A joint collaborative project of:
Office of National Marine Sanctuaries
National Oceanic and Atmospheric Administration
Ocean Acidification Program
National Oceanic and Atmospheric Administration

Education

Ocean Acidification: Rugose Reef Tag

Grade Level

- 4-8

Timeframe

- 30-45 Minutes

Materials

- A space or room with desks, tables, chairs or other obstacles which can be re/moved OR that also has open space available free from chairs, tables, etc.
- Something to denote a student predator; can be something students carry around such as a stuffed animal or can wear (i.e. a fin, hat of reef shark)
- Something to denote a student prey; can be something they carry around such as a stuffed animal something that is worn like a hat (i.e. fish, Nemo)

Essential Question

What protection does a healthy coral reef provide for smaller fish?

Activity Summary

Coral reefs are extremely important ecosystems to both marine organisms and humans. The health of coral reefs and the organisms that live within them is at risk because of the change in the ocean's composition due to additional carbon dioxide that is dissolved into sea water from the burning of fossil fuels and land use change. This change in ocean chemistry called ocean acidification, can alter the landscape of a reef, causing less structural diversity, roughness or rugosity. This decrease in rugosity can lead to a decrease in diversity due to less available niches and a change in predator prey relationships. These changes can impact the coral reef food web and humans who depend on the creatures who live there.

Learning Objectives

Students will be able to:

- Understand and value the importance of how human activities influence the chemistry and thus health of the ocean ecosystem and organisms.
- Understand and value the importance of how changes in the coral reef ecosystem caused by ocean acidification can affect life on the reef, and those humans who depend on or enjoy them (sustenance and tourism).

Background Information

Coral reefs are extremely important ecosystems to both marine organisms and humans. The health of coral reefs and the organisms that live within them is at risk because of the change in the ocean's composition due to additional carbon dioxide that is dissolved into sea water from the burning of fossil fuels and land use change. This change in ocean chemistry called ocean acidification, can alter the landscape of a reef, causing less structural diversity, roughness or rugosity. This decrease in rugosity can lead to a decrease in diversity due to less available places or niches within the ecosystem for marine organisms like fishes to hide, grown and live. This can change in predator- prey relationship. These changes can impact the coral reef food web and humans who depend on the creatures who live there.

Key Messages

- Coral reefs are one of the most diverse ecosystems in the ocean and home to marine life that sustain many island and tropical communities through both tourism and sustenance fishing.
- Human actions are changing the ocean's chemistry which is causing a structural change to the reef, which can affect predator-prey dynamics there, in turn affecting food web and overall diversity and health of the coral reef ecosystem.
- We want to make sure that coral reef ecosystems remain healthy to provide for people (coastal protection, sustenance fishing) and their quality of life.

Values

Interconnected – Our ocean is home to very special and important ecosystems such as coral reefs, that support people who live near them and those that travel to them to explore

Stewardship – our everyday actions on land can effect unique and biodiverse ecosystems such as coral reefs

Simplifying models – Coral reefs are complex structures that provide habitat and hiding places for many organisms to live and grow. Ocean acidification causes reefs to be less complex, so there are not as many places for fishes and other organisms to hide and thrive in the reef

Causal chain – burning fossil fuels emits CO_2 → the ocean absorbs CO_2→ the ocean becomes more acidic → a key building block for shells and skeletons, calcium carbonate, is not readily available → it is more challenging for corals to build their skeletons → the coral reef becomes less rugose or complex→ the resources and quality of life that coral reefs provide could be compromised

Procedure

1) Create a “reef” low in complexity or rugosity – one representing an “acidified” ocean (future atmospheric CO_2 levels) where there are fewer obstacles (less chairs, tables, etc. in the space).
2) Denote one student predator and another prey. Allow the prey to start where he would like in the designated space.
3) On “go” predator student will try to tag prey student.

a. The tag or “capture” should happen relatively quickly given that there are no obstacles or places for the prey to hide from or slow down the predator.

4) Repeat with a “reef “that is high in rugosity representing a healthy reef that hasn’t been affected by acidification with many more chairs, tables, desk, etc.
   a. The “capture” will be more challenging, entertaining, and time consuming.

Follow up Discussion

1. Compare the two reefs?
   a. Which reef would you rather be the prey or “Nemo” on?
      i. Why?
   b. Which ocean was it easier to for the predator to tag or capture the prey?
      i. Why?
   c. Which reef would there be more like to be a more types of creatures (diversity)?
      i. Why?
   d. What can we/you as humans do to help coral reefs stay complex and therefore healthy and biodiverse?

Education Standards

Common Core ELA Standards	Reading: Informational Text Grades 4-8: 1 – Refer to details and examples in a text when explaining what the text says explicitly and when drawing inferences from the text 4 – Determine the meaning of general academic and domain-specific words or phrases in a text 7 – Interpret information presented visually, orally, or quantitatively and explain how the information contributes to an understanding of the text in which it appears. **Writing Standards Grades 4-8:** 1 – Write opinion pieces on topics or texts, supporting a point of view with reasons and information 2 – Write informative/explanatory texts to examine a topic and convey ideas and information clearly • 4 – Produce clear and coherent writing in which the development and organization are appropriate to task, purpose, and audience
Common Core Math Standards	Mathematical Practices: Reason abstractly and quantitatively • Construct viable arguments
Next Generation Science Standards	4 Structure, Function, and Information Processing 4-LS1-1 Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction Science and Engineering Practices: Engaging in Argument from Evidence Crosscutting Concepts: Cause and Effect Systems and System Models 3-5 Engineering Design 3-5-ETS1-2 Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem. Science and Engineering Practices: Constructing Explanations and Designing Solutions Crosscutting Concepts: Influence of Science, Engineering, and Technology on Society and the Natural World MS Human Impacts MS-ESS3-3 Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment Science and Engineering Practices: Constructing Explanations and Designing Solutions Crosscutting Concepts: Cause and Effect Influence of Science, Engineering, and Technology on Society and the Natural World
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 A,C,E 6 Human activities are impacting the climate system

Evaluation

Students will write a short essay on the effects of ocean acidification. They will need to address the following:

- What is ocean acidification
- What happens (chemically) when the oceans absorb CO_2?
- What does the absorption of CO_2 by the ocean mean for certain organisms such as pteropods and oyster larvae?
- What is creating the atmospheric CO_2? What can humans do to decrease the amount of atmospheric CO_2?

Utilize the International Student Carbon Footprint Challenge website (http://footprint.stanford.edu/calculate.html). Students will investigate how to calculate their own carbon footprint and develop and present ideas on how they individually, as a family, and as a school community can lower their carbon footprint and help decrease the amount of CO_2 (produced by the burning of fossil fuels) being absorbed by the world's oceans. Have students present and compare their solutions to reduction of carbon footprint and have them use individual plans to come up with the best overall plan. For middle and high school students have students devise a way to evaluate the effectiveness of their solution(s).

Extensions

Students will read Earth's Acid Test published in Nature March 10, 2011 and answer questions about the text.
Students will explore the http://www.cisanctuary.org/ocean-acidification/ Web site (with supervision of teacher) to learn more about ocean acidification.
Investigate what other types of organisms may be the first to be impacted by ocean acidification and why.
Students will explore ways they can effect change in the use of fossil fuels beyond their home and school communities.
Share portions of archived SOARCE (Sharing Ocean Acidification Resources for Communicators and Educators) Ocean Acidification webinars with students.
http://oceanacidification.noaa.gov/AreasofFocus/EducationOutreach/SOARCEWebinarSeries.aspx

Resources:

http://www.cisanctuary.org/ocean-acidification/
http://oceanacidification.noaa.gov/

Credit: Original lesson created by NOAA Ocean Acidification Program, additions and correlation to Common Core and Next Generation Science Standards by Maria Petueli. Email noaa.oceanacidification@noaa.gov with any questions.