Anthropogenic Aftermath

with Science, Art, Math, and Language Arts Extensions

Objective

Students will be introduced to the current conditions of the Florida Reef Tract, and how they can help save the reefs.

Overview

This interdisciplinary activity encourages students to think about the current conditions of the Florida Reef Tract, and humans' effects on this habitat. This activity has the ability to have a long-term impact on both corals and ocean stewardship at large, giving the students understanding of anthropogenic effects and a chance to help save our reefs. This activity can be adapted to a single day or longer, with the inclusion compare / contrast of other barrier reefs, math, and language art extensions. *This activity was designed to be used in collaboration with the* ***2019 Coral to Action Competition*** *for K-12 grade students, but can be used independently as well.*

Background Information

The Florida Reef Tract is the third largest barrier reef in the world and the only barrier coral reef in the continental United States. In the last 40 years, the Florida Reef Tract has lost around 97% of the populations of the once dominant, reef-building coral species - staghorn (*Acropora cervicornis*) and elkhorn (*Acropora palmata*). A number of local factors contributed to the loss of coral populations on the Florida Reef Tract, all of them anthropogenic (caused by humans): Poor water quality as a result of sewage discharge into the ocean, Nutrient runoff from agricultural operations, Disease outbreak amongst sea urchins (Diadema sp.) which are critical in controlling algal growth, causing a mass die off of their populations, also attributed to poor water quality, Over-fishing, Coastal development, Lack of mooring balls and poor boating practices contributing to anchor damage, Direct damage by divers and snorkelers .Other pollutants, including oxybenzone, a common ingredient in sunscreens, Large-scale coral bleaching events attributed to climate change.

Materials

- See Extension Lists
- Camera
- Video Editing Software
- Internet Access
- Computer
- Other supplies to make PSA

Vocabulary

- Coral
- Coral Reef
- Cartilaginous
- Echinoderms
- Crustaceans
- Bleaching
- Ocean Acidification
- Overfishing
- Microplastics
- Nutrient Runoff
- Oxybenzone
- Buoyancy
- Pathogens

Preliminary Phase

Find out what the students already know.

Teacher displays pictures of coral reefs.

Teacher talk:

- *What is coral? Is it an animal? Is it a plant? Is it a mineral?*

At this point, depending on the age of the students, Teacher might have to explain the differences between animals, plants, and minerals are. If other CRF activity packs have been done with the class, such as ***Appetizing Acropora***, this will be a review for them. Teacher makes a table on the board, and students vote and their votes are placed on the board for all to see.

Teacher talk:

- *If you answered animal, you are 100% correct. If you answered vegetable or mineral, you are not 100% wrong though. Corals are animals that may have a special relationship with a microscopic plant (or vegetable) and that can make an external limestone (or mineral) skeleton.*
- *Have you ever seen a coral reef before?*
- *What lives in a coral reef across the world?*

Teacher begins listing all the animals that can be found in reefs. Some examples include: bony fish (clownfish, wrasse, eels, etc.), cartilaginous fish (sharks and rays), mammals (dolphins, dugongs, whales, etc.), reptiles (marine turtles, estuarine crocodiles, sea snakes), echinoderms (star fish, brittle stars, sea cucumbers, sea urchins etc.), crustaceans (lobsters, crabs, prawns, etc.), molluscs (clams, octopi, squid, snails, etc.), corals (both soft corals such as sea pens, and more common hard species), sea anemones, jellyfish, bristle worms, sponges, and many more.

Teacher talk:

- *There is estimated to be more than 1 million different species of animals living on or relying on coral reefs around the world! Although coral reefs cover less than 1% of the Earth's surface, they are home to 25% of all marine fish species*
- *What do coral reefs do for people?*

Teacher guides conversation to first locally than globally. Some statistical facts that can be given to the students are:

• The value of coral reefs globally is $9.9 trillion USD. *(Costanza, R., R. de Groot, P. Sutton, S. van der Ploeg, S.J. Anderson, I. Kubiszewski, S. Farber, and R.K. Turner. 2014 "Changes in the*

global value of ecosystem services". Global Environmental Change 26: 152-158.)

• Although coral reefs cover less than 1% of the Earth's surface, they are home to 25% of all marine fish species. *(Burke, L., D. Bryant, J. McManus, and M. Spalding. 2008 "Reefs at Risk." World Resources Institute (WRI): 56 p.)*

•Coral reef ecosystems are important for human subsistence, fisheries, tourism, shoreline protection, and yield compounds that are important in the development of new medicines.

• At least 500 million people rely on coral reefs for food, coastal protection, and livelihoods. *(Wilkinson, C. (ed.) 2004 "Status of Coral Reefs of the World: 2004. Volume 1". Australian Institute of Marine Science. Townsville, Queensland, Australia. 301 p.)*

• Over 275 million people worldwide live in the direct vicinity of coral reefs (within 30 km of reefs and less than 10 km from the coast), and approximately 850 million people live within 100 km of coral reefs. *(Burke, L., K. Reytar, M. Spalding, and A. Perry. 2011 "Reefs at Risk Revisited". Washington, D.C., World Resources Institute (WRI), The Nature Conservancy, WorldFish Center, International Coral Reef Action Network, UNEP World Conservation Monitoring Centre and Global Coral Reef Monitoring Network, 114p.)*

• In developing countries, coral reefs contribute about one-quarter of the total fish catch, providing food to an estimated one billion people in Asia alone. *(Moore, F. and B. Best. 2001 "Coral Reef Crisis: Causes and Consequences". In: Papers Presented at a Symposium held at the 2001 Annual Meeting of the American Association for the Advancement of Science.)*

• Coral reefs form natural barriers that protect nearby shorelines from the eroding forces of the sea, thereby protecting coastal dwellings, agricultural land and beaches. More than 150,000 km of shoreline in 100 countries and territories receive some protection from reefs. *(Burke, L., K. Reytar, M. Spalding, and A. Perry. 2011 "Reefs at Risk Revisited". Washington, D.C., World Resources Institute (WRI), The Nature Conservancy, WorldFish Center, International Coral Reef Action Network, UNEP World Conservation Monitoring Centre and Global Coral Reef Monitoring Network, 114p.)*

• Coral reefs are a critical part of a healthy ocean. Over 70% of the oxygen on Earth is produced by the oceans. *(University of Leicester. "Failing phytoplankton, failing oxygen: Global warming disaster could suffocate life on planet Earth." ScienceDaily. ScienceDaily, 1 December 2015.)*

Focus Phase

The students explore examples of the concept.

Teacher talk:

- *The most famous reef is called the Great Barrier Reef in Australia, but a lot of you might not know that we have a barrier reef in the continental United States as well, and it is the third largest barrier reef on the planet! Where do you think this barrier reef is located?*

Teacher gives some time for guesses. Remind them that we are talking about the continental United States. Once they have discovered its location in Florida…

Teacher talk:

- *Florida is the only state in the continental United States to have extensive shallow coral reef formations near its coasts. These reefs extend from St. Lucie Inlet in Martin County, to the Dry Tortugas in the Gulf of Mexico. The most prolific reef development occurs seaward of the Florida Keys. The most extensive living coral reef in the United States is adjacent to the island chain of the Florida Keys. The Florida Reef Tract possesses coral formations very similar to those found in the Bahamas and Caribbean Sea. The Florida Reef Tract is nearly 360 linear miles long It is the third largest barrier reef ecosystem in the world.*
- *In addition to local residents, millions of vacationers come to Florida in order to enjoy scuba diving, snorkeling, and fishing on south Florida's coral reefs. These activities provide a great source of income for Florida and its coastal communities. It is estimated that coral reef activities in Martin, Palm Beach, Broward and Miami-Dade counties generate $3.4 billion in sales in general and income and support 36,000 jobs in the region each year*
- *But, our barrier reef is in danger! In the last 40 years, the Florida Reef Tract has lost around 97% of the populations of the once dominant, reef-building coral species - staghorn (Acropora cervicornis) and elkhorn (Acropora palmata). There are many causes that lead to this state, but all are anthropogenic (or man-made). Let's explore these!*

Exploration Phase

The students exchange, debate, and test ideas.

Teacher talk:

- *What are some anthropogenic actions that may have led to this quick decline in reef-building corals?*

Teacher makes a list of each example that the students come up with. As one of the following is proposed, teacher can stop, go to the Application Phase, and come back to continue the list:

- Ocean Acidification caused by increasing CO_2
- Over-fishing
- Plastic pollution clinging to branching corals, creating abrasions, which leads to disease and death
- Nutrient runoff from agricultural operations and coastal development
- Other pollutants, including oxybenzone, a common ingredient in sunscreens
- Lack of mooring balls and poor boating practices contributing to anchor damage, as well as direct damage by divers and snorkelers
- Poor water quality as a result of sewage discharge into the ocean, leading to white-pox disease of elkhorn corals.
- Disease outbreak amongst sea urchins (Diadema sp.) which are critical in controlling algal growth, causing a mass die off of their populations, also attributed to poor water quality

Some of these will not be familiar to the students, and Teacher may need to give leading questions to complete.

Application Phase

The students apply their rules to new situations.

With each of the above examples, there is an extension activity associated with it. Each of these activities, if chosen to complete, should be done before the Challenge Phase. Either after the completion of the extension activity, or in lieu of….

Teacher talk:

- *What can be done to help stop or restore the effects of (insert anthropogenic example)?*

Anthropogenic Effect	Solution
Ocean Acidification	Reduce Carbon Footprint
Over-fishing	Making sustainable food choices
Plastic Pollution	Reduce single-use plastics
Nutrient Runoff	Avoid fertilizers or toxic chemicals at home
Sunscreen	Avoid oxybenzone
Boating / Diving	Educate responsible ocean interaction
Poor Water Quality	Supporting environmental legislation
Disease Outbreak	Support science; who look for solutions

Challenge Phase

The students take their application to a real-world situation

Teacher talk:

- *Now that we have a better understanding of the Florida Reef Tract, the anthropogenic effects that caused its decline, and what can be done to help restore the reef, we need to get the word out! The Coral Restoration Foundation™ has challenged us to create a short, 30 second public service announcement (PSA) video about the condition of the Florida Reef and what they can do to protect it!*

The PSA can be done as individuals or as a class. If this activity is being in conjunction with the **Coral To Action Challenge**, you can find all rules, regulations, and submission forms at www.coralrestoration.org/coral-to-action/

Synthesis Phase

The students take their overall understanding to the next level.

Teacher talk:

- *The only way to restore the Florida Reef Tract is through a lot of people caring an awful lot, and by us creating this PSA, we can get more people to understand the current plight of the reefs.*
- *Despite the ongoing threat to coral reefs from climate change, there is still hope, and there is every need to continue to work to restore damaged coral reef ecosystems.*
- *Despite warming waters and increasing ocean acidification, the corals that the Coral Restoration Foundation™ are outpanting on the Florida Reef Tract are thriving. Many of the older outplants are now spawning, which demonstrates that they are healthy- in order for corals to spawn, they must have energy available to do so.*
- *This success is likely due the wild coral genotypes that provided the initial parent stock for CRF™r operations are hardy, having withstood decades of multiple stressors. Their persistence in the wild until a decade ago indicates that these genotypes are resilient and probably capable of eventually adapting to increasingly dynamic environmental conditions.*
- *Saving coral reefs requires action at multiple levels. While organizations work to curb carbon emissions, it is essential that we work to maintain viable wild coral populations that will have a chance to recover once we mitigate the effects of climate change.*

Extension 1 – Acropora Acidification

ADAPTED FROM CAROLINA BIOLOGICAL: RED CABBAGE JUICE: A HOMEMADE pH INDICATOR!

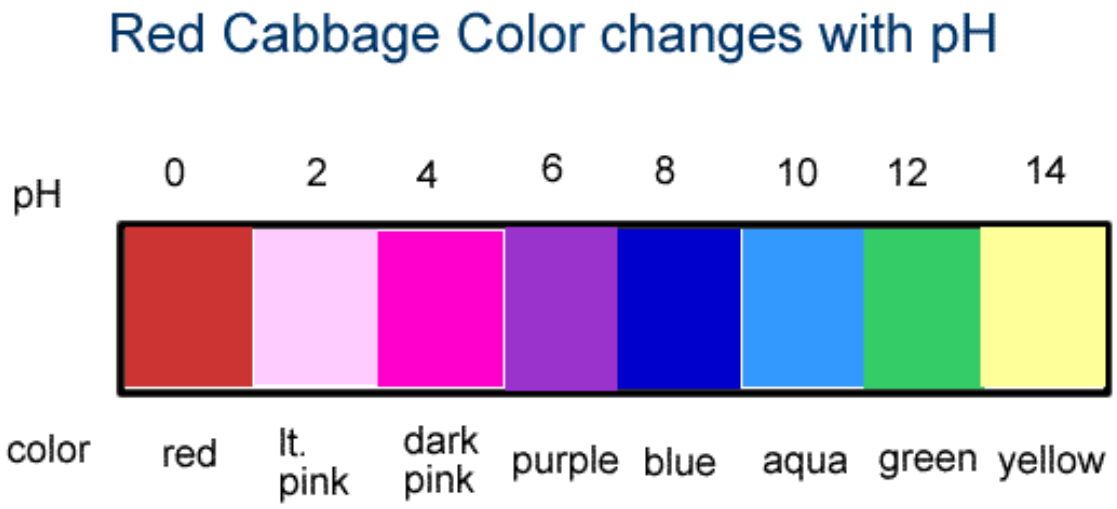
Materials

- Red Cabbage Leaves
- 200 mL water
- Blender
- Strainer
- Medicine Dropper
- Salt Water
- Dry Ice (gloves / goggles)

To be used in conjunction with Application Phase: Ocean Acidification

Instructions:

1. Combine chopped cabbage leaves and 200 mL of water into the blender.
2. Pour mixture through a strainer. This is now your universal indicator.
3. Put the universal indicator into the salt water, and check the pH. The lower the number, the more acidic the substance is. Salt water should be around an 8.
4. Adult puts dry ice (wear gloves and goggles) into Salt Water, and watch PH. Dry ice releases carbon dioxide, and by increasing carbon dioxide, the water becomes more acidic.



Extension 2 – Empty Estuary

ADAPTED FROM CALIFORNIA ACADEMY: SUBSTAINABLE FISHING IN THE PHILIPPINES

Materials

- Wooden dowel or stick (one per student)
- String
- Tape
- Toothpicks (one per student)
- Spoons (one per group)
- Popcorn
- Paper cups (one per student)
- Large paper plates (one per group)
- Timer
- Candy

To be used in conjunction with Application Phase: Over-fishing

Instructions:

1. Have students create a fishing pole and hook out of the dowel, string, tape, and toothpicks
2. Put 30 pieces of popcorn on each groups plate and give each group a cup.
3. Tell them that they need to each collect a minimum of 2 pieces of popcorn per round, but every piece above 2, they receive a candy. Their cup represents their boat.
4. If a piece of popcorn falls off the plate but not into the cup, it is considered by-catch, and doesn't count
5. Give each team 30 seconds to fish. If they do not catch 2 fish, they are out.
6. After the first round, all those who caught enough fish can adjust their fishing poles
7. Add one popcorn per 2 remaining ocean fish, as the population reproduces
8. Have a second round, and whomever, per group, this round has the most, on top of the extra candy, get a spoon for the third round. This represents using nets rather than fishing poles
9. Continue on until one group runs out of fish

Extension 3 – Lunchtime Landfill

ADAPTED FROM 5 GYRES: WORLD OF WASTE

Materials

- Student lunches
- Writing materials
- Scale
- Calculator

To be used in conjunction with Application Phase: Plastic Pollution

Instructions:

1. This activity might need to take place in the lunchroom at school
2. Take the students lunch, and weigh them, packaging and all. If it includes disposable lunch trays, include that in the weight.
3. After the students eaten their food, record the type of trash that is left over, and how many of each time.

Number of Plastic Items	
Number of Glass Items	
Number of Metal Items	
Number of Paper Items	
Number of Cardboard Items	
Number of Other Items	

4. After recording, weigh the amount of packaging and trash that is left over. Do not weigh uneaten food.
5. For older classes, you can find what percent of the weight was packaging.
6. Ask the class to explore ways that these could have less packaging, and challenge the students the next day to have less.
7. The next day at lunch, do the experiment again, and see if you were able to reduce plastic use.

Extension 4 – Fertilizer Freeway

ADAPTED FROM OCEAN CONSERVANCY: TRACE THE TRASH

Materials

- Highlighter (one per student)
- United States Hydrological Map
  - A great example of a Hydrological Map can be found here: http://www.somebits.com/rivers/rivers-polymaps.html

To be used in conjunction with Application Phase: Nutrient Runoff

Instructions:

1. This activity can be done either on a computer or printed off
2. Have each student find a location on the US map that is important to them. Examples can be where they were born, where their parents were born, favorite vacation, etc.
3. Give each a hydrological map of the US. Tell them that, at that location, someone is pouring fertilizer, and when it rains, it enters the river system. From the closest river, have the student highlight how that fertilizer would reach the ocean.

Extension 5 – Wean Obscene Sunscreen

ADAPTED FROM CONNECTIONS ACADEMY: THE SCIENCE OF SUNSCREEN

Materials

- UV Photo-sensitive Paper
- Reef Safe Sunscreen (Mineral Sunscreen)
- Normal Sunscreens (different SP)
- Paintbrushes

To be used in conjunction with Application Phase: Oxybenzone

Instructions:

1. Teacher demonstrates the difference between Reef Safe and Not Reef Safe Sunscreen on themselves. Explain how non-reef safe is absorbed into the skin rather

than coating it. Coral larvae can also absorb this, and cause them to die.

2. Put the different sunscreens out and give paintbrushes. Have the students paint a picture using the sunscreens on the UV sensitive paper. Explain that the higher the SP, the less light that will go through.
3. Place the artwork outside until sun has been exposed enough to cause the paper to activate.

Extension 6 – Delicate Dive Down

ADAPTED FROM TWO LIQUID CARTESIAN: THE HOUSE OF EXPERIMENTS

Materials

- Recycled Soda Bottle with top for each student
- Ketchup Packet (that floats) for each student
- Paraffin Oil
- Window Washer Fluid

To be used in conjunction with Application Phase: Boating / Diving

Instructions:

1. Fill each bottle half full with window washer fluid and half full with paraffin oil. They will not mix. The window washer fluid represents the reef and the oil represents the water.
2. Put the ketchup packet inside. This represents the diver. Make sure you have a packet that floats on the oil, because not all will. If it won't float, a piece of straw with the ends glued together can work too, but clay may need to be added if too hard to sink. This represents the diver.
3. Challenge the students to squeeze the bottle and have their diver "dive" towards the reef, without touching. See if they can keep buoyant and how close they can get to the reef without touching
4. Explain to the students that divers have to do this, and when they don't, they can damage the reef and the corals.

Extension 7 – Invertebrate Indicator

ADAPTED FROM MACROINVERTEBRATE GRAPHING: STREAMSIDE SCIENCE

Materials

- Candy-coated colored chocolate candies
- Graph Paper
- Colored Pencils
- Pictures of Reef Invertebrates

To be used in conjunction with Application Phase: Water Quality

Instructions:

1. Explain to the students that certain animals can only survive in good water quality conditions
2. Give each student a bag of candies. Have them count and figure out how many color of each they have
3. Explain what each of them represent:

    a. Blade Fire Coral: Green (6)
    b. Slaghorn Coral: Blue (5)
    c. Elkhorn Coral: Brown (4)
    d. Boulder Coral: Yellow (3)
    e. Finger Coral: Orange (2)
    f. Mustard Hill Coral: Red (1)

4. The number represents the score for the reef. The higher the score, the more healthy the reef. Blade Fire Coral usually bleaches first, while mustard hill coral is the most hardy.
5. Have the student graph their results, and find out who had the most-healthy reef

Extension 8 – Transmittable Travesty

ADAPTED FROM AIR-BORNE DISEASE: SASKATCHENWAN

Materials

- Nerf balls
- Big open area

To be used in conjunction with Application Phase: Disease

Instructions:

1. Explain to the students that the disease that killed the sea urchins started when it came through the Panama Canal. How was it able to spread so far?
2. Have the students spread out at least 10 feet apart from each other, and give each student a nerf ball.
3. Have one student be the original sick sea urchin. Have them throw their ball to another student. This represents the current moving the pathogen
4. Continue this until all students have become “sick” and show how far away it travelled.
5. Explain how all the sea urchin populations were effected with over 99% mortality.