NO PREP

Ocean Acidification

Threats to Marine Life

Includes: Student reading, case study, differentiated questions, teacher key

Name: Period: Date:

Ocean Acidification: Threats to Marine Life

What Is Ocean Acidification?

The term ocean acidification describes the gradual lowering of the ocean's pH due to the absorption of excess carbon dioxide (CO_2) from the atmosphere. Since the Industrial Revolution, humans have burned enormous amounts of fossil fuels, releasing CO_2 into the air. About one-third of this gas dissolves into seawater. When CO_2 mixes with water, it forms carbonic acid (H_2CO_3), which then releases hydrogen ions (H^+). The increase in hydrogen ions lowers pH, making the water more acidic. While the pH of seawater remains above neutral, even small decreases have significant impacts. Pre-industrial seawater averaged around 8.2, but today it is closer to 8.1, with projections suggesting further declines by the end of the century. A shift of 0.1 units may seem small, but because the pH scale is logarithmic, this represents about a 30% increase in acidity. Ocean acidification does not happen uniformly. Coastal regions, upwelling zones, and areas with high nutrient input often experience faster changes. These local variations add to the stress

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How Acidification Impacts Marine Organisms

The organisms most directly affected by acidification are those that build shells or skeletons of calcium carbonate ($CaCO_3$), such as corals, oysters, mussels, and some plankton. As seawater becomes more acidic, the concentration of carbonate ions (CO_3^{2-}) decreases. Without enough carbonate, these organisms struggle to build or maintain their structures. For corals, this means slower reef growth and weaker skeletons, which are more vulnerable to storm damage and erosion. For shellfish, acidification can interfere with larval development, reducing survival rates. Even tiny planktonic organisms, which form the base of the marine food web, are affected—

threatening ecosystems from the bottom up. Beyond structural issues, acidification influences physiology. Fish exposed to low pH conditions can show altered behavior, such as difficulty detecting predators. Some species experience changes in metabolism, reproduction, and immune function. The impacts vary widely, but the trend is clear: acidification creates new challenges for marine life across ecosystems.

Global Ripple Effects of Ocean Acidification

The consequences of ocean acidification extend beyond individual species. Coral reefs, often called the "rainforests of the sea," provide habitat for thousands of marine organisms. If reef-building slows or stops, biodiversity declines, and coastal protection weakens. Communities that rely on reefs for fishing and tourism face economic losses. On a global scale, acidification affects the biological pump, the process by which plankton absorb CO_2 and transfer it to the deep ocean. If plankton populations shrink, less carbon is stored in the ocean, leaving more in the atmosphere to fuel climate change. This creates a feedback loop that intensifies the problem. The issue of acidification underscores the interconnectedness of Earth systems. Human activity on land—burning coal, oil, and gas—reshapes the chemistry of the largest ecosystem on the planet. The health of marine life, global climate, and human economies all depend on how well we address this challenge.

Key Information: Table: Key Impacts of Ocean Acidification

Impact Area	Examples of Effects	Consequences for Humans
Coral Reefs	Slower growth, weaker skeletons	Loss of biodiversity, weaker coastal protection
Shellfish	Poor larval survival, fragile shells	Economic damage to fisheries and aquaculture
Plankton	Difficulty forming shells, population decline	Reduced carbon storage, weaker food webs
Fish	Altered behavior, metabolic stress	Changes in fisheries yields and species balance

Case Study: The Oyster Industry in the Pacific Northwest

In the early 2000s, oyster hatcheries in Oregon and Washington faced sudden, mysterious die-offs. Millions of oyster larvae were failing to survive in their early stages, threatening an industry that supplies jobs and food along the Pacific coast. Scientists discovered the culprit was not disease, but seawater chemistry. Seasonal upwelling was bringing CO_2-rich deep water to the surface, and as atmospheric CO_2 rose, the seawater pH was dropping even further. Young oysters are especially vulnerable to acidic conditions because they must quickly form shells of calcium carbonate. In corrosive waters, larvae either fail to form shells or develop shells that are weak and fragile. Hatcheries began monitoring seawater chemistry closely and adjusting intake water to avoid the most acidic conditions. This adaptation has helped the industry survive, but the long-term threat remains as acidification intensifies globally. The oyster case highlights a larger reality: human communities that depend on marine resources are already feeling the effects of ocean acidification. What once seemed like a distant scientific concern has become an urgent economic and social issue, directly connecting ocean chemistry to human livelihoods.

1. Why are young oysters particularly vulnerable to changes in pH?

2. How does the oyster industry case study show the connection between ocean chemistry and human society?

Multiple Choice

1. What is the current average pH of seawater?

    a) 8.1

    b) 7.0

    c) 8.5

    d) 9.0

2. Why does ocean acidification reduce carbonate ion availability?

    a) Sodium displaces carbonate

    b) Carbonate evaporates with water

    c) Carbonate forms from sodium chloride

    d) Hydrogen ions bind with carbonate

3. Which industry has already been heavily impacted by acidification?

    a) Whale watching

    b) Tuna fishing

    c) Oyster farming

    d) Seaweed cultivation

Matching

Write the letter of the correct definition on the line next to each term.

Term	Definition
1. ___ Process where CO_2 dissolves and lowers ocean pH	A) Climate change
2. ___ Organisms most affected due to calcium carbonate shells	B) Biological pump
3. ___ Ecosystems often called the "rainforests of the sea"	C) Shellfish
4. ___ Movement of carbon into the deep ocean via plankton	D) Coral reefs
5. ___ Example of a feedback loop worsened by acidification	E) Ocean acidification

Fill-in-the-Blank

1. The absorption of excess _____ from the atmosphere is the main driver of ocean acidification.

2. Corals and shellfish build their skeletons and shells from _____ carbonate.

3. Ocean acidification threatens the ocean's role as a major _____ sink.

Short Answer

Answer each question in 2-4 complete sentences.

1. How can ocean acidification affect fish behavior?

_____

_____

_____

2. Why are coral reefs particularly important to both marine ecosystems and humans?

_____

_____

_____

3. How does ocean acidification connect to climate change feedback loops?

_____

_____

_____