

Ocean Acidification

What a more acidic ocean means for marine life

The oceans are arguably our world's most valuable asset. In addition to providing a home for a wide range of plants and animals, the oceans also provide food and jobs for millions of people throughout the United States and the world. The oceans have moderated Earth's climate for millennia by absorbing atmospheric carbon dioxide. Today, the chemistry of the ocean is changing at an unprecedented rate—ocean waters are absorbing more carbon dioxide than they have in at least 650,000 years. The ocean is now 30% more acidic than it was before the Industrial Revolution. If fossil fuel use and deforestation continue at present rates, it is predicted that the ocean will experience another 100 - 150% increase in acidity by 2100. The current

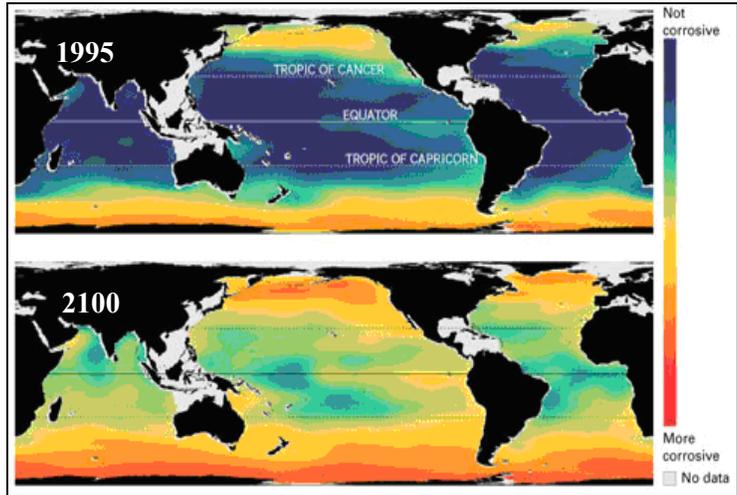


Image: National Geographic Maps

rate at which ocean acidification is occurring will likely have profound biological consequences for ocean ecosystems within the coming decades. The rate of change in ocean acidity is so great that many marine organisms will probably not be able to adapt quickly enough to survive these changes. Research into the short- and long-term ecological implications of ocean acidification is in its infancy and significant research investment is essential to assess the magnitude and severity of the acidification threat to marine life, including economically lucrative commercial fisheries.

Organisms affected by Acidification



Reef-building corals provide food and shelter for commercial fish species

Source: NOAA

Plankton are the basis for a number of marine ecosystems and provide nearly 50% of the world's oxygen.



Source: oxygentimerelease.com



US fishery landings for calcifiers such as mussels, clams and scallops were valued at \$675 million in 2006 alone.

Source: sunsetmarineresort.com

What is Ocean Acidification?

Ocean acidification is the process whereby the ocean is becoming more acidic because it is absorbing large quantities of carbon dioxide, nitrogen and sulfur from the atmosphere. Today, the overwhelming cause of ocean acidification is fossil fuel carbon dioxide released to the atmosphere by humans. Atmospheric carbon dioxide from coal fired power plants, automobiles, cement production and other sources is absorbed by the ocean and reacts with seawater to form carbonic acid. Follow-on reactions cause an increase in ocean acidity and a decrease in carbonate ions, the primary building blocks marine organisms use to build their skeletons and shells of calcium carbonate.

Why should we care ?

- **Ocean acidification is harmful to plankton, corals, shellfish, fishes and marine ecosystem structure**

Decreasing carbonate concentrations in seawater make it more difficult for marine life to build their skeletons and shells, a process similar to osteoporosis in humans. More acidic oceans cause increased dissolution and erosion of skeletons and shells, which compromises the survivability of organisms that depend on

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these structures for protection. Plankton are the oceans' primary producers and play critical roles in marine food webs. Any reduction in plankton numbers will likely have significant impacts on marine life which depend on them for core functions. Many fish species and marine mammals (filter feeding whales) depend on marine life that have calcium carbonate shells (e.g. whales and juvenile salmon eat tiny marine snails called pteropods, which build a calcium carbonate shell). Ocean acidification will also affect the physiology of water breathing animals (fishes) by increasing acidity in the tissues and body fluids. This can cause long-term effects on metabolic functions, growth and reproduction. Fish in early developmental stages (eggs, larvae and juveniles) are particularly sensitive to ocean acidification.



Photo: virtualalaska.com

- **Ocean acidification will impact commercial and recreational fishing**

Ocean acidification will probably have negative consequences for commercial / recreational fisheries and food security. US commercial fishing revenues for 2006 were \$4 billion and recreational fishermen went on approximately 90 million fishing trips. Coral reef fisheries alone accounted for \$100 million of the commercial fish catch. It is not yet clear how severely fisheries will be impacted by ocean acidification, but many commercial and recreational fish species depend on marine life that build calcium carbonate shells and skeletons for food/shelter and will be harmed by changing ocean chemistry.

- **Ocean acidification will negatively impact coastal communities and economies**

Coastal tourism generates billions of dollars in revenue each year for local communities through recreational fishing, diving and boating. Coastal tourism activities support local businesses, such as hotels, restaurants and shops (e.g. over 4 million tourists visit the reefs of the Florida Keys each year and contribute over \$1 billion to the local economy). For some communities, such as the US territories of Guam and the Northern Mariana Islands, over 90% of new economic development is dependent on coastal tourism. Healthy coral reefs generate tourist dollars and provide protection for coastal infrastructure (hotels, resorts, etc.) from storm surge and other natural phenomena. The coral ecosystems that underpin these commercial activities are highly threatened by ocean acidification because their calcium carbonate structures will experience high erosion rates.

What can we do?

More funds are needed for ocean acidification research. The ocean acidification bills circulating in both houses of the US Congress will enable researchers to better quantify the impacts and adaptation potential of marine life to ocean acidification. Understanding the implications of ocean acidification will facilitate the development of strategies to counteract the detrimental impacts of ocean acidification by the scientific and management communities. The only long term solution to ocean acidification is a substantial reduction in carbon dioxide emissions to the atmosphere. It is imperative that ocean acidification research move forward while strategies to reduce carbon dioxide emissions are formulated and debated.

Next Steps:

1. Determine the direct and indirect effects of ocean acidification on marine organisms and ecosystems.
2. Develop better predictive models of ocean acidification.
3. Explore and implement management options that help protect marine ecosystems from ocean acidification.
4. Support ocean acidification research legislation.
5. Support carbon dioxide emission reductions.