

STANDARDS

- <u>CCSS</u>: RST.9-10.1, 2, 3, 4, 5, 7, 8, 10; RST.11-12.1, 2, 3, 4, 8, 10; SL.9-10.1, 2, 3, 6
 SL.11-12.1, 2, 3, 6
- **<u>NGSS</u>**: HS-ESS2-1, HS-LS2-6
- <u>OLP</u>: 5.B.7, 5.B.8, 5.C.33, 7.A.5, 7.C.2, 7.C.3

ONLINE CONTENTS

- Reef Zonation Quiz
- <u>Coral Reef Zones Video</u> Scientists divide coral reefs into zones. They base these divisions on location within the reef and characteristics such as depth, wave action, light intensity, temperature, and water chemistry. Zones of the reef include: lagoon, back reef, reef flat, reef crest, and fore reef.

REEF ZONATION

This lesson is a part of the *Reef Zonation* unit, which explains the characteristics and location of the reef zones. Below is a summary of what is included in the entire unit.

UNIT CONTENTS

A. Background Information

- Reef Zones
- Zonation Patterns
- B. Lessons
 - Watch it! Coral Reef Zones
 - A worksheet to accompany the <u>Coral Reef Zones</u> video

Modeling the Reef

 An art project to research and model a coral reef

GIS Mapping

An activity exploring interactive GIS mapping tools

Read it! Let's Name the Zones

 A worksheet to accompany the <u>Let's Name the Zones, the</u> <u>Zones, the Zones of the Reefs... of Raivavae and Tubuai</u> field blog







LESSON 1

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LEARNING OBJECTIVES

- Identify the three main types of coral reefs.
- Observe the differences between the three main types of coral reefs.
- Describe the vertical zones (and lagoon) for the three main types of coral reefs.
- Build a model of one of the main types of coral reefs, demonstrating the vertical zonation pattern typical of that type.

KEYWORDS

- Abiotic Factor
- Algal Ridge
- Atoll
- Back Reef
- Barrier Reef
- Drop-off
- Fore Reef
- Fringing Reef
- Lagoon
- Patch Reef
- Reef Crest
- Reef Flat
- Reef Front
- Spur and Groove Reef

MATERIALS

- Internet/library
- Shoebox (have students provide) or cardboard
- Thick cardboard or another flat material to use as a base for the clay model – this needs to be water resistant if you want to do the second *Extension* activity
- Paint
- Assorted modeling tools (toothpicks, spoons, forks, wood craft sticks)
- Modeling clay
- Toothpicks
- Scissors
- Construction paper

TEACHER'S NOTES

- Markers
- Watch It! Coral Reef Zones student worksheet
- Lesson 1: Modeling Coral Reefs student worksheet
- Appendix A: Coral Reef Photos

INTEGRATING SUBJECTS

- Art
- Public Speaking

PRIOR KNOWLEDGE

Students will have an understanding of the three main types of reefs. See *Unit 10: Reef Types - Background Information*.

EXTENSIONS

- Have students create a conservation poster about their assigned coral reef, displaying the negative environmental impacts that are occurring, and answering the following: What are the human induced threats that are affecting this reef? Who are the contributors to these threats? What are the negative consequences to these threats? How can we help stop these negative effects? (See *Unit 19: Threats*)
 - Put one or more of the clay models into a clear, plastic container. Add water so that it covers the top of the model. Remove half of the water and discuss what happens when sea level drops. Next, add more water in order to show sea level rise and then discuss the consequences for the future. (See *Unit 12: Reef Formation*.)

EVALUATIONS

- Randomly place the **Appendix A: Coral Reef Photos** around the room. Have students match the clay models to the photos. (You may want to give the models a letter so they can easily write down their answers, matching it to the numbers on the photos.) Students should label each one as a barrier reef, fringing reef, or atoll.
- Have students use the models to create an in depth description of each of the three main types of coral reefs.

STANDARDS

- <u>CCSS</u>: RST.9-10.5, 7; RST.11-12.8; SL.9-10.1, 2, 3, 6; SL.11-12.1, 2, 3, 6
- <u>NGSS</u>: HS-ESS2-1, HS-LS2-6
- <u>OLP</u>: 5.B.7, 5.B.8

PROCEDURE

See next page.

PROCEDURE

Several weeks before the lesson, have students start bringing in shoeboxes. You may want to have those who can, bring in more than one for any students who forget or do not have access to shoeboxes. You only need one per group. If shoeboxes are unavailable, use a piece of cardboard as a backdrop for their model.

- Watch Coral Reef Zones YouTube video (<u>https://youtu.be/1wMrB37_Gvl</u>) and answer questions on Watch It! Coral Reef Zones student worksheet.
- 2. Hand out Lesson 1: Modeling Coral Reefs student worksheet.
- 3. Teach *Unit 11: Reef Zonation Background Information*. Have students answer questions under instruction #1 on their student worksheet.
- 4. Divide students into groups of 3-4 students. Hand out one of the **Appendix A: Coral Reef Photos** to each group.
- 5. Discuss the information in the grading rubric.
- 6. Give students time to research their coral reef. You may want to discuss which websites they are allowed to use.
- 7. Once students have answered the research questions (under instruction #2 on their student worksheet), discuss the various ways students can and cannot use the modeling tools. You may want to approve their answers to the questions under instruction #2 before they are allowed to create their models. Go over the steps in instruction #3 on the student worksheet.
- 8. Give students time to create the shadowbox and a clay model of their reef.
- 9. Label a different corner of the room with each of the three types of reefs (barrier, fringing, or atoll). Have each group present their model, paying close attention to the zonation. After each presentation, have the students vote by moving to the corner of the room that indicates which type of coral reef the model shows. Each time, ask at least one student in each corner why s/he thinks it is that type. Allow students to move after each student speaks, if they change their mind.
- 10. To end the discussion, have students brainstorm the differences in the zonation patterns of each type of reef. Write their answers on the board. Get a student to illustrate each one at the end.







MODELING THE REEF

INSTRUCTIONS:

- 1. Answer the following questions:
 - a. Describe each of the three main types of coral reefs.

- b. What are the different vertical zones found in coral reefs?
- c. How do the abiotic factors differ between the zones? Add your answers to the table below.

Reef flat	Lagoon	Reef crest	Reef front	Back reef

d. How do the biotic factors differ between the zones? Add your answers to the table below.

Reef flat	Lagoon	Reef crest	Reef front	Back reef



2. Research the coral reef assigned to you by your teacher so that you can make a model of it. Answer the following questions:

Name of assigned reef: _____

a. Use the picture provided to sketch an aerial view of your coral reef in the space below.

b. Use the picture provided to sketch a cross section of your reef. You will need to estimate changes in depth. Look at the colors – the darker the blue, the deeper it is, while brown indicates shallow areas.



- c. Label the reef zones in your drawings from a. and b.
- d. Where in the world is your reef located? Be sure to include the name of the ocean where the reef is located, as well as a more specific area description (country, group of islands, etc.).

e. What are some coral species growing on your reef? What do they look like? Use <u>http://www.</u> <u>coralsoftheworld.org/page/home/</u> to explore the region you described in question d.

f. Describe some of the other animals that live on and around your reef. Be sure to include species you would want to put in your shadowbox. Put the information from your answer to question d in the "Geographical Area" box of <u>http://www.marinespecies.org/aphia.php?p=checklist</u> to identify animals found on your reef (click on Distribution in the left hand panel if you do not see this box). You may need to do a further search of the internet to find out more information about the species. You can add a term to the "Limit to taxa belonging to" box, if you would like to find certain types of animals (for instance, enter *Elasmobranchii* here if you want to see what sharks and rays are found on your reef).

- 3. Create your shadowbox.
 - a. Make sure the base that you use for your model fits into the shoebox. It can hang out the side, but needs to be a little bit smaller than the bottom so it can slide in and out. See diagram below.



- b. Paint the back of your box with a sky and ocean water each taking up about 50% of the backdrop. Allow to dry.
- c. Make a model of your coral reef out of the clay you do not have to model the entire reef, but should include a good representation of all of the zones found there. Be sure you match the height of your clay model with the height of the ocean water you painted in your shoebox.
- d. Add fine details to your reef by using the modeling tools provided by your teacher.
- e. Label the different zones of your reef with a small piece of construction paper attached to a toothpick.
- f. When the box is dry, slide your clay model into it.
- g. Get creative add waves, palm trees, clouds, fish, etc. (refer to your answers in #2).
- 4. When directed by your teacher, present your model to the class.



GRADING RUBRIC:

Category	4	3	2	1	Score
Research Drawings	Drawings are neat and informative. All zones are labeled.	Drawings are informative. All except 1 zone is labeled.	Drawings are messy or not informative. 2 zones are not labeled.	Drawings are not present or not useful. 3 or more zones are not labeled.	
Research Questions	All questions (d- f) are answered in complete sentences.	All questions (d-f) are answered.	3 or more of the questions (d-f) are answered.	Less than 3 questions (d-f) are answered.	
Shadowbox Model Size	Clay model is the correct size for the ocean portion of the background.	Clay model is within an inch of the correct size for the ocean portion of the background.	Clay model is within 1-3 inches of the correct size for the ocean portion of the background.	Clay model is more than 3 inches from being the correct size for the ocean portion of the background.	
Shadowbox Accuracy	Model is detailed, and accurate, including all labels.	Model is detailed and mostly accurate, including all labels.	Model is mostly accurate, including most of the labels.	Model is inaccurate with little detail and few to no labels.	
Shadowbox Creativity	There are more than 3 creative details.	There are 2-3 creative details.	There is 1 creative detail.	There are no creative details.	
Presentation Accuracy	Presentation was completely accurate.	Presentation had 1-2 minor errors.	Presentation had some inaccuracies.	Presentation had many inaccuracies.	
Presentation Delivery	Excellent and clear verbal articulation of ideas.	Explained ideas well.	Ideas were well stated, but lacked some clarity.	Ideas were difficult to understand.	
Presentation Follow-up	Student can accurately answer all questions related to the shadowbox.	Student can accurately answer about 75% of questions related to the shadowbox.	Student can accurately answer about 50% of questions related to the shadowbox.	Student appears to have insufficient knowledge about the shadowbox.	
TOTAL				Out of 32:	



INSTRUCTIONS:

- 1. Answer the following questions:
 - a. Describe each of the three main types of coral reefs.
 - Fringing reefs: Found directly off-shore with no lagoons.
 - Barrier reefs: Linear reefs that run parallel to shore with an expansive lagoon between them.
 - Atolls: A roughly circular oceanic reef surrounding a large central lagoon that's usually located in mid-ocean.
 - b. What are the different vertical zones found in coral reefs?
 Reef flat, reef crest, reef front, and back reef. Lagoon may be included, but technically is not a zone.
 - c. How do the abiotic factors differ between the zones? Add your answers to the table below.

Reef flat	Lagoon	Reef crest	Reef front	Back reef
Temperature, light, and salinity vary widely.	Temperature and light depend on the depth and nutrient levels depend on the reef's location.	Receives the highest amount of wave action and may be exposed to air at low tide.	Can have drop- offs, so varies greatly in light and temperature.	Receives low wave action, but can still be exposed to air during low tide.

d. How do the biotic factors differ between the zones? Add your answers to the table below.

Reef flat	Lagoon	Reef crest	Reef front	Back reef
Diversity of corals is lower.	Have patch reefs, seagrass, and a lot of coral rubble and sand.	Corals are strong, but this zone is often dominated by coralline algae.	In the deeper parts, corals are often found with wider growth forms, such as foliose or plating, to catch the light.	A lot of dead coral, due to air exposure.

EXAMPLE OF SHADOW BOX



APPENDIX A ANSWER KEY

- 1. Fringing reef
- 2. Atoll
- 3. Fringing and barrier reef
- 4. Barrier reef
- 5. Barrier reef
- 6. Atoll
- 7. Fringing reef
- 8. Atoll

UNIT 11: REEF ZONATION - MODELING THE REEF APPENDIX A

#1 MILMAN ISLET NATIONAL PARK, AUSTRALIA



#2 TENARARO, FRENCH POLYNESIA



#3 HUANINE, FRENCH POLYNESIA



#4 RAIATEA, FRENCH POLYNESIA





UNIT 11: REEF ZONATION - MODELING THE REEF APPENDIX A

#5 BORA BORA, FRENCH POLYNESIA



#6 MOTU ONE, FRENCH POLYNESIA



UNIT 11: REEF ZONATION - MODELING THE REEF APPENDIX A

#7 MOPELIA, FRENCH POLYNESIA



#8 NIAU, FRENCH POLYNESIA

