



CORAL REEF CONSERVATION LESSON PLAN

Who Has the Data?

Theme

Coral Reef Monitoring

Links to Overview Essays and Resources Needed for Student Research

<http://oceanservice.noaa.gov/topics/oceans/coralreefs>

<http://www.sanctuaries.noaa.gov/about/ecosystems/coralwelcome.html>

<http://www.coris.noaa.gov/activities/assessment.html#monitor>

See specific citations on “Coral Monitoring Data Worksheet” on Page 9 of this Lesson Plan.

Subject Area

Life Science/Earth Science

Grade Level

9-12

Focus Question

What types of data do scientists collect to monitor coral reefs, and how are these data used?

Learning Objectives

- Students will be able to access data on selected coral reefs and manipulate these data to characterize these reefs.
- Students will be able to explain the need for baseline data in coral reef monitoring programs.
- Students will be able to identify and explain five ways that coral reefs benefit human beings.
- Students will be able to identify and explain three major threats to coral reefs.

Materials Needed

- “Coral Monitoring Data Worksheet,” one copy per student group

- (optional) Computers with internet access; if students do not have access to the internet, you can download copies of the reef habitat images cited under “Learning Procedure” and prepare transparent grids for use in determining area of habitat types on each reef; you can also download copies of other materials cited under “Learning Procedure” and on the worksheet, and provide copies of these materials to each student or student group
- (optional; see Learning Procedure) Grid (approximately 2 mm square) photocopied onto transparencies; one for each student group

Audio/Visual Materials Needed

None

Teaching Time

One 45-minute class period, plus time for student research

Seating Arrangement

Groups of 3-4 students

Maximum Number of Students

32

Key Words

Coral reefs
Zooxanthellae
Monitoring
Benthic habitat
Fish census
Bleaching

Background Information

Coral reefs are some of the most biologically productive and economically valuable ecosystems on Earth. Benefits provided by coral reefs include protecting shorelines from erosion and storm damage, supplying foods that are important to many coastal communities, and providing recreational and economic opportunities. In addition, the highly diverse biological communities associated with coral reefs are new sources of powerful antibiotic, anti-cancer and anti-inflammatory drugs that have the potential to benefit the entire human race.

Despite these benefits, many coral reefs are threatened by human activities as well as natural processes. Sewage and chemical pollution can cause overgrowth of algae, oxygen depletion, and poisoning. Poor land management and deforestation can lead to excessive runoff and sedimentation that can smother living reefs and reduce light needed by many shallow-water corals. Fishing with heavy trawls, poisons, and explosives damages the physical structure of reefs as well as the coral animals that build them. Careless tourists, boat anchors, and collection for the aquarium trade also cause mechanical damage. Thermal pollution from power plants and unusually hot weather cause physiological stress that kills coral animals and leaves the reef structure vulnerable to erosion. Oil spills, fuel discharges, and anti-fouling chemicals from boats add additional stress. Many of these impacts are the result of ignorance; people simply aren't aware of the importance of coral reefs or the consequences of their actions. But the damage and threats to reefs continue to increase on a global scale.

In addition to stress from human activities, coral reefs are also subject to natural threats. Hurricanes and cyclones can break corals loose and scatter them into areas where they cannot survive. Severe storms also cause impacts on coastal areas that increase sedimentation and runoff. Unusually low tides can leave corals exposed to high temperatures, solar radiation, and the risk of drying out. Heavy rains can lower salinity to dangerous levels.

High temperatures associated with phenomena such as El Niño cause severe damage through thermal stress. Shallow-water reef-building corals are found primarily in tropical latitudes (less than 30° north or south of the equator) and live near the upper limit of their thermal tolerance, so temperatures one or two degrees above normal can result in thermal stress. One of the most striking responses to thermal stress is known as "bleaching." Most reef-building corals have single-cell algae (zooxanthellae) living within their tissues. These algae play an important role in the corals' nutrition and growth. Pigments in the algae are also responsible for most of the corals' color. Under thermal stress, some corals may expel these algae, causing the corals to appear bleached. Some corals may recover

and acquire replacement algae, but others may die. Corals are also subject to predation and disease. Rates of disease outbreaks in corals appear to be increasing, and many researchers believe that at least part of the reason is that the corals have been weakened by other stress factors.

In response to growing concern for the future of coral reefs, the President of the United States established the Coral Reef Task Force (CRTF) in 1998 to protect and conserve coral reefs. The CRTF has prepared a plan to reduce human threats to coral reefs and to improve our understanding of coral reef ecosystems. Strategies for reducing human threats include:

- Expanding and strengthening coral reef marine protected areas (MPAs);
- Reducing damage caused by extractive uses such as overfishing;
- Reducing habitat destruction and pollution;
- Restoring damaged reefs; and
- Creating an informed public.

Strategies to improve our understanding of coral reef ecosystems include:

- Comprehensive mapping, inventory and monitoring of U.S. reefs; and
- Research on coral reef ecology, bleaching, diseases, and best management practices for successful coral reef conservation.

Mapping and monitoring are an essential part of coral reef conservation. The purpose of this activity is to acquaint students with sources of information and data on coral reef monitoring, and to provide hands-on experience with manipulating and interpreting some of these data.

Learning Procedure

1.

If you plan to have your students use NIH Image to analyze benthic habitat maps, download the program and manual from <http://rsb.info.nih.gov/nih-image/>. Be sure that the RAM allocation for the Image program is at least 8,000K, and that the Clipboard and Undo Buffer is set to 1,000K. An alternative to this approach is to photocopy a grid (approximately

2mm squares) onto transparencies, and have students use the transparencies to count the number of grid squares contained in each of the habitat regions shown on the habitat maps. The total number of squares for each habitat type can be used to quantify the relative area occupied by each habitat.

2.

Direct students to the Corals Discovery Kit at <http://oceanservice.noaa.gov/education/kits/corals>. You may want to assign different tutorial sections to each student group. Have each student or student group complete one version of the Self-Test in the Lesson Plan section of the Discovery Kit (downloadable), and lead a discussion to review the answers.

Briefly review the purpose and activities of the U. S. Coral Reef Task Force (CRTF), and highlight the monitoring functions that are intended to identify threatened reef areas and to improve understanding of reef ecosystems (visit <http://coralreef.noaa.gov> for more information on the CRTF).

3.

Tell students that their assignment is to use online data tools to investigate selected coral reefs. Assign one of the following marine protected areas in the Florida Keys to each student group:

- Carysfort/South Carysfort Reef
- French Reef
- Molasses Reef
- Conch Reef
- Hen and Chickens
- Davis Reef
- Alligator Reef
- Sombrero Key
- Looe Key
- Western Sambos/Eastern Sambos
- Sand Key

Provide each student group with a “Coral Monitoring Data Worksheet.” Have each student group complete the tasks described, and prepare a written report containing answers to the questions on the worksheet.

4.

Lead a discussion of students' results. Students should realize that a primary purpose of habitat and fish census data is to establish baselines that can be compared with subsequent surveys to detect changes in coral reef systems. Discuss the variability of habitats in marine protected areas of the Florida Keys. Students should recognize that there is often considerable variability among habitats, even though the habitats are in the same geographic area. An important part of developing a comprehensive understanding of coral reef ecosystems is knowing how reefs change over time in response to various types of environmental change. Students' examination of sea surface temperature data should reveal that Sombrero Key (the monitoring station located in the Florida Keys) was exposed to water temperatures exceeding the coral bleaching threshold on three occasions during the period January 1, 2000 – December 31, 2003; during August and September 2001, August 2002, and August 2003.

Students should recognize that fish census data from St. Croix, USVI, are typical of many healthy coral reef systems in that while there are a large number of different species present, only a few of these are present in large numbers, and there are many more small fishes than large ones. The two most abundant species (*Halichoeres bivittatus* and *Thalassoma bifasciatum*) are strongly associated with reef/hard bottom substrates. In contrast, the two species with the greatest number of large (> 30 cm) individuals were much more strongly associated with vegetated areas.

The Bridge Connection

www.vims.edu/bridge/ – Click on “Ocean Science Topics” in the navigation menu to the left, then “Ecology,” then “Coral.”

The Me Connection

Have students write a short essay on why coral reefs are personally important and what specific actions individuals might take to reduce threats to coral reefs.

Extensions

Online data and tools introduced in this activity can be used for a wide variety of additional activities related to coral reefs

and coral reef management. Many of these data and tools can be accessed through “Discover NOAA’s Data” at the CoRIS home page (<http://coris.noaa.gov/>) and the “Corals Roadmap to Resources” (http://oceanservice.noaa.gov/education/kits/corals/supp_coral_roadmap.html)

Resources

<http://www.nodc.noaa.gov/col/projects/coral/Coralhome.html> – The National Oceanographic Data Center (NODC) coral reefs Web page

<http://response.restoration.noaa.gov/oilaid/coral/tour/tour.html>
– Guided tour of coral reefs presented by the National Ocean Service, Office of Response and Restoration; includes a basic overview of coral ecology, types of things which can harm coral, and shows how resource managers go about response and restoration efforts

Anonymous, 1998. Bleaching The Great Unknown. Reef Research Volume 8. http://www.gbrmpa.gov.au/corp_site/info_services/publications/reef_research/issue2_98/2rmn1.html

Ariadne, D. and D. Diamante-Fabunan. 2000. Coral Bleaching: the Whys, the Hows and What Next? OverSeas, The Online Magazine for Sustainable Seas. http://www.oneocean.org/overseas/200009/coral_bleaching_the_hows_and_whys_and_whats_next.html

<http://www.coral@coral.aoml.noaa.gov> – Web site with a bulletin board on coral bleaching

http://www.crc.uri.edu/download/COR_011.PDF – “Coral Bleaching: Causes, consequences and response;” a collection of papers from the ninth international coral reef symposium.

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 D: Earth and Space Science

- Geochemical cycles

Content Standard E: Science and Technology

- Understandings about science and technology

Content Standard F: Science in Personal and Social Perspectives

- 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/H2**

“Like many complex systems, ecosystems tend to have cyclic fluctuations around a state of rough equilibrium. In the long run, however, ecosystems always change when climate changes or when one or more new species appear as a result of migration or local evolution.”

5D/H3

“Human beings are part of the earth’s ecosystems. Human activities can, deliberately or inadvertently, alter the equilibrium in ecosystems.”





CORAL REEF MONITORING LESSON PLAN

Coral Monitoring Data Worksheet

1. Obtain a map of benthic habitats for your assigned area:
 - a. Point your web browser to *<http://coris.noaa.gov/>*. This is the home page for NOAA's Coral Reef Information System (CoRIS), which is designed to be a single point of access to NOAA coral reef information and data products.
 - b. Click on "Discover NOAA's Data," then "Browse," then "Browse Data Descriptions."
 - c. Select "Place Keywords - Multiple Pages." Click on the letter "F," then scroll down to "Florida" and find the entry for "florida_keys_benthic_habitat_1992." Click on "FAQ" then "3. What does it look like?."
 - d. Select the link to "*http://spo.nos.noaa.gov:16080/projects/benthic_habitats/pro_areas_htmls/pro_areas_map.html*" which opens a page showing protected areas in the Florida Keys for which benthic habitat maps have been constructed.
 - e. Click on the name of the reef area that has been assigned to your group. A window will open with a benthic habitat map for the selected area.
 - f. Click on "Legend" and print a copy of the map legend.
2. Return to the previous page (with the benthic habitat map) and copy the map image into an image processing program such as Adobe Photoshop. Save the image as a TIFF file. Do not compress the file in any way, or it will not open in NIH Image.
3. Open the saved TIFF file in NIH Image. Use the heart-shaped freehand selection tool to trace the outline of each habitat on the map that is inside the protected area (the boundaries of the protected area are drawn in magenta). When you have completed tracing one of the habitats, choose "Measure"

under the “Analyze” pull-down menu. The area of the traced area will appear in the “Info” window. The units of measurement are squares, which is adequate for the purpose of this analysis since we are only interested in the relative abundance of each habitat type. Keep a list of the area measurements for each habitat.

4. When all habitats have been traced, add the area measurements for each habitat type and prepare a table showing these areas.
5. Add all the measurements together, then divide this number into the total area for each habitat type to calculate the relative area (percent of total) for each habitat.
6. Construct a pie chart showing the relative areas for each type of habitat.
7. Coral bleaching events often occur in areas where the sea surface temperature is 1°C or more above the normal maximum temperature. Find out whether coral reefs in the Florida Keys have been exposed to water temperatures that could cause “bleaching.” From the entries under “Florida” in step 1c, find the entry for “avhrr_cur_timeseries.” Click on “FAQ,” then “1.How should this data set be cited?” and select the link to http://coralreefwatch.noaa.gov/satellite/current/sst_series_24reefs.html, to open the “Most Current SST Time Series” page.

This page contains links to sea surface temperature (SST) data for 24 selected coral reef locations beginning in the year 2000. These data are obtained from the Advanced Very High Resolution Radiometer (AVHRR), which provides information on sea surface temperature (SST) for the entire Earth on a daily basis. The AVHRR is carried on NOAA’s Polar Orbiting Environmental Satellite (POES).

Click on the location that is in or near the Florida Keys.

During the period January 1, 2000 – December 31, 2003, did the water temperature at this location ever exceed the coral bleaching threshold? How often?

8. Point your web browser to *http://biogeo.nos.noaa.gov/*. This is the home page for NOAA's Biogeography Program that is responsible for developing knowledge and products on living marine resource distributions and ecology throughout the Nation's estuarine, coastal and marine environments, and to provide managers and scientists with an improved ecosystem basis for making decisions.
 - a. Click on "Projects," then on "Reef Fish Ecology" in the menu on the left side of the page.
 - b. Click on "Reef Fish Database," then "Custom Summary Statistics."
 - c. Click on St. Croix in the map image. This opens a summary page for reef fish censuses in St. Croix, USVI.
 - d. Click on "Species List," which opens a page that summarizes information for all fish species included in the St. Croix fish censuses. Identify:
 - Which two species had the largest number of individuals?
 - In what type of habitat would you most likely find these species?
 - Which two species had the largest number of individuals whose length was greater than 30 cm?
 - In what type of habitat would you most likely find these species?