# Unit 1:
# Ecology

Khaled bin Sultan Living Oceans Foundation

## Coral Reef Ecology Curriculum

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This unit is part of the *Coral Reef Ecology Curriculum* that was developed by the Education Department of the Khaled bin Sultan Living Oceans Foundation. It has been designed for secondary school students, but can be adapted for other uses. The entire curriculum can be found online at *lof.org/CoralReefCurriculum.*

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## KEYWORDS

- Abiotic Factor
- Biology
- Biome
- Biosphere
- Biotic Factor
- Community
- Ecology
- Ecosystem
- Emergent Property
- Inference
- Observation
- Organism
- Population

# ECOLOGY

This unit explains what ecologists study and how it applies to coral reefs.

## STANDARDS

- **CCSS**: RST.9-10.1, 3, 4, 5, 7, 8, 10; RST.11-12.1, 3, 4, 10; SL.9-10.1, 2, 3, 4, 6; SL.11-12.1, 2, 3, 4, 6; HSN.Q.A.1; HSS.IC.A.1
- **NGSS**: HS-LS1-2, HS-LS2-6
- **OLP**: 1.B, 5.B.1, 5.B.5

## MULTIMEDIA RESOURCE

- *What is Ecology?* YouTube video (*https://youtu.be/TGR-QGdH3QU*)

## LEARNING OBJECTIVES

- Define ecology.
- Define abiotic and biotic factors.
- Cite examples of abiotic and biotic factors in ecology.
- Define biology.
- List the levels of biological hierarchy in order.
- Define and recognize examples of an emergent property.
- Recognize and list the levels of ecological organization.
- Identify each level of ecological organization by using examples.

## UNIT PROCEDURE

1. Show *What is Ecology?* YouTube video.
   a. Complete **Watch It! What is Ecology?** student worksheet.
2. Teach *Unit 1: Ecology - Background Information*.
   a. Complete **Lesson 1: Factors of the Reef** student worksheet.
   b. Complete **Lesson 2: Backyard Ecosystem** student worksheet.
3. Teach students how to read and critique blogs.
   a. Complete **Read It! Lionfish - Scourge of the Caribbean** student worksheet.
4. Evaluate students using **Unit 1: Ecology Quiz** (found online at *www.lof.org/education/portal/quiz/ecology-assessment-1/*). NOTE: User must be logged in.

# BACKGROUND INFORMATION

Welcome to coral reef ecology! In this unit, we will learn about what ecologists study and how it applies to coral reefs.

Before we begin talking about coral reefs, we first have to understand the meaning of the word ecology. In Greek, this word translates to:

| ***eco*** | ***logy*** |
|---|---|
| οίκος (oikos) | λογία (logos) |
| house | the study of |

So the word ecology translates to *the study of the home*. What's in your house? Can you categorize all of the items you listed as either living or non-living? The answer is yes. Pets, plants, and family members are all living things. TVs, couches, beds, water, air conditioning, radios, cooking utensils, and books are all non-living things (figure 1-1). Who cares if there are living and non-living things in your house? You should! If your house didn't have electricity or running water, how could you cook your meals or take a shower? This interaction of you (living) and the non-living things in your house is all part of the definition of ecology. **Ecology** is the scientific study of the distribution and abundance of life and the interactions between organisms (living) and their natural environment or *home* (non-living).

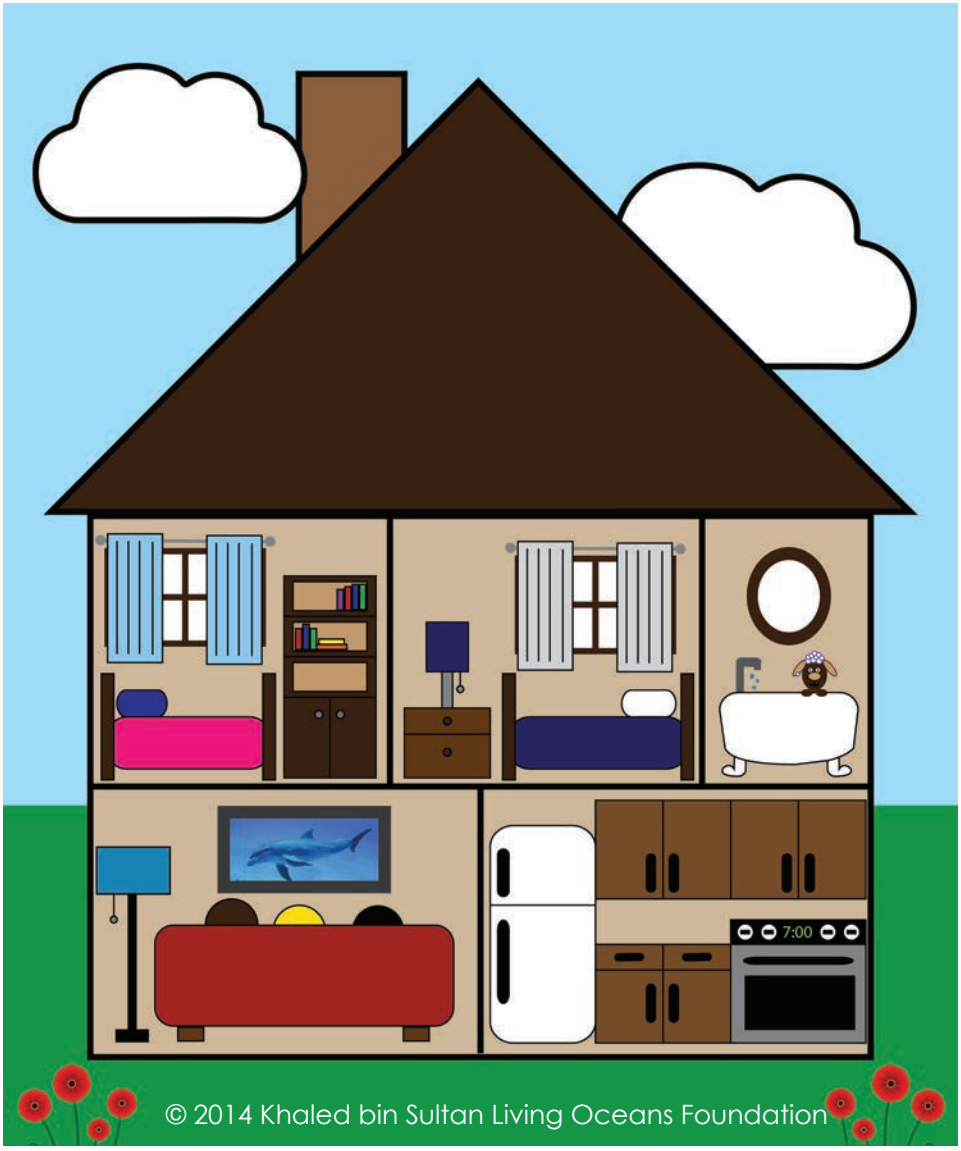



**FIGURE 1-1.** Cross section of a house

Non-living components are referred to as **abiotic factors**. Let's break down the word abiotic:

| ***a*** | ***biotic*** |
|---|---|
| without | life |

Therefore, abiotic means *without life*. Abiotic factors are non-living components of an organism's environment. What do you think biotic means? It means *life*. **Biotic factors** are living or once living components of a community.

The study of ecology encompasses more than all of the living plants, animals, bacteria, and the non-living things like rocks, soil, sunlight, weather, temperature, and water. It also describes how the living and non-living factors interact. Ecology also includes processes such as photosynthesis, cellular respiration, and relationships like mutualism and commensalism (*Unit 4: Coral Feeding*); reproduction (*Unit 5: Coral Reproduction*); life cycles (*Unit 6: Life Cycle*); distribution (*Unit 7: Distribution*); adaptations and evolution (*Unit 13: Evolutionary History*); diversity, abundance, and populations (*Unit 14: Biodiversity*); interactions such as predation, energy movement in a system, and food web dynamics (*Unit 17: Food Web Dynamics*); and natural and man-made influences (*Unit 19:Threats*). Ecology also includes knowledge about the past, present, and future.

Ecology is a branch of **biology**, a natural science concerned with the study of life and living organisms. As we have learned, there are a lot of different topics in this branch of science. Often, ecology is referred to as a multidisciplinary science, which means that other branches of math and science are used to aid in studying and understanding ecology. These include architecture, biology, biophysics, chemistry, climatology, engineering, geology, mathematics, mechanics, and physics. For example, ecologists must use chemistry to help understand chemical cycles such as photosynthesis or the formation of sulfuric acid in volcanic vents. Mathematics is central to ecology and helps us measure things like population size, biodiversity, energy transfer, and distribution of species.

## A) BIOLOGICAL HIERARCHY OF LIFE

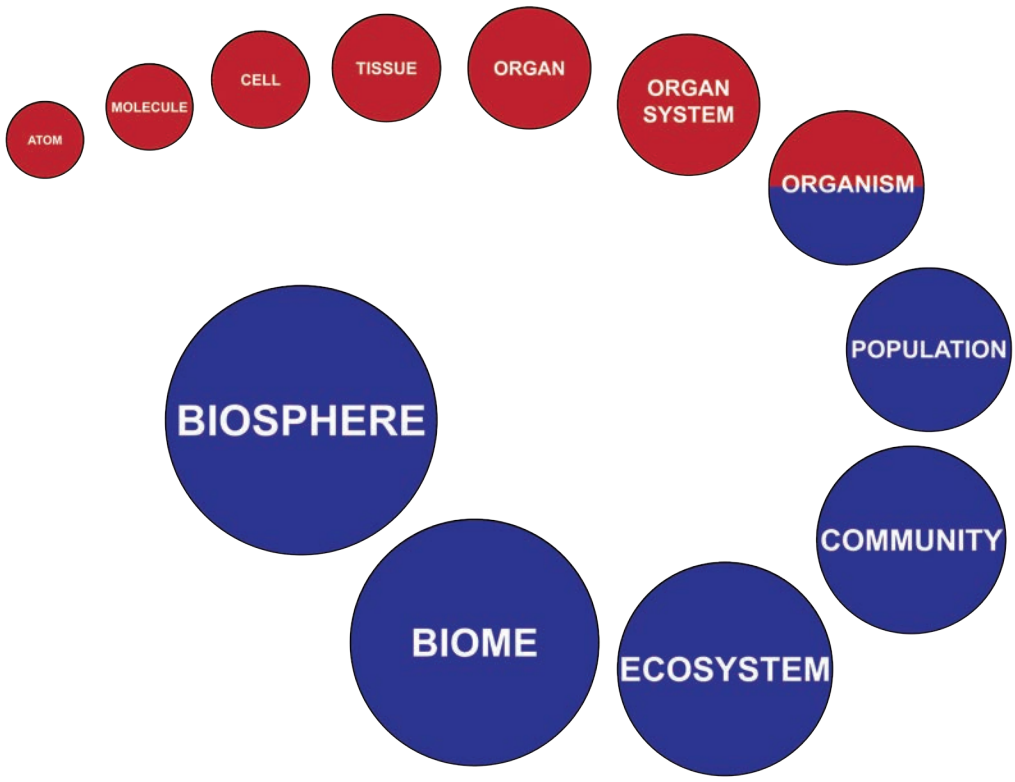



**FIGURE 1-2.** The red circles represent levels of biology and blue circles represent levels of ecology. Notice that the levels are arranged from smallest (atoms) to largest (biosphere).

Biology is organized into a hierarchical system - from small to large (figure 1-2; red circles). These levels are made up of several parts, each a part of the previous level. For example, tissue is composed of many cells. Each level of organization has **emergent properties**. With each level, there is a property that shows up that isn't in the previous level. Therefore, each level becomes more complex than the previous one. Here are two examples:

- Hydrogen (H) and oxygen (O) atoms exist as individual *atoms* (figure 1-3). When two hydrogen atoms combine with one oxygen atom, they form a water *molecule* ($H_2O$). The water molecule is more complex and stable than the individual atoms. A *molecule* emerges from *atoms*.

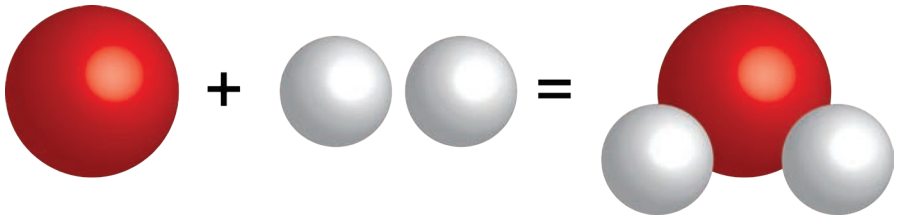


**FIGURE 1-3.** A red oxygen atom (1) and white hydrogen atoms (2) bond, forming a water molecule

- Multiple butterflyfish that live in a defined area are part of a *population*. When other species of organisms, like coral, live in the same defined area, they are part of a *community* with butterflyfish. Some butterflyfish feed on coral. In this example, the emergent property is predation.

## B) ECOLOGICAL LEVELS OF ORGANIZATION

Due to the complexity of ecology, when we study it, it's easiest to organize it into different levels. There are six levels of organization in ecology (figure 1-2; blue circles). Notice that we begin with organism, which is very specific, and continue to biosphere, the broadest description.

Ecologists study each ecological level from the individual organism to the entire biosphere and how each of these levels is interconnected (figure 1-4). The first level of ecology is **organism**, which is most specific and deals only with a single individual. The second level builds onto the first and consists of multiple organisms of the same species that are living in a defined area. This is called a **population**. The third level of ecology is called a **community**. In this level, there are several different populations composed of different species living in a defined area. In the fourth level, ecologists are now taking into account the biotic and abiotic factors of that environment; together they all form an **ecosystem**. The fifth level is called a **biome**, which consists of several different ecosystems that are geographically and climatically defined. On Earth we have 5 main types of biomes: aquatic, desert, forest, grasslands, and tundra. The final level of ecological organization is **biosphere**, which contains all the biomes on Earth.

Using a coral reef ecosystem as an example, let's look at the ecological levels of organization (figure 1-4). In the first box, we have a single *organism* - the butterflyfish. Next, a group of butterflyfish makes up a *population*. A *community* could consist of butterflyfish, hermit crabs, corals, starfish, and even sea slugs. Finally, this *ecosystem* would consist of the living organisms just mentioned, but it would also include abiotic factors such as water temperature, pH, sunlight, salinity (amount of salt in the water), and even water currents (not all pictured). A coral reef ecosystem would be a part of the aquatic *biome*. This biome is just one of many that make up the Earth's *biosphere*.

Coral reefs are classified as *ecosystems*. In the following units, we will be discussing the living organisms and the non-living environment, processes, mechanisms, and relationships that make-up the coral reef ecosystem.

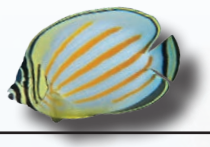
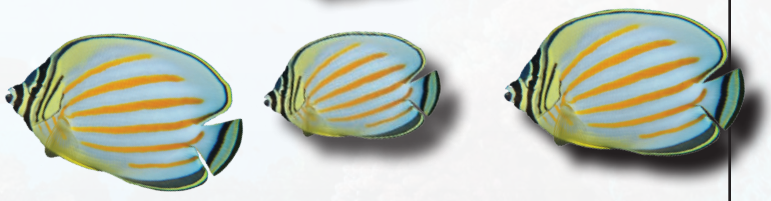
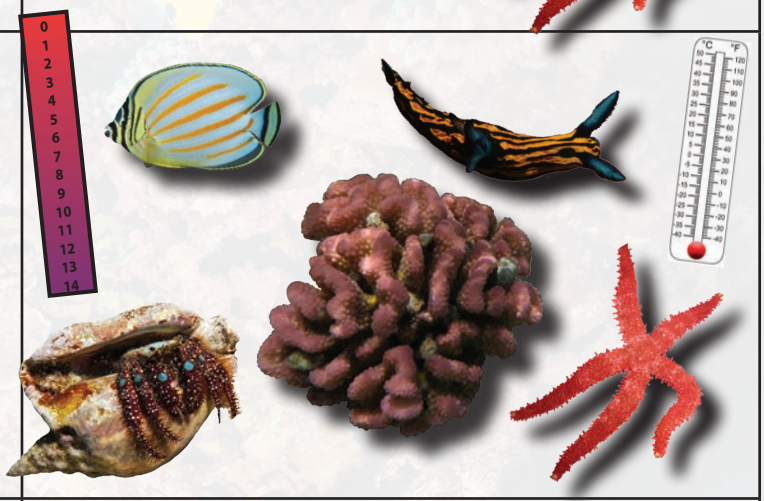
| LEVEL | MEANING | EXAMPLE |
|---|---|---|
| **Organism** | A single species. |  |
| **Population** | Multiple organisms of the same species living in a defined area. |  |
| **Community** | Different populations composed of different species that live in a defined area. |  |
| **Ecosystem** | Include all of the biotic (living) factors and the abiotic (nonliving) factors.<br><br>Some abiotic factors include water temperature, sunlight, pH, salinity, sand, rocks, etc. (not all pictured). |  |
| **Biome** | They are major ecosystems that are geographically and climatically defined. A biome (aquatic) can be made up of multiple ecosystems (coral reefs and mangroves. |  <br>  |
| **Biosphere** | Contains all the biomes on Earth. Again, dependent on biome classification system. |  |

**FIGURE 1-4.** Ecological levels of organization

# ATTRIBUTIONS

**Figure 1-1**. Poppies By Liz Aragon [CC-BY-NC-SA-3.0 (*http://creativecommons.org/licenses/by-sa/3.0/*)] 30 May 2012 via Sweet Clip Art. *http://www.sweetclipart.com/red-poppy-flowers-957*.

**Figure 1-4**. Earth By Azcolvin429 (Own work) [CC-BY-SA-3.0 (*http://creativecommons.org/licenses/by-nc-sa/3.0*)] 21 January 2013 via Wikimedia Commons. *http://commons.wikimedia.org/wiki/File%3A1_Earth_(blank_2).png*.

**Figure 1-4**. Thermometer By Teacher Files [CC-BY-NC-SA-3.0 (*http://creativecommons.org/licenses/by-sa/3.0*)] n.d. via Teacher Files. *http://www.teacherfiles.com/clip_art_thermometers.htm*.

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# WATCH IT! WHAT IS ECOLOGY?

**INSTRUCTIONS:** Watch *What is Ecology?* YouTube video (*https://youtu.be/TGR-QGdH3QU*) and answer the following questions.

1. How is ecology related to biology?

_____

_____

2. 'Oikos-' means _____ and -'logos' means _____.

3. Define ecology.

_____

_____

4. List 10 living and 10 non-living things found inside and/or outside your house.

| Living | Non-living |
|---|---|
| 1. | 1. |
| 2. | 2. |
| 3. | 3. |
| 4. | 4. |
| 5. | 5. |
| 6. | 6. |
| 7. | 7. |
| 8. | 8. |
| 9. | 9. |
| 10. | 10. |

5. What are some animals that can be found living in the coral reef ecosystem?

a. _____ d. _____

b. _____ e. _____

c. _____ f. _____

6. What are some abiotic factors or non-living things that interact with coral reefs?

a. _____ c. _____

b. _____ d. _____

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# WATCH IT! What is Ecology?

## VIDEO TRANSCRIPT:

Ecology is a branch of biology.

The word ecology comes from two Greek words, “oikos” and “logos.” Oikos means house and logos means the study of.

So, ecology is the study of the house or home environment and everything in it.

What’s in your house?

“*In my house there is a cat, hamster, two hermit crabs, bed, couch, tv, carpets, lizard, a refrigerator, four beds, we have sinks, lots of stuffed animals, toothbrushes, three kids and one mom*.”

Around your house might be kids, plants, maybe even a hamster.

These are some of the living things in your environment.

But a lot of things aren’t living, like blocks, tables, books, and shoes, even sunlight.

Ecology explores living things, plus the way they interact with one another and their physical surroundings, whether those surroundings are on land or underwater.

A coral reef is a very special type of home.

It provides nourishment and shelter to an amazing range of living creatures.

Thousands of species of fish can live here, plus turtles, sea urchins, even dolphins – all kinds of marine animals.

They interact with non-living things, like rocks and sand, ocean current, temperature, and much more.

A vast fragile web among living and non-living things makes up the ecology of coral reefs, the home on which the well-being of the surrounding ocean depends.

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# WATCH IT! What is Ecology?

**INSTRUCTIONS:** Watch *What is Ecology?* YouTube video (*https://youtu.be/TGR-QGdH3QU*) and answer the following questions.

1. How is ecology related to biology?

   **Ecology is a branch of biology.**

2. 'Oikos-' means **house** and -'logos' means **the study of**.

3. Define ecology.

   **Ecology is defined as the study of the house and all of the things in it including all living and non-living things.**

4. List 10 living and 10 non-living things found inside and/or outside your house. (**Answers may vary.**)

| Living | Non-living |
|---|---|
| 1. **Dog** | 1. **Shoes** |
| 2. **Fern** | 2. **Refrigerator** |
| 3. **Mom** | 3. **Bed** |
| 4. **Sister** | 4. **Laptop** |
| 5. **Dad** | 5. **Couch** |
| 6. **Spider** | 6. **TV** |
| 7. **Bacteria** | 7. **Keys** |
| 8. **Cats** | 8. **Clothes** |
| 9. **Flowers** | 9. **Books** |
| 10. **Grass** | 10. **Dishes** |

5. What are some animals that can be found living in the coral reef ecosystem? (Answers will vary.)

   a. **Corals**
   b. **Fish**
   c. **Sharks**
   d. **Eels**
   e. **Sea turtles**
   f. **Sea urchins**

6. What are some abiotic factors or non-living things that interact with coral reefs?

   a. **Rocks**
   b. **Sand**
   c. **Ocean currents**
   d. **Temperature**

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# LESSON 1 TEACHER'S NOTES

## AUTHORS

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## LEARNING OBJECTIVES

- Differentiate between observation and inference.
- Classify ecological factors as biotic or abiotic
- Describe interactions between biotic and abiotic factors.

## KEYWORDS

- Abiotic Factor
- Biotic Factor
- Ecology
- Inference
- Observation
- Organism

## MATERIALS

- **Watch It! What is Ecology?** student worksheet
- **Lesson 1: Factors of the Reef** student worksheet
- **Appendix A: Coral Reef Pictures**

## STANDARDS

- CCSS: RST.9-10.4, 5, 7; RST.11-12.4; SL.9-10.1, 3, 4, 6; SL.11-12.1, 3, 4, 6; HSN.Q.A.1; HSS.IC.A.1
- NGSS: HS-LS1-2
- OLP: 1.B, 5.B.1

## PROCEDURE

1. Watch *What is Ecology?* YouTube video (https://youtu.be/TGR-QGdH3QU) and answer questions on Watch It! What is Ecology? student worksheet.
2. Teach *Unit 1: Ecology - Background Information*.
3. In order to reuse the activity, laminate the reef pictures found in **Appendix A: Coral Reef Pictures**.
4. Break students into groups. The activity will work best in groups of 3-4 students. This activity can also be conducted by individual students.
5. Hand out **Lesson 1: Factors of the Reef** student worksheet.
6. Go over *Additional Background Information* on the **Lesson 1: Factors of the Reef** student worksheet. Discuss the difference between observation/inference and biotic/abiotic. Ask students to write the definitions for each on their worksheet.
7. Either assign each group three pictures or set up stations around the room using all six pictures. Groups can rotate to each station.
8. Explain to students that they are going to make observations about a picture of a coral reef. They will identify a factor on the reef and record their observations about it. Remind students that they should use their prior knowledge.
9. Next, students will infer whether the factor is biotic or abiotic. Students can also use evidence related to their observations to explain how they came to their inference. They should identify at least one abiotic factor for each picture.
10. Once each group has finished, instruct them to present their findings for one or more of the pictures (This depends on group size). Each person in the group must present. If students are working individually, have each student present one factor to the class. Students should share what they observed and what inferences were made. Have the class decide whether they agree or disagree with whether the factor is biotic or abiotic. If anyone disagrees, be sure to ask that student why.
11. Have students answer the questions on their worksheet.

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# LESSON 1 FACTORS OF THE REEF

## ADDITIONAL BACKGROUND INFORMATION:

Do you know the difference between observation and inference?

Let's say that one day you're taking a walk along the beach. You look towards the sky to the west and you notice that some very dark clouds are forming, the wind suddenly picks up, and thunder starts to boom. What are your observations? What inferences can you make using this information?

**Observation** is a fact that is learned through the senses. There are five senses: sight, hearing, touch, taste, smell. When walking on the beach you *felt* and could probably *hear* that the wind had picked up. You were able to *hear* the thunder and *see* dark clouds. These are all observations.

**Inference** is based on observations and past experiences. While walking on the beach, you probably inferred that there is a storm on the way. You knew this based on your observations and past experiences of being in a storm.

What is the difference between an abiotic factor and a biotic factor?

Remember that abiotic means without life, so it is the non-living components of an ecosystem, like rocks, temperature, or the sun.

Biotic means living. Most scientists agree that all living organisms

- are made up of at least one cell,
- reproduce,
- have DNA to pass on to the next generation,
- and use energy to perform life functions and maintain their internal environments.

There are other characteristics, like movement, that indicate that an organism is living, but not all organisms have them. Other examples of these characteristics are:

- response to a stimulus,
- complexity,
- and growth/development.

## INSTRUCTIONS:

1. Write the definitions for *abiotic*, *biotic*, *inference*, and *observation* in the space provided below.
2. In *Table 1*, write down the picture number that you were assigned by your teacher.
3. Observe the picture. Record all of your observations in *Table 1*. You should have at least 8 observations per picture.
4. Choose three factors from your observations. Make an inference about whether it is biotic or abiotic. Record this in the right-hand column of *Table 1*. Be sure to include an explanation for why you said this, based on your observations. (NOTE: You should describe at least one abiotic factor per picture.)
5. Repeat steps 2-4 with other reef pictures that are assigned by your teacher.
6. Present the information about one of the pictures to the class.
7. Answer the questions below.

**INSTRUCTIONS:** Fill out the table.

| Term | Definition |
|---|---|
| **Abiotic** | |
| **Biotic** | |
| **Inference** | |
| **Observation** | |

**TABLE 1:**

| Photo # | Observations | Inferences |
|---|---|---|
| 1 | | |
| | | |
| | | |

| Photo # | Observations | Inferences |
|---|---|---|
| 2 | | |
| | | |
| | | |
| 3 | | |
| | | |
| | | |

| Photo # | Observations | Inferences |
|---|---|---|
| 4 | | |
| | | |
| | | |
| 5 | | |
| | | |
| | | |
| 6 | | |
| | | |
| | | |

## INSTRUCTIONS:

1. Did inferences change the way that you classified the factors? Explain your answer and provide an example.

2. Did you classify any of the factors incorrectly? Why did this happen?

3. Write a paragraph explaining three interactions among these factors. Use both observations and inferences to help you with your writing. Your interactions should include:
   - how two biotic factors affect each other
   - how two abiotic factors affect each other
   - how an abiotic factor affects one of the biotic factors

**INSTRUCTIONS:** Fill out the table.

| Term | Definition |
|---|---|
| **Abiotic** | **The non-living component(s) of an organism's environment.** |
| **Biotic** | **The living or once living component of an organism's environment.** |
| **Inference** | **Drawing a conclusion based off of past experiences and observations.** |
| **Observation** | **A fact that is learned through one of the five senses: sight, sound, touch, taste, and hearing.** |

**TABLE 1: Answers may vary.**

| Photo # | Observations | Abiotic/Biotic Inferences |
|---|---|---|
| 1 | • There are a lot of fish.<br>• Some of the fish are blue and some are yellow.<br>• Light can be seen at the surface of the water.<br>• The light looks white.<br>• The water is blue.<br>• The water is rippled at the surface.<br>• The fish at the top of the photo has a rainbow on it.<br>• Rainbows are created from a refraction of light in the water.<br>• There are many types of coral.<br>• Most of the coral is brown, but some is orange and some is red/pink. | Light is not made up of matter or cells, so it is abiotic.<br><br>The water is moving around, so it is biotic. (NOTE: This is an inference that a student could potentially make. However, water is abiotic.)<br><br>The rainbow is abiotic because it is made up of light, which is abiotic. |

| Photo # | Observations | Abiotic/Biotic Inferences |
|---|---|---|
| 2 | • The clam is really big and maroon.<br>• It has a siphon in the center.<br>• Its shell is covered with other organisms.<br>• The human is holding a camera.<br>• The camera is black and has flash bulbs.<br>• The human has blue fins on.<br>• There is a big hunk of yellow coral on the left.<br>• There is green algae growing around the clam.<br>• There is sand on the bottom of the water column.<br>• The sand is white.<br>• There are many things growing out of the sand.<br>• The water is darker blue in the background and aqua close to the sand. | The clam is biotic because it uses its siphon to filter food. Living things need food.<br><br>The camera is made of synthetic materials, such as plastic, so it is abiotic.<br><br>The sand cannot move on its own and does not eat, so it is abiotic. |
| 3 | • The snake takes up most of the picture.<br>• It is S-shaped and has a paddle shaped tail.<br>• The snake is sort of orange colored, with its head darker than its body.<br>• Its eye is open.<br>• There are patterns in the sand.<br>• Currents are the movement of water.<br>• The sand is white.<br>• There is purple coral under the snake.<br>• There are patches of living coral and algae on the rock behind the snake.<br>• There is a bowl-shaped coral on the back of the rock.<br>• It looks like bubbles are coming out of it.<br>• The back part of the picture is darker than the front. | Snakes on land move in an S-shape, so this snake is swimming through the water. Moving things are biotic.<br><br>Currents are putting the patterns in the sand. They are not touchable, so they are abiotic.<br><br>The photographer used a flash. Since darkness is not always there, it is abiotic. |

| Photo # | Observations | Abiotic/Biotic Inferences |
|---|---|---|
| 4 | • There are many types of corals.<br>• Some look like fingers reaching up.<br>• Others are round.<br>• Most of the coral is tan colored.<br>• There are many things growing on the corals, like the green and pink blobs between the fingers.<br>• There are many types of fish in the background.<br>• Some of them are multicolored.<br>• The water is blue with lighter patches at the top.<br>• There are little dots all over the water column, catching the light.<br>• The sand on the bottom is white.<br>• The coral to the left of the center is making a shadow on the sand.<br>• Shadows form when light is blocked by an object. | Corals are abiotic because they cannot move and they look like rocks.<br>(NOTE: This is an inference that a student could potentially make. However, coral is biotic.)<br><br>The dots in the water column are plankton, which is a character on Sponge Bob, so it is biotic.<br><br>Shadows are not always there, so they are abiotic. |
| 5 | • The water is a light blue.<br>• There is a spot of white light at the top of the photo.<br>• The corals are little branching mounds.<br>• They are many different colors.<br>• There are two yellow and black fish at the front of the photo.<br>• More fish are in the background.<br>• The fish are at different depths and different angles.<br>• There is green algae that looks like lettuce growing between the corals in the front, right of the photo. | It is sunny and warm here. Temperature is not tangible, so it is abiotic.<br><br>The fish are swimming around. Moving things are biotic.<br><br>The green color of the algae means it does photosynthesis, so it is biotic. |
| 6 | • Bubbles are clumped up near the top of the photo.<br>• There is a school of black-striped fish.<br>• There is coral on the bottom half of the photo.<br>• It is tan colored and bumpy.<br>• There is a black and orange fish under the human.<br>• The human is holding a camera.<br>• She has a blue tank with a yellow and green label and a black bottom on her back.<br>• Her legs are spread apart. | The bubbles are floating up from the person so probably contain carbon dioxide. They are abiotic.<br><br>The tank is made of metal and filled with oxygen, so it is abiotic.<br><br>The human is kicking to move through the water, so she is biotic. |

**INSTRUCTIONS: Answers may vary.**

1. Did inferences change the way that you classified the factors? Explain your answer and provide an example.
   **Inferences changed the way that I classified factors as biotic or abiotic. Without this previous knowledge, I might have classified the organisms differently. For example, I know that fish are vertebrates. Vertebrates are animals and therefore they are living or biotic.**

2. Did you classify any of the factors incorrectly? Why did this happen?
   **I classified water as biotic. I thought it could move on its own and things that move are living. I classified coral as abiotic. I thought it was a rock which is not living.**

3. Write a paragraph explaining three interactions among these factors. Use both observations and inferences to help you with your writing. Your interactions should include:
   - how two biotic factors affect each other
   - how two abiotic factors affect each other
   - how an abiotic factor affects one of the biotic factors

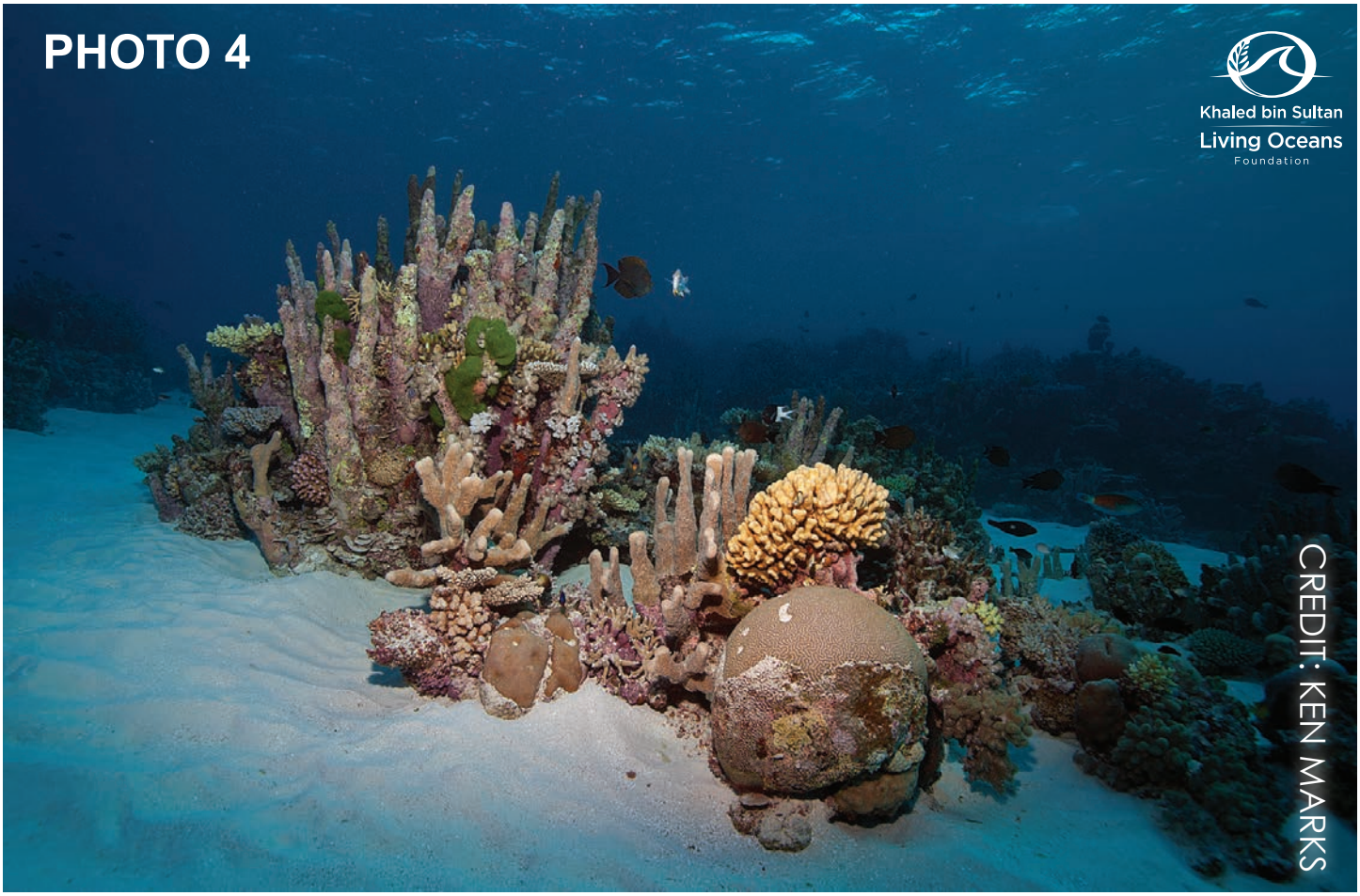
   **Biotic and abiotic factors can affect each other. For instance, a sponge (biotic) may try to grow on a coral (biotic), which could kill it. The water (abiotic) can move sand (abiotic) around so it is in different places and shapes. Finally, the sun (abiotic) helps the coral (biotic) get energy.**

## PHOTO 1


## PHOTO 2

## PHOTO 3


## PHOTO 4



## PHOTO 5


## PHOTO 6

Khaled bin Sultan Living Oceans Foundation

# LESSON 2 Teacher's Notes

## AUTHOR

- Amy Heemsoth, Khaled bin Sultan Living Oceans Foundation

## LEARNING OBJECTIVES

- Draw an ecosystem.
- Identify and record the abiotic and biotic factors that make up an ecosystem.
- Record observations and inferences.
- Identify plants and animals.
- Graph data and draw conclusions based on evidence.

## KEYWORDS

- Abiotic Factor
- Biotic Factor
- Ecosystem
- Inference
- Observation
- Organism

## MATERIALS

- 33 feet (10 meters) string
- Ruler or measuring tape
- Pencil or colored pencils
- Camera (optional)
- Binoculars (optional)
- Magnifying glass (optional)
- Microscope (optional)
- Internet/library
- **Watch It! What is Ecology?** student worksheet
- **Lesson 2: Backyard Ecosystem** student worksheet

## PRIOR KNOWLEDGE

- Students will have prior knowledge about adaptations and invasive species.
- For more information about invasive species, have students read *Lionfish: Scourge of the Caribbean* blog (*http://www.livingoceansfoundation.org/lionfish-ccourge-of-the-caribbean/*) and complete student worksheet.

## EXTENSIONS

- If there is time and materials, collect samples such as soil and water and look at the samples under a microscope.
- With the data collected, calculate biodiversity.

## STANDARDS

- **CCSS**: RST.9-10.3, 4, 5, 7; RST.11-12.3, 4; SL.9-10.1, 2, 6; SL.11-12.1, 2, 6
- **NGSS**: HS-LS1-2, HS-LS2-6
- **OLP**: 5.B.1, 5.B.5

## PROCEDURE

1. Teach *Unit 1: Ecology - Background Information*.
2. Watch *What is Ecology?* YouTube video (*https://youtu.be/TGR-QGdH3QU*) and answer questions on **Watch It! What is Ecology?** student worksheet.
3. Explain the difference between observation and inference. Ask students to provide examples. See **Lesson 1: Factors of the Reef** for more information.
4. Discuss with students what type of tools they would use to make observations.
5. Ask students, "What types of observations might you collect? List the answers on the board. Possible answers:
   a. Size, color, shape of leaves, trees, bark, fruit, animals
   b. Animal tracks, nests, feathers, and calls
   c. Soil type
   d. Temperature, time of day, season
   e. Animal behavior (i.e. predation, competition, symbiosis, etc.)
6. Explain the difference between abiotic and biotic factors. Ask students to provide examples of abiotic and biotic factors.
7. Discuss how scientists collect data.
8. Review safety procedures for working in the field.
9. Hand out **Lesson 2: Backyard Ecosystem** student worksheet.
10. Go outside to perform experiment.
11. In class, allow students to research the organisms they found in their ecosystem. Provide identification books and/or access to a computer. **NOTE**: It may be helpful to teach *Unit 2: Classification - Background Information*.
12. Students will then make a bar graph and answer the questions on the student worksheet. **NOTE**: Students can also use Excel to create bar graphs.

Name: _____ Date: _____

Khaled bin Sultan Living Oceans Foundation

# LESSON 2 BACKYARD ECOSYSTEM

## OBJECTIVES:

- Draw an ecosystem.
- Identify and record the abiotic and biotic factors that make up an ecosystem.
- Record observations and inferences.
- Identify plants and animals.
- Graph data and draw conclusions based on evidence.

## MATERIALS:

- 10 meter string
- Ruler or measuring tape
- Pencil or colored pencils
- Camera or drawing materials (colored pencils and sketchpad)
- Other tools (binoculars, magnifying glass)

## PROCEDURE:

1. Choose an outdoor ecosystem. This can be your backyard, a park, a forest, pond, beach, etc.
2. Using your 10 meter string, create a circle around your chosen ecosystem.
3. Second, sketch the ecosystem in the space provided. On the following page name your ecosystem. Be as accurate as possible.
4. Record all of the abiotic and biotic factors of your ecosystem in *Table 1*. When recording the biotic factors list how many of each are present by using tally marks. If you cannot identify certain organisms, take detailed notes about them (color, shape, size, sound it makes, habitat, physical characteristics, etc.), so that you can identify them later. **NOTE**: When possible take photos of the abiotic and biotic factors as well as any observations and inferences that you make. This will come in handy later, especially if you can't identify an organism. It is suggested that you record all of the fast moving organisms first in *Table 1*.
5. Sit down and be as quiet as possible. List all of your observations in *Table 2*. These interactions can occur outside of the circle. Don't forget to include any interactions that you see including organisms interacting with their environment or other organisms.
6. Now based on your observations, make inferences about what you are observing. When making inferences, use your prior knowledge to explain what you are seeing. For example, you observe that the leaves on a maple tree are red, orange, and yellow. Your prior knowledge tells you that the reason that the leaves are changing colors is because it's fall. This is an inference. Write your inferences next to the corresponding observation in *Table 2*. You may not be able to make inferences for all observations.
7. In class, identify each of the organisms (plants and animals) that you found in your ecosystem. Identify each organism to the lowest classification level possible and include the common name. Use your photos or drawings to help you identify these organisms. You may use guide books and the internet to help you. In *Table 3*, make a list of the organisms that you identified including the common name and the lowest classification. Transfer your tallies from *Table 1* to *Table 3*.
8. Label the drawing with the corresponding number for each organism from *Table 3*. For example, if #1 is a shark, then in the drawing, place a 1 next to the shark. Circle the number. If there are more than one of the same types of organism, write the same number next to each one.
9. Create a bar graph including all of the organisms that you listed in *Table 3*. Make sure to label each axis, create a title, and create a scale on each axis.
10. Answer the questions.
11. If you took photos, include your photos in a document and turn them in with your student worksheets.

**INSTRUCTIONS:** Sketch your ecosystem.

**Title:**_____

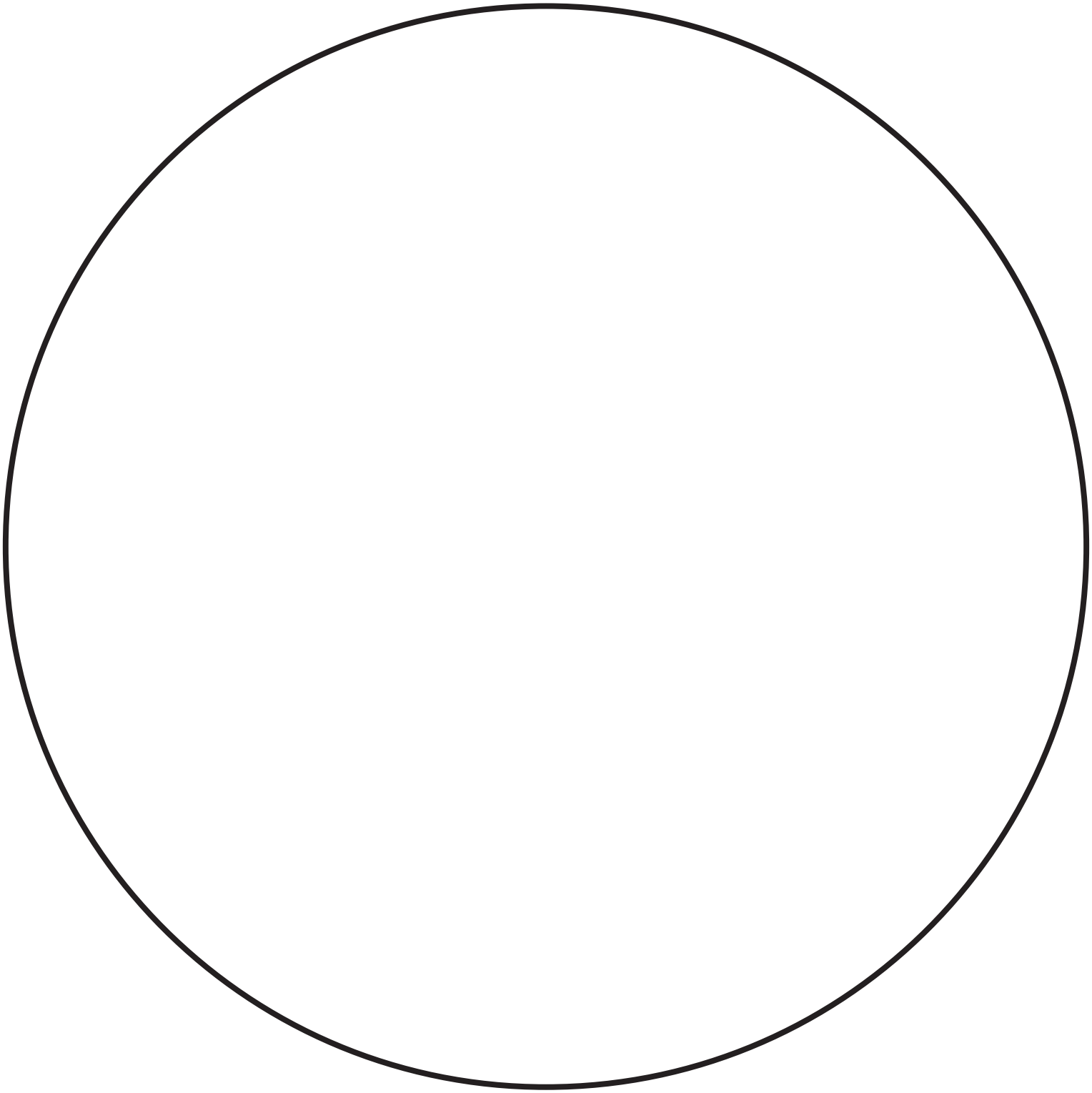


**Table 1:**

| Abiotic Factors | Biotic Factors | Biotic Tally |
|---|---|---|
| 1. | | |
| 2. | | |
| 3. | | |
| 4. | | |
| 5. | | |
| 6. | | |
| 7. | | |
| 8. | | |
| 9. | | |
| 10. | | |
| 11. | | |
| 12. | | |
| 13. | | |
| 14. | | |
| 15. | | |
| 16. | | |
| 17. | | |
| 18. | | |
| 19. | | |
| 20. | | |
| 21. | | |
| 22. | | |
| 23. | | |
| 24. | | |

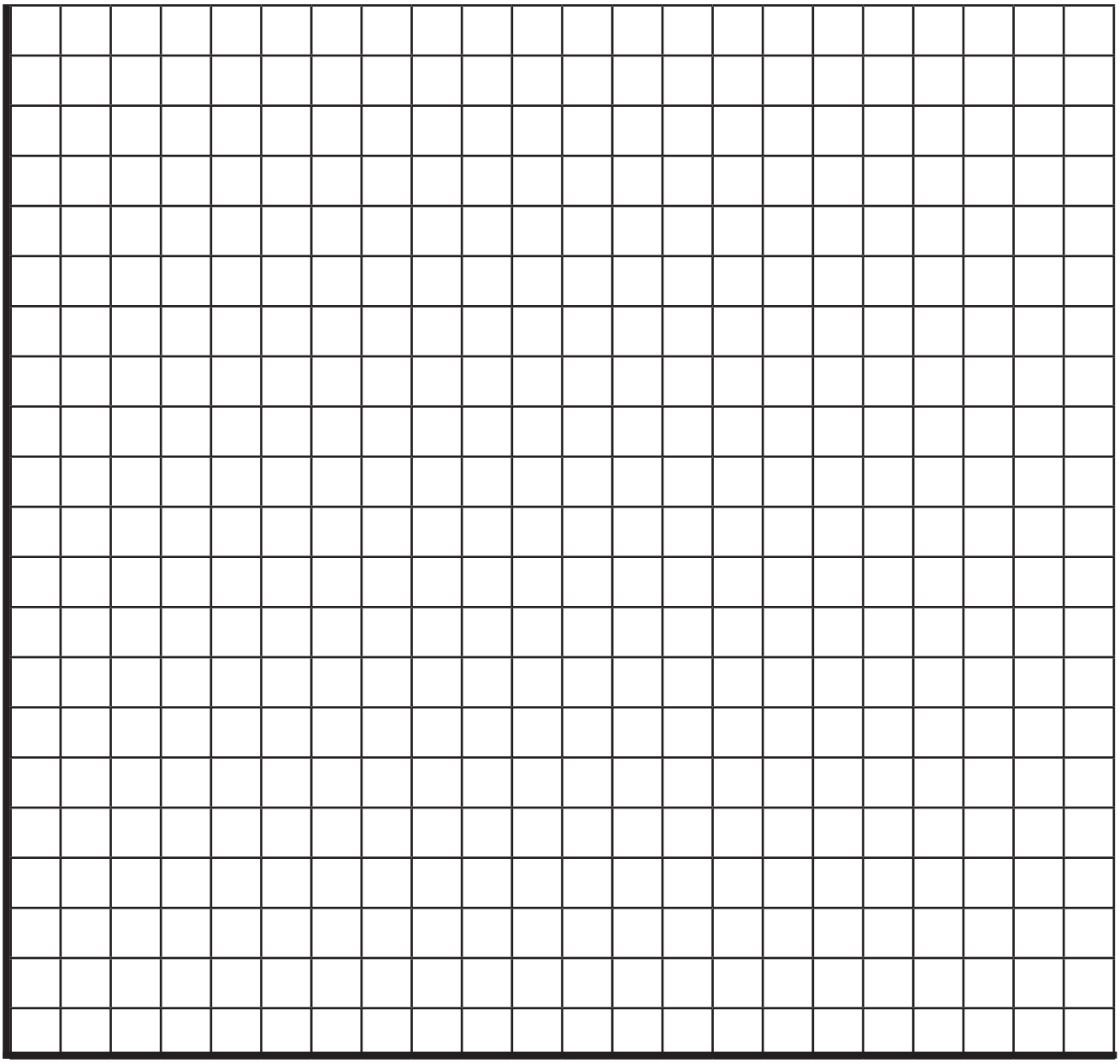
**Table 2:**

| Observation | Inference |
|---|---|
| 1. | |
| 2. | |
| 3. | |
| 4. | |
| 5. | |
| 6. | |
| 7. | |
| 8. | |
| 9. | |
| 10. | |
| 11. | |
| 12. | |

**Table 3:**

| Organism | Number |
|---|---|
| 1. | |
| 2. | |
| 3. | |
| 4. | |
| 5. | |
| 6. | |
| 7. | |
| 8. | |
| 9. | |
| 10. | |
| 11. | |
| 12. | |
| 13. | |
| 14. | |
| 15. | |
| 16. | |
| 17. | |
| 18. | |
| 19. | |
| 20. | |
| 21. | |
| 22. | |
| 23. | |
| 24. | |

**INSTRUCTIONS:** Create a bar graph using the data from Table 3.



**INSTRUCTIONS:** Answer the following questions:

1. Looking at the bar graph, do you think that your ecosystem is diverse? Why or why not? Explain how you came to these conclusions.

2. List three abiotic factors that would exist in most ecosystems.

   a. _____

   b. _____

   c. _____

3. Do you think that the time of day would change the animal and plant interactions? Why?

4. Do you think that the time of year would change the animal and plant interactions? Why?

5. Do you think that there were organisms that you couldn't see? If so, where would you expect to find them?

   a. Do you think that they are important? Explain.

6. Choose two organisms found in your ecosystem. Describe an adaptation that allows these organisms to live in their ecosystem.

   a. Would they survive if you moved them to a different ecosystem? Explain your answer.

7. Did you find any invasive species in your ecosystem? How do you think that invasive organisms affect ecosystems?

8. Did you notice any human interactions? Explain your answer.

9. How do you think that human interactions affect ecosystems? Provide two examples to back up your claim.

**INSTRUCTIONS:** Sketch your ecosystem. **Answers may vary on pages 19-23.**

**Title:** Pacific Coral Reef Wonderland

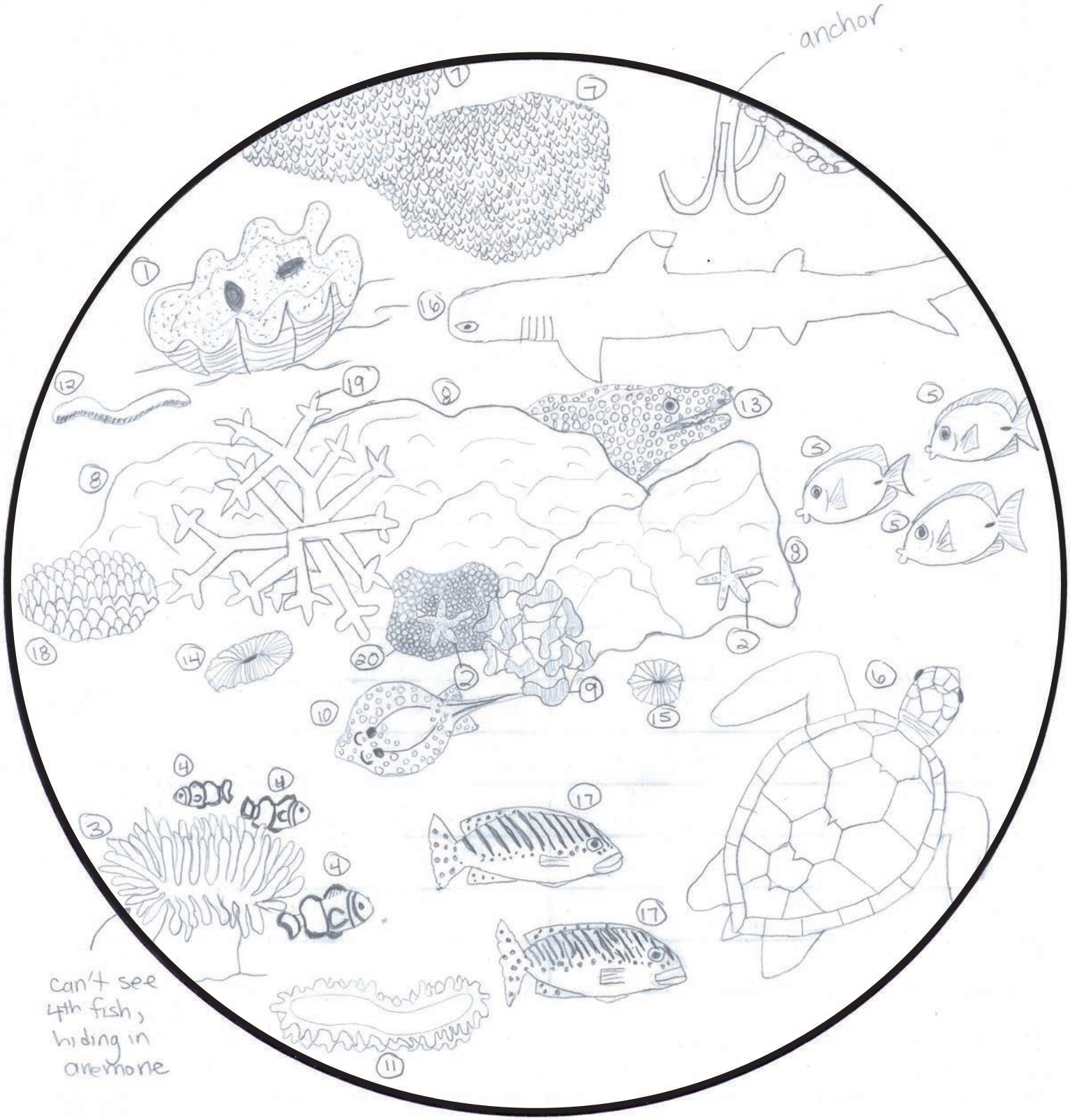


**Table 1:**

| Abiotic Factors | Biotic Factors | Biotic Tally |
|---|---|---|
| 1. Sand | Giant clam | \| |
| 2. Rocks | Stringray | \| |
| 3. Sunlight | Sea turtle | \| |
| 4. Water temperature | Shark | \| |
| 5. Rocks | Blue surgeonfish with yellow pectoral fin | \| \| \| |
| 6. Salinity | Clownfish | \| \| \| \| |
| 7. Weather | Anemone | \| |
| 8. Waves | Blue starfish | \| \| |
| 9. Current | Black sea cucumber with frilly edges | \| |
| 10. Ocean depth | Small, round coral in sand | \| |
| 11. Light | Purple coral with large branches | \| |
| 12. Buoyancy | Roundish coral with small circles all over it | \| |
| 13. Turbidity | Large rock-like corals that are yellow-brown in color | \| \| \| |
| 14. Nutrients | Sea cucumber with pink underside | \| |
| 15. Substrate | Table corals | \| \| |
| 16. Dissolved gases in water | Coral has small knobs or fingers all over it | \| |
| 17. pH | Oblong, small coral in sand | \| |
| 18. Wind | White fish with yellow fins and tail with black spots; diagonal black bars; large lips | \| \| |
| 19. Water density | Brown eel with white spots | \| |
| 20. | Pink coral that has branches and the tips are shaped like lima beans | \| |
| 21. | | |
| 22. | | |
| 23. | | |
| 24. | | |

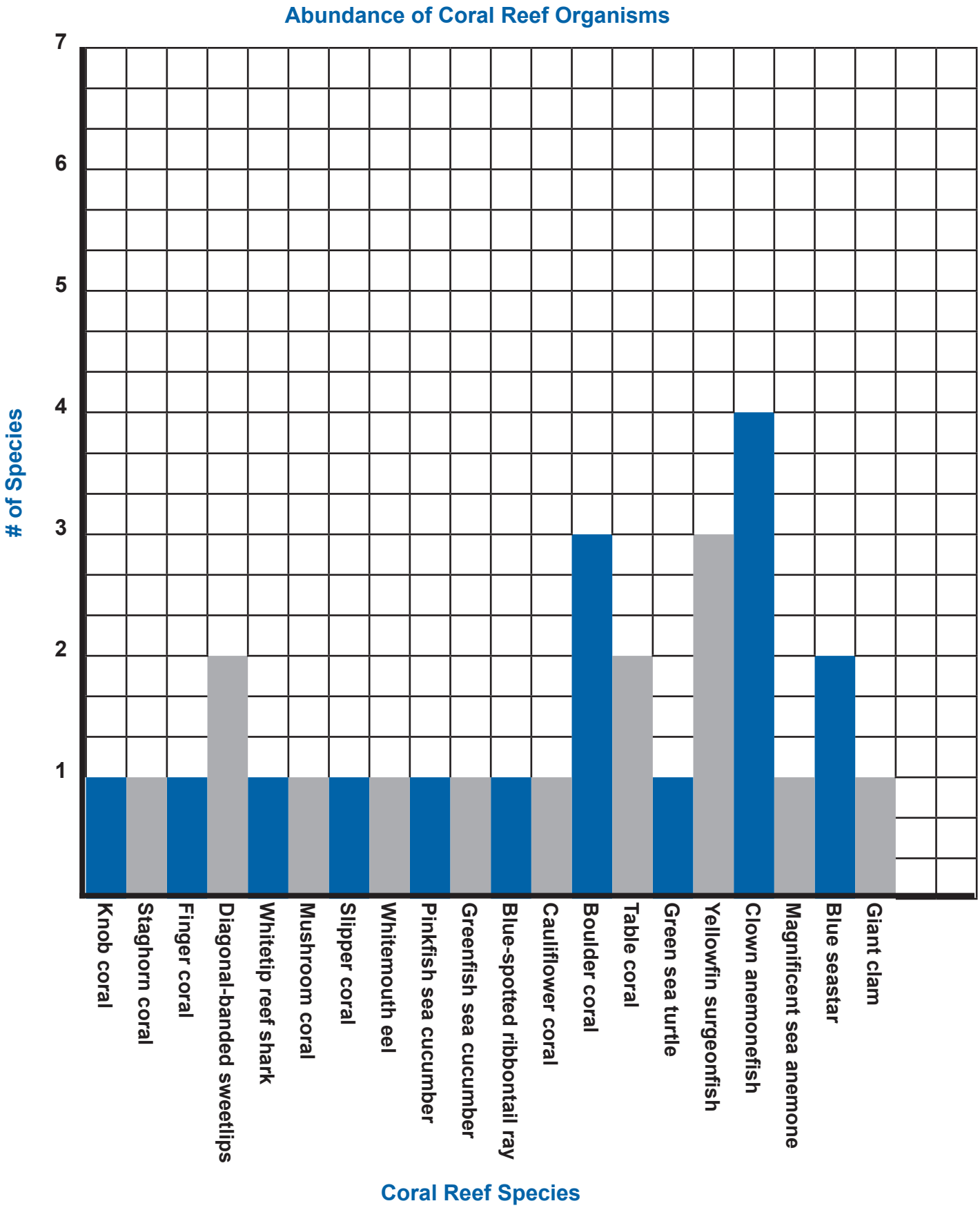
**Table 2:**

| Observation | Inference |
|---|---|
| 1. Sea turtle goes to the surface of the water. | Sea turtles need air to breathe. |
| 2. Clownfish hide in the anemone. | Anemones have stinging cells. Clownfish hide in the anemone to gain protection against predators. |
| 3. Both of the sea cucumbers are in sandy areas. | Sea cucumbers consume sand and eat different things in the sand. |
| 4. The whitetip shark has a white notch on the end of its dorsal fin. | |
| 5. The whitemouth eel's mouth keeps opening and closing. | Eels open and close their mouths in order to pass water over their gills, so that they can breathe. |
| 6. When I put my ears in the water, I can hear crunching. | |
| 7. The blue surgeonfish and sweetlips have different shaped mouths. | Different shaped body part provide different functions. |
| 8. The stingray is sitting on the sandy bottom. | Sting rays' mouths are on the underside of their body and they feed on invertebrates in the sand. |
| 9. The shark's tail moves from side to side. | The tail helps the shark to move forward through the water. |
| 10. The water is salty. | The ocean consists of salt water. |
| 11. Many animals are hiding in the corals. | Coral reefs provide shelter and food for many different organisms. |
| 12. The blue surgeonfish have a white notch near their tails. | |

**Table 3:**

| Organism | Number |
|---|---|
| 1. Giant clam, *Tridacna gigas* | 1 |
| 2. Blue seastar, *Linckia laevigata* | 2 |
| 3. Magnificent sea anemone, *Heteractis magnifica* | 1 |
| 4. Clown anemonefish, *Amphiprion percula* | 4 |
| 5. Yellowfin surgeonfish, *Acanthurus xanthopterus* | 3 |
| 6. Green sea turtle, *Chelonia mydas* | 1 |
| 7. Table coral, *Acropora* sp. | 2 |
| 8. Boulder coral, *Porites* sp. | 3 |
| 9. Cauliflower coral, *Pocillopora* sp. | 1 |
| 10. Blue-spotted ribbontail ray, *Taeniura lymma* | 1 |
| 11. Greenfish sea cucumber, *Stichpus chloronotus* | 1 |
| 12. Pinkfish sea cucumber, *Holothuria edulis* | 1 |
| 13. Whitemouth eel, *Gymnothorax meleagris* | 1 |
| 14. Slipper coral, *Ctenactis* sp. | 1 |
| 15. Mushroom coral, *Fungia* sp. | 1 |
| 16. Whitetip reef shark, *Triaenodon obesus* | 1 |
| 17. Diagonal-banded sweetlips, *Plectorhinchus lineatus* | 2 |
| 18. Finger coral, *Acropora* sp. | 1 |
| 19. Staghorn coral, *Acropora* sp. | 1 |
| 20. Knob coral, *Favia pallida* | 1 |
| 21. | |
| 22. | |
| 23. | |
| 24. | |

**INSTRUCTIONS:** Create a bar graph using the data from Table 3.



**INSTRUCTIONS:** Answer the following questions. **Answers may vary depending on the ecosystem.**

1. Looking at the bar graph, do you think that your ecosystem is diverse? Why or why not? Explain how you came to these conclusions.

   **Yes, the ecosystem is diverse. There are many different types of organisms (in different amounts; abundance) living in the coral reef. There are also many other organisms that were constantly moving around the reef and many others that I couldn't see that were not documented. Additionally, after some research I found that coral reefs are one of the most diverse ecosystems in the world.**

2. List three abiotic factors that could exist in most ecosystems.

   a. **Oxygen**

   b. **Water**

   c. **Temperature**

3. Do you think that the time of day would change the animal and plant interactions in an ecosystem? Why?

   **Yes, many organisms perform different interactions during different times of the day. For instance, some animals are nocturnal. They are most active at night. Nocturnal organisms feed at night and they sleep during the day. Other animals such as plants create food during the day because they need sunlight in order to photosynthesize.**

4. Do you think that the time of year would change the animal and plant interactions in an ecosystem? Why?

   **Yes, throughout the year, the length of day changes due to the tilt of the Earth's axis. During different times of the year there are seasons. Seasons bring a change in the number of hours in the day, weather, and ecology. Animals respond to the changing seasons. In colder climates, some animals hibernate during the winter. Trees and plants shed their leaves and shunt nutrients to their branches, storing them during the winter. Areas near the equator remain relatively warm during the winter months; however, they may receive very little precipitation. Organisms must adapt to these dry conditions. All plants and animals have adapted to living in certain areas. For instance, animals that need to stay warm grow thicker fur. These changes may also bring about differences in feeding, reproduction, migration, and life cycles.**

5. Do you think that there were organisms that you couldn't see in your ecosystem? If so, where would you expect to find them?

   **Yes, there were organisms that I couldn't see. There were organisms that were hiding in the cracks and crevices of the reef. There are also organisms that were buried in the sand. After doing some research, I also found that there are microscopic organisms that are not visible to the naked eye. They include bacteria, phytoplankton, zooplankton, and zooxanthellae.**

   a. Do you think that they are important? Explain.

   **Yes, these organisms are all very important to the food web including the microscopic ones. Many of these microscopic organisms recycle nutrients and are a food source or provide a food source for many other organisms in the food web. Without these organisms, the food web would be out of balance. For example, a symbiotic algae known as zooxanthellae lives inside corals. Zooxanthellae are believed to provide up to 95% of the food that corals need to survive. Without them, most stony corals would die. Without corals, the coral reef would not exist.**

6. Choose two organisms found in your ecosystem. Describe an adaptation that allows these organisms to live in their ecosystem.
   1. **Giant clams cannot move to get food and therefore, they have adapted to these conditions. One of the ways that they get food is by filtering seawater, siphoning out small organisms such as plankton.**
   2. **Clownfish form a symbiotic relationship with anemones. Anemones have stinging cells that harm predators. Clownfish have adapted to living in the anemone. Scientists believe that they produce mucus that protects them from the anemone's sting.**

   a. Would they survive if you moved them to a different ecosystem? Explain your answer.
   **Unless you moved these organisms to an ecosystem that had the same environmental conditions, the organisms would not be able to survive. Organisms have different adaptations that they have acquired over time. It can take hundreds to thousands of years for them to adapt to certain conditions. For example, if you took a stony, warm-water coral and placed it in an area without light, the coral would eventually die, because the zooxanthellae would not have light to photosynthesize, which provides food to the coral. The coral cannot choose to go to an area with light; most corals cannot move.**

7. Did you find any invasive species in your ecosystem? How do you think that invasive organisms affect ecosystems?
   **No, there were not any invasive species in the coral reef ecosystem; however, coral reefs in the Atlantic have invasive lionfish. With few predators these invasives have disrupted the balance on coral reefs. Introduced species often have negative impacts on ecosystems altering their functions. For instance, invasives can out-compete native species causing extinction. Like lionfish, invasives often change the food web by destroying or replacing native organisms in it. Invasives can alter the biodiversity and/or the abundance of species in an ecosystem by replacing native species due to competition, disease, and predation. Invasives can also alter the conditions of an ecosystem. For example, European buckwood (*Rhamnus cathartica, L.*) is a shrub that is an invasive species in Midwestern United States. It is believed to alter the properties of soil, like pH and nutrient content.**

8. Did you notice any human interactions? Explain your answer.
   **Yes, I did notice some human interactions. When I was snorkeling, I noticed an anchor that was left behind. I also noticed that people were accidentally kicking the corals, which could cause harm to the corals.**

   **Depending on the ecosystem chosen, students will have a variety of answers. Answers can include pollution, habitat destruction, runoff, climate change, destructive fishing practices, overhunting, overfishing, deforestation, etc.**

9. How do you think that human interactions affect ecosystems? Provide two examples to back up your claim.

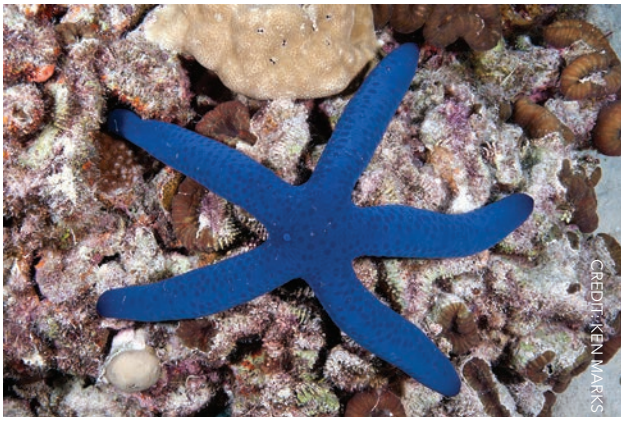
   **Humans can cause negative impacts to ecosystems. These negative impacts can threaten the health of an ecosystem.**

   1. **Destructive fishing such as anchoring on corals, dynamite and cyanide fishing, and fishing gear entanglement causes corals and other animals to die as well as animal's homes to be destroyed.**
   2. **Around the world, mangroves have been cut down to build houses, businesses, roads, etc. Coastal development causes habitat loss for mangroves and the organisms that rely on them for food and shelter.**

**Here is an example of how students can submit their photos.**

**1. Giant clam**


**2. Blue seastar**




**6. Green sea turtle**


**7. Table *Acropora***


**12. Pinkfish sea cucumber**


**14. Slipper coral**


**17. Diagonal-banded sweetlips**


**19. Staghorn coral**

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# READ IT! Teacher's Notes

## AUTHOR

- Melinda Campbell, Khaled bin Sultan Living Oceans Foundation

## LEARNING OBJECTIVES

- Read, interpret, and comprehend a blog.
- Determine how to responsibly use the internet for collecting and responding to information.

## MATERIALS

- Internet access
- *Lionfish: Scourge of the Caribbean* blog (*http://www.lof.org/lionfish-ccourge-of-the-caribbean/*)
- **Read It! Scourge of the Caribbean** student worksheet

## INTEGRATING SUBJECTS

- English Language Arts

## PRIOR KNOWLEDGE

- Students will have prior knowledge about bias and how to critique the validity of websites.

## STANDARDS

- **CCSS**: RST.9-10.1, 4, 5, 8, 10; RST.11-12.1, 4
- **NGSS Practices**: 6, 7, 8

## PROCEDURE

1. Have students read *Lionfish: Scourge of the Caribbean* blog (*http://www.lof.org/lionfish-ccourge-of-the-caribbean/*).
2. While reading, instruct students to take notes, connecting the information to their prior knowledge. They can note things that they agree and disagree with. A space, called *Notes*, is provided for this on the **Read It! Scourge of the Caribbean** student worksheet.
3. Ask students to analyze the blog to determine the elements (like tone or visual design) and content that they like and dislike. Remind students to explain why they like or dislike each element they mention. There is also a space provided for these answers on the student worksheet.
4. Have students answer the questions on their worksheet. When they are looking for definitions, they should use the context from the blog, our glossary, or other online resources. You may want to set rules distinguishing other websites or resources that they are allowed to access.
5. If you set up an online community for your class, have the students post their comment(s) from the last question and allow them to respond to each other. If you do not have an online community, have the students share their comment(s) with each other, either orally or by passing their written responses around the classroom.

Khaled bin Sultan Living Oceans Foundation

# READ IT! SCOURGE OF THE CARIBBEAN

## INSTRUCTIONS:

1. Read *Lionfish: Scourge of the Caribbean*, a blog from our Jamaica mission (*http://www.lof.org/lionfish-ccourge-of-the-caribbean/*).
2. While reading the blog, take notes and connect it to your prior learning. Note things that you agree or disagree with. There is a space, below, for this.
3. Next, document what you like and dislike about this blog into the space below. Be sure to pay attention to things like style and tone, along with the content and visual design. Be sure to *explain* what it is that you do or do not like about each element.
4. Answer the questions.

## NOTES

## LIKES

## DISLIKES

1. How does the first paragraph tie into the rest of the blog (what is its purpose)?

2. What is the problem with lionfish in the Caribbean?

3. What conclusion was made by the author? Cite specific textual evidence to support this.

4. Did the author fully support his claim? Explain why you think this.

5. *Invasive species*, *native*, and *lionfish derbies* are specific vocabulary for the topic of this blog. Define them below.

6. Write a sentence of your own creation that connects the three words from #5, above.

7. Is this blog a reliable source for scientific information? Why or why not?

8. Do you notice any bias in this writing? If so, what?

9. Describe three things that you learned while reading this blog entry (they do not have to relate to the central idea).

10. Construct a comment to post in response to this blog. Remember that a good comment makes connections, asks a question, or gives an opinion in a respectful manner. You might want to quote the part of the blog that you are specifically referring to. Don't be afraid to disagree with another writer, but be sure to explain yourself and remain polite.

1. How does the first paragraph tie into the rest of the blog (what is its purpose)?
   **This is background information about the author's location. It helps connect the reader to the information in the rest of the article.**

2. What is the problem with lionfish in the Caribbean?
   **They are an invasive species. They do not have any natural predators in the area and eat large amounts of native populations, so their population is increased as native populations may be decreasing.**

3. What conclusion was made by the author? Cite specific textual evidence to support this.
   **Lionfish are a problem in the Caribbean so we should try to eradicate them. Students should have specific quotes to back up this claim, which may vary but might include the following:**
   - **"Conscientious divemasters spear them at every opportunity…"**
   - **"...a small patch reef with a resident lionfish had 79% fewer new juvenile fishes than one without..."**
   - **"Scientists fear that the lionfish, with its booming numbers and aggressive tendencies, will lower reef diversity by pushing native species into worse habitats..."**

4. Did the author fully support his claim? Explain why you think this.
   **Answers may vary. Be sure they explain their reasoning.**

5. *Invasive species*, *native*, and *lionfish derbies* are specific vocabulary for the topic of this blog. Define them below.
   - **Invasive species: a species that is not native to an area that is causing harm to the ecosystem.**
   - **Native: naturally belonging to the area described.**
   - **Lionfish derbies: a competition where the goal is to collect as many lionfish from the area as possible in order to remove them from their invaded territory.**

6. Write a sentence of your own creation that connects the three words from #5, above.
   ***Lionfish derbies*** **are competitions where lionfish, an** ***invasive species*****, are collected to try to save** ***native*** **species from a decrease in population.**

7. Is this blog a reliable source for scientific information? Why or why not?
   **Yes. This is a first-hand account of what the author has seen. It is from a reputable organization that is based on scientific research. It also links you to the author's credentials.**

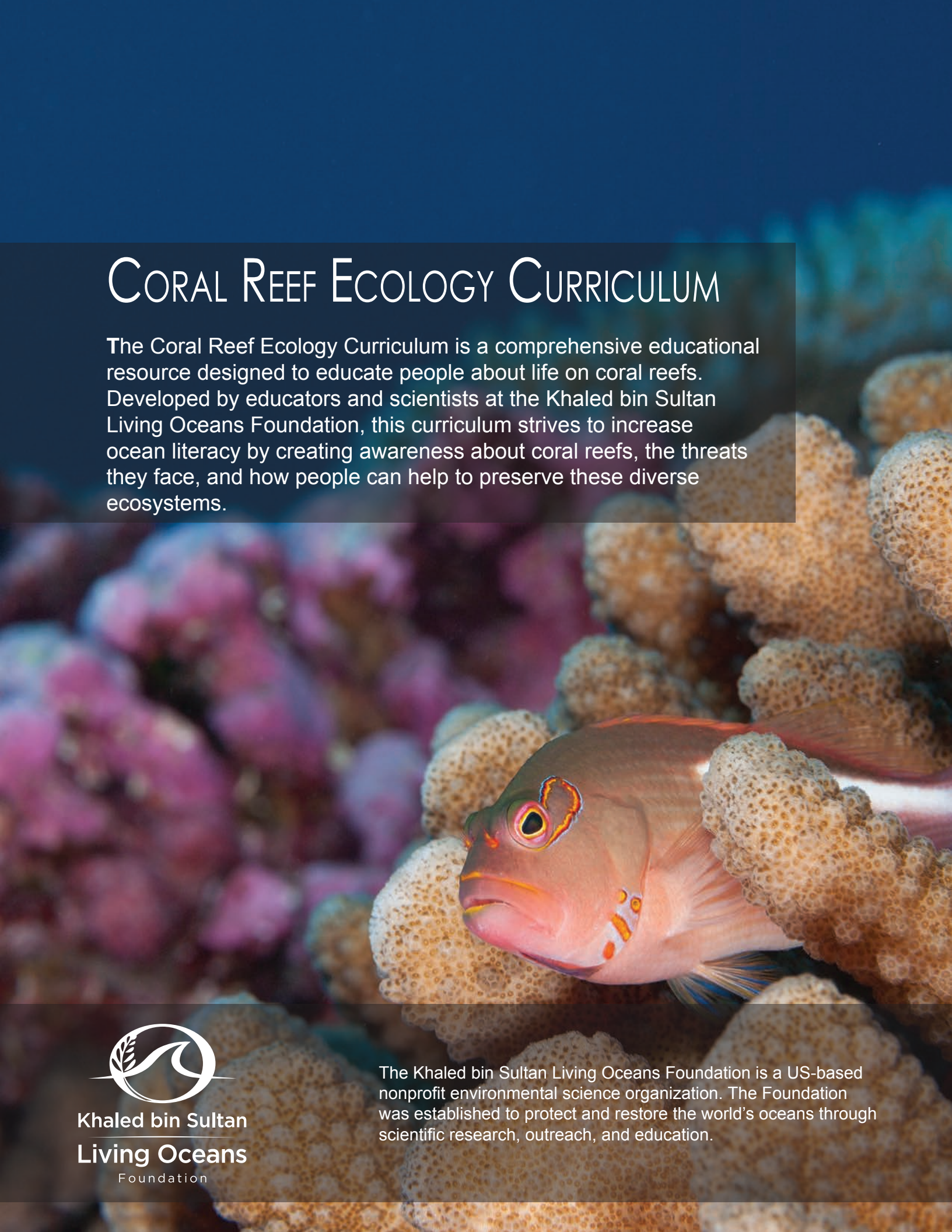
8. Do you notice any bias in this writing? If so, what?
   **Answers may vary, but should mention that it is written from a conservationist stand-point.**

9. Describe three things that you learned while reading this blog entry (they do not have to relate to the central idea).
   **Answers may vary.**

10. Construct a comment to post in response to this blog. Remember that a good comment makes connections, asks a question, or gives an opinion in a respectful manner. You might want to quote the part of the blog that you are specifically referring to. Don't be afraid to disagree with another writer, but be sure to explain yourself and remain polite.
    **Answers may vary.**

# Coral Reef Ecology Curriculum

**T**he Coral Reef Ecology Curriculum is a comprehensive educational resource designed to educate people about life on coral reefs. Developed by educators and scientists at the Khaled bin Sultan Living Oceans Foundation, this curriculum strives to increase ocean literacy by creating awareness about coral reefs, the threats they face, and how people can help to preserve these diverse ecosystems.



Khaled bin Sultan
Living Oceans
Foundation

The Khaled bin Sultan Living Oceans Foundation is a US-based nonprofit environmental science organization. The Foundation was established to protect and restore the world's oceans through scientific research, outreach, and education.