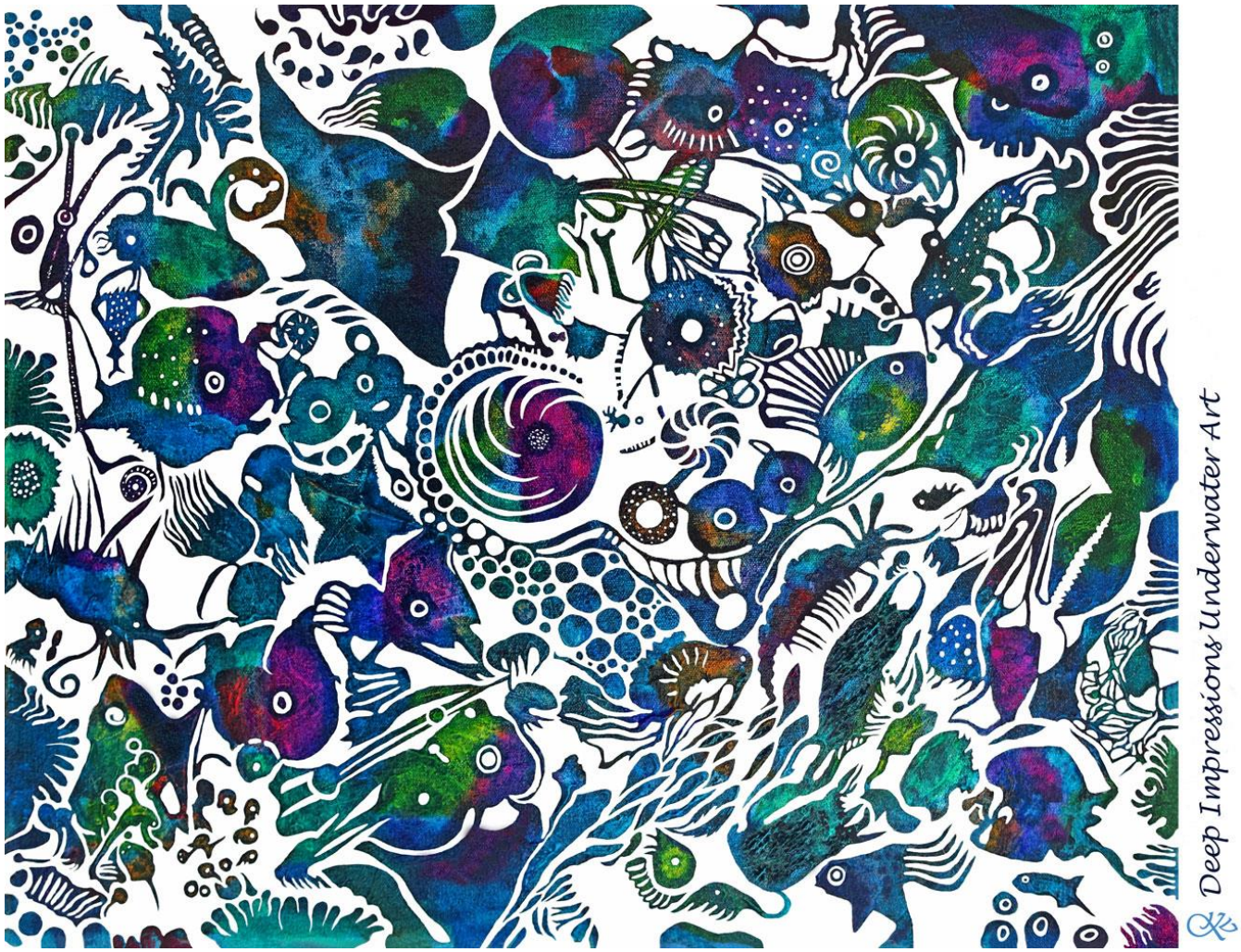
Plankton ecosystem function: biodiversity, forecasting, and prediction needs

November 9-10, 2020, Beautiful Tropical and Arctic virtual space



"Plankton". Courtesy and art credits: Deep Impressions Underwater Art

Organizers: Marine Biodiversity Observation (MBON), Modelling Different Components of Marine Plankton Biodiversity team (MODIV), OceanObs research Coordination Network (OO RCN)

Contents

Report summary

The Marine Biodiversity Observation (MBON), Modelling Different Components of Marine Plankton Biodiversity team (MODIV) and OceanObs research Coordination Network (OO RCN) organized a workshop titled: "Plankton ecosystem function: biodiversity, forecasting, and prediction needs" on November 9-10, 2020. The workshop aimed to bring observationists, experimentalists and modellers closer together to discuss (i) how we can better link data and models for exploring the effect of plankton biodiversity on ecosystem functions, (ii) the value of plankton and (iii) concrete actions and leaders to address key research and applications goals. A total of 23 participants from different research organizations (e.g. SCCOOS, GCOOS, OBIS, Darwin-MIT, IOCCP, AtlantECO, IOOS, NOAA) and universities from 8 countries (Norway, Denmark, Germany, Belgium, Poland, Portugal, Switzerland, USA (7 different states) participated.

The workshop started with MBON and MODIV representatives giving an overview of the state of the art of field, lab and modelling approaches used to study plankton biodiversity. The MBON team presented a summary of the US MBON efforts on data collection, handling data streams from different projects, providing a user-friendly interface that can be used by stakeholders and sharing best practices and frameworks to evaluate the status and identify trends in biodiversity. The MODIV team provided a summary of different modelling approaches for studying plankton biodiversity, as well as the kinds of data most used and needed for models. The workshop continued with breakout sessions on plankton databases (*what we have and what we would like* and the *Value of Plankton Ecosystem Functions*. More details can be found in the breakout session section below (pp. 7-14).

The discussions during the workshop were focused on identifying crucial observations (in monitoring systems) for species and functional biodiversity; ecological processes that can be studied with the available data; and how observation networks, such as MBON, can help with model validation and forecasting. Discussions highlighted the importance of data consistency and comparability, in particular for (i) field practices among regions and (ii) setting minimum data and measurements requirements for data synthesis of different regions. For modelling studies, usefulness of data does strongly depend on the availability of data (i) matching the temporal and spatial scales and dimensions of the specific model and (ii) auxiliary data including environmental, physiological and functional data used for model validation.

The participants highlighted the importance of creating a community-agreed unit conversion policy for reducing data uncertainty for models' development, validation and intercomparison and data management according to the FAIR principals. Insufficient funding for field data and data meta-analysis was indicated as a main limiting factor for steps forward. In the end, the participants highlighted the value of plankton biodiversity and community structure in marine ecology, biogeochemistry and ecosystem services. The value of plankton for water quality, ecosystem function and health, the connection of plankton with iconic species, the beauty of plankton and the role of plankton in biogeochemistry are some of the plankton values participants outlined. These values justify the importance of plankton monitoring and forecasting actions for studying the domino effects of changes between environmental conditions and plankton communities through time.

The main outputs of the workshop can be summarized as follow:

- The workshop provided a space for the communities to come closer together and to form new collaborations.
- The discussion around the value of plankton is something that is missing in the community and from that perspective, the workshop added something new to the community.

- Given the range of topics addressed at this workshop, it is necessary to define specific actions based on common minimum requirements, in order to have tenable scientific progress. The following actions have been proposed:

i. The MODIV team will provide a list for modelling data requirements which are missing in the existing databases (e.g. environmental, physiological data). The data providers and database developers will decide which data are easier to implement to the databases.

ii. Development of community-agreed unit conversion tables (e.g. abundance to carbon) published as best practices documents and/or available as online tools.

iv. Develop groups for a deeper study of the ecological, biogeochemical, cultural, aesthetic and recreational value of plankton with colleagues from different fields (ecology, education, economics, citizen science) and regions for a global perspective. Aiming for a synthesis paper and a proposal for the Ocean Decade call on the plankton value in 2022.

From the organizing committee,
Maria Grigoratou, Chris Lindemann, Jeffrey Runge
12/18/2020

Call

Workshop title: Plankton ecosystem function: biodiversity, forecasting, and prediction needs
Where: Beautiful Tropical and Arctic virtual space
When: November 9-10, 2020, 10:00 - 13:15 pm ET (i.e. 16:00 - 19:15 pm CET).

Organizers: Marine Biodiversity Observation (MBON), Modelling Different Components of Marine Plankton Biodiversity team (MODIV), OceanObs research Coordination Network (OO RCN)

Climate change is affecting life in the sea in ways that carry significant risks to ecosystem services. There is a need to better understand and predict how marine biodiversity, marine ecosystems, their function and services change on different time scales. Understanding the diversity of life will require aligning multiple research tools and approaches, data, methods, protocols and knowledge.

This virtual workshop aims to bring experimentalists and modelers together to provide an overview on the state of the art of field, lab and modelling approaches used to study plankton biodiversity. The workshop will emphasize on data availability, its access and use and most specific on: (i) what kind of data people need and do not have yet and (ii) how we can better link data and models for exploring the effect of plankton biodiversity on ecosystem functions. Participants will propose research actions, each linked to specific efforts to improve links between biological oceanographers and other scientists. The goal is to define concrete actions and leaders to address key research and applications goals.

Organizing committee: Maria Grigoratou, Frank Muller- Karger, Enrique Montes Herrera, Chris Lindemann, Artur Palacz, Fi Prowe, Jeff Runge, Selina Vage.

Program

(The time is in ET)

First day - Monday November 9, 2020

Room Noctiluca

Chair: Artur Palacz, Note taker: Selina Vage

09:45-10:00: Coffee time (time for people to login, casual chat)
10:00- 10:30: Introductions (name, institution, topic, main used method/approach) – Maria Grigoratou
10:30 – 11:00: **"*Bringing communities of practices together to build a global Marine Biodiversity Observation Network (MBON) in service of the global society*."**– Enrique Montes Herrera
11:00 – 11:30: Q&A- discussion
11:30 – 12:00: Break
12:00- 12:30: ***"Modeling diverse plankton communities – How is it done and what are we missing?"***– Fi Prowe and Chris Lindemann
12:30 - 13:00: Q&A- discussion
13:00 – 13:15: Wrap-up

Second day - Tuesday November 10, 2020

Room Noctiluca

Chair: Frank Muller- Karger, Note taker: Enrique Montes Herrera

09:45-10:00: Coffee time (time for people to login, casual chat)
10:00 – 10:05: Opening – Maria Grigoratou
10:05 – 10:50: Breakout session 1 – ***Databases: what we have and what we would like***
Room Phronima: Group Phytoplankton
Room Copepod: Group Zooplankton
Room Blue Skeletonema: Group Integration of different approaches
10:50- 11:00: Break
11:00- 11:45: Breakout session 2 – ***The Value of Plankton Ecosystem Functions***
Room Phronima: Group Biogeochemistry
Room Copepod: Group Recreational
Room Blue Skeletonema: Group Ecology
11:45- 12:15: Break
12:15 – 13:15: Wrap-up, set next goals and steps – Jeff Runge
(Room Noctiluca)

Abstracts

Bringing communities of practices together to build a global Marine Biodiversity Observation Network (MBON) in service of the global society

Governments and interest groups around the world have recognized the need for information to assess changes in ocean ecosystems and forecast species populations and biological communities as part of national biodiversity action plans and to advance ocean-based economies. The development of strategies to achieve targets of the U.N. Sustainable Development Goals (including SDG 14) and those of the Post-2020 Agenda of the Convention on Biological Diversity require high quality, standardized, timely and publicly available marine biodiversity information and data. The Marine Biodiversity Observation Network (MBON) aims to respond to these needs by highlighting the need for biodiversity observations, and using best practices in the collection, management and application of biodiversity observations to ensure the sustainable use of marine living resources and conservation efforts. MBON is promoting and supporting the establishment of communities of practice that build knowledge and understanding on the status and trends of biodiversity using different types of observations, including traditional techniques such as fish and benthic scuba surveys, plankton net tows and microscopy counts, and more novel methods based on flow cytometry, photo imagery and video footage, passive and active acoustics, environmental metabarcoding (eDNA), and satellite remote sensing for animal tracking and biogeographic seascape ecology. MBON is collaborating with the Global Ocean Observing System (GOOS) and the Ocean Biodiversity Information Network and is engaged in capacity building efforts.

Modeling diverse plankton communities – How is it done and what are we missing?

Ecological interactions across trophic levels and consequently biogeochemical cycling in an ecosystem are shaped by the biological diversity present in the system. Biodiversity thus constitutes a fundamental part of the functioning of ecosystems, and hence is important to be captured appropriately in ecosystem models. For the pelagic ecosystem, a multitude of models have been developed in recent years that capture different aspects of plankton diversity and address different questions. Yet we still lack a robust assessment of how the various modelling approaches compare. Here we present different modelling approaches to study plankton ecology and diversity, discussing the models' limitations and potentials. We emphasize the spatial and temporal scales they resolve and consider the models' potential to serve as tools to solve societal challenges. Finally, we highlight where the various modeling approaches would benefit the most from improved field or experimental data, and propose most important data criteria to strengthen the integration of observational and modelling efforts in understanding plankton biodiversity.

Breakout sessions

First session: Databases, what we have and what we would like to have

The last decades there have been extraordinary community efforts to create plankton databases (e.g. COPEPOD, MAREDAT, PhytoBase). This breakout session will focus on how we can further develop existing databases to be: (i) more user-friendly and fit for the purposes of, both experimentalists as data providers and users, and modelers as intermediate data users, (ii) providing free and open access to FAIR data, and (iii) acknowledging people's contribution towards collecting, analyzing and providing the data to the users. We envisage a discussion to identify what are the major obstacles preventing modellers from better utilizing existing data collections, and to recommend solutions to overcome them. This can include information on what would be most useful to be added/further developed (e.g. physiological data, trade-offs, functional groups, organisms' size & biomass, abiotic factors, omics), as well as discussionsregarding the data format (e.g. size bins, data expressed in units useful for models).

Proposed ideas for discussions in each of the three subgroups:
- availability of collocated abiotic and biotic data
- consistent reporting of data quality
- abundance and biomass data binned into size classes (cell/body size)
- development of community-agreed unit convertion tables (e.g. abundance to carbon) published as best practices documents and/or available as online tools
- include physiological/trait/functional data for species

Groups:
- Phytoplankton database requirements
- Zooplankton database requirements
- Integration of different approaches (in situ, remote sensing, molecular):

Phytoplankton database requirements

Room: Phronima

1. Meike Vogt (Chair)
2. Chris Lindemann
3. Enrique Montes Herrera
4. Clarissa Anderson
5. Stephanie Dutkiewicz
6. Barbara Kirkpatrick
7. Maria Kavanaugh
8. Alice Soccodato

Summary of the discussion

The participants discussed processes on collecting and analyzing phytoplankton data and current challenges. In the past, the compilation of existing *in situ* data have been sparse but methodological progress (e.g. FlowCam IFCB (Imaging Flow Cytobot), -omics, satellite, *in situ* imaging, autonomous platforms) provides millions of data points. The group identified the following challenges: (i) Omics provide important new information, but their direct use is still challenging, especially for models, as the data are relative, not quantitative. (ii) Much data residing in the literature are still not in the databases. The community should focus on adding data into a central database than creating new databases. (iii) The lack of uncertainty and standardized frameworks for data collection, taxonomy and unit conversion are bigger challenges than data availability for data-users.

The group proposed the following as potential steps forward: (i) As a community, we need to build capacity at 3 levels: taxonomic data, data science, and data management for providing data useful to the community. (ii) We need ideas on how we can make the basic data available before we transform it into a specific product. Some groups provide open access to their algorithms for data meta-analysis, but merging is difficult, and metadata is challenging to agree upon; so even that requires a translator and is a funded project. (ii) As a community we need to show how useful tool databases are for everybody, so we can get more funding and stronger collaborations among the community.

Zooplankton database requirements

Room: Copepod

1. Todd O'Brien (Chair)
2. Maria Grigoratou
3. Jeff Runge
4. Thomas Kiørboe
5. Fi Prowe
6. Andre Visser
7. Abby Benson

Summary of the discussion

The conversation was focused on what data exist (quantity) and if they are sufficient for community needs (quality). The participants identified the following challenges: (i) the research question defines the data needs. As observationists might have different research questions than modelers, a deeper communication on data needs along the community could benefit the data collection, metanalysis and use. (ii) We cannot observe the whole ocean in the quality and quantity we want, but models can help with that. However, current models are challenged to link biodiversity and ecosystem function, as the relationship between functional diversity and taxonomic diversity is not always sufficiently defined. (iii) More data (e.g. stoichiometry, traits, environmental data) are required for a more in depth understanding of biodiversity and its link to ecosystem function. Species biodiversity requires well-trained taxonomists and lots of time for data collection and data meta-analysis. However, measurements alone do not address biodiversity roles. For functional biodiversity, identification of fundamental species traits (e.g. lipids, size, feeding, motility, stoichiometry) is at least as important as abundance,(in terms of density of individuals, carbon, dry weight, etc.). (iv) Limited funding and a diminishing pool of skilled specialists are the main barriers for field observations, taxonomy work in the lab, data meta-analysis and database update and maintenance. (v) For the databases, data availability only after publication is another challenge for adding new data. As a first step, the modelers of the group agreed to provide a list with data requirements to the group and the data providers and database managers to identify the level of difficulty for collecting and providing each data requirement.

Integration of different approaches (in situ, remote sensing, molecular):

Room: Blue Skeletonema

1. Frank Muller- Karger (Chair)
2. Ward Appeltans
3. Selina Vage
4. Artur Palacz
5. Carlo Fezzi
6. Isabel Sousa Punto
7. Gabrielle Canonico
8. Monique Messié

Summary of the discussion

The participants tried to identify ways to better link remote sensing, molecular/nucleotide and *in situ* (abiotic and biotic) databases. The development of a portal with a list of plankton databases could act as a database inventory with a summary of their holdings (e.g. geographic area covered, time covered, types of plankton data, information on formats and access), while keeping major types of databases separate. Although MBON and other portals allow the visualization of abiotic and ancillary biotic data, the lag between biotic and abiotic data collections and the need for separate submissions are still major issues. The participants recommended two actions in this direction; (i) when possible use the ENV data in Darwin Core (ii) encourage major databases to work with each other to have cross-tags. Those actions will also help to improve the data quality and identify duplicate records between datasets. The participants highlighted the importance of collecting information on traits, horizontally, vertically, over time for studying functional biodiversity.

For merging databases, the group highlighted the need of a standardized framework for data collection and analysis; the need to identify a common data type or property (e.g. carbon) that links different data types; and a community effort to use common standards when datasets are generated. The development of a master conversion sheet with Guidelines on Conversions between parameters with an on-line interactive tool that lists Master Directories and different databases could help for creating common standards.

Second session: The Value of Plankton in Ecosystem Functions

Goal of session: This breakout session explores the values of plankton in ecosystem functions and how they relate to ecosystem services. Participants will outline the justification for plankton monitoring and forecasting at local to global scales. Of interest are ecological, societal and economic reasons to build out observing systems and to identify critical priorities for the short term (next 5 years) and long term (by 2030 and beyond). Participants will identify details and specific observations that are required in this context and provide the reasoning.

Justification: Planktonic organisms are the productive base of aquatic ecosystems defining the structure of oceanic food webs, the biogeochemical cycles of many elements, and play a key role in defining water quality. Monitoring phytoplankton and zooplankton concentrations is essential to forecast marine mammal, bird, fish, and invertebrate abundance, to assess water quality, and to evaluate drivers and feedbacks in large-scale changes in the ocean and in climate. To accomplish forecasting of ocean ecological processes, it is important to 'get plankton right'. Our capacity to observe plankton is improving with the use of new approaches (genomic, quantitative imaging, optical methods, active acoustics) and increasing in resolution through use of remote sensing and autonomous platforms. Participants will list the most salient and compelling reasons to build up the number and frequency of observations regionally and in the global ocean, define regional and vertical target priorities, and justify why the community should invest in plankton forecasting.

Groups:

- The ecological value of plankton
- The biogeochemical value of plankton
- The cultural, aesthetic and recreational value of plankton

The ecological value of plankton

Studies have highlighted the importance of plankton on the food dynamics from pelagic forage fish to whales and deep-sea food webs. Additionally, recent studies suggest that the indirect effects of climate change, such as the prey availability and quality, are stronger than the direct effects of temperature and other abiotic factors for higher predators. Neverthess, the connection between plankton and higher predators in policy and fisheries is weak.

In this subgroup the participants will discuss and suggest ways of how we can better connect the ecological value of plankton with:
- pelagic higher predators
- with the benthic community
- fisheries
- regional, social and economic priorities

Participants will also suggest:
- priorities for observation (taxonomy, functional groups, geography, water column/benthos)
- priorities for forecasting
- possible pilot programs and collaborations

Room: Blue Skeletonema

1. Frank Muller- Karger (Chair)
2. Carlo Fezzi
3. Gabrielle Canonico
4. Barbara Kirkpatrick
5. Todd O'Brien
6. Selina Vage
7. Abby Benson
8. Andre Visser

Summary of the discussion

Environmental changes lead to changes in the physiology and distribution of plankton and trophic cascades with effects on ocean biogeochemistry and production. Plankton forecasting is important for projecting impacts of those changes (in plankton) and how they are reflected in (i) global food web structure and geochemical cycles, (ii) water quality and hazards, (iii) food (i.e. higher predators) abundance and (iv) species distribution models for valuable plankton (food, pharma, etc.). The participants discussed how the ecological value of plankton can be expressed in different ways; for the rest of the ecosystem (ecosystem functionality) or humans specifically (e.g. pharmaceutical, materials, sustaining quality, fisheries and other recreational activities). Quantifying the value of ecosystem function can be challenging since the general public may not care about ecosystem functioning, but about the derived product value, while economists may quantify non-use values (utility value or happiness). Additionally, there is a value chain that may not be directly or obviously tied to plankton. From an

economical perspective, the participants suggested that a link of species or biodiversity to something that humans value (e.g. iconic species, recreational activities, water quality) will help to emphasize the ecological value of plankton to policymakers and the general public. Furthermore, the participants highlighted the importance of using standard approaches, such as regional guidelines and approaches that also can be used globally, for measuring potential plankton changes and assign value to the changes. They proposed that a standardized framework will help to better address potential changes in plankton productivity and link them to changes in scattering layers where at the moment we are not measuring in a local and global scale.

The biogeochemical value of plankton

Plankton has a huge contribution on Earth's health, by producing 50% of the global oxygen and by regulating nutrient, carbon, and carbonate cycles. The effect of plankton on ocean biogeochemistry has been well studied at both short and long-time scales. In this subgroup the participants will discuss and suggest ways we can better connect the value of plankton in biogeochemistry with:

- earth system models, including nutrient cycling and the biological pump at different spatial and time scales.
- carbon flow in the food web.

Participants will also suggest:
- priorities for observation (taxonomy, functional groups, geography, water column/benthos)
- priorities for forecasting
- possible pilot programs and collaborations

Room: Phronima

1. Fi Prowe (Chair)
2. Stephanie Dutkiewicz
3. Maria Kavanaugh
4. Meike Vogt
5. Chris Lindemann
6. Thomas Kiørboe
7. Enrique Montes Herrera
8. Monique Messié

Summary of the discussion

While BGC often focuses on long time scales and large spatial scales, the effects of plankton diversity are most evident from observations on seasonal and local scales. The participants discussed how we can bridge spatiotemporal scales from minutes and micrometers to 1x1degree means and annual to millennia when we want to account for biological processes and their influence on global biogeochemical cycling (GBC). A wide range of relevant variables is already being measured, and more data may be available from projects conducted not with diversity in mind, e.g., bioacoustics. However, several links between

biodiversity and ecosystem functioning that are not well understood yet and/or need further research, such as the role of stoichiometry and diazotrophy. Among those, trophic interactions, which affect all ecosystem functions and are relevant to fisheries management and other societal questions, are difficult to observe and quantify. The group discussed what kind of data are needed to study the biogeochemical value of plankton. They proposed the following: (i) Exports-type measurement campaigns, for a holistic picture of marine ecosystem structure, function, and rates of energy and nutrient transfer, (ii) measurements for constraining Fe cycling, (iii) more data on the influence of diazotrophs on the marine N cycle, (iv) laboratory experiments and mesocosm studies on the effect of multiple stressors on marine plankton communities, (v) experiments and *in situ* studies quantifying the impact of stressors and extreme events on marine communities to understand and tipping points in marine ecosystems, (vi) further data on species co-occurrence patterns and food web structure might also provide essential information on food-web stability and BGC; (vii) depth-resolved size spectrum of zooplankton and counts/abundances of life stages as a function of depth. Novel imaging methods may provide such data.

The cultural, aesthetic, and recreational value of plankton

Humans have always seen the open and coastal ocean as a space associated with cultural identity, natural beauty and recreational activities, with many coastal countries' economy relying substantially on coastal tourism. Plankton has a strong influence on water quality, biodiversity and the presence of charismatic species like whales. Climate change and eutrophication have caused changes in plankton dynamics with impacts on human marine activities, such as closing of shoreline to shellfish harvesting due to HABs, nuisance jelly blooms on beaches, whale watching and recreational fishing. While HABs have been well studied already, other effects have not received much research effort. In this subgroup the participants will discuss and suggest ways on how we can better connect the value of plankton to humans with:
- policy makers
- public engagement on healthy ecosystems (e.g. citizen science)
- educators.

Participants will also suggest:
- priorities for observation (taxonomy, functional groups, geography, water column/benthos),
- priorities for forecasting
- possible pilot programs and collaborations

Room: Copepod

1. Jeff Runge (Chair)
2. Maria Grigoratou
3. Alice Soccodato
4. Ward Appeltans
5. Clarissa Anderson
6. Artur Palacz
7. Isabel Sousa Punto

Summary of the discussion

Plankton can be related to cultural, aesthetic and recreational human values. For example because plankton is linked through the food web to higher trophic levels, humans can enjoy the biodiversity marine life underwater and regions' iconic marine species, such as fish, benthic organisms and mammals. Even if plankton has a variety of values, the value of HABs is the most studied due to the direct link to humans. The participants agreed that to understand these aspects of biodiversity, there is a need to observe changes and increase the understanding of the processes controlling the distribution and behaviour of species. They also considered citizen science and outreach activities and education as important ways to raise awareness about the value of plankton. A lot of outreach activities have been done around the globe for all ages (e.g. school educational programs, Frontiers Young Minds, TARA photos showing the beauty of plankton, art exhibitions, storytelling, SmartFin, PlanktonPlanet citizen science), but as outreach is commonly the least funded component of scientific projects/progams we need to find ways to upscale them. Engaging local communities in coastal observing, such as the Gallery of Jellyfish Sightings run by the Bigelow Laboratory for Ocean Sciences, also provides opportunities to participate in the observing of ecosystem change. Artificial Intelligence is a promising step forward to assist those without much prior background to participate in plankton enumeration. Ecosystem modeling could also be further developed as an heuristic educational tool. As a step forward, the group proposed local and global teams of ecologists, educators, artists, social and environmental economists to work on the value of plankton for human's culture, aesthetic and recreation, thus bringing awareness to the general public. The possibility of this theme as a subject for a UN Ocean Shots project was discussed.

Final Plenary Discussion: Steps forward

A primary goal of the workshop was to connect members of the observing community in the U.S. MBON with members of the modeling community in MODIV, with a focus on considering data needs and how link data and models for exploring the effect of plankton biodiversity on ecosystem functions. The following next steps were agreed upon:

1. The MODIV team will provide a list for modelling data requirements that are presently missing or underrepresented which are missing in the existing databases (e.g. biomass of taxonomic units in terms of carbon, environmental, physiological data). MBON representatives will discuss with the network's data providers to work with database managers to prioritize which new and existing data can be mobilized into existing large databases accessible to modelers.
2. Development of community-agreed unit conversion tables (e.g. abundance to carbon biomass) published as best practices documents and/or available as online tools.
3. Establish small working groups for a deeper study of the ecological, biogeochemical, cultural, aesthetic and recreational value of plankton with colleagues from different fields (ecology, education, economics, citizen science) and regions for a global perspective. The possibility of organizing more formally within an ICES or SCOR working group was discussed.
4. Consider development of a perspectives paper discussing the role of plankton biodiversity in providing ecosystem services and providing conceptual scenarios of the potential for ecosystems services to be affected by future changes in plankton biodiversity. The paper could provide examples of present applications of biodiversity data and analysis and also identify observing biodiversity data

(e.g. eDNA time series) that have potential application in the future. The need for engagement of a social scientist and/or resource economist in this effort was identified. Such a collaborative effort may lead to a proposal for the Ocean Decade call on the plankton value in 2022.

No specific timelines for these next steps were established. The meeting organizers nevertheless agreed to follow up with these directives in 2021, with the possibility of calling a follow up meeting at a future date.

List of Participants (Alphabetically)

	Name	Institution	email	comment	Country
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