

LOST CITIES

CORAL RESILIENCE LAB

HAWAI‘I INSTITUTE OF MARINE BIOLOGY

ELEMENTARY (3-5) LEVEL

OBJECTIVE

Students will be able to identify what a coral reef is and the benefits they provide for the ecosystem. They will also learn about the importance coral plays in Native Hawaiian culture, as well as understand the threats corals are facing and what they can do to help.



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Curriculum Funded by NOAA's Bay Watershed Education Program (BWET)

This curriculum was developed in accordance with the Next Generation Science Standards (NGSS):

3-LS2-1	Construct an argument that some animals form groups that help them survive
3LS4-3	Construct and argument with evidence that in a particular habitat some organisms can survive well, some survive less well, and some can't survive at all
4-LS1-1	Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction
5-PS3-1	Use models to describe that energy in animals' food (used for body repair, growth, motion, and to maintain body warmth) was once energy from the sun
5-ESS3-1	Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.

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Vocabulary

Coral Reef

Kumulipo

Ko‘a

Akua

Invertebrates

Cnidarians

Nematocysts

Endemic

Colony

Polyp

Zooxanthellae

Symbiosis

Habitat

Coral Bleaching

Preserve

Climate Change

Kuleana

Introduction

Coral reefs are diverse ecosystems found throughout tropical regions that support thousands of species. While coral reefs only cover about 1% of the ocean floor, around 25% of all the fish in the ocean spend some portion of their lives on coral reefs. Half a billion people worldwide rely on coral reef ecosystems for food, protection, and income. It’s been estimated that we’ve already lost 50% of the world’s coral reefs¹, and we may lose 90% by the year 2050². Global **climate change** is the biggest threat coral reefs are facing.

Background

In Native Hawaiian culture, coral is considered to be the foundation of all life. In the beginning of the ***Kumulipo***, the Hawaiian creation chant, the **ko‘a**, or coral polyp, was the first organism created:

Darkness of the sun, darkness of the night

Nothing but night.

The night gave birth.

Born was Kumulipo in the night, a male

Born was Po‘ele in the night, a female

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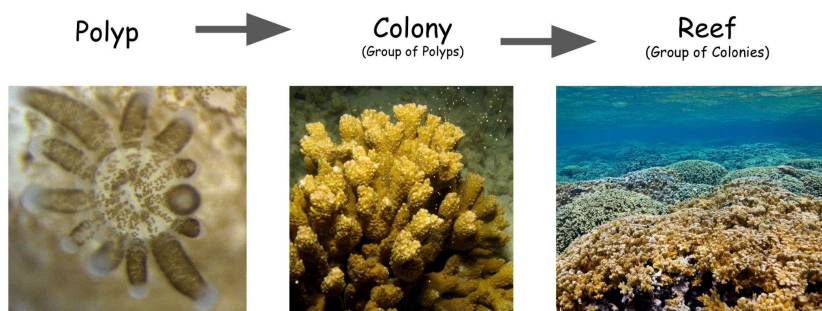
Born was the coral polyp, born was the coral, came forth.

Coral reefs built up the islands in the Hawaiian archipelago, and the coral polyp is the oldest ancestor to all living things. Coral is an **akua**, or a divine spirit, and has many documented uses in Native Hawaiian culture. They were used as tools, medicine, in the building of building *kuʻula* (fishing temples), in games like *kōhane* (similar to modern checkers), and in polishing canoes. Additionally, *Palythoa toxica*, a zoanthid or soft coral, was used as poison on spear points.

Corals are **invertebrates** belonging to the phylum **Cnidaria**, and are “cousins” to jellyfish, anemones, and sea fans and soft corals. Cnidarians are grouped together because they all have a single body cavity and **nematocysts**, or stinging cells on their tentacles. They use these tentacles and nematocysts to protect themselves, and to grab some of their food out of the water column. There are thousands of species of corals throughout the world, but the three lessons included in this curriculum (Lost Cities, [Coastal Protection](#), and [Coral Bleaching](#)) will be focusing on hard corals, which are reef-building corals and are essential to the marine ecosystem in Hawai‘i. Overall, around 70-80 species of hard corals can be found in Hawai‘i. Because the region is so isolated, some of these species are **endemic**, meaning that they are found nowhere else in the world. Some examples include *Porites compressa* (finger coral), *Montipora flabellata* (blue rice coral), and *Psammocora verrilli*³.

A single coral **colony** is composed of thousands of tiny animals called coral **polyps**.

These polyps come from the same parent coral, and grow together to form a coral colony that is attached to a hard substrate. Lots of coral colonies growing together



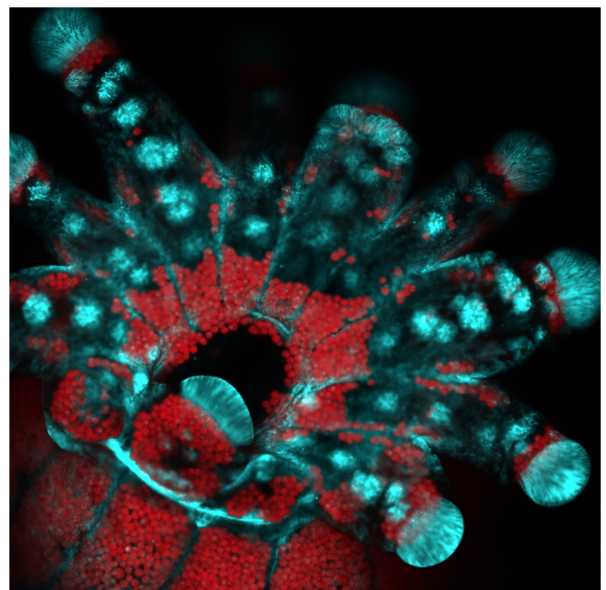
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is called a reef. The coral polyps are connected by a layer of tissue, and each polyp lays down a hard skeleton using chemicals from the ocean. Inside the coral polyp lives tiny algae cells called **zooxanthellae**, which use energy from the sun to provide food for the coral, while the coral provides a home for the algae. This relationship is called **symbiosis**. When corals become stressed, often from water temperatures that are too hot, they get rid of their zooxanthellae, leaving the tissues of the coral animal stretched over its white skeleton. Corals that go through this process are called bleached corals. Once the algae is gone, the coral may not get enough nutrition and can die. But a bleached coral doesn't always end up dying. Coral can survive a bleaching event if ocean conditions return to normal, and the coral is able to recover, but a full recovery could take years.

Coral reefs are some of the most valuable and diverse ecosystems in the world, and provide habitat for millions of marine species by providing food, breeding areas, and protection from other animals. Not only do coral reefs support marine animals, but they help humans too. Because coral reefs support so much life, scientists are able to create medicine from animals that live on the reef, as well as from the coral itself. People from all over the world come to admire the beauty of the coral reefs in Hawai'i, providing revenue and jobs through tourism agencies and recreation. Corals are also important because they protect our homes against the powerful motion of the ocean. Coral reefs buffer about 97%^{4,5} of the energy coming from waves and storms, protecting coastlines and allowing more people to live close to the water. For more information on coral reefs' role in coastal protection, refer to our [lesson](#) on the subject.

Corals are incredibly important to animals in and out of the water, but sadly they are experiencing a lot of stress right now. Various human activities are causing our



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precious coral reefs to die. Some activities harming corals include overfishing, pollution from runoff and debris, and coastal development. The ocean is also becoming warmer due to climate change, making it hard for corals to live comfortably. In fact, 2016 and 2020 are tied for the warmest years on record, which shows that the temperature is continuing to go up⁶.



When a coral is stressed, they get rid of their beneficial algae, leading to **coral bleaching** and even death, but there are ways to help corals. Our [Coral Bleaching lesson](#) goes into detail about this topic.

Actions can be taken on a global and local level to help **preserve** coral reefs. Because climate change is the biggest threat corals face globally, helping to reduce the amount of pollution you produce, and advancing climate solutions is the best thing we can do for coral. Ways to reduce your pollution include reducing your meat and dairy consumption, walking or riding a bike when possible, and recycling or repurposing old items, just to name a few. On a local level, helping corals can start by practicing good ocean stewardship. Clean up the beach if you see trash, and don't disturb corals in the water while swimming or snorkeling. Most importantly, educate yourself and others about coral reefs. Coral reefs help make Hawai'i special, and it is our **kuleana** to help protect these beautiful ecosystems for future generations to come.

Overview

This curriculum will help students understand what coral is, the threats they are facing, and how to help corals. They will also learn about the science being done to help coral using the visual media provided in [Lost Cities](#). Students will also engage in a hands-on activity to create their own coral polyp.

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Materials

- Computers and internet access
- Copies of student worksheets
- Colored paper
- Base paper (can be recycled paper, cardboard, cereal box)
- Tape
- Scissors
- Modeling clay or [playdough](#)

Teacher Prep

- Familiarize yourself with [Lost Cities](#) by going through all of the modules
- Obtain computers for students to work individually or in pairs
- Students will need headphones if not listening as a class

Procedure/Instructions

Part 1: Lost Cities and Introduction to Corals

1. Engage students by explaining they will be choosing their own story while learning about corals
2. Pass out copies of the student worksheet to each student
3. Individually log onto <http://lostcities.org/> on computers
4. Have students follow along with the documentary and answer the questions on the provided worksheet

Part 2: Creating a coral polyp

1. Start by reminding students what a coral polyp is and what lives inside of it
2. Each student can make their own polyp, and will come together in the end to form a coral reef

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3. Procedure for students:
 - a. Roll a piece of colored paper into a tube and tape one end of the tube to secure it
 - b. Cut the other side of the roll into strips about $\frac{3}{4}$ of the way down the roll
 - c. Take about a golf ball-size amount of clay or dough and roll it into a base for your polyp. This is the hard skeleton the coral lays down
 - d. Pinch and mound the dough to the base paper/cardboard
 - e. Roll additional dough into tiny balls. Attach and flatten them to the tentacles of your polyp to represent zooxanthellae
 - f. Once your polyp is created, stick the polyp into the base dough and you're done!
4. Once students finish, bring their polyps together to form a coral reef

Note: Alternatively, students may make their polyps out of clay only. Instructions are below:

1. *Each student will get a golf-ball size ball of clay*
2. *Instruct them to split the clay into two equal parts*
3. *Take one part of the clay and start to build the body plan of the coral polyp by flattening the piece into a rectangle and gently roll it into a cylinder*
4. *This tube represents the stomach and mouth of the coral polyp*
5. *Divide the second piece of clay into two equal parts*
6. *Start making the polyps tentacles by dividing one piece into 12 small rods and attach them to the mouth of the polyp (open end of the cylinder)*
7. *Pinch off tiny pieces of clay and roll them into little dots, placing them all over the coral body, tentacles, and mouth, representing zooxanthellae*
8. *With the remaining clay, flatten into a circle and place the coral polyp body onto it, representing the coral calyx, the hard base where the polyp sits*
9. *Have students bring their coral polyps together and form a coral colony*



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10. *Once the clay is dried, students may paint their polyps*

Part 3: Climate Warriors! What can you do to make a difference?

1. After students are familiar with what coral is and what is happening to them, facilitate a discussion about what they can do to help corals.
2. You may ask the students questions and have them write their answers on the board, or print out these questions and work in groups to come up with answers.

What can **you** do to reduce your impact on climate change and help coral reefs? Brainstorm a few things you do everyday or often. Think about a more sustainable way you can accomplish these tasks and challenge yourself to make the change. Maybe you already do some of these things. If so, what are they (Examples: brushing your teeth, drinking water, what food you consume).

What is one step you can take to combat the effects of climate change in your **community**?

What would you like to tell an **elected official** in your town, country or world about climate change and how we can save coral reefs?

Created by Madeleine Sherman, Coral Resilience Lab, March 2021

Contributions from Maile Villablanca; Coral Resilience Lab, 2022; Hayley Luke; Coral Resilience Lab 2021; and Kailua High School Students: Angela, Taty, Maddie D., Sienna M., and Zoila V.

Lost Cities

Student Worksheet

Instructions:

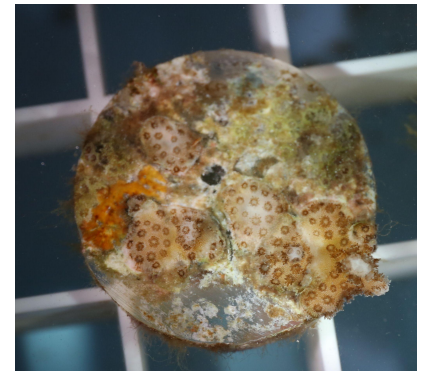
1. Go to <http://lostcities.org/>
2. Click "Begin" and complete all thirteen modules. You can pick the order you watch by clicking on "Story List" in the top right corner.
3. Make sure you read all of the embedded text boxes within each module.
4. Follow along with this worksheet and answer the questions.



Lost Cities Questions

1. A coral is a(n) _____, a _____, and a _____.

2. What does the algae do for the coral?



Group of newly settled coral polyps, attached to a hard surface, and sitting on a tray in the coral lab

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3. Why are coral reefs important for our food supply?

4. What is a bleached coral? Is it dead?

5. What change is happening in the ocean that is making corals bleach?

6. What actions can we take as individuals and as a community to preserve coral reefs?

7. Click on the "Take Action" tab in Lost Cities. List a couple things you can do to help coral reefs:

Dig In Deeper....

1. Why do you think that coral polyps all live together in a colony, rather than each polyp living on its own?



A coral colony in the ocean during spawning

2. What are some of the things corals have that make them better able to survive?

3. Why is sunlight important in helping coral grow?

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Sources Cited

1. Ashworth, James. "Over Half of Coral Reef Cover across the World Has Been Lost since 1950." *Natural History Museum*, The Trustees of the Natural History Museum , 26 Sept. 2021,
<https://www.nhm.ac.uk/discover/news/2021/september/over-half-of-coral-reef-cover-lost-since-1950.html>.
2. Advocate, Responsible Seafood. "Experts: World's Coral Reefs Could Vanish by 2050 without Climate Action - Responsible Seafood Advocate." *Global Seafood Alliance*, Global Seafood Alliance , 20 Apr. 2022,
<https://www.globalseafood.org/advocate/experts-worlds-coral-reefs-could-vanish-by-2050-without-climate-action/>.
3. "Hawai'i Coral Restoration Nursery." *Department of Land and Natural Resources: Coral Reefs*, State of Hawai'i, 2022,
<https://dlnr.hawaii.gov/coralreefs/hawaii-coral-restoration-nursery/>.
4. Nuwer, Rachel. "Coral Reefs Absorb 97 Percent of the Energy from Waves Headed toward Shore." *Smithsonian.com*, Smithsonian Institution, 15 May 2014,
<https://www.smithsonianmag.com/smart-news/coral-reefs-absorb-almost-all-energy-crashing-waves-headed-toward-shore-180951462/>.
5. The Coral Reef Alliance. "Coastal Protection." *Coral Reef Alliance*, Coral Reef Alliance, 1 Sept. 2021,
<https://coral.org/en/coral-reefs-101/why-care-about-reefs/coastal-protection/>.
6. "2020 Tied for Warmest Year on Record, NASA Analysis Shows – Climate Change: Vital Signs of the Planet." *NASA*, NASA, 21 Jan. 2021,
<https://climate.nasa.gov/news/3061/2020-tied-for-warmest-year-on-record-nasa-analysis-shows/>.