

OCEAN CLASSROOM

The Study of Corals

Threats to Coral Reefs

STUDENT GUIDE

THE
UNIVERSITY
OF RHODE ISLAND
GRADUATE SCHOOL
OF OCEANOGRAPHY

Guiding Question

“What threats to coral exist today?”

Informational Essay: Threats to Coral Reefs

Coral reefs are in decline in the U.S. and around the world. Many scientists now believe the very existence of coral reefs may be in jeopardy and the

people of the world need to protect them. Threats to our coral reefs come from both local and global sources.



Local Threats

Most coral reefs occur in shallow water near shore. As a result, they are particularly vulnerable to the effects of human activities on the land and in the sea. Coral reefs face many threats from local sources, including:

- Physical damage and destruction from coastal development, dredging, quarrying, destructive fishing practices and gear, boat anchors and groundings, as well as from harmful recreational practices like touching or removing corals.
- Pollution that originates on land but finds its way into coastal waters. There are many types and sources of pollution from land-based activities.

Types of pollution include:

- Sedimentation
- Excessive nutrients
- Pathogens
- Toxic substances
- Trash and plastics
- Overfishing
- Coral harvesting

All of the types of pollution work together and stress the corals. They harm not only the corals, but they also hurt all the inhabitants of the coral reef ecosystem! Let's look at each in detail:

- Sedimentation from coastal development, urban stormwater runoff, forestry, and agriculture
Sedimentation, or all the matter that settles to the bottom of the ocean, is a primary stressor to coral species and their habitats. Sediment deposited

onto reefs can smother corals and interfere with their ability to feed, grow, and reproduce.

- Excessive nutrients (nitrogen and phosphorous) from agricultural and residential fertilizer use,

Informational Essay (Continued from previous page)

sewage discharges (including wastewater treatment plants and septic systems), and animal waste

Nutrients are generally recognized as beneficial for marine ecosystems; however, coral reefs are adapted to low nutrient levels; so an excess of nutrients can lead to the growth of algae that blocks sunlight and consumes the oxygen in the water. Corals need the sunlight for photosynthesis, and they need the oxygen for respiration. This imbalance affects the entire ecosystem. Excess nutrients in the sea can also result in an increase in the growth of microorganisms, like bacteria and fungi, and this overgrowth can also harm corals.

- *Pathogens from poorly treated sewage, stormwater, and runoff from livestock pens*

A pathogen is any organism that can invade and cause harm to another living thing. Although rare, bacteria and parasites from fecal contamination can cause disease in corals. Corals are fragile and disease occurs in even healthy ecosystems, but by adding pathogen-containing pollution to their ecosystem, we increase the frequency and intensity of disease outbreaks.

- *Toxic substances, including metals, organic chemicals and pesticides found in industrial waste, sunscreens, urban and agricultural runoff, mining activities, and runoff from landfills*

Pesticides (chemicals used to kill pests) can affect coral reproduction, growth, and other basic life functions. Herbicides (weed killers), in particular, can affect the symbiotic algae (plants) that live

in the tissue of corals. This can damage their photosynthesis process and result in bleaching. Heavy metals, such as mercury and lead, and organic chemicals, such as polychlorobiphenyls (PCBs), oxybenzone and dioxin, affect coral reproduction, growth rate, feeding, and defense mechanisms.

- *Trash and plastics from improper disposal of rubbish and stormwater runoff*

Trash such as plastic bags, bottles, and discarded fishing gear (also called marine debris) that makes its way into the sea can snag on corals and block the sunlight needed for photosynthesis. Trash can also entangle and kill reef organisms and break or damage corals. Plastics and microplastics (e.g. beads in soap) can be consumed by coral, fish, sea turtles, and other reef animals, which can block their digestive tracts and spread toxins in their bodies.

- *Overfishing*

can alter the food-web structure and result in harmful imbalances, such as reducing the numbers of grazing fish that keep corals clean of algal overgrowth. Blast fishing (i.e. using explosives to kill fish) can cause physical damage to corals as well.

- *Coral harvesting*

for the aquarium trade, jewelry, and tourist novelties can lead to over-harvesting of specific species, destruction of reef habitat, and reduced biodiversity.

THREATS TO CORAL REEFS LAND-BASED SOURCES OF POLLUTION

Coastal development & impervious surface
sedimentation and toxicants

Stormwater runoff
sedimentation, toxins, nutrients, and pathogens

Deforestation
sedimentation

Oil and chemical spills
toxicants

Road construction
sedimentation

Agriculture
nutrients and sedimentation

Failed septic systems
nutrients and pathogens

Some chemicals from sunscreens
toxicants

Pollution = sedimentation + toxins + pathogens + increased nutrients

HOW YOU CAN HELP

- Apply fertilizers and pesticides sparingly.
- Pick up after your pets.
- Wash your car on your lawn.
- Dispose of lawn clippings in a compost pile.
- Harvest rooftop rain water through rain barrels or rain gardens.
- DO NOT** dump paint, oil, antifreeze, debris, or other household chemicals into street gutters or storm drains.
- Clean up spilled brake fluid, oil, grease, and antifreeze.
- Maintain proper septic system function with inspections and pumpouts every 3-5 years.
- Seek shade between 10 a.m. and 2 p.m., use Ultraviolet Protection Factor (UPF) sunwear, and choose sunscreens with chemicals that don't harm marine life. For more information, visit oceanservice.noaa.gov/sunscreens.

POLLUTION

- sedimentation
- toxicants
- pathogens
- increased nutrients

- causes disease and mortality
- disrupts ecological functions
- changes dynamics and feeding behaviors
- prevents coral growth and reproduction

As human population & development expands in coastal areas, the landscape is altered, increasing land-based sources of pollution & **THREATENING CORAL REEF HEALTH.**

Go to this NOAA site for more facts about this poster:
<https://oceanservice.noaa.gov/facts/coral-pollution.html>

Informational Essay (Continued from page 3)



Global Threats

Corals have been found to be very sensitive to changes in temperature and the pH of the water. Today, an increase in ocean temperatures and changing ocean chemistry are the two greatest global threats to coral reef ecosystems. These threats are caused by warmer atmospheric temperatures and increasing levels of carbon dioxide in seawater. Pollution, from both natural and man-made causes, is at the root of this problem.

- Global Warming

As temperatures rise in our atmosphere, the temperature of the ocean also rises. This warming causes corals to lose the microscopic algae that uses photosynthesis to produce food for corals. Without this algae, corals also lose their coloration, a condition known as coral bleaching. Without algae, all that's left is the white color of the calcium carbonate skeleton under the polyp. Severe or prolonged bleaching can weaken corals and leave them more vulnerable to disease. And eventually, coral colonies will die.

- Ocean acidification

refers to a change in ocean chemistry in response to pollution in the atmosphere (an increase in

carbon dioxide). When CO₂ increases in the atmosphere, which is a result of burning fossil fuels (oil, coal, and natural gas), CO₂ also increases in the ocean water. Carbon dioxide entering seawater reacts to form carbonic acid, causing an increase in acidity. Ocean acidification (lower number on the pH scale) lowers the amount of calcium carbonate that corals use to grow their skeletons. If acidification becomes severe, coral skeletons can actually dissolve.

- Warm Oceans

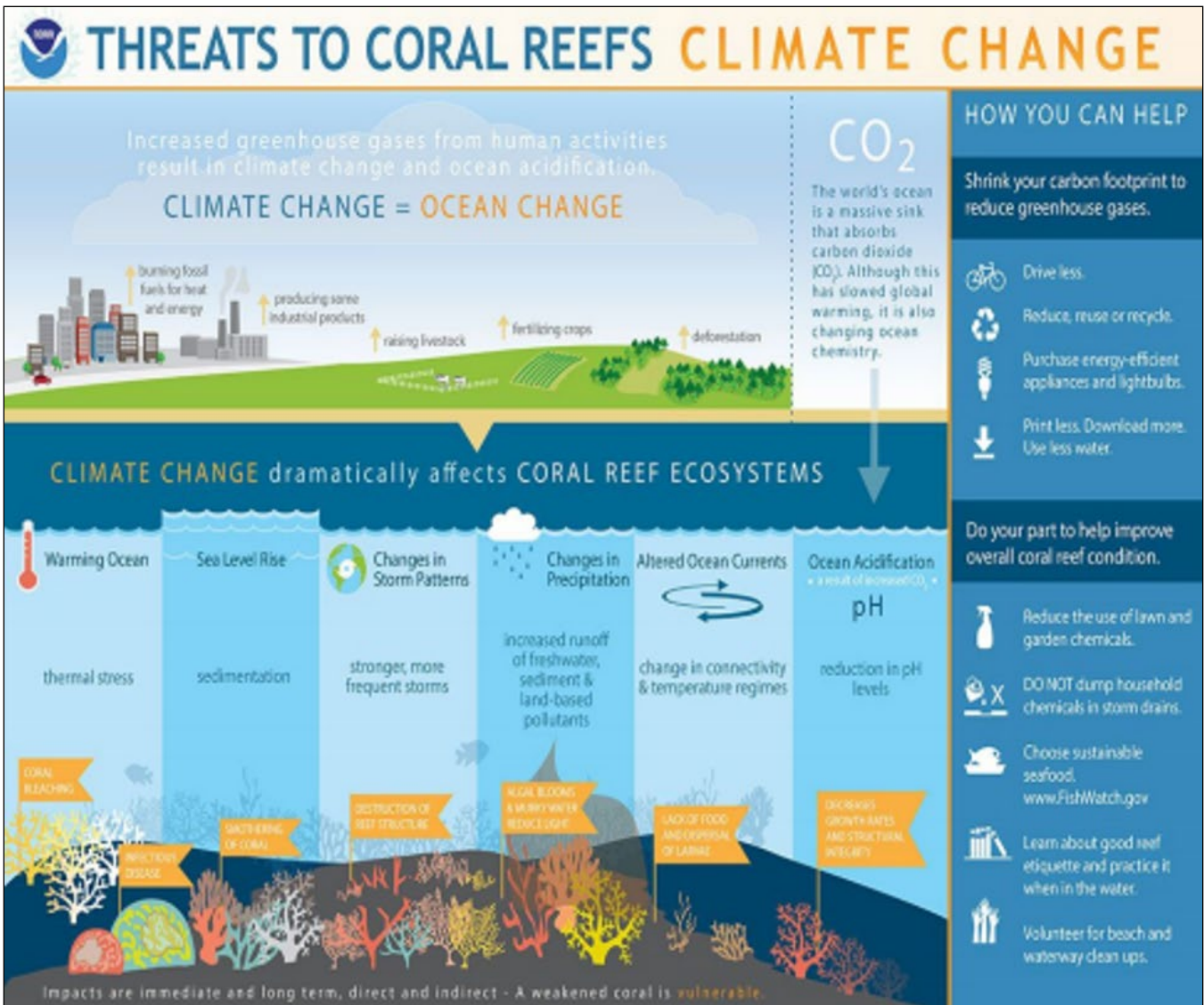
The last three years have been the three highest annual values for sea surface temperature ever observed. Glaciers around the world are losing mass (melting).

Easy Experiment: (videos, questions, explanations)

<https://www.exploratorium.edu/snacks/ocean-acidification-in-cup>

Ocean Acidification in a Cup (Grades 2 through 6)
with Extension (Grades 6 through 12)

Go to this NOAA site for more facts about this poster:
<https://www.iyor2018.org/wp-content/uploads/2018/06/coralleaching-large.jpg>



Go to this NOAA site for more facts about this poster:
<https://oceanservice.noaa.gov/facts/coralreef-climate.html>

Did you know?

Facts from NOAA: <https://coast.noaa.gov/states/fast-facts/state-of-climate.html>

- **25 Protected Species are at risk:** Under the Endangered Species Act, 22 coral species are listed as threatened, and three are listed as endangered!
- **Mass Bleaching:** From 2014 to 2017, heat stress resulted in mass bleaching to more than 75 percent of global reefs; nearly 30 percent of these reefs died. This bleaching event was the longest, most widespread, and most destructive on record!
- **Too Much CO²:** The atmospheric concentration of carbon dioxide is now higher than has been observed on Earth for at least the last 800,000 years.
- **Warm Oceans:** The last three years have been the three highest annual values for sea surface temperature ever observed. Glaciers around the world are losing mass (melting).

Videos about the threats to corals

- https://www.youtube.com/watch?v=mQ10xBI8XMQ&ab_channel=NationalGeographic
- https://www.youtube.com/watch?v=14ot4DrXdds&ab_channel=AtlasPro
- <https://www.wri.org/our-work/project/reefs-risk/interactive-map>
- <https://ejfoundation.org/reports/coral-reefs-in-crisis>
- <https://education.abc.net.au/home#!/media/524983/can-coral-reefs-survive>
- <https://youtu.be/Wo-bHt1bOsw> (Upper grades- calcium carbonate)
- <https://www.khanacademy.org/partner-content/cas-biodiversity/why-is-biodiversity-threatened/biodiversity-global/v/ocean-acidification-and-biodiversity-impacts> (Upper grades acidification)

Coral Bleaching Activity: (Grades 7 through 12)

https://d43fweuh3sg51.cloudfront.net/media/media_files/Coral-Activity-Teacher.pdf

Video <http://mass.pbslearningmedia.org/resource/b6771c72-58ba-4140-8663-79a2775f40b2/coral-bleaching-hhmi-biointeractive/>

Activity <http://mass.pbslearningmedia.org/resource/0d5be00d-db70-4b6a-ab25-f95175958c00/coral-bleaching-activity-hhmi-biointeractive/support-materials/>

Vocabulary Terms Assignment

Get together with your group. Divide these 16 terms amongst yourselves. Look up your vocabulary terms and write a clear, detailed and precise definition for each one. When done, each member must share their definitions until everyone in the group has ALL the vocabulary terms defined.

Calcium Carbonate (CaCO_3) _____

Carbon Dioxide (CO_2) _____

Carbon Footprint _____

Climate Change _____

Coral Bleaching _____

Conservation _____

Fluorinated Gasses (F-gasses) _____

Fossil Fuels _____

Global Warming _____

Greenhouse Effect _____

Methane (CH_4) _____

Nitrous Oxide (N_2O) _____

Ocean Acidification _____

Pathogens _____

Restoration _____

Sedimentation _____

Displaying Data Activities:

<https://www.epa.gov/ghgemissions/global-greenhouse-gas-emissions-data#Sector>

A. Global Activities Causing Greenhouse Gasses

Facts: The United States Environmental Protection Agency (EPA) has identified activities that cause greenhouse gasses to be emitted into our atmosphere. Here is their list of activities along with the percentage of gasses each one gives out:

| | |
|--|--|
| Electricity and Heat Production .25% | Other Energy10% |
| Industry.21% | Residential /Commercial Buildings.6% |
| Transportation14% | |
| Agriculture,Forestry and Other Land Use24% | |

Assignment: Your group members must decide how to best display this information. You could use a Pie Chart or a Bar Graph. Make sure your diagram is detailed, accurate, neat and labeled .

<https://www.epa.gov/ghgemissions/global-greenhouse-gas-emissions-data#Gas>

B. Greenhouse Gasses Being Released Globally

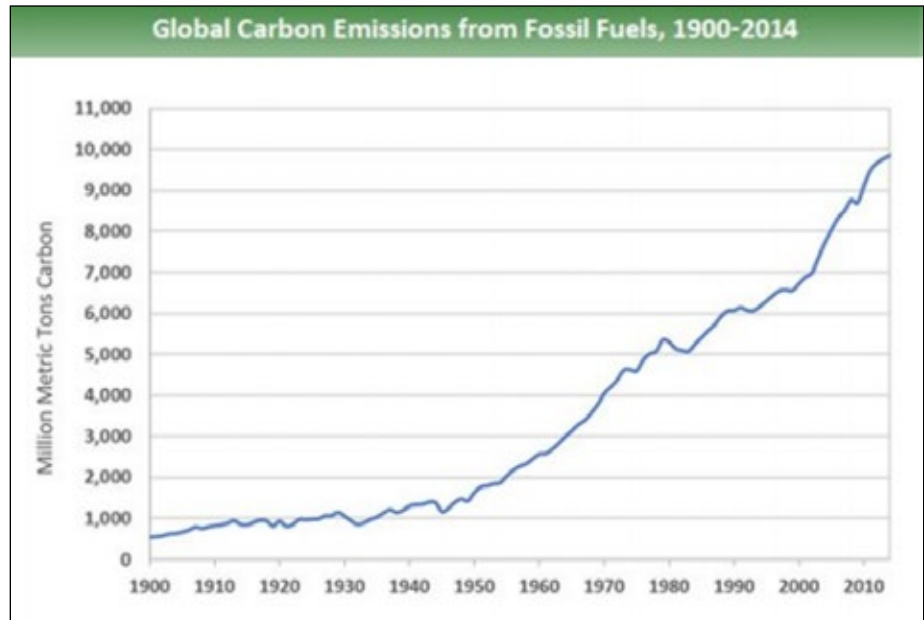
Facts: The United States Environmental Protection Agency (EPA) has identified the percentage of greenhouse gasses that are being released worldwide. Here is their list:

| | |
|--|---|
| Carbon dioxide (CO ²)81% | Nitrous oxide (N ² O).7% |
| Methane (CH ⁴)10% | Fluorinated gases (F-gases). . . .3% |

Assignment: Your group members must decide how to best display this information. You could use a Pie Chart or a Bar Graph. Make sure your diagram is detailed, accurate, neat and labeled.

Textbook Activity:

Directions: The Rapid Learning Science Textbook Company has hired YOU to write a page in their science textbook. Look at the graph below. Think about what you want students to learn from your activity. **Then write five questions that relate to the graph.** (You can not ask “Yes/No” questions.):



Source: Environmental
Protection Agency

<https://www.epa.gov/ghgemissions/global-greenhouse-gas-emissions-data>

When you are done with this activity, go to this site to play a game about Climate Change: <https://climatekids.nasa.gov/offset/>