CHANGES IN OCEAN HEALTH

ABOUT THE LESSON

In this lesson, students will learn about the role oceans play in regulating our Earth's climate and the importance of ocean health. Oceans absorb heat and carbon, acting as a sink and mitigating a large part of human-made emissions. However, this is leading to changes in ocean temperature and chemistry, which can have a lasting impact on marine life and on humans who depend on them.

ESSENTIAL QUESTIONS:

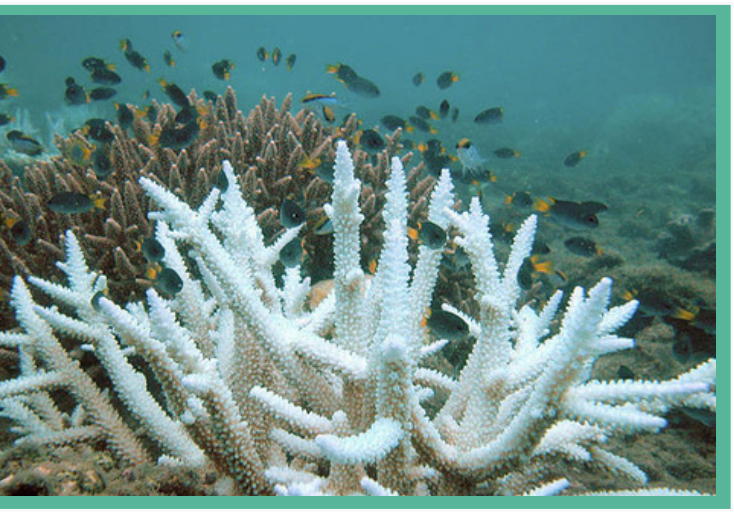
- Why are ocean temperatures rising?
- What is ocean acidification?
- How are ecosystems changing as ocean acidity and
- temperature increases?
  How is ocean health related to human health?

LEARNING OBJECTIVES:

- Explore species interactions across multiple ecosystems.
- Learn how small changes in one part of a system cascades into
- large ecosystem change.
- Draw evidence of change from informational articles.
- Interpret data and answer questions based on graphs and models.
  Understand how human activity draws on natural resources.

Patterns; Cause & Effect; Stability & Change
NOAA Guidelines: 2.2, 3.1, 3.3 & 7.1

Have your students read the two news articles below and discuss the following questions as a group. You can choose any other relevant or latest news articles using the SEARCH feature to anchor your classroom discussion on heatwaves and wildfires.



IMPACT ON CORALS

What would a healthy coral reef look like versus one that is unhealthy and under stress?

Look at THIS map that shows the locations of reef-building corals. What can you tell about where they are found globally?

From reading the article, discuss what a symbiotic relationship means? How do corals and algae mutually benefit each other?

What causes a coral reef to lose color?

FOREVER PLANTS

Look at THIS map that shows the location of seagrass beds. What can you tell about where they are found? Are there any close to where you live?

According to the article, which marine ecosystems are the most efficient in trapping carbon?

How much blue carbon is stored by seagrass beds? What other important functions does this ecosystem serve?

What are some of the threats that seagrass ecosystems face? What are some ways we can protect these ecosystems?

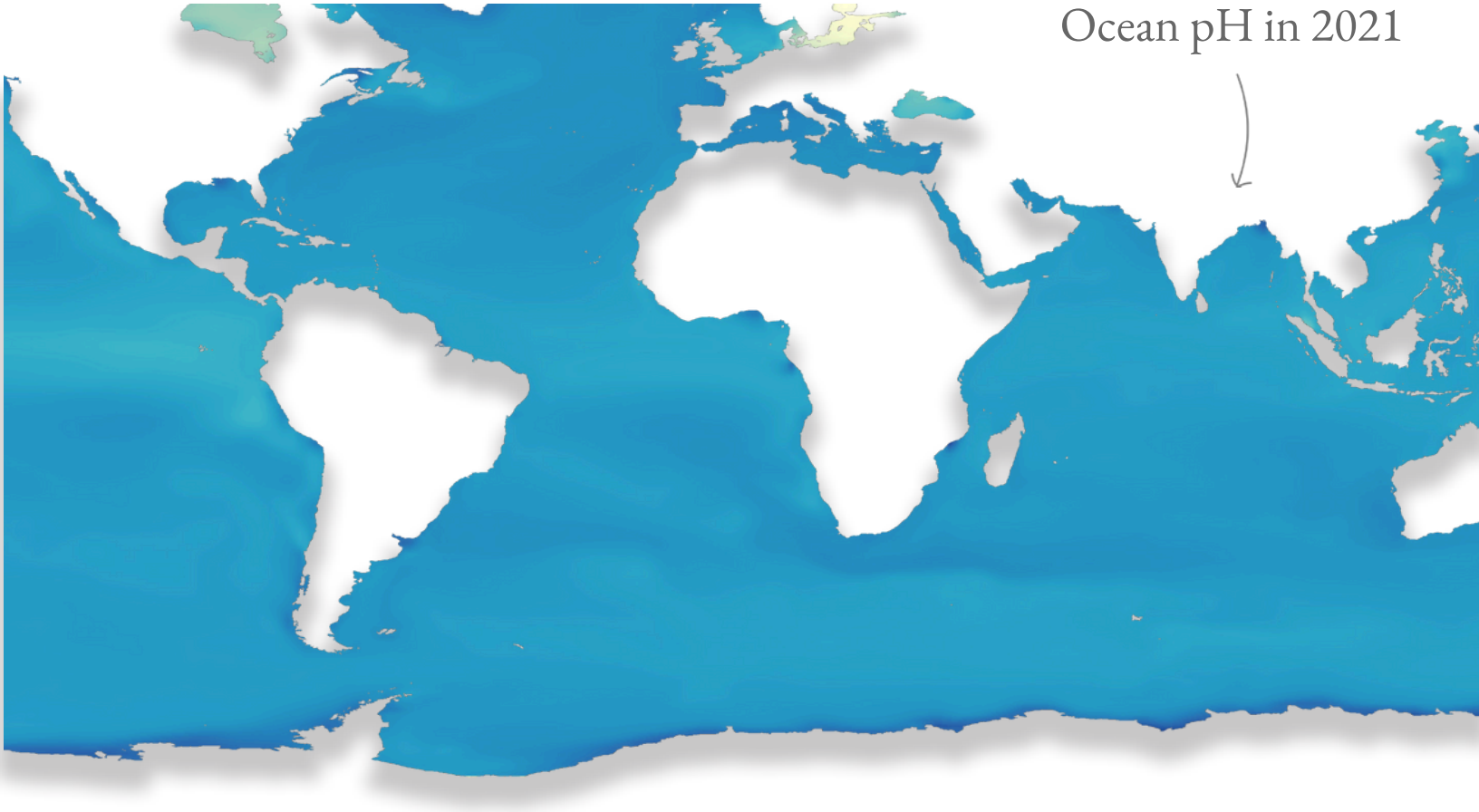
INFORMATION	YOUNGZINE CONTENT
IMPACT ON CLIMATE The ocean, which regulates the Earth's climate, acts as a sink for both heat and carbon that it absorbs from the atmosphere. Oceans absorb 90% of the heat, which is then circulated by waves, tides, and ocean currents. The carbon from the atmosphere dissolves in water, making it slightly acidic. Data shows that our oceans have been getting warmer (especially the upper 700 m) and the pH has decreased by 0.1 (which means the waters are 30% more acidic. Read this article to learn how ocean health is measured by scientists, and the changes we are observing.	Read Module 2.3: Changes in Oceans and take the quiz: Examine Figure 2.3.3 HERE: Which regions of the ocean have seen the most warming? Which regions have seen the least warming? Additionally, why are ocean temperatures increasing slowly compared to air temperatures? [Hint: Refer to the heat capacity of water vs air.]
IMPACT ON OCEAN Rising surface temperatures —> More heat absorbed and stored in ocean —> Marine heat waves + Stronger storms + Sea level rise due to thermal expansion of water + Less oxygen stored in water Burning fossil fuels —> Increased carbon emissions —> More carbon absorbed by ocean —> Seawater becomes more acidic	Read the Changing Oceans and Rising Sea Levels sections of Module 4.3: Impact on the Hydrosphere. To understand why storms get stronger, read the Precipitation and Intense Storms sections of Module 4.2: Impact on Extreme Weather. Optionally, take the quizzes for both.
IMPACT ON ECOSYSTEMS & COMMUNITIES Warmer waters and ocean acidification pose a multitude of problems for marine life and the people who depend on marine resources. Many species are migrating toward cooler waters to mitigate warming effects, while those that cannot move undergo heat stress events like coral bleaching. Furthermore, changes in acidity corrode shells and impair the senses of marine species, disrupting both marine and terrestrial ecosystems.	Read Module 4.5: Impact on Marine Ecosystems and take the quiz: Examine Graph 4.5.2 in the article: Based on both graphs, between 1982 and 2015, how much deeper and farther have marine species migrated to escape hotter waters?

Data Dive!

NOAA Global Data Explorer: Ocean Acidification

Go to the following websiteand clickonthedatavaluescheckboxtoobserve seawater pH over the last 150 years. Use the slider toviewpast,present,andfuturepHconditions based on current estimates of carbon emissions.

1. **Around what decade did there start to be a noticeable decrease in overall ocean pH?**
2. **Compare ocean pH in the year your parents were born, the year you were born, and 2021.** What are the average pHs and how big is the difference?
3. **Pick 15 data values for 15 different years and graph them to see the slope. Be sure to measure the pH at the same location each time.** What do you notice about the rate of ocean acidification?
4. **Where do you notice higher rates of acidification?** Why might that be?



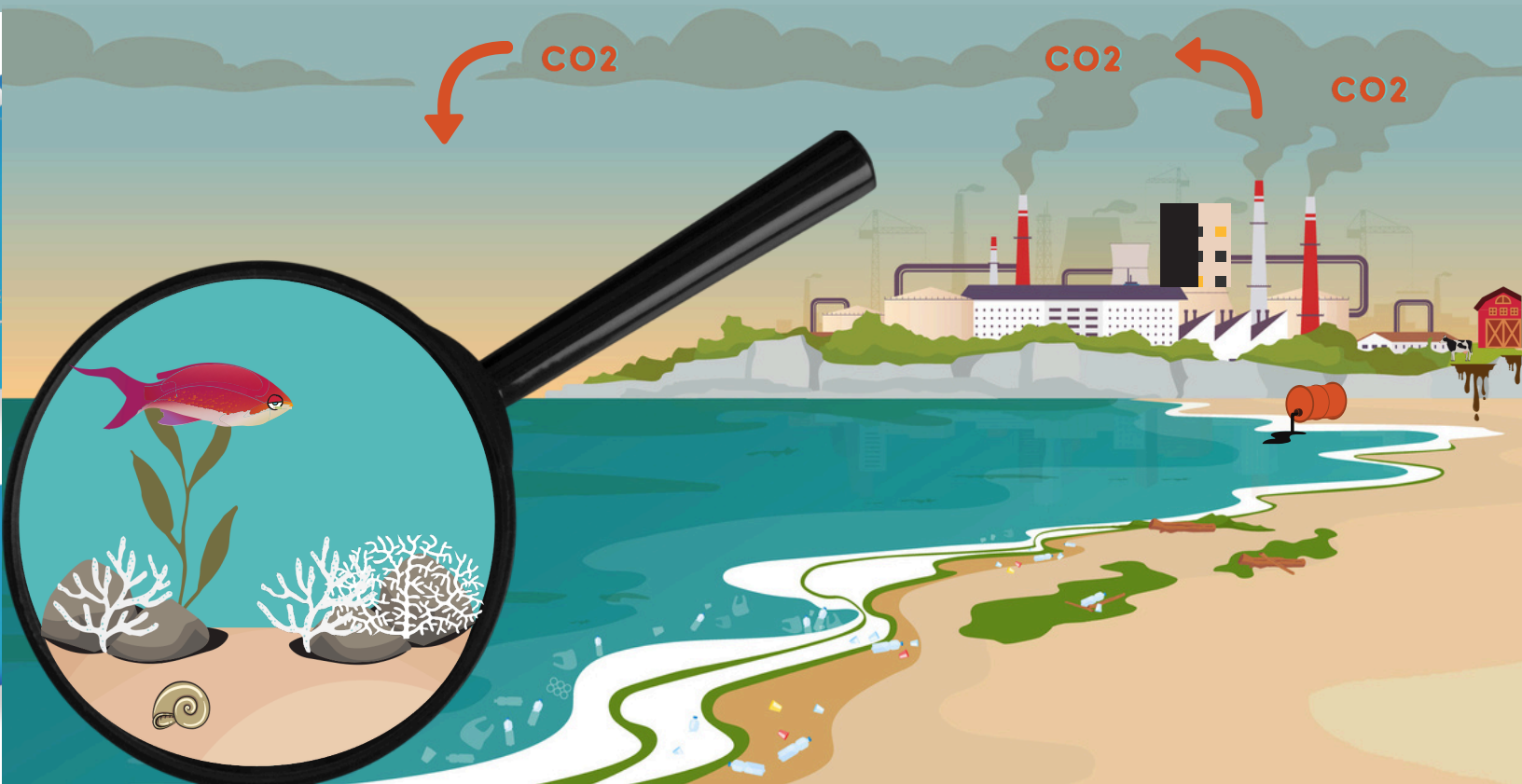
What's Happening Here?

Think about the different elements of the ecosystem. Use the questions below to guide you thinking.

What do you notice? Does the ecosystem seem healthy and thriving? If not, what could be causing them to be under stress? What are some common themes that you notice?

Next, think about how marine ecosystems impact humans. Discuss the following questions to explore how people can be affected by changes in ocean ecosystems.

1. Coral reefs provide habitat to 25% of all marine life and are highly productive environments. In what ways do people use the resources they provide? Why is it important to protect the reefs?
2. Many people rely on the ocean for their primary source of food. If coral reefs are negatively affected by the effects of heat and carbon, what impact might an unhealthy ecosystem have on the fishing industry?
3. Kelp forests act as carbon sinks and can extract 20 times more carbon dioxide than forests on land. How do these habitats help regulate our climate and atmosphere?



Why is this Ecosystem Stressed?

Use the infographic to fill in the blanks below and understand how human activity and climate change disproportionately affect coastal marine ecosystems.

HEAT

Because ocean temperatures are _____ *[increasing/decreasing]*, coral polyps are forced to expel the algae that live inside them, causing the corals to turn white. We call this coral _____.

Heat stress causes many coral reef fish to migrate to _____ *[deeper/shallower]* waters for relief, food, and protection from predators.

CARBON

The ocean absorbs carbon dioxide from the atmosphere, causing seawater pH to _____ *[increase/decrease]* and become more _____ *[basic/acidic]*. This results in the erosion of calcium carbonate structures, such as snail shells and coral reefs, and makes them harder to build.

Ocean acidification can _____ *[positively/negatively]* alter fish behavior, potentially making them more prone to predation.

OXYGEN

Terrestrial runoff from nearby factories pollutes the water and promotes the growth of marine algae, which _____ *[increases/decreases]* the amount of space and light left for kelp forests and coral reefs.

Large blooms of phytoplankton decompose and use dissolved oxygen in the water, creating oxygen _____ zones in coastal areas close to sources of pollution.

WRAP UP & CLOSING DISCUSSION

What was something that surprised you as we learned about changing ocean ecosystems?

How might your own life be affected by our oceans changing in temperature and acidity?

Have you visited the ocean? Turn to the person next to you and share a memory you have of the ocean.

What are some ways we can protect our oceans as the climate continues to change?

Certain chemicals in suncscreen can be toxic to corals. How can we reduce sunscreen's impact on the ocean?

Journal Activity

Extend Your Thinking

1. There are many aquatic ecosystems that are affected in different ways by anthropogenic climate change. Pick an ecosystem, research it, and demonstrate how it is being impacted by human activity.

a, The open ocean (<200 m)

[Ans: Overfishing and harmful fishing practices, plastic/toxic pollution, rising sea levels, oil spills, etc.]

b. Deep sea (>200 m)

[Ans: Deep sea mining, commercial trawling, carbon and nutrient recycling, etc.]

c. Rivers & lakes

[Ans: Pollution from runoff, drought, overfishing, habitat loss/fragmentation, invasive species, etc.]

2. It can also be helpful to examine climate change through an endangered species and its habitat. Pick an aquatic species of interest and in 250 words or less, describe its habitat, what function it serves in the ecosystem, how it is being negatively impacted, and any potential conservation strategies.

3. An important part in studying climate change is learning about potential solutions. For each environmental hazard, read the article, discuss in groups, and come up with at least two solutions on how to mitigate its effects.

a. Plastic pollution

b. Fertilizer/pesticide runoff

c. Oil spills

d. Overfishing

4. Create a 1 minute skit! Students work together in groups of 4-6 and are assigned a row from the table below. Students choose a character to play from that row and create a skit, filling in the solutions for themselves based on their discussions.

Cause	Problem	Impact	Sol ution
Global warming	Warmer waters	Coral bleaching	?
Carbon dioxide	Ocean acidification	Altered fish behavior	?
Carbon dioxide	Ocean acidification	Brittle coral and shells	?
Nutrient runoff	Algal blooms	Oxygen dead zones	?