"And the Tide Comes In..."

Supplemental Materials

The activities below were designed to accompany the children's book, "And the Tide Comes In," which provides an introduction to salt marsh ecosystems. They were designed by M. Alber, V. Butler, C. Linsky, and E. Torbush, with help from many of the participants in the GCE-LTER Schoolyard program. For more information, to submit children's work, and to see suggestions from other people who have used these materials, please visit our website: gce-schoolyard.uga.edu.

These activities have been aligned to the Georgia Performance Standards (GPS) for Science (S), English Language Arts (ELA) and Art (A), and range from grades 3-7. See Appendix A for a complete listing of standards and an explanation of the coding. (The Appendix also organizes the activities according to grade level.) These materials also address many of the essential principles of ocean literacy that have been identified by scientists and educators nationally as important for inclusion in K-12 classrooms (http://www.coexploration.org/oceanliteracy/documents/OceanLitConcepts_10.11.05.pdf)

Information in italics is for the teacher/group leader.

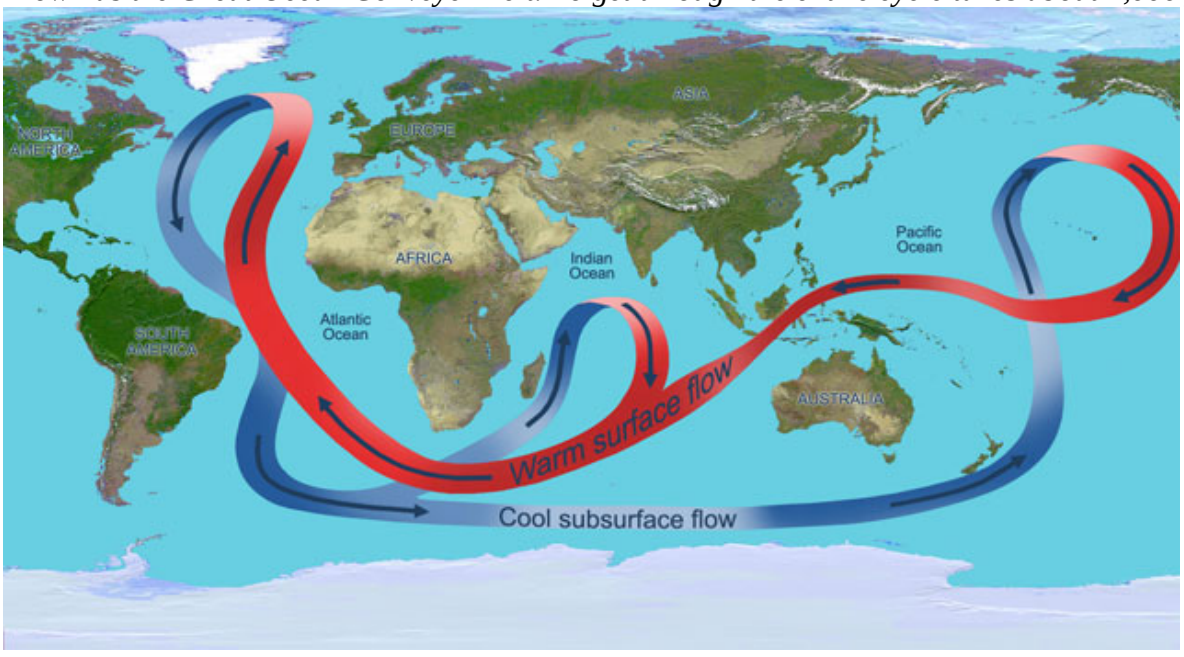
pp. 2-3

A. Discussion: Compare and contrast the marsh ecosystem with another ecosystem you've studied (e.g. the story refers to mountains).
[GPS Targets: S3L1, S4L1, S7L1, S7L4]

B. Writing across the curriculum: In the beginning of this story we learned that the main character was in touch with her cousin, Ginger, about the marshes. Write an e-mail or a letter to your cousin or a friend about the ecosystem you live in.
[GPS Targets: ELA3R2, ELA3W1, ELA4W1, ELA5R3, ELA5W1, ELA6R1, ELA6R2, ELA6RC3, ELA6W1, ELA7R2, ELA7RC3, ELA7W1]

C. Exploration: How do currents connect the oceans from the east coast to the west? How long does it take for water to go through all of the oceans?
[GPS Targets: S6E3, S6E5, ELA3R3, ELA4W3, ELA4W1, ELA4R1, ELA5R1, ELA6R3, ELA7R2]

The diagram below shows how surface water from the Pacific ends up in the Atlantic, through what is known as the Great Ocean Conveyer Belt. To get through the entire cycle takes about 1,000 years.



http://www.jpl.nasa.gov/news/news.cfm?release=2010-101
For further information see http://www.enviroliteracy.org/article.php/545.html

pp. 4-5

A. Discussion: What are the things that slow down the action of a hurricane or other ocean-borne storm as it moves towards the mainland? (*Have the students think about dunes, wetlands, and other types of buffers that can provide protection from a storm in contrast to a situation where the houses are built right on the beach.*)
[GPS Targets: S3CS4, S5E1, S6E3, S6E5, S7CS5]

B. Organization: Draw a "Mind-map" of what the students associate with the word "coast". Have them list words that come to mind, and write them on the board with the word "coast" circled in the middle. Have them categorize their words into groups.

C. Discussion: There are lots of different habitats associated with a barrier island. Discuss each of these with the students, and then ask them to sort them in the order you'd encounter them if you cross over a barrier island.
[GPS Targets: S3CS4, S3L1, S5E1, S7CS5, ELA3R2, ELA6RC3, ELA7RC3]
Barrier Island habitats include beaches, dunes, maritime forest, tidal creeks and salt marshes:
    - *Beaches – There is both a "wet beach," which is the part covered by the water during at least some part of the tide, and a "dry beach," which is the sand that is always dry. The edge of the wet beach is often marked by the highest wrack line, the line of debris left by the water.*
    - *Dunes – Dunes are usually in several rows, with the primary dunes closest to the ocean and secondary dune fields beyond. Primary dunes are colonized by sea oats, which help to stabilize the sand. In the sheltered areas between the lines of dunes you often see shrubs. The plants have to be pretty hardy because they are exposed to wind and salt air.*
    - *Maritime forests – Maritime forests grow in the interior of the Island. The trees in a maritime forest are still exposed to wind and salt air so they're not usually very tall. In the southeastern US the maritime forest has live oaks, palmetto palms, Spanish moss, and Yaupon holly.*
    - *Marshes – Marshes are found in protected areas on the back side of the barrier island. They are intertidal areas, like the beach. In contrast to the beach side there is very little wave energy here and instead of sand there is mud. These marshes are intersected by numerous tidal creeks.*
    - *Estuaries – Advanced students can continue their transect and be prompted to recognize that after the marsh there is water that is part of an estuary (or Sound), beyond that there is more salt marsh associated with the intertidal areas of the estuary, and then finally there is the mainland.*

pp. 6-7

A. Exploration: If you have a creek near you, do you know where it begins? Have the students use a topographic map to locate a creek and trace it from start to finish. This discussion can also be linked to a discussion of watersheds.
[GPS Targets: S3CS4,S5E1, S6E3, S6E5, S7CS5]

B. Analogy: Have students look at the aerial view of the marsh illustrated in the book, which shows how a marsh can be compared to the branches of a tree. Discuss the movement of substances through a marsh and compare that with the movement of sugar and water through the branches of a tree. Another possibility is to compare the movement of oxygen through your lungs, which is another way to think about the tides, "breathing" the marsh.
[GPS Targets: S3CS4,S5E1, S6E3, S6E5, S7CS5]

pp. 8-9

A. Discussion: Marsh mud does not allow oxygen to penetrate very deep. What might that mean for the organisms in the marsh? *Animals need to breathe, so have students think about how oxygen might get into the sediment through burrows, etc., and/or have them research how plant roots get oxygen.*
   [GPS Targets: S3CS4, S3L1, S4L2, S5E1, S6E3, S6E5, S7CS5, S7L4]

B. Demonstration: Marsh Mud: Get a clear jar with a lid, and add small pebbles, soil, and talcum powder (to represent silt) until the jar is about 1/3 full. Fill with water, and seal well. Ask the students: "What would happen if I shook this up? Would layers form? If so, what would go on the bottom? On the top? How about in between? Then shake up the jar and observe the layering. Explain to the students that the soil and rocks settle first because they're the heaviest. They need strong motions or currents to move them. The strong currents in the tides and the waves carry sand out to the beach where they settle. However, the talcum powder is much lighter, so it doesn't take as much energy to move around. That's why they're the last to settle down. The slow going currents of the intertidal creeks carry clay and silt until they slow down long enough to settle. Demonstrate this early in a class period and set the jar aside to view again before the end of the school day. Leave the jar overnight for one more look the next day, to see if any further settling has occurred.
   [GPS Target: S5E1]

C. Exploration: One of the groups of organisms found in the mud are called meiofauna. Have students research what these are.

Meiofauna are organisms found in the sediment that are smaller than 0.5 mm (as opposed to macrofauna, which are larger than 0.5 mm). Meiofauna live in between the grains of sediment, and can either be the juveniles of macrofauna (considered "temporary" meiofauna because as soon as they get big enough they are no longer less than 0.5 m), or they can be full-grown organisms (considered "permanent"). There are representatives of meiofauna from lots of different phyla, but they are all very long and skinny, which is an adaptation to living between the sediment grains (see diagram). When an organism eats sediment (like many worms), they are actually also eating meiofauna!

http://seawifs.gsfc.nasa.gov/OCEAN_PLANET/IMAGES/G-534.gif

pp. 10-11

A. Exploration: *Spartina* has salt glands to handle the salt, as described in the text. Some other marsh plants use what is called the "succulence" strategy. Tell your students that "succulent" plants are "fat plants" because they retain water and have a waxy skin to keep the water in. It is often seen in dry climates. Have your students figure out that this is a characterstic of cactuses and guide them to an understanding that even though the marsh is different than a desert, there is not a lot of fresh water so the plants have to have adaptations to hold onto it. (*If they have gone on a field trip to the marsh, it is likely that they will have seen Salicornia (common name = glasswort), which uses this strategy. They may have even tasted it—it tastes like a pickle.*)
   [GPS Targets: S3L1, S4L2, S7L1, S7L4]
B. Building on Prior Knowledge: Ask if students have fish tanks at home (get a show of hands.) What would happen if you put your salt water fish in a fresh water tank? Vice versa? Why would it be a good thing for a fish to be able to live in the salt water? Why might it be a bad thing? (*This can be used to initiate a discussion of adaptations.*)
   [GPS Targets: S3L1, S4L2]

pp. 12-13

A. Discussion: Male fiddler crabs have one large claw and one small claw, whereas females have two small ones. See if students can figure out the purpose of the one large claw. List other fiddler crab adaptations. *The large claw is used to attract mates (it actually gets in the way of feeding).*
   [GPS Targets: S3L1, S4L2, S7L1]

pp. 14-15

A. Art - Create a model to illustrate the tide diagram in the book. (*Students can do this as a drawing or a 3-d model.*)
B. Demonstration - Tide demonstration: (this can be done outdoors and will take a full period – see Appendix B)
   [GPS Targets: S6E1, S6E2, A6E3, A6W5]

pp. 16-17

A. Building on Prior Knowledge question: What other animals are good at holding their breath? (*sea turtles, whales, manatees, etc.*)
B. Game: Sharing the Marsh :
    a. Designate 5 students as mussels, 5 as killifish, 5 as fiddler crabs and 5 as raccoons.
    b. Have them figure out if they feed under water (during high tide) or when exposed (during low tide).
        i. *High tide feeders: Mussels (close up at low tide and then open up and filter at high tide). Mussels cannot move.*
            1. *Killifish (swim into the creeks at high tide; are out of the marsh at low tide). Killifish crawl around on their bellies.*
        ii. *Low tide feeders: Fiddler crabs (hide in burrows at high tide and then crawl around at low tide) Fiddler crabs skitter in a "crab walk"*
            1. *Raccoons (go up to the land at high tide; forage out on the marsh at low tide) Raccoons crawl on all fours.*
    c. Designate a marsh area, a water area (where the killifish can go at low tide), and an upland area (where the raccoons can go at high tide). Scatter about 200 pieces of macaroni and

about 50 beans on the ground in the marsh area. Tell the students that the macaroni represent worms that live on the marsh surface, and the beans represent food that is brought in with the tide.

d. To start the game, call out "low tide". Those animals that can feed at low tide move about—they can collect up to 5 pieces of food. (Give them about 30 seconds.)
e. Next, call out "high tide" and as you do throw in about 50 more beans to represent new food coming in. Those animals that can feed at high tide move about—they can collect up to 5 pieces of food.
f. Alternate between "low tide" and "high tide" 2 more times, throwing in new beans at every high tide.

C. Discussion (to follow marsh game, or can be done without it): Have students compare terrestrial and marine food webs – get them to think about what other organisms would be in the marsh at high vs. low tide. *A marsh food web can include: insects, grasshoppers, spiders, raccoons, rice rats, birds, snails, mussels, oysters, fish, blue crabs, fiddler crabs, grass shrimp, and turtles.*

p. 18-19

A. Discussion: See if students can name animals found (at least sometimes) in the marsh that fit the following categories:
   a. Mammals, Shellfish, Reptiles, Fish, Birds, Crustaceans, Insects
   b. [for advanced students, map these to phyla (the plural of phylum)
   c. Could also ask students to create a graphic organizer to categorize their organisms.

   [GPS Targets: S3L1, S5L1,S7L1]
B. Discussion: What is a mammal? What are other mammal examples?
   [GPS Targets: S3L1, S5L1,S7L1]

p. 20-21

A. Demonstration - Marshes as Nurseries: Simulation
   a. Materials: 1. A flat open surface (like a tray or area of concrete) next to a carpet-like area (like a bath mat or even a grassy area) 2. Small objects like paper clips or dried macaroni noodles.
   b. One student looks away while the other student puts items in the open area. Next tell the student that s/he has 5 seconds to pick up as many of the items as s/he can. Count the items and record the info.
   c. Next, the student looks away again and the other student "hides" the same items in the grass or bath mat. Allow the student to turn back around and have another 5 seconds to pick up as many items as possible.
   d. Tie it all back in to the example: If young (small) animals are out in the open ocean, they have nowhere to hide. Predators like eating the juveniles because they can't swim very fast, so they're easy to catch. However, the marsh allows the animals to hide between the grasses. The predators are too big to fit up in the grasses, so they have a safe place to grow and develop.

   [GPS Targets: S3L1, S4L1,S4L2, S7CS5, S7L1, S7L4]

p. 22-23

A. Discussion: Commercial fishermen catch adult shrimp and crabs, so why is it important to maintain healthy salt marsh habitats? *Get the students to think about the fact that the young shrimp*

and crabs depend on the marshes.
[GPS Targets: S3CS4, S7CS5]

B. *Note: The book makes the point that blue crabs that we eat are a different species than the fiddler crabs found in the marsh. The same is true for shrimp: we generally eat white, brown, and pink shrimp but marsh creeks have grass shrimp, which are smaller. Likewise, the ribbed mussels we see in the marsh are different than the blue mussels that are served in restaurants.*
C. Field trip follow up: Have you ever seen grass shrimp?

p. 24-25

A. Math: A snail releases 1,000 eggs. What might happen to them? (Let's say 262 are eaten by larval fish, 228 are eaten by other zooplankton, and 500 drift away with the currents). Have student calculate how many would survive and still be in the area ready to settle? [*262+228+500 = 990; 1000-990 = 10*] (Can have advanced students calculate percentages of the eggs in each category.)

p. 26-27

A. Art: Have your students illustrate a salt marsh coffee shop. Get them to think about who might be there? What would they have on the menu? What would they call it? When would it be open? (*Note that the coffee shop doesn't necessarily have to just cater to birds.)*
[We would love to see and share these pictures; you can submit them on-line at gce-schoolyard.uga.edu]
[GPS Target: S4L1]

p. 28-29

A. Exploration: What makes the water change colors? Why is it sometimes grey? What other colors is it? Discuss reflection and refraction of light here. Allow some of the visual learners to take pictures of a body of water in different kinds of light to show how the color of the water changes as the light changes. (This information could be included in the letter about the marsh assignment, which is listed next.)
B. Field Trip Follow Up: Pretend you are the narrator of the story. Write a letter to Ginger (or your cousin or friend) about your visit to the marsh.
[We would like to have some of these letters as well, which can be submitted on line at xxx.]

pp. 30-31

A. If the students draw pictures or do other work connected with the book, we'd love to see it. Please go to gce-schoolyard.uga.edu to see what other classes have done.

B. For further information – This book was written by Dr. Merryl Alber, a scientist at the University of Georgia who directs the Georgia Coastal Ecosystems Long Term Ecological Research (GCE-LTER) program. The Georgia Coastal Ecosystems LTER (gce-lter.marsci.uga.edu/) is one of 25 NSF-sponsored LTER sites. Scientists involved in the GCE-LTER project study the marshes and estuaries of the Georgia coast in order to understand how these ecosystems function, to track how they change over time, and to predict how they might be affected by future variations in climate and human activities. The GCE-LTER website provides access to data collected for the project, a species list, a bibliography, and links to other resources. There is also information about the GCE-LTER Schoolyard program, which is geared towards K-12 teachers.