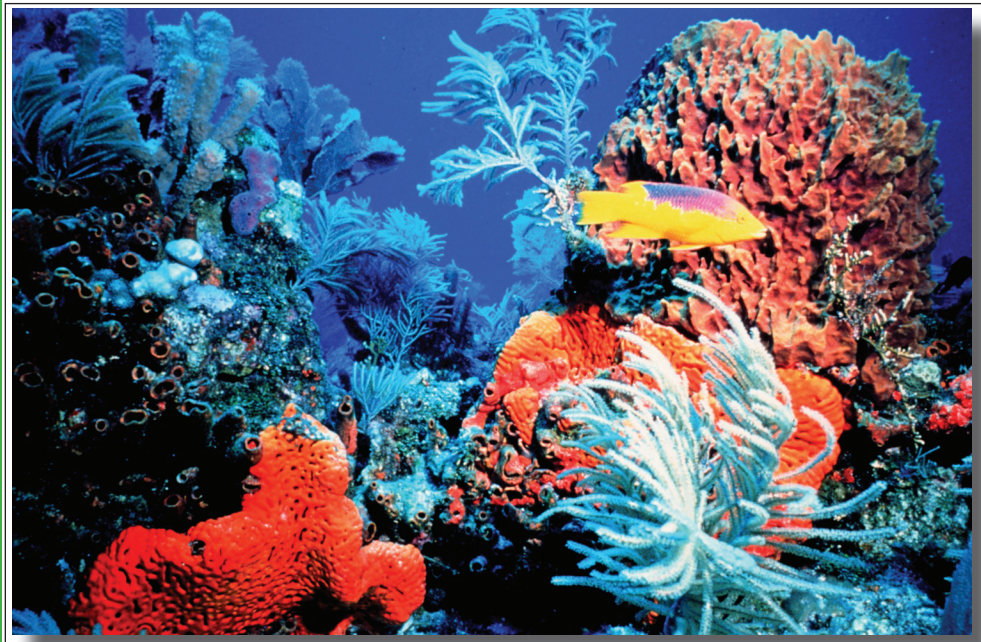

Spanish hogfish at reef.
Courtesy Florida Keys National Marine Sanctuary

Make an Edible Coral Reef

You have probably seen pictures of coral reefs before—lots of colors, fishes, and weird looking shapes! Coral reefs are not only beautiful to look at; they are also home to thousands of other species. In fact, scientists estimate that there may be another one to eight million undiscovered species living in and around reefs! Coral reefs support more species per square foot than any other marine environment. This abundance of living organisms is key to finding new medicines for the 21st century. Many drugs are now being developed from coral reef animals and plants as possible cures for cancer, arthritis, human bacterial infections, viruses, and other diseases.

Coral reefs are important for other reasons as well. Coral reefs are a breeding ground for many fish and other species, and millions of people and thousands of communities all over the world depend on coral reefs for food. In the United States, coral reef ecosystems support hundreds of commercial and recreational fisheries worth more than 200 million dollars. Local economies receive billions of dollars from visitors to reefs through diving tours, recreational fishing trips, hotels, restaurants, and other businesses based near reef ecosystems. Coral reefs protect shorelines against waves, storms and floods, and help prevent loss of life, property damage and erosion.

Despite their importance, many of Earth's coral reefs are in trouble. Severe storms, water pollution, overfishing, disease, global climate change, and ships running aground are some of the things that have destroyed or badly damaged many reefs. Because of these threats, coral reefs and all of the creatures that call them home may be in danger of disappearing if something isn't done to protect them. NOAA is one of many organizations

What You Will Do

Make an edible model of a coral reef!

participating in the U.S. Coral Reef Task Force, which was established in 1998 to protect and conserve coral reefs. Satellites are being used to map shallow U.S. coral reefs, as well as to watch for high sea surface temperatures that can damage corals and to detect harmful algae that can smother reefs. NOAA's National Undersea Research Program does research projects to learn more about coral reefs, and restores damaged reefs in marine reserves and among deep sea coral banks.

Coral reefs need your help, too! More people need to understand why coral reefs are important and what needs to be done to protect them. Here's a tasty way to start a conversation about coral reefs.

What You Will Need:

- ❒ One half sheet cake; if you want to bake your own cake you will need a box of cake mix and other ingredients listed on the box
- ❒ Icing in various colors
- ❒ Food coloring
- ❒ Marshmallows, licorice whips, small cookies, candy sprinkles, or other edible materials for modeling coral reef animals and habitat features

Warnings:

1. Get an adult to help with baking.
2. Don't eat too much!
3. Wash your hands before handling food! If more than one person is involved with this activity, you may also want to wear disposable gloves.

How to Do It:

1. If you aren't familiar with coral reefs, read the sidebar "What is a Coral Reef?" You may also want to look at books about coral reefs or check out the Web sites listed under "Want to Do More?"

A purple soft coral. Courtesy Florida Keys National Marine Sanctuary

A healthy coral reef ecosystem contains thousands of species, so you can't really include everything in your model. Instead, plan a model that is colorful and interesting, using the images on these pages for ideas. Remember, the main idea is to create a model that will help start a conversation about coral reefs (and is also good to eat!).

Before you actually make your model, make a list of what plants or animals you want to include, and what materials will be used to show them on the model. Mounds of icing can be used for boulder-shaped corals. When icing mounds have hardened they can be sculpted to form caves and overhangs. Small cookies could represent plate-shaped corals. Coconut colored with green food coloring could be used for seagrass. Sponges could be modeled with small pieces of sponge cake (of course). Licorice whips could represent branching corals. Gummy fish or fish crackers on toothpicks can represent fish. Raisins or chocolate chips might be sea urchins. Of course, there are many more possibilities, and you probably already have a pretty good idea of things you could use in your model.

2. If you plan to bake you own cake, mix the batter according to instructions on the box, and bake the cake in an oversized flat pan like a broiler pan or turkey roasting pan. Your cake will probably take less time to bake than the time stated on the cake mix box, because your cake will be thinner than usual.

3. The flat cake is the base of your model reef. Add the features you planned in step 1 to complete the model. This is a lot of fun to do with two or three other people, but be sure you wash your hands and wear disposable gloves so you can safely eat the model later.

4. Show your model to your friends, parents, school, or other groups, and talk about why coral reefs are important, why they are in trouble, and what we can do to help save them. If you are using your model at school, your teacher may be able to arrange for you to make a presentation about coral reefs to another group of students, perhaps a younger class. When you have finished your presentation, you can say, "Now it is time for us to have a direct interaction with this model reef." Which means everyone can eat the cake!

Grey snappers at the reef.
Courtesy Florida Keys National Marine Sanctuary

Want to Do More?

www.coris.noaa.gov/– Information about coral reefs from NOAA's Coral Reef Information System

oceanservice.noaa.gov/facts/thingsyoucando.html – Things You Can Do to Protect Coral Reefs, a National Ocean Service fact sheet

www.coralreef.noaa.gov/– NOAA's Coral Reef Conservation Program

coralreefwatch.noaa.gov/satellite/education/ – Coral Reef Conservation Program, Education and Outreach

oceanservice.noaa.gov/education/tutorial_corals/welcome.html – Coral Tutorial from NOAA's National Ocean Service

www.teachoceanscience.net/teaching_resources/education_modules/coral_reefs_and_climate_change/how_can_you_help_coral_reefs/ - Teacher resources from Teach Ocean Science

Barrel sponges.
Courtesy Florida Keys National Marine Sanctuary

Elkhorn coral and a white spotted filefish.
Courtesy Florida Keys National Marine Sanctuary

Butter hamlet fish with soft corals.
Courtesy Florida Keys National Marine Sanctuary

What is a Coral Reef?

Corals are animals that do not have backbones, and are related to jellyfish. The large boulders that we see in pictures of coral reefs are colonies of many individual coral animals called polyps ("PAH-lips"). Polyps are made of an outer cell layer called epidermis ("ep-ih-DERM-iss") and an inner cell layer called gastrodermis ("gas-tro-DERM-iss"), with a jelly-like substance called mesoglea ("mez-oh-GLEE-uh") in between. Each polyp makes its own cup-shaped skeleton called a calyx ("KAY-lix)" from limestone (calcium carbonate). The base of the calyx is called the basal plate, and the outer walls of the calyx are called the theca ("THEE-kuh"). Vertical partitions called septa extend part-way into the cup from the inner surface of the theca. The outer surface of the theca is covered by the soft tissues of the coral. Polyps have a mouth surrounded by a ring of arms called tentacles. The tentacles have stinging cells called nematocysts ("nee-MAT-oh-sists") that polyps use to capture food. Most corals are carnivorous, and feed on small floating animals or even fish. Many corals also feed by collecting very small bits of floating material on strings of mucous, which they pull into their mouths. Food is digested by digestive filaments in the stomach. Waste is expelled through the mouth.

Most reef-building corals have very small polyps, about one to three millimeters in diameter; but all of the polyps in a whole colony can make a limestone rock that weighs several tons! Individual polyps in a coral colony are connected by a thin band of living tissue called a coenosarc ("SEE-no-sark").

A colony of star coral. Courtesy Commander William Harrigan, NOAA Corps (ret.), Florida Keys National Marine Sanctuary

As the polyps grow and multiply, the coral colony may become shaped like boulders, branches or flattened plates. Some corals form tall columns, others resemble mushrooms, and some simply grow as a thin layer on top of rocks or the skeletons of dead corals.

When corals reproduce, they release free-swimming larvae that can be carried many miles away by ocean currents. A new reef begins when these larvae attach to underwater rocks or other hard surfaces along the edges of islands or continents.

As the corals grow and expand, other animals and plants join the reef system. Sponges and soft corals (sea fans and sea rods) are particularly visible on many reefs. Various types of seaweed and algae are also important. Some of algae produce limestone structures that add to the overall reef structure. Fishes and many other types of animals take advantage of shelter provided by the reef, and feed on algae and bacteria that grow on surfaces within the reef.

Most reef-building corals also contain algae that live inside the soft tissue of the polyp. These algae are called zooxanthellae (pronounced "zoh-zan-THELL-ee"), and like other algae are able to use energy from the sun to make food. So the corals and algae have a relationship that is called "mutualistic." This means that the coral and algae both benefit from the relationship: The coral gives the algae a protected environment and chemicals the algae need to make food. In return, the algae provide the coral with food, oxygen and help remove wastes from the coral. This relationship allows corals to grow in waters that do not have much food available.

Besides providing corals with food, zooxanthellae are also responsible for the bright colors of many corals. When corals are stressed, particularly by high temperature, the polyps lose their zooxanthellae and the coral colony becomes completely white. This is often called "coral bleaching." Coral polyps can live for a short period of time without zooxanthellae, but if bleaching lasts too long the coral may die.

Why are Coral Reefs in Trouble?

Coral reefs face numerous hazards and threats. Among these are:

Excessive Fishing – Many coral reefs have very few fishes because they have been captured for food or aquariums. In healthy reef ecosystems, fishes graze on algae. Without the fishes, algae can grow rapidly and smother coral polyps.

Destruction of Habitats – Some fishing methods destroy living reefs. Bottom trawling is extremely destructive. In some countries, fishermen use dynamite to stun fish, which also kills corals and damages the reef structure.

Invasive Species – Plants and animals that do not naturally live on reefs can damage the reef ecosystem. Some invasive seaweeds grow rapidly and smother reef-building corals.

"The Rise of Slime" – Many reefs are becoming overgrown with marine algae and films of bacteria. Part of the problem is pollution. In the Gulf of Mexico, for example, fertilizer pollution causes excessive growth of algae that is responsible for a "dead zone" the size of New Jersey. Habitat destruction, overfishing, and pollution also kill natural filters like oysters and sponges that normally help clean the water.

The 3RD Global Coral Bleaching Event 2014-2017 This is by far the longest and most widespread event in recorded history. In 1998, a huge underwater heatwave killed 16% of the corals on reefs around the world. Triggered by the El Niño of that year, it was declared the first major global coral bleaching event. The second global bleaching event that struck was triggered by the El Niño of 2010. The US National Oceanic & Atmospheric Administration (NOAA) announced the third global bleaching event in October 2015 and it has already become the longest event recorded, impacting some reefs in consecutive years.

The Death of a Coral Reef. This image shows the same reef in American Samoa before, during, and after a coral bleaching event. Photographed by The Ocean Agency / XL Catlin Seaview Survey / Richard Vevers.

The new phenomenon of global coral bleaching events is caused by ocean warming (93% of climate change heat is absorbed by the ocean). Corals are unable to cope with today's prolonged peaks in temperatures – they simply haven't been able to adapt to the higher base temperatures of the ocean. Although reefs represent less than 0.1 percent of the world's ocean floor, they help support approximately 25 percent of all marine species. As a result, the livelihoods of 500 million people and income worth over $30 billion are at stake.

The two previous events caught us relatively unprepared. The world simply didn't have the technology, understanding or teams in place to reveal and record them properly. This year is different—sponsored by an insurance company interested in the risk resulting from ocean warming, the XL Catlin Seaview Survey, running off predictions issued by NOAA's Coral Reef Watch programme (which have proven to be accurate), has been able to respond quickly. A major global bleaching event is considered one of the most visual indicators of climate change. Working together with science partners around the world, these free resources have been developed to help you research and communicate this important issue, and to ensure this event doesn't stay out of sight and out of mind.

www.globalcoralbleaching.org/#overview

Coral Bleaching: Essential Facts

Why do corals matter?

A coral reef is like an oasis in a desert. Corals provide both food and shelter for a staggering amount of marine life. Although coral reef ecosystems represent less than 0.1% of the area of the ocean, approximately 25% of all marine species relies on them. They are especially important as a nursery for juvenile fish until they are large enough to venture into open-ocean. Losing a coral reef can have a dramatic impact on local food,fisheries and livihoods. About 500 million people globally depend on such fisheries.

What is coral bleaching?

Coral bleaching is the process by which corals lose their colouration and turn a ghostly white. This happens when they become overly stressed especially when exposed to warmer than normal temperatures and excessive sunlight (normally over 4-6 weeks).

What happens when corals bleach?

When corals bleach they are actually expelling the brown algae that they grow within their body tissues. Corals expel algae because high temperatures cause the algae to produce toxic compounds. The expulsion of algae makes the corals appear a brilliant white—which is due to skeletons being visible through their translucent coral tissue.

How often does coral bleaching occur?

Bleaching is becoming increasingly common throughout the coral reef regions of the world as a direct result of warming oceans. Nowadays there is at least some limited coral bleaching reported each year especially during summer months, although the major, global events that span multiple oceans are usually associated with natural variability (*e.g.* El Niño conditions) building on top of seas that ar now warmer because of climate change.

Coral bleaching in the Maldives captured by The Ocean Agency / XL Catlin Seaview Survey in May 2016

What is the connection between bleaching and climate change?

Coral bleaching is one of the most visual indicators of thermal stress due to climate change. It is a phenomenon caused by ocean warming. The oceans have absorbed 93% of the heat from climate change and are now significantly warmer than they were 50 years ago. The heat that is causing reefs to turn white represents the momentum of climate change—it will increasingly impact our weather, climate and rainfall for decades to come until a new equilibrium is reached. This hidden energy could also trigger runaway heating if the ocean's methane deposits are released. It is why coral reefs are often referred to as "the canary in the coalmine."

What is Mass or Global Coral Bleaching?

Mass coral bleaching is where whole reef systems bleach and not just a few individual corals. This was first recorded in 1979. It is thought that a tipping point was reached around that time when the short-term temperatures that normally accompany El Niño events began to exceed the temperatures that corals could tolerate.

How damaging are mass bleaching events?

Mass bleaching events can be extremely damaging. A reef can turn from a coral dominated reef to an algae dominated reef in the space of a few months – a process that can take decades or longer to reverse. The Galapagos Islands was one of the first places where mass bleaching and mortality was first documented. the reefs there lost over 95% of their coral during the 1982 event.

Why is coral bleaching associated with El Niño?

El Niño events result in higher than normal ocean temperatures in large parts of the world. This causes higher levels of stress on coral reefs. During the warm season, the higher than normal ocean temperature, combined with additional seasonal heating and sunlight, is often enough to now cause corals to bleach.

Does bleaching only occur when there is an El Niño?

Major global events have only happened in El Niño years to date, however the baseline temperature of the ocean is now high enough that we see some mass bleaching every year. It is now only a matter of time before we have a global event that is not triggered in an El Niño year.

Can anything be done to reduce the risk of corals bleaching?

The coral's ability to recover often depends on how healthy it was before the event. Coral reefs can be 'prepared' for bleaching events by ensuring local stressors, such as overfishing and pollution, are minimised.

How does the XL Catlin Seaview Survey help?

The XL Catlin Seaview Survey team is conducting the most extensive visual and scientific survey of the world's coral reefs. The Survey's images are are available for expert insight and comment on corals, bleaching and ocean change.

This Essential Guide to Coral Bleaching was prepared by Professor Ove-Hoegh-Guldberg, XL Catlin Seaview Survey's Chief Scientist and Director of the Global Change Institute at the University of Queensland, Australia. www.globalcoralbleaching.org/#essential-facts