Bubbles	Water penetrates to the bottom of the substrate	Releases water the quickest	60 mL	
Sand	Bubbles	Totally saturated Water sitting on top	No change	65 mL	

THE ESTUARY SALT WEDGE

ALIGNMENT
4th through 8th Grades.

INTRODUCTION

In this lesson, students explore the properties of water and the interactions between salt and freshwater in an estuary through two hands-on, inquiry-based activities. Students will develop an understanding of density and stratification, and discover the applications in nature, such as an estuary saltwater wedge.

OBJECTIVES
Students know:

- Freshwater behaves differently than salt water due to differences in the density of the water.
- The effect density has in nature, as incoming freshwater from streams remains on top in an estuary, while salt water from the ocean travels up stream along the bottom of a tidal wedge.
- Stratification: layering due to density differences.

BACKGROUND

Buoyancy is the upward pressure exerted on an item by the fluid in which it is immersed. This pressure is equivalent to the weight of the fluid that the object displaces. In general, heavy objects sink and light objects float, but much depends on the size, shape and density of the objects. Water's buoyant principles allow for objects to be carried over a long distance with little energy. Density is the mass or amount of matter per volume.

Freshwater from the land and seawater from the ocean mix in coastal estuaries. Estuaries act as two-way streets for water movement, where freshwater flows in from streams over dense saltwater that flows in and out with the tides. The two layers are separated by a halocline, or a strong salinity gradient, where low density surface water cannot easily mix down through this zone without an external force. Because of the friction between these two layers, small eddies of salt water are dragged up into the freshwater, and seaward flowing freshwater becomes increasingly salty as it reaches the ocean. The saltwater forms a wedge under the incoming freshwater, with the thin end pointed upstream. The degree of stratification can vary with the flow of the river or the time of year.

ACTIVITY ONE-WATER EXPLORATION

MATERIALS

- 2 1gal Pitchers
- 8 Clear Plastic Cups
- Sink/Float Objects: plastics eggs, wood sticks, pennies, paper clips, plastic figurines…
- 8 Glass Bottles, 12-16 ounces
- 4 Clear, Plastic Pans
- 2 3"x5" card, cut in half
- 1 Vial of food coloring

- 1 Dropper
- 2 “Fresh Cats” handouts
- 2 “Salty Dogs” handouts
- Predictions and Outcomes worksheet, enough for each student
- Pencils/colored pencils, enough for each student
- 1 gallon freshwater
- 1 gallon saltwater
- Chalkboard/Chalk, Poster Paper/Pens or Whiteboard/Pens

PREPARATION

- If necessary, prepare saltwater in one of the 1gal pitchers, using 1/2cup Kosher to 1 gallon of water. Kosher salt dissolves clear so that cloudiness is not a distinguishing factor between water types.
- Obtain clear glass bottles for each group. Plastic bottles do not work, as students tend to squeeze them, changing the experimental results and making a mess.
- Print “Fresh Cats” handouts, “Salty Dogs” handouts, and copies of the Predictions and Outcomes worksheets. Consider laminating the handouts.
- Cut a few 3”x5” cards in half.
- Fill half the glass bottles with saltwater and the other half with freshwater. Label the bottles #1 (for freshwater) and #2 (for saltwater). Do the same with the plastic cups.
- Prepare 4 plastic pans with materials for each group. Each student should have a Predictions and Outcomes worksheet. Each group should have a plastic pan, 2 glass bottles (a #1 filled with fresh water and a #2 filled with saltwater), 2 plastic cups (a #1 filled with fresh water and a #2 filled with saltwater), Sink/Float objects, half a 3”x5” card, and later a “Fresh Cats” OR “Salty Dogs” handout.

ACTIVITY (50 minutes)

- Invitation: (10 minutes) Place students into four groups. Place two plastic cups, #1 with freshwater and #2 with saltwater, in front of each group. Do not tell them there is a difference. Ask students to discuss, in pairs, any observations about the liquid in the bottles. *How do the liquids compare to each other?* After a few minutes, have students share their thoughts.
- Exploration: (15 minutes) Tell students that one bottle contains saltwater and the other contains freshwater, water without salt in it. Ask them to discuss how they might tell which is which. *What kind of experiments could you design (no tasting)?* Have students *explore* the water types, using the sink/float objects in their tray. After 5 minutes, ask them if they were able to discover which was salty and which was fresh. Have students explain their conclusions.
- Concept Introduction: (5 minutes) Introduce the word density and the concept that saltwater is denser than freshwater, and therefore more objects will float in saltwater that freshwater.
- Application: (20 minutes) Now pass out the “Fresh Cats” and “Salty Dogs” handouts. Half of the groups will be “Fresh Cats” and the other half will be “Salty dogs.”
    - Describe the steps for each procedure as you pantomime with the materials (see handouts for procedure).

- Draw each scenario on the board (salt/colored bottle on top and salt/colored bottle on bottom). Have students predict what will happen after 5 minutes on their worksheet and have a few students explain their predictions to the class.
- When students understand the directions, allow them to get started. Walk around to answer questions and anticipate problems.
- Have students look at the results of other groups. (The salty dogs should have the two bottles mix so that both bottles are the same color, and the fresh cats should have bottles that did not mix so that the top bottle is still clear).
- Have students talk about what the demonstrations can tell them about freshwater and saltwater (saltwater is heavier, more dense, that freshwater, so freshwater will float on top of saltier water).
- Ask them to explain the results of the demonstrations (The fresh cats had the freshwater on top, and since freshwater is less dense than saltwater, it remained on top and vise versa). Record their observations on their worksheets and draw the results on the board).
- Now ask students how they would answer the question about how to tell the difference between the two bottles. *What have students learned that they didn't know before? Have they changed their mind about anything?*

ACTIVITY TWO-APPLICATION

MATERIALS

- 2 1gal Pitchers
- 4 Clear, Plastic Pans, to act as the estuary
- 8 Glass Bottles
- 4 Plastic Cups, with holes in the bottom
- Several small stones or pebbles 1 Bottle Food Coloring
- 1 Dropper
- 1 gallon Saltwater
- 1 gallon Freshwater
- Something to elevate one end of the plastic pan (wood, binder…)

PREPARATION

- If necessary, prepare saltwater in one of the 1gal pitchers, using 1/2cup Kosher to 1 gallon of water.
- Tint the saltwater with food coloring.
- Fill half the glass bottles with saltwater and the other half with freshwater. Label the bottles #1 (freshwater) and #2 (for saltwater-red).
- Prepare 4 plastic pans with materials for each group. Each group should have a plastic pan, 2 glass bottles (a #1 filled with fresh water and a #2 filled with saltwater), 1 plastic cup with holes in the bottom, something to elevate one end of the plastic pan, and several pebbles.

ACTIVITY (45 minutes)

- Invitation (5 minutes) Begin by telling students that you will be continuing your exploration of saltwater and freshwater by studying a type of wetland called an estuary. Review what you learned about salt and freshwater. Ask students if they know where the water in an estuary comes from. *Is it salty or fresh? Can the salinity change? How?*

- Exploration (20 minutes)
  - Tell students that you are you going to make a model of the water in an estuary, adding saltwater to freshwater and observing what happens. Have students form a hypothesis about what the interaction will be.
  - Divide the class into 4 groups and have them gather materials. Explain the procedure before allowing students to begin.
  - Place one end of the plastic pan on a book to elevate about 1 inch high.
  - Make several holes in the bottom of the cup. Weight the cup with small stones and place in the low end of the pan.
  - Pour room temperature tap water into the pan until it is about half an inch from the top of the pan. Allow a few minutes for the water to settle. *Why do we do this?* Discuss other variables that could affect the outcome (rate the water is poured, angle of the pan).
  - Slowly and gently pour the colored, room temperature salt water into the cup a little at a time. Observe. You may not need to use all of the water, only use enough to clearly see the results. Get down and look through the side of the pan to see the results from a better angle.
- Concept Introduction (10 minutes)
  - As a class, have students share their observations, and how their conclusions compare and contrast to their hypotheses**.**
  - Discuss the words: density, buoyancy, saltwater wedge, stratification, halocline. Discuss the physical makeup of a pycnocline and the barrier it creates against mixing.
- Application (10 minutes)
  - Have students compare the model to the dynamics of an estuary. *How could the model be improved to better show what happens in nature?*
  - Ask the question, *how would tides affect the tidal wedge? How does this halocline affect the organisms in the estuary?*

STANDARDS
3: 1defg, 5ade
4: 3b, 6cdf
5: 1i

EXTENSIONS
Allow students to test their initial ideas about how to tell the difference between salt and freshwater.
Mix up water of different salinities with different colors and challenge students to put them in order of salinity.
Have students conduct research on a large California river that empties into the ocean. Does it have a strong tidal wedge? What types of organisms live there, and how have they adapted to the changes in salinity? Have the dynamics changed over the years? What has contributed to these changes?

Fresh Cats

1. Note Bottles 1 and 2.

2. Add four drops of food coloring to Bottle 2. Screw on the lid, shake up the bottle, and remove the lid.

3. Place index card on top of Bottle 1, turn the bottle upside down, and place the clear bottle on top of the colored bottle.

4. Observe what happens.

Salty Dogs

1. Note Bottles 1 and 2.

2. Add four drops of food coloring to Bottle 2. Screw on the lid, shake up the bottle, and remove the lid.

3. Place index card on top of Bottle 2, turn the bottle upside down, and place the colored bottle on top of the clear bottle.

4. Observe what happens.

BIRD BEAK BUFFET

Adapted from Teacher's Guide to Wetlands.
MARE. Lawrence Hall of Science, University of California, Berkeley.

ALIGNMENT

2nd and 3rd Grades.

INTRODUCTION

In this lesson, students learn about niches, resource partitioning, and adaptations. Students will role-play species of birds with beaks of different shapes and sizes. They will gather "food" with their different beaks, graph the data, and compare the results to show how the adaptation of different beak types allows many birds to feed together and not compete for food.

OBJECTIVES

Students will:

- Understand the concept of a food web.
- Learn about the ecological roles of wetlands.
- Understand the concept of adaptation and how these adaptations can lead to limitation in what animals can eat and where they can live, and also benefit the whole population.

BACKGROUND

Estuaries are rich in nutrients that support large phytoplankton populations, which in turn support large populations of zooplankton, fish, benthic organisms, and birds. Estuaries play a major role in the productivity of coastal oceans, serving as a home, nursery, or breeding ground for many organisms. Wetlands are home to 43% of the federally listed endangered and threatened species.

Wetlands support huge numbers of shorebirds that use the habitat as a refuge and refueling station. While all these birds are feeding at the same time, they are rarely competing for the same food. Though they appear to be feeding together, the shape of their beaks, their food preference, and their behavior patterns help them to adapt to specialized food types. This is called resource partitioning and it serves to decrease the amount of competition between species. In a wetland, many different kinds of birds can be feeding together because there are many different kinds of foods to support individual preferences.

MATERIALS

For a class of 30

- 10 of each of the following, to represent beaks
  - Plastic Spoons
  - Metal Tweezers
  - Chopsticks (pairs)
    - Alternates include clothespins, popsicle sticks, tongue depressors, tongs, plastic forks, tea strainers and ice cream scoops
- 150 of each of the following, to represent food
  - Pennies

- Toothpicks
- Rubber bands
  - Alternates include washers, marbles, and various pastas
- 30 Plastic Cups
- Markers, wide tip
- 50 each of three different colored tokens (3 small “Post-its” pads of different colors or 2” square pieces of construction paper)
- Masking tape
- 2 large sheets of butcher paper (3ft X 6ft), preferably with graphing squares, for Data Charts
- Large, non-slippery floor
- Hanging space for data charts
- Pictures of different birds and bird beaks, bird books and field guides
- Tape player and audio tape (optional)

PREPARATION

- Gather bird pictures from old magazines, calendars, or postcards, showcasing as many different beak types as possible.
- Decide what types of beak and food types you would like to use and begin to gather these materials.
- Make two charts, using the large sheets of butcher paper, labeling them “Bird Beak Buffet Data Chart #1: One Food Item at a Time” and “Bird Beak Buffet Data Chart #1: All Three Food Items at One Time.”
  1. Draw two horizontal lines to create three rows. Label the rows Spoonbills, Tweezerbills, and Chopstickbills.
  2. Within each rows, label three food types (pennies, toothpicks, and rubber bands) and tape examples next to each.
- Decide what to use as tokens for graphing
  - Use 3 small pads of “Post-its” notes, 50 of each color to represent a different food type.
  - Use three different colors of construction paper to represent three different food types and cut into 50 2” squares in each color (150 squares total).

PROCEDURE (130 minutes)

- Perform a “thought swap” to get students engaged in the subject
  - Tell students that during this introductory activity, they will get a chance to talk with different classmates. They will need to cooperate, follow directions, and talk quietly with each of their partners. Review the qualities of a good listener.
  - Have students stand in two lines, facing each other. The person across from you is your first partner.
  - Ask a question (listed below) and give students in one line 1 minute to talk about the answer with their partner. After 1 minute, have a few students report what their partner told them. Shift one line so that students have a new partner and repeat the process until all the questions have been asked. Switch off which line is talking and which line is listening.
    - *Have you ever seen birds at the ocean or other body of water? Where were they and what were they doing?*
    - *What do you think the birds were eating?*

        - *What foods do you like to eat and how do you eat them?*
        - *What do birds use to help them eat?*
        - *Describe what a bird's beak look like.*
        - *Do you think birds compete with each other for food? How would you know?*
- Tape the charts to the wall near where the students will sit on the floor in a circle. Welcome them to the school mudflat. Tell them they are shorebirds that have come to this very productive wetland to feed at low tide.
    - The data will only be clean if your total number of shorebirds is a multiple of three. If you have too many students, pull out one or two students and make them into Red-Shoulder Hawk, rotating the hawks with each round (see below).
- Tell students there are a limited number of coastal areas that have the right conditions to make a wetland, and that many of these areas have been destroyed. Since there are less wetlands where shorebirds can go to feed, and they can only feed at low tide, there are often a lot of birds all feeding at the same place at the same time. *What might be the result of this?*
- Ask students:
    - *Why do birds only come here to feed at low tide?*
        - Their food (clams, worms, snails, insects, crabs, shrimp) are exposed at low tide and birds can simply walk on the mud or wade in the narrow water to find them.
    - *Why don't they feed here at high tide?*
        - Water protects their prey and is to deep to wade in.
    - *Where do shorebirds go during high tide?*
        - Roosting in trees or sleeping on beaches
- Introduce the students to their new body parts (beak and cup stomach) and food sources. Pass out a stomach (cup) and a beak to each student. There should be equal numbers of students with each beak type.
- Demonstrate the rules of the game
    - When you say "Low Tide" and the music starts they may begin collecting food items and putting them in their cup-stomachs. They may move around but must remain on their knees.
    - The only way to pick up food is with the beak they were given. No hands. No scooping with cup-stomachs.
    - Everyone must immediately raise their cup-stomach and beak when you say "High Tide" and the music stops.
- Explain that in the wild shorebirds tend to stick together in flocks to ward off predators. Birds not doing what all the other birds are doing can call attention to them selves and be singled out by predators who might want to eat them. At your classroom mudflat, peregrine falcons are on the look out for shorebirds misbehaving. Anyone caught feeding after high tide, walking on their feet, or using improper feeding technique will be eaten by the Hawk and must dump out all their food.
- Trial 1, Penny Clam Buffet
    - Spread the first food item around within the circle of students. Give the students the signal to begin picking up food and placing it in their stomachs, "On your mark, get set, LOW TIDE." You may also play music while the birds are feeding.
    - Time the food collection. After 20-25 seconds, yell "HIGH TIDE" and turn off the music. Every student should immediately stop and raise their beak and stomach into the air.

- o Have each student count the number of food items they collected and round off to the nearest multiple of five. Pass out tokens to each student. One token represents every five food items they collected.
- o Ask for a volunteer from each beak type to collected tokens from everyone with the same beak type. Ask the volunteer from the spoon beak group to count the tokens from all the spoon beaks, and graph them on the data chart. Ask the same of the chopstick beak and tweezer beak volunteers.
- o Meanwhile, have the rest of the students return to their seats in the circle and ask for five more volunteers to collect the all the food items. If you have two adults, one adult can be aiding the volunteers with the data chart, while the other discusses with the rest of the group predictions for the beak-type best adapted to that food type. *What kind of food in the wetland might the pennies represent? Which beak-type do you think ate the most food? The least? Why?* Introduce the term adaptation (something that helps an organism be successful in its habitat).
- o Review the results of the bar graph. *Which beak gathered the most food? The least? How did our predictions compare with what happened? How might some birds with the same beak type as others be more successful? How might we test to see if aggressiveness or experience is an issue in our flock? Why do you think some beaks didn't do as well as others? What is it about the shape of the beak and the shape of the food that might make it difficult to be successful? What type of food do you think they could successfully collect?*

- Trial 2: The Toothpick Shrimp Buffet
  - o Repeat as in trial 1 using the second food item, round toothpicks. Have students predict the results before the trial and after the trial but before seeing the graphs. Ask for new volunteers to help with the graphing and switch your falcon.
  - o After graphing the results, lead another discussion. *Which beak type gathered the most food? The least? Why do you think this might be? How did our predictions compare to what actually happened? If there were only penny clams in the wetland for a long time, what might happen to the three types of birds? What if there were only toothpick shrimp available? What could a bird do if only one food type was available and it wasn't very good at gathering them?*
- Trial 3: The Rubberband Worm Buffet
  - o Repeat as in trial 2 using the third food item, rubberband worms. Again have students predict the results before the trial and after the trial but before seeing the graphs.
  - o After graphing the results of trial 3, lead another discussion. *Which beak type gathered the most food? The least? Why do you think this might be? How did our predictions compare to what actually happened? Are some birds on the graph good at gathering more than one food item? Which birds?* These birds are called generalist. *Are some birds good at gathering only one food type? Which ones?* These birds are called specialists. *Do you think that wetlands have only one food type available? Imagine that all three of the food types are available to the birds at the same time. Do you think each of the birds would attempt to feed on one, two, or all three of the food types available?*
- Trial 4: The Clam, Shrimp, and Worm Buffet - All three food items at once
  - o Repeat as in the other trials using all three food types at the same time. Now have students discuss and predict how each beak type will act. Have them think about what strategy they will use. *Will they be a specialist or a generalist?*

- After the trial, have students count and round up their results for each food item, and give them the corresponding colored tokens for each food item. As volunteers graph the results, have the rest of the class discuss what they think will happen.
- Once the results are graphed, lead another discussion. *What can we say about the results we obtained when all the food types were present? Did all three of the bird types get enough to eat? Did birds seem to concentrate on one food type? Did each bird go after a different food type? Was it easier to get food when one item or all three items were available? If birds are concentrating on different food types, are they competing for food?* No, this is called resource partitioning with each bird concentrating on it is most adapted to eat or that no one else wants. *If you look around at all the bird pictures, can you see which birds might have beaks like those our beaks represent?*

STATE STANDARDS

K: 1a, 2a, 4de
1: 2bc, 4c
2: 2d, 4ace
3: 3abd, 5bcde
4: 6ce
5: 6g

ADAPTATIONS AND EXTENSIONS

Have students observe birds at school or at the CSMR. Try to see if the birds are choosing certain food types, competing with other birds, and observe their behavior.

Discuss what might happen if a housing development were built on the wetland where the birds were feeding, a city began dumping garbage, or pesticides entered through a stream. Would the number of available food sources change?

PLANT ADAPTATIONS

(PART 1)

TEACHER PREPARATION PROTOCOL

ALIGNMENT

3rd Grade

INTRODUCTION

This lesson is designed to peak interested in salt marsh plants prior to a formal discussion. Students will develop hypotheses and conduct an experiment that tests the salinity preference of plants adapted to and not adapted to the salt marsh habitat. Students should find that grass dies when watered with salt water, whereas *Jaumea* thrives in either situation. This helps explain why *Jaumea* can thrive in local salt marshes when other native species cannot, but why is it not found away from the marsh?

BACKGROUND

Salt water entering the marsh with the incoming tides can make it difficult for non-adapted vegetation to survive. Seawater from the ocean mixes with freshwater from groundwater, rivers and run-off, to form brackish water that can fluctuate wildly in salinity and temperature. Salt in high concentrations can be toxic to plants, so plants must have special adaptations that allow them to thrive in the salty environment. Most plants, including the common upland (areas not flooded by the incoming tides) grass that you will use in this experiment, can remove small amounts of salt using tiny sodium-potassium pumps within the cell membranes of the roots. Plants that are adapted to live in salt water must deal with the higher concentrations of salt found in marshes and have specially developed glands which take excess salt from the water and secrete it from the plant onto the surface of their leaves. You can often see salt crystals on the leaves of many plants found in the Carpinteria Salt Marsh. Salty Susan (*Jaumea carnosa*) is extremely salt tolerant and is the dominant lowland (area frequently flooded by incoming tides) plant in southern California salt marshes.

MATERIALS

PROVIDED BY TEACHER:

- 1/2 Cup Table Salt
- 2 Gallons Water
- 2 One-Gallon Milk Jugs (or other containers to hold water)

PROVIDED BY CSMR STAFF:

- 2 pots containing *Jaumea*, one to be watered with fresh water, the other with salt water
- 2 pots containing grass, one to be watered with fresh water, the other with salt water

Procedure

- Introduce students to the potted *Jaumea* and grass.
  - Ask students if they have seen these plants before. Explain that they come from the Carpinteria Salt Marsh, which they will be studying in a few weeks. Until then, they will prepare by testing to see whether either of these plants could survive there. The other 3rd grade class will be repeating this experiment to see if they get the same results.
  - *What is a salt marsh?*
  - *What might make it hard for a plant to survive in a salt marsh?*
  - *If we water one of the Jaumea plants with salt water and one with fresh water (not salty water), and do the same with the grass plants, what do you think will happen to the plants?*
  - Tell students that they must help you keep the plants alive and see what happens to the plants in the next couple weeks.
- Fill 2 one-gallon milk jugs with tap water. Funnel 1/2 cup of salt into **one** of the containers to make 33ppt “seawater.” (This is equivalent to the salinity of our local ocean water.) Replace cap, shake to mix. Label each container clearly, “Salt Water” and “Fresh Water.”
- Label one Jaumea pot and one Grass pot “Watered with Salt Water,” and the other Jaumea and Grass pots “Watered with Fresh Water.”
- Place plants in a location where they will get plenty of sunlight. Ask students to help you choose a good spot. *Why is this a good spot?*
- Have students volunteer to water plants every couple days. Water just enough to keep pots moist, being sure to water on Fridays before the weekend.

State Standards

K: 2ac
1: 2abe
2: 4g
3: 3abc, 5ade
4: 6cd

PLANT ADAPTATIONS

(PART 2)

IN CLASS ACTIVITY

ALIGNMENT

3rd Grade

INTRODUCTION

This activity explores why certain plants thrive in local salt marshes while others cannot. To help students understand this concept, they will prepare with an experiment looking at plants grown in salt vs. fresh water, to be discussed in this lesson. Through a discussion about CSMR, students will learn about the adaptations plants and animals have to live in a harsh salt marsh environment.

OBJECTIVES

Students understand that:

- Plants have adaptations for certain environments and must adapt or move when the environment changes.
- Salt marsh plants have special structures that allow them to survive in an environment where salinity and temperature can change daily.
- Humans have influenced the layout of the CSMR over time.

BACKGROUND

The definition of a wetland is an area that is saturated by surface or groundwater at a frequency and duration sufficient to support a prevalence of vegetation adapted for life in saturated conditions. In other words, wetlands are wet for some part of the year, and support plants that cannot typically survive in other habitats. Salt marshes are coastal areas where salt and freshwater mix. Seawater from the ocean mixes with freshwater from groundwater, rivers and run-off, to form brackish water that can fluctuate wildly in salinity and temperature. Salt water entering the marsh with the incoming tides can make it difficult for non-adapted vegetation to survive.

Salt in high concentrations can be toxic to plants, so plants must have special adaptations that allow them to thrive in the salty environment. Most plants, including the common upland (areas not flooded by the incoming tides) grass in this experiment, can remove small amounts of salt using tiny sodium-potassium pumps within the cell membranes of the roots. Plants that are adapted to live in salt water must deal with the higher concentrations of salt found in marshes and have developed special glands which take the excess salt from the water and secrete it out of the plant onto the surface of their leaves. You can often see salt crystals on the leaves of many plants found in the Carpinteria Salt Marsh. Pickleweed (*Salicornia virginica*), a salt adapted plant like the one used in this experiment, Salty Susan (*Jaumea carnosa*), has taken things further, developing a special, membrane bound storage facility called the vacuole. Pumps move salt into the vacuole of cells near the tip of the plant, until the tip becomes saturated and breaks off. Pickleweed is extremely salt tolerant and is the dominant lowland (areas frequently flooded by incoming tides) plant in southern California salt marshes. Pickleweed does not require a salty environment to grow, but it is usually out-competed for resources in upland parts of the marsh.

Another salt marsh plant is Salt Marsh Dodder (*Cuscuta salina*), a parasitic plant that lives off Pickleweed and Jaumea. Germinated seeds initially develop into free-living (non-parasitic) young plants, green with chlorophyll. Once the dodder reaches a host plant, it sends roots into the host and the original roots and stems die. It then loses most of its green color and develops orange threads and tiny white flowers, securing its nutrients from its host.

Salt Marsh animals: The horn snail (*Cerithidea californica*) can often be found in large groups in the salt marsh. They are deposit feeders, ingesting mud, digesting the organic material, and then excreting clean mud as small compact mud fecal pellets. The horn snail is also typically infected with a trematode (worm) parasite. The trematode castrates the snail and produces an offspring that leaves the host to search for a second, intermediate, host (like a fish, clam, or crab). The trematode can greatly affect the second host's behavior, making them more susceptible to predation by the trematodes final host (a bird). The trematode lives in the gastrointestinal tract of the final host, mates and produces eggs that are excreted back into the marsh to final the horn snail and complete their life cycle.

The Lined Shore crab, *Pachygrapsus crassipes*, is an omnivore that lives in crevices, and can spend half its time on land. To grow, crabs must molt their shell. They can regenerate appendages within several molts if dropped (a form of defense).

There are three species of clams living in the CSMR; the little neck clam (*Protothaca staminea*), bentnose clam (*Macoma nasuta*), and California jackknife clam. When viewed on edge, the valves of the bentnose clam are bent at an angle. *Protothaca* have thicker shells and are generally found closer to the surface than the thinner-shelled, bentnose clam.

Aerial photos show the change of the Carpinteria Salt Marsh over time. 1869: prepared by the US Coast Survey, shows the large size of the estuary, termed El Estero de la Carpinteria. Despite its size, the wetland is smaller than it would have been before the establishment of the mission, and local agriculture and urbanization. The drainage area extends almost to Carpinteria Creek. Notice the oak woodlands to the east, the agricultural plots to the north, the sand dunes southwest of the marsh, and the existence of a road that would eventually become Carpinteria Avenue. 1929: Sand Point Road, Sandyland Cove Road, and Del Mar Avenue appear, along with residential parcels along Sand Point. The beach is extensive, and a town appears north of the railroad tracks. 1947: Wetlands along Sand Point Road filled in after property loss from continued loss of the beach and dunes (following construction of Santa Barbara Harbor). Estero Way is built to get to gas and oil resources, and the marsh continues to be filled in along Del Mar and Holly Avenues. 1968: The freeway and mobile home park appear. Santa Monica and Franklin Creeks are channelized after 1966 flooding. 1981: Santa Monica and Franklin Creeks are further channelized. More water flows to the salt marsh, bringing pollutants as water runs over concrete instead of being absorbed into soil.

MATERIALS

PROVIDED BY TEACHER:

- 4 potted plants from preparation experiment

PROVIDED BY CSMR STAFF:

- Wetland Animals Poster
- What is a Wetland? Poster
- CSMR Historical Map Poster
- Cooler
- Animals from CSMR (crabs, clams, snails)
- Pieces of different salt marsh plants (*Salicornia*, Grass, *Jaumea*, *Frankenia*)

PROCEDURE (75 minutes)

- (15 minutes) Begin with an introduction to the CSMR. *Has anyone ever seen/visited CSMR? Did you notice anything interesting about it? Did you see any animals or cool plants? What is a salt marsh?* Refer to the "What is a Wetland?" poster. Talk about the saturated soil, and fresh and saltwater mixing. *What factors do salt marsh animals have to deal with? How do they deal with these factors? What kinds of plants and animals are specialized to live in a salt marsh?* Refer to the posters to help students see the types of plants and animals living there. Include a little background about the different types of wetlands. Adaptations include those to salinity, tides, and temperature.
- (15 minutes) Talk about the experiment the students performed. *How did you do the experiment?* Encourage students to explain the experimental design. *How often did you water? Where did you keep the pots? Why? Why did you perform this experiment? What did you think would happen? What happened? Why?* Then go on to talk about the implications of the results. *Jaumea* can grow in lowland areas of the salt marsh.
- (15 minutes) Next, talk about the different plants. *Why can Jaumea grow in a salt marsh, but grass cannot?* Talk about the vascular system in pickleweed. *Why don't salt marsh plants live in other places?* Explain how salt marsh plants are out-competed in other places. Next, show the Dodder. Dodder grows off pickleweed, kills it, and opens up space to allow other plants to use this space. *Why is this important?* Explain biodiversity.
- (10 minutes) Transition to talking about the history of CSRM. Refer to the map poster. *Can you recognize places on these maps?* Point out the school, the roads, and the houses. Talk about the shift of land use from agriculture to housing and roads. *How does this affect the salt marsh?* More freshwater flows over the concrete to the salt marsh, lowering salinity.
- (20 minutes) And now the best part, bring out the snails, crabs and clams. Talk about the natural history of each, and let students hold them.

STATE STANDARDS

K: 2ac, 4e

1: 2abe

3: 3abc, 5d

GROUND WATER, FOUND WATER

ALIGNMENT
5th Grade

INTRODUCTION
This lesson is designed to introduce students to the topic of groundwater. Students will demonstrate how rainwater percolates down into the aquifer, and learn about the presense of freshwater underground.

BACKGROUND
One often-overlooked source of freshwater for streams and reservoirs is groundwater. Beneath the earth's surface, water percolates down into the spaces between the soils and rock. Water percolates down until it reaches a layer of clay or compacted shale that prevents further movement. Like streams, groundwater flows from zones of higher elevation to zones located downhill, eventually tying into other bodies of water. As water percolates through layers of soil and sedimentary rock, it becomes purified.

OBJECTIVES
- Students will understand that groundwater is part of a path for freshwater.

MATERIALS
For 4 groups
- 20 Plastic Cups
  - 4 with pin holes in the bottom
  - 4 to hold water
  - 4 to hold rock
  - 4 to hold gravel
  - 4 to hold soil
- 4 2-liter Soda Bottles, with the top cut off
- Modeling clay to fit the bottom of 4 bottles
- 4 cups of each:
  - Soil
  - Gravel
  - Rocks
- 4 cups Water

PREPARATION
- Poke holes in the bottom of 4 cups.
- Cut off the tops of the soda bottles.
- Pour enough rock for each group into a plastic cup. Do the same for gravel and soil.
- If necessary, gather water in 4 cups ahead of time, otherwise have students do this during the lesson.

- Arrange materials for each group. Each group should have a cut soda bottle, modeling clay, a plastic cup full of water, a plastic cup full of rocks, a plastic cup full of gravel, a plastic cup full of soil, and a plastic cup with holes on the bottom.

PROCEDURE

- Ask students where water in a well comes from, or where water goes when it rains. Discuss the definition of groundwater. Explain that students will help you build a model of an aquifer to show how groundwater works.
- Have students help flatten the modeling clay into the bottom of the 2-liter soda bottles. *What does this clay represent?*
  - The clay or shale that stops water from going deeper underground.
- Have students pour 1 cup of rock, gravel, and then soil into the 2-liter bottle on top of the clay. *What do these layers represent?*
  - The different layers of the earth.
- Have students hold the plastic cup with holes above the bottle. Pour water into the cup and allow students to watch as the "rain" pours onto the topsoil and then down though each layer to the clay. The water collecting at the bottom is called groundwater. Ask students to describe their observations.
- *In what direction does groundwater flow?*
- *Why is groundwater important?*
- *What happens when concrete is laid over this system?*
- *At what step in the water cycle does groundwater play a part?*

STANDARDS

2: 3c
4: 5c
5: 3de
6: 2c, 4a

EXTENSIONS

Leave a hole in the modeling clay to allow percolating water to pass through and be collected beneath. Experiment with different concentrations of salt, chlorine, motor oil (etc…) in the rainwater and see how the concentrations change after the water passes through the earth.

CLAM DISSECTION

ALIGNMENT
Grades 3 and 5.

INTRODUCTION
In this hands-on activity, students will dissect clams in small groups to learn about the structure and biology of these bivalves. Students will learn about the clam's special body parts and ways of behaving that are adaptations for surviving and being successful in their habitat.

OBJECTIVES
- Students will gain experience in a hand-on scientific investigation
- Students will understand that organisms have special body parts and ways of behaving that are adaptations for surviving and being successful in their habitats and be able to explain this concept in reference to a clam.

BACKGROUND
Clams are members of the Phylum Mollusca, one of the oldest and largest groups of invertebrates (animals without backbones). Most Molluscs have hard shells and a soft, unsegmented body. Clams are a part of the Class Bivalvia (animals with two shells). Their shells are made up of two halves that serve to protect their soft bodies within. They use their fleshy foot like a plough to burrow through the mud, and extend a straw-like siphon up through the mud and into the water column to facilitate feeding and breathing. The siphon sucks water through the body of the clam, filtering plant and animal plankton with their gills and absorbing oxygen.

We know from shell middens (early kitchen garbage dumps) in Europe, North America and Asia, that clams have been widely harvested by humans since prehistoric times. Some Native American populations have also used shells as a form of currency. Today the health of wetland habitats where these animals live are highly threatened, decreasing the amount of available habitat for them.

MATERIALS
- Access to a freezer
- 1 set of Clam Anatomy transparencies (1: inside and outside views, unnamed, 2/3: views with numbered parts, 4: detailed sketch) and one Clam Anatomy Answer Key (1b)
- 1 Overhead Projector
- Overhead Projector Pens
- Newspaper to cover the desks
- Paper Towels

For each group of 2-4 students and yourself
- 1 Clam
- 1 Paper Plate
- 2 Toothpicks
- 1 Pair of Scissors

- 1 Clam Dissection Outline

PREPARATION

- Purchase clams from your local grocery store. Buy only the ones that are closed up tightly, to ensure freshness. Clams at least 3” are a good compromise between price and ease of seeing all the parts during the dissection. Freeze for a minimum of 3 days to make sure all have perished. They will keep indefinitely in the freezer.
  - Consider reserving two clams for live observation. Place in a tank with saltwater (or freshwater, if that type of clam) with about 3” of clean sand in the bottom. Allow them to settle and you will observe them burrowing into the sand with their foot and extending their siphon.
- Make copies of the Calm Dissection Outline for each group and yourself.
- Pull clams from freezer and allow a few hours to thaw. Structures are most obvious when just barely thawed.
- Gather the rest of the materials and divide between groups. Each group of 2-4 students should have a clam, a paper plate, a pair of scissors, and 2 toothpicks. Cover the tables with newspaper and distribute paper towels to all tables.

ACTIVITY (60 minutes)

- Before beginning the dissection, lead a discussion about how to treat these animals that were once alive. It is important to treat these animals with the care and respect that they deserve and learn as much from them as we can. Reassure them that no one is required to touch the clams if they don’t want to, but you are sure that everyone will want to participate once they see that it isn’t icky. Ask students how they will show respect (don’t poke/stab, don’t scare others or put messy hands in classmates’ faces, follow directions, and listen carefully).
- Remind students to follow your directions and leave the clams attached to their shells until directed otherwise so that their parts will be easier to see.
- Have students sit in groups of 2 to 4 for the dissection. Distribute 1 clam on a paper plate and 2 toothpicks to each group of students and keep a set for yourself.
- Display the Clam Anatomy transparency. Use the Clam Dissection Outline as your guide to lead the dissection. Take it one step at a time, naming each part and it’s function. Point to each clam part on the Clam Anatomy transparency as well.
- Have students take turns acting as “experts.” Show experts the clam part on your clam dissection and have them fan out and help other groups around the room. After they have checked all the groups, have them sit down and chose a new “expert” group.
- Have students scrape the muscles and soft tissue from the valves (fingernails work best) and throw it away. If you have enough, you can also clean the valves and allow students to take a valve home (be sure to clean them better when they get home so they don’t begin to smell).
- Toss clam parts, plates and toothpicks. Collect scissors to be washed.
- Regroup students and discuss what they have seen. Have students name some structures they found and give its function. Have them help you label the parts on the unnamed Clam Anatomy transparency.

Standards

1: 2a
3: 3ad
5: 2abd
7: 5b

Extensions

Have students chose another mollusc (choose Molluscs from other classes, like Chitons, Polyplacaphora, and Squid, Cephalopods) and research their natural history and adaptive structures.

Research various ways in which people have used shells and shelled animals (food, currency, tools, ornamentation).

CLAM DISSECTION OUTLINE

*1.*Valves: Protect the clams from drying out, being eaten by predators or being harmed. *Why is the clam called a bivalve?*
2.Muscle Scars: Where the muscle attaches to the shell.
3.Umbos: The oldest part of the shell, where the shell started to grow.
4.Hinge: Attaches the two halves of the shell and allows the shells to swing open and closed.
5.Hinge Teeth: Help to keep the valves from sliding past each other.
6.Siphons: The incurrent siphon sucks in water so that the clam can get food and oxygen. The excurrent siphon pushes water carrying waste and carbon dioxide out of the clam.
7.Muscles: Help to hold the shell tightly together and keep out predators.
8.Mantle: Thin layer of skin lining the inside of the shell. Takes calcium from the water to make the shell (or pearls!).
9.Gills: Absorb oxygen and release carbon dioxide so the clam can breathe. Also helps catch food particles with mucus.
10. Foot: A strong muscle that can stretch out and pull the clam around so it can dig or move around in the mud. *Hold your clam up so it looks like it's buried in the sand. Show your partners where the siphons and foot would stick out. Some clams can burrow 12" in 10 seconds. How could this behavior help the clam survive?*
11. Palps: These finger-like projections around the mouth help to sort food from material the clam can't digest, like sand.
12. Mouth: Food enters the stomach through the mouth.
13. Heart: This small, oblong-shaped structure pumps the blood around the clam's body, carrying nutrients (food) and oxygen. At this point, remove the clam from the shell. The heart is located on the body near the hinge and the umbo.
    - The intestines can look like it runs into the heart, so it may help to follow this dark line to the heart.
    - Some clams will have hearts that are easier to see. Find these clams and be sure everyone sees them. It will be easier to find on their own clams once they know what they're looking for.
14. Stomach: This greenish, roundish structure is filled with plankton the clam has filtered out of the water. It contains a structure called the crystalline style, which helps to digest the food.
15. Intestines: Loops around the stomach and passes right next to the heart. It ends at the anus where the waste is emptied near the siphon.
16. Kidneys: Help to regulate the amount of salt and other ions the clam ingests with its food.
17. Liver: Helps to digest food.

Note: The Kidney and Liver can be hard to find. You may consider allowing students to just explore the insides of the clam to find them. While doing this, they may also want to find the crystalline style inside the clam's stomach.

STREAM CURRENTS

(PART 1)

TEACHER PREPARATION PROTOCOL

ALIGNMENT

This lesson targets grades 6-8, but can easily be used for younger or older.

INTRODUCTION

This activity is a preparation for an activity to take place at the CSMR. During this activity, students will learn about currents, velocity, mean calculation, and tides by building and launching popsicle stick boats in the waterways at the CSMR. Students will build boats and design and implement an experiment that tests stream flow in the marsh. (See “Field Activities” for completion of this lesson.)

OBJECTIVES

- Students can apply simple formulas to calculate stream current.
- Students know that ocean tides enter and affect estuary stream flow.
- Students know how to use a transect line and stopwatch.

MATERIALS

PROVIDED BY TEACHER

- Popsicle Sticks
- White School Glue
- Markers
- Construction Paper
- Scissors

PREPARATION

- Gather materials and set out for student use

ACTIVITY (40 min)

- Invitation: (10 min) Begin with a short discussion about factors affecting stream flow. *Can you think of any factors that might influence stream flow in a wetland? How might we test to see how fast the stream is flowing?* Consider writing an experimental method on the board. Explain that in order to be prepared for the experiment when visiting the CSMR, the class will need to build boats beforehand.
- Construction: (30 min) Allow students to build their own popsicle stick boats. Be sure they won’t sink.
- Put student’s names on each boat and store boats in a place where they won’t get broken.

THE FILTER EFFECT

ALIGNMENT
1st and 3rd Grade

INTRODUCTION

This lesson illustrates the filtration power of wetland plants. Students will use a celery stalk in colored water to simulate how wetland plants absorb pollution and act as natural water filters. The lesson takes two days, as students will need to let the celery stalks sit overnight to observe the results.

OBJECTIVES

- Students understand that wetland plants filter water that passes through a wetland.

BACKGROUND

Wetlands clean the water that flows through them. Wetland plants trap sediments suspended in the water and allow them to settle to the bottom as the flow rate of the water decreases. Settling of sediments is important because excessive sediment can smother bottom dwellers such as oysters, mussels or aquatic insects, impair fish spawning by covering sensitive eggs, reduce visibility for visual feeders, and lower the amount of available dissolved oxygen. Generally, the more plants in a wetland, the slower the water flows. Wetland plants also trap pollutants with these sediments. These pollutants are either drawn up by the roots of wetland plants or consumed by microorganisms among the plant roots.

Understanding nature's filtration process can be useful. Engineers often design constructed wetlands, which are similar to natural wetlands, but are built to treat wastewater from domestic, agricultural, and industrial processes. Roots and stems of wetland plants form dense mats where biological and physical processes occur to treat the wastewater. Constructed wetlands are fifty to ninety percent less expensive to build than conventional chemical treatment systems. In addition to treating wastewater, these constructed wetlands also create wildlife habitats and assist with flood control.

MATERIALS

- 4 Jars
- 1 Vial Food Coloring
- 1 Dropper
- 1 Knife
- Celery Sticks (1 for each pair of students)
- 1/2 gal Tap Water

PREPARATION

- Purchase a celery bunch from a local store.
- Collect jars that are sturdy enough to not tip over under the weight of the celery stalks.

- Set out celery for pairs of students, jars for several pairs, and the food coloring, dropper and knife for yourself. If water is not nearby, fill jars with water or fill a pitcher before beginning the lesson.

ACTIVITY (55 minutes total, Day 1=25 minutes, Day 2=30 minutes)

Day 1

- Invitation (10 minutes)
  - Ask students to recall the many functions of wetlands. Wetlands act as filters for water that flows through them. *Have you ever wondered how wetlands do this? How do you think wetlands filter water? Why is this important?* Wetland plants trap and absorb pollution from the water. Tell students that your experiment for the next two days will be to observe how plants actually do this.
- Exploration (15 minutes)
  - Distribute celery stalks to pairs of students and jars to several pairs. Fill the jars with water and add several drops of food coloring to each jar of water.
  - *What do the food coloring and celery represent in this model*?
    - The food coloring represents pollution and the celery represents plants in a wetland.
  - *What do you think will happen when you place the celery stalks in the water overnight?* Make hypotheses.
  - Cut off the bottom half inch of the celery to prepare them for absorption. Perform or monitor this process with younger children.
  - Place celery in the water overnight. The colored water will travel up the stalks overnight, showing how plants absorb pollutants when they take up water.

Day 2

- Concept Introduction (20 minutes)
  - Have students sit with their partners and observe their celery stalks. Observe how the colored water has traveled up the stems and into the leaves. Break open the stalks to see the colored water in the tissue. *Were you correct in your hypothesis of what would happen to the plants?*
  - *Where does the water go after it is absorbed into the plant?*
    - Root→stem→leaves→transpired through stomata (pores)
  - *Where do the pollutants go after they are absorbed into the plant?*
    - Pollutants are stored in plant tissue until they are released into the environment when the plant dies.
  - *What happened to the colored water? Was all the color absorbed? Is this what happens in a real wetland?*
    - Yes. Wetland plants can only do so much; this is why we need to minimize the amount of pollutants that enter our streams. Hopefully, as more clean water flows into a wetland, the pollutants are diluted.
- Application (10 minutes)
  - *Why is knowing how a wetland functions important? Are there ways that humans could use this technology?*
  - Explain that some cities actually do use this technology, building constructed wetlands for their waste treatment systems. *What are some benefits and flaws to this method?*

- They replace the use of chemical treatment systems. They are natural and have little impact on the environment. They create a habitat for birds and other organisms.
- Cities need enough open space to build a contained “wetland.”

EXTENSIONS

Explore the other ways wetlands filter water. Take students out to the play yard, to an area near a hose, a grassy area, and concrete. Place a pile of dirt on the grass and on the nearby concrete, and spray each with the hose. Compare the results. *Does the dirt on the grass remain in place better or worse that the dirt on the concrete? How might this apply in a wetland?* Wetland plants trap suspended sediments and improve water quality.

Teach the structures of plants. Have students research how the water travels up the plant, expending no energy but using the properties of water and the energy of the sun to draw it up, even over long distance (picture tall trees).

K: 2c, 1:2e, 3: 3a, 5: 2ae, 7: 5ab

STANDARDS

K: 2c, 4be
1: 2e
2: 4ag
3: 3a, 5ade
4: 3d
5: 2ae
6: 7a
7: 5ab

ADAPTATIONS

K-2: Cut celery ends for students, but do so right before placing in water or stalks will lose their water absorbing ability.

4: Discuss the beneficial microorganisms that live amongst the roots of wetland plants and consume pollutants.

Field Activities
for the
CARPINTERIA SALT MARSH RESERVE

ALISO SCHOOL 3RD GRADE TOUR

INTRODUCTION

This lesson outlines a typical CSMR tour and was given to a 3rd grade class from a local elementary school, Aliso Elementary.

MATERIALS

- Large CSMR Map
- 1 Corer
- 1 Seine Net
- 2 Trays

PREPARATION

- Have students bring their signed waivers.
- Catch crabs ahead of time and keep them in a tray for when your group arrives.

ACTIVITY (1 hour)

- Introduction (20 minutes)
  - The tour begins with an introduction to the Carpinteria Salt Marsh Reserve. Ask students, *Where we are? What is this place?* Using the large CSMR map, have students find Aliso School on the map, then ask students to point in the direction of their school from where they are standing. Ask students to point to their current location on the map. Point to your location and the road in the marsh to help students orient the map in the correct direction. Next, have students point to the ocean, then ask what direction the ocean is. Help them see that when the tides come in, salty water from the ocean comes into the marsh. *Can you think of any other sources of water coming into the marsh? Rain?* Ask students to point to the rivers they can see on the map. Point out Franklin and Santa Monica Creeks. With these creeks come freshwater. Introduce the concept of watersheds, water that drains into these creeks (and everything that comes with that water) makes up the watershed of the CSMR.
  - Ask students if they can think of anything else that might come into the marsh with the creek water. Trash. Have students guess the top three types of trash that come into the marsh. Styrofoam cups, plastic grocery bags, and plastic soda bottles (items that float).
  - Point to the large, bright green patch on the map. Ask students if they can think of what this might be. It is a patch of algae that thrives on the fertilizer runoff from the greenhouses (point to these on the map). *Is this good or bad for the marsh?* It could be bad. Algae does photosynthesis during the day and flourishes with the nutrients from the greenhouse fertilizers, but at night all this extra algae does respiration and can consume a lot of oxygen from the water, creating hypoxic conditions in the water.
  - If this affects organisms in the water, it could also affect animals in the marsh that are further up in the food chain, like the species of special concern that live in the marsh. These include: The Light Footed Clapper Rail (possibly now extinct in CSMR), The Belding’s Savannah Sparrow (threatened), and several plants (The Salt Marsh Bird’s Beak, Salt Marsh Gold Fields, Ventura Marsh Milk Vetch).
- Invertebrates (20 minutes)

  - Walk students down the road to a flat area where you can walk down to catch crabs. Bring a couple crabs and horn snails (*Cerithidea californica*) back to the students. Talk about what makes an invertebrate an invertebrate and the various adaptations of the organisms. The crabs are decapods that must molt their exoskeletons to grow large and can regenerate lost appendages. The snails are molluscs that can close their operculum to hold in water and keep out predators.
- Fish (20 minutes)
  - Walk students to the end of the road and down to the channel. Run a seine net through the channel and collect a couple fish from various species in a tray for students to observe. Compare vertebrates to the invertebrates you looked at. Talk about the spines on the sculpin, the counter-shading and life history of the flatfish, and use of schooling and silver coloring on others.

STREAM CURRENTS

(PART 2)

ALIGNMENT

This lesson targets grades 6-8, but can easily be used for younger or older.

INTRODUCTION

During this activity, students will learn about currents, velocity, mean calculation, and tides by building and launching popsicle stick boats in the waterways at the CSMR. Students will build boats and design and implement an experiment that tests stream flow in the marsh. This activity is to be prepped in class before coming to the CSMR. (See "Classroom Activities" for preparation of this lesson.)

OBJECTIVES

- Students can apply simple formulas to calculate stream current.
- Students know that ocean tides enter and affect estuary stream flow.
- Students know how to use a transect line and stopwatch.

BACKGROUND

Stream flow has important implications for how any stream will affect inhabitants and the surrounding area. Slow streams do not have the power to pick up and move sediments, but powerful streams will. Fast streams can potentially move sediments around an estuary, erode banks, or carve new paths of flow. For organisms, learning to read current speed is an important, and sometimes lifesaving, skill.

Several factors can affect stream flow. Times of heavy or light rain can alter how much water is flowing. When the tide comes in, stream flow through the estuary can slow or even reverse directions.

MATERIALS

For a class of 30

- 7 Stopwatches
- 1 Transect Line (25-50 meter length)
- 7 Calculators
- 15 Pencils
- 15 Clipboards
- 15 Datasheets
- 30 Pre-made popsicle stick boats

PREPARATION

- Each pair of students will have a datasheet, a clipboard, and a pencil. The stopwatches and calculators should be shared between groups. Students should bring their own popsicle-stick boat.
- Gather materials and set out for students to help carry to the edge of the creek.

ACTIVITY (50 min)

- Invitation: (5 min) *Can anyone guess how fast this stream is moving?* Define "velocity." *What are some factors that might affect how fast this stream is moving? Could rain affect stream flow? Could flow change directions?*
- Exploration: (30 min) *How might we test to see how fast the stream is moving and how it varies throughout CSMR?* This is your question*. What is the next step in the scientific process?* Walk students through the steps of the scientific process, leading them to come up with a hypothesis and a method to test how fast the stream is moving. Have them perform their experiment. Float each boat twice (at each site).
    - Have students break into pairs and pass out stopwatches, pencils, datasheets, and clipboards. Everyone should have his or her boat. *What information can we fill in on our datasheets right now?* Allow time to do this and remind them about units.
    - Have students lay out 25 meters of the transect line. *What information does this give us for our datasheets?* You may need to show students how to read the transect line and use meters.
    - Students should set their boats in the water a few feet before the beginning of the transect line. Begin timing as the boat passes "0 m," and stop as it crosses "25 m." Record data on datasheets and calculate velocities while waiting for stopwatch or for other to finish.
    - Find the mean of the stream velocity by averaging both boats and both trials at that site.
- Concept Introduction: (10 min) Discuss every pair's results. *Was there a pattern? Can you describe this pattern? Can you explain why we might have observed this pattern?*
- Application: (5 min) *Do we know everything about stream flow? What other factors could have affected how fast the stream was flowing? Why is it important to know about stream flow?* Discuss how tides, rainfall, etc., could affect our results. This experiment would need to be repeated many times, and under many different conditions to truly be able to define a pattern of stream flow in the CSMR.
- Look over worksheets to be sure students understand the mathematical concepts.

STANDARDS /ADAPTATIONS

K: 1a, 3b, 4bcde

Simplify. Have a boat race. Talk about how fast the boats went and compare the shapes and sizes of the different boats. Talk about how the currents could change with the seasons.

1: 2ab, 3ab, 4ad

Talk about how the currents affect wetland plants and animals, and how they adapt. Discuss the tools you are using and units each measures. Students have not yet learned about division or means.

2: 1ab, 4abcg

3: 1c, 3abd, 5abcde

Discuss the energy transfer that flows with the currents in the stream. Talk about how the currents affect wetland animals, and how they adapt. Emphasize repetition. Students are just learning about division and have not yet discussed means.

4: 5ac, 6d

Discuss effects of transport created by stream currents. Students have not yet learned about means.

5: 4c, 6fgh

Discuss the impacts of weather.

6: 2ab, 7ab

Concentrate on the method for calculating means, this is usually students' first exposure to mean/median/mode. Discuss the exchange of energy and nutrients with stream currents.

7: 7a

Reiterate the method for calculating mean.

8: 1abcf, 8cd, 9f

Focus on velocity and possibly buoyancy.

9-12:

Do tests at several locations along the stream to see if velocity changes when the stream gets narrower or wider, or when the stream becomes deeper or shallower.

Consult a tide chart and return to a site throughout the day to see if stream flow changes at different tide levels. Does change in tide affect certain areas of the estuary more than others (reverse flow close to ocean, create stagnant water closer to the mountains)?

Discuss how currents might affect nutrient cycling.

Discuss how each boat's aero/hydrodynamics could have affected what they interpreted to be current velocity. Test different boat designs to which designs reduce drag.

Have students write a lab report on their research and findings.

STREAM FLOW DATA SHEET

Team Members' Names:____ Date:___________

Air Temperature:_____ Wind Speed:__________

Cloud Cover (circle one) 0 1-25% 26-5-% 51-75% 76-100%

Site 1 - Time:_________ Tide Height:__________

Site 2 - Time:_________ Tide Height:__________

Site 3 - Time:_________ Tide Height:__________

Boat	Trial	Site	Distance (meters)	Time (seconds)	Velocity (meters/second)

Current Speed (Low)	Current Speed (Mid)	Current Speed (High)

Formulas

BOAT VELOCITY = $\frac{\text{Distance Traveled}}{\text{Time Traveled}}$

CURRENT SPEED = Average of Boat Velocities = $\frac{\text{Sum of Boat Velocities}}{\text{Number of trials}}$

Outreach Activities

WETLAND WORD SEARCH

T	A	T	I	B	A	H	W	S	D	E	I	P	N	U	R	S	E	R	Y
H	W	I	L	D	L	I	F	E	T	L	C	E	S	M	L	I	W	E	A
A	I	T	N	E	F	I	N	Y	B	D	R	O	A	A	V	K	E	C	D
L	N	H	O	R	N	S	N	A	I	L	P	M	L	E	R	S	T	O	T
B	R	A	C	K	I	S	H	C	R	I	A	A	T	O	T	H	D	S	E
U	A	S	A	T	B	E	R	U	D	W	N	H	W	U	G	D	A	Y	G
F	R	O	Y	T	I	M	P	A	S	F	T	U	A	D	E	Y	W	S	V
F	E	C	L	A	M	Y	E	L	H	E	R	R	T	R	O	R	B	T	E
E	N	O	I	T	A	T	E	G	E	V	Y	D	E	F	I	L	T	E	R
R	O	R	A	R	D	I	S	A	P	P	E	A	R	V	D	O	D	M	N
D	I	L	E	A	N	R	P	E	F	I	S	H	E	A	B	B	L	E	A
E	T	P	T	D	L	I	A	R	R	E	P	P	A	L	C	C	K	W	L
E	A	O	A	O	M	S	R	W	E	T	L	A	N	D	P	I	E	E	P
W	R	M	L	E	W	E	R	T	S	E	D	I	M	E	N	T	S	L	O
E	U	I	O	N	H	T	O	Y	H	F	O	O	D	W	E	B	E	C	O
L	T	G	C	S	D	L	W	F	W	E	S	A	L	I	N	I	T	Y	L
K	A	R	R	E	N	A	O	O	A	B	W	I	E	B	O	F	M	T	H
C	S	A	E	U	S	E	D	I	T	S	A	B	S	O	R	B	A	R	C
I	M	T	P	N	R	Y	D	W	E	E	M	H	S	I	F	T	A	L	F
P	S	E	C	R	U	O	S	E	R	D	P	M	N	T	G	B	O	G	I

WETLAND
ESTUARY
MARSH
FEN
BOG
VERNAL POOL
SALINITY
ECOLOGY
ECOSYSTEM
DISAPPEAR
HABITAT

BUFFER
FILTER
NURSERY
PANTRY
MIGRATE
SEDIMENTS
VEGETATION
RESOURCES
ABSORB
SEEP
PERCOLATE

SATURATION
FRESHWATER
SALTWATER
BRACKISH
TIDES
DENSITY
HORN SNAIL
CRAB
CLAM
FISH
FLATFISH

BIRDS
CLAPPER RAIL
SPARROW
PICKLEWEED
DODDER
WILDLIFE
ALGAE
FOODWEB

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