Reefs at Risk

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Overview: This lesson is designed to provide a visual demonstration of the interdependency within the food web of the coral reef, and to show what happens to the delicate balance of that ecosystem when people interfere with it. Students will be introduced to the biodiversity of the coral reef community and also to the destructive activities of humans that are threatening the oldest and most productive ecosystem on Earth.

Connection with National Geography Standards:

Essential Element: Physical Systems

7. The physical process that shape the patterns of Earth's surface
8. The characteristics and spatial distribution of ecosystems on Earth's surface

Essential Element: Environment and Society

14. How human actions modify the physical environment

Suggested Grade Levels: 4-12

Time: 2 class periods

Purpose: The purpose of this lesson is to demonstrate interdependence in the coral reef food web and to show how that interdependency can be affected by outside influences. The lesson also introduces specific human activities that can have an impact on coral reefs world wide and concludes with a discussion of why the reefs need to be protected.

Primary Question: Do coral reefs need to be protected?

Secondary Questions:

1. What is a coral reef?
2. Where are coral reefs located?
3. Why are coral reefs important?
4. How do coral reefs work (feed, grow, sustain)?
5. What human activities affect coral reefs?

Materials:

- Food chain handout (Attachment #1) for each student
- Overhead transparency of Attachment #1 for teacher
- Food web handout (Attachment #2) for each student
- Overhead transparency of Attachment #2 for each group and for teacher
- Interdependency chart (Attachment #3) for each student
- Overhead transparency of Attachment #3 for teacher
- Scenario worksheet for each group (Attachment #4)
- Transparency pens for teacher and for each group
- Overhead projector

Procedures:

Opening the Lesson

1. Review the concept of an ecosystem - functional system formed by the interaction of a community of organisms (plants and animals) with their environment.
2. Review the concept of interdependency within the ecosystem and the undesirable effects any intrusion or interruption in the natural balance would have on other parts of the system.
3. Ask students which species of animal on the planet they think has had the greatest impact on the imbalance of the Earth's ecosystems.

Developing the Lesson (Secondary Question #4 - How do coral reefs work?)

1. Distribute Attachment #1 to students, and, using the overhead transparency for Attachment #1, discuss a food chain and how it works. Emphasize that a food chain is a sequence of organisms through which energy and materials flow within an ecosystem. Attachment #1 shows a basic linear chain of the hierarchy within a coral reef ecosystem. Have students add arrow points to the lines connecting the organisms to show how the energy flows from the sun to the phytoplankton, from the phytoplankton to the zooplankton, and so on. The teacher should show the same flow on the overhead transparency by adding the arrow points to the connecting lines and also remind students that the energy flows from the prey to the predator. (Answer key, Attachment #1A)
2. Distribute Attachment #2 which diagrams the coral reef food web. Explain that the coral reef supports so many different organisms (biodiversity) that the food chains interconnect and overlap to form an interdependent food web. Illustrate this by placing the Food Web transparency (Attachment #2) over the Food Chain transparency (Attachment #1) on the overhead projector.
3. Distribute the Interdependency Chart (Attachment #3), and point out that the food web's interconnections provide most predators with more than one prey and most prey with more than one predator.
4. Using the Interdependency Chart (Attachment #3) and the Food Web handout (Attachment #2), explain that the students will work in groups to show the energy flow through the web. Have students transfer the basic food chain connections that they did on Attachment#1 to the food web (Attachment #2). Then, using transparencies for Attachments #2 and #3, demonstrate how to fill in the connections on the food web using the information from the Interdependency Chart (Attachment #3). Begin with algae, and on the Food Web transparency (#2), show the energy flow (gleaned from #3) from one to another - in this case, from algae to angel fish, coral and sea urchins - by adding arrow points to the corresponding connecting lines. Remind students that the energy flows from the prey to the predator, so that the arrows will point from the prey to the predator as well. Instruct students to follow the Interdependency Chart sequentially by showing the connections from both columns. (i.e., show an arrow pointing from the sun to the algae - photosynthesis - and also from algae to angel fish, coral, and sea urchins). The answer key is Attachment #2A.
5. Instruct students to add the arrow points to the connecting lines for the remainder of the web.
6. Compare the food web to the food chain pointing out the major differences including the lateral predator/prey relationship (sea anemones and angel fish, giant grouper and octopus) and the cannibalistic relationship (sea stars).

Group Activity (Secondary Question #5 - What human activities impact the reef?)

1. Pass out the scenario sheets and an overhead transparency of the Food Web (Attachment #2) to each group.
2. Explain that the scenarios are factual and give examples of human activities that effect the coral reef ecosystem.
3. Choose one of the scenarios to discuss with the entire class. Read it aloud and ask the students to discuss what effect the actions in the scenario might have on the coral reef ecosystem. Use the transparency and a transparency pen to emphasize and illustrate the projected damage.
4. Assign each group one scenario and have them discuss the affect it might have on the food webs they have drawn. Ask one of the students in each group to copy the completed web from the handout to the transparency by placing the transparency on top of the handout and recopying the arrow points. Students should then make changes on the transparency to show the results of the actions in their scenarios.
5. After several minutes of discussion, each group should present a summary of its scenario to the class, and using the revised food web transparency, explain the changes that might occur under each circumstance.

Closure

1. After presentations, it should be obvious to students that point are doing things that upset the balance of coral reef ecosystems, and that those activities having a negative impact should be regulated or prevented.
2. Based on the scenarios, the major causes of stress and destruction in the reefs should be reviewed, and the primary question should be reviewed and discussed.
3. The discussion should raise questions about what can be done to protect the reefs and lead to independent research and pursuit of the answers.

REFERENCES

The scenarios were written by Nancy Geldermann using information obtained from the sources below.

Overhead Transparencies:
NGS Picture Pack: *Coral Reef*, National Geographic Society, Washington, D.C., © 1998.

Software:
A Field Trip into the Sea, Sunburst Communications, Inc., Pleasantville, NY, © 1995.

Jean-Michael Cousteau's World, Cities Under the Sea, Sunburst Communications, Inc., Pleasantville, NY, © 1995.

Publications:
Chadwick, Douglas H., "Coral Eden", *National Geographic Magazine,* Volume 195, No.1, January, 1999, p.31.

Doubilet, David, "Coral Eden", *National Geographic Magazine,* Volume 195, No.1, January, 1999, p.2.

Getis, Arthur, Judith Getis, and Jerome Fellman, *Introduction to Geography*, Wm. C. Brown Publishers, Dubuque, IA, © 1991.

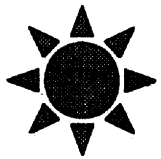
Johnson, Sylvia A., *Coral Reefs*, Lerner Publications Company, Minneapolis, MN, © 1984.

Muzik, Katy, *At Home in the coral Reef*, Charlesbridge Publishing, Watertown, MA, © 1992.

NatureScope, Diving into Oceans, National Wildlife Federation, Washington, D.C., © 1989.

Wu, Norbert, *A City Under the Sea-Life in a Coral Reef*, Simon & Schuster, NY, © 1996.

Coral Reef Food Chain



phytoplankton

zooplankton

coral

sea slugs

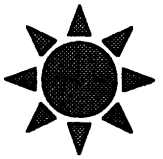
angel fish

giant grouper

shark

Atttachment 1

Coral Reef Food Chain



phytoplankton

zooplankton

coral

sea slugs

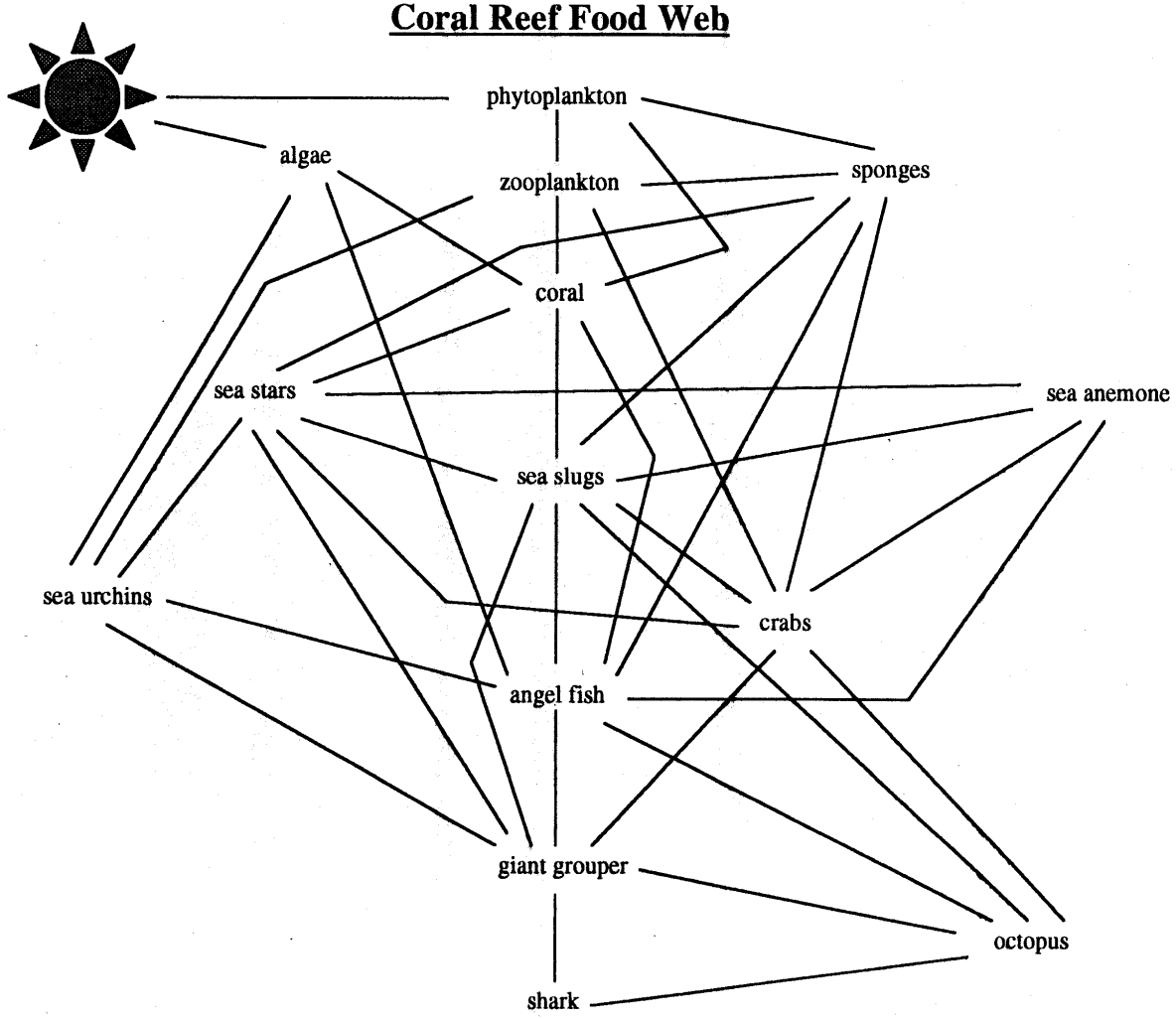
angel fish

giant grouper

shark

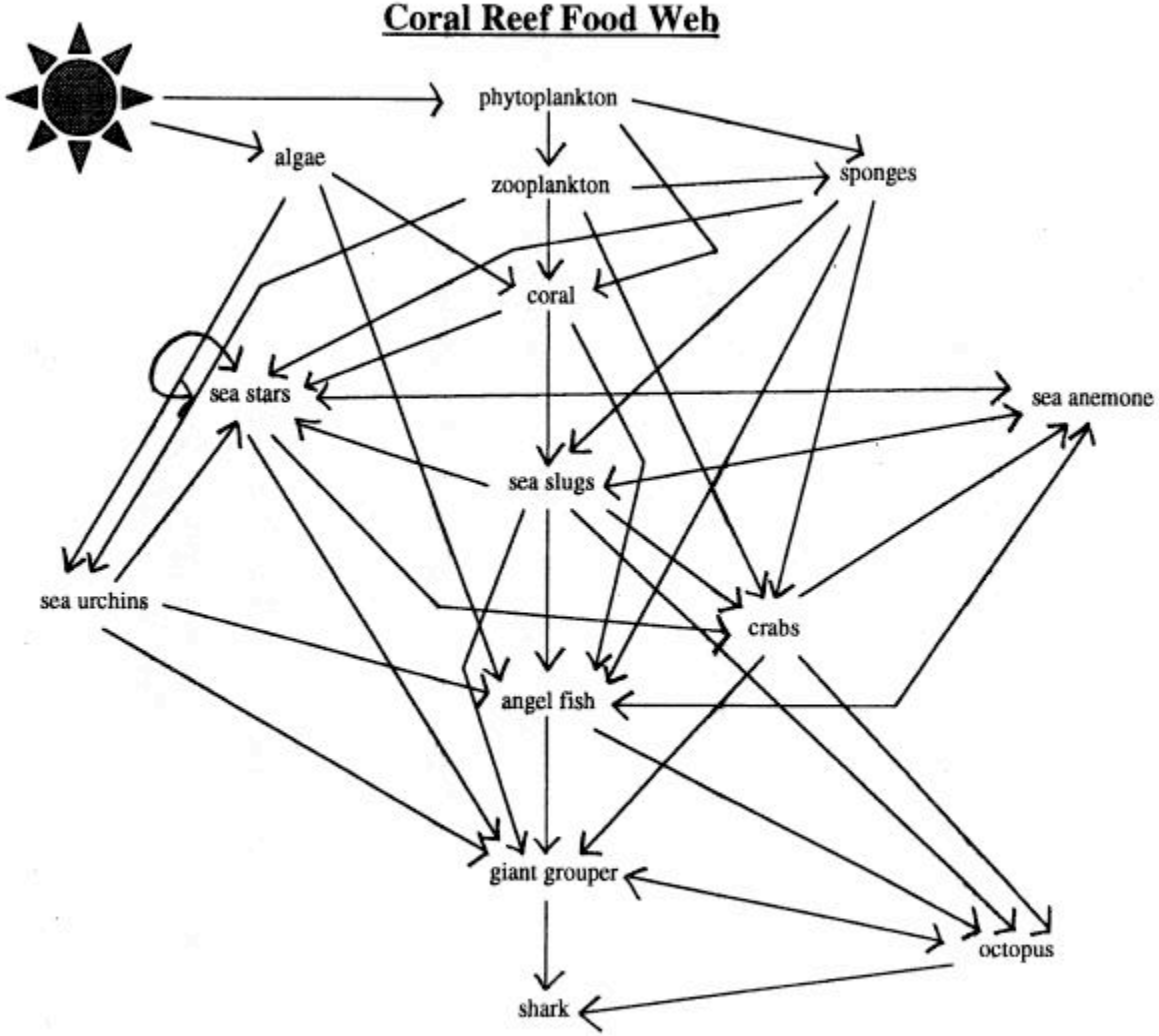
Atttachment 1A -KEY

Coral Reef Food Web



Attachment 2

Coral Reef Food Web



Attachment 2A - KEY

INTERDEPENDENCY CHART

	Energy from: Food Source	*Energy to:* Food For
Algae	photosynthesis	angel fish coral sea urchins
coral	algae phytoplankton zooplankton	angel fish sea stars
crabs	sponges sea slugs zooplankton	giant grouper sea anemones octopus
giant grouper	crabs sea slugs sea urchins angelfish	shark
octopus	crabs sea slugs angelfish giant grouper	giant grouper sharks
phytoplankton	photosynthesis	zooplankton coral sponges
sea anemone	crabs angelfish sea slugs sea stars	sea slugs sea stars angel fish
sea stars	coral sea urchins sea slugs crabs	sea stars crabs giant grouper
sea urchins	algae zooplankton	angelfish sea stars
sharks	giant grouper octopus	
sponges	phytoplankton zooplankton	sea slugs sea stars angelfish crabs
zooplankton	phytoplankton	coral sponges

Scenarios

1. Overfishing in the Philippines, Guam, and Indonesia has caused the disappearance of many types of food fish (groupers, snappers, emperors) from entire areas. Without these predators in the area, the sea urchin population has increased. Sea urchins kill live coral as they feed on algae. Eventually, algae growth overtakes the coral, and new polyps cannot grow. Explain the effect these changes might have on the food web you have made.

2. Since the 1960's, thousands of fishermen in Asia and Indonesia have been using sodium cyanide to collect live fish (such as angel fish) for the aquarium trade. They squirt the chemical onto coral colonies, then pry the coral apart with crowbars to capture stunned fish that are hiding in the crevices. It is estimated that 330,000 pounds of poison have been sprayed onto 33 million coral polyps each year for the last ten years. One half of the fish that are live-caught die during capture and transport, and another 30% die within six months because the cyanide poisons their major organs. The aquarium industry grosses millions of dollars a year worldwide, and the biggest market is in the United States. Th use of cyanide for this business has been outlawed, but it is difficult to patrol the vast oceans. The business of selling fish for aquariums is not illegal. Explain the effects the aquarium business has on the coral reef ecosystem and your food web.

3. Many sunken treasure ships have become overgrown with coral and form the basis of coral reefs. When treasure hunters discover the wreckage, they must cut away the coral structure surrounding the ships to find the treasure they are seeking. Explain what might happen to the coral reed if it is cut away to expose the ship within it. (One 6 pound chink of dead coral removed from the Great Barrier Reef contained 1441 worms from 103 different species.) Explain how the removal of parts of the reef might affect the ecosystem and your food web.

4. Tourists bring business to many of the countries that are surrounded by coral reefs, but the damage they do is putting the future of both tourism and the coral reef in jeopardy. Most people do not realize how fragile the reef is and carelessly destroy it without thinking. Ecologists have discovered patches of dead coral in the shape of diver's footprints. Boat anchors can break off a quarter century of growth in an instant, and if allowed to drag, can leave a trench of dead coral in their wakes. Explain what might happen to the coral reef and your food web if tourists are allowed to continue to destroy it.

5. Coral reefs, made up mostly of animals and minerals, are efficient ecosystems that thrive in water low in nutrients. If more nutrients are added to the water, phytoplankton and algae produce more food and become overabundant. When this happens, many of the phytoplankton, including the larvae of may mollusks and crustaceans, die. Algae overgrows the coral, and an imbalance occurs. It is estimated that 700 tons of nutrients are dumped into the ocean off the coasts of Florida each year. Most of the nutrients come from fertilizer in run-off from the land. The fertilizer encourages plant growth. Explain the effects this sewage dumping might have on the coral reef and your food web.

6. Coral bleaching occurs when coral polyps are under stress. When this happens, the polyps expel algae (zooxanthellae) from within their cells which, in turn, exposes their white limestone skeletons. The algae provides food for the coral and also holds the colony together. The bleaching of the coral indicates the absence of the algae and signals trouble for the reef. Without the algae, the coral will not reproduce and will eventually die. Sometimes coral bleaching can be attributed to hurricanes, pollution, or disease, and, when it occurs in small amounts, can be stopped so that the coral will eventually renew itself. In other cases, when the cause cannot be pinpointed but can be associated with rising water temperatures or when it occurs in large amounts, the reef becomes imperiled. Explain what effect coral bleaching could have on your food web.

7. Although blast fishing with dynamite has been outlawed, it is still a popular way for Asian fishing companies to meet the demands of the fishing industry. Dynamite is dropped onto the coral reef where many fish are known to be, and when it explodes, the dead fish float to the top and are scooped up in waiting nets. The fish are cleaned, processed, frozen, and shipped off to market leaving the destruction from the dynamite behind. Explain the effects this type of fishing could have on the coral reef and your food web.

8. Coastal development increases the amount of sediment in the water, and when and abundance of construction activity occurs on a coast close to a coral reef, the extra soil particles drift down through the water and block the pores of sponges as they take in nutrients. If the pores are blocked, food and wastes cannot flow through the animals, and eventually they will die. Explain the effect a decrease in the sponge population might have on the coral reef ecosystem and as well as your food web.

9. The lips of a lumphead wrasse are considered a delicacy in Hong Kong and sell for $225.00 a plate. Giant grouper is equally expensive, as are other food fish of the coral reef. Fishermen set traps and nets to catch these animals, which decrease their population within the reef, and also pulls up any additional animals that happen to fall into the catch. Explain the effect of the loss of the giant grouper on the coral reef ecosystem and on your food web.