Corals Growth & Skeletons

Materials

For the leader:

Projector

Whiteboard to project data graph onto

For the activity:

Copy of coral data table

Computer program to graph in or graphing paper

Copy of student worksheet

Copy of coral images

Overview

In this activity students will investigate how carbon availability may affect coral growth. Corals use dissolved inorganic carbon from seawater to create their calcium carbonate skeletons and in the process release carbon dioxide (**calcification**: $Ca^{2+} + 2HCO_3^- \rightarrow CaCO_3 + CO_2 + H_2O$). Therefore, corals must to live in waters that have sufficient quantities of dissolved carbon.

Using data from Dr. Tali Mass's research, students will plot the relationship between calcification and depth for corals in the Red Sea. They will use these data in combination with observations of morphological differences in corals with depth to brainstorm what might happen to corals as the sea surface temperature increases. The activity places a strong emphasis on teaching students how to look at multiple data sources to draw conclusions. The students first need to plot the calcification data and then interpret the data with additional information from their observations of coral images for conclusions about the affects of carbon availability on coral growth. Through gaining these data interpretation skills, students will also gain a better understanding of how scientists look at evidence when asking questions about the variables effecting coral growth/morphology and make predictions of future impacts of climate change and rising sea surface temperatures on corals.

Motivating Questions: What do scientists study that affects coral growth? What does that information tell us about how corals will adapt to the changing climate?

Take Home Message

Scientists use data from multiple variables to investigate potential causes of visible differences in coral growth. Gaining a better understanding of what influences coral growth under different conditions currently can guide scientists' predictions of future changes in coral growth due to climate change.

Engage: Lead the students in a discussion about what they know about corals and coral growth. Share the images of different coral morphology with depth.	15 minutes
Explore: Students investigate data of calcification with depth.	20 minutes
Make Sense: Students use the coral images and calcification data to make predictions about future impacts on corals with increasing sea surface temperatures.	10 minutes
Total:	**45 minutes**

Audience

Late elementary and middle school students (4^{th}-8^{th} grade).

New Jersey Core Curriculum Content Standards - Science

Grade	Content Statement	CPI#
4	Tools and technology are used to gather, analyze, and communicate results.	5.1.4.B.2
4	Evidence is used to construct and defend arguments.	5.1.4.B.3
4	Reasoning is used to support scientific conclusions.	5.1.4.B.4
4	Organisms can only survive in environments in which their needs are met. Within ecosystems,	5.3.4.C.1

	organisms interact with and are dependent on their physical and living environment.	
4	Individuals of the same species may differ in their characteristics, and sometimes these differences give individuals an advantage in surviving and reproducing in different environments.	5.3.4.E.1
4	In any ecosystem, some populations of organisms thrive and grow, some decline, and others do not survive at all.	5.3.4.E.2
6	Various human activities have changed the capacity of the environment to support some life forms.	5.3.6.C.1
6	The number of organisms and populations an ecosystem can support depends on the biotic resources available and on abiotic factors, such as quantities of light and water, range of temperatures, and soil composition.	5.3.6.C.2
6	Changes in environmental conditions can affect the survival of individual organisms and entire species.	5.3.6.E.1
8	Individual organisms with certain traits are more likely than others to survive and have offspring in particular environments. The advantages or disadvantages of specific characteristics can change when the environment in which they exist changes. Extinction of a species occurs when the environment changes and the characteristics of a species are insufficient to allow survival.	5.3.8.E.1
8	Mathematics and technology are used to gather, analyze, and communicate results	5.1.8.B.2
8	Carefully collected evidence is used to construct and defend arguments.	5.1.8.B.3
8	Scientific reasoning is used to support scientific conclusions.	5.1.8.B.4

Preparation (15 minutes)

1. Write the motivating questions on the board:

   How do scientists study what effects coral growth? What does that information tell us about how corals will adapt to the changing climate?

2. Make class copies of student worksheets for each student (at the end of this write-up).
3. Make copies of the different coral morphology images for each student group/table (at the end of this write-up).

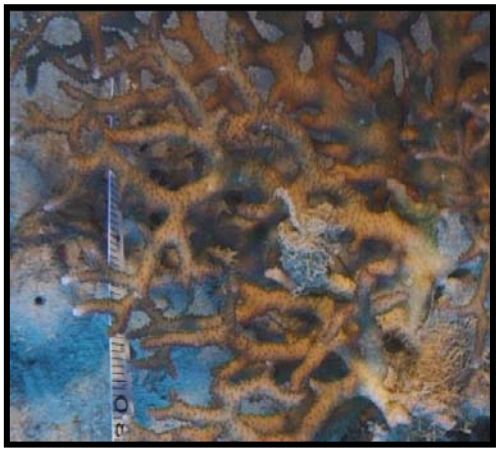
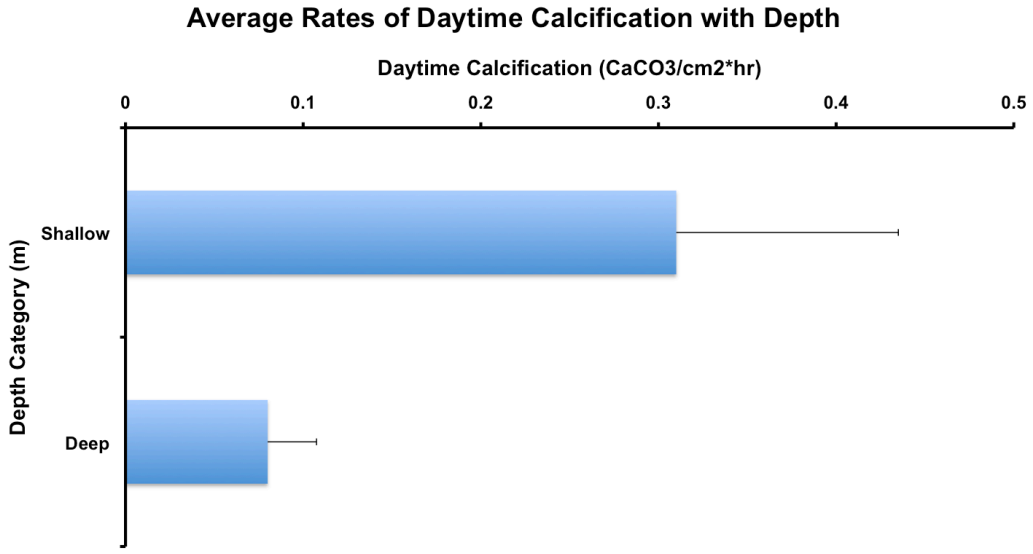


Figure 16: Colony morphology-Shallow water colonies are sub-spherical and whitish (left), deep water colonies are planar, with the upper part dark, while its bottom facing part is pale (right).

4. Make or project a graph of the data on the board, but make sure it is hidden from the students.



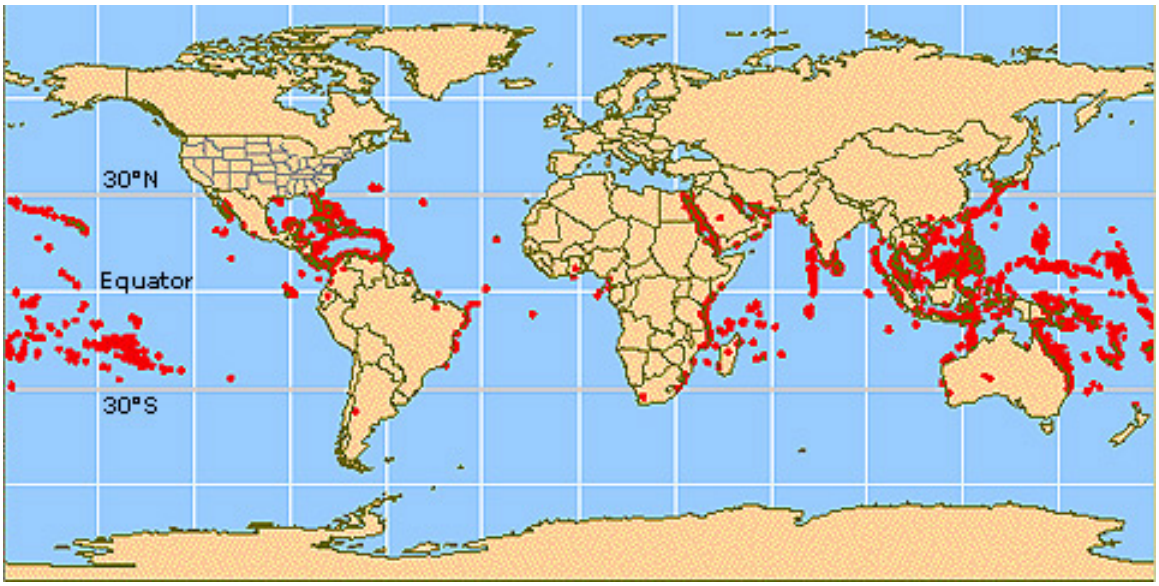
Engage (15 minutes)

1. Lead the students in a discussion about corals and coral growth.

Q. What do you know about corals? Where do they grow?

Q. How do corals grow? What do they need to survive?

2. Be accepting of all responses from the students.
3. After a minute or two, and depending on what the students already know, share some information with them that you feel they need to know to understand the activity of the day. Make sure students understand:
    a. That corals are animals and not plants.
    b. That they live mostly around the equator.



c. That corals build their skeletal structure (grow) by removing calcium and carbon (in bicarbonate) from the surrounding seawater to make calcium carbonate. This is done through a process called **calcification**: $Ca^{2+} + 2HCO_3^- \rightarrow CaCO_3 + CO_2 + H_2O$.

d. Corals need food to eat (zooplankton), calcium and carbon in the water to make their skeletal structures, temperatures that are warm enough to live in but not so hot that they kill the zooxanthellae (phytoplankton) that live within the corals.

4. Then pass out the images of the different coral morphologies. Ask the students:

Q. What could cause differences in how individuals of the same species of coral look in different places?

5. Have the students brainstorm in small groups why the corals may look differently from one another, but make sure to tell the students that all of the images are of the same species of the hard coral *Stylophora pistillata* in the Red Sea (just taken from different depths).

6. After a few minutes pull the students back together and have them share their thoughts. Be accepting of all answers.

a. Make sure the students eventually understand that corals of the same species take on different morphology (shape, orientation, color, etc.) under different environmental conditions. This is an example of a species adapting to its environment. Some of the observable differences from the images include:

	Shape	**Orientation**	**Color**
Shallow	Pointy	Vertical	White
Deep	Fan-like	Horizontal	Brown

Explore (20 minutes)

1. Explain to the students that they will be taking a closer look at one variable that affects coral growth in relation to depth. In fact they will be making their own plots of this variable with depth to look for patterns in the data and looking for the relationship between this data and the differences in coral growth they observed in the images.

2. Explain the data preparation portion of the investigation to the students:

a. In a few moments they will receive a data table of the average Daytime Calcification and Depth categories from the Red Sea.

b. Before they obtain the data, however, they need to come up with a hypothesis about the relationship between daytime calcification and depth. They should use their prior knowledge about calcification and carbon in the ocean, but should NOT look at the data.

3. Ask the students what did they decide about calcification and depth? Call on different students or student groups to share their opinions. Allow them to discuss for a few minutes but stress that they do NOT need to come to a consensus as a class.

4. Explain the data plotting and interpretation portion of the investigation:

a. First, the students should look at the calcification and depth data.

b. Ask the students:

i. What kind of graph will we use? (Bar graph)

ii. What is the x-axis? (Daytime Calcification)

iii. What is on the y-axis? (Depth)

c. Then the students should plot the data. (Note – If applicable, have your students also plot the standard deviation for the averages to support their understanding that there is always variation around an average value.)

d. Have the students look at the graph to find the pattern in the data and complete the student worksheet.

5. As the students finish their graphs and answering the questions on the student worksheet, ask them to write responses to:

Q. Looking at the pattern between calcification and depth, what can that tell us about how corals grow in deeper waters?

Q. How could the changes in coral growth in deeper waters relate to the observed differences in coral growth patterns from the images?

Q. What might happen to the coral populations if some corals can no longer grow in shallow areas because the water temperature is too hot? What would the corals look like?

Make Sense (10 minutes)

1. After a few minutes of writing their responses, tell the students that we are going to interpret and analyze the data as a class.
2. Have the students report out what patterns they observed in the calcification data with respect to depth. Make sure to have the students support their statements of the patterns by stating what evidence they are using. Help the students see that calcification decrease with depth.
3. Lead the students in a discussion about these observed patterns and the coral growth differences with depth. Some discussion points you might want to hit on:

   a. Help the students think about what it means for coral growth at depth if calcification is decreased at depth.

      Corals are not able to grow as well because of many factors: a decreased efficiency in making their skeletal structures, which reduces the amount of carbon dioxide and water that they produce, which means there is less carbon dioxide available for the zooxanthellae to use during photosynthesis, additionally at greater depths there is less light, so the zooxanthellae are less able to complete photosynthesis, so they produce less sugar, lipids, and oxygen that the corals need to grow.

   b. Then help the students think about why it is important for scientists to understand these natural variations in coral growth across a depth gradient currently.

      By understanding these variations scientists are able to put together a clearer picture of what is the natural range of processes and adaptations that exist within a population. Understanding these variations enables scientists to observe new variations and make predictions about what might happen under different conditions in the future.

   c. Help the students think about what this means for coral growth if the sea surface temperature continues to rise with climate change so that corals can no longer live at the surface. (Note – this is a brainstorming activity, there are no correct answers.)

      In general if the sea surface temperature rises, corals will not be able to survive in the shallower areas of their range. Corals at a greater depth will be less affected, as it is cooler

with depth, but those corals do not grow as well. Therefore, the shallow coral morphology may be lost and the surviving corals will not grow as well overall.

4. Once the discussion slows down, point to the motivating questions and ask:
   Q. What do scientists study that affects coral growth? What does that information tell us about how corals will adapt to the changing climate?
5. Ask students to share their ideas about the questions with a partner. After a minute, ask volunteers to share the ideas they discussed with the entire class. Be accepting of all responses from the students. This is your opportunity to make sure the students understand the "take home message".
6. Ask if the students have any final questions about the activity, graphing, or relationship between coral growth and climate.

Corals Growth & Skeletons

Name: _____

Date: _____

Coral Data Table –

Depth Category	Daytime Calcification (µmol CaCO3/cm2*hr)	Daytime Calcification Standard Deviation (STD)
Shallow	0.31	0.13
Deep	0.08	0.03

Use the data above and the images of the corals to answer the following questions.

1. Describe the overall pattern between calcification and depth. What happens to the calcification as you get into deeper water?

Writing Prompts:

Q. Looking at the pattern between calcification and depth, what can that tell us about how corals grow in deeper waters?

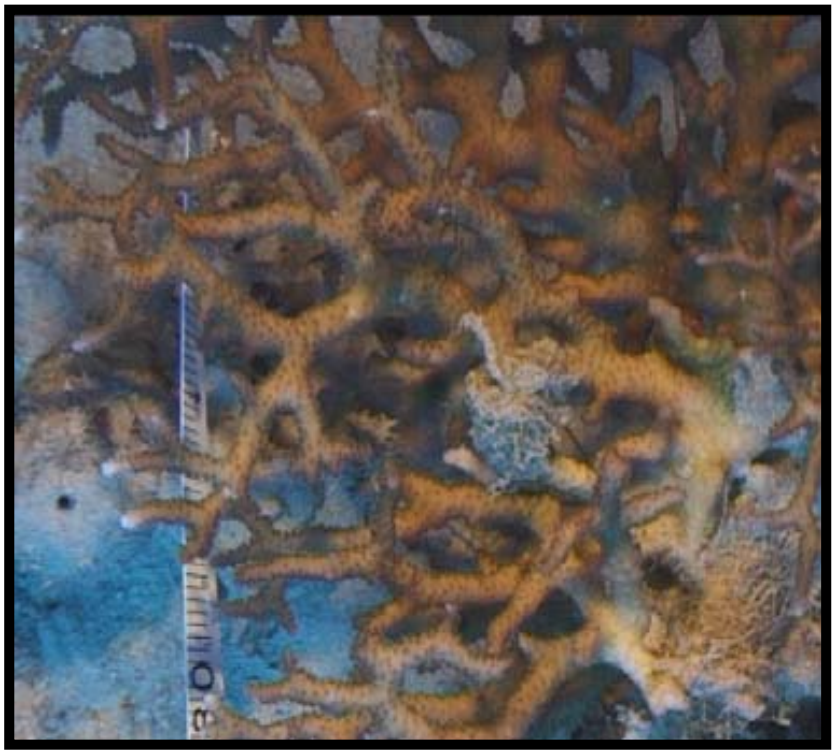
Q. How could the changes in coral growth in deeper waters relate to the observed differences in coral growth patterns from the images?

Q. What might happen to the coral populations if some corals can no longer grow in shallow areas because the water temperature is too hot? What would the corals look like?

Corals Growth & Skeletons: Coral Images

Shallow

Deep



Images of the hard coral *Stylophora pistilla* in the Red Sea.

Corals Growth & Skeletons

Name: _____
Date: _____

Use the data above and the images of the corals to answer the following questions.

1. Describe the overall pattern between calcification and depth. What happens to the calcification as you get into deeper water?

Calcification decreases in deeper waters.

Writing Prompts:

Q. Looking at the pattern between calcification and depth, what can that tell us about how corals grow in deeper waters?

Because calcification decreases, corals are not able to grow as well in deeper waters. They cannot make as much calcium carbonate for their skeletal structures.

Q. How could the changes in coral growth in deeper waters relate to the observed differences in coral growth patterns from the images?

Corals in deeper waters cannot grow as well, so they change their shape in deeper waters to adapt to the environment of lower amounts of carbon to help them maximize their growth. A more horizontal shape increases the volume of water (and thus carbon) that is available to the corals for calcification and growth. In addition, the zooxanthellae that live within the coral polyps have more dark pigment that helps them trap light for photosynthesis, which is harder at deeper depths, and make more of the sugars, lipids/fats, and oxygen that the corals need to grow. That is why the deeper corals are a darker color.

Q. What might happen to the coral populations if some corals can no longer grow in shallow areas because the water temperature is too hot? What would the corals look like?

If corals can no longer grow in shallow areas, then the white vertical shape of the corals would be lost from the population and only the brown horizontal shapes would remain. Also, the corals would not be able to grow as well overall because they would be at deeper depths with lower amounts of calcification.