Millicoma Marsh:
An Opportunity for Scientific Inquiry

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Introduction

"No Child Left Inside". This is a catch-phrase popular now with science teachers across America, emphasizing a shift in science education towards utilizing the outdoors as an instructional 'classroom'. Many teachers find it difficult to give their students meaningful lessons outside of the school building, due to time or monetary constraints. This is especially true if buses are required to transport students to a field site. As teachers feel increasing pressure to teach different content standards and have students reach specific benchmarks, it can be difficult to schedule time for meaningful outdoor experiences that enable the students to engage in real scientific inquiries and investigations while fitting into a convenient time frame for the teacher. If there are no natural areas surrounding a school, the logistics behind scheduling field trips to provide these experiences can further discourage teachers from engaging in them.

The faculty at Millicoma Intermediate School enjoys the privilege of having freshwater and saltwater marshes right in "your own backyard". These marshes provide teachers with a great opportunity to incorporate outdoor education, real-life science, and inquiry, in a setting that naturally captures and retains student interest. In his book, *Last Child in the Woods,* Richard Louv described the trend of children spending less time outdoors as "nature deficit disorder". He said, "An increasing pace in the last three decades, approximately, of a rapid disengagement between children and direct experiences in nature… has profound implications, not only for the health of future generations but for the health of the earth itself."[1] Field inquiry projects in Millicoma Marsh provide students with a healthy and engaging activity that promotes scientific inquiry while it introduces students to nature, or reinforces their curiosity about the natural world. Additionally, these projects can be used to encourage students to be lifelong stewards of their natural communities.

Utilizing Millicoma Marsh for Scientific Inquiries

"I don't really know that much about the marsh. I could never do what scientists do in the marsh. What if my students ask me questions about the marsh that I don't know the answer to?" Teachers who are not familiar with the marsh may not realize how easy it is to find an inquiry project out there. Sometimes, there is a fear when teaching science that if a teacher doesn't know the answer to a question before he or she presents it to the class, then a desirable outcome might not be reached, and the entire process will be a waste of time. Actually, the opposite is true. Sometimes, the greatest scientific experiences can involve spectacular failures, when a fantastic experiment went horribly wrong. What if a student asks a question that you don't know the answer to? The response should be, "That is a GREAT question! How could we find out the answer?" This teaches students to think about how to find answers for themselves and establish procedures to answer their own questions.

When designing an inquiry project, the best procedure to follow is to take the students out to the marsh for an hour. Have a worksheet (such as the "Marsh Introduction" worksheet, included below) designed

[1] Last Child In The Woods Interview by Claus von Zastrow, Public School Insights

to get the students to observe different things in the marsh. On the way through the marsh, stop occasionally and point out interesting things. Share with them some questions that you might have about something that you are seeing. "What do you think that thing is? Why do you think that plant looks like that? What do you think that bug eats?" Bring a clipboard so that you can write down any questions that the students might have. If you have an idea already of what you would like to focus on for the project, then direct their attention to different aspects of that topic. Examples of questions that you could ask to encourage your students to think critically while out in the marsh include the following: "Why do you think that different plants are found up near the top of the levee? Do you think that they grow faster than the plants down in the marsh? How do you think the plants on the levee would react to saltwater? What do you think is living in the water? Why do you think that water looks so green?"

When you get back to the classroom, have students generate a list of questions that they had about the marsh. Write down the list of questions as they brainstorm them. Don't throw any out yet! After a lot of brainstorming, review with the students the concept of a 'testable' question. "Can we test if a certain food makes a beetle *happy*? Can we find out what would happen to a plant if it were winter all the time?" Then, have the students decide which questions are not testable. After they have weeded out those questions, then have the students decide which question they want to test. You can have them vote on it, or you can decide which one will be most feasible to do with the time available.

Once the question is selected, have the students write a hypothesis. They should always explain their reasoning behind their hypothesis. "*Why* do you think that freshwater plankton will be larger than saltwater plankton? Why do you think that the soil by the cattails will be wetter?"

After they write a hypothesis, they need to establish their procedure for finding evidence that might support their hypothesis. It is crucial that students have a hand in designing the experimental set-up, so that they know the reason behind the procedures that they are doing, and so that they can have more ownership of the project.

Once that has been done, it is time to go out in the marsh, conduct the experiments, collect data, and present it, using graphs, tables, etc., following the Science Content Standards 5.3S.1-5.3S.3 for 5th grade Science, and Standards 6.3.S.1-6.3.S.3 for 6th grade Science.

Conducting an inquiry experiment in this way takes a lot of pressure off of the teacher to come up with an inquiry project idea. The students never fail in finding at least one question that the class can test for their inquiry project. However, here is a list of ideas that might get the creative juices flowing:

There are a lot of interesting little creatures that live in soil. Many inquiry activities could be done using creatures that live in soil. How many different kinds of creatures live in the soil? How big are they? Do the same creatures live in freshwater and saltmarsh soil? What happens to the creatures if the soil gets too wet or too dry?

Are there different insects in different areas of the marsh? Will you find more ground-dwelling insect species in the freshwater marsh than in the saltwater marsh? Will you find more ground-dwelling insect species in dry areas of the marsh than in wet areas of the marsh? During what time of year will you find more ground-dwelling / flying insects? (Use pitfall traps or flypaper) What are insects attracted to?

There are different zones of life in the marsh. In the salt water marsh, there are some plants that live in the tidal channels, and different plants that live far from the tidal channels. There is a corner of the salt marsh that actually contains freshwater plants (Mrs. Farr can point this out to you if you have questions). An interesting scientific inquiry might be to discover why different plants or animals are found in one area of the marsh, but not another area. Have the students come up with ideas as to why cattails are found in the freshwater side of the marsh, but not the saltwater side, for example. Students might be able to predict the moisture content of soil based on whether or not cattails are present. Have the students find out if there are some things that live in the soil near the tidal channels, but do not live in the soil near the levees.

Will you find the same kind of plankton in the freshwater pond as you find in the freshwater ditch next to the school? Are freshwater plankton larger than saltwater plankton? Can saltwater plankton survive in freshwater? If so, for how long are they able to survive in the freshwater? How long can they stay in the freshwater before being put back into saltwater and still survive (which might be what happens when the tide goes out and there is a lot of rainwater)?

The questions listed above are only samples of questions that could be used for inquiry projects. For students to truly take ownership over their inquiry project (and therefore ownership of their own learning), it is important that they test questions that they are interested in. Even if they don't get any results because the plants all died over Christmas break or because you can't look at some of the pitfall traps because there are dead mice inside, the procedure of asking a question and figuring out how to test it or answer it will be valuable to the students.

Procedures

The following are procedures teachers may find useful when designing inquiry experiments with students:

Water Quality

Thermometers can be used to measure temperature

Refractometers can measure salinity very accurately. They can, however, be expensive. Hydrometers can also be used to measure salinity. They may not be as accurate, but they are much more affordable.

pH strips are used to measure pH, and can be purchased for a very reasonable price from supply companies.

Fecal coliform bacteria test kits are used to test for the presence of fecal bacteria (a potential indicator of sewage contamination). These can be purchased from supply companies.

Other water quality test kits can be purchased from supply companies that measure the nitrates, nitrites and phosphates (all of which are possible plant fertilizers), dissolved oxygen, iron, or copper in water.

Turbidity tubes can be used to measure how much sediment is in the water (how clear the water is)

Insect Pitfall traps

Buy some plastic cups. Dig a cup-sized hole in the soil. Fill the cup about ¼ full of water, and place the cup in the hole, so that its rim is barely flush with the edge of the hole (so insects crawling along the ground will fall into the hole). To ensure it is not disturbed, place 3 or 4 small rocks around the cup, and cover it with a small piece of wood so that it is covered and can't be seen, but insects will still be able to crawl in to it. Leave it for a few days, and then go out and collect the cups. Pour the contents of each cup into a separate container, and have the students use popsicle sticks to sort through the insects and count the number of insects that they caught, and the number of different species that they caught.

You can test what things the insects are attracted to by changing what is put into the cups, to see if a substance attracts more insects than others. For example, beer might attract snails. Sugar water might attract ants.

Flying Insect Collector

Another way to look at the abundance and diversity of insect life in the marshes is to use flypaper. This will collect flying insects, rather than ground-dwelling insects. Take a piece of fly paper and attach one side to a very thick index card or to a small piece of cardboard (so that it is stiff). Remove the protective paper on the other side of the fly paper so that it is sticky. Attach the insect collector to a tree or cattail, or place it in a bush. Let it sit overnight. Collect it the next day, and have the students observe the number of different insects that they collected, and the number of different species that they collected.

Transects

This is a procedure that many ecologists use in many different types of environments. Scientists perform transects using submarines, or along rocky shorelines, in deserts, forests, and on mountains. It is a very useful tool for determining which species can be found in an area, or the abundance of a species in an area.

To establish a transect, you need a very long measuring tape. Stretch the measuring tape out along a straight line that crosses the area that you are studying. Lay it across the area in such a way that the plants that it is laying on are typical to the site. (i.e. if you are laying a transect in the salt marsh to see what kinds of salt marsh plants there are, lay the measuring tape across the marsh, and not along the levee. The levee has different plants growing on it than you will find in the marsh.) This is called the transect line.

Then, place a square made out of PVC pipe (or a hula-hoop) every meter along the transect line. The PVC square or hula hoop is called a quadrat. If it is a small transect line, you may want to lay one quadrat down every two feet, but on alternating sides of the line, so that the students don't crowd each other. Students will then count the different numbers of plants that they see in their quadrat. Or, they may want to identify each of the plants that they find in their quadrat. Or, they may want to estimate how much of each quadrat is covered by the different types of plants. For example, they might say 50% of the quadrat is covered with sedges, 25% is covered with pickleweed, and 25% is bare ground.

Soil

It is very simple to measure the amount of water in soil. First, collect a soil sample and place on aluminum foil. Weigh the foil and soil packet. Then, bake the soil sample in an oven at about 450 degrees for 3-4 hours. Weigh the packet again. The water was baked out of the soil in the oven, so the DIFFERENCE in weight is equal to the weight of the water that was originally in the sample. To calculate the percent of water that was in the sample, take the soil sample off the aluminum foil, and weigh the aluminum foil. Subtract that from the weight of the foil and soil packet to give you the weight of the soil.

For example: You collect a soil sample, place it on aluminum foil, and find that the combined mass is 110 grams. You then bake it, and weigh it again, and find the mass of the dry soil and foil to be 80 grams. You remove the aluminum foil and find that the mass of the foil is 10 grams. Therefore:

110 - 80 = **30** grams of water in the soil sample

80 – 10 = **70** grams of soil in the soil sample.

Therefore, the sample was 30% water, 70% soil.

Additional Marsh Lesson Ideas

While Millicoma Marsh is an excellent site to use for inquiry activities, other lessons could also be adapted for use in the marsh. The Oregon State Board notes that "it is essential that [the Science Content Standards] be addressed in contexts that promote scientific inquiry, use of evidence, critical thinking, making connections, and communication. The following activities utilize evidence, encourage critical thinking, or can be used as projects to make connections to other subject areas, or to issues that are relevant outside the classroom.

One of the Oregon State Board of Education's Science Content Standards for 6th grade is "Compare and contrast the types and components of cells. Describe the functions and relative complexity of cells, tissues, organs, and organ systems. (Standard 6.1L.1)" While it is relatively standard for classes to look at cells using onion and cheek cells, it would be a more engaging activity to go to the marsh to collect plankton, and compare and contrast components of cells in different types of plankton. Observing swimming plankton cells through a microscope can help students to more fully appreciate the relative complexity of cells. Students could also observe cells from salt plants and freshwater plants, to compare the similarities and differences between them.

Another Science Content Standard for 6^{th} grade is "Explain the water cycle and the relationship to landforms and weather. (Standard 6.2E.1)" Students can observe water cycle processes in the marsh, and can design experiments and collect data pertaining to the water cycle in the marsh. A very simple activity could be done by measuring the depth of the water in the freshwater pond each day, and measuring the amount of rainfall each day, to see if there is a correlation between rainfall and pond depth.

The following are additional activities that could be conducted in the marsh.

1. How does the saltwater marsh change with the tide? Students can go out and observe the salt marsh at high tide on one day, half-way between low tide and high tide on another day, and at low tide on a third day. Students can observe changes in the marsh, including changes in the depth of the water in the tidal channels, and changes in the appearance of plants, and in the abundance of animals in the marsh. Do animals in or on the plants and soil bordering the tidal channels move when the tide comes in or goes out? Have students form hypotheses about how a plant can survive being partially submerged once or twice a day in salt water. What adaptations might their cells have to help them to survive?
   (Lesson can be designed to fit Standard 5.2L.1: Explain the interdependence of plants, animals, and environment, and how adaptation influences survival, or to fit Standard 6.1L.1: Compare and contrast the types and components of cells. Describe the functions and relative complexity of cells, [and] tissues…)
2. Research plants and animals that can be found in the marsh, and connect them in a food web in the classroom. Then, take a field trip out to the marsh to see if any associations discussed in the classroom are observed, such as ducks feeding in the pond, or insects trapped in spider webs. (Lesson can be designed to fit Standard 5.2L.1: Explain the interdependence of plants, animals, and environment, and how adaptation influences survival, or to fit Standard 6.2L.2: Explain how individual organisms and populations in an ecosystem interact and how changes in populations are related to resources.)
3. How do you change salt water to fresh water? When salt water is boiled, or when saltwater is left in the open, the water evaporates, and the salt is left behind. The water that evaporates is freshwater. Take students to the levee between the salt marsh and the freshwater marsh, and have them reflect on the processes that formed the freshwater pond, and the processes that are occurring in the saltwater marsh. Have the students form hypotheses about how evaporation might affect plants, animals, or plankton in the salt marsh. What happens to the salinity of seawater as the water evaporates? How might this affect plants or animals in the marsh? (Lesson can be designed to fit Standard 6.2E.1: Explain the water cycle and the relationship to landforms and weather.)
4. Learn to properly label and preserve specimens. Take students out to the marsh to collect small plant specimens, or to collect insects. In the classroom, they can press the plants, or make their own insect collection. Plants can be pressed by placing a plant between two sheets of newspaper (or blotting paper inside folded newspaper), and placing the newspaper between two pieces of corrugated cardboard (increases air circulation to aid drying). Stack pieces of cardboard (with plant specimens between them) in an area with high amounts of air circulation (next to a fan or vent would be preferable). Place something heavy, such as a stack of textbooks, on top of the stack of cardboard to press the plants.

For an insect collection, first prepare a Marsh Insect Display Box. Take a shoe box or similarly-sized box, and glue a thick piece of cardboard to the inside bottom of it. When the insects are caught, place them into jars. Place the jars in a freezer (depending on the insect, it may need to be in the freezer for at least a week). Or, add to the jar a cotton ball which has been lightly soaked in nail polish remover (acetone). This will kill the insect. Then, put a small label on a pin, stick the pin through the insect, and pin it to the bottom of the Marsh Insect Display Box.

5. Identify different pollutants that might be present in the marsh. Pollutants might include things that are readily visible, such as trash in the marshes, or soap in the water (in the stream near the sewage lagoon). Or, they might include pollutants that your students have to discover using scientific testing kits (which can be bought from companies like Carolina Biological Supply). These test kits can include nitrates, heavy metals such as copper or iron, or fecal coliform bacteria, which are an indicator for bacteria from animal (e.g. human) feces in the water. After students have identified the presence of any pollutants, they can create and present anti-pollution posters, drawings, or essays to the class.
6. Study the life histories of animals, such as insects or tadpoles, in the marsh. Insects such as dragonflies, moths, butterflies, and frogs have a life history that is more complex than ours. They are also very interesting to observe. Throughout the course of a year, students can observe different life history stages (i.e. tadpole and adult) of different animals within the marsh.

Equipment

Most of the equipment can be ordered from supply companies. The scientific supply companies most commonly used by high school teachers are:
Carolina Biological Supply: www. carolina.com
Forestry Suppliers, Inc.: www.forestry-suppliers.com
Sargent-Welch: saargentwelch.com
Flinn Scientific: www. flinnsci.com

Coos Bay School District has 15 to 20 GPS units, and 11 digital cameras available for teachers to check out to use in the classroom. Reservations for this equipment are made on a first-come, first-served basis. To reserve equipment, contact Peggy Ahlgrim in the Coos Bay Public Schools Curriculum Office (Phone: 541-267-1318; e-mail: peggya@coos-bay.k12.or.us)

The University of Oregon's Institute of Marine Biology also has equipment available through the National Science Foundation's GK-12 program for use by teachers in the area. For more information, please contact Trish Mace (e-mail:tmace@uoregon.edu).

Field Guides

Some teachers may be hesitant about using the marsh because they are not familiar with the plants or animals that may be found in the marsh. Any careful observer who sloshes through the salt marsh, or travels along the levees through the freshwater marsh cannot help but be impressed by the diversity of life in these two areas. Regardless of a teacher's familiarity with the wildlife in the area, it is a good idea to have some field guides handy when heading out to the marsh. The Coos County Library System has many field guides available for check out. Any of these books may be placed on hold.

Alden, P. 1998. National Audubon Society field guide to the Pacific Northwest Knopf Publishing Group: New York

Plants

Brown, Lauren. 1979. Grasses, an identification guide Houghton Mifflin: Boston, Mass

Kershner, Bruce, Gil Nelson, Daniel Mathews, Richard Spellenberg, Terry Purinton. 2008. National Wildlife Federation field guide to trees of North America Sterling Publishing Company: New York

Little, Elbert L. 2000. National Audubon Society field guide to North American trees Knopf Publishing Group, Random House Publishing: New York

Petrides, George A. 1998. A field guide to western trees : Western United States and Canada Houghton Mifflin: Boston, Mass

Starker, T.J. 1941. Identification of northwestern trees: manual identification of northwestern trees OSC Cooperative Association: Corvallis, OR

Symonds, George W.D. 1958. The tree identification book: a new method for the practical identification and recognition of trees M. Barrows: New York

Symonds, George W.D. 1963. The shrub identification book : the visual method for the practical identification of shrubs, including woody vines and ground covers William Morrow: New York

Wilson, B. et al. 2008. Field guide to the Sedges of the Pacific Northwest Oregon State University Press: Corvallis, OR

Animals

Alderfer, Jonathan. 2006. National Geographic Field Guide to Birds: Washington and Oregon National Geographic Society: Washington, D.C.

Brinkley, Edward S. 2007. National Wildlife Federation field guide to birds of North America Sterling Publishing, New York

Corkran, Charlotte C. 1996. Amphibians of Oregon, Washington and British Columbia : a field identification guide Lone Pine Publishing, Vancouver, B.C.

Elliott, Lang. 2009. The frogs and toads of North America : a comprehensive guide to their identification, behavior, and calls Houghton Mifflin, Boston

Evans, Arthur B. 2007. National Wildlife Federation field guide to insects and spiders of North America Sterling Publishing, New York

Floyd, Ted. 2008. Smithsonian field guide to the birds of North America HarperCollins Publishers, New York

Grassy, John. 1998. National Audubon Society first field guide: Mammals Scholastic Publishing, New York

Peterson, Roger T. 2008. Peterson field guide to the birds of North America Houghton Mifflin: Boston

Sibley, David. 2003. The Sibley field guide to birds of western North America Knopf Publishing Company, New York

Smith, Hobart M. 2001. Reptiles of North America : a guide to field identification St. Martin's Press, New York

Weidensaul, Scott. 1998. National Audubon Society first field guide : Birds Scholastic Publishing, New York

Wilsdon, Christina. 1998. National Audubon Society first field guide: Insects Scholastic Publishing, New York

Activity: A Field Guide to Millicoma Marsh

An excellent and memorable field trip could involve teacher and students learning about the different wildlife in the marsh together. In this activity, students build their own field guides for plants and animals seen in the marsh. As an extension, they could have a separate field guide for the freshwater marsh and saltwater marsh.

Activity:

1. Bring in several copies of different field guides for the students to look through. They could be field guides to fish, insects, trees, wildflowers, etc. The students can use these books as references. Point out that field guides include pictures, and observations about size, behavior (for animals), etc.
2. Armed with clipboards, paper, pencils, meter sticks, crayons (if appropriate), and published field guides, head out to the marsh. Have students identify 4 different organisms (3 plants and one animal, or two plants and two animals) to observe for the field guide. On a single sheet of paper (on one side), students draw the plant or animal, measure it when applicable, and write observations about it.
3. Compile appropriate pages into a book to make a Millicoma Marsh Field Guide comprised of pages made by class members.

Activity: Bird Songs

The Stokes Field Guide CD is a fun and very unique tool to use in the classroom. Each week, select a different local bird call for the students to learn. As the students come in to the room in the morning, have the bird call playing for a couple of minutes before class starts. The sound clip says the name of the bird before the clip is played, so there is minimal teacher input required. Then, every so often, quiz the students on the bird songs that they have learned. As a final cumulative activity, when approximately thirty bird songs have been learned, have the students take a bird walk around the marsh and listen to how many different bird calls they are able to recognize. Scientists do something similar to this to help them estimate the diversity of birds in mountain forests. Scientists sit very quietly for several minutes in the forest, and keep track of what kinds of birds they hear, and try to estimate how many different members of the same species they hear.

Available from the Coos County Public Library System:

Audio CD: Colver, Kevin J. 1999. Stokes Field Guide to Birds Time Warner AudioBooks: New York, NY

Book: Stokes, Donald W. 1996. Stokes Field Guide to Birds Little, Brown: Boston, MA

Millicoma Marsh Management Plan

Courtesy of Jamie Fereday

The Millicoma Marsh Management Plan was developed by the Millicoma Marsh Board. It contains further ideas of ways to utilize the Marsh and two lesson plans. It also includes some historical information about the Marsh that teachers may find useful when they take their students out to do their investigations. If you are interested in seeing the Marsh Management Plan, contact Trish Mace, tmace@uoregon.edu

Jamie Fereday, now at Sunset Middle School, and his classes initially established the monitoring protocols at the site. Monitoring protocols are established procedures used when quantifying aspects of the marsh, or collecting data about different marsh characteristics. A protocol enables different teachers to follow the same procedure, which enables them to more accurately compare their results. Mr. Fereday has the data from the years that he and his classes monitored the sites; teachers who are interested in conducting the same protocols can use the data as references.