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**Implementation of global, sustained and multidisciplinary observations of plankton communities**

**Plankton-mob**

**June 25-27, 2018**

**Goals of the workshop:**

* To draft detailed implementation plans to develop the Phytoplankton diversity and biomass and Zooplankton diversity and biomass EOVs from a multidisciplinary perspective.
* To develop a pilot project to test such multidisciplinary approach to plankton observations considering one or more platforms, locations and through integration with a GOOS Regional Association and/or project.
* To draft the outline of the global plankton observation community paper for OceanObs19

**Monday, June 25**

**07:30** *Breakfast*

**08:15** Registration

**08:45** Welcome and round of introductions – institutions and expertise – Nic Bax / Jay Pearlman

**09:00** Introduction to the Workshop and Desired Outcomes (15 min each)

-Workshop goals and dynamics – Frank Muller-Karger

-Short review of IMSOO plankton discussions – Jay Pearlman

 -Introduction of P-OBS (SCOR) working group objectives – Sandy Tomalla

 -Introduction to GOOS BioEco EOV implementation plans – Patricia Miloslavich

 -Open discussion

**10:30** *Coffee*

**11:00** Group discussion – Daniel Dunn (moderator)

 Implementing a global, sustained and multidisciplinary plankton observing system: the vision and mission (what we want), the requirements (why is it needed – scientific and societal perspective), the challenges (how it can be done)

**12:15** *Lunch*

**13:20** Introduction to breakout discussions – Frank Muller-Karger

We will have four breakout sessions. Each of them will have a different topic, but all of them to be focused on actions to address the cross-cutting issues of (1) priority needs/requirements, (2) technical and human capacity development needed and (3) strategy to secure funding for implementation. Topics of breakout sessions will be:

1. **Observing capabilities:** engaging all networks and communities of practice. How do we make the system global? What is needed to engage more developing countries? and sustained in time.
2. **Technological requirements and innovations** to maximize and automate observations: how can we improve current platforms and infrastructure? What needs to be developed (at the system level, for sensors, for analyses and model interfaces, etc.)
3. **Data management**: information chain from sensors to users.
4. **Implementation plan including products and deliverables:**

Workshop participants will be pre-assigned into two groups representing the GOOS plankton EOVs, phytoplankton and zooplankton. Each group will discuss the same issues, but the convergence on a common platform or region to collect multidisciplinary data concurrently will require consensus. This and other cross-cutting issues should be discussed in the breakouts but will be discussed in plenary to arrive at consensus.

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| **Chairs of all breakout sessions:** * **Raphael Kudela and Peter Thompson (phytoplankton)**
* **Sonia Batten and Ana Lara López (zooplankton)**
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**13:45** What did we learn from IGMETS for plankton? Laura Lorenzoni & Todd O’Brien (remotely)

**14:00** Breakout Session 1: **Observing capabilities**. Discussion topics include:

* + What are the current capabilities?
	+ What needs to be improved?
	+ What supporting variables (e.g. physics, biogeochemistry) are needed?
	+ Are the methods and data inter-operable – are the standards and best practices documented?
	+ Gap assessments – what areas require more observations – what would it take to expand to those
	+ What are the costs, what are the funding options to improve current capabilities
	+ What capacity development is needed

**15:45** *Coffee*

**16:15** Reports to plenary by session chairs and discussion from Breakout Session 1. Moderator: Henry Ruhl

**17:15** Daily Summary – Patricia Miloslavich

**17:30** *Adjourn*

***Walk on the wild side (Marine Sanctuary tour and walk along the cost)***

**Tuesday, June 26**

**07:30** *Breakfast*

**08:30** Breakout Session 2: **Technological requirements and innovations** to maximize and automate observations. Discussion topics include:

* + What actions are needed to improve current platforms and infrastructure
	+ Identify near-term innovation priorities for observing platforms and sensors, data and modeling to enable multi-disciplinary observations
	+ What are the costs, what are the funding options to improve current technologies
	+ What capacity development is needed

**10:30** *Coffee*

**11:00** Reports to plenary by chairs and discussion of Breakout Session 2 – Moderator: Frank Muller-Karger

**12:00** *Lunch*

**13:30** Use of Marine Omics, Microbial Ecology, Data Science (Ontology/Analytics) – Pier Buttigieg (remotely)

**14:00** Breakout Session 3: Data management. Discussion topics include:

* + Mapping the data management network (who is doing what)
	+ Describing requirements for:
		- data standards
		- data processing (QA/QC)
		- data archiving
		- data provenance and traceability
		- data access
		- manuals and human helpdesk support
	+ Developing a concept for a data system architecture, 5-year roadmap and workplan, including resource (human, technical and financial) requirements.

**15:30** *Coffee*

**16:00**  Reports to plenary by chairs and discussion of Breakout Session 3 – Moderator: Jay Pearlman

**17:00** Daily Summary – Ward Appeltans

**17:15** *Adjourn*

***Workshop Dinner to follow (not hosted)***

**Wednesday, June 27**

**07:30** *Breakfast*

**08:30** Breakout Session 4: Implementation plan. Discussion topic include:

* + How do we engage all stakeholders
	+ What products do we need to deliver (e.g. science, society, government, management) and inform global assessments (e.g. indicators)
	+ What are the costs, what are the funding options to support these
	+ What capacity development is needed

**10:30** *Coffee*

**11:00** Reports to plenary by chairs and discussion of Breakout Session 4 – Moderator: Nic Bax

**12:15** *Lunch*

**13:15** Outline of an Implementation Strategy and Recommendations for a pilot implementation concept/project (Plenary Discussion) – Moderator: Patricia Miloslavich

**15:30** Workshop Summary - Jay Pearlman

**15:45** *Adjourn*

**List of participants**

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| **Participant** | **Institution/Program** | **Country** | **Expertise** |
| Clarissa Anderson | SCRIPPPS / SCCOOS | USA | Plankton, modelling, operations |
| Ward Appeltans | IOC / OBIS | Belgium | Data management |
| Luis Felipe Artigas | Université du Littoral (ULCO) | France | Phytoplankton monitoring |
| Douglas Au | MBARI | USA |  |
| Patricia Ayon | IMARPE | Peru | Zooplankton diversity and ecology |
| Sonia Batten (\*) | SAHFOS / GACs | Canada | Zooplankton, large scale ocean climate variability |
| Nic Bax (\*) | CSIRO / GOOS BioEco | Australia | Marine biodiversity, modelling, marine policy |
| Pier Luigi Buttigieg remote (TBD) | Alfred-Wegener-Institut | Germany | Marine Omics, Microbial Ecology, Data Science (Ontology/Analytics) |
| Francisco Chávez (\*) | MBARI | USA | Impact of climate change on phytoplankton |
| Daniel Dunn (attending first day only) | Duke University / GOOS BioEco | USA | Ocean connectivity, marine policy |
| Marion Gehlen (\*) | CNRS-Institut Pierre Simon Laplace / IGMETS | France | Biogeochemical ocean modelling |
| Ken Johnson | BGC Argo | USA | Ocean biogeochemistry |
| Raphael Kudela (\*) | UCSC / GlobalHABs / TrendsPO | USA | Phytoplankton ecology, harmful algal blooms |
| Ana Lara-López | IMOS / UTAS | Australia | Observing programs, zooplankton |
| Laura LorenzoniRemotely (TBD) | NASA | USA | Time series, biological and biogeochemical oceanography |
| Patricia Miloslavich (\*) | UTAS / USB / GOOS BioEco | Australia / Venezuela | Biological oceanography, program management |
| Frank Muller-Karger (\*) | USF / MBON | USA | Remote sensing, phytoplankton, changes in marine ecosystems |
| Mark Ohman | SCRIPPS | USA | Zooplankton modelling |
| Jay Pearlman (\*) | IEEE | USA | Ocean observing technologies |
| Francoise Pearlman (\*) |  RCN | USA | Logistic support |
| Dan Rudnick | SCRIPPS | USA | Physical oceanography |
| Henry Ruhl | IOOS | USA |  DOOS - Biology |
| Lars Stemmann | Vfr | France | plankton |
| Kazuaki Tadokoro | JFRI | Japan | Fisheries |
| Peter Thompson (\*) | CSIRO / TrendsPO | Australia | Phytoplankton ecology and physiology |
| Sandy Tomalla | CSIR | SA | P-OBS SCOR Working Group |
| Anya Waite remotely (TBD) | AWI | USA | Marine optics, biological-physical interactions in the water column |
| Cara Wilson | NOAA / IOCCG | USA | Ocean color |
| Kedong Yin | Sun Yat-Sen (Zhongshan) University / TrendsPO | China | Phytoplankton, variability and regulating mechanisms of phytoplankton biomass, HABs |
| Sun Xiaoxia | CAS | China | Zooplankton, jellyfish blooms |
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| (\*) Attended IMSOO meeting |  |  |  |

**BACKGROUND AND RATIONALE**

**Implementation of global, sustained and multidisciplinary observations of plankton communities**

**Plankton-mob**

**BACKGROUND**

A major objective of the ocean observation community is tobetter understand the ocean, its ecosystems, and its vulnerability to human impacts. Response to this challenge, as addressed in the “Implementation of Multidisciplinary Sustained Ocean Observations” (IMSOO) workshop, was to follow the approach of the Framework for Ocean Observing (FOO), within which societal and scientific requirements for measurements as well as the feasibility of making such measurements combine to prioritize Essential Ocean Variables (EOVs). Through the work at IMSOO, an international and multi-disciplinary group of experts in ocean observations and modelling identified near-term innovation priorities for observing platforms and sensors to support multi-disciplinary observations across three themes.

One of the themes addressed was planktonic communities – how to measure ocean health and ecosystem dynamics through plankton, and how these communities are changing at regional and global scales. Existing successes and challenges in plankton monitoring were noted and some recommendations developed to extend measurements on existing sampling platforms to support multidisciplinary observations. The workshop report can be downloaded from the GOOS website at:

http://goosocean.org/index.php?option=com\_oe&task=viewDocumentRecord&docID=19543

Some of the major challenges identified to advance global plankton monitoring were: the lack of automation of measurements, the limitations in monitoring capacity in many countries, the variety of methods used to measure the same variable, the constraints in data sharing and of making data available closer to real time, and the need to effectively use and integrate associated biogeochemistry and physics measurements for a better understanding and interpretation of changes in the community.

Some of the recommendations provided by the Plankton Breakout group at IMSOO included the routine collection of environmental data simultaneously with planktonic samples (specifically dissolved oxygen for example from continuous plankton recorders or CPRs), to increase synergies with existing autonomous networks and the remote sensing community, and to integrate measurement of biological EOVs into current global observing platforms and networks (e.g. GO-SHIP). Some progress has been made to implement these recommendations including a request from GOOS to the Board of the Global Alliance of CPRs (GACs) to consider whether, and under what conditions, the instrumentation necessary to carry out oxygen measurements could be added to CPR operations; and establishment of a new SCOR working group on biological observation sensor systems for ocean sampling platforms (P-OBS). The P-OBS working group will focus on evaluating the methods and technical feasibility of incorporating biological observations into ocean observing platforms such as moorings, GO-SHIP and other vessels, and autonomous assets, that will increase information of biological stocks, diversity, and rates or fluxes. Such evaluation will include identifying areas of priority investments to develop and implement the required observing technologies.

The GOOS Biology and Ecosystems Panel is facilitating the implementation of an observing system of EOVs. The first step of the implementation phase is to organize a series of workshops around each of the EOVs and this paper describes some key elements of the workshop to develop the implementation plan for the plankton biomass and diversity EOVs.

***Objectives of the workshop:***

The workshop will build on the ideas of the IMSOO-Plankton discussions and craft detailed implementation plans for the *Phytoplankton diversity and biomass* and *Zooplankton diversity and biomass* EOVs. To achieve this goal, the workshop will bring together a multidisciplinary team to identify the necessary components of a multi-year implementation plan that will ultimately deliver a mature system in terms of requirements, coordination of observations, and data management and information products.

***Outcomes of the workshop:***

The major outcome of the workshop will be an initial **draft of implementation plans for the GOOS *Phytoplankton diversity and biomass* and *Zooplankton diversity and biomass* EOVs**. The implementation plans will include the following:

1. The mission, as well as the **short (2-3 years) and long-term vision (10 years)**
2. The scientific and societal requirements within **international considerations**: “fit to purpose”
3. The current **capabilities and gaps**: inventory of current programs and communities of practice, of infrastructure and maturity of sensors and observation systems, their geographic distribution, methods and protocols (best practices) used, institutional and funding partners
4. The **societal and scientific impacts**: what are the plans to engage stakeholders and inform global assessments, to engage developing countries and develop capacity, to transfer technology and to manage and deliver data.
5. The **actions** to achieve the plan: how to expand geographically, which technologies need to be developed, how to achieve coordination and integration across disciplines, networks and programs, and what are the implementation priorities to maximize impacts.
6. Recommendations for a **funding strategy**

In the short term (2019), we envision that these implementation plans will contribute to OceanObs19 as white papers for validation by the scientific and observing community and discussions with the funding organizations for program implementation. In the long term, we envision that the implementation plans will include a full 5-year (2019-2024) strategy and budget for implementation activities that will help establish the effectiveness of the approach for broader adoption into operational ocean observation programs.

***Organizing Committee:***

* GOOS: Patricia Miloslavich, Daniel Dunn
* RCN: Frank Muller-Karger, Jay Pearlman
* OBIS: Ward Appeltans
* University of California at Santa Cruz (UCSC) - host institution: Raphael Kudela
* P-OBS: Emmanuel Boss or Anya Waite

The workshop will be supported by the National Science Foundation (NSF), the Research Coordination Network (RCN), the GOOS program of the Intergovernmental Oceanographic Commission (IOC), NASA and NOAA (IOOS CenCOOS / MBON).

***Date:***

25-27th June 2018. The workshop will have a duration of 3 full days.

***Participants***

Participants are to provide expertise in phytoplankton and zooplankton ecology, diversity and monitoring as well as in biogeochemical and physical oceanography, modelling, and ocean observing technologies. The workshop will be aligned with SCOR Working Group WG 154 on *Integration of Plankton-Observing Sensor Systems to Existing Global Sampling Programs (P-OBS)* and will also build on the discussions of the IMSOO workshop in 2017. Other potential participants are to represent observing platforms and or tools (e.g. gliders, eDNA, remote sensing, etc.).