NO PREP

Upwelling and Nutrient Cycling in the Ocean

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

Name: Period: Date:

Upwelling and Nutrient Cycling in the Ocean

Nutrient Highways of the Sea

One of the most fascinating processes in the ocean is upwelling, where deep, cold, nutrient-rich water rises to the surface. This movement is driven by winds and the rotation of the Earth. Upwelling zones may seem like invisible events happening far offshore, but they have profound effects on marine ecosystems and human societies. By bringing nutrients like nitrogen and phosphorus to the surface, upwelling supports

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The Science Behind Upwelling

The physics of upwelling is tied to Ekman transport, a process where surface water is pushed by winds and deflected by the Coriolis effect. In the Northern Hemisphere, winds blowing parallel to a coast drive surface waters away from land, allowing deep water to replace it. In the Southern Hemisphere, the direction is reversed, but the outcome is the same: nutrient-rich water wells upward. This nutrient cycling not only fuels ecosystems but also regulates Earth's climate. When phytoplankton absorb nutrients, they also take in carbon dioxide for photosynthesis. Some of this carbon sinks into the deep ocean when organisms die, a process known as the biological pump. This carbon storage slows the pace of global warming, making upwelling an important natural climate regulator.

Key Information: Key Concepts Table

Concept	Description	Example/Impact
Upwelling	Cold, nutrient-rich water rising to surface	Supports fisheries in Peru, California
Phytoplankton	Microscopic plants at ocean's surface	Base of the marine food chain
Ekman Transport	Wind-driven movement of surface water	Deflects right in Northern Hemisphere
Biological Pump	Carbon stored in deep ocean	Slows climate change
Fisheries Connection	Human reliance on upwelling productivity	Anchovy fishery in Peru

Case Study: The Peruvian Anchovy Fishery

The waters off the coast of Peru host one of the world's most famous upwelling systems. Here, winds push surface waters away, bringing up nutrient-rich waters that fuel massive plankton blooms. These plankton feed swarms of anchovies, which in turn support seabirds, marine mammals, and one of the largest fisheries on Earth. In the 1960s, Peru's anchovy fishery boomed, providing a huge share of the world's fishmeal. However, in the early 1970s, a strong El Niño disrupted upwelling, reducing nutrient input and collapsing anchovy populations. Combined with overfishing, this led to a catastrophic crash in the fishery, devastating Peru's economy. Today, Peruvian fisheries are more carefully managed, with quotas and monitoring in place to avoid repeating history.

1. How does El Niño affect upwelling off the coast of Peru?

2. What lesson does the Peruvian anchovy collapse teach about the connection between natural cycles and human activity?

Multiple Choice

1. What makes upwelling zones some of the most productive areas of the ocean?

    a) Warm water rises to the surface

    b) Salinity increases significantly, making fish more abundant

    c) Tides stir up coastal waters daily

    d) Nutrients from the deep ocean are brought upward

2. Which process explains how winds drive upwelling?

    a) Ekman transport

    b) The biological pump

    c) Thermohaline circulation

    d) Lunar tides

3. What role does the biological pump play in climate regulation?

    a) It increases oxygen in deep waters

    b) It decreases ocean salinity

    c) It traps carbon in the deep ocean

    d) It generates heat in the ocean

Matching

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

Term	Definition
1. ___ Ekman Transport	A) Cold, nutrient-rich water rising to the surface
2. ___ Phytoplankton	B) Industry dependent on plankton-fueled ecosystems
3. ___ Biological Pump	C) Microscopic plants at the surface that photosynthesize
4. ___ Upwelling	D) Wind-driven deflection of water causing upwelling
5. ___ Anchovy Fishery	E) Carbon carried into deep ocean through sinking matter

Fill-in-the-Blank

1. When winds push surface water away from shore, _____ water rises to replace it.

2. The collapse of Peru's anchovy fishery was partly caused by _____.

3. The biological _____ stores carbon in the deep ocean.

Short Answer

Answer each question in 2-4 complete sentences.

1. Explain why upwelling zones are often found along the western coasts of continents.

_____

_____

_____

2. How does nutrient cycling in upwelling zones affect global food webs?

3. Why is managing fisheries in upwelling zones especially important?