International Earth system expert workshop on ocean stresses and impacts

Summary workshop report

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Content

1. Introduction

Between 11th and 13th April 2011 world experts on the ocean met at the Margaret Thatcher Conference Centre, Somerville College, University of Oxford. This event was led by the International Programme on the State of the Ocean (IPSO), in partnership with the International Union for Conservation of Nature (IUCN), and brought together a select group of world science leaders on ocean stresses and impacts to reflect on these, and propose creative solutions.

The workshop provided a rare opportunity to interact with other disciplines to determine the net effect of what is already happening to the ocean and is projected to do so in the future. Over the three days 27 participants from 18 organisations in 6 countries (Annex 1) assessed the latest information on impacts and stresses, and the synergistic effects these are having on the global ocean.

Through presentations, discussions and recommendations the workshop documented and described the cumulative effects of such impacts, how these commonly act in a negatively synergistic way, and why therefore concerted action is now needed to address the consequences set out in this report.

The scientific outcomes from this workshop will be used first and foremost to strengthen the case for greater action to reduce anthropogenic emissions of carbon dioxide related to climate change and ocean acidification while also reducing other stressors. The findings underscore the need for more effective management of fisheries and pollution and for strengthening protection of the 64% of the ocean that lies beyond the zones of national jurisdiction. They thereby form a major contribution to implementation of the major IPSO report on the Global State of the Ocean. This event follows on from the IPSO/Royal Society event in 2009 that focussed on the future for coral reefs.

2. Workshop objectives

The objectives of the workshop were to:

- Review the latest information on ocean stresses and impacts and the levels of confidence around what is being expressed;
- Summarise the likely consequence of existing stresses on the ocean;
- Summarise the likely consequence of projected stresses from 2020 through to 2050;
- Determine the synergistic effects of multiple stresses on the ocean and what this may mean for the future.

The timeline for consideration was from today through 2020 to 2050.

3. Scientific conclusions from the workshop

The workshop enabled leading experts to take a global view on how all the different effects we are having on the ocean are compromising its ability to support us. This examination of synergistic threats leads to the conclusion that we have underestimated the overall risks and that the whole of marine degradation is greater than the sum of its parts, and that degradation is now happening at a faster rate than predicted.

It is clear that the traditional economic and consumer values that formerly served society well, when coupled with current rates of population increase, are not sustainable. The ocean is the largest ecosystem on Earth, supports us and maintains our world in a habitable condition. To maintain the goods and services it has provided to humankind for millennia demands change in how we view, manage, govern and use marine ecosystems. The scale of the stresses on the ocean means that deferring action will increase costs in the future leading to even greater losses of benefits.

The key points needed to drive a common sense rethink are:

- **Human actions have resulted in warming and acidification of the oceans and are now causing increased hypoxia.**
  Studies of the Earth's past indicate that these are three symptoms that indicate disturbances of the carbon cycle associated with each of the previous five mass extinctions on Earth (e.g. Erwin, 2008; Veron, 2008a,b; Veron et al., 2009; Barnosky et al., 2011).

- **The speeds of many negative changes to the ocean are near to or are tracking the worst-case scenarios from IPCC and other predictions. Some are as predicted, but many are faster than anticipated, and many are still accelerating.**
  Consequences of current rates of change already matching those predicted under the "worst case scenario" include: the rate of decrease in Arctic Sea Ice (Stroeve et al., 2007; Wang & Overland, 2009) and in the accelerated melting of both the Greenland icesheet (Velicogna, 2009; Khan et al., 2010; Rignot et al., 2011) and Antarctic ice sheets (Chen et al., 2009; Rignot et al., 2008, 2011; Velicogna, 2009); sea level rise (Rahmstorf 2007a,b; Rahmstorf et al., 2007; Nicholls et al., 2011); and release of trapped methane from the seabed (Westbrook et al., 2009; Shakova et al., 2010; although not yet globally significant Dlugokencky et al., 2009).

  The 'worst case' effects are compounding other changes more consistent with predictions including: changes in the distribution and abundance of marine species (Beaugrand & Reid, 2003; Beaugrand 2004, 2009; Beaugrand et al., 2003; 2010; Cheung et al. 2009, 2010, Reid et al., 2007; Johnson et al., 2011; Philippart et al., 2011; Schiel, 2011; Wassmann et al., 2011; Wernberg et al., 2011); changes in primary production (Behrenfeld et al., 2006; Chavez et al., 2011); changes in the distribution of harmful algal blooms (Heisler et al., 2008; Bauman et al., 2010); increases in health hazards in the oceans (e.g. ciguatera, pathogens; Van Dolah, 2000; Lipp et al., 2002; Dickey & Plakas, 2009); and loss of both large, long-lived and small fish species causing widespread impacts on marine ecosystems, including direct impacts on predator and prey species, the simplification and destabilization of food webs, reduction of resilience to the effects of climate change (e.g. Jackson et al. 2001; Pauly et al., 1998; Worm & Myers, 2003;

Baum & Myers, 2004; Rosenberg et al., 2005; Worm et al., 2006; Myers et al., 2007; Jackson, 2008; Baum & Worm, 2009; Ferretti et al., 2010; Hutchings et al., 2010; Ward-Paige et al., 2010; Pinskya et al., 2011).

- **The magnitude of the cumulative impacts on the ocean is greater than previously understood** Interactions between different impacts can be negatively synergistic (negative impact greater than sum of individual stressors) or they can be antagonistic (lowering the effects of individual impacts). Examples of such interactions include: combinations of overfishing, physical disturbance, climate change effects, nutrient runoff and introductions of non-native species leading to explosions of these invasive species, including harmful algal blooms, and dead zones (Rabalais et al., 2001, 2002; Daskalov et al., 2007; Purcell et al., 2007; Boero et al., 2008; Heisler et al., 2008; Dickey & Plakas, 2009; Bauman et al., 2010; Vaquer-Sunur & Duarte, 2010); increased temperature and acidification increasing the susceptibility of corals to bleaching (Anthony et al., 2008) and acting synergistically to impact the reproduction and development of other marine invertebrates (Parker et al., 2009); changes in the behavior, fate and toxicity of heavy metals with acidification (Millero et al., 2009; Pascal et al., 2010); acidification may reduce the limiting effect of iron availability on primary production in some parts of the ocean (Shi et al., 2010; King et al., 2011); increased uptake of plastics by fauna (Andrady 2011, Hirai & Takada et al. 2011, Murray & Cowie, 2011), and increased bioavailability of pollutants through adsorption onto the surface of microplastic particles (Graham & Thompson 2009, Moore 2008, Thomson, et al., 2009); and feedbacks of climate change impacts on the oceans (temperature rise, sea level rise, loss of ice cover, acidification, increased storm intensity, methane release) on their rate of CO_2 uptake and global warming (Lenton et al., 2008; Reid et al 2009).

- **Timelines for action are shrinking.**
The longer the delay in reducing emissions the higher the annual reduction rate will have to be and the greater the financial cost. Delays will mean increased environmental damage with greater socioeconomic impacts and costs of mitigation and adaptation measures.

- **Resilience of the ocean to climate change impacts is severely compromised by the other stressors from human activities, including fisheries, pollution and habitat destruction.**
Examples include the overfishing of reef grazers, nutrient runoff, and other forms of pollution (presence of pathogens or endocrine disrupting chemicals (Porte et al., 2006; OSPAR 2010)) reducing the recovery ability of reefs from temperature-induced mass coral bleaching (Hoegh-Guldberg et al., 2007; Mumby et al., 2007; Hughes et al., 2010; Jackson, 2010; Mumby & Harborne, 2010) . These multiple stressors promote the phase shift of reef ecosystems from being coral-dominated to algal dominated. The loss of genetic diversity from overfishing reduces ability to adapt to stressors.

- **Ecosystem collapse is occurring as a result of both current and emerging stressors.**
Stressors include chemical pollutants, agriculture run-off, sediment loads and over-extraction of many components of food webs which singly and together severely impair the functioning of ecosystems. Consequences include the potential increase of harmful algal blooms in recent

decades (Van Dolah, 2000; Landsberg, 2002; Heisler et al., 2008; Dickey & Plakas, 2009; Wang & Wu, 2009); the spread of oxygen depleted or dead zones (Rabalais et al., 2002; Diaz & Rosenberg, 2008; Vaquer-Sunyer & Duarte, 2008); the disturbance of the structure and functioning of marine food webs, to the benefit of planktonic organisms of low nutritional value, such as jellyfish or other gelatinous-like organisms (Broduer et al., 1999; Mills, 2001; Pauly et al. 2009; Boero et al., 2008; Moore et al., 2008); dramatic changes in the microbial communities with negative impacts at the ecosystem scale (Dinsdale et al., 2008; Jackson, 2010); and the impact of emerging chemical contaminants in ecosystems (la Farré et al., 2008). This impairment damages or eliminates the ability of ecosystems to support humans.

- **The extinction threat to marine species is rapidly increasing.**
  The main causes of extinctions of marine species to date are overexploitation and habitat loss (Dulvy et al., 2009). However climate change is increasingly adding to this, as evidenced by the recent IUCN Red List Assessment of reef-forming corals (Carpenter et al., 2008). Some other species ranges have already extended or shifted pole-wards and into deeper cooler waters (Reid et al., 2009); this may not be possible for some species to achieve, potentially leading to reduced habitats and more extinctions. Shifts in currents and temperatures will affect the food supply of animals, including at critical early stages, potentially testing their ability to survive.

The participants concluded that not only are we already experiencing severe declines in many species to the point of commercial extinction in some cases, and an unparalleled rate of regional extinctions of habitat types (eg mangroves and seagrass meadows), but we now face losing marine species and entire marine ecosystems, such as coral reefs, within a single generation. Unless action is taken now, the consequences of our activities are at a high risk of causing, through the combined effects of climate change, overexploitation, pollution and habitat loss, the next globally significant extinction event in the ocean. It is notable that the occurrence of multiple high intensity stressors has been a pre-requisite for all the five global extinction events of the past 600 million years (Barnosky et al., 2009).

4. Recommendations from the workshop

The participants of the meeting agreed to the following recommendations based on workshop conclusions.

Technical means to achieve the solutions to many of these problems already exist, but that current societal values prevent humankind from addressing them effectively. Overcoming these barriers is core to the fundamental changes needed to achieve a sustainable and equitable future for the generations to come and which preserves the natural ecosystems of the Earth that we benefit from and enjoy today. This meeting of experts offers the following recommendations to citizens and governments everywhere to transform how we manage, govern and protect the ocean:

- **Immediate reduction in CO_2 emissions** coupled with significantly increased measures for mitigation of atmospheric CO_2 and to better manage coastal and marine carbon sinks to avoid additional emissions of greenhouse gases.
    - It is a matter of urgency that the ocean is considered as a priority in the deliberations of the IPCC and UNFCCC.

- **Urgent actions to restore the structure and function of marine ecosystems,** including the coordinated and concerted action in national waters and on the High Seas (the high seas water column and seabed Area beyond national jurisdiction) by states and regional bodies to:

    - reduce fishing effort to levels commensurate with long-term sustainability of fisheries and the marine environment;
    - close fisheries that are not demonstrably managed following sustainable principles, or which depend wholly on government subsidies;
    - establish a globally comprehensive and representative system of marine protected areas to conserve biodiversity, to build resilience, and to ensure ecologically sustainable fisheries with minimal ecological footprint;
    - prevent, reduce and strictly control inputs of substances that are harmful or toxic to marine organisms into the marine environment;
    - prevent, reduce and strictly control nutrient inputs into the marine environment through better land & river catchment management and sewage treatment;
    - avoid, reduce or at minimum, universally and stringently regulate oil, gas, aggregate and mineral extraction;
    - assess, monitor and control other uses of the marine environment such as renewable energy schemes or cable / pipeline installation through comprehensive spatial planning and impact assessments procedures.

- **Proper and universal implementation of the precautionary principle** by reversing the burden of proof so activities proceed only if they are shown not to harm the ocean singly or in combination with other activities.

- **Urgent introduction by the UN Security Council and the UN General Assembly of effective governance of the High Seas** beyond the jurisdiction of any individual nations. This should include a global body empowered to ensure compliance with the UN Convention on the Law of the Sea and other relevant legal duties and norms and to establish new rules, regulations and procedures where necessary to implement these requirements in an ecosystem-based and precautionary manner. (See Annex 2 for detailed proposals for a new Global Ocean Compliance Commission GOCC).

4. Conclusions

The current inadequate approaches to management of activities that impact the ocean have lead to intense multiple stressors acting together in many marine ecosystems.

The impact of such stressors is often negatively synergistic meaning that the combination of the two magnifies the negative impacts of each one occurring alone. This is already resulting in large-scale changes in the ocean at an increasing rate and in some regions has resulted in ecosystem collapse. The continued expansion in global population exerts ever increasing pressures on scarcer ocean resources and tackling this issue needs to be a part of the solution to current concerns.

The changes in the ocean that are coming about as a result of human CO_2 emissions are perhaps the most significant to the Earth system particularly as they involve many feedbacks that will accelerate climate change.

The resilience of many marine ecosystems has been eroded as a result of existing stressors, leading to increased vulnerability to climate change impacts and a decreased capacity for recovery. An example is coral reefs, the most biodiverse marine ecosystem and one of the most valuable in socioeconomic terms to humankind.

Human interactions with the ocean must change with the rapid adoption of a holistic approach to sustainable management of all activities that impinge marine ecosystems. This has to be part of a wider re-evaluation of the core values of human society and its relationship to the natural world and the resources on which we all rely. As such the current and future state of the ocean should form an integral part of the discussions on sustainable development at the Earth Summit in Rio, 2012.

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Annex 2. Detailed proposals for a UN Global Ocean Compliance Commission (GOCC).

Based on evidence presented at this meeting, it is recommend that:

1. The burden of proof under UNCLOS [and international customary law and treaties] be reversed to ensure that those utilizing resources or engaging in activities that affect the High Seas (defined as the high seas water column and seabed Area beyond national jurisdiction) must demonstrate that their activities are in compliance with the law.

2. Within the next 6 months, the UN Security Council in conjunction with the General Assembly call on the UN Secretary General to establish a Global Ocean Compliance Commission (GOCC) for the High Seas to address issues such as, but not limited to, highly migratory and straddling species, discrete high seas species, pollution including long-range/transboundary pollution, illegal fishing, overfishing, marine spatial planning, protected areas and ecosystem conservation and other processes and activities that may adversely affect the High Seas.

3. Powers: The Compliance Commission will set out the regulatory requirements to comply with the provisions of UNCLOS with respect to protection and preservation of the marine environment and the conservation, sustainable and equitable use of high seas biodiversity and resources in accordance with the ecosystem approach and precautionary principle. It will have reference to UNFSA, decisions taken by the CBD, the UNFCCC, the IMO, the ISA, the UN Convention on Desertification, and other relevant bodies, conventions and global commitments.

4. The Commission shall have power to levy mandatory contributions from *inter alia*, States, High Seas resource users, and registered vessel owners

5. The Commission shall have powers to develop and implement a regime for sharing of benefits of marine genetic resources originating from areas beyond national jurisdiction, building on the access and benefit sharing agreement developed under the CBD and other relevant mechanisms.

6. Secretariat: The Commission will establish a Secretariat to oversee the implementation of and compliance with the regulations established by the Commission.

7. Compliance Fund: The Commission will establish a Compliance Fund. . The fund shall be used to enhance the conservation and equitable use of High Seas resources and biodiversity, and to build the capacity of developing states to participate in the formulation of and to comply with Commission regulations.[1]

8. Enforcement: The Commission shall be empowered to develop an effective enforcement regime. Such a regime should include powers to levy fines, suspend a States right to flag vessels

[1] From Article 21 of the Port State Measures Agreement

and/or to suspend the power of an RFMO to regulate fisheries and allocate fish quotas if found in repeated breach of the Commission's regulations. In furtherance of such a regime, the Commission shall have the power to establish or designate an organization to conduct investigations, initiate judicial proceedings on an expeditious basis, and apply sanctions in respect of violations that are adequate in severity to be effective in securing compliance and discourage violations wherever they occur and deprive offenders of the benefits accruing from their illegal activities. In circumstances where there is no RFMO or the RFMO is suspended, the Commission shall have the power to assume management responsibility or designate another body for that purpose.[2]

9. Data and Information: The Commission shall have the power to require the provision of data and information[3] from any one engaged in high seas activities or resource use that it deems necessary to demonstrate compliance with Commission regulations. The Commission shall have regard to the need to protect commercial and other sensitive information and to maintain such confidentially, as appropriate. The confidentiality of such data must in no way be used to impair the proper functioning of the Commission. Consistent with the above, the Commission shall endeavor to make all data and information freely available.

10. Capacity building and development: The Commission shall have the power to provide financial support and develop programs of training and technical assistance for the purposes of building the capacity of developing states to participate in the formulation of and to comply with Commission regulations.[4]

[2] Based on 1958 High Seas Living Resources Agreement.
[3] Based on UNCLOS 217
[4] From Article 21 of the Port State Measures Agreement

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