Long-Term Reef Monitoring

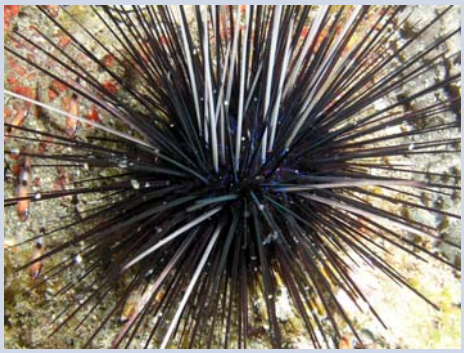


Photo FGBNMS/Hickerson

Grade Level

6-12

Timeframe

45-60 Minutes

Materials

- *Find the Differences* pictures, 1 per student
- Series of photos from *Repetitive Photo Stations* at Stetson Bank, 1 series per group
- Paper and pencil, 1 set per group

Key Words

Long-term Monitoring

Repetitive Photo Station

Bottom Time

T-frame

Photo: FGBNMS

Activity Summary

Environmental monitoring is a challenging activity, especially underwater. Appropriate equipment must be selected to record the best possible results in the most consistent manner. It is also important that the monitoring procedures themselves create as little impact on the environment as possible. This activity will introduce students to the methods used for evaluating underwater habitats and the kinds of information that can be learned from those efforts.

Learning Objectives

Students will be able to:

- Describe how a reef habitat is marked for monitoring.
- Explain what techniques are used to make monitoring work more efficient and why.
- Identify habitat changes in reef monitoring images and potential causes of those changes.
- Discuss challenges in monitoring techniques and image evaluation.

Background Information

Long-term monitoring data has been collected at East and West Flower Garden Banks on a continuous basis since 1978. This was originally

prompted by drilling activity in the vicinity. The Minerals Management Service (now known as the Bureau of Offshore Energy Management or BOEM), charged with regulating oil and gas production activities in the Gulf of Mexico, wanted to establish a means of determining what impacts, if any, oil and gas activities were having on nearby coral reefs. In 1993, a similar monitoring program was established by the Gulf Reef Environmental Action Team (GREAT) at Stetson Bank.

Together, these monitoring activities constitute one of the longest monitoring programs of a coral reef anywhere in the world.

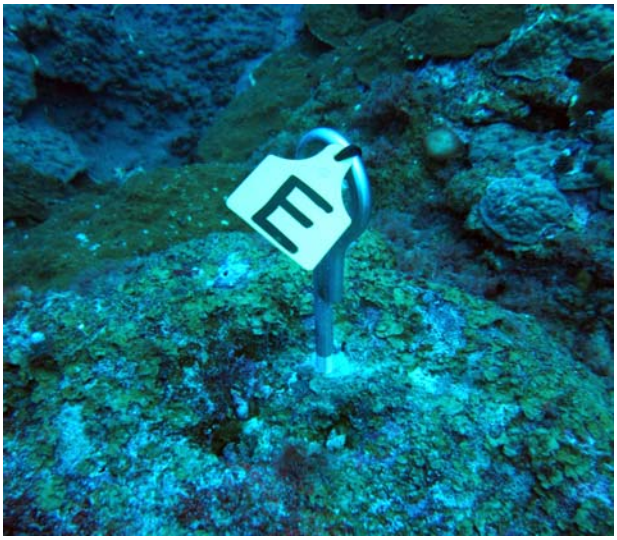
Over the years, these monitoring activities have changed only slightly in number and scope. Today these monitoring activities include the following:

East and West Flower Garden Banks:

- Repetitive photo stations – show growth, loss of tissue, coral cover and incidents of bleaching and disease
- Repetitive close-up stations – examine the advance or retreat of colonies of *Diploria strigosa* (a species of brain coral)
- 10-meter random photo transects – show percent cover, species diversity, frequency of occurrence and dominance of benthic species
- Fish surveys – determine species, abundance, and size of fish traveling within a certain distance of the surveyor over a specified period of time

Stetson Bank:

- Repetitive photo stations – show growth, loss of tissue, coral cover and incidents of bleaching and disease
- 10-meter transects – show percent cover, species diversity, frequency of occurrence and dominance

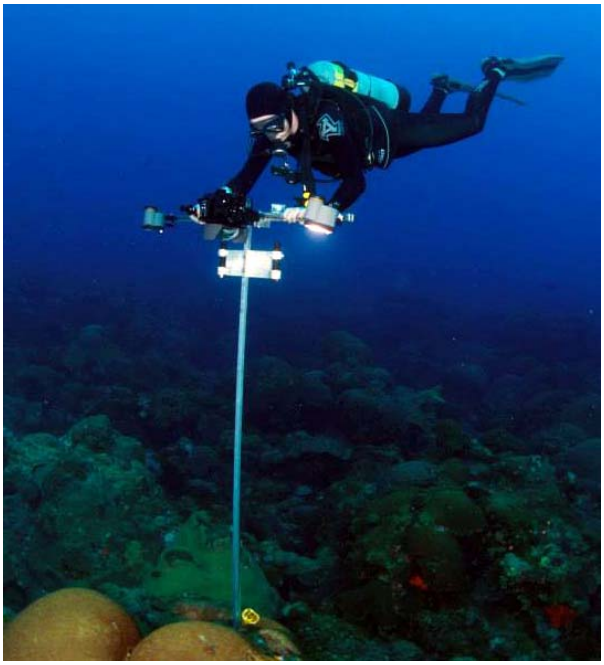


Repetitive photo stations are the biggest part of these monitoring programs. The purpose of these stations is to capture the same photo at the same place every year, for comparison.

Stations are marked by metal eyebolts embedded in the reef, with number or letter tags attached (cattle ear tags). This seems to be the best way to establish a permanent marker with little impact to the reef itself.

To make the photos the same every year, researchers mount the camera on a special T-frame. The camera is positioned in the middle of the crossbar at the top of the ‘T’ with the lens facing down toward the ground. A compass, a level, and camera flashes are also mounted on the crossbar.

The base of the T-frame is placed at the pin location. The frame is rotated until it is facing north and the level is used to make sure the camera is perpendicular to the sea floor. Then, the picture is taken. This system allows the camera to capture the exact same area in the image every year.



Monitoring Procedures

Since each diver participating in the research effort has a limited amount of time he or she can stay underwater, due to the limitations of scuba diving, work is conducted in shifts. Each dive team has a specific task to accomplish so that the next shifts will be able to make the most of their bottom time (time under water).

A typical monitoring expedition goes something like this:

Shift 1: Lay measuring tapes (transects) on the bottom starting at buoy moorings and swimming out on predetermined compass headings for specific distances.

Shift 2: Locate monitoring pins using tape transects and underwater maps for reference. The maps show distances and compass headings from the tapes to pin locations. Relative location of one pin to another is also noted. Even so, the pins are often difficult to find thanks to continuous algae growth.

Scrape algae and other growth off pin tags as they are located so numbers can be seen. Mark pins with weighted lengths of white plastic chains (18”). The chains float up into the water so the pin locations can be seen from much farther away.

Shift 3: Take photos at all of the marked pins, documenting the order in which they are taken and how many are taken at each location. The photographer can quickly move from one station to the next by simply looking for the floating chain markers. Collect chains as photos are taken.

Shift 4: Remove transect tapes.

Move boat to another study site, and repeat!

Monitoring Challenges

Of course, no system is perfect! When this system was first established we didn’t have digital cameras, so film cameras were used. This meant that the researchers were unable to tell if their images were captured correctly until they returned to shore and had their film developed.

In 2007, the camera malfunctioned during both East and West Bank and Stetson Bank monitoring trips, resulting in no usable photos. Both trips had to be rescheduled and all stations re-photographed. In 2008, sanctuary researchers switched to digital photography.

Vocabulary

BOTTOM TIME – the amount of time a scuba diver can spend underwater based on the limitations of available air to breathe and build-up of nitrogen in body tissues

LONG-TERM MONITORING – evaluation of an ecosystem over an extended period of time, often on an annual basis

REPETITIVE PHOTO STATION – a designated location at which a photograph is taken, at least once a year, for comparison with previous images at that location

T-FRAME – a camera stand in the shape of a "T" that allows for consistent photographs at specific locations

What other challenges are associated with this type of monitoring project? As with any project at sea, weather and sea conditions are always a concern. Researchers schedule the monitoring to take place in the same month each year, but that doesn't always mean that is when it will happen. Mother Nature may have other ideas.

Rescheduling the trips is also a challenge because they depend on availability of both staff time and a research vessel to get them there. Once on site, equipment failure and lighting conditions may affect the quality of the photos themselves.

The job of the researchers is to manage time and materials so they are as prepared as possible when the next monitoring opportunity presents itself.

Preparation

- Collect "Find the Differences" cartoons. These are often available in the Sunday comics of your local newspaper. You can also find books of images that challenge people to spot the differences.
- Laminate "Find the Differences" pictures so that they can be used over and over again.
- Print and laminate full-color sets of the monitoring photos available on the web site at https://flowergarden.noaa.gov/education/teachers.html. There are photo series from several different photo stations. Make enough sets so that each group will have its own series of images to examine.

"Find the Differences" example

Procedure

ENGAGE

1. Divide the class into groups of 3-4 students and assign each group a work area.
2. Distribute one "Find the Differences" picture to each student.
3. Challenge each student to find as many differences as possible in his/her picture within a minute.
4. Have students within each group swap pictures and try to find the differences again. Allow another minute.
5. Repeat the picture swap until each student has seen all of the pictures within his/her group.

EXPLAIN

1. Within each group have the students discuss on average how many differences they were able to find in each of the picture sets and how they found those differences. What techniques did they use? In which pictures were the differences harder or easier to find? Did color make it easier or harder? Did the subject matter make it easier or harder? Did it matter how “busy” the picture was?
2. Have each group select one person to report the group’s findings.
3. Engage the entire classroom in the same discussion so that each group can share its findings. Make note on the board of the different techniques used to find the differences. The list may include some or all of the following: use prior knowledge (previous experience with these types of puzzles), examine small sections of the picture at a time, overlay the picture with a grid, write down the changes as they are found, repeated sampling, cover part of the picture.

EXPLORE

1. Distribute one series of photo station photos to each group.
2. Explain that these photos were taken within Flower Garden Banks National Marine Sanctuary, in the Gulf of Mexico. The photo stations were located 60-80 feet underwater.
3. Challenge each group to identify and document the changes that have taken place from year to year within their set of photos. Allow 5-10 minutes for this process.
4. Collect the photo sets and redistribute them to the groups so that each group has a different photo station than before.
5. Challenge each group to again identify and document the changes that have taken place from year to year within their set of photos. Allow another 5-10 minutes for this process.
6. Repeat the photo swap until each group has seen photos from each of the three photo stations.

EXPLAIN

1. Within each group have the students discuss, on average, how many differences they found at each of the photo stations and how they found those differences. How did this compare to the "Find the Difference" activity? Was it easier or harder? Why? Did they use the same techniques in both activities? Was one photo station easier or harder than another to evaluate? Was lack of familiarity with the subject an issue?
2. Have each group select one person to report the group’s findings.
3. Engage the entire classroom in a discussion of the types of changes observed from one year to the next in the photo station sets. Note on the board the different responses. These responses may include some or all of the following: color change, change in size of the objects, new objects, missing objects. It is important to keep students from presuming what happened. They should just make literal observations.

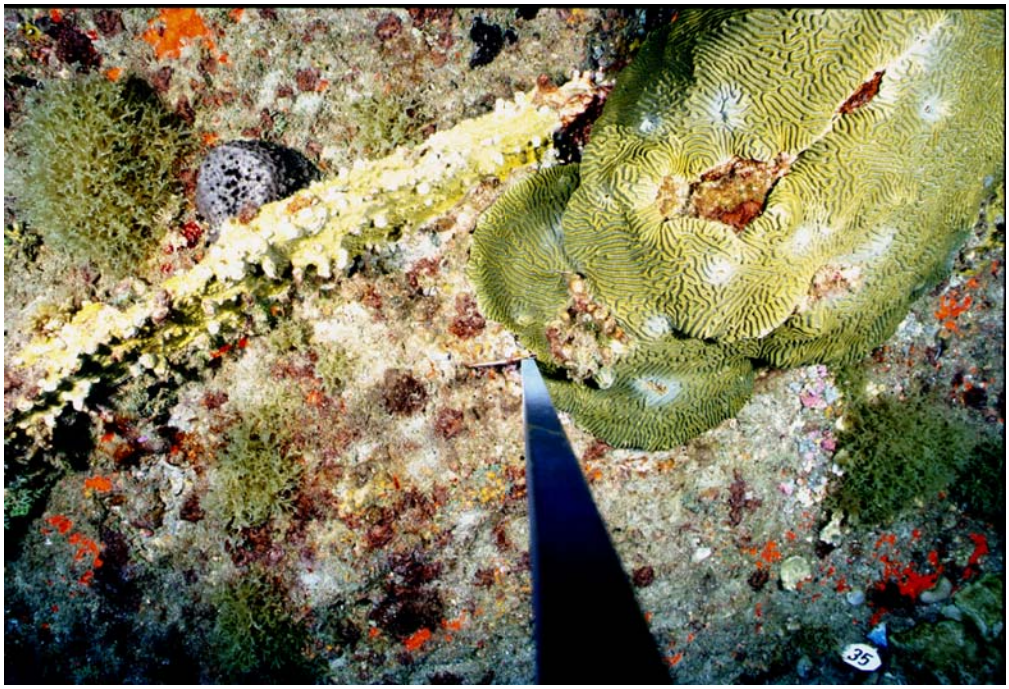
EXTEND

1. In groups, or individually, challenge students to identify the different objects in the photo station photos. Some of the objects they should be able to identify are sponges, fire coral, brain coral, algae, fish.
2. Next, direct the students to learn about the conditions for growth required of each of the biological specimens in the photos.
3. Which of these objects is likely to be an indicator of change over time? Why? *Sponges, corals and rocks are more stable objects and likely to be better indicators.* Which is not? Why? *Fish change location constantly and are therefore not an indicator of specific changes in the substrate, however they may be more likely to hang out in an area based upon what is or is not there. The amount of algae growth may indicate change, but algae is also easily removed from an area by animals, physical impacts, etc. so there would have to be substantial change from one year to the next to indicate any type of long-term alteration.*
4. In groups, have students re-evaluate their original set of photo station photos. Does being able to identify the objects in the photos make it any easier to identify changes?

EVALUATE

Have each group answer the following questions regarding their original set of photo station images.

1. Between what years were the most significant changes noted? *June 2005 to June 2006*
2. What was the nature of these changes? *Objects missing, broken, or greatly reduced in size. Lots of algae growth*
3. What could have caused these changes? Students should do some research to find out what was happening in the Gulf of Mexico during that time. Use the following hints if needed – HINTS: What major events occurred in the Gulf of Mexico in late summer of 2005? What major event occurred on coral reefs around the world in the summer of 2005? *Hurricane Rita passed directly over the sanctuary as a category 5 hurricane in September 2005. In 2005 there was also a massive bleaching event on coral*



Education Standards

National Education Standards	Science: MS-LS2.C Ecosystem Dynamics, Functioning, and Resilience. Ecosystems are dynamic in nature; their characteristics can vary over time. Disruptions to components of an ecosystem can lead to shifts in all its populations. Science: HS-LS2.C Ecosystem Dynamics, Functioning, and Resilience. A complex set of interactions within an ecosystem can keep it relatively constant over long periods of time under stable conditions. ELA/Literacy: WHST.6-8.9 Draw evidence from informational texts to support analysis, reflection, and research. ELA/Literacy: WHST.9-12.9 Draw evidence from informational texts to support analysis, reflection, and research. ELA/Literacy: RST.11-12.9 Synthesize information from a range of sources into a coherent understanding of a concept.
Texas Essential Knowledge and Skills (TEKS) - Science	6.2E Analyze data to formulate reasonable explanations, communicate conclusions, and predict trends. 6.12E Describe biotic and abiotic parts of an ecosystem in which organisms interact. 7.2E Analyze data to formulate reasonable explanations, communicate conclusions, and predict trends. 7.8A Predict and describe how different types of catastrophic events such as hurricanes impact ecosystems 7.13A Investigate how organisms respond to external stimuli found in the environment. 8.2E Analyze data to formulate reasonable explanations, communicate conclusions, and predict trends. 8.11B Investigate how organisms and populations in an ecosystem depend on and may compete for factors such as light, water, range of temperatures, or substrate. Aquatic Science.3A Analyze, evaluate and critique scientific explanations. Aquatic Science.5A Evaluate data over a period of time from an established aquatic environment. Aquatic Science.6B Examine the interrelationships between aquatic systems and climate and weather. Aquatic Science.12A Predict effects of chemical, organic, physical, and thermal changes from humans on the living and nonliving components of an aquatic ecosystem. Biology.2G Analyze, evaluate, make inferences, and predict trends from data. Biology.3A Analyze, evaluate and critique scientific explanations. Biology.11B Investigate and analyze how organisms, populations, and communities respond to external factors. Biology.12F Describe how environmental change can impact ecosystem stability. Environmental Systems.3A Analyze, evaluate and critique scientific explanations. Environmental Systems.8A Analyze and describe the effects on areas impacted by natural events such as hurricanes.
Ocean Literacy Principles	5. The ocean supports a great diversity of life and ecosystems. (c,d,f) 7. The ocean is largely unexplored. (b)
Climate Literacy Principles	3. Life on Earth depends on, is shaped by, and affects climate. (a)

Related Links

Flower Garden Banks National Marine Sanctuary (FGBNMS)
https://flowergarden.noaa.gov

FGBNMS Education Lessons & Activities
https://flowergarden.noaa.gov/education/teachers.html

Long-Term Monitoring
https://flowergarden.noaa.gov/science/monitor.html#longterm

East and West Flower Garden Bank Monitoring
https://flowergarden.noaa.gov/science/eastwestmonitor.html

Stetson Bank Monitoring
https://flowergarden.noaa.gov/science/stetsonmonitor.html

Hurricane Rita Report
https://flowergarden.noaa.gov/doc/reports/hurricaneritareport.pdf

Hurricane Ike Report
https://flowergarden.noaa.gov/science/ike2008.html

Post-Hurricane Assessment from BOEM (2006-2008)
https://flowergarden.noaa.gov/doc/reports/boem2009032.pdf

FGBNMS Species Lists
https://flowergarden.noaa.gov/about/specieslist.html

National Marine Sanctuaries
https://sanctuaries.noaa.gov

For More Information

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