# Lab: Gizmos Coral Reefs

Directions: Follow the instructions to go through the simulation. Respond to the questions and prompts in the orange boxes.

Vocabulary: consumer, coral, coral bleaching, coral reef, filter feeder, food chain, food web, grazer, nutrients, ocean acidification, pH, plankton, predator, producer, sediment, zooxanthellae

Prior Knowledge Questions (Do these BEFORE using the Gizmo.)

1. Look at the graph to the right. What does it show?

2. Why do you think **corals** have declined since 1977?

Percentage of coral cover in Caribbean Reefs, 1977-2012
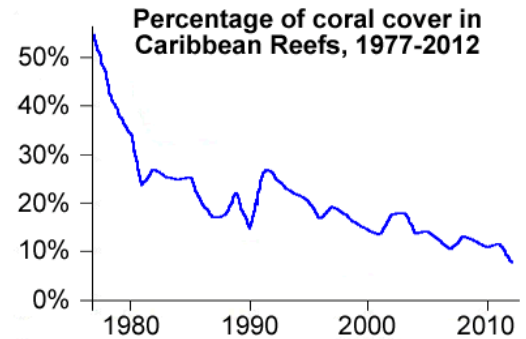
Gizmo Warm-up

Coral reefs are some of the most diverse habitats on Earth, home to over a quarter of all marine species. The *Coral Reefs* Gizmo provides a simplified model of interactions among 10 key species in Caribbean reefs. In the *Coral Reefs 1* exploration, you will focus on the effects of environmental factors on Caribbean reefs.

1. Click **Advance year** 10 times. Look carefully at the composition of the reef over time. Do you see any major changes?

2. Select the DATA tab. Check that **Staghorn coral**, **Star coral**, **Sponges**, and **Algae** are selected. Populations are given as a percentage of normal populations. What do you notice about these populations?

3. On the right side of the Gizmo, select the SUMMARY tab. In a healthy reef, what are the values for **Nutrient load**, **Water clarity**, **Coral cover**, and the total number of fish species?
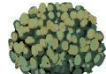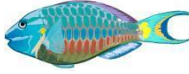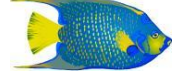
Nutrient load:

Water clarity:

Coral cover:

Total fish species:

Activity A: The Caribbean reef ecosystem	Get the Gizmo ready: ● On the CONDITIONS tab, click **Return to original settings**. Click **Restart**. ● Select the CORAL REEF tab.	

Introduction: A healthy Caribbean reef is home to over 50 species of coral and over 400 fish species. In this simplified model, we only consider the interactions of ten important species.

Question: How do different species interact in a healthy coral reef?

1. Describe: On the CORAL REEF tab, click on each organism shown in the table below. For each organism, give its name and what it eats (or how it obtains energy).

Picture	Name	What it eats (or how it obtains energy)

2. Corals obtain energy from tiny photosynthetic algae, called **zooxanthellae**, which live inside the coral's tissue. How do you think corals would be affected by cloudy, muddy water?

3. Classify: A **producer** is an organism that makes its own energy, usually from sunlight. A **consumer** is an organism that gets energy by feeding on other organisms.

    A. Which of the reef organisms in this Gizmo are producers?

    B. Which of the reef organisms are consumers?

    C. Consumers in the reef can be further classified as **filter feeders**, or organisms that eat **plankton** by filtering water; **grazers**, or organisms that feed on organisms that don't move; and **predators**, or organisms that eat other animals. List at least one example of each.

    Filter feeders:

    Grazers:

    Predators:

4. Create: A **food chain** is a series that shows what organisms eat other organisms. For example, the food chain "grass → mouse → hawk" means that the mouse eats grass and the hawk eats the mouse.

Create two possible food chains for the Caribbean coral reef based on what you have learned about the ten organisms in this Gizmo.

    Food chain 1:

    Food chain 2:

5. Challenge: A **food web** is a more complicated diagram that shows the feeding relationships of all the organisms in the ecosystem. As with a food chain, an arrow (→) pointing from species A to species B indicates species A is eaten by species B.

✏️ In the diagram at right, create a food web by drawing arrows (→) to show which organisms are eaten by others. Hand draw or click on the image and select EDIT.

Nassau grouper	Yellowtail snapper
Hawksbill sea turtle	Long-spined sea urchin
Queen angelfish	Stoplight parrotfish
Sponges	Algae
Star coral	Staghorn coral

| **Activity B:**

Ocean conditions | <u>Get the Gizmo ready</u>:

● On the CONDITIONS tab, Click **Return to original settings** and **Restart**. Check that **Ocean conditions** is selected on the dropdown menu. | |

Introduction: In recent decades, global climate change has altered ocean conditions in the Caribbean. Average surface temperatures have risen about 0.25 °C – 0.5 °C. Many scientists think climate change will lead to stronger storms and may cause the ocean to be more acidic.

Question: How are coral reefs affected by storms, high temperatures, and acidic water?

1. <u>Predict</u>: Coral reefs in the Caribbean are sometimes damaged by hurricanes. Of the two types of coral shown, which do you think is more resistant to storm damage? Explain.

2. <u>Observe</u>: Set the **Storm severity** to 50%. Click **Advance year** 10 times. What changes do you notice?

3. <u>Analyze</u>: On the DATA tab, select **Staghorn coral**, **Star coral**, **Sponges**, and **Algae**. Which organism was most hurt by increased storms, and why do you think this is so?

4. <u>Predict</u>: In the Caribbean, water temperatures typically range from 24 °C to 30 °C. What do you think might happen if temperatures rise much higher than 30 °C?

5. <u>Observe</u>: Select the CORAL REEF tab. Click **Return to original settings** and **Restart**. Set the **Ocean temperature** to 33 °C. Click **Advance year** 10 times.

   A. What changes do you notice?

   The white corals you see have undergone **coral bleaching**. At high temperatures, corals may lose their zooxanthellae, causing corals to lose their color and their main source of food. Once bleaching occurs, the coral colony usually dies.

   B. Select the DATA tab. Which coral is most affected by bleaching?

6. Analyze: On the DATA tab, select every organism. In general, how does the decline in corals affect the other organisms on the reef?

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7. Predict: The **pH** of a solution is a measure of how acidic or basic it is. The greater the pH, the more basic the solution is. Corals and other marine invertebrates require less energy to make their exoskeletons and shells when ocean water is slightly basic. As carbon dioxide concentrations in Earth's atmosphere rise, ocean water absorbs carbon dioxide and becomes more acidic. This process is called **ocean acidification**. How do you think ocean acidification will affect the coral reef?

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8. Observe: Click **Return to original conditions** and **Restart**. Set the **Ocean pH** to 7.6. Click **Advance year** 20 times. What changes do you see on the CORAL REEF and DATA tabs?

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9. Observe: Select the SUMMARY tab. How has the loss of coral affected the number of fish species present on the reef?

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10. Summarize: Many scientists predict stronger storms, warmer oceans, and lower ocean pH in the future. If this occurs, how do you think these changes will affect Caribbean coral reefs? Test your ideas using the Gizmo.

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11. Apply: In the 1970s, staghorn corals dominated Caribbean reefs. Since that time, staghorn corals have declined by over 90% and are now classified as critically endangered. What do you think are the causes of this decline, and why do you think staghorn corals are so vulnerable?

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12.

	Get the Gizmo ready:	
Activity C: **Land use**	● On the CONDITIONS tab, click **Return to original settings** and **Restart**. Select **Land use**.	

Introduction: Corals depend on ample sunlight, warm (but not too warm) temperatures, clear water, and low levels of **nutrients** such as nitrogen and phosphorus. Algae and sponges, on the other hand, thrive in water that is higher in nutrients. Logging, agriculture, and other human activities can add excess nutrients and **sediments** (small dirt particles) to the sea.

Question: How do changes in land use affect reefs?

1. Observe: Select the SUMMARY tab. Under normal conditions, what is the sediment load, nutrient load, and water clarity? The sediment load and nutrient load are measured in *parts per thousand* (ppt).

2. Predict: Logging removes vegetation that anchors soil and prevents erosion. How do you think logging will affect a coral reef? Explain.

3. Observe: On the CONDITIONS tab, set **Logging** to 50%. Select the SUMMARY tab. What is the sediment load, nutrient load, and water clarity?

4. Observe: Click **Advance year** 10 times. What changes do you notice?

5. Analyze: On the DATA tab, select **Staghorn coral**, **Star coral**, **Sponges**, **Algae**, **Stoplight parrotfish**, **Queen angelfish**, and **Long-spined sea urchin**.

   A. Which species were hurt the most by logging?

   B. Which species were helped most by logging?

   C. Why do you think the populations of parrotfish and long-spined sea urchins changed the way they did?

6. Observe: Click **Restart**. On the CONDITIONS tab, set **Logging** to 0% and **Sewage** to 50%. Select the SUMMARY tab. What is the sediment load, nutrient load, and water clarity now?

7. Predict: The primary effect of dumping raw sewage into ocean water is a sharp increase in the nutrient load. How do you think this will affect the reef?

8. Observe: Select the CORAL REEF tab. Click **Advance year** 10 times. What changes do you notice?

9. Analyze: On the DATA tab, select every organism except **Red lionfish** and **Crown-of-thorns starfish**. (These are invasive species you will experiment with in another activity.)

   A. How does the increase in nutrients affect the algae population? __
   B. How does this change the populations of the two species that eat algae, parrotfish and sea urchins?

10. Experiment: Click **Restart**. In 1983, a mysterious disease killed off most of the long-spined sea urchins in the Caribbean. To model this, select **Disease** from the CONDITIONS tab and set the **Sea urchin infection rate** to 100%. Check that **Sewage** is still 50%.

    A. Click **Advance year** 10 times. What happens?
    B. Based on these results, what is the importance of long-spined sea urchins to Caribbean reefs?

11. On your own: Click **Return to original settings** and **Restart**. Investigate the effects of agriculture on Caribbean reefs. Summarize your findings on a separate sheet of paper to turn in with this activity.