NATURAL RESOURCE RESTORATION LESSON PLAN

SAV Me!

Theme

Natural Resource Restoration (Submerged Aquatic Vegetation)

Links to Overview Essays and Resources Needed for Student Research

http://nos.noaa.gov/topics/coasts/restoration/
http://noaa.chesapeakebay.net/HabitatSAV.aspx

Subject Area

Life Science

Grade Level

9-12

Focus Question

Why is submerged aquatic vegetation (SAV) important in coastal ecosystems, and how can SAV be restored in areas where it has been depleted?

Learning Objectives

- Students will define submerged aquatic vegetation, and describe at least three benefits that SAV provides to humans and other species.
- Students will describe typical causes for reduced SAV coverage in coastal ecosystems.
- Students will describe at least three actions that can be undertaken to restore SAV in depleted areas.
- Students will describe and discuss a research project that could provide information to help improve SAV restoration programs.

Materials Needed

- (Optional) Computers with internet access; if students do not have access to the internet, download copies of materials cited under "Learning Procedure" and provide copies of these materials to each student or student group

- (Optional) Materials for student research projects; see Learning Procedure Steps 2, 4, and 5

Audio/Visual Materials Needed

None

Teaching Time

One or two 45-minute class periods, plus time for student research

Seating Arrangement

Classroom style or groups of 3-4 students

Maximum Number of Students

32

Key Words

Resource restoration
Submerged aquatic vegetation
Coastal habitats

Background Information

Coral reefs, estuaries, fisheries and other coastal resources are frequently threatened by damage from storms, ship groundings, oil spills, chemical releases, and many other natural events and human activities. In recent years, science and technology have been used to protect and restore coastal resources affected by this damage. Such efforts can include removing pollutants and invasive species (species of plants or animals that are not native to the ecosystem and cause economic harm, environmental harm, or harm to human health) repairing damaged habitats, restoring natural ecosystem processes such as water flow, and re-introducing native organisms. In addition, restoration projects often include monitoring activities to evaluate long-term success. Benefits from these projects include improved habitats for fish, birds and other wildlife, protection against flooding, better water quality, enhanced recreational opportunities, and increased economic opportunities through activities such as commercial fisheries and tourism. Restoring coastal resources is a primary responsibility of the National Ocean Service's Office of Response and Restoration and the National Marine Fisheries Service's Office of Habitat

Conservation, which take active roles in restoring injured resources as well as providing data, science and tools needed for restoration planning. For more information about a wide variety of restoration projects, see "Fix It!" at *http://oceanservice.noaa.gov/education/classroom/lessons/08_restor_fixit.pdf* (9 pages, 252kb).

In many coastal areas, restoration initiatives have focussed on a group of underwater grasses known as "submerged aquatic vegetation" (SAV). These plants provide food and habitat for many aquatic animals, help maintain water quality, and protect shorelines from erosion. As a result, SAV is directly important to fishing, hunting, birdwatching, and many other human activities on the coast. Particularly in the Chesapeake Bay, SAV abundance and distribution declined dramatically in the 1970's and 1980's, but recovered to some extent in the late 1990's. Intensive restoration and monitoring efforts have been undertaken to help accelerate this recovery. Many of these efforts involve citizen volunteers who work in partnership with professional ecologists. School groups are particularly important in some programs, with students raising SAV plants in their classrooms and eventually transferring the plants to restoration sites.

In this activity, students will investigate the importance of SAV, as well as SAV restoration projects, and will design and (optionally) conduct a research project that could provide information to help improve SAV restoration programs.

[Note: SAV can also be a serious nuisance in some locations, since an overabundance of plants can cause waters to become oxygen-depleted when the plants die and decompose. This situation most often occurs when SAV species are introduced to waters where they do not normally grow (in which case, the species are called "exotic" or "alien;" see "Alien Invasion!" and "The Lionfish Invasion" at *http://oceanservice.noaa.gov/education/classroom/lessons/06_coastal_alien.pdf* (20 pages, 552kb) and *http://oceanservice.noaa.gov/education/stories/lionfish/*, respectively, for more information).]

Learning Procedure

1.

To prepare for this lesson, review:

- The background essay on natural resource restoration at *http://nos.noaa.gov/topics/coasts/restoration/*;
- The NOAA Chesapeake Bay Office Web page on Underwater Grasses/Submerged Aquatic Vegetation at *http://noaa.chesapeakebay.net/HabitatSAV.aspx*;
- The "Bay Grasses in Classes 2006 Wild Celery Protocol" at *http://www.dnr.state.md.us/bay/sav/bgic/download/wild_celery/wc_protocol_06.pdf* (23 pages, 296kb); and
- The abstract, "Sexual reproduction of wild celery (*Vallisneria americana*): Why it's worth the effort" in Appendix 1.

You may also want to review Jessie Campbell's thesis on "Influences of Ecological Factors on the Germination of *Vallisneria americana* Seeds" (*http://www.vims.edu/library/Theses/Campbell/Campbell05.pdf*; 174 pages, 1.3mb).

Make copies of these resources for student research, unless you plan to have students obtain these for themselves.

2.

Briefly review the importance and inherent vulnerability of coastal resources. Ask students to list some of the benefits obtained from these resources and examples of events that can damage them. Make sure students include natural events as well as anthropogenic damage (damage caused by human activities; e.g., construction, oil spills, nonpoint source pollution). Tell students that their assignment is to learn about a particularly important and often-damaged resource called "SAV." Don't offer more information at this point, but refer students to the "SAV Inquiry Worksheet," and say that their assignment is to find answers to the worksheet questions.

3.

Lead a discussion of students' answers to questions on the worksheet. Key points include:

- "SAV" stands for "submerged aquatic vegetation," which is plants growing in shallow water, up to the surface but not above the surface.

- Benefits from SAV include:
  - Providing habitat and protection from predators for juvenile and adult fish and shellfish;
  - Providing food for waterfowl, fish and mammals;
  - Absorbing wave energy and nutrients;
  - Producing oxygen;
  - Causing suspended sediment to settle, thereby improving water clarity;
  - Stabilizing bottom sediments with SAV root systems;
  - Providing good places for fishing, crabbing and waterfowl hunting;
  - Providing good places for wildlife study and bird watching; and
  - Protecting shorelines from erosion by absorbing wave energy.

- The presence, abundance, diversity, and health of SAV are considered to be primary indicators of the health of the Chesapeake Bay, because SAV responds directly to local water-quality conditions, and provides critical habitat for numerous aquatic species.

- In 1978, SAV coverage in the Chesapeake Bay was 10% or less of estimated historic coverage.

- Decline of SAV in the Chesapeake Bay is believed to have been caused by a reduction in the amount of light that reached the submerged plants.

- The amount of sediment and other material in the water column (called total suspended solids, or TSS), and the amount of nutrients available in the water column are believed to have the greatest effect on the amount of light that reaches SAV in the Chesapeake Bay.

- Too much sediment in the water column can reduce available light to levels that are too low to allow SAV to survive. An overabundance of nutrients (such as nitrogen and phosphorus) can stimulate excessive algal growth, which can block light from reaching submerged plants.

- Increased sediment influx is often caused by shoreline erosion due to human activities such as construction, agriculture, or natural processes. The most significant sources of excess nutrients in nearshore areas of the Chesapeake Bay are fertilizer from agriculture and home use, outflow from sewage treatment facilities, and runoff from impervious surfaces such as roads, parking lots and buildings.

- Aquatic animals that use SAV for habitat include juvenile blue crabs, spotted seatrout, menhaden, herring, shad, spot, croaker, weakfish, red drum, striped bass, and white perch.

- Strategies to help restore SAV to the Chesapeake Bay include:
  – Improving Water quality by reducing the nutrient and suspended sediment content of runoff entering the Bay and its rivers;
  – Protecting SAV through regulations that protect shallow water habitats during dredging and other activities; and
  – Restoring SAV by planting native species of aquatic grasses.

- Individuals can help protect and restore SAV by:
  – Avoiding disturbance to SAV beds when boating;
  – Using pump-out stations to dispose of boat waste;
  – Avoiding vegetated shallows when planning dredging or pier construction;
  – Helping with SAV surveys and replanting activities;
  – Minimizing the use of fertilizer and weed killers on lawns and home gardens, applying them in the fall when they are less harmful to SAV than in the spring, and making lawns smaller by replacing them with native ground covers that require less maintenance;
  – Reducing the use of gasoline engines whose exhaust contains nitrous oxides that pollute water bodies, and that add contaminants to paved areas which increases harmful runoff; and
  – Reducing shoreline erosion by planting emergent vegetation such as beach grass, and using other shore stabilization techniques that do not involve "hard" solutions such as paving or seawalls.

4.

Tell students that in November, 2005, Jessie Campbell (a graduate student from the Virginia Institute of Marine Science) won an award for her presentation to the Estuarine Research Federation about her study of seed germination in a type of sea grass called wild celery (*Vallisneria americana*). Campbell's experiments showed that wild celery seeds germinate most successfully when oxygen is present, water temperatures exceed 70°, the water is only slightly salty, and seeds are buried less than one-half inch deep. Her results are important to help improve SAV restoration projects in the Chesapeake Bay as well as other locations. You may want to have students review the abstract of Campbell's paper in Appendix 1.

Tell students that their assignment is to design a research project that could provide information to help improve sea grass restoration programs. You may want to refer students to the "Bay Grasses in Classes 2006 Wild Celery Protocol" (*http://www.dnr.state.md.us/bay/sav/bgic/download/wild_celery/wc_protocol_06.pdf*; 23 pages, 296kb) and/or Jessie Campbell's thesis on "Influences of Ecological Factors on the Germination of Vallisneria americana Seeds" (*http://www.vims.edu/library/Theses/Campbell/Campbell05.pdf*; 174 pages, 1.3mb). Alternatively, you may choose to have students discover these (and other) resources for themselves. You may also want to provide a rubric for assessing the project designs. Key points could include:

- A clear hypothesis;
- Appropriate experiments to test the hypothesis, with appropriate controls;
- An appropriate number of replicates of each test;
- Detailed statement of materials, sources, and methods; and/or
- Statistical tests that will be used to analyze experimental data.

5.

Have each student group present their research project. If you plan to have students actually conduct their projects, encourage suggestions from other students as to how the proposed project could be improved. Be sure students have identified suitable sources of materials. You may want to suggest that they contact your state's department of natural resources, and/or your county extension agent, as these organizations often have specific information about local species and restoration programs, and may be able to suggest local sources of SAV plants or seeds. To minimize stress on organizational resources, it may be best to have a single representative make the contacts and then report back to the class as a whole.

[Note: The following sources may be able to provide SAV plants or seeds:

http://www.kestersnursery.com/

http://www.kollarnursery.com/

John J. Lemberger
Wildlife Nurseries, Inc.
PO Box 2724
Oshkosh, WI 54902
(920) 231-3780]

The Bridge Connection

http://www.vims.edu/bridge/sav.html

The Me Connection

Have students write a brief essay describing personal actions that might have a negative impact on aquatic vegetation, the potential personal consequences, and what actions they could take to reduce these impacts

Extensions

1. See Ducks Unlimited's "Teacher's Guide to Wetland Activities" for more activities related to SAV and wetland habitats (*http://www.epa.gov/gmpo/education/pdfs/DUTeachers4-6.pdf*; 35 pages, 2.7mb).

2. Visit *http://www.response.restoration.noaa.gov/kids/kids.html#exper* for experiments, projects, and teaching resources related to oil spills, including a Sediment Penetration Exercise, Mearns Rock Graphing Project, and a project on Oil Spills at the Water Surface.

3. Visit *http://www.response.restoration.noaa.gov/esi/exercise/index.html* for instructions and materials for an exercise in planning a protection strategy for a coastline threatened by an oil spill using environmental sensitivity index maps.

4. Visit *http://oceanservice.noaa.gov/education/stories/lionfish/welcome.html* for a Discovery Story case study about "The Lionfish Invasion."

Resources

http://nerrs.noaa.gov/Education/pdf/EstAquKeepwriteup.pdf – Chesapeake Bay National Estuarine Research Reserve publication, "Estuarine Aquarium Keeping for Beginners" by Bob Carroll (19 pages, 156kb)

Granger, S., M. Traber, S.W. Nixon, and R. Keyes. 2002. A practical guide for the use of seeds in eelgrass (*Zostera marina L.*) restoration. Part I. Collection, processing, and storage. M. Schwartz (ed.), Rhode Island Sea Grant, Narragansett, R.I. 20 pp. available online at *http://seagrant.gso.uri.edu/bookstore/eelgrass_seed_one.pdf* (1.4mb)

http://www.epa.gov/gmpo/education/pdfs/DUTeachers4-6.pdf – "Teacher's Guide to Wetland Activities" from Ducks Unlimited (35 pages, 2.7mb)

http://www.dnr.state.md.us/bay/sav/bgic/download/wild_celery/wc_protocol_06.pdf – Maryland Department of Natural Resources publication, "Bay Grasses in Classes 2006 Wild Celery Protocol" (23 pages, 296kb)

National Science Education Standards

Content Standard A: Science as Inquiry
- Abilities necessary to do scientific inquiry
- Understandings about scientific inquiry

Content Standard C: Life Science
- Interdependence of organisms

Content Standard E: Science and Technology
- Understandings about science and technology

Content Standard F: Science in Personal and Social Perspectives

- Personal and community health
- Natural resources
- Environmental quality
- Natural and human-induced hazards
- Science and technology in local, national, and global challenges

Links to AAAS "Oceans Map" (aka benchmarks)

5D/H1 – Ecosystems can be reasonably stable over hundreds or thousands of years. As any population of organisms grows, it is held in check by one or more environmental factors: depletion of food or nesting sites, increased loss to increased numbers of predators, or parasites. If a disaster such as flood or fire occurs, the damaged ecosystem is likely to recover in stages that eventually results in a system similar to the original one.

5D/H3 – Human beings are part of the Earth's ecosystems. Human activities can, deliberately or inadvertently, alter the equilibrium in ecosystems.

NATURAL RESOURCE RESTORATION WORKSHEET

SAV Inquiry Worksheet

1. What is SAV?

2. List at least five benefits that SAV provides to humans and other species:

3. Why are the presence, abundance, diversity, and health of SAV considered to be primary indicators of the health of the Chesapeake Bay?

4. How do estimates of historic SAV coverage in the Chesapeake Bay compare with coverage in the Bay in 1978?

5. What change in the Chesapeake Bay environment caused the decline of SAV in the Bay?

6. What two factors have the greatest effect on the amount of light that reaches SAV?

7. How do these factors act to reduce the amount of light that reaches SAV?

8. What human activities affect these two factors?

9. List three aquatic animals that use SAV for habitat.

10. What strategies are used to help restore SAV to the Chesapeake Bay?

11. How can individuals help protect and restore SAV?

NATURAL RESOURCE RESTORATION APPENDIX

Sexual reproduction of wild celery (*Vallisneria americana*): Why it's worth the effort

by Jessie J. Campbell and Ken A. Moore
Virginia Institute of Marine Science
College of William and Mary

presented at the
Annual Meeting of the Estuarine Research Federation
Norfolk, Virginia
October 19, 2005

Abstract

Vallisneria americana is a submersed macrophyte found in freshwater systems across North America. Despite considerable annual seed production, the role of seeds in the ecology of this and other SAV species are not well known although recent research has highlighted the importance of seeds in long distance dispersal and restoration. Our objective was to address this gap by quantifying environmental conditions for *V. americana* seed germination to explain both population dynamics and improve our restoration efforts. We investigated the effects of sediment organic content (1-8%), seed burial depth (2-100 mm), light (present/absent), dissolved oxygen (DO <2 or >4 mg l-1), temperature (13-31°C), and salinity (0-15 psu) on total percent germination under controlled conditions and relate these to field dynamics. Seeds were found to germinate under a wide variety of conditions indicative of a species with a wide habitat range. Germination percentages increased significantly when oxygen was present, temperatures were >19°C, salinities were <5psu, sediment organic content was <3%, and seed burial depths were <15mm. The presence/absence of light had no significant effect on germination. These results represent an important step in understanding the seed ecology of *V. americana* and its role in SAV population dynamics.