Lesson 2: Preventing Coral Reef Catastrophes

Theme: Threats to Florida's Coral Reef

Grade Levels: 9-12

Duration: 45-60 minutes

Students will learn about local stressors and global threats to Florida's Coral Reef. Students will model human impacts on a healthy coral reef habitat to demonstrate the gradual collapse of this ecosystem, and brainstorm and present ways their local community can reduce impacts.

Next Generation Sunshine State Standards:

SC.912.L.17.4 Describe changes in ecosystems resulting from seasonal variations, climate change and succession.

SC.912.L.17.8 Recognize the consequences of the losses of biodiversity due to catastrophic events, climate changes, human activity, and the introduction of invasive and nonnative species.

SC.912.L.17.14 Assess the need for adequate waste management strategies.

SC.912.L.17.16 Discuss the large-scale environmental impacts resulting from human activity, including waste spills, oil spills, runoff, greenhouse gases, ozone depletion, and surface and groundwater pollution.

SS.912.C.2.5 Conduct a service project to further the public good.

Next Generation Science Standards:

HS-LS2-7 Design, evaluate and refine a solution for reducing the impacts of human activities on the environment and biodiversity.

HS-LS2-6 Evaluate claims, evidence and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.

OBJECTIVES

- Identify human impacts and environmental stressors to coral reefs in Southeast Florida.
- Describe what happens to coral under stressors.
- Recognize the consequences of human impacts on Florida's Coral Reef.

MATERIALS

- Coral replicas.
- Coral catastrophe cards.
- White chalk (10 to 15 pieces).
- 5 to 6 cups of distilled white vinegar (not provided in the trunk).
- Clear glass jar/container/beaker (2 per pair of students).
- Computer/internet access with projector.
- Lesson 2 PowerPoint.

Lesson plan written by Lindsay French, 2020

VOCABULARY

CALCIUM CARBONATE:	a white compound secreted by reef-forming coral polyps to build their skeleton, also known as limestone
MARINE DEBRIS:	any manufactured items that either intentionally or unintentionally end up in the ocean
OCEAN ACIDIFICATION:	a reduction in the pH of the ocean over an extended period, caused primarily by uptake of carbon dioxide from the atmosphere
PH:	a scale used to determine how acidic or basic a solution is
RUNOFF:	Flow of excess water, often caused by rainfall and storms, from the surface of an area of land to a waterway. Runoff occurs when the water cannot infiltrate the soils and substrate fast enough.

Ocean Literacy Principles

5. The ocean supports a great diversity of life and ecosystems.
6. The ocean and humans are inextricably interconnected.

Climate Literacy Principles

3. Life on Earth depends on, is shaped by and affects climate.
6. Human activities are impacting the climate system.
7. Climate change will have consequences for the Earth system and human lives.

Background Information

Florida's Coral Reef is the only barrier reef system in the continental United States. It extends 350 miles from the St. Lucie Inlet in Martin County south past Key West to the Dry Tortugas. That's like driving from Miami to Jacksonville! Australia's Great Barrier Reef is the largest in the world, stretching over 1,400 miles, but Florida's Coral Reef is unique because the corals are so close that you can swim to them from the beach in certain places. In comparison, the Great Barrier Reef ranges from 10-100 miles offshore, requiring most visitors to take a one to two-hour boat ride in each direction.

The proximity to shore makes Florida's Coral Reef a highly desirable tourist attraction. However, its proximity to the shoreline also makes Florida's Coral Reef more vulnerable to human activity in densely populated urbanized areas. Incompatible fishing, diving and other recreational uses can damage the reef. Polluted runoff, coastal construction projects and marine debris can degrade reef health. Florida's Coral Reef also faces global threats caused by climate change, including ocean acidification and warming sea surface temperatures.

Local Threat: Land-Based Sources of Pollution[1]

Land-based sources of pollution can either be manufactured substances or elevated levels of naturally present substances, such as nutrients, metals and sediments. In Southeast Florida, land-based pollutants include nutrients, heavy metals, pharmaceuticals, herbicides/pesticides, carbon dioxide, sediments, bacteria and marine debris. Pollutants can reach levels that degrade Florida's Coral Reef and the creatures that inhabit it.

[1] hyperlink can be found on page 7

Marine debris can be any manufactured items that are disposed of in the marine environment. However, most marine debris begins its journey on land as trash. Trash can be transported by rainfall and wind into local waterways and storm drains that lead to our oceans. Single-use plastics, such as straws and plastic water bottles, are some of the most common types of marine debris items found in our oceans. Marine debris can smother and entangle corals, making it difficult for them and other animals to survive.

Lawn and garden fertilizers are highly concentrated with nutrients, typically nitrogen and phosphorus. When applied in excess or right before a storm, these nutrients are washed away by rainfall and transported as runoff into our local waterways. Excess nutrients in marine and coastal ecosystems can result in rapid growth of algae and sometimes cause harmful algal blooms. Too much algae on the reef can smother coral and block sunlight needed for coral growth. Similar to fertilizers, pesticides carried by runoff into our local waterways can be sources of harmful toxins that disrupt coral reproduction and can lead to coral degradation and even bleaching. For more details on fertilizers and pesticide pollution, explore the DEP brochure on best management practices for fertilizers and pesticides.[2]

Local Threat: Incompatible Fishing, Diving and Other Uses[3]

Scuba divers and snorkelers who stand on or kick corals can damage them. Boaters who drop anchors on the reef can damage and sometimes kill corals, and vessel groundings can impact reefs as well. Adhering to fishing regulations is important for maintaining biodiversity on Florida's Coral Reef. Use the Southeast Florida Reef Locator app to identify where reefs are located and find mooring buoys to tie to instead of anchoring on reefs.[4]

Local Threat: Coastal Construction and Maritime Industry Activities[5]

Coastal construction, beach nourishment, and dredging can increase the sediment and turbidity levels of nearshore waters. Sediment particles or murky water block sunlight, which inhibits coral growth.

Global Threat: Ocean Acidification

Ocean acidification is the result of excess carbon dioxide emitted into the atmosphere through human activities such as burning of fossil fuels (industries, car emissions, etc.). When carbon dioxide is absorbed by sea water, a chemical reaction occurs that creates carbonic acid in the water, which lowers the pH of the saltwater.

The ocean's natural pH is around 8.1; however, as the ocean absorbs more carbon dioxide, the pH decreases, making the ocean more acidic. As ocean acidification increases, less calcium and carbonate molecules become available in the water. This is particularly harmful to calcifying species such as oysters, clams and corals, which need calcium carbonate to make hard shells and skeletons. The effects of ocean acidification on coral reefs include soft skeletons and, in some cases, disintegration of coral skeletons.

Explore NOAA's educational resources to learn more about ocean acidification[6]

Engagement

Show your students one or all of the coral reef-related videos below.

1. Coral Reef 101 by National Geographic[7] (4:00 minutes)
2. The Importance of Coral Reefs by the Georgia Aquarium[8] (1:26 minutes)
3. What Happens If All The Coral Dies? by Life Noggin[9] (3:32 minutes)

[2, 3, 4, 5, 6, 7, 8, 9] *hyperlinks can be found on page 7*

Florida's Coral Reef is the only barrier reef ecosystem in the continental United States and is unique for its close proximity to the coastline. The reef system is just offshore from highly urbanized Southeast Florida coastal communities, which makes Florida's Coral Reef particularly susceptible to impacts from human activities. Introduce your students to this concept by having them explore these coral reef maps using a GIS tool.

Directions

Open the link for the ReefBase Coral Reef Locator Map[10] (the ReefBase website will only work in Internet Explorer). Use the magnifying tool on the top of the map to zoom in to Florida's Coral Reef. Use the distance tool (measuring tape) on the top of the map to measure the distance from Florida's shoreline to the edge of the reef by clicking the shoreline and dragging the measuring tape to the reef. Take note of the distance between the shoreline and edge of the reef. Continue this process along different spots on the Florida coastline. Then, for comparison, scroll the map over to the largest barrier reef in the world – the Great Barrier Reef, located along the northeastern coast of the Australian continent. Once again, use the distance tool to measure the distance from Australia's shoreline to the edge of the reef and take note of the distance from shoreline to reef. Continue this along different spots on the Australian coastline.

Reflection

As a class, compare Florida's Coral Reef and the Great Barrier Reef in reference to their distance from the coastline. Discuss how the proximity of Florida's Coral Reef to the shoreline makes it highly vulnerable to human impacts and stressors. What sort of human impacts do you think are impacting Florida's Coral Reef?

Exploration

Coral Reef Catastrophe

In this lesson, students will model human impacts on a healthy coral reef habitat in order to demonstrate the gradual collapse of this ecosystem. For this lesson, you will need the coral replicas and the Coral Reef Catastrophe laminated sheets provided in the classroom kit. This activity requires open floor space.

Procedure

1. Divide your class into three evenly sized groups and assign each group as either Team Coral, Team Marine Life or Team Human Impact.
2. Team Coral will begin the lesson by constructing a coral reef by using the coral replicas to create a reef formation within a designated spot on the floor. Space each coral replica out to make the coral reef larger. Have the students read off the species of coral that their replica represents as they are placing it on their reef.
3. Once the coral reef has been constructed, it is time for Team Marine Life to add the sea creatures that depend on the coral reef as food and habitat. Give Team Marine Life the laminated marine life Coral Reef Catastrophe sheets and direct them to place each species on the reef however they prefer. Have each student name the species they are adding to the reef. Discuss each species and the ways each of them depends on the coral reef, as well as each other, to balance the ecosystem.
4. Now, it is time for Team Human Impact. Give each team member a laminated human impact sheet. One at a time, have the students read off their human impact card, including what the human impact is and how it will affect the coral reef ecosystem. Follow the directions on each card to demonstrate the ecosystem's response to such stressors.

[10] hyperlinks can be found on page 7

Dive Deeper

Use the Our Florida Reefs Marine Planner to explore some of the human impacts that are threatening Florida's Coral Reef.[11] Using the Layer List on the mapping tool, select the down arrow next to the "MarinePlanner_WMS" layer and explore the "people" sublayer by selecting categories of human impacts, such as beach debris, fishing areas, dive sites, marine debris, etc.

Reflection

- What human impacts are affecting Florida's Coral Reef?
- Did any of the impacts seem to cause the biggest disturbance in the ecosystem?
- How did the ecosystem respond to such stressors?
- Were the coral species the only species affected by these human impacts?
- What can you do in your everyday life to lower your individual impact on Florida's Coral Reef and the ocean as a whole?

Explanation

In this post-lesson, students will witness the destruction of a coral reef by demonstrating the effects of ocean acidification on coral by use of an acid (vinegar) and calcium carbonate (white chalk). First, allow your students to dive deeper into their understanding of ocean acidification by showing a 3-minute video, The Acid Test, provided by NOAA.[12]

Assign your students into groups of two. Give each group two glass beakers, or encourage each student to bring in a glass jar from their recycling bin at home prior to the activity. Fill one beaker with a half-cup of water and the other beaker with a half-cup of distilled white vinegar. Give each group a piece of chalk and explain how chalk is made from calcium carbonate, the same components used to form coral skeletons.

Direct the students to break the chalk in half, placing one half in the beaker of water and the other half in the beaker of vinegar. What sort of immediate reaction occurred in each beaker? The students should see the chalk (calcium carbonate) release carbon dioxide bubbles and begin to disintegrate in the vinegar. Have your class leave their chalk in the vinegar overnight and make observations in the morning. The chalk should have disintegrated partially overnight, leaving a layer on the bottom of the beaker. Discuss how this reflects the effects of ocean acidification on coral reefs. What will happen to our coral reefs if our oceans continue to decrease in pH and increase in acidity?

John Pennekamp Coral Reef State Park

[11, 12] hyperlinks can be found on page 7

Extension

Take Action

Most human impacts threatening Florida's Coral Reef begin with activities occurring on land. Even if you live far from the coastline, your daily actions affect our oceans and coral reef ecosystems. Encourage students to participate at a service project to support the health of Florida's Coral Reef and our ocean. A great way to get involved is by organizing a cleanup on your school campus or by participating in a cleanup in a community park or local waterway to prevent trash from becoming marine debris. Join the global movement of trash-free seas by documenting your cleanup data using the Ocean Conservancy's Clean Swell App. Watch this short video about how to use the Clean Swell mobile app.[13]

For waterway cleanup events in your local area, visit VolunteerCleanup.org.[14]

Evaluate

Divide your class into groups of four to five students and assign each group one of the following human impacts they learned in the core lesson: local and global threats. As a homework assignment, direct your students to work in their groups to research their human impact in more detail and brainstorm ways in which their local community can reduce this impact. Each group should create a PowerPoint to present to the class, including detailed information on what their human impact is, the threat that this human activity is causing specifically to Florida's Coral Reef, and how they plan to get their local community involved. Each student should have a talking role during their group's presentation.

Project Rubric

Shared Roles 10 pts.	Organization 10 pts.	Explanations of Human Impact 40 pts.	Information Specific to Florida's Coral Reef 20 pts.	Creativity in Community Involvement 20 pts.

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Hyperlink Web Addresses

Page 2

1 FloridaDEP.gov/LBSPfocus

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2 FloridaDEP.gov/LBSP24
3 FloridaDEP.gov/FDOUfocus
4 FloridaDEP.gov/CoralApp
5 FloridaDEP.gov/MICCIfocus
6 NOAA.gov/education/resource-collections/ocean-coasts/ocean-acidification
7 YouTube.com/watch?v=ZiULxLLP32s
8 YoutTube.com/watch?v=YZQTRz9XKLs
9 YouTube.com/watch?v=7-DQNTKOO1M

Page 4

10 ReefGIS.ReefBase.org/default.aspx?wms=RGWReefGIS

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11 ArcGIS.com/apps/webappviewer/index.html?id=0825dda753674dabbd184ea5cae8a8c8&extent=-9381939.8924%2C2833900.6103%2C-8442681.6888%2C3250941.0367%2C102100
12 OceanToday.NOAA.gov/theacidtest/welcome.html

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13 YouTube.com/watch?v=RnHU6TsbHQE#action=share
14 VolunteerCleanup.org/find