name/date/period

Mapping Coral Reef Habitats

(adapted from "What's Down There" @ oceanexplorer.noaa.gov)

Introduction

Coral reefs are one of the most biologically productive ecosystems on Earth, and benefit humans in a variety of ways that 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, these highly diverse biological communities are proving to be very promising sources of powerful new antibiotic, anti-cancer and anti-inflammatory drugs. Most drugs in use today come from nature. While almost all of these drugs are derived from terrestrial plants and microbes, recent systematic searches for new drugs have shown that marine invertebrates produce more antibiotic, anti-cancer, and anti-inflammatory substances than any group of terrestrial organisms. Particularly promising invertebrate groups include sponges, tunicates, ascidians, bryozoans, octocorals, and some molluscs, annelids, and echinoderms.

Even though they provide numerous benefits to humans, many coral reefs are threatened by human activities. Sewage and chemical pollution can cause overgrowth of algae, oxygen depletion, and poisoning. Fishing with heavy trawls and explosives damage the physical structure of reefs as well as the coral animals that build them. Careless tourists and boat anchors also cause mechanical damage. Some of the most severe damage appears to be caused by thermal stress. Shallow-water reef-building corals live primarily in tropical latitudes (less than 30° north or south of the equator). These corals live near the upper limit of their thermal tolerance. Abnormally high temperatures result in thermal stress, and many corals respond by expelling the symbiotic algae (zooxanthellae) that live in the corals' tissues. Since the zooxanthellae are responsible for most of the corals' color, corals that have expelled their algal symbionts appear to be bleached. Because zooxanthellae provide a significant portion of the corals' food and are involved with growth processes, expelling these symbionts can have significant impacts on the corals' health. In some cases, corals are able to survive a "bleaching" event and eventually recover. When the level of environmental stress is high and sustained, however, the corals may die.

Prior to the 1980s, coral bleaching events were isolated and appeared to be the result of short-term events such as major storms, severe tidal exposures, sedimentation, pollution, or thermal shock. Over the past 20 years, though, these events have become more widespread, and many laboratory studies have shown a direct relationship between bleaching and water temperature stress. In general, coral bleaching events often occur in areas where the sea surface temperature rises 1° C or more above the normal maximum temperature.

In 1998, the President of the United States established the Coral Reef Task Force (CRTF) to protect and conserve coral reefs. Activities of the CRTF include mapping and monitoring coral reefs in U.S. waters, funding research on coral reef degradation, and working with governments, scientific and environmental organizations, and business to reduce coral reef destruction and restore damaged coral reefs. NOAA monitors reefs using a system of specially designed buoys that measure air temperature, wind speed and direction, barometric pressure, sea temperature, salinity and tidal level, and transmit these data every hour to scientists. Satellites are also used to monitor changes in sea surface temperatures and algal blooms that can damage reefs. Research and restoration projects on selected coral reefs are conducted by NOAA's National Undersea Research Program (NURP). Using high-resolution satellite imagery and Global Positioning Satellite (GPS) technology, NOAA has made comprehensive maps of reefs in Puerto Rico, the U.S. Virgin Islands, the eight main Hawaiian Islands and the Northwestern Hawaiian Islands. Maps of all shallow U.S. coral reefs are expected to be completed by 2009.

While these maps show where various reef habitats are located, they are unable to provide detailed information needed for effective management of complex coral reef systems. Side-scan sonar techniques are able to cover large areas, but cannot distinguish individual organisms in communities of fish, algae, and invertebrates. Video and photographic data can be collected by divers in areas shallower than 20 to 30 meters, and by towed cameras, remotely operated vehicles, and manned submersibles in deeper waters. None of these methods, though, are ableto collect the large amounts of visual data needed to make detailed maps of coral reef habitats.

A new technology called laser line scan (LLS) may provide a bridge between broad-scale approaches such as side-scan sonar and fine-scale video and still photography. LLS systems can detect objects as small as about one centimeter. This is much better resolution than is possible with side-scan sonar, but not quite as good as video. While LLS systems are unable to cover as much area as side-scan sonar, these systems provide two to five times the coverage of video. One of the most publicized uses of LLS was in the search for wreckage from TWA Flight 800, which went down off Long Island in 1996. In 2001, the Ocean Explorer program and NURP co-sponsored a field test of a commercial LLS system for imaging seafloor habitats. Results from this test confirmed the potential of LLS technology for mapping benthic habitats. The laser images revealed details of low relief sediments such as sand waves and ripples, and showed a variety of fishes, salp chains, sea anemones, sea pens, kelp and other macro-algae. These images allowed scientists to identify fish and invertebrate species within a given habitat, and to observe the relationships of these animals to their habitats. The purpose of the 2006 Laser Line Scan Expedition is to test the ability of LLS technology to provide detailed information about a variety of coral reef habitats in the Hawaiian Archipelago.

In this lesson, students will learn about some sources of data on coral reefs, and will have hands-on experience with manipulating and interpreting some of these data.

PreLab Questions

1. What types of pharmaceuticals have been developed from marine invertebrates?

2. Explain three examples of human activity that threaten coral reefs?

3. Define “coral bleaching”.

4. Describe the activities performed by the Coral Reef Task Force.

5. How are maps helpful in coral reef management?

6. Why is laser line scan (LLS) an important technology in coral reef mapping?

Procedure

a. Each lab group will be assigned one of the reef habitats surrounding Molokai Island, Hawaii.
b. Examine the map and identify the habitat types using the key provided.
c. Using the transparent grid provided count the number of grid squares occupied by each habitat. **Multiply the number of grid squares by 0.01 to convert to square kilometers (km^2)**.
d. Record your data in the table below then create a pie chart showing the relative abundance of each habitat type **(use total amounts of each type)**.
e. Compare your data with other groups (who have different maps along the same island) and answer the analysis questions.

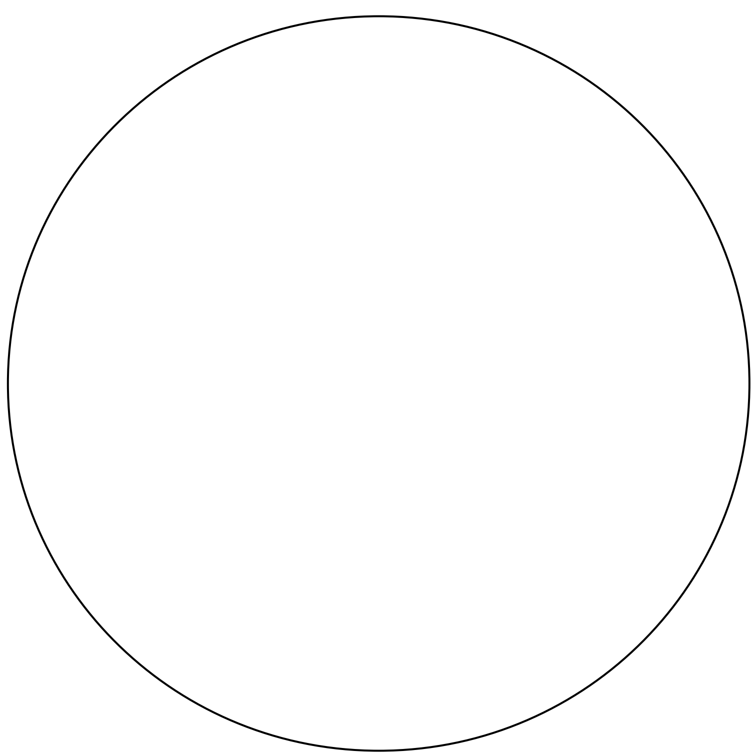
Results

Data Table 1: Biological Cover Type of Molokai Benthic Habitats

BIOLOGICAL COVER TYPE	km^2	BIOLOGICAL COVER TYPE	km^2
Coral 10-50%		Macroalgae 10-50%	
Coral 50-90%		Macroalgae 50-90%	
Coral 90-100%		Macroalgae 90-100%	
TOTAL CORAL		**TOTAL MACROALGAE**	
Seagrass 10-50%		Unclassified	
		Unknown	

BIOLOGICAL COVER TYPE	km^2	BIOLOGICAL COVER TYPE	km^2
Coralline Algae 10-50%		Turf 10-50%	
Coralline Algae 50-90%		Turf 50-90%	
TOTAL CORALLINE ALGAE		Turf 90-100%	
		TOTAL TURF	
Emergent Vegetation 10-50%			
Emergent Vegetation 50-90%		Uncolonized 50-90%	
Emergent Vegetation 90-100%		Uncolonized 90-100%	
TOTAL EMERGENT VEGETATION		**TOTAL UNCOLONIZED**	

Pie Chart 1: Biological Cover Type of Molokai Benthic Habitats



Analysis Questions

7. Describe the location of your map on the island of Molokai.
8. Which of the habitat types dominate your map?
9. Give several examples of creatures you would expect to find based on the habitats that dominate your map.
10. Compare and contrast your map with an adjacent one (another group has the adjacent frame #).
11. Discuss possible reasons for a change in dominant habitat type as you explore the island perimeter.
12. Discuss possible reasons for a change in dominant habitat in the same area over time.
13. How might these changes affect populations of benthic species?
14. How might these changes affect population of nekton species?
15. Give several examples of potential human impacts on the habitats that dominate your map.
16. Discuss ways in which scientists could use the information on your map for the benefit of marine ecosystems.