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OCB-OA: Policy development and decisionmaking

On this page:

Is it too late to do anything?

Basic/Intermediate: It is within our technical and economic means to modify our energy and transportation systems and land-use practices to largely eliminate carbon dioxide emissions from our economies by mid-century. It is thought that the cost of doing this — perhaps 2% of the worldwide economic production — would be small, yet at present it has proven difficult for societies to decide to undertake this conversion.

Every individual can take important steps that can help our societies to be carbon free. We can make changes in our own daily lives that will contribute to reducing carbon emissions, such as reducing our own energy usage and being more energy efficient. We can also ensure that we are utilizing our strength as consumers by purchasing products that have smaller carbon footprints and are less destructive to the ocean, for instance choosing locally caught, sustainable fish. This will not only send a message to industries that we are no longer interested in buying carbon intensive, unsustainable products, but will also help to protect vulnerable marine ecosystems and ensure they are more resilient to the changes likely to occur due to ocean acidification. But changes need to be society wide, so while individual action is incredibly important, it is also vital that we tell our leaders to make the right choices to transition our societies and eliminate carbon dioxide emissions. The more people that send our leaders this message the better. Tell your friends, family, community and anyone who will listen about ocean acidification and how they can help to prevent it. In the long run these steps will not only help to prevent future acidification of the ocean, but will also reduce climate change, make the oceans more resilient and healthy and in many cases save you money as well.—K. Caldeira, E. Harrould-Kolieb

Should we place marine protected areas in areas less likely to suffer OA and other stressors?

Basic: Yes. For example, if we can reduce the stresses to sensitive ecosystems that are within our control like land-based sources of pollution and overfishing, then this will give those ecosystems the best chance of dealing with additional stresses, such as those due to climate change, that we can't control.

Intermediate: Yes. If we can reduce the stresses to sensitive ecosystems that are within our control like land-based sources of pollution and overfishing, then this will give those ecosystems the best chance of dealing with additional stresses, such as those due to climate change that we can't control. Conversely, if we do nothing to manage the threats within our control, then the combined stress of pollution, overfishing, and ocean acidification makes it much more difficult for coral reef ecosystems to function with the added stress from climate change impacts. The threat of ocean acidification has only recently been brought to the forefront of our collective concern. There is still much that must be learned in regards to the threat of OA such as basic information on the spatial and temporal variability in carbonate chemistry, as well as the sensitivity of different species and taxa. This type of information is a critical for managers to make informed decisions on consideration of marine protected areas (MPAs) (McLeod et al. 2012). As such, only very recently have the discussions begun with regards to how to manage the threat of ocean acidification.—D. Manzello, K. Yates, J. Hall-Spencer, D. Herr

Advanced: Yes. One of the silver linings to emerge from the global-scale coral-bleaching event of 1997-98 is that not all coral reefs responded in the same way to thermal stress. In fact, this observation led to the pioneering concept of managing for resilience (e.g., West and Salm 2003). In general, the idea is that the best way to strengthen the ability of ecosystems, like coral reefs, to large-scale, unmanageable threats like global climate change is to carefully manage those stressors that are in our control. For instance, if we can reduce the impacts within our control like land-based sources of pollution and overfishing, then this will give coral reefs the best chance of dealing with recurrent mass-bleaching events. We can use this approach for OA in several ways; for example, cold water coral reefs are in regions that are becoming more corrosive, it is sensible to include MPAs that incorporate shallower examples of these reefs and to exert extra efforts to protect them from other destructive activities such as bottom trawling (Tittensor et al. 2010). Conversely, if we do nothing to manage the threats within our control, then the combined stress of pollution, overfishing, and ocean acidification makes it much more difficult for coral reef ecosystems to function with the added stress from climate change impacts.

This is not to say, however, that areas that have been degraded, or suffer multiple stressors, are not worth protecting, or that areas that are likely to change due to ocean acidification are beyond hope. In addition, there are regions and habitats in which the organisms experience unusually high levels of carbon dioxide and/or unusually low pH (e.g. upwelling areas and enclosed seas, as well inshore sediments with high levels of organic decomposition). It is sensible to afford protection to these places too, as they likely harbour strains of organisms that are resilient to the levels of ocean acidification predicted this century. Thus a network of MPAs is required that anticipates likely change and encompasses a wide range of environmental states including pristine as well as stressed habitats.

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different species and taxa is a must for managers to make informed decisions on consideration of marine protected areas (MPA) (McLeod et al. 2012). For instance, recent work has shown that coral reefs which exist within areas of dense seagrass beds, and can act as carbon sinks, experience highly favorable carbonate chemistry that will likely make them refugia from OA (Manzello et al. 2012). Identifying areas that will experience continued low CO_2 levels will be key locales for preservation of those sensitive calcifying taxa and genetic diversity negatively effected by global-scale OA.—D. Manzello, K. Yates, J. Hall-Spencer, D. Herr

If ocean acidification is so potentially serious why isn't it included in the UNFCCC COP climate mitigation negotiations?

Basic/intermediate: The chemistry of ocean acidification has been understood for a long time. More recently, scientists have found that a wide range of marine organisms could be affected. As our understanding of this has grown, international groups such as the United Nations have begun to include ocean acidification in current planning, for example, in the United Nations Framework Convention on Climate Change (UNFCCC) Conference of the Parties (COP) activities.—J. Kleypas, C. Turley, E. Harrould-Kolieb

Advanced: Although scientists have known for decades that ocean acidification would occur as CO_2 increased in the atmosphere, the consequences to marine life were not realized until about 10 years ago. At that time, biologists discovered that ocean acidification affected the ability of many marine organisms to form their shells or skeletons. Since then, many more effects of ocean acidification have been found to influence a wide array of organisms and marine processes. Because the scientific process relies on formal research protocols, peer-review, and publishing, it takes some time for a new finding to be verified and accepted by the scientific community. However, sufficient evidence about ocean acidification existed by 2007 that the IPCC Fourth Assessment Report on Climate Change (2007) stated in the Summary for Policy Makers, “The progressive acidification of the oceans due to increasing atmospheric carbon dioxide is expected to have negative impacts on marine shell-forming organisms (e.g. corals) and their dependent species.” Ocean acidification and its effects have now been documented to the point that they are widely accepted by the scientific community and it will be seriously addressed by the Fifth Assessment Report of the IPCC.

Many research scientists, programmes and institutions as well as intergovernmental and non-governmental organizations have been involved in the UNFCCC process and have increased policy maker awareness of the threats of ocean acidification to ecological and socio-economic systems. They have been involved in many side-events and other civil society actions as part of the negotiation process. Despite this the Parties to the Convention have been slow to recognize the potentially serious nature of ocean acidification and have yet to give it more than a mere mention in a footnote of any outcome documents. That said, in August 2012 the United Nations Secretary-General, Mr. Ban Ki-moon, announced *The Oceans Compact* (https://www.un.org/Depts/los/ocean_compact/oceans_compact.htm) an initiative to set out a strategic vision for the UN system to deliver on its ocean-related mandates. It mentions ocean acidification as one of the key stressors that have put oceans at risk of “irreversible damage.” —J. Kleypas, C. Turley, E. Harrould-Kolieb

Are there any international agreements or regulations focused on mitigating OA?

Basic/intermediate: To date there are no international policies put in place to stop ocean acidification. Nevertheless, OA is now being discussed by many global organizations like the United Nations General Assembly, specialized UN bodies, and the World Bank. Ocean acidification was recently identified as a priority topic by the Conference of the Parties (COP) to the Convention on Biological Diversity (CBD), and it was included in the outcome text of the June 2012 Conference on Sustainable Development (Rio+20) as a recognized threat to economically and ecologically important ecosystems and coastal communities.—E. Harrould-Kolieb, G. Galland, C. Vivian

Advanced: There is, to date, a lack of concrete international policy action focused on the mitigation of ocean acidification. Ocean acidification has, however, begun to appear on the agendas of various global institutions, including the United Nations General Assembly, specialized UN bodies and the World Bank. For instance, the Conference of the Parties (COP) to the Convention on Biological Diversity (CBD) has not only recognized ocean acidification as a pressing threat to the conservation of biodiversity, but has also initiated, in collaboration with other agencies and conventions of the UN, a process to monitor and assess the impacts of ocean acidification on marine and coastal biodiversity through a series of expert reviews (CBD, 2010). In addition, parties to a number of regional agreements, including the Convention for the Protection of the Marine Environment of the North-East Atlantic (the OSPAR Commission), the Commission for the Conservation of Antarctic Marine Living Resources (the CCAMLR Treaty) and the Secretariat of the Pacific Regional Environment Programme (SPREP) have expressed concern over ocean acidification and have initiated activities within their mandates to better monitor and prepare for the impacts of ocean acidification. For instance, the OSPAR Commission is putting in place coordinated monitoring of pH, alkalinity, dissolved inorganic carbon and pCO_2 in the OSPAR maritime area (OSPAR, 2012).

The UNFCCC COP has been lax to recognize ocean acidification as a pressing threat and place it high on its agenda, despite calls for the COP for greater inclusion of ocean acidification across its deliberations (IOC/UNESCO, IMO, FAO, & UNDP, 2011; Watson-Wright, 2012). To date, the only mention of ocean acidification in any of the UNFCCC outcome documents is within a footnote in the 2010 “Cancun Agreements”, in which ocean acidification is listed as a slow onset event resulting from climate change, along with sea level rise and glacial retreat (UNFCCC, 2010, p.4) - a definition that seems to contradict the notion that ocean acidification and climate change are separate, albeit related problems. Also of particular note, is the outcome text of the June 2012 Conference on Sustainable Development (Rio+20), in which ocean acidification is highlighted as a threat to economically and ecologically important ecosystems and coastal communities (UNGA, 2012, p.34) and the need for global cooperation to prevent further change to ocean pH is stressed (UNGA, 2012, p.32). This agreement, though not specific and nonbinding, is, by definition, a call to mitigate ocean acidification. —E. Harrould-Kolieb, G.

Are governments or management agencies considering ocean acidification in the context of multiple stressors?

Basic/Intermediate: Governing bodies appear to be waiting to see what current studies show before taking specific actions. Several government-sponsored research projects and programs around the world are focusing on multiple stressors such as ocean acidification, warming, and deoxygenation on marine systems. These projects are finding that combined effects tend to be more severe than just one stressor alone, so communicating this research is critical to inform policy. Consequently, researchers around the world have collaborated to communicate their concerns about these three stressors to key stakeholders at national, international, and intergovernmental levels (see www.oceanunderstress.com). —R. Feely, C. Turley, C. Vivian, S. Dupont

Advanced: Other than a call in 2012 by the European Union for proposals within its Framework 7 programme to address the impact of multiple stressors, we are not currently aware that this is being considered in any detail elsewhere. There is increasing recognition that other stressors need to be included in multi-stressor studies but the agencies appear to be waiting on the outcome of current research before taking specific actions. The UK Ocean Acidification Research programme (www.oceanacidification.org.uk) and BIOACID Phase II (www.bioacid.de) also consider warming as well as acidification to some extent. Nevertheless, researchers from around the world have collaborated on communicating their concerns about the combined impacts of warming, acidification and deoxygenation to key stakeholders at the national, international and intergovernmental level (see www.oceanunderstress.com).

The combined impacts of multiple stressors, such as ocean warming, acidification and deoxygenation, on marine ecosystems are starting to emerge as an important issue. Many researchers have recently focused on the combined impact of two or more of these stressors. Both observational and modeling studies have addressed the combined effects of increased temperature, reduced oxygen and acidification on changing pH and calcium carbonate saturations states in the oceans and some coastal regions (Gruber 2011; Turley et al., 2011). Marine ecologists are studying the combined effects of increased temperature and higher CO_2 levels on marine organisms (e.g. Metzger et al. 2007; Anthony et al., 2008; Pörtner et al. 2011). While the results are just beginning to appear in the scientific literature it is clear that, in some cases, the combined effects are significantly more severe than the individual processes alone. More research on this topic is needed before we have a clear understanding of the overall impacts.

It is critical to better understand the response of marine organisms and ecosystems to multiple stressors to inform policy makers. Among the key unknowns are the interactive effects of ocean acidification and other stressors such as warming and deoxygenation (oxygen loss) – there are few studies looking at the synergistic effects of all three. These three stressors share the same origin, anthropogenic CO_2 emissions, and therefore occur concurrently. They could have synergistic effects, amplifying or dampening their impact. It may be equally important to consider OA in the context of local anthropogenic stressors such as over-fishing, pollution, or even changes in salinity. —R. Feely, C. Turley, C. Vivian, S. Dupont

Last updated: September 19, 2012

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