

Ocean Acidification: The Other CO₂ Problem

Ocean acidification (OA) is the quiet tsunami of environmental degradation. Within a few decades, OA may devastate some marine ecosystems and threaten the productivity of our fisheries. When we burn oil, coal, or gas, scientists have recently shown, we are transforming the fundamental chemistry of the oceans, rapidly making the water more acidic.

What Is Ocean Acidification?

The process of ocean acidification is surprisingly simple. Carbon dioxide from the burning of fossil fuels accumulates in the atmosphere, where it causes global warming. But it also affects our oceans. As carbon dioxide enters the ocean, it reacts with sea water to form carbonic acid. Since the start of the Industrial Revolution about 150 years ago, approximately one-quarter to one-third of all CO₂ from fossil fuels—or 500 billion tons—has been absorbed by the seas, increasing the average acidity by 30 percent.

That's the equivalent in weight of 500 billion Volkswagen Beetles dumped at sea.

Changes in ocean acidity are undeniably linked to human activities. Carbon dioxide produced from the burning of fossil fuels can be identified and measured in ocean water and the acidification effect of the CO₂ is undisputed.

The Acid Test

A primary concern about rising ocean acidity is that it reduces the availability of carbonate, a substance used by tens of thousands of marine species to form shells and skeletons. This depletion results in slower growth rates and weaker shells in nearly all species studied. If acidity gets high enough, ocean water becomes corrosive and literally dissolves the organism's shells. This may lead to their extinction.

Ocean acidification could result in a "global osteoporosis," harming not only commercially important shellfish, such as lobster, crabs, and mussels, but also key species in marine food webs. The ripple up the food chain would affect fish, birds, and mammals.

Evidence is accumulating that acidification may already be impacting marine life around the world. For example, Pacific oysters have

not successfully reproduced in the wild since 2004, and algae are supplanting mussels in an intertidal zone on an island off of the coast of Washington. On the other side of the planet, coral species in Australia's Great Barrier Reef have shown a 14 percent decline in calcification since 1990, and body weights of a species of plankton in Antarctica are now 30 to 35 percent lower than they were historically.

If CO₂ emissions rates are not curtailed dramatically, these results of stress will multiply and many forms of marine life will continue to diminish.

Ocean Acidification: The Problem Beneath the Waves

If we do not slow the rate at which we now burn fossil fuels, average ocean acidity will more than double by the end of century, computer models show. Scientists predict the Arctic will become corrosive to some shelled organisms within a few decades, and the Antarctic by mid-century. This is pure chemistry; the vagaries of climate do not apply to this forecast.

OA is expected to impact commercial fisheries worldwide, threatening a food source for hundreds of millions of people as well as a multi-billion dollar industry. In the United States alone, ocean-related tourism, recreation and fishing are responsible for more than 2 million jobs.

Shellfish will be affected directly, thus impacting finfish who feed on them. For example, pteropods—tiny marine snails that are particularly sensitive to rises in acidity—comprise 60 percent of the diet for Alaska's juvenile pink salmon. And this affects diets farther up the food chain, as a diminished salmon population would lead to less fish on our tables.





Learn more! "Acid Test: The Global Challenge of Ocean Acidification" a half-hour film about ocean acidification produced by NRDC, and narrated by Sigourney Weaver, will air on Discovery Green throughout the month of August. Visit www.nrdc.org/acidtest for more information.

Coral reefs will be especially hard hit by ocean acidification. As ocean acidity rises, corals will begin to erode faster than they can grow, and reef structures will be lost worldwide. Scientists predict that by the time atmospheric CO₂ reaches 560 parts per million (a level which could happen by mid-century; we are currently nearing 400 ppm), coral reefs will cease to grow and even begin to dissolve. Areas that depend on healthy coral reefs for food, shoreline protection, and lucrative tourism industries will be profoundly impacted by their loss.

Solutions to Save Our Seas

Combating acidification requires reducing CO₂ emissions and improving the overall health of the oceans.

What can you do? We need to power our lives without emitting huge quantities of CO₂. To accelerate our transition to a clean energy future, we need to enact federal carbon cap-and-trade legislation and adopt an energy policy that invests in efficiency and encourages renewable sources based on wind and sun.

But we can also help the ocean defend itself by making sure its systems are as healthy

as possible. Just as people with compromised immune systems are the most likely to die from common diseases like pneumonia and flu, stressed marine organisms are the first to succumb to "diseases" like ocean acidification. Establishing a strong national policy to protect, maintain, and restore the health of marine ecosystems, ending overfishing, and creating marine protected areas—essentially national parks for the sea—are three essential steps to restoring our nation's beleaguered marine resources.

Ocean Acidification: The Final Warning Sign

Think of ocean acidification as a "final warning" that we are fundamentally changing the way the planet works. We have already compromised the planet's atmosphere by the burning of fossil fuels. Considering that oceans represent a bigger system—500 times by weight—than our atmosphere, changes to ocean chemistry signal a massive disruption.

The future of the Blue Planet is at stake.

References

- Caldeira, K. and M. E. Wickett (2003). "Anthropogenic carbon and ocean pH." *Nature* 425(6956): 365-365.
- De'ath, G., J. M. Lough, et al. (2009). "Declining Coral Calcification on the Great Barrier Reef." *Science* 323(5910): 116-119.
- Doney, S. C., V. J. Fabry, et al. (2009). "Ocean Acidification: The Other CO₂ Problem." *Annual Review of Marine Sciences* 1: 169-192.
- Fabry, V. J. (2008). "Ocean science - Marine calcifiers in a high-CO₂ ocean." *Science* 320(5879): 1020-1022.
- Feely, R. A., C. L. Sabine, et al. (2008). "Evidence for upwelling of corrosive "acidified" water onto the continental shelf." *Science* 320(5882): 1490-1492.
- Moy, A. D., W. R. Howard, et al. (2009). "Reduced calcification in modern Southern Ocean planktonic foraminifera." *Nature Geoscience* 2(4): 276-280.
- Orr, J. C., V. J. Fabry, et al. (2005). "Anthropogenic ocean acidification over the twenty-first century and its impact on calcifying organisms." *Nature* 437(7059): 681-686.
- Sabine, C. L., R. A. Feely, et al. (2004). "The oceanic sink for anthropogenic CO₂." *Science* 305(5682): 367-371.
- Silverman, J., B. Lazar, et al. (2009). "Coral reefs may start dissolving when atmospheric CO₂ doubles." *Geophysical Research Letters* 36.
- Steinacher, M., F. Joos, et al. (2009). "Imminent ocean acidification in the Arctic projected with the NCAR global coupled carbon cycle-climate model." *Biogeosciences* 6(4): 515-533.
- Wootton, J. T., C. A. Pfister, et al. (2008). "Dynamic patterns and ecological impacts of declining ocean pH in a high-resolution multi-year dataset." *Proceedings of the National Academy of Sciences of the United States of America* 105(48): 18848-18853.