International Union for Conservation of Nature
ISSUES BRIEF
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OCEAN ACIDIFICATION

- As carbon dioxide (CO_2) dissolves in sea water, it forms **carbonic acid**, **decreasing the ocean's pH**, a process collectively known as **ocean acidification**.
- Present ocean acidification occurs approximately **ten times faster than anything experienced during the last 300 million years**, **jeopardising the ability of ocean systems to adapt to changes in ocean chemistry due to CO_2.**
- Ocean acidification has the potential to **change marine ecosystems** and **impact many ocean-related benefits to society** such as coastal protection or provision of food and income.
- **Increased ocean temperatures** and **oxygen loss act concurrently** with **ocean acidification** and constitute the '**deadly trio**' of climate change pressures on the marine environment.
- To combat the worst effects of the deadly trio, **CO_2 emissions need to be cut significantly** and **immediately at the source**.
- **Sustainable management, conservation, restoration and strong, permanent protection of at least 30% of the ocean are urgently needed**.

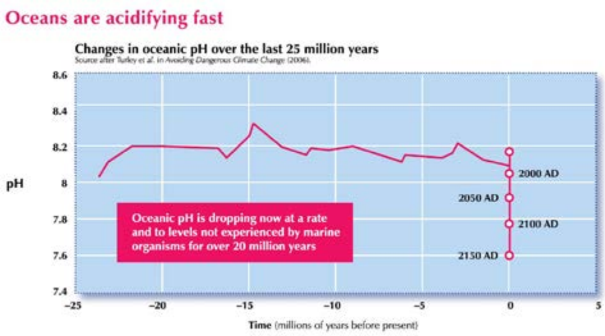
What is the issue?

Ocean acidification is a direct consequence of increased human-induced carbon dioxide (CO_2) concentrations in the atmosphere. The ocean absorbs over 25% of all anthropogenic emissions from the atmosphere each year. As CO_2 dissolves in sea water it forms carbonic acid, thereby decreasing the ocean's pH, leading to a suite of changes collectively known as ocean acidification. Ocean acidification is happening in parallel with other climate-related stressors, including ocean warming and deoxygenation. This completes the set of climate change pressures on the marine environment – heat, acidity and oxygen loss – often referred to as the '**deadly trio'**. Interaction between these stressors is often cumulative or even multiplicative, resulting in combined effects that are more severe than the sum of their individual impacts.

Why is this important?

Present **ocean acidity change** is unprecedented in magnitude, occurring at a rate approximately ten times faster than anything experienced during the last 300 million years. This rapid timeline is **jeopardising the ability of ocean systems to adapt to changes in CO_2** – a process that naturally occurs over millennia. Changes in ocean pH levels will persist as long as concentrations of atmospheric CO_2 continue to rise. To avoid significant harm, atmospheric concentrations of CO_2 need to get back to at least the 320-350 ppm range of CO_2 in the atmosphere.

Compared to other similar events in Earth's history, ocean acidification, over hundreds of years, has been happening very fast. However, its recovery has been very slow due to the inherent time lags in the carbon and ocean cycles.



From: Laffoley, D. d'A. and Baxter, J.M. (eds) (2010). *Ocean Acidification: Questions Answered.*

Ocean acidification has the potential to **change marine ecosystems** and impact many ocean-related benefits to society such as coastal protection or provision of food and income. Although more knowledge on the impacts of ocean acidification on marine life is needed, changes in many ecosystems and the services they provide to society can be extrapolated from current understanding. Some of the strongest evidence of the potential effects of ocean acidification on marine ecosystems stems from experiments on calcifying organisms.

Increased sea water acidity has been demonstrated to affect the formation and dissolution of calcium carbonate shells and skeletons in a range of marine species, including corals, molluscs such as oysters and mussels, and many phytoplankton and zooplankton species that form the base of marine food webs.

Changes in species growth and reproduction, as well as **structural and functional alterations in ecosystems**, will **threaten food security, harm**

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fishing industries and **decrease natural shoreline protection.** They will also increase **the risk of inundation and erosion** in low-lying areas, thereby hampering climate change adaptation and disaster risk reduction efforts.

Increased ocean temperatures are likely to have direct effects on the **physiology of marine organisms** and influence the **geographical distribution of species**. Some species such as reef-forming corals, already living at their upper tolerance level, will have more difficulties 'moving' fast enough to new areas. Drastic changes in ocean temperature can also lead to **coral bleaching** events, where corals expel the symbiotic algae living in their tissues, causing them to turn completely white. The role of coral reefs in buffering coastal communities from storm waves and erosion, and in supporting income generation (fisheries and tourism) for local communities and commercial businesses, is jeopardised. The potential recovery of such bleaching events is hampered due to the declining calcification rates on reefs caused by ocean acidification.

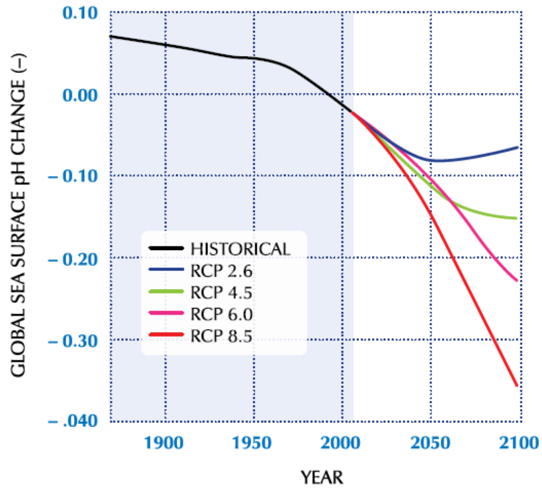
What can be done?

The long time lags inherent in the marine carbon cycle put an added penalty on **delaying limits on CO_2 emissions** and a premium on early action if the worst damages associated with ocean acidification are to be avoided. While climate change is the consequence of a range of greenhouse gas (GHG) emissions, ocean acidification is primarily caused by increased concentrations of atmospheric CO_2 dissolved in sea water. It becomes evident, however, that the objective of the United Nations Framework Convention on Climate Change (UNFCCC) to achieve 'stabilisation of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system' cannot be encapsulated by a single 'one-size-fits-all' climate indicator. **The current emissions targets need significant tightening if they are to tackle the issue of ocean acidification and ocean warming.** Limiting the global average temperature increase to well below 2°C, rather than a lower level, will significantly harm the ocean life on which we all depend in some form or another. Scientists even suggest that a healthy ocean needs an atmospheric carbon concentration of much less than 400 ppm. This benchmark has recently been exceed.

Other initiatives such as the Ocean Acidification international Reference User Group (OAiRUG), composed of scientists and various stakeholders, need to be engaged as a key means of conveying scientific results. The OAiRUG examines in detail the types of data, analyses and products that are most useful to managers, policy advisers, decision makers and politicians, and ensure an appropriate format and distribution pathways.

Sustainable management, conservation and restoration of the ocean are needed. At the IUCN World Conservation Congress 2016, IUCN Members approved a resolution calling for the protection of 30% of the planet's ocean by 2030.

The severity of future ocean acidification depends on the scale of future CO_2 emissions, shown here for the four IPCC pathways: RCP 2.6, lowest emissions (atmospheric CO_2 at ~421ppm in 2100); RCP 6.0, low emissions (~538ppm); moderate emissions (~670ppm); and RCP 8.5, high emissions (~936ppm). After Bopp *et al.* 2013.



From: Laffoley, D. d'A. and Baxter, J.M. (eds) (2015). *The Monaco Ocean Acidification Action Plan*

Where can I get more information?

IUCN Global Marine and Polar Programme: iucn.org/marine

Laffoley, D. d'A. and Baxter, J.M. (eds). (2015). *The Monaco Ocean Acidification Action Plan. Heralding the next era of action on ocean acidification*.

Laffoley, D. d'A. and Baxter, J.M. (eds). (2010). *Ocean Acidification: Questions Answered*.

Herr, D. el al. (2014). *Ocean Acidification: International Policy and Governance Option*s. Gland, Switzerland: IUCN.

Hilmi N. et al. (eds.) (2015). *Bridging the Gap Between Ocean Acidification Impacts and Economic Valuation: Regional Impacts of Ocean Acidification on Fisheries and Aquaculture.* Gland, Switzerland: I UCN.

Gattuso, J.-P. et al. (2015). 'Contrasting futures for ocean and society from different anthropogenic CO_2 emissions scenarios'. *Science* Vol. 349, Issue 6243