WHEN THE HABITAT GETS SALTY

Effects of Salt Water Intrusion on Bald Cypress Seedlings

Rationale and Objective

The overall goal of the *Coastal Roots* Seedling Nursery Program is to assist students in developing an attitude of stewardship toward our natural resources and to provide a constructive, active learning situation in which they can explore strategies for sustaining our coastal ecosystems.

The National Science Education Standards indicate that learning through inquiry is the best way to produce science- literate students capable of solving complex problems.

The objective of this module is to provide students with the reference skills and hands-on, minds-on situations useful in constructing inquiry investigations related to salinity as a limiting-factor related to successful germination and development of Louisiana's state tree, the bald cypress.

Teacher Background

The bald cypress, Louisiana's state tree, is disappearing from our wetlands at an alarming rate. Without the tree root systems to hold the soil in place and the shade necessary for many under-story organisms, the habitats, the associated food sources, the cypress swamps themselves are disappearing. The destruction of saplings by voracious nutria has contributed to wetland loss. Oil drilling-related canals, old logging channels, levees and low rainfall increase the intrusion of saltwater into the wetlands resulting in destruction of these salt-intolerant trees. (And from early 1998 continuing through spring 2001, south Louisiana experienced extreme below average rainfall.) Additionally, bald cypress seeds do not germinate underwater, therefore, prolonged or deep flooding make germination unlikely.

COASTAL ROOTS Student Designed Projects: Using the 4-Question Strategy and Experimental Design Diagrams should be completed prior to this module.

In this module students will design an inquiry investigation focusing on the effects of salinity on bald cypress seedlings. This module will challenge students to use reference skills and higher order thinking skills related to a relevant and interesting topic. As time and materials, including cypress seeds/ seedlings may be limited; completion of the designed investigation is optional. The activities included in this module could also be used as a template for research reports or inquiry investigations into the effect of salinity, flooding, or temperature on other tree species, including the black mangrove and wax myrtle.

As with most COASTAL ROOTS modules, the amount of time required to complete the activities will vary with the class. The "note cards" may need to be assigned as homework if Internet access is not available in the classroom.

If students carry out their investigations, time for watering and data collection should be given each day in class for at least 2 months. Weekend and/or holiday care should be given consideration.

Louisiana Science Benchmarks

LOUISIANA BENCHMARKS:

SI-H-A1, A2, A3, A4, A5, A6, A7
PS-H-A1 LS-H-F3 SE-H-A3

SI-M-A1, A2, A3, A4, A5, A6, A7, A8
LS-M-C4 SE-M-A2

Materials: For Investigation (may vary)

PER GROUP
Minimum of 30 bald cypress seedlings (in pots or Single Cell Cone-tainers)
Planting media
Saltwater solutions of specified salinities (1- 10 ppt)
"Fresh water" (0 ppt salt)
Flood pool and/or other watering devices
Refractometer
COASTAL ROOTS Nursery Journals
Labels

Procedure: Reference Skill Activity

Researching the resources is a necessary part of investigating. In this activity, students review (or are introduced to) a means of collecting and organizing relevant information pertaining to the test subject (in this situation, bald cypress seedlings).

1. Distribute Student Worksheet #1-Reference Skills. (Copies of the reference skills" note cards" are included in the attached teacher reference materials.)
2. Read and discuss the introduction and instructions with the students.
3. Guide students through the first three cards that have been completed for them.
4. Working individually or in small groups, have the students complete cards 4 and 5. (Completion of cards 4 and 5 may need to be assigned as homework if Internet access is not available in the classroom.)
5. Review the cards to assess student ability to locate appropriate resources and to identify and record relevant information.
6. Assign students to complete additional research cards (on index cards or in their notebooks) as you deem necessary/appropriate.

Procedure: Four-Question Strategy Activity

1. Distribute copies of Student Worksheet #2-Four Question Strategy. (A teacher reference version of Student Worksheet #2 is included in the attached teacher reference materials.)
2. Review the Four Question strategy with the students.
   (Procedures for completing the Four Question Strategy are included in the ROOTING INTO INQUIRY module.)
3. Instruct the students (working in their cooperative learning groups), to complete the Four Question Strategy worksheet in selecting their inquiry topic.
4. Discuss choices with each group.

NOTE: While student-designed inquiry is desirable in working with the seeds and seedlings, a primary objective of the COASTAL ROOTS Program is to produce wetland plants that can be used in hands-on restoration projects. Environmental parameters must, therefore, be established to avoid loss of large numbers of plants. (For example, salinity is a known limiting factor of cypress; students should not expose these plants to salinity levels above 10 ppt.)
If appropriate levels of the experimental variable are in doubt, contact:
Dr. Blanchard (PamB@lsu.edu) or Dr. Bush (ebush@agctr.lsu.edu) or , if available, consult a copy of the United States Department of Agriculture, US Forest Service Bulletin, *Seeds of Woody Plants of the U.S.*

Procedure: Experimental Design Activity

1. Distribute Student Worksheet #3-Experimental Design.
2. Review Experimental Design techniques/vocabulary with the students. (Experimental Design Diagrams and the science processes vocabulary are included in the ROOTING INTO INQUIRY module.)
3. Have cooperative lab groups complete their experimental design diagram.
4. Monitor student progress and assess their understanding and abilities as they develop their plan, prepare the materials list and write procedures.
   NOTE-You may need to provide students with a list of available materials. Otherwise, students may select materials that are too costly, dangerous, or inappropriate for your classroom or greenhouse situation.
5. Collect/obtain the necessary materials.
6. Review safety procedures and tools with students prior to allowing them to begin the lab investigation.
7. Review data collection and organization with the students.
8. Monitor student work and provide feedback.
9. Take photos of the kids at work on their projects.
10. Forward copies of student lab reports and the photos to Dr. Blanchard.

Procedure: Germinating Mangrove Seeds

In this module students will design an inquiry investigation focusing on the effects of salinity on bald cypress seedlings. This module will challenge students to use reference skills and higher order thinking skills related to a relevant and interesting topic. As time and materials, including cypress seeds/seedlings may be limited; completion of the designed investigation is optional. The activities included in this module could also be used as a template for research reports or inquiry investigations into the effect of salinity, flooding, or temperature on other tree species, including the black mangrove and wax myrtle.

As with most COASTAL ROOTS modules, the amount of time required to complete the activities will vary with the class. The "note cards" may need to be assigned as homework if Internet access is not available in the classroom. If students carry out their investigations, time for watering and data collection should be given each day in class for at least 2 months. Weekend and/or holiday care should be given consideration.
Student worksheets are included in the module. If students do not complete the investigation, no other materials are necessary.
Materials required in completion of the investigation will vary but will include (See Materials Page 2)
1.Review germination stages of black mangrove seeds.
Once placed in water, the black mangrove seed will float and the seed coat will loosen and fall off. Once the seed coat is shed, the cotyledons swell and open and the primary root will emerge from the seed's widest end. The speed at which this occurs depends upon water temperature and salinity. In low salinity and high salinity, the seed coat falls off slowly.

Procedure: Hardening of Mangrove Seedlings

As the time to plant the seedlings in a restoration area draws near, black mangroves should be "hardened". This means they should be exposed to conditions like those in which they will be growing; in other words, they should be grown in a brackish or saltwater solution. But how salty should the water in which they "harden" best? Again, an opportunity for student-designed inquiry!

1. Distribute a copy of the COASTAL ROOTS EXPERIMENTAL DESIGN DIAGRAM to each student. Working as a class or in small cooperative lab groups, have students design an experiment

REFERENCE SKILLS

In the first activity, the students are asked to imagine that, for the school Science Fair, they are researching the effects of salinity on bald cypress seedlings. Research "note cards" are provided for three resource references, expected to summarize relevant information from two specified resources, and assigned to locate and collect notes from an additional resource of choice.
Copies of the "note cards" are included below.

Note card 1: Salt Tolerance of Southern Baldcypress www.nwrc.usgs.gov/climate/fs92_97.pdf

Salinity tolerance studies at the National Research Center (Lafayette, LA) investigated the possibility of developing salt-water tolerant bald cypress strains. Researchers collected and germinated bald cypress from brackish to freshwater areas in coastal Louisiana, Mississippi, and Alabama. The salinities of these areas ranged from 0.1 to 7.5 ppt.) They watered groups of seedlings at salinity levels of 0 ppt, 2 ppt, 4 ppt, 6 ppt, and 8 ppt. Measurements of seedling survival rates, height, diameter, and physiology (body function) were monitored.

Note card 2: Interaction of Flooding and Salinity Stress on Baldcypress (*Taxodium distichum)*
James A. Allen, S. Rezba, and James L. Chambers
http://heronpublishing.com/treefiles/domain/data/vol16/16-01-37.pdf

For cypress seedlings grown in pots and watered with a 10 ppt salt solution for 3 months, survival rate was 100%. However, their mean height was 83% of that of controls watered with fresh water.
Other cypress seedlings which were held in nursery flood pools in which the salinity was held constant at 10 ppt, all died within 2 weeks.

Note card 3: Gulf Coastal Prairies and Marshes
Louisiana Nature Conservancy www.louisianananature.org/preserve/gulfcoast2.htm

Average salinity for marshes in Louisiana is:
16 ppt for salt marshes
8 ppt for brackish marshes
3-4 ppt for intermediate marshes
0.5-1 ppt for fresh marshes and rarely exceed 2 ppt

Note card 4: Salt is Good on Sunflower Seeds, But What About Cypress?
Lessons on the Lake, chapter 6/ activity 3 Lake Pontchartrain Basin Foundation
www.saveourlake.org/lessons/chpt6/act3.htm (also available as hard copy lab manual)

Student notes will vary but should include information on the effect of salt on seeds. This lesson also includes a simple experiment that may serve as a model for students' investigation plans.

Note card 5: Choices will vary.

Four-Question Strategy

This may be a good time to review your notes the Four Question Strategy for Problem Solving and Experimental Design Diagrams.

COASTAL ROOTS STUDENT-DESIGNED EXPERIMENT
Answers listed are possible answers, but not the only possible answers.

Test subject: bald cypress seedlings

1. What materials are readily available for conducting experiments on your test subjects?
Seeds or seedlings
Salt solutions
Water
Refractometer

2. How will the test subject respond?

It will grow taller.
It will turn yellow.
It will die.

3. How can you change the set of materials to affect the response of your subject?

I can vary the salinity of the water the trees stand in.
I can vary the salinity of the water used to water the plants.
Plants can be exposed to the same salinity but for differing lengths of time.
Some trees could be watered with water of a particular salinity and the others would stand in water of the same salinity.
The depth of the salt solution could be different in each flood pool.

4. How can you measure or describe the response to the change?

Count the number of seedlings that survive
Measure the length of time seedlings survive
Measure height of seedlings
Determine relative health of seedlings (based on turgidity, color, presence of salt "burns")

EXPERIMENTAL DESIGN
The Experimental Design Diagrams will reflect the individual choices of the students and their skills.

CARRYING OUT THE INVESTIGATION

COASTAL ROOTS Nursery Journals should be incorporated in the data collection process should students carry out their projects.
Review of construction and use of tables and graphs would be useful. Drawing and communication of conclusions should also be introduced or reinforced during this aspect of the investigation.

When the Habitat Gets Salty: Effects of Saltwater Intrusion on Bald Cypress Seedlings

Student Name: _____

The bald cypress, Louisiana's state tree, is disappearing from our wetlands at an alarming rate. Without the tree root systems to hold the soil in place and the shade necessary for many under-story organisms, the habitats, the associated food sources, the cypress swamps themselves are disappearing.
The destruction of saplings by voracious nutria has contributed to wetland loss. Oil drilling-related canals, old logging channels, levees and drought conditions increase the intrusion of saltwater into the wetlands. This saltwater intrusion results in destruction of these salt-intolerant trees. Additionally, bald cypress seeds do not germinate underwater, therefore, prolonged or deep flooding make germination unlikely.

WHEN THE HABITAT GETS SALTY ACTIVITY

Imagine that for the school Science Fair, your group has chosen to study the effect of salt water on baldcypress seedlings. Your first step is to research what is already known. Your partner has started researching Internet resources and shares her notes with you. As your teacher expects your group to submit notes from at least 5 references, your partner supplies you with the web addresses of one site to research but she expects you to locate and review at least one additional resource on your own.

Read her notes and complete your "note cards".

Note card 1: Salt Tolerance of Southern Baldcypress www.nwrc.usgs.gov/climate/fs92_97.pdf

Salinity tolerance studies at the National Research Center (Lafayette, LA) investigated the possibility of developing salt-water tolerant bald cypress strains. Researchers collected and germinated bald cypress from brackish to freshwater areas in coastal Louisiana, Mississippi, and Alabama. The salinities of these areas ranged from 0.1 to 7.5 ppt.) They watered groups of seedlings at salinity levels of 0 ppt, 2 ppt, 4 ppt, 6 ppt, and 8 ppt. Measurements of seedling survival rates, height, diameter, and physiology (body function) were monitored.

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3-4 ppt for intermediate marshes
0.5-1 ppt for fresh marshes and rarely exceed 2 ppt

When the Habitat Gets Salty: Effects of Saltwater Intrusion on Bald Cypress Seedlings

Student Name: _____

Record concise, relevant notes.

Note card 4: Salt is Good on Sunflower Seeds, But What About Cypress?
Lessons on the Lake, chapter 6/ activity 3 Lake Pontchartrain Basin Foundation
www.saveourlake.org/lessons/chpt6/act3.htm (also available as hard-copy lab manual)

Note card 5:

When the Habitat Gets Salty: Effects of Saltwater Intrusion on Bald Cypress Seedlings

Student Name: _____

Four Question Strategy

Armed with all that knowledge, you are ready to complete the Four Question Strategy to focus your choice for the effect of salinity on cypress seedling investigation. This may be a good time to review your notes and worksheets from the COASTAL ROOTS Student Designed Experiments: Using the 4-Question Strategy and Experimental Design Diagram activities.

Once you've completed the 4-Question Strategy exercise, review your choice with your teacher before moving on to the Experimental Design Diagram.

COASTAL ROOTS STUDENT-DESIGNED EXPERIMENT

Test subject: ***bald cypress seedlings***

1. What materials are readily available for conducting experiments on your test subjects?

2. How will the test subject respond?

3. How can you change the set of materials to affect the response of your subject?

4. How can you measure or describe the response to the change?

ROOTING INTO INQUIRY: Experimental Design Diagram

Student Name: _____

Title (Inquiry Problem Question):

Purpose: On a page you attach to this sheet, describe in one or more paragraphs, the real-world reason for selecting this particular project. Explain how this project will help other Coastal Roots nurseries do a better job raising their seedlings. Include background information.

Hypothesis:

If…..

then,

Independent Variable:						
Levels of the <u>Independent</u> Variable Units of measure						
Number of Repeated Trials x sample size:						
___ x ___	___ x ___	___ x ___	___ x ___	___ x ___	___ x ___	___ x ___

<u>Dependent</u> Variable:

Constants:

Control Group:

When the Habitat Gets Salty: Student Name: _____
Effects of Saltwater Intrusion on Bald Cypress Seedlings

Now, move on to the final planning stage. (Add additional pages if necessary.)

1. **Make a list of the materials you'll need. Be as specific as possible.**

2. **Explain how you will carry out your experiment.**
   Record your procedures as full-sentence, numbered, consecutive steps.

3. **Have your teacher review your plans and offer suggestions.**

If materials, time and space are available, your teacher will have your group complete your lab and record the data in your COASTAL ROOTS Nursery Journal. Have your teacher forward copies of your final lab report to Dr. Blanchard. Please, send along photos for her to add to the website!