

Messages for Rio+20

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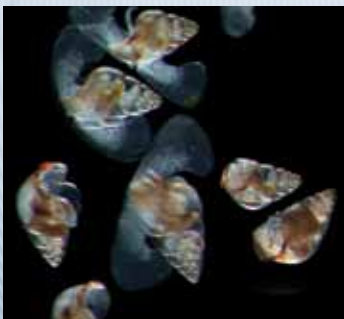
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RIO+20

United Nations Conference
on Sustainable Development

It is amazing to think that just ten years ago hardly anyone had heard of ocean acidification. It is now much more widely understood that the increasing amount of carbon dioxide (CO₂) we are emitting into the air by our activities is reacting with the ocean to alter its chemistry and push it along the scale towards acidity. One major effect is reducing the availability of carbonate ions needed by many marine animals and plants to build their shells and skeletons.

This briefing paper from the International Ocean Acidification Reference User Group provides essential information and highlights the actions needed on ocean acidification by Governments at Rio+20

There is little doubt that the ocean is undergoing dramatic changes that will impact many human lives now and ever more so in the coming generations, unless we act quickly and decisively. Previous acidification events in the Earth's geological record were often associated with extinctions of many species. Whilst the causes of such extinction episodes are complex, it is notable that the biodiversity recovery took hundreds of thousands and, after mass extinctions, millions of years.

Ocean Acidification: ACTING ON EVIDENCE

Key challenges for Rio+20

- Acknowledge that ocean acidification is a direct consequence of increasing atmospheric CO₂ concentration. Even at the current concentration (~390 ppm CO₂) it may already be having an effect, and important marine ecosystems are likely to be harmed if the atmospheric CO₂ concentration reaches 450 ppm.
- Recognize that significantly reducing the build-up of anthropogenic CO₂ in the atmosphere is the only practicable solution to mitigating ocean acidification.
- Support the implementation of actions to reduce global CO₂ emissions by at least 50% of 1990 levels by 2050 and continue to reduce them thereafter.
- Reinvigorate action to reduce, or where possible prevent or eliminate at the regional or local scale other environmental stressors, such as over-fishing, pollution and eutrophication which are considered to magnify impacts.
- Strengthen ocean resilience by allowing the ocean space and time for recovery from human impacts, through designating and ensuring protection of an effective network of marine reserves and by implementing effective marine planning.
- Support the international coordination of integrated ocean acidification research.

Key facts about ocean acidification

- Currently, each year the ocean absorbs approximately 26% of all the CO₂ we emit.
- This hidden ocean 'service' has been estimated to represent an annual subsidy to the global economy of US\$60 – US\$400 billion per year.¹
- Ocean acidity has increased by 30% since the beginning of the Industrial Revolution and if CO₂ emissions continue to increase the rate of acidification will accelerate in the coming decades. This rate of change, to the best of our knowledge, is many times faster than anything experienced in the last 55 million years.
- Numerous animals and plants in the sea have calcium carbonate skeletons or shells. Many are sensitive to small changes in acidity, particularly young life stages and there is evidence that they are already being affected. Physiological processes and behaviour also show sensitivity to ocean acidification in other species.
- Some organisms may apparently benefit from ocean acidification (e.g. photosynthetic algae as well as other marine plants like seagrasses). However, it is important to bear in mind that even positive effects on one species can have a disruptive impact on food chains, community dynamics, biodiversity and ecosystem structure and function.

1. This assumes a theoretical replacement cost based on sequestration of 2Gt C/yr at an expected future carbon credit price of \$30 – \$200/t CO₂, and should be considered as nominal monetary value for services which are unlikely to be replaceable in practice.

- Many of the most sensitive species are directly or indirectly of great cultural, economic, or ecological importance for example, warm-water corals that reduce coastal erosion and provide habitat for many other species.

Building the global policy framework²

The most effective way of preventing dangerous climate change is to stabilize and reduce the level of greenhouse gases in the atmosphere, particularly of CO₂ (the main driver of climate change and the major cause of ocean acidification). This is reflected in the ultimate goal of the United Nations Framework Convention on Climate Change (UNFCCC) and all affiliated bodies to achieve "stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system" (UNFCCC, 1992, Article 2).

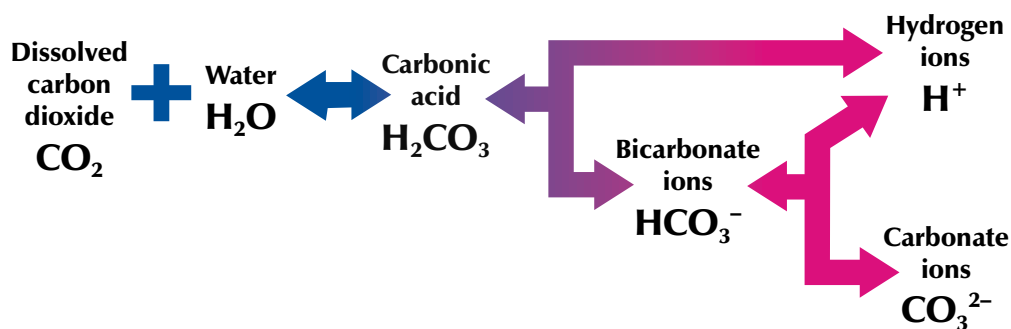
The actions urged through this briefing paper must form part of a broader strategy to address ocean acidification alongside other key threats to the marine environment such as overfishing and pollution. The ocean is an integral part of the climate system and by absorbing large amounts of CO₂ it plays an important role in helping to moderate the rate and severity of climate change. Unfortunately this benefit jeopardizes the health of the ocean and its ability to continue to provide important ecosystem services, food production and sustainable economic development.

Ocean acidification can no longer remain on the periphery of international debates on climate, the environment and sustainability. Although it is not a consequence of global warming it is a concurrent problem with wide potential consequences for habitats, species and humankind. The UNFCCC appears to be the most appropriate body to address the mitigation of ocean acidification but other global environmental conventions, such as the Convention for Biological Diversity, must play their part if successful integrated actions are to be taken.

One of the fundamental adjustments required involves the recognition of the differences between the mitigation strategies of the interlinked problems of ocean acidification and climate change, as this will ultimately influence the types of measures that are used to address them. Measures focusing on regulating emissions of other greenhouse gases, while a vital contribution to tackling climate change, will have no impact on the progressive acidification of the ocean. Furthermore, proposals for alternative 'geoengineering' strategies aimed at reducing global temperatures through solar radiation management would not contribute to stabilization or reduction of levels of atmospheric CO₂ and would therefore be similarly ineffective in addressing ocean acidification, irrespective of any benefits and drawbacks in relation to climate change.

2. Harrould-Kolieb & Herr. (2011). *Ocean Acidification and climate change: synergies and challenges of addressing both under the UNFCCC*, Climate Policy, DOI:10.1080/14693062.2012.620788.

The burning of fossil fuels not only increases CO₂ in the atmosphere but also in the ocean. As a result, the concentration of hydrogen ions increases (increasing acidity) whilst the concentration of carbonate ions decreases. Source University of Maryland.

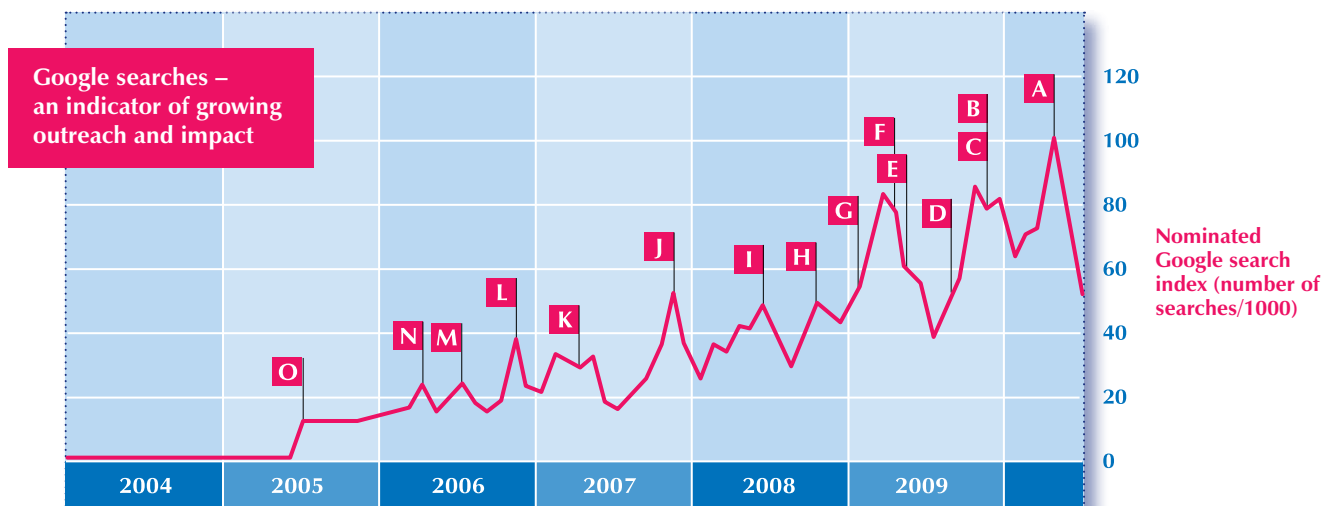


Who is taking action on ocean acidification?

In the last few years there has been a significant growth in scientific studies to understand what is happening now and what may happen in the future as a result of ocean acidification.

Current scientific studies focus on understanding the consequences and mechanisms of this global problem to identify the best strategies for addressing it. There is a need to ensure that the concerns of developing countries are adequately addressed, and also that new findings are rapidly disseminated as they emerge in the research community.

In November 2010, the CSM and the IAEA (sponsored by the USA Peaceful Uses Initiative) jointly hosted an international workshop with the endorsement and support of the Principality of Monaco, the Oceanographic Museum, the Prince Albert II of Monaco Foundation and the French Ministry of Ecology, Energy, Sustainable Development and the Sea. This meeting on the *Economics of Ocean Acidification: Bridging the Gap between Ocean Acidification Impacts and Economic Valuation* produced a set of recommendations as a basis for policy decisions concerning ocean acidification (www.iaea.org/nael/page.php). Another workshop is planned for 2012 to further develop the natural and social scientific collaborations.



Turley and Boot (2011) in *Ocean Acidification* (Gattuso and Hansson eds), Oxford University Press.

- A** Paper on fish behavioural response to predators under high CO₂
- B** Oceans Day and other acidification activities during COP15
- C** Launch of the film, *Acid Test*
- D** Threat of high CO₂ waters to Alaskan fisheries
- E** *Interacademy Statement* on ocean acidification
- F** CBO legal proceedings against the EPA
- G** *Monaco Declaration*
- H** Oceans in a High CO₂ World symposium
- I** Key articles e.g. *Upwelling of high CO₂ water off the west coast of North America* and *Vulnerability of calcifiers around natural CO₂ vents*
- J** *IPCC 4th Assessment Report on Climate Change*
- K** NSF, NOAA, USGS report, *Impacts of Ocean Acidification on Coral Reefs and Other Marine Calcifiers*
- L/M** *Avoiding Dangerous Climate Change Symposium* and book
- N** *Scientific American* and *New Yorker*
- O** Royal Society Report

Major studies underway or in advanced stages of planning

European Union

In 2008 the European Commission funded the European Project on Ocean Acidification (EPOCA) (www.epoca-project.eu/), an initiative to investigate 'Ocean acidification and its consequences' as a multinational effort that includes 32 laboratories located in ten European countries. This 4-year research project aims to monitor ocean acidification and its effects on marine organisms and ecosystems, to identify the risks of continued acidification, and to understand how these changes will affect the Earth system as a whole. In 2011 the European Commission funded Mediterranean Sea Acidification in a Changing Climate (MedSeA) (www.medsea-project.eu/) which assesses uncertainties, risks and thresholds to Mediterranean Sea acidification and warming at organism, ecosystem and economic scales and potential regional adaptation and mitigation strategies. MedSeA is funded for 3 years and involves 16 institutes from 10 countries mainly from the Mediterranean area.

Australia

Ocean acidification in the Australasian region focuses on impacts from the Southern Ocean through to the Great Barrier Reef and into Papua New Guinea. Research in the Southern Ocean by the Antarctic Climate & Ecosystems Cooperative Research Centre (a multidisciplinary partnership of 23 national and international organizations) includes monitoring sea water chemistry changes and the responses of key species. The Integrated Marine Observing System (IMOS) makes these data available through its Ocean Portal (www.imos.aodn.org.au).

China

The Ministry of Science and Technology (MOST) and National Science Foundation of China (NSFC) have started to support research into ocean acidification. CHOICE-C is a newly funded 5-year project to study high CO₂ and ocean acidification issues in Chinese marginal seas, a joint project of 7 major institutes. NSFC started to fund projects on ocean acidification in 2006, and there are several ongoing national level projects exploring the impacts of ocean acidification on calcifying organisms.

Germany

The Biological Impacts of Ocean Acidification (BIOACID) programme (www.bioacid.de) involves 18 research institutes and is funded by the Federal Ministry of Education and Research (BMBF) for an initial 3-year period starting in September 2009. Its main focus is on the effects of ocean acidification on the marine biota at the sub-cellular to ecosystem level and their potential impacts on ecosystem services and biogeochemical feedbacks.

Japan

Five major programmes in Japan fund research relevant to ocean acidification. Japan's Ministry of Environment supports research programmes to elucidate the future impact of ocean acidification on various marine organisms using sophisticated mesocosm facilities (e.g. AICAL, Acidification Impact on CALcifiers). The Ministry



EPOCA CO₂ experiments

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of Education, Science, Sport and Culture (MEXT) and the Japan Agency for Marine Science and TEchnology (JAMSTEC) also support ocean acidification research such as modelling efforts on the Earth Simulator supercomputer to predict future ocean conditions.

Korea

The Korea Science and Engineering Foundation is funding the 5-year Korea Mesocosm Project to examine the effects of elevated CO₂ and temperature on natural phytoplankton assemblages, which involves five Korean laboratories.

Monaco

In October 2011, the IAEA Environment Laboratories began a Coordinated Research Project (CRP) entitled *Ocean Acidification and the Economic Impact on Fisheries and Coastal Society*, supported by the United States Department of State. The CRP seeks to engage developing countries in research on impacts of ocean acidification on fisheries, aquaculture, and marine ecosystem services that support sustainable food security and human well-being. The first coordination meeting is planned for July 2012.

United Kingdom

Following an initial study, Implication for the Marine Environment of CO₂ (2004-2007), a 5-year UK Ocean Acidification (UKOA) research programme (www.oceanacidification.org.uk) is now underway involving over 120 researchers in 26 laboratories. UKOA is funded by the Natural Environment Research Council (NERC), the Department for Environment, Food and Rural Affairs (Defra) and the Department of Energy and Climate Change (DECC).

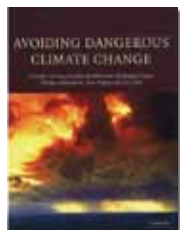
United States

The Federal Ocean Acidification Research and Monitoring Act: of 2009. The FOARAM Act in US Public Law 111-11 was signed by President Obama in March 2009. The Act requires that the National Oceanic and Atmospheric Administration (NOAA), the National Science Foundation (NSF) and other federal agencies work together through the Interagency Working Group on Ocean Acidification (www.st.nmfs.noaa.gov/iwgoa/) to develop an integrated national program on ocean acidification beginning in 2010.

Finding out more about ocean acidification – useful sources of further information

Ocean acidification featured as new topic in the press release from the first global meeting on the *Ocean in a High CO₂ World*, supported by the United Nations Educational, Scientific and Cultural Organization (UNESCO). Since then, a rapid expansion in work and concern on this issue has occurred.

Key reports that together provide a comprehensive source of knowledge are as follows:



The first time many policy advisers became aware of ocean acidification was through the 2005 international conference on *Avoiding Dangerous Climate Change: A Scientific Symposium on Stabilisation of Greenhouse Gases*. This took place under the United Kingdom's presidency of the G8, with the

participation of around 200 internationally renowned scientists from 30 countries. It examined the link between atmospheric greenhouse gas concentration, and the 2°C (3.6°F) ceiling on global warming thought necessary to avoid the most serious effects of global warming. Previously this had generally been accepted as being the concentration of 550 ppm CO₂ rather than being linked to a temperature ceiling.

The first major publication on ocean acidification rapidly followed. The Royal Society 2005 policy document *Ocean acidification due to increasing atmospheric carbon dioxide* recognized ocean acidification is a significant threat to many calcifying organisms with the potential to alter food chains and other ecosystem processes and lead to a reduction of biodiversity in the oceans. The appointed working group made specific policy recommendations, including limiting the accumulation of CO₂ emissions to avert impending damages from ocean acidification.



In 2006 the German Advisory Council on Global Change released *The Future Oceans – Warming Up, Rising High, Turning Sour*. This document presents the hazards of acidification within the context of other climate change processes in the ocean. Policy makers were urged to acknowledge the role of CO₂ as an ocean hazard during

future negotiations under the United Nations Framework Convention on Climate Change.

Impacts of Ocean Acidification on Coral Reefs and Other Marine Calcifiers: A Guide for Future Research came from a joint effort by NSF, NOAA and USGS. This is a 2006 summary report on the state of the science regarding the biological consequences of acidification, particularly as they affect calcifying organisms. The report concludes with a recommended research agenda and underscores the need for research to place the long term biological



changes induced by acidification into a historical context.

In 2006 a report was produced from The Convention for the Protection of the Marine Environment of the North East Atlantic (the OSPAR Convention). *Effects on the Marine Environment of Ocean Acidification Resulting from Elevated Levels of CO₂ in the Atmosphere* was a product of The Scoping Workshop on Ocean Acidification Research.



From 2007 onwards ocean acidification began to regularly feature in reporting in the UK on marine climate change impacts. These took the form of *Annual Report Cards produced by the Marine Climate Change Impacts Partnership (MCCIP)*. In April 2009 more

significant coverage was provided on ocean acidification through their publication *Exploring ecosystem linkages*. This builds on the previous Annual Report Cards to show how the interconnected nature of the marine ecosystem magnifies the many discrete impacts of climate change.

The U.S. Ocean Carbon and Biogeochemistry Program (OCB) sponsored a workshop in conjunction with NOAA, National Aeronautics and Space Administration (NASA) and NSF at the Scripps Institution of Oceanography to develop a U.S. research strategy. With the cooperation of around 100 scientists, a plan was developed to investigate the impacts of ocean acidification on four marine ecotypes: coral reefs, coastal margins, tropical subtropical open ocean systems and high latitude regions. The recommended research was reported in 2008 in *Present and Future Impacts of Ocean Acidification on Marine Ecosystems and Biogeochemical Cycles*.



Also in 2008, a significant policy document was provided for the Australian government: *Position Analysis: CO₂ Emissions and Climate Change: Ocean Impacts and Adaptation Issues*. This document sought to describe the process of acidification, outline the biological and human effects and to advise the Australian government on issues

relevant to policy development. It was accompanied by a one page fact sheet *Ocean Acidification: Australian Impacts in the Global Context* that discussed ocean acidification in terms of the science: what is known, what needs to be known and what can be done.

In 2008 The Nature Conservancy and the International Union for Conservation of Nature (IUCN) held a meeting on ocean acidification which resulted in the *Honolulu Declaration*. This identified two major strategies that must be implemented urgently and concurrently to mitigate the impacts of climate change and to safeguard the value of coral reef systems: 1) limit fossil fuel emissions; 2) build the resilience of tropical marine ecosystems and communities to maximize their ability to resist and recover from climate change impacts.





In 2008 the European Geosciences Union, Asia Oceania Geosciences Society and the Japan Geosciences Union produced a joint *Position Statement on Ocean Acidification*. This concluded that the impacts of ocean acidification may be just as dramatic as those of global warming (resulting from anthropogenic activities on top of natural variability) and the combination of both

are likely to exacerbate consequences, resulting in potentially profound changes throughout marine ecosystems and in the services that they provide to humankind.

In 2009 a further milestone report was produced. The *Monaco Declaration* is supported by H.S.H. Prince Albert II of Monaco who, whilst taking part in the working sessions of the second international symposium *The Ocean in a High-CO₂ World*, expressed his earnest wishes for the *Monaco Declaration* to be drafted. The resultant declaration is approved by 155 scientists from 26 countries, all leaders of research into ocean acidification and its impacts. It calls on policymakers to act quickly to avoid severe and widespread damages, all of which are ultimately driven by increasing concentrations of atmospheric CO₂. By acting quickly to incorporate these concerns into plans to stabilize atmospheric CO₂ at a safe level not only would this avoid dangerous climate change but also dangerous ocean acidification.



Another result of the second international symposium *The Ocean in a High-CO₂ World* was the production of a *Summary for policy makers* of the new research findings presented at the symposium. More detailed information is synthesised in a scientific report, *Research Priorities for Ocean Acidification* (2009), available from www.ocean-acidification.net

In 2009 the International Ocean Acidification Reference User Group produced a guide to ocean acidification, *Ocean Acidification The Facts*. Available in English, French, Spanish, Chinese and Arabic the guide sets out in plain language an introduction to the topic, summarizing key issues around this important topic.



Interacademy Panel (IAP) statement on ocean acidification (2009) signed by over 100 National Academies stated that marine food supplies are likely to be reduced and that coral reef and polar ecosystems will be severely affected by 2050 or potentially even earlier. It stated that even with stabilization of atmospheric CO₂ at 450 ppm, ocean acidification would have profound impacts on many marine systems and that large and rapid reductions of global CO₂ emissions are needed by at least 50% by 2050.

European Science Foundation Science Policy Briefing on Impacts of Ocean Acidification (2009) amongst several recommendations called for improved coordination of ocean acidification research and collaboration, both



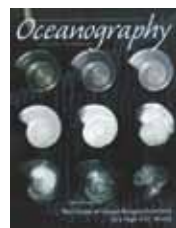
at national and international levels, and integration of efforts between natural and social sciences in order to understand the impacts on natural resources and humans (www.esf.org/publications/science-policy-briefings.html).

Ocean Acidification Frequently Asked Questions (2010) was published by OCB (www.us-ocb.org), EPOCA (www.epoca-project.eu) and UKOA (www.oceanacidification.org.uk) in response to the growing research across disciplines and the increasing need for clear answers by experts to frequently asked questions. In total, 27 experts from 19 institutes and five countries contributed.



In 2010 the International Ocean Acidification Reference User Group produced their second guide on ocean acidification, *Ocean Acidification: Questions Answered*, to say how sure the international scientific community is about what is already happening to the ocean, to discuss what the future may hold for the ocean in a high CO₂ world, and to explore the consequences for all of us of what is now happening. The guide is available in English, French, Spanish, Chinese, Arabic and German.

Environmental consequence of ocean acidification: a threat to food security. UNEP Emerging Issues Bulletin (2010). With 1 billion people relying on marine protein as their sole protein source, an expanding global population increasingly reliant on marine food sources including aquaculture this is the first time ocean acidification has been linked to potential risk to food security.



In 2009 a special issue of *Oceanography* was devoted to understanding the present and future impacts of ocean acidification in a high CO₂ world. The special issue contained review articles on processes and impacts of acidification to marine ecosystems.

The National Research Council of the US National Academies *Ocean Acidification. A National Strategy to Meet the Challenges of a Changing Ocean* (2010). This publication, requested by Congress, is one step amongst many that US scientists and funders are taking towards forming a National Ocean Acidification Research Programme.



The Intergovernmental Panel on Climate Change's (IPCC) *4th Assessment Report on Climate Change* (2007) recognized ocean acidification for the first time in an IPCC report. Since then an IPCC WGII/WGI Workshop on Impacts of Ocean Acidification on Marine Biology



and Ecosystems was held in Okinawa, Japan 17-19 January 2011 and findings of the experts published: www.ipcc-wg2.gov/meetings/workshops/OceanAcidification_WorkshopReport.pdf. The 5th IPCC Assessment Report due in 2014 will include a more in depth assessment of both ocean climate change and acidification.

In 2011, the Antarctic Climate & Ecosystems Cooperative Research Centre created a Southern Ocean focused report card at the Australian government's request, *Southern Ocean Acidification Report Card*, to clearly communicate what we know, what we need to know and what's at risk due to ocean acidification in the region.



Ocean Acidification (eds Gattuso and Hansson, 2011) The first book on ocean acidification with key chapters on impacts on marine organisms, ecosystems and biogeochemistry, projections of the consequences of CO₂ emission scenarios on future acidification and socio-economics and policy responses and societal challenges as the topic has emerged.

The Convention on Biological Diversity (CBD) became interested in ocean acidification impacts on biodiversity and published a *Scientific Synthesis of the impacts of ocean acidification on marine biodiversity*. In 2011 they convened an Expert Meeting to develop a series of joint expert review processes to monitor and assess the impacts of ocean acidification on marine and coastal biodiversity in Montreal (19-20 October), in which it was agreed that in order to preserve biodiversity, CO₂ emissions must be reduced and ecosystem resilience managed.



Films

In the past few years a number of films have also been produced to explain ocean acidification to a wide audience and how the issue is being tackled by scientific studies and new innovative science/policy/outreach partnerships. Four key films released in the past few years are:

Acid Test, a film produced in 2009 by the National Resources Defence Council (NRDC), narrated by Sigourney Weaver, was made to raise awareness about the largely unknown problem of ocean acidification, which poses a fundamental challenge to life in the seas and the health of the entire planet. Like global warming, ocean acidification stems from the increase of CO₂ in the earth's atmosphere since the start of the Industrial Revolution.

A group of 11-15 year old students from Ridgeway School in Plymouth, working with Plymouth Marine Laboratory, have made their concerns about the state of the world's oceans clear through a hard hitting film. *The Other CO₂ Problem*, released in 2009, is a seven and a

half minute animation starring characters from King Poseidon's Kingdom beneath the sea and laments the fact that Doctopus, Britney Star, Michelle Mussel, Derek the Diatom and other subsea creatures are suffering as the ocean becomes more acidic as a result of human activities; the film ends with Poseidon demanding that we terrestrials sort the problem out and stop pumping more and more CO₂ into the atmosphere to be absorbed by the sea, with potentially disastrous consequences. The children and their animation won the Royal Society of Chemistry's Bill Bryson Prize for Science Communication.



The movie *Tipping Point* released in 2011 mostly describes research performed in the framework of the European Project on Ocean Acidification. It just received the Prince Rainier III Special Prize at the 51st Monte-Carlo Television Festival. Nicolas Koutsikas, the producer, received the award from Prince Albert II of Monaco on 10 June 2011. This is the third award received by *Tipping Point* after the 'Best 2011 science documentary award' at the 15th International Festival of Scientific Documentary and Movie and the "Best Scientific Movie" award at the Mediterranean film festival.



A powerful short film on Ocean acidification: *Connecting science, industry, policy and public*, released in 2011 by Plymouth Marine Laboratory as part of the UK Ocean Acidification Research Programme's outreach.



As scientific research reveals more about how the ocean and the life it contains might be affected, there is a need for scientists to engage with a wider community including policy makers, industry, environmental managers and the general public to understand what is happening, how we might be affected and what actions could be taken to reduce any risks. The film brings together a wide range of stakeholders including, HSH Prince Albert II of Monaco, school children, a Plymouth fishmonger, a UK government Chief Scientific Adviser, representatives from industry and policy making departments, as well as a group of internationally recognized expert scientists.

Science to Policy

Following the successes of the first and second symposia on *The Ocean in a High-CO₂ World*, the latest scientific findings on ocean acidification research will be presented at a third symposium*³ in September 2012. The symposium will also cover policy and management implications of ocean acidification.

Decision makers are invited to attend. The outcomes will be presented in a summary for policymakers.

www.highco2-iii.org



3. Organized by the Scientific Committee on Oceanic Research, the International Geosphere-Biosphere Programme and UNESCO's Intergovernmental Oceanographic Commission.



What is the International Ocean Acidification Reference User Group?

A key challenge is ensuring that ground-breaking science on issues such as ocean acidification addresses the questions that need to be answered and that these answers get quickly and effectively into the hands of policy advisers and decision makers so that action can be taken. The International Ocean Acidification Reference User Group (IOA-RUG) draws on UK, European and international experience in fast-tracking the exchange of information between scientists and end users.

The original RUG was established in 2008 to support the work of the European Project on Ocean Acidification (EPOCA), and now as the IOA-RUG supports complementary studies in Germany (BIOACID), the UK (the UK Ocean Acidification research programme, UKOA), the Mediterranean through the Mediterranean Sea Acidification in a Changing Climate (MedSeA), with strong links in similar processes in the USA and the Australian ocean acidification RUG. The IOA-RUG draws together a wide range of end users to support the work of leading scientists on ocean acidification, to facilitate the rapid transfer of knowledge, and help the effective delivery of quality science.

This guide draws on the experience of the IOA-RUG, coupled with the knowledge of the leading experts on ocean acidification, to provide an introduction for policy advisers and decision makers at Rio+20 on this most critical and urgent of issues.

Online Guide

Download a copy of this new guide to ocean acidification and learn more about this issue at: www.epoca-project.eu/index.php/Outreach/RUG/

Further details and contacts

Further details on the work of the International Ocean Acidification Reference User Group and its membership, and EPOCA can be found at:

www.epoca-project.eu/index.php/Outreach/RUG/
and the UK Programme at www.oceanacidification.org.uk
For BIOACID please see www.bioacid.de/
For MedSeA please see medsea-project.eu/

If you have any further enquiries please contact us at:
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Sources and contributors

This document draws from previous RUG presentation and associated materials. It also draws on the recent publication by Harrould-Kolieb & Herr (2011): Ocean acidification and climate change: synergies and challenges of addressing both under the UNFCCC, Climate Policy, DOI:10.1080/14693062.2012.620788.

We are grateful to all the scientists and experts who contributed to the development of this report. Their contributions have ensured that it represents a broad consensus of the key information and actions needed on ocean acidification.

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