

## **Annual report of SCOR Working Group 149**

### **Changing Ocean Biological Systems (COBS): How will biota respond to a changing ocean?**

Chair: Philip Boyd (Australia)

Full Members: Aurea Ciotti (Brazil), Sinead Collins (UK), Kunshan Gao (China-Beijing), Jean-Pierre Gattuso (France), Marion Gehlen (France), David Hutchins (USA), Christina McGraw (Australia), Jorge Navarro (Chile), and Ulf Riebesell (Germany)

Associate Members: Haimanti Biswas (India), Sam Dupont (Sweden), Katharina Fabricius (Australia), Jonathan Havenhand (Sweden), Catriona Hurd (Australia), Haruko Kurihara (Japan), Gorann Nilsson (Norway), Uta Passow (USA), Hans-Otto Pörtner (Germany), and Marcello Vichi (South Africa)

Progress since mid 2017 – done by each Term of reference (ToR) – presented in Appendix I

#### **TOR1**

The following Review was published – and is open access.

Boyd, P.W., S. Collins, S. Dupont, K. Fabricius, J.-P. Gattuso, J. Havenhand, D.A. Hutchins, U. Riebesell, M.S. Rintoul, M. Vichi, H. Biswas, A. Ciotti, K. Gao, M. Gehlen, C.L. Hurd, H. Kurihara, C.M. McGraw, J.M. Navarro, G.E. Nilsson, U. Passow, and H.-O. Pörtner. 2018. Experimental strategies to assess the biological ramifications of multiple drivers of global ocean change—A review. *Global Change Biology* DOI: 10.1111/gcb.14102

#### **TOR2**

We have been better aligning and cross referencing research efforts by making contact with other groups engaged in multiple driver research. In particular we have swapped details and posted them reciprocally on partner websites (see Group Web site: <https://scor149-ocean.com/partners/>)

We are also trying to grow stronger international linkages, and during our 3<sup>rd</sup> annual WG in July 2018, we skyped with Denise Breitburg (chair of the GO2NE IOC-based hypoxia programme) and Salvatore Arico (IOC) about the very recent decision to have a WG on multiple drivers at IOC (with the terms of reference largely based on our 2018 GCB Review paper). We have also been engaging with IMBER, and plan to jointly host a 1 day workshop at their 2019 Open science conference in Brest, France.

#### **TOR3**

We were part of a joint session on multiple stressors along with IMBER and NOAA as part of the ECCWO Climate Change conference in Washington DC in May 2018  
<https://meetings.pices.int/meetings/international/2018/climate-change/scope>

We also ran a special session on multiple drivers and microbes at the AGU Ocean Sciences meeting in Portland Oregon in February 2018.

We have also been engaging with IMBER, and plan to jointly host a 1 day workshop at their 2019 Open science conference in Brest, France (see details in the Appendix II).

#### **TOR4**

The main topic of discussion at our annual meeting was the advances of the www-based BPG (see cartoon at the end of Appendix III).

In summary, the decision support strand is complete, the 'story-board' and 4D look-up data table for the virtual laboratory strand is also complete, and the first video tutorial is ready to be released.

The 40 page 'course-book' pdf is written with a cover design (see Appendix III, top).

We have had some delays with the software/graphical interface company, such that we are now seeking another company to carry out this part of the www-based guide. Christina McGraw continued to shoot video footage at the SCOR WG and at the GRC (Kristy Kroeker on meta-analyses and Gretchen Hoffman on Evolution and Ecology). Thanks to the WG for making remarkable progress since our meeting in June 2017.

The forthcoming www-based BPG has been publicised at a range of venues:

Ocean Sciences (Feb 18 Portland Oregon, posters at SCOR and OCB booths); US Ocean Acidification PI meeting (March 18, Poster); Ocean GBC GRC (July 18, Hong Kong, poster); IMBER SSC (Hobart, April 18, oral) Ocean Carbon Biogeochemistry workshop (Woods Hole, June 18, poster and oral presentation); and oral presentations at both the Ocean Global Change Biology GRS and GRC (July 18, NH)

Our plans for the rest of 2018 are to finish and launch the www-based BPG – and so we will be calling upon members to help with some publicity within each of your countries/institutions about the launch.

#### **TOR5**

We will run a training workshop (sponsored by IAEA) in their Monaco lab from 24-28 June 2019. We are in discussions to arrange other training workshops/summer school – potentially in the USA and Europe in 2020.

#### **TOR 6 & 7**

These will be worked on via intersessional work, that we already have had some input on from Jean-Pierre and others.

#### **Future plans**

In 2019 we plan to have our 4th annual meeting in France either in association with the IMBER OSC in Brest (details below) or during the training workshop (sponsored by IAEA) in Monaco the week after the IMBER OSC.

Ordinarily, our WG would be coming towards its final year, however, we received news from Ed Urban that we will get a two year extension (funded by NSF) for the middle of 2019, that will be invaluable to maintaining our considerable momentum. We will write new ToR for this period.

It is likely those ToR will focus on:

Refinement and improvements to the www-based BPG based on community use and feedback.

Integration of international research efforts on multiple drivers.

## **Appendix I**

### **Terms of Reference**

1 Assess the current status of emerging research themes 1-3 by reviewing the literature to assess the dominant research foci, their relative coverage, and identify any major gaps and/or limitations. Publish this review in an open-access peer-reviewed journal.

2 Raise awareness across different scientific communities (evolutionary experimental biologists, ecologists, physiologists, chemists, modelers) to initiate better alignment and integration of research efforts.

3 Co-ordinate thematic transdisciplinary sessions to attract and assemble experts from other fields such as paleoceanography and marine ecotoxicology to learn from the successful approaches their fields have developed to address multiple drivers.

4 Develop a multi-driver Best-Practice Guide (BPG, or other tools) as one potentially valuable way to help this research field move forward in a cohesive manner.

5 Mentor early career scientists in the design process for complex multiple driver manipulation experiments, familiarize them with BPG, and teach them practical methodologies for the analysis of their experimental findings.

6 Publish a series of short articles in both the scientific media and with scientific journalists to disseminate the challenges and opportunities surrounding multiple drivers and ecosystems.

7 Engage with policy-makers and science communication experts to produce a glossary of terms and an implementation guide for policy-makers to better understand the role of multiple drivers in altering marine living resources and ecosystem services.

Meetings:

#3:13-15 July 2018 in Waterville, New Hampshire

Publications:

Boyd, P.W., S. Collins, S. Dupont, K. Fabricius, J.-P. Gattuso, J. Havenhand, D.A. Hutchins, U. Riebesell, M.S. Rintoul, M. Vichi, H. Biswas, A. Ciotti, K. Gao, M. Gehlen, C.L. Hurd, H. Kurihara, C.M. McGraw, J.M. Navarro, G.E. Nilsson, U. Passow, and H.-O. Pörtner. 2018. Experimental strategies to assess the biological ramifications of multiple drivers of global ocean change—A review. *Global Change Biology* DOI: 10.1111/gcb.14102

Group Web site: <https://scor149-ocean.com/partners/>

## **Appendix II**

**The Future Oceans2 IMBeR Open Science Conference will be held at the Le Quartz Congress Centre in Brest, France**

Workshops 15-16 June 2019 - SCOR will co-host a workshop on one of these days

“Setting priorities for research into Changing Ocean Biological Systems” and would result in a position paper (jointly between IMBER and SCOR WG149) and a research paper.

Main conference 17-21 June 2019

We will have a session at the workshop – on

“Multiple drivers and their role in ocean global change biology”

IMBER Workshop abstract

“Setting priorities for research into Changing Ocean Biological Systems”

In this workshop we will commence with several plenary talks to stimulate discussion. We also invite participants to offer short informal presentations on what the state-of-the-art is in the research theme of Ocean Global Change Biology. For example, what are the rate limiting steps for modellers that are preventing further advances this field? What are the next steps for experimentalists investigating physiological, ecological and evolutionary aspects of this broad topic? And are these communities effectively sharing ideas and their findings. At a broader scale, can we better link the research being conducted by international programmes, and how can the cumulative weight of these activities help to set future research priorities?

IMBER Session abstract and potential convenors

Multiple drivers and their role in ocean global change biology

List of potential convenors

Philip Boyd, IMAS, University of Tasmania

Sinead Collins, University of Edinburgh

Marina Gehlen, Laboratoire des Sciences du Climat et de l'Environnement (LSCE)

Jon Havenhand, University of Gothenberg

David Hutchins, University of Southern California

There is growing awareness that a wide range of drivers, in addition to warming or ocean acidification, are influencing the physiological, ecological and evolutionary responses to ocean global change. These drivers include hypoxia, altered salinity, stratification, nutrient and trace metal supply, and changes to underwater light climate. The suite of drivers that influence nearshore, shelf and offshore waters will vary with locale and often with season, making their study particularly challenging. In addition, there are often interactive effects between drivers that can either offset or

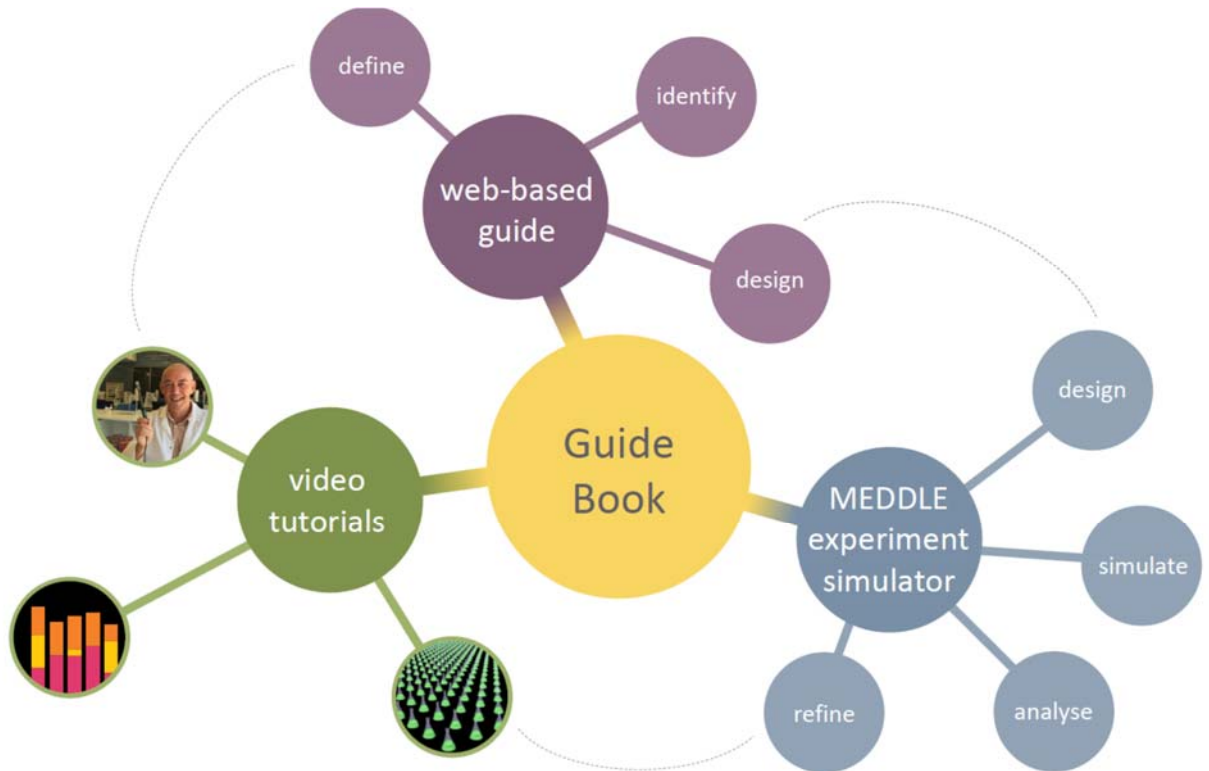
enhance their influence on marine life. This wide range of permutations for the modes of environmental control means that we must better integrate the efforts of experimentalists, observationalists and modellers, and ideally that these groups should work together within both national and international frameworks.

In this session, we seek to invite researchers across these disciplines to illustrate the challenges of conducting holistic research in the face of so many permutations, and to present examples of how we can begin to resolve these pressing issues.

### Appendix III

#### A schematic of the BPG followed by front cover of course book for the BPG

Three stranded structure of www-based BPG



Front cover of course book for the BPG



WG149

H A N D B O O K  
to support the www-based

## Guide to multiple driver experimental design for changing ocean biological systems



- Question(s)
- Inventory
- Design
- Experiment



- Improved design
- Question answered