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STANDARDS

- **CCSS**: RST.9-10.1, 3, 4, 5, 7, 8, 9, 10; RST.11-12.1, 3, 4, 8, 9, 10; W.9-10.4, 7, 8; W.11-12.4, 7, 8; SL.9-10.1, 3, 6; SL.11-12.1, 3, 6
- **NGSS**: ESS 2.D, HS-LS2-6
- **OLP**: 1.B, 1.B.3, 5.A.2, 5.B.1, 5.B.2, 5.B.5, 5.C.25, 5.C.33, 5.C.34

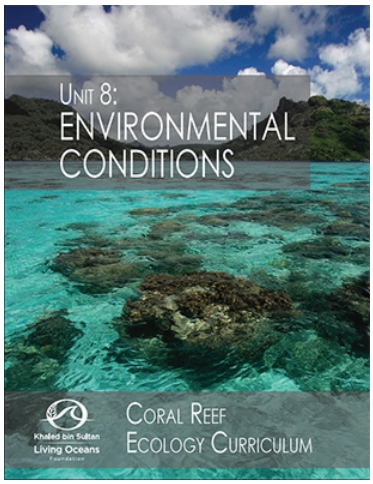
ONLINE CONTENTS

- Environmental Conditions Quiz

ENVIRONMENTAL CONDITIONS

This lesson is a part of the *Environmental Conditions* unit, which explains the abiotic factors that corals need to thrive. Below is a summary of what is included in the entire unit.

UNIT CONTENTS



A. Background Information
   - Environmental Conditions
   - Abiotic Factors

B. Lessons

Conditional Corals
- A lab to evaluate the water quality at potential sites for a new coral reef colony

Deep Conditions
- A lesson to research deep-water corals and compare them to shallow-water corals

Read it! Shivering for Science
- A worksheet to accompany the *Shivering for Science* field blog

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LESSON 2

Teacher's Notes

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LEARNING OBJECTIVE

- Compare and contrast shallow- and deep-water corals.

KEYWORDS

- pH
- Salinity
- Substrate
- Temperature
- Turbidity

MATERIALS

- NOAA lesson *Deep Gardens* (*https://oceanexplorer.noaa.gov/explorations/06davidson/background/edu/lessonplans.html*)
- Internet/library
- **Lesson 2: Deep Conditions** student worksheet
- **Appendix A: Map**

EXTENSION

- Students can compare and contrast the community of organisms that are found on and around shallow- and deep-water corals.

RESOURCE

- NOAA lesson *Deep Gardens* (*https://oceanexplorer.noaa.gov/explorations/06davidson/background/edu/lessonplans.html*)

STANDARDS

- **CCSS**: RST.9-10.4, 5; RST.11-12.4; W.9-10.4, 7, 8; W.11-12.4, 7, 8; SL.9-10.1; SL.11-12.1
- **NGSS**: HS-LS2-6
- **OLP**: 1.B, 1.B.3, 5.A.2, 5.B.1, 5.B.2, 5.C.33, 5.C.34

PROCEDURE

1. Teach *Background Information Unit 8: Environmental Conditions*.
2. Complete *Deep Gardens* lesson from NOAA (*https://oceanexplorer.noaa.gov/explorations/06davidson/background/edu/lessonplans.html*). NOTE: For *Learning Procedure* #2, use the *Background Information* of *Unit 2: Classification* and *Unit 3: Coral Anatomy*.
3. Hand out **Lesson 2: Deep Conditions** student worksheet.
4. Have students fill in the table. Further research may be necessary.
5. Discuss with students whether they think there are areas of the ocean that could support both shallow- and deep-water corals. Once most students have contributed, show **Appendix A: Map** and identify areas of deep-water corals that have been discovered near shallow-water corals.

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LESSON 2 Deep Conditions

INSTRUCTIONS: Fill in the table to compare shallow- and deep-water corals and then answer the questions below.

Ideal Condition	Shallow-water corals	Deep-water corals
Light		
Depth		
Water temperature		
Salinity		
Turbidity		
Nutrients		
pH		
Substrate		

1. Examine the information in the table above. Do you think there may be some areas of the ocean that could support both shallow- and deep-water corals at the same time? Why or why not?

2. How do the growth rates of the two types of corals compare to each other?

3. Why would you not find a shallow-water coral below 70 m depth?

4. Why do we know so much more about shallow-water corals than we do about deep-water corals?

5. List human-caused threats to each of the types of corals.

Deep-water corals	Both	Shallow-water corals

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LESSON 2 Deep Conditions

INSTRUCTIONS: Fill in the table to compare shallow- and deep-water corals and then answer the questions below.

Ideal Condition	Shallow-water corals	Deep-water corals
Light	**Moderate amount**	**Little to none**
Depth	**30 m or less**	**50 m or more**
Water temperature	**16-34°C**	**4-13°C**
Salinity	**23-42 ppt**	**32-39 ppt**
Turbidity	**Low**	**Low to moderate**
Nutrients	**Low**	**High**
pH	**8.0-8.3**	**7.4-7.9**
Substrate	**Hard**	**Prefer hard, but some species can handle soft**

1. Examine the information in the table above. Do you think there may be some areas of the ocean that could support both shallow- and deep-water corals at the same time? Why or why not?
   Answers may vary. Remember that the parameters listed are general guidelines and there are often exceptions to the rule, so there are locations where shallow- and deep-water corals are found close to each other, like in Hawaii and Australia.

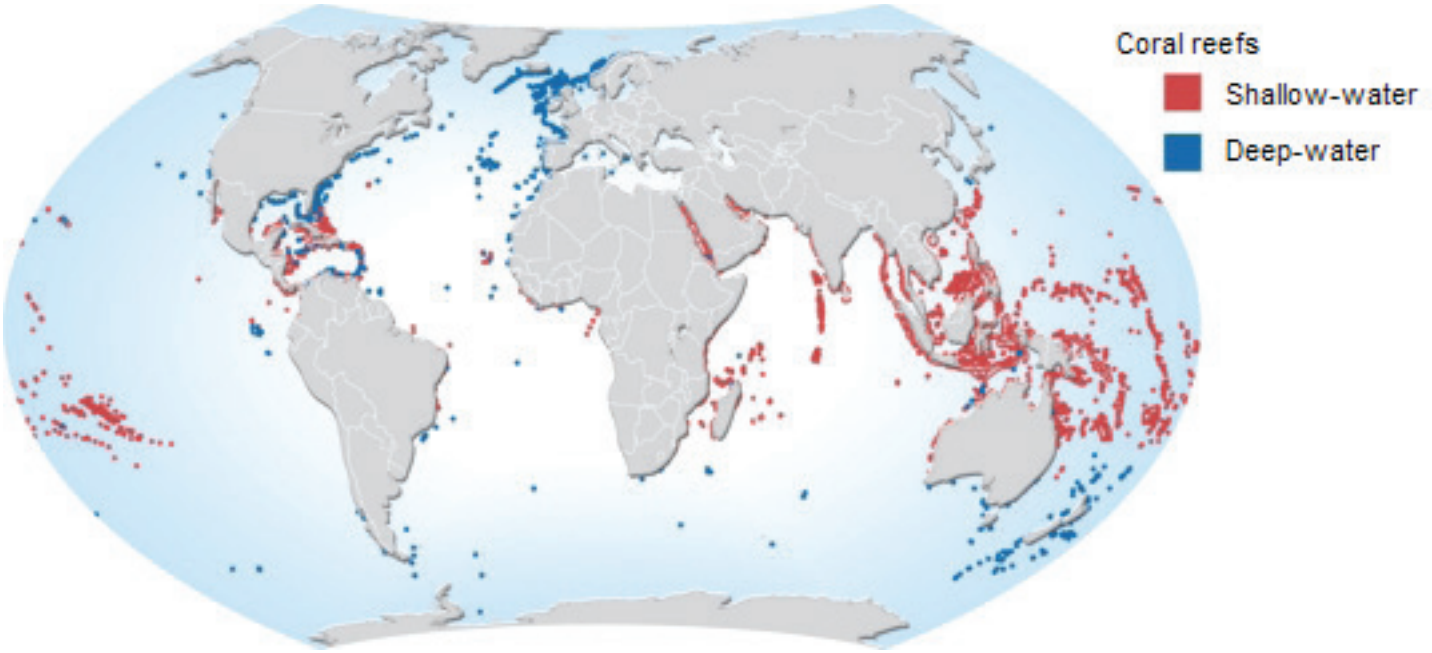
2. How do the growth rates of the two types of corals compare to each other?
   Deep-water corals grow much slower than shallow-water corals (which grow slowly to begin with). This is due to the cold temperatures and the lack of light. Deep-water corals are often very long-lived, with scientists finding one colony that was over 4,000 years old. Shallow-water coral colonies may live for a few hundred years.

3. Why would you not find a shallow-water coral below 70 m depth?
Shallow-water corals generally rely on zooxanthellae for most of their energy. Without enough light, the zooxanthellae cannot perform photosynthesis, so at these deep levels, there would not be enough energy produced to survive.

4. Why do we know so much more about shallow-water corals than we do about deep-water corals?
Due to the lack of light, cold temperatures, and increased pressure, it is difficult to survey deep parts of the ocean for deep-water corals, while shallow-water corals are easily visited with a snorkel or SCUBA gear. Scientists have been exploring shallow-water coral reefs for over half a century, but are just starting to regularly survey areas where they think deep-water corals may exist.

5. List human-caused threats to each of the types of corals.
Answers may vary, but might include the following:

Deep-water corals	Both	Shallow-water corals
• Bottom trawling	• Global warming • Nutrient runoff	• Direct contact



ATTRIBUTION

Adapted from Hugo Ahlenius, UNEP/GRID-Arendal *https://www.grida.no/resources/7197*.