

A bay walk guide

To the teacher: This guide is a comprehensive list of potential information for a baywalk. Please read through and make it your own by tailoring information for your students; cut and paste parts to meet your needs. The recommended websites have been checked for accuracy and at the time of this printing they were good websites. Please use the photo gallery to enhance the materials you will give to your students. We would appreciate if you acknowledge use of the written materials or photos on the handouts from our website, including the information that the site was developed from a NOAA grant.

Any time that you go out on a bay walk, it is a good idea to bring along gloves and bags for cleaning the shoreline. The teacher guide will have notes in [] that will be suggestions for you to consider. These will not be included on the student activity sheets. It is a good idea to bring a first aid kit for minor scrapes; be careful of fire ants. Be sure to talk to students about how to be a responsible bay citizen before you leave; EPA has great resources on marine debris complete with lesson plans and curriculum matrix to locate age appropriate activities (<http://www.epa.gov/owow/OCPD/Marine/contents.html>). If you are taking water and/or food, be sure to bring back all of your garbage. Students should have hats and sunscreen to make sure that they are protected from the sun and insect repellent to protect from biting insects.

For all groups, it is interesting to make sun prints (many craft stores will sell special sun print paper or you can create your own from blue print paper as described on sites such as http://www.diynetwork.com/diy/pa_techniques/article/0,2025,DIY_14159_2270778,00.html; see below for some print suggestions). This can be used as an exercise to discuss the effects of the sun on pigments. It is a good way to discuss the effects of the sun on humans and to discuss how pigments in human skin work. The EPA has a good site to introduce children to the sun and some of its effects <http://www.epa.gov/sunwise/kids.html>. Be sure to take a portfolio, mailing tube or other carrier for the finished sun prints.

Before you go out, you might also want to take the students on a virtual tour. This can give you the opportunity to discuss with students the types of organisms that they might see as well as to show them the major habitats that you will explore. EPA has some good examples, though not for Florida (<http://www.estuaries.gov/elive.html>), a general trip is found at (<http://www.fieldtrips.org/sci/salt/index.htm>), or if you are interested in a webquest created with children go to <http://www.geocities.com/beckwithlorax/> (this site has some links broken or out of date, but can give you an idea of how you can do your own webquest with your class). The Florida Fish and Wildlife Research Institute has brochures on different habitats that can enhance your preparations with your class (<http://www.floridamarine.org/products/products.asp>). Younger students might enjoy playing critter card games like “go fish” to learn about different organisms. The Monterey Bay Aquarium has examples that you can use and the resource shows how you can make your own cards (http://www.mbayaq.org/lc/activities/critter_cards.asp). Most of the genera can be found on our coast though the species differ. Using these cards or creating your own to mix and match can be useful in teaching about the organisms and habitats before a field trip. As a cultural exercise, you can also include information in Spanish, French and other languages. Students can also make their own cards after the trip to fill in information that they learned. This will help students to remember key concepts

about the organisms and the areas visited. It is very simple to laminate cards using self-lamination sheets if your school does not have lamination service through its library or other resources.

You can describe the bay and the intertidal areas in simple terms with items familiar to students. Depending on the length of time that you have and the age of the students, you can conduct some simple experiments with inexpensive materials to illustrate local currents. Before you begin, talk to students about how scientists explore their environments. If age appropriate, review the scientific method. Talk about the importance of longshore currents in shaping habitats for organisms. Ask students to make an hypothesis about the direction of the longshore current locally. For 9-12 graders, this might be an excellent time to show them navigation charts and aerial photos. Sometimes, tackle shops or marinas will give you old charts. Aerial photos of an area can be obtained at your local land appraiser office (<http://maps.scgov.net/>). Often, for educators, you can get one or a few copies of an aerial free. To discuss how the sand is moved along the shore, you can take a couple of beach float toys to illustrate your points. Be sure to tie a string to the toys so that you can retrieve them without getting too wet. Toss a toy near shore and ask the students to watch how the toy moves in 10 minutes; have one student stand where the toy was tossed in and one stand where the toy is at the end of 10 minutes. Ask the students to measure the distance and if appropriate for the age group, ask them to calculate the speed of movement. Now toss the toy so that it is farther from shore. Ask the student to predict what will happen to the toy (will it come in to shore, will it parallel shore or will it be taken out to sea). This is a good time to talk to the students about longshore currents and how these same currents that they see moving the toys will also move sand.

A simple diagram of the intertidal can be found at <http://www.enchantedlearning.com/subjects/ocean/Intertidal.shtml>. If you have a digital camera, you might take some photos of major organisms or features of the environment for students to use later. Students should also be encouraged to make their own sketches of these. Sometimes students are shy about their art skills, so you may have to remind them that sketches are for reference, not artistic renditions. You will want to have students collect sediment samples while in the field. Plastic sandwich containers or baggies can be used. Make sure the students label their samples with location.

You can download animal field guides for the area at <http://www.enature.com/zipguides/>. General drawings of organisms can be found at <http://biodidac.bio.uottawa.ca/>. A good general site for helping students understand how they can observe organisms in the field is at <http://www.thewildones.org/>.

If you are interested in seeing what others are doing in the education field or you have a contribution that you think might be of interest to others, you should check out the online journal free to educators at www.accessexcellence.org/LC/BEOn/register.html .

Teachers: Potential grants for funding activities

<http://myfwc.com/educator/grant.htm> You should investigate participating in one of the workshops from the Florida Wildlife Commission. Not only will you gain information that will be useful in classes, it will also make you eligible for a grant application.

Information for students on Bay Walk:

Materials for the field trip: Notebooks (like a composition book) to record observations, pencils (you might bring some color pencils if you will be outside for a while), floatable toys with string attached, measuring rope or measuring tape, small plastic containers/baggies or film canisters to collect sand/sediment, sifter, picture guide (you can download pictures from this website for major organisms or you can use a guide (eg *Petersen's Guide to Seashore Animals*), hand lens (at least one for every two students), child safe thermometer (optional), digital camera (optional) and paper for sun prints (optional). If you have a hat, please wear it and use sun screen.

You are about to travel through an interesting type of **habitat**. A habitat is a physical place where organisms live. Organisms can be individuals, part of a population (together at the same place at the same time), or communities (interacting groups). Typically, the term “**habitat**” refers to the physical surroundings such as light, temperature, soil, etc. (Think about how you would describe your own habitat—your home, your neighborhood, your community.)

When you first get out to the site, look around and record what you see and hear in your notebook. Make a sketch of the area or if there is a digital camera available, take a picture of the surroundings. Be sure to record the time of day and if you have access to the information, the temperature. Look up in the sky and guess at the amount of cloud cover (0%-bright, sunny, 20%-some clouds, but mostly sunny, 50%--about half clouds and half sun, 75%--mostly cloudy, some sun, 100%-completely overcast with clouds) because this can affect the types of animals that you see or hear. Record whether the wind is blowing (calm, light wind, strong breeze, gusty) and from which direction (ask your teacher the direction if you are not sure) [*teacher note: this might be a chance to introduce the notion that winds are describe by the direction from which they originate while currents are described by the direction in which they travel. You can show students a short video on clouds prior to the trip <http://www.globe.gov/hq/templ.cgi?theater&lang=en&nav=1>. Good websites to introduce students to some of the organisms that they will see are <http://www.dnr.sc.gov/marine/pub/seascience/dynamic.html> or <http://life.bio.sunysb.edu/marinebio/spartina.html>].*

First you will explore the **intertidal** area. This is the habitat between the high tide mark (you will see a line of items washed up on the shore like dead seagrass, bits of wood, seaweed, etc) and the low tide mark (the farthest area uncovered by the water during the day. These can change with season and organisms will move accordingly. For today, you should use the measuring rope or tape to find out the size of the intertidal. Within the intertidal, the area where water is moving back and forth is called the **swash zone**. Note whether the water is moving gently over the swash area or whether it is coming and going rapidly. This will tell you whether the intertidal is low energy or high energy (do you think that different animals live in high energy and low energy areas? Do you think that the size of the sand grains differ on high and low energy beaches? Explain). To learn about waves and **longshore currents**, you can try a simple experiment. Longshore currents generally form when waves approach the shore at an angle and break unevenly along the wave front.

Do you see any vegetation in or near the water? If the vegetation is in the water, it is likely seagrass, a submerged Florida native plant. All of the seagrasses are similar to grasses found on land. They are flowering plants that have a true root system, stems, and blades and live under water (<http://www.fknms.nos.noaa.gov/edu/seagrassmonth/welcome.html>). They have special adaptations for living in this habitat. Remarkably, they can pollinate under water, or they can grow vegetatively by the rhizomous roots that they have. A big problem for any plant that is submerged is how to keep from being waterlogged. Seagrasses have special cells on their surfaces that allow them to control the amount of water that enters and leaves the plant tissues. The process of controlling water content is called **osmoregulation**. Another difference between these plants and their terrestrial counterparts is that their blades do not have openings to perform gas exchange. All of the gas exchange for seagrasses occurs across the surface of the blade. Take a small pinch of seagrass blade and look at it with your hand lens. What does the surface look like? Seagrasses around Sarasota Bay occur both intertidal and subtidal. Those that grow in shallow areas can be exposed for several hours at low tide, especially during the winter months. The depth at which they can grow is dependent on light penetration and water quality. Think about how humans might affect where seagrass can grow [**For the teacher: this is a good place to stop and talk to students about the effects of hardened surfaces, fertilizers, and other factors that contribute to pollution in the Bay.**] Much of the Bay is shallow, so there is potential for many areas to contain seagrass beds. Some seagrass can be found in small patches while other seagrass occurs in “meadows”. [*teacher note:* <http://www.globe.gov/hq/templ.cgi?theater&lang=en&nav=1> has several short videos that will show how different physical measurements of nutrients in water are taken. There are different formats for the videos that should be useful.]

Seagrasses have several important functions in the bay. You can find information on how to identify the various seagrasses that occur in Florida at <http://floridaconservation.org/psm/habitat/grassid.htm>; the three most common species that occur off of Sarasota and Manatee Counties are *Thalassia testudinum*, *Syringodium filiforme* and *Halodule wrightii*. *Ruppia maritima* is another type of seagrass that tends to dominate in areas where rivers or tidal creeks empty into the bays; they tolerate a wide range of salinities and are called **euryhaline**. Functions include providing a habitat for many invertebrates (crabs, shrimps, barnacles, amphipods, isopods) as well as vertebrates (fishes, sea turtles). For some animals, the seagrasses are critical resources for only a part of their life cycles. For example, some fish larvae and juveniles shelter and feed in seagrasses before moving to deeper areas of the bay or into open ocean. Seagrasses also have **epiphytic algae** associated with them; algae that grow on the seagrass blades. These algae are important in both releasing and fixing nutrients in the water such as nitrogen as well as in providing food for grazing animals. Like grasses on land help to prevent erosion, seagrasses help to hold sediment in an area. The seagrass blades slow down the water movement over their surfaces because of friction. This “dampening” effect has two important purposes. First, finer sediments become trapped in the seagrass as the water slows down. When these types of particles are removed, the water seems clearer or less **turbid** (density of particles in the water is lower). You can do an experiment to see how removing these particles can clear the water. Second, small animals can shelter in the grasses from the full effects of water movement around them. Third, the blades also hold moisture and provide protection for organisms when the grassbeds are exposed at low tide. Seagrasses themselves can also be major food sources for marine animals. The sea urchin, *Lyttechinus variegatus*, found in Sarasota Bay and along the Gulf coast can consume large amounts of grass daily. Large organisms like manatees (*Trichechus manatus latirostris*) and hawksbill (*Eretmochelys imbricata*) and green (*Chelonia mydas*) sea turtles graze on seagrasses. [*teacher note:*

there is an excellent set of manatee activities for different grade levels at the manatee education center website <http://www.manateecenter.com/>].

In the shallow waters and on the shore you may see both living and dead horseshoe crabs (*Limulus polyphemus*) (<http://www.dnr.state.md.us/education/horseshoecrab/>). These are not true crabs, but they are arthropods. The blood of these animals is used in cancer research and the shell (chitin) is used to coat sutures. They also have several other uses in medicine. So many have been collected along the eastern coast of the US for research that **conservationists** are concerned about populations of seabirds that are dependent on the hatching larvae of the horseshoe crabs for food. Horseshoe crabs lay their eggs in pits on the beach that they cover.

On the dry part of the shoreline, take a sand sample. Place it into your plastic collecting container. Be sure to label it with the location and the date. You can look at the particles in the field with your hand lens. When you get back to the classroom, you can examine the sample more closely.

If you see vegetation along the shoreline, but emerged from the water, you may encounter mangroves or marsh plants. Sarasota Bay is near the northern end of the range for mangroves. We have three that are common in our area: black mangrove (*Avicennia germinans*), white mangrove (*Laguncularia racemosa*) and red mangrove (*Rhizophora mangle*) (<http://www.nhmi.org/mangroves/id.htm>). Another tree often associated with mangrove community is the buttonwood (*Conocarpus erectus*). Though the classical model of the mangrove forest places the red mangrove the most seaward and the buttonwood the most terrestrial, it is evident that all of the different mangrove species can co-occur at the same water/land level. The black mangrove can be easily identified by the **pneumatophores** (aerial roots) that occur around its base. These roots allow the tree to increase gas exchange. The white mangrove has leaves that are typically thickened and may feel rubbery. The leaves are generally rounded. There are salt glands on the surface of the leaves, so you will find salt crystals common near the base of the leaves. The red mangrove has what are known as prop or drop roots. If the roots come from the trunk they are called prop roots and if they come from branches, they are called drop roots. **Gastropods** can be found commonly on the roots of mangroves. The coffee bean snail (*Melampus coffeus*) occurs in great numbers on the roots. In addition, we are at the northern range of the mangrove tree crab (*Aratus pisonii*) (http://www.sms.si.edu/IRLFieldGuide/Aratu_pisoni.htm). These crabs have long legs and sometimes are mistaken for spiders. We are at the northern end of the range for these tree crabs. If you find some on the baywalk, take a few minutes to observe their behaviors. If the tide is low, they may be down on the roots or even on the sand feeding. If the tide is high, they generally move along the tree trunk and canopy relative to their sizes. [*teacher note: these crabs can be kept easily in the lab, but they are very hard to catch in the field.*]

Often, it is difficult to find the actual trunk of the mangrove tree because the prop roots are so numerous. Determining tree size of a single individual can be challenging as the roots of several individuals come together in dense forest areas. Their **propagules** (seedlings) develop directly on the tree and drop off when mature (they do not have seeds like other flowering plants; can you think of why this might be of advantage for the tree?). These seedlings float around until they come to an area where the end can begin to set down roots. The propagule is “weighted” so that the end that will grow roots is always pointed downward. [*teacher note: Mangroves are now being used in refugia (living filters) of large aquarium systems to uptake nitrogen and other waste products from animals. If you are talking to students about recreating captured environments, this is a good place to ask them about the*

function of the mangrove in this shoreline system (<http://www.reefkeeping.com/issues/2004-12/ac/feature/index.php>.) The buttonwood tree generally is found in drier areas; it is sometimes used as an ornamental tree in landscaping. Like the white mangrove, it has distinctive salt glands. However, its glands are found on the underside of the leaves, near the middle.

Along the shoreline, you may also see *Spartina alterniflora* (<http://aquat1.ifas.ufl.edu/spaalt.html>). This is a type of grass that is usually found in saline or brackish waters of the Atlantic and Gulf coasts and is native to the area. It is of great value to stabilize sediment in areas and provides habitat for shore dwelling organisms. Because of the tremendous growth rate of the plant, it also contributes to the **detritus** (decaying material) that is important to the health of the nearshore ecosystem. Take a sample of the sediment from the grass area. Is it different from the sand on the shoreline? Look at it with the hand lens. In Florida, its growth along creeks also promotes its use as food for grazing cattle. [*teacher note: This type of grass is also considered a non-native invader for the US west coast. This could be a nice place to talk to students about how organisms in the wrong system can be harmful. There are many invaders in Florida (<http://www.invasivespeciesinfo.gov/unitedstates/fl.shtml>). This is also a nice webquest project. You can find a general guide to a scavenger hunt prepared for a beach field trip at <http://dhp.disl.org/PDFs/TeachersResor/DIScavenger.pdf>; this is a good exercise for younger students especially and can be easily adapted for a short field trip. Because the soils in this area typically have high clay content and they have high activities of micro-organisms, they are excellent to use in creating mud cloth. See the activities at the of the baywalk to learn how to do this.*]

One of the animals that you will find on the emerged plants is the periwinkle (*Littorina anguilifera*, *Littorina littorea*, or *Littorina irrorata* are common in our area). These animals are very interesting for their adaptations to living in the intertidal. Notice that the shell is thick. Also, if you pull one from a blade of grass, you should see that they are attached by mucous. These animals not only have an **operculum** (covers shell opening) but also they secrete a mucous to make sure that moisture remains in the shell. They can stay out of water for many hours. They can also do what is called “trickle cooling” by dribbling small amounts of water from their shell, allowing it to evaporate, and cooling slightly the air in front of the opening. The periwinkles have an interesting behavior of moving up and down associated with the tides. There are many aquatic organisms that will eat them. They climb vegetation like *Spartina* and mangroves as the water moves inshore. [*teacher note: You can work with these animals well in the lab. There are some observations and experiments that you can do readily.*] Look for other plants nearby. You may see things like glasswort (*Salicornia perrenis*), railroad vine (*Ipomoea pes-caprae*) and sea oats (*Uniola paniculata*).

Look around in the grasses and in the sand around to see if there is evidence of animals. Students may see fiddler crab burrows (*Uca* species), ghost crab burrows (*Ocypode quadrata*), and mammal tracks. Many of the fiddler crab species create “feeding balls” by passing wet sand through their mouthparts and stripping the sand of small plants and organic materials. These animals are called fiddler crabs because the males have one big claw and one small claw. The males will stand outside of their burrows and wave their claws to attract females. [*teacher note: <http://www.fiddlercrab.info/> has a great deal of information on these crabs including videos of feeding, claw waving, and aggressive displays*]. The burrows are very important, serving as shelter from predation. In addition, the fiddler crabs use the burrows to survive high tide. Fiddler crabs breathe in the air as adults (they will drown if submerged too long). So, they use a plug of mud to seal the burrow opening as the tide comes in. This traps a small amount of air in the chamber as the burrow is covered with water. In addition, when the

crabs are in the dark of the burrow, their respiration rate decreases, allowing them to breathe the trapped air until the tide recedes. Some species of fiddler crabs will build elaborate entrances to their burrows to aid in attracting a mate. They also use the claw in combat with other males for territory or over mates. The **cheliped** (claw) is so large, however, that it cannot be used in feeding. If any of the legs are broken off, the crabs can grow a new one after each **molt**.

Ghost crabs also build burrows. They breathe air like the fiddler crabs. However, they have some interesting adaptations that allow them to survive long periods (several weeks) in their burrows. They can plug up their burrows very tightly so that the opening is nearly invisible. Older crabs tend to burrow farther away from the waterline. They run very fast across the sand. If you get a chance to see these crabs, notice that they run sideways not forward. Usually, they only move forward if they are feeding. Can you think of why it might be easier for these crabs to run sideways? Ghost crabs will **scavenge** (eat dead or dying animals) along the shoreline, but they are also known to be predators of sea turtle eggs.

[*teacher note:* <http://www.archbold-station.org/discoveringflscrub/unit1/proj1b1.html> gives a good introduction to interpreting animal tracks and the book <http://www.lonepinepublishing.com/cat/1-55105-147-8?PHPSESSID=8dba716a1712dc0d7e6e6aff589b5c6c> is a good introduction to the tracks of vertebrates in Florida; you can use Plaster of Paris, also called casting plaster, to make a copy of the track; craft stores carry this material generally; it takes about 20 minutes to dry but if you add about a teaspoon of table salt per pint it will dry a little faster. You can give your plaster mold a border by cutting a ring from a quart or half gallon milk jug.]

You can do field observations on the distribution of the fiddler crab burrows. If students see feeding balls nearby, the burrows are “active”. If there are no nearby feeding balls, it is likely that the burrows are “inactive”. As a class project, you can do **transects** through the area, create a grid for sampling, or toss a hoop. If you are doing transects, decide whether you are going to direct them parallel to the shoreline or perpendicular. If the transects are parallel, there is likely less variation in overall vegetation and slope of the area. If the transects are perpendicular, one might be able to observe the effects of different slope and vegetation. So, depending on what your interest is in making the observation, you can choose how to direct the transect. Typically, the class should do two or more transects so that there is a better representation of the overall area. Once the direction of the transect is decided, you need to determine two other things: how wide will the transect be and how long will it be.

As you move along the bayfront, you will see and hear a variety of birds. To learn how to watch birds, be sure to look at <http://floridabirdingtrail.com/Birdbasics.htm>. You may hear the Florida state bird, the mockingbird, in upland areas near shore. Most common along the shore are the brown pelicans (*Pelicanus occidentalis*), osprey (*Pandion haliaetus*), Caspian tern (*Sterna caspia*), Sandwich tern (*Sterna sandvicensis*), sanderlings (*Calidris alba*), white ibis (*Eudocimus albus*), snowy egret (*Egretta thula* has black legs and yellow feet), great egret (*Ardea alba*), red tailed hawk (*Buteo jamaicensis*), [*teacher note:* This might be an interesting place to include information about Seminoles and their relation with various animals. There is an excellent site at <http://www.seminoletribe.com/calendar/dna/studyguide/questions.shtml> with lesson plans and activities that are easy to implement.] double crested cormorant (*Phalacrocorax auritus*), herring gulls (*Larus argentatus* has long pink legs), laughing gulls (*Larus atricilla* has black legs), ring billed gulls

(*Larus delawarensis* has yellow legs), great blue heron (*Ardea herodias*), black-crowned night heron (*Nycticorax nycticorax*), yellow-crowned night heron (*Nyctanassa violacea*) little blue heron (*Egretta caerulea*), and green heron (*Butorides virescens*). [*teacher note: you can find reproducible pictures of some Florida birds at <http://www.geocities.com/Heartland/5960/birds.html> and you can find recordings of bird sounds as well as pictures at <http://www.flmnh.ufl.edu/birds/sounds.htm>]. Are these birds feeding or wading? Do you notice them individually, in groups of the same types of birds, in mixed groups? Brown pelicans have excellent eyesight for finding prey and lots of different feeding behaviors. Watch them when they are diving for fish versus when they are catching fish while swimming along the surface. When diving, they will typically rise above the water and plunge downward, beak first, settling on the surface to strain water from their prey. Generally, you will see groups of birds diving together. Humans can have a large impact on the pelicans. Do not feed these animals or any seabird. If you are fishing and get a pelican on your line, DO NOT CUT THE LINE. Leaving a hook in one of these birds can cause it to suffer or die. Have an adult help you to extract the hook. You should work with your parent or adult fishing with you before you begin your fishing trip so that you will know what to do if you do hook a pelican. A few simple acts can prevent a tragedy (<http://seabirdrehab.org/bookdontcutline.htm>). Even a small amount of fishing line left attached to the bird can become entangled when it goes back to roost. [*teacher note: an interesting observation that you can have students do is to observe the number of individuals that dive together. They can make graphs of singles, pairs, triples, etc. If students live near the water, they can observe the birds at different times of the day feeding to discover whether singles or groups feed differently at various times of the day. A good webquest exercise is to have students research how humans have affected seabird health. Teachers, a visit to the Pelican Man's Bird Sanctuary in Sarasota can be a great way to augment your classroom exercises. Groups are welcome for a small fee. In addition, there are classes offered with lab fees. Some of these are more suitable for older children. Going to one of the classes is a great way for a student to learn about volunteering or to bring back information to share with classmates.*] If you have dry detention ponds around your school, when it rains look to see if the wading birds are there. Some schools have freshwater wetlands nearby. Observe these areas early in the morning and late in the afternoon. Sometimes the “marine” birds will also use freshwater habitats to supplement their diets.*

Gulls are found everywhere along our coast. Because they tend to eat and rest together, they are among the most conspicuous of our sea birds. Many of the gulls are not good hunters of live food; they will scavenge along the shoreline (and in human garbage dumps). They will also steal food from pelicans and from each other. Sometimes you can even see a gull sitting on top of a pelican's head! When you are observing the pelicans, look to see if you can also see gulls nearby. How many do you see? Because these birds can be noisy and aggressive, marina owners and others who live around the coast try to discourage them from feeding nearby. However, these birds are an important part of the coastal system, removing dead and dying animals from the intertidal. If you are around where these birds are feeding on land, you should be careful of their feces. This material can harbor not only parasites, but also large numbers of bacteria.

If you are taking your walk in the evening, you may see bats in some of the high marsh areas. Most of these bats eat mosquitos. [*teacher note: there is an excellent set of activities created by the national wildlife federation at <http://www.nwf.org/outside/pdfs/batguide.pdf> for teaching about bats and their importance to our environment. If you want to follow up with other activities on bats, NASA has some nice materials on remote sensing, biodiversity and the properties of light, relating use of satellite*

imagery to how bats view their world. The teacher guide is very good, and the lessons combine physical and biological sciences well. Students can read the story of Echo online or a book version can be purchased for the library. The activities can be adapted easily for different age groups <http://imagers.gsfc.nasa.gov/teachersite/index.html>].

In this area that is often referred to as high marsh, you may also see trees. If you wish to measure the height of a tree, you can do this using math! [*teacher note: go to <http://archive.globe.gov/tctg/tgtoc.jsp> for a series of materials on how to measure land cover. There are several different methods suggested for obtaining tree heights; included are educational standards as well. You can also use the Earth as a system activities to look at seasonal changes: green up and green down will give some hints of how to do this.*] Can you think of how you might do this? Take a look at the trees. Do you see any buds? Dead leaves? How would you estimate the numbers of buds or dead leaves without actually counting them?

Soils in these areas can be very interesting. [*teacher note: the NASA soil science education page has many activities and resources that are very accessible for different age groups <http://soils.gsfc.nasa.gov/>.*]

Waves and current experiment

Form teams of 3-5 students. Each team should have at least a timer, recorder and experimenter. Look at how the waves come to the shore. Are the waves parallel to the shore or do they come in at an angle? Toss a floatable toy into the back of the swash zone. Have one of your team members stand on shore where you tossed in the toy. Watch the toy for 10 minutes to determine where it goes. Have one team member stand onshore where the toy is at the end of 10 minutes. Another one of the team can retrieve the toy (try not to get too wet). Now, measure the distance between the two team members onshore. How far did the toy move? In which direction? Compare your results with the other teams? Did the toys move about the same distance? Did they move in the same direction? What was the speed (distance/time=speed)? Collect some sand from the intertidal area, pour out any excess water, mark the sample as “intertidal” with the location and date. Keep the sample for later analysis. Scoop up some of the sand in your hand and look at it with your hand lens. Describe what you see in your notebook. Share this information with your team mates. Do you see any animals or plants in the swash zone? Scoop some sand into your sifter and dip the bottom of the sifter into the water until the sand is removed. Do you see some animals now that were buried in the sand? Describe what you see in your notebook. Compare your notes with others on your team and in the class.

Now, attach a long string with a small weight on it to a floatable toy. Toss the toy beyond the swash zone into the **breaker zone**; the weight will help you to throw the toy farther. The breaker zone is the place where the waves begin to break. Repeat the previous experiment. Does the toy travel at the same speed? In the same direction? Describe what you see. How do you explain this result? [*teacher note: If the students have successfully thrown the toy beyond the swash area, they should see either little movement or much slower rate. In some cases, depending on the area, they may see a reversal of the direction. Waves transmit energy, not water flow. Water that is in the form of collapsed waves is moving on the shore. As water piles up along the shore, it will move along the shoreline creating the*

longshore current with a net transport parallel to the shore. However, beyond the area where waves are collapsing, students may see the effects of the energy transfer. This will show the toy moving up and down, but not moving significantly along the shoreline. The toy also will not move significantly closer to shore if the students have successfully tossed it beyond the breaker zone. See <http://meted.ucar.edu/marine/ripcurrents/NSF/print.htm#21>].

If the water moves in this way, how do you think the sand moves? In a storm, more energy is transported so the waves come to shore more often and are generally higher. How do you think this might affect the longshore current? The area beyond the swash zone? [*teacher note: When you return to class, these experiments give a good introduction to a discussion of building houses on barrier islands. This type of discussion can be done across grade levels. For more advanced students, you might ask them to create a webquest study (<http://webquest.sdsu.edu/materials.htm> --this is an excellent overview of how to develop a webquest for your class constructed mostly by teachers; http://warrensburg.k12.mo.us/webquest/teacher_quest/) of the question using the information from the class trip as well as information that they can find online.]*

Water clarity experiment-understanding fine particles

[*Teacher note: you can show a video from the GLOBE program on water clarity and temperature to help students prepare for this activity <http://www.globe.gov/hq/templ.cgi?theater&lang=en&nav=1>]*

Seagrasses are important in removing fine particles from water. These particles can scatter light and decrease the ability of light to penetrate the water. To do this experiment, you will need a sample of sediment that contains a range of particle sizes. You can use beach sand. Obtain two pint jars. Place equal amounts of your sediment in each. Add water to the top in both jars. To one jar, add two drops of dish detergent. Place lids on both jars and gently invert 5 or 6 times to mix the sediment with the water. You do not want to shake vigorously because it will cause the water to foam. The water should be somewhat opaque in both jars. Record what you see. Now remove the lid from each and take a sample of the water one centimeter from the surface using a dropper. Place 2 droppers of water onto a piece of filter paper (a white coffee filter can be used if filter paper is not available). Allow the paper to dry. When the paper is dry, look at it using your hand lens. Do you see fine particles? Rub the area gently with your finger. Do you feel any sediment? Record your results as instructed by your teacher. Continue to watch the jars every day, noting when the water starts to clear. Be sure to note the size of the clear area each day. Does one jar clear faster than the other? [*teacher note: Likely the jar with the soap added will clear last. The soap will break apart clumps that have formed from clay size particles adhering to larger particles. It generally takes longer for the clay particles to come out of suspension. However, if there is only a small amount of clay size particles in the sample, the difference may not be obvious in this type of experiment.*] Continue to sample and observe the water in the same way each day until the area above the sediment at the bottom of the jar is completely clear.

Water clarity experiment –understanding fine particles, part II

For this experiment, you will need the same materials as above except you also must have a piece of artificial grass and a piece of wax paper. You do not need to use the soap. You can use a clean door mat that has plastic “grass” blades. Place the sediment into the bottoms of the jars and fill the jars with water as described above. Gently invert the jars 5 or 6 times. You will pour the water slowly over the surface of the mat and collect the water to place in the jar again. For the second jar, you will pour the

water over the surface of the wax paper and collect the water to place in the jar again. Replace the lids and repeat the observations that were made for the first experiment. Did you see any difference in the outcomes? [*teacher note: the plastic grass should have collected some of the finer particles, so it is likely that this jar cleared faster. Again, if there was little fine material in the sample, students may not see a difference using this method of observation. Geological oceanographers use very precise instruments to measure the settling velocities of particles. One of the newest techniques being used commonly is LISST or Laser In-Situ Scattering and Transmissometry (www.commtec.com/Prods/mfgs/Sequoia/App_Notes/1007.pdf; <http://rov.it/Prods/mfgs/Sequoia/lisstst.htm>).]*

Experiments with periwinkles

What tells periwinkles to climb?

You can create several different hypotheses to examine the behavior of these organisms.

Periwinkles are very easy to keep in the classroom. You can do some simple experiments with them to illustrate their adaptations to living at the edge.

The periwinkles move up and down objects as the tide changes. To test whether they move because of water covering them or because of some internal clock, you can do the following. Find a tide chart for the area (<http://cyberangler.com/weather/tides/> is one of the many sites that allows you to access tide information; you can also pick up a local tide table from most fishing tackle shops). Look to see when high and low tides occur. Place the animals in a bowl and observe what they do. Record your observations. This takes some planning in our area because of the type of cycle that we have, so be sure to look at the tables in advance to have the experiments during class time. Sometimes when encountering a new environment, the animals climb. So, it is best to make your observations a day after you first place them into their container. This allows the animals to **acclimate** (adjust) to their conditions. Place some carrot slivers and some dry fish flavor cat food in the bottom near the winkles. If there is an internal clock related to tide, you should be able to see them climb for “high” tide and come to the bottom to feed during “low” tide. You may have to take a few days to a couple of weeks to get the observations at the different tide times.

If the animals react to water, you should be able to change their behaviors quickly. In the bowl with some periwinkles, tilt the bowl and place about a cup of seawater in it. Slowly right the bowl until the winkles are covered with water. What do they do? Tilt the bowl again to uncover the winkles. Does their behavior change? If it does change, how long does it take for them to move? Be sure to check the tides if your previous experiment showed that they move up and down with the tides.

You can buy a frozen blue crab from the grocery store. Blue crabs (*Callinectes sapidus*) are major predators of periwinkles. During high tide, they can be seen shaking *Spartina* to dislodge periwinkles or pushing over the grass to remove the winkles. Remove a leg from the crab carcass and allow it to thaw in a small container of seawater. You are creating “essence of predator” that you can use in the following experiment.

Now that you have observed whether the periwinkles climb with you cover them with water, you can determine if their rate of climbing might be affected by the presence of a predator. The essence of predator that you have created can be used instead of a live predator. This suggests that the periwinkles smell their predators before they see them (Is this a reasonable guess? What do you think?) Add several drops of your crab essence to the test bowl and tilt it to cover the periwinkles with the water. Time them to see if they move faster with the essence in the water than they did with just the water in the previous experiment.

Do periwinkles have a preference for objects that they climb?
Perhaps periwinkles will climb particular objects if given an opportunity?

Background readings for *Littorina* experiments

Here are a few references that might be of use. Students in grades 9-12 should be able to read these papers and understand the information.

Chandrasekara and Frid, 1998. A laboratory assessment of the survival and vertical movement of two epibenthic gastropod species, *Hydrobia ulvae* (Pennant) and *Littorina littorea* (Linnaeus), after burial in sediment, *Journal of Experimental Marine Biology and Ecology* 221 (2): 191-207.

Duval, Calzetta, and Rittschof. 1994. Behavioral responses of *Littorina irrorata* (Say) to water-borne odors. *Journal of Chemical Ecology*, 20: 3321-3334.

Hamilton, 1982. Behavioral responses to visual stimuli by the snail, *Littorina irrorata*. *Animal Behaviour*, 30: 752-760.

Keppel and Scrosati, 2004. Chemically mediated avoidance of *Hemigrapsus nudus* (Crustacea) by *Littorina scutulata* (Gastropoda): effects of species coexistence and variable cues. *Animal Behaviour*, 68: 915-920.

Remy and Dill, 2000. Mortality, behavior and the effects of predators on the intertidal distribution of littorinid gastropods, *Journal of Experimental Marine Biology and Ecology* 253 (2): 165-191.

Yamada, Navarrete and Needham, 1998. Predation induced changes in behavior and growth rate in three populations of the intertidal snail, *Littorina sitkana* (Philippi). *Journal of Experimental Marine Biology and Ecology* 220:213-226.

Periwinkle Maintenance

Periwinkles can be maintained in the lab for several weeks with little special equipment. As with all animals, however, please return them to their native habitats as soon as possible.

Get a clear container and fill it with about 4 cm of beach sand or mixed beach and play sand. Add enough seawater to the container to cover the sand by a cm. Tilt the container so that some of the sand

is dry. Place algae covered rocks in the container. If you have a dock, you can suspend tiles or pieces of rock to collect algae so that you can have a fresh supply for the snails on a regular basis.

Periwinkles are grazers, ingesting plant material along with bacteria. Occasionally, they will also eat meat. To maintain the animals in the laboratory, it is necessary to supply rocks covered with algae. They will also eat small slivers of carrot and other vegetables. You can try a variety, but do not leave food in the container for more than a day.

You must have an area in the container that is only partially covered with water. If the container is completely filled, the snails will climb to the top and remain there. After you have the container set up, place the snails into the container at the edge of the water and near the rocks. Some will climb the sides of the container while others may climb on the rocks. Be sure to put a lid on the top of the container so that the snails do not climb out. Once every two to three days, spray the container with spring water to simulate rain. This helps to compensate for evaporation in the container. You can keep the container in an area that gets partial sun exposure, but do not keep in full sunlight. When the animals get too hot, they secrete a mucous plug and do not feed.

Fiddler Crab Maintenance

Fiddler crabs are relatively easy to keep in the classroom if you know what you are doing. You can use either a small aquarium or a clear plastic box (much cheaper than an aquarium; so that you can see some of the sand layers and possibly some burrowing activity). Do not overcrowd the container; you should have one or two males along with females. For example, if you use a 10 gallon aquarium, you can have 6-8 crabs. The sand or substrate is critical to keeping the crabs healthy in your captured environment. Pet stores will recommend using aquarium sand or play sand in the tank. This is not ideal. If you can obtain moist sand from a beach, it will have small plants and diatoms on the grains. These are important for crabs to get some of their natural foods. If you do use aquarium sand or play sand, you should obtain some moist sand from a beach to “seed” your substrate with natural food for the crabs. You can simply mix the moist beach sand with the other sand by pouring it on the surface and using a fork or other object to rake through the moist sand until the top few millimeters of the substrates are mixed. You will need at least 10 centimeters of sand to give the crabs enough depth to burrow.

Place your sand in the bottom of the container. Then add seawater so that it is about 2 cm above the surface of the sand. Natural seawater is best, but you can use artificial sea salt as well. Many pet stores will try to sell you chemicals to remove chlorine from tap water. If you place tap water into plastic milk jugs, shake the jugs, then leave the lids off for a few days, most of the chlorine will be removed. I suggest that you use spring water that can be purchased at many stores (DO NOT USE DISTILLED WATER) to mix your artificial seawater. After the water has been added to the container, tilt it so that approximately one third to one half of the sand is covered. This gives the crabs access to seawater and wets the substrate to support the **microflora** on the sand surfaces. But, it also provides a drier area for the crabs to burrow without drowning. In the dry part of the container, you will need to place a small dish of the spring water. Be sure that the dish is not too deep or if you choose a deeper dish, include a way for the crabs to climb out if they fall in (a rock is an easy object to use). You can also include some egg shell in the water. Crabs need calcium to molt properly. Adding clean egg shell to the water gives the crabs some additional calcium. The crabs do not need other

objects in the container, though pet stores will try to sell you plastic plants, “ship wrecks”, driftwood, and other materials for your container. Every two or three days, use a spray bottle to moisten the dry area. This keeps the substrate from drying too much, keeps up the humidity in the container, and replaces some of the water that evaporates from the container. If the crabs dry out too much, they cannot breathe properly and will weaken or die.

It is important to provide good food for the crabs to supplement the food that they can get from the sand. Crabs should be supplemented every two to three days; to keep your maintenance time to a minimum, it is best to feed them after you have sprayed the container with spring water. **DO NOT OVERFEED THEM.** FMR hermit crab food (can be purchased in many pet stores) and dry cat food (crushed into small bits) are good general foods. You can also use slivers of vegetables occasionally. Clean egg shell can also be provided occasionally. The crabs may crunch or scrape the shells as a part of their feeding and may be able to obtain calcium from the shells. You should remove excess food or egg shells before spraying with spring water to maintain a healthy environment with fresh food for the crabs.

If you are going to try to keep the crabs for an extended period (more than a month or two), you should do a complete sand and water change. Waste materials will begin to build up in the container and can cause the crabs to sicken or die. If you are keeping them for a shorter time, replace about half of the water every month. Be sure **NOT** to put the aquarium in full sunlight for long periods. Place them in an area where there is some sun exposure if possible.

To encourage the crabs to burrow along the sides of the container, you can cover the outside with a skirt of paper to darken it. Keep the paper on the aquarium unless observations are being made.

Students can watch the crabs to observe feeding and interaction behaviors. Be sure to have them look at tide tables to see if the crabs still can keep “sea time” in the classroom.

Background readings for fiddler crab maintenance and observations

Aicher, B., and J. Tautz. 1990. Vibrational communication in the fiddler crab, *Uca pugilator*. I. Signal transmission through the substratum. *Journal of Comparative Physiology* 166A(3):345-353.

Chiussi, R., and H. Díaz. 2002. Orientation of the fiddler crab, *Uca cumulanta*: Responses to chemical and visual cues. *Journal of Chemical Ecology* 28(9):1787-1796.

Denger, B. C., and R. A. Tankersley. 2005. Rhythmic activity of adult fiddler crabs *Uca pugilator* from areas with different tidal regimes. *Integrative and Comparative Biology* 45(6):1124.

Palmer, J. D. 1990. The rhythmic lives of crabs. *BioScience* 40(5):352-358.

Pratt, A. E., D. K. McLain, and G. R. Lathrop. 2003. The assessment game in sand fiddler crab contests for breeding burrows. *Animal Behaviour* 65:945-955.

Takeda, S; Poovachiranon, S; Murai, M. 2004. Adaptations for feeding on rock surfaces and sandy sediment by the fiddler crabs (Brachyura: Ocypodidae) *Uca tetragonon* (Herbst, 1790) and *Uca vocans* (Linnaeus, 1758). *Hydrobiologia* 528(1-3):87-97.

Yamaguchi, T; Henmi, Y. 2001. Studies on the differentiation of handedness in the fiddler crab, *Uca arcuata*. *Crustaceana* 74(8):735-747.

Yamaguchi, T; Henmi, Y; Ogata, R. 2005. Sexual differences of the feeding claws and mouthparts of the fiddler crab, *Uca arcuata* (De Haan, 1833) (Brachyura, Ocypodidae). *Crustaceana* 78:1233-1263.

Yamaguchi, T.; Henmi, Y; Tabata, S. 2005. Hood building and territory usage in the fiddler crab, *Uca lactea* (De Haan, 1835). *Crustaceana* 78:1117-1141.

Zeil, J; Hemmi, JM. 2006. The visual ecology of fiddler crabs. *Journal of Comparative Physiology, A* 192 (1): 1-25.

Maintenance of small horseshoe crabs

Horseshoe crabs are hard animals to keep if you have limited space. However, you can obtain small specimens to keep in a 20 gallon aquarium. If you are near a beach where the horseshoe crabs are mating, you can mark the area where a mating pair (the male clings to the female to fertilize her eggs as she digs a shallow nest on the beach) has come ashore. Come back to this area after several hours and you should be able to collect some fertilized eggs that you can take back to your classroom. Eggs can be placed into an aquarium or glass container that is gently aerated. Keep in mind that it will take 5-6 weeks for the eggs to hatch. Students can sample the eggs regularly to see the development of the larvae within the egg by using a microscope. Once hatched, the larvae should be transferred to an aquarium and fed brine shrimp larvae or rotifers. Generally, the larvae are hardy and can be viewed by the students readily with the naked eye. You should release those animals that you do not need for your observations.

For the aquarium, there should be at least 5 cm of substrate on the bottom as these animals will bury periodically, especially if the container is too cold or if it is time for them to molt. They are carnivores, feeding on worms and bivalves in the field. In the laboratory, they will accept cut fresh or frozen fish, shrimp or clam. Fresh oysters are readily consumed. They will also eat shrimp pellets, but do not generally do well on these pellets over a long period of time. If you are feeding them fresh foods, you must keep a watch on the nitrate level of the aquarium to make sure that it is not increasing rapidly.

It takes nearly 15 years for the animals to reach sexual maturity. After they reach this age, they typically no longer molt. Males are generally smaller than females.

Background Readings for horseshoe crab projects

Brockmann, HJ; Penn, D. 1992. Male mating tactics in the horseshoe crab, *Limulus polyphemus*. *Animal Behaviour* 44 (4): 653-665.

Chabot, CC; Kent, J; Watson, WH III. 2004. Circatidal and Circadian Rhythms of Locomotion in *Limulus polyphemus*. *Biological Bulletin, Marine Biological Laboratory, Woods Hole* 207 (1): 72-75.

James-Pirri, MJ; Tuxbury, K; Marino, S; Koch, S. 2005. Spawning Densities, Egg Densities, Size Structure, and Movement Patterns of Spawning Horseshoe Crabs, *Limulus polyphemus*, within Four Coastal Embayments on Cape Cod, Massachusetts. *Estuaries* 28 (2): 296-213.

Swan, B. 2005. Migrations of Adult Horseshoe Crabs, *Limulus polyphemus*, in the Middle Atlantic Bight: a 17-Year Tagging Study. *Estuaries* 28 (1): 28-40.

Maintenance of mangrove tree crabs

Mangrove tree crabs are easy to maintain, but difficult to catch. Raccoons feed on the crabs, so by observing how these animals catch them, we developed an easier method. Raccoons approach the crabs which then move to the opposite side of the root or trunk. By reaching immediately behind the root or trunk, often you can catch the crab. You will have to develop your own method.

Prior to capturing your organisms, you need to make preparations. If mangrove seedlings are being dropped, you can collect a few and plant them (<http://lamer.lsu.edu/projects/coastalroots/pdf/CR%20Lesson%20Need%20salt%20on%20that%20mangrove%202.pdf>). You can also purchase seedlings (<http://www.floridaplants.com/Mangroves/Default.htm>; <http://www.nova.edu/ocean/aqua/mangroves/>; http://www.mangrovesmania.com/mangrove_seedlings.html). Plants can be kept in pots of different sizes and can be watered with spring water or with dilute salt water.

Mangrove tree crabs are good climbers and jumpers, so they need to be maintained in an enclosure. If using an aquarium, make sure that there is a tightly fitting cover. Building a screen enclosure for your mangrove allows more room for the animals to move around and more area for you to observe them.

The crabs are primarily herbivores, but will occasionally eat meat. Slivers of carrots and apples supplement the nutrition that the crabs can derive from eating the mangrove leaves. A small piece of fish can also be added to give variety to the diet. There should be fresh spring water available in the enclosure. Do not overcrowd the enclosure. Generally, one crab per cubic foot of enclosure is a good rule to follow.

Background Readings for Mangrove tree crab projects

Beever, J; Simberloff, D.; King, LL. 1979. Herbivory and predation by the mangrove tree crab *Aratus pisonii*. *Oecologia* 43 (3): 317-328.

Chiussi, R. 2003. Orientation and Shape Discrimination in Juveniles and Adults of Mangrove Crab *Aratus pisonii* (H. Milne Edwards, 1837): Effect of Predator and Chemical Cues. *Marine and Freshwater Behaviour and Physiology* 36 (1): 41-50.

How to make sun prints

If you are going on a field trip, you can take paper with you to make sun prints or you can bring back objects for prints to the classroom.

You can make sun prints in many ways. If you have ever left construction paper out in a room you have probably discovered how dark colors will differ in shade depending on their exposure to light. You can use this same method to create your sun print. Using black or dark construction paper (dark greens, dark reds, browns, and dark golds are nice for contrasts in a collage), arrange objects on paper that you want outlined. If the sun is strong, it will take 45 minutes to an hour for the sun to create a distinctive difference in the paper. If the sun is weak (winter months or late in the day), it might take longer.

If you can get some blueprint paper, this also can be used for the sun prints. [*teacher note: Blueprint paper can be purchased in blue or sepia colors as rolls. This is the most economical way to purchase this type of paper. If you keep it in the dark in a mailing tube, a roll can last several years.*] Place the blueprint paper so that the white side is down and the blue side up. Arrange the objects that you want outlined on the paper. Leave only for about 10 minutes if the sun is strong. You can roll up your picture until you return to the classroom. For pictures developed on blueprint paper, you can place the paper into a cool water bath to stabilize colors. Then dry on newspaper out of direct sunlight. Do not expose the prints to strong sun even after they have been dipped in water. The exposures will fade. These prints can be framed attractively.

You can also buy sun-sensitive paper at many craft stores. This paper can be used in a similar way. Follow the directions on the package. Usually the pieces of paper are small, so you will have to be selective in the types of objects you want outlined or you will have to think about how you might want to create a collage of images. [*teacher note: Have the students experiment with leaving the materials exposed for different lengths of time. Ask them to relate to their own sun exposure.*]

How to make mud cloth from *Spartina* mud

Soils from the *Spartina* marsh areas are excellent for making mud cloth. When you are in the marsh, take a trowel and dig near the *Spartina* roots. You will likely smell hydrogen sulfide (smells like rotten eggs) from the activities of the soil microbes. The rich, dark soil is what you want to collect. You might also find some soil that has an orange color. This is likely iron oxide that is formed in the mud through actions of the microbes there. You should collect the mud several days before you are ready to use it on your cloth. Keep it moist and covered in the classroom until you are ready to make the cloth. To understand a little about how soils relate to making mud cloth, NASA has a good explanation of the overall process [<http://soils.gsfc.nasa.gov/bogolan/bogolan.htm>]. I have adapted the process to be easier for you to use in classes.

To create the initial background of light yellow to brown, you should have clean white cloth to begin. A freshly washed sheet can be cut into several sections for a class to use. A natural dye that makes a nice color is strongly brewed tea. Use only a couple of cups of water to 3-5 tea bags. Other types of dyes include heated instant coffee, boiled yellow onion skins, and boiled cumin. If you want a “warmer” color, you might combine thinly sliced or shredded carrots to instant coffee that is boiled.

You can experiment with different kinds of natural dyes to get the kind of background desired—think of all of those food that leave stains on your clothes and you will get the idea of what types of materials will be useful for dyes. Allow the dye water to cool to slightly above body temperature (feels warm to the touch). Then add your pieces of cloth to soak for a few minutes (light background) to half an hour (darker color). If you have more than one piece of cloth in your dye bath, be sure to stir the items so that the dying process is more uniform. After you are satisfied with the background color, gently wring out the pieces and hang them up to dry. When the cloth is dry, you can begin to sketch your designs on the material. You can use a pencil to draw the design lightly (you are going to cover the design fully with the mud dye, so do not be too concerned about perfectly straight lines or smooth curves. Mud cloth usually has a series of geometric designs (to get some ideas of what you might include, you can look at African Textiles online [*teacher note: this might be an interesting webquest for students to find out information about different textiles and the cultures from which they originate*]). You can make simple designs or they can be very complicated. To begin, you should keep it simple. When you are satisfied with the design, you can prepare your mud dye. Take some of the mud that you have collected from the marsh and add a little water until the mud forms a paste. Using a popsicle stick or a wooden cuticle stick, paint over your design with the mud. **BE CAREFUL NOT TO GET THE MUD ALL OVER YOU**, remember, you are using it as a dye. You might have to work on completing the design over a couple of days. When you have completely covered the design with mud paste and allowed it to dry, gently dip your cloth in fresh, clean water to remove excess mud. After removing the mud, dip your cloth again in the background dye. This will restrain the background. You are also using the acids in the background dye to help make the mud dye “fast” (so that it does not fade or wash out easily). Now, repeat covering the design with the mud paste, allow the cloth to dry, and rinse with clean water to remove excess mud. Now you are ready for the finishing touches on the cloth. If you want to have the background dye in the design, you are done. Most of the finer kinds of cloth will have the background color removed. You can use a bleach pen to color over the background areas. Be careful with the pens and be sure to use them as directed. When you have completed bleaching the background area, rinse the cloth again but this time in ice water or very cold water. This will help to keep the colors from fading. The cloth can be framed or used to make a variety of items. Be creative!

When you have become comfortable with this technique, try some variations on your own. What would you use if you wanted a blue cloth background, for example. You can also experiment with designs. For instance, you can pin leaves to cloth and outline them or shells. Use your imagination. Be sure to keep a log book of the different things you have tried so that you will be able to repeat your experiments if you like the outcomes.

Websites of interest

http://www.smithsonianeducation.org/educators/lesson_plans/ocean/main.html several activities related to ocean sciences; the projects are interdisciplinary and can be adapted for use at different grade levels. The projects using maps are especially well written.

<http://www.sciencebuddies.org/> this site offers a very good overview of how to do a science project, including information on keeping a lab notebook

<http://www.ocean.udel.edu/extreme2002/home.html> This is a virtual expedition to a hydrothermal vent area from a mission completed in 2002. There are some excellent pictures and great resources on marine geology. In the resources, there are several suggested activities.

<http://whale.wheelock.edu/Welcome.html> There are several different satellite tagging projects here where students can track different marine mammals. Background information is very good on how such organisms are tagged and tracked.

http://www.seasky.org/sea_games.html These are some interesting puzzles and games for kids. Some require Flash while others require JAVA. The puzzles are timed.

www.marine.usf.edu/beachbuddies This is a site created by the College of Marine Science at the University of South Florida through a grant from the Tampa Bay National Estuary Project. The title of the project is “Tampa Bay Beach Buddies” and the focus is on keeping beaches clean. There are several activities to heighten awareness of how humans contribute to ocean pollution.

http://animal-world.com/encyclo/information/aquarium_glossary.htm This is a nice glossary of words that you will find associated with many aquarium books, videos, and magazines.

A neat science gift

You can make your own bath salts very easily. You will need to get some Epsom salt. This is available at many places including the grocery store, drug store, and discount stores. Place salt into a plastic container (so if it falls in the bathroom, it will not break) all the way to the top. You can recycle some of your plastic bottles this way; for example, you can use single serving juice bottles for this gift. There will be spaces between the salt for your “scent” to permeate. Depending on what you like, you can use some of the following: cinnamon, vanilla extract (a small amount), orange extract (small amount), anise, sage, dried flower petals, or scented oils (peppermint is nice or for a Florida effect, add orange oil, for example). You get the idea; experiment with fragrances that you like. Be careful, though, not to use something that would be irritating or that would cause an allergic reaction. After you add the scent, shake your container gently (you do not want to fragment your salts too much). You can cover the lid with a decoration or leave as it is. If it is a gift for someone special, you can decorate the outside of the container and add your own comments on the outside. For instance, tell the person why you selected the scents that you did, add a few lines from a favorite poem or quote, or tell the person why they are special to you.