Designing the observing system for the world’s ocean – from microbes to whales

WORKSHOP #2

GOOS Report GOOS-242

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I. PARTICIPANTS

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Post-doc: Erin Satterthwaite

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Documents at: https://drive.google.com/drive/folders/1DH6Rbt1j4f-UmplmM_ve4Yvtgu95E6WB?usp=sharing

Doc 1 – Pegasus project proposal
Doc 2 – WG participants
Doc 3 – NCEAS letter of invitation
Doc 4 – Flyer: The Global Ocean Observing System for Marine Life
Doc 5 – EOV / Targets / Indicators matrix: https://drive.google.com/open?id=14Y3dcH6c5Tyti8p7SpS8XAH0gLE1Qg
Doc 6 – GOOS BioEco Terms of Reference
II. EXECUTIVE SUMMARY

A globally coordinated and sustained ocean observing system is urgently needed to systematically assess the status of the ocean's biodiversity and ecosystems. This system would track how ocean life is responding to increased human use and a changing climate, enabling the global community to effectively predict, mitigate, and manage our ocean.

Monitoring of measurable essential biological ocean variables (EOVs) will increase scientific understanding at a global level, and support policy and management decisions on sustainability and use of the ocean's biodiversity and ecosystems. The first Pegasus workshop held in March 2019 advanced the design of an observing system for these variables by: (1) Identifying the monitoring backbone for each EOV, (2) Identifying goals and material extensions to the existing backbone that could be reasonably achieved in the next 10 years, (3) Developing criteria to define biological observing networks that would be effective in a global system and (4) Identifying and prioritizing implementation activities within specified timelines to ensure that products support monitoring progress against the Convention on Biological Diversity 2050 Vision, Agenda 2030 and other critical international agreements including the UN Decade of Ocean Science for Sustainability. The 10year roadmap and network criteria were endorsed by the international community in September 2019 at OceanObs’19.

Building on the outcomes of the first workshop, the discussions in this second workshop were focused on: (1) mapping/visualizing the current network of observing programs (i.e. spatial and temporal coverage of current networks across the biological EOVs, data availability, gaps) as well as their qualities, attributes, and level of readiness, (2) planning the implementation strategy for each of the six goals of the proposed 10yr roadmap, from communication to strengthening partnership, building the foundations, implementing technological developments, coverage expansion, and advancing use and impact of the observations, (3) devising how the biological monitoring data within the ECV/EOV/EBV frameworks will support policy by feeding into the SDGs, Aichi Post 2020, UN Decade, IPBES, Expert Panel on a Sustainable Ocean Economy on biodiversity (Blue Papers), and other high-level policy needs.

In addition, strategic next steps and follow-up actions for the GOOS BioEco panel were proposed. These were related to:

- The EuroSea project which will co-support the international project office for the next 3 years
- Improving connection with the UN Decade planning and activities
- Establishing criteria and endorsement process for the Ocean Best Practices (OBP) platform
- Supporting the GOOS 2030 strategy
- Future implementation plan workshops for other biological EOVs
- Funding strategy post the Pegasus grant
- Renewal of BioEco panel leadership and membership

The workshop agenda and participants can be found at the GOOS event website. We thank participants for their contributions and NCEAS and Future Earth for its sponsorship.
III. WORKSHOP BACKGROUND: rationale, goals, and expected products

The main goal of this second workshop was to: analyze the information compiled on networks (e.g. programs, projects, observatories) associated to biological Essential Ocean Variables; to map the extent of these observations in the global ocean, including their spatial and temporal scales and gaps; and compare these with desired EOV coverage. The group also planned the Implementation of the roadmap goals, actions and products developed during the first workshop and aimed at supporting monitoring and reporting regularly on progress against the Convention on Biological Diversity 2050 Vision, Agenda 2030 and other critical international agreements as well as the UN Decade of Ocean Science for Sustainability.

More specifically, the goals were to:

1. **Map the network:** To analyze the results of the on-line survey and network inventory: spatial and temporal coverage of current networks across the biological EOVs, data availability, gaps. Visualizing this information. Feedback to the paper in prep by Satterthwaite et al. (Developing a biological Global Ocean Observing System: qualities, attributes, and readiness of existing biological Essential Ocean Variable networks)

2. **Keep building the momentum:** To plan the implementation strategy for the proposed roadmap (goals, actions and deliverables) considering current state, current gaps, and what is needed to overcome present limitations. Develop reporting template for biennial reporting on progress against the implementation strategy. Feedback from the OceanObs19 breakout session.

3. **Support policy:** To discuss on how the biological monitoring data within the ECV/EOV/EBV frameworks will feed into the SDGs, Aichi Post 2020, UN Decade, IPBES, Expert Panel on a Sustainable Ocean Economy on biodiversity (Blue Papers), and other high-level policy needs.

The expected products of the meeting were a workshop report, two publications, and a matrix of EOVs related to policy processes. The first publication will identify the spatial and temporal coverage and gap analysis of biological ocean observations based on: (1) temporal coverage (number of years of observations and frequency), (2) spatial coverage, and (3) data availability and format. The second publication will detail the vision of a global observing system achieved through the implementation of actions and deliverables described in the roadmap. The completed matrix of EOVs against relevant Aichi and SDG targets will detail the potential contribution that EOV data could have on the relevant indicators to inform policy processes.

The workshop agenda and participants can be found at the GOOS event website.
IV. WORKSHOP REPORT

1. Introduction & Welcome

Project chairs Nic Bax, Daniel Dunn and Patricia Miloslavich welcomed all participants and introduced the main goals of the project (as mentioned above). This brief introduction was followed by an “around the room” introduction of all participants who represented a diverse array of disciplines and sectors (science, policy, management). Ginger Gillquist provided a brief orientation to some logistics at the NCEAS. Ben Halpern, the NCEAS Executive Director, described the history of NCEAS and missions. NCEAS was established in 1995 as the first synthesis science center in the world. The Center pioneered the movement toward a collaborative approach to science and has helped build a community of scientists around it. Currently, NCEAS focuses on applied questions and assists with helping to translate science into action. In addition, NCEAS supports many projects, working groups, and training/mentoring programs. A central feature of this working group was to compile information on the existing biological observing networks globally to understand how to leverage and coordinate existing efforts, to continue to develop the identity of the global biological observing community, and to explore ways to ensure that the biological observing systems are integrated into global policy processes and institutions.

2. Overview of the project & progress up to date

2.1. Overview of Essential Variables & Essential Ocean Variables (EOVs)

Nic Bax provided an overview of the work achieved by the working group in the first working group that was held at NCEAS in March 2019 (report here: http://www.goosoocean.org/index.php?option=com_oe&task=viewDocumentRecord&docID=24407).

The goal of the first working group was to begin identifying the features of the global biological observing system. The OceanObs 2019 conference was a forum to continue to refine, adapt, and assess buy-in from the observing community. Professor Bax provided an overview of the essential variable framework, described how the EOVs fit within that framework, and provided an overview of the history of the development of EOVs.

Essential Variables (EVs) serve as guiding concept for the planning and implementation of observing systems. EVs exist for weather (EVs- WMO), ocean (EOVs- GOOS), biodiversity (EBVs- GLOBON), and climate (ECVs- GCOS), and there are different levels of operationalization of the EVs. There was a concern with some participants that the term, “essential” may be used too regularly, and their needs to be some way to limit the number of “essential variables”. This may involve negotiating variables and choosing the most feasible.

Within the context of ocean observing, the goal of the Global Ocean Observing System (GOOS) Panels is to provide accurate descriptions of the present state of the oceans and provide continuous of
the future conditions of the sea. Focal areas of the GOOS panels include Real Time Services, Climate, and Ocean health.

The Essential Ocean Variables (EOVs) arose out of a selection process detailed in Miloslavich et al. (2018). The EOVs were designated based on taxa and habitats, which is optimal since people tend to develop communities around taxa and habitats. The initial development of the EOVs involved a broad community. Now that the EOVs have been identified, groups for each EOV will begin to develop the implementation plans and further progress at their own pace, yet with ample coordination and mutual learning. The progress of the individual EOVs is detailed below. The EOV specific workshops have been funded by various organizations including: UNEP (Coral), POGO (Macroalgae), NASA (Seagrass and Mangroves- focus on remote sensing methods), and SCOR (Seagrass).

2.2. EOV Updates

2.2.1. Macroalgae- Lisandro

Lisandro provided updates on Macroalgae EOV. The Macroalgae EOV community has been working on how to make existing data interoperable. They have undertaken a pilot project of working with existing datasets and getting them into OBIS and developing a pipeline to upload information into the system. They have also been working to get the panel’s endorsement of best practices integrated into the specification sheets.

2.2.2. Microbes- Pier Luigi

A thematic OMIC-BON under GEOBON has been proposed which will focus on eDNA and ‘omics technologies. This will align with the principles of the International Nucleotide Sequence Database Collaboration (INSDC) for sequencing data. MixOmics is a ‘omics data integration project for the exploration and integration of ‘omics datasets. mixMC is a multivariate framework implemented in mixOmics for microbiome data analysis aiming at identifying key microbial communities associated with their habitat or environment. The Global Omics Observatory Network (GLOMICON) aims at bringing together omically enabled observatories to create an integrated, global system of multi-omic monitoring. GLOMICON is collecting protocols which involve or have been developed through collaboration by GLOMICON nodes but also those that have been tested across multiple institutions and were designed to maximise consistency (https://www.protocols.io/groups/glomicon/research) (e.g. minimum information for sequences). Some of these topics were discussed at the Biodiversity Information Standards meeting (TDWG Annual Conference) held in the Netherlands (October, 2019). Outcomes include establishing scene setting- grants to innovate and change the “culture”.

2.2.3. Phytoplankton & Zooplankton EOV- Frank Muller-Karger, Raphael Kudela & Sonia Batten

Recently, a P-OBS (a SCOR WG) workshop was held to continue to finish drafting the implementation strategy / feasibility of incorporating plankton observation on GO-SHIP. GO-SHIP is considering incorporating phytoplankton into their operations and the imaging flou-cytobot network has recently been developing – 10 researchers networked across California. There is also the Global Harmful Algal Bloom (HAB) Imaging plankton, with a funded workshop in May focused on HABs. Although plankton may be a diffuse network, in that many people work on it in numerous ways, we are starting to
see key networks emerging within the global phytoplankton community. Other efforts include developing R code to facilitate data transformation to standardized formats, and a data task team would be ideal to further these efforts. There may be opportunities to engage and facilitate connections with the TOPAZ (tropical array) and DOOS (deep ocean observing strategy).

### 2.2.4. Fish EOV- incoming Rick Stuart-Smith & Anthony Bernard

The Fish EOV hasn’t progressed much because of the on-going discussion on how to deal with commercial fisheries data. It was decided that the focus of this EOV will be on fisheries independent surveys, avoiding the duplication of efforts with entities like FAO. To develop the Fish EOV, two new panel members were recruited (Rick Stuart-Smith and Anton Bernard). They will initially focus on establishing global networks for underwater video census of shallow reefs and baited remote underwater video for deeper areas.

### 2.2.5 Turtle, Bird, Marine Mammal EOVs- Karen Evans, Daniel Dunn, & Tammie Davis

The Turtle and Mammal EOV “networks” are fairly disparate, but the Bird EOV networks are likely better connected, especially through Birdlife International. Using existing fora, such as the World Marine Mammal Conference, may be a valuable place to further identify interested champions for the marine megafauna EOVs (Turtle, Birds, and Marine Mammals). During this working group, Samantha Simmons, was attending the World Marine Mammal Conference and giving a talk on the EOV frameworks to the Marine Mammal community.

Tammie Davies (BirdLife International) described how the seabird tracking database began initially focused on albatross and then grew as new species were added. The information was able to inform policy processes and Regional Fisheries Management Centers. Since individual researchers are working on other topics than conservation there isn’t a conflict of interest, and in many cases the conservation impact from individual researchers sharing their data is high relative to the little time it takes to make the data open. The ownership of data stays with individual researchers and the researchers have the say on how “open” the data are (e.g. only for a specific paper, to BirdLife International only, completely open). It was also noted that there are best practices for telemetry data, such as through the large aggregator, Movebank.

### 2.2.6 Seagrass, Coral, Mangroves, and Ocean Sound EOVs

Lead experts for these EOVs were absent, however a short update on their activities was provided by Miloslavich. For the seagrass and mangrove EOVs, there was a joint workshop in June 2019: "Coordinated Implementation of Mangrove and Seagrass Essential Observations workshop" (=Sea Plants Workshop). The full meeting report is GOOS Report #236 and can be found at:


A short summary of the goals, outcomes and recommendations of the meeting was published in Eos:


Additionally, a SCOR Working Group to establish a “Coordinated Global Research Assessment of Seagrass System (C-GRASS)” was approved in September. This will be SCOR’s WG #158 and will be
chaired by Emmett Duffy (Smithsonian Marine GEO) and Lauren Weatherdon (WCMC, UK). Goals and terms of reference can be found at:


For the coral EOV, The Global Coral Reef Monitoring Network (GCRMN) has engaged in the new Implementation and Governance Plan for the GCRMN adopted by the ICRI General Meeting in December 2018 and endorsed by GOOS and MBON. The plan defines a common global strategy for coral reef monitoring and reporting. The key elements of re-design include: (1) applying the principles of the Framework for Ocean Observations, (2) applying the Drivers Pressures Status Impact Responses (DPSIR) model used in many convention processes, and (3) adopting the Essential Ocean Variable (EOV)/Essential Biodiversity Variable (EBV) frameworks to identify the priority variables for understanding and reporting on the health of coral reefs, and mechanisms to improve and expand their delivery.

For the Ocean Sound EOV, a one-day workshop was held on the September 2019 within the framework of OceanObs19. Sound was recognized as a cross-cutting topic that could support all biological EOVs and it was agreed that the IQOE would draft a proposal to organize a workshop (in mid to late 2020) aimed at defining intermediate goals (e.g. how effectively can acoustics be used to manage marine biodiversity and abundance in MPAs).

2.3. Overview of progress to date

The use of existing fora, such as conferences, workshops, and meetings, was suggested as a great way to increase the visibility and use of EOVs as a coordinating framework and to get feedback on the progress from the observing community. There may be an opportunity to get the support of the IOC to have more presence and buy-in for sessions at some of the large, global ocean and sustainability conferences. It was also asserted that since much of the movement of coordinating biological observing globally requires a culture change in the way we think about coordination and open data, there may be an opportunity to have funders drive the culture change with incentives built into the funding structure.

Exposure, support, and feedback from the biological observing community for the EOV framework has come from interactions with the community in many different contexts. Specifically, OceanObs 2019 provided a valuable forum to introduce the idea, garner support, and solicit feedback. The Integrated Ocean Observation III: Across Disciplines and Networks session at OceanObs 2019 led by Patricia Miloslavich, Nic Bax, and Samantha Simmons was used as a space to interact with the biological observing community, get feedback on the proposed roadmap and plans developed at the first workshop, and share progress to date. More details on the next steps based on feedback to this session are provided in section 6.2.2.

The Ocean Best Practices System (OBP) has bought into the EOV framework with the goal of developing common standards that individual researchers can use. A best practice is a methodology that has repeatedly produced superior results relative to other methodologies with the same ultimate objective. In order to be elevated to a best practice, a method needs to be adopted and employed by multiple organizations. The Global Ocean Observing System (GOOS) best practice endorsement process is being developed in cooperation with the joint IOC-WMO Technical Commission for Oceanography and Marine Meteorology Observation Coordination Group (JCOMM OCG) and the Ocean Best Practices
System (OBP). The aim of this process is to support the entire ocean community in sharing methods and developing best practices. The endorsement process is one role that GOOS is expected to play in the context of coordinating the biological global ocean observing system. Once the specification sheets are finalized, the EOV communities need to demonstrate that these specification sheets would be feasible to inform best practices.

The EOVs fit into the Essential Climate Variables (GCOS), in that the ECVs include Plankton and Marine Habitat properties. Yet, there is still uncertainty if GCOS is only interested in the inclusion of marine variables in order to close the carbon cycle or if they are also interested in elucidating the impacts of climate on the marine systems. In any case, some of the biological EOVs are linked to the ECVs and given the climate momentum, improving the coordination of efforts could be beneficial for both entities.

One of the fundamental questions that remains is: “How do we ensure that biological components of ecosystems are included in international processes?” In addition, we would like to ensure that targets for objectives of international agreements are formulated based on best available science. This requires continued engagement with the international policy community and scientists informing that community.

In moving forward, this working group will work to continue to support and coordinate existing networks and leverage the existing efforts of the physical oceanography observing community. It was noted that the governance of JCOMMOPS is changing, in that it will sit under GOOS instead of WMO. In addition, the future of the BioEvco Panel is envisioned as a series of regionally focused implementations of the global strategy with the first regional focus through the r the EuroSea project. Further information on the EuroSea project can be found below.

A hiring process is underway for a new International Project Officer to succeed Patricia Miloslavich. The workshop participants gave a hearty round of applause for Patricia’s dedication to and support of the Biology and Ecosystems Panel for the last 5 years.

3. Inventory of Observing Networks

3.1. Qualities, attributes, and readiness of existing biological Essential Ocean Variable networks—Erin Satterthwaite

Erin Satterthwaite described the recent efforts that she has been working on in collaboration with working group participants. Specifically, the goals were to: (1) develop a list of marine biological observing networks existing around the world, similar to a Global Directory of Marine Biological Observing Systems; (2) collect data on the attributes of the biological observing networks (e.g. sampling region, sampling duration & frequency, data access, and if data are in OBIS); and (3) determine “readiness” of EOV networks from network attributes; and (4) write a paper and develop an online tool to collate collected information on observing programs.

The initial criteria for the observing programs that were included in the survey were that they sample environments in the marine or coastal realms and at the land-sea interface, are currently active, long-term (>3 years running), and sample biological variables. An initial list of ~729 existing biological observing programs globally was compiled from the initial survey in Miloslavich et al. (2018), other lists of observing programs (e.g. AWI & UK-DMOS) found on the web, expert consultations with the EOV leads, primary literature tables of observing programs (community white papers)
searches, and an initial survey was sent to data providers of biological EOVs in OBIS (~1492 people) to gather the names and contact information for additional national & regional observing programs around the globe.

To collect data on the attributes of the biological networks around the world, a survey detailing information on the program type, EOVs sampled, sampling area, sampling duration and frequency, and data access was developed by Erin Satterthwaite, Samantha Simmons, and Roxanne Carini with the support of the BioEco leads and panel members. The survey was sent out to ~729 network contacts, of which we received 354 responses from 322 distinct programs. A total of 478 engaged with the email in some way, 60 bounced, 190 emails were sent but not opened. Additional emails were sent as new programs were identified by survey respondents. From this survey, the readiness of the EOV networks were assessed. The key features of the observing networks that are considered to be part of a global network include a scientific and societally relevant mission, sufficient spatial scale, sustainability, best practices, FAIR data standards, and capacity development and technology transfer. The attributes of the specific EOVs were detailed. The general trends observed across all networks were that many were raw data collectors (260 programs) or networks of raw data collectors (118 networks). In many cases the funders of these observing programs were academic research institutions and policy/government entities. The sampling for EOVs is fairly widespread globally, but gaps exist in some parts of Africa and ocean basins. Between a quarter and a half of EOV networks have fully open data. A majority of programs have best practices and support capacity development.

3.2. Feedback on qualities, attributes, and readiness of existing biological Essential Ocean Variable networks

A discussion ensued on how we can sustainably maintain a record of global biological observing programs. Some suggestions were that networks wanting to be considered part of the global system need to updating their metadata periodically, since GOOS will not have resources for this. We aim to set up a system to detect regular data providers and invite them to register in something similar to a “catalog of data sources”. It will be important to have a centralized place to register, so people do not have to complete multiple surveys. A question that was raised was how to identify networks that provide data to GBIF but not to OBIS and cross-link back to OBIS. Sky Bristol with OBIS will work to resolve this.

A few points were raised in relation to the survey. “Capacity development” was not clearly defined in the survey, so the interpretation and contributions may be quite variable across observing programs, so GOOS may be able to guide efforts. The hard coral EOV appears to be monitored in areas where they may not exist which could be attributed to confusion of the term, lack of specificity on which sampling locations measure which EOVs for a given program, and/or networks that survey deep sea corals/octocorals. In addition, in-situ mangrove sampling shows sampling in Tasmania where there are no mangroves. This is likely from the fact that sampling locations were specified for a given program/network, and all EOVs were linked to all sampling locations.

Another similar effort to catalogue time series of marine data include BioTime.
A key feature that was noticed in our discussions was that the vocabulary in relation to the observing programs and networks needs to be made very clear and explicit, such as data collectors, networks of data collectors, data aggregators, data users, and data product developers.

4. Mapping the Network: Discussion & Break-outs

4.1. Overview of Mapping the Network session

This goal of this discussion session was to analyze the results of the on-line survey and network inventory to understand the spatial and temporal coverage of current networks across the biological EOVs, with reference to the desired coverage for each EOV, data availability and gaps. EOV leads looked at the list of networks/programs to prioritize for each EOV aiming to have a list of programs by EOV that are key to obtaining "global" coverage. The goals were to prioritize (1) networks/programs that are widespread & have open data ("champion networks" which could move toward best practices); (2) those that are widespread but do not have open data (figure out how to support in getting data in OBIS/open); (3) those that have open data but are small scale and not connected to an existing network (support in them linking to existing network or other way to coordinate).

The results from the survey were used to provide a focused exploration of networks related to each EOV. The questions that guided this part of the discussion were:

1. What EOV programs/networks are missing? What may be wrong with the current information?
2. Who are the major “players”, such as programs and networks, for each EOV?
3. Should we prioritize around networks of data collectors? How do we address “orphan” programs?
4. What is the best way to visualize these data?

Overall, the main goal was to learn the status of and ability of the network to report on the EOVs.

4.2. Discussion of Mapping the Network

In order to envision the future biological observing system, we felt that we must understand what a “mature” observing program looks like, we defined programs as active, data collectors, that have SOPs/best practices, and open data (a GOOS priority). An important point was made that if a data collector is collecting the data but not sharing the data, it does not mean it is immature, it just means that we may need to work on convincing them to share. In addition, the term “sustainability”, should be replaced by persistence or replicability. Each of the EOV experts was tasked to revise the survey results in order to note: (1) What is missing? What is wrong?, (2) Major players, (3) Should we prioritize around networks?, and (4) How do we visualize this data?
Overall, the outputs from the survey will be (1) a manuscript focused on the coverage of biological observing programs globally and an assessment of gaps and readiness broadly and (2) an interactive tool and database platform developed in partnership with JCOMMOPs so that the biological observing program inventory is integrated into the existing structures. In addition, (3) another possible product could be a social network map of data collectors, networks of data collectors, and data aggregators to better understand the landscape of observing programs worldwide, especially for each EOV, which would allow the EOV leads to target especially connected or widespread programs.

4.3. Discussion of vocabulary and terminology surrounding observing programs/networks

An important aspect that arose out of mapping the network was that the terminology of the different “players” in each EOV networks is important and needs to be clearly defined. These definitions should be linked to the EOV specification sheets and semantic technologies (ontologies), such as through Internationalized Resource Identifiers (IRIs).

The terms that we agreed were important to consistently use are: Data collectors, Networks of data collectors, and Data Aggregators, depending on the roles that programs/networks play. Programs/Networks can fill many roles, such as an individual network can be a network of data collectors and aggregate data. We decided that the distinguishing feature of a network of data collectors was that they must have the ability to have some coordination of best practices and communication with the individual data collectors. An aggregator must have a way to put data together from different data collectors. Observing programs and networks can play many different roles, so these terminologies are not mutually exclusive. Thus, programs can fulfill many different roles, such as coordinating, networking, and defining best practices and standards (e.g. a data collector network that is also a data aggregator). For example, the Global HAB program serves coordinating roles, that serves as a network of data collectors.

We concluded that the most “ideal” networks are those that (1) are networks of data collectors so are widespread and (2) data aggregators.

One of the important questions to explore when thinking about getting large-scale data collector networks and data aggregators to join in this effort is, “What is the incentive for large entities that are already largescale and well networked?” The value proposition is that GOOS is collecting a lot of information, so if the large scale programs comply with this then they have a far greater impact to end-users at a global scale and fulfill a commitment to GOOS. The value proposition to individual scientists is that having greater impact and reach can support funding and the persistence of observing programs and can fulfill broader impacts requirements by funding agencies.

Metadata is a key facet of coordinating networks since the metadata records support with the identification and coordination of programs. The observing programs will need to update metadata in OBIS and GOOS supports the metadata standards.
Figure 1. Schematic detailing the discussion of terminologies, data collectors, data collector networks, and data aggregators, used in the discussion of observing programs and networks. These terminologies are associated with roles or attributes of a program/network, but are not mutually exclusive. Thus, programs can fulfill many different roles (e.g. a data collector network that is also a data aggregator).

4.4. Case study: Reef Life Survey (Rick Stuart-Smith)

Reef Life Survey (RLS) is an ideal case study to understand the end to end connection of a large-scale biological observing program. Rick Stuart-Smith, the co-founder of Reef Life Survey, provided an overview of the program. RLS has been using the same set of methods for 25 years for temperate marine park monitoring around the globe. The program started in 2008, with many training programs to build a critical mass. Currently, the program has over 250 divers who have conducted 13,000 surveys of over 5,000 species. Reef Life Survey also has a public facing website with reef fish of the world.

Reef Life Survey is a network of data collectors (citizens and scientists using the same methods). The data are collected and supported by IMOS and input into open data repositories (GBIF). All data are openly accessible in IMOS/OBIS/GBIF data systems and the data are used to inform targets and indicators for reporting. Currently, RLS is in the process of developing an online indicator reporting tool (service built on an internal product) which will calculate indicators and model time series data. The current distribution of sites that has time series is focused around Australia and some parts of the world. In many cases it can be hard to sustain local teams, but remote teams can support local teams. Citizen science is a promising way to collect data but can prove challenging in some cases where people don’t “trust” the data.

Large networks of data collectors and data aggregators, such as RLS, can integrate the language of the EOVs into existing efforts to support the formation of a culture around the EOVs. Thus, the
networks that may be a priority to target in the initial phases of the EOV network development consist of large scale networks of data collectors/data aggregators. In addition, actors can help shape the EOVs as a whole, which should be adaptable based on regional and national experiences.

5. Planning activities to achieve the roadmap goals

5.1. Overview of achieving the roadmap: Breakout discussions

Feedback and discussion focused on the roadmap that was developed at the first working group meeting with EOV leads and other biological ocean observing system representatives and revised at Ocean Obs 2019 with the broader observing community. The specific goals of this activity were for participants to contribute ideas on which actions need to be completed to achieve the roadmap goals and what products could/should be delivered for each goal (e.g. metrics for success). In addition, the interactions between entities, "network diagrams" (present and future vision of EOV landscape), and how they link to key partnerships were discussed. A subset of people started at each goal and discussed the important facets of each goal from there one person stayed while others rotated to the other goals proposing ideas.

The goals consisted of 6 main topics:

Goal 1: Communicate value proposition (Leopoldo Cavaleri Gerhardinger / Rick Stuart-Smith)
Goal 2: Strengthen partnerships and develop leadership (Pier Luigi Buttigieg / Tammy Davis)
Goal 3: Build the foundation for implementation (Frank Muller-Karger / Sonia Batten)
Goal 4: Implement technological developments (Karen Evans / Anthony Bernard)
Goal 5: Expand network coverage (Raphael Kudela / Lisandro Benedetti-Cecchi)
Goal 6: Advance the use and impact of observations (Marjo Vierros / Tristan Wellman)

5.2. Goal 1: Communicate value proposition (Leopoldo Cavaleri Gerhardinger / Rick Stuart-Smith)

5.2.1. Develop a communication strategy

A key aspect to communicating the value proposition is to develop a communication strategy that (1) identifies key audiences, (2) identifies best channels to reach these audiences, (3) prioritises when the audiences should be targeted (i.e. in what order?), (4) identifies actors/people with responsibility for particular tasks and roles in communicating, (5) provides an action plan for communication, and (6) provides for review and updating as communication needs evolve.

5.2.2. Identify key audiences & possible strategies

End-users. In the context of this discussion, end-users were considered national and international policy makers and government officials within the context of international policy processes (e.g. CBD, SDG14, UN Decade, WOA, IPBES, CMS, National governments, UN Environmental Economic
Accounts etc. Key aspects of communicating with end-users include (1) timeliness, (2) appropriate, targeted language, (3) personal contact and relationships, (4) developing business investments in marine biodiversity, and (5) connecting to end users by highlighting common standards across groups.

*Data collectors and networks.* The value proposition to data collectors and networks that we may want to join these efforts include communicating about the (1) scientific value and policy relevance, (2) visibility of work/reputational value, (3) leveraging policy impact of the work (e.g. such as ARC in Australia, REF in UK, H2020 in EU), (4) fulfilling the broader impacts and other conditions for permits, publications, and funding, (5) benefits from access to and linking with other data streams, (6) provide existing networks an overarching banner/framework that is connected to global entities, which could include GOOS in acknowledgements and/or keywords in publications.

*Data aggregators.* The value proposition to data aggregators may be (1) funding opportunities from national governments and the Global Environmental Fund (GEF), (2) opportunities to improve metadata and data infrastructure, and (3) improve quality and uptake of data.

*Funders.* In this context funders of science of coordination may be important to prioritize initial targeting so that the efforts from the working group can be sustained. Some of the important points that came out of the discussion for funders include: EOVs should be a recognised mechanism in international policy, there should be an optimized input of diverse data-sets and transparent use to inform indicators, impact of the EOVs should be clearly documented and tracked, and the data that feeds into indicators should be diversified and broadened.

### 5.2.3 Identify data gaps

Orphans form an important target group for communicating the value proposition, but a key issue with gaps in coverage relates to a lack of data collectors and networks in some areas altogether (true data gaps). The question remains: Who should communication be targeted at and what strategies are best to help cover these gaps?

### 5.3 Goal 2: Strengthen partnerships and develop leadership (Pier Luigi Buttigieg / Tammy Davis)

#### 5.3.1 General overview of strengthening partnerships and developing leadership

As a core principle, the GOOS panel will strengthen partnerships by empowering, positioning, and coordinating the activities of disciplinary champions, who will lead localised efforts. The coordination will ensure that the activities of these champions align to a global mission, vision, and implementation plan and roadmap. Where no partnerships exist to match a need, the Panel will seed them or otherwise facilitate their creation.
The GOOS panel acts as a reliable and trusted interface/broker between disciplinary focal points and decision makers across society (e.g., policy, community leaders). Consequently, the GOOS Panel's value and strength is in its role as a neutral facilitator of globally synchronised action. It will coordinate the development of partnerships as it changes over time, depending on the needs and capacities distributed across the stakeholders it bridges. [see diagram at bottom of photo, below]

5.3.2. Partnerships

A common goal and a global mission and vision is central to partnerships. The messaging should be simple and inclusive, but it should also be recognised that a broad partnership may also bring challenges. It is important to diplomatically handle differing ideologies operating under one ‘brand’. The Panel maintains a common identifiable ‘brand’ (1) delivering coordination services (local to regional to global) which are staffed at each scale to balance workload and create focused and relevant reports and executive summaries up to the next scale and (2) leveraging existing networks (e.g., GOOS RA, IMOS) and align these to the global mission through concrete methods. This could include interoperable data flows, shared (or at least compatible/calibrated) standards, best practices, and data infrastructure. Alignment and resonance is the key to strengthening the partnerships established. The EOV foci could act as the organic network and partnership nuclei and then work to interlink these with the more abstract and hard to see global links or missions. Through the partnerships it is important to match needs and capacities to accelerate capacity development.

5.3.3. Leadership

Developing leadership requires identifying champions as natural leaders of a localised, either thematically or spatially, effort and aligning them to the global mission thus creating a distributed leadership structure. Important features of champions are those who can lead by example, already having measurably succeeded in either affecting policy, developing best practices, performing excellent science linked to societal needs, or other demonstrable successes in the context of EOV networks. In addition, champions should have a track recording of pulling in funding or multiplying their impact across networks. Once the champion has been secured and aligned then work to raise their profile, connect with more global resourcing, and impact on the GOOS stage. The GOOS Panel could coordinate this constellation of local/thematic leads and ensures that a) they are aligned to the GOOS mission and b) they have a pathway to deliver and extend impact to the relevant stakeholders on the global stage. In successful cases, socialise the activities of these champions to inspire and shape the next generation of ocean observers. This could be achieved through early-career research groups and existing early-career networks, and mentorship programs (e.g., IMBER), effectively helping the community to lead itself.

5.4. Goal 3: Build the foundation for implementation (Frank Muller-Karger / Sonia Batten)

The discussion recognized that a good foundation is dependent on simultaneously communicating the value proposition (Goal 1) and strengthening partnerships (Goal 2). An over-arching ‘theme’ for Goal 3 was that we need to “change the culture”, which means changing the way things have traditionally operated, especially with regards to recommendations by GOOS on initial components of the observing
system, adequate recognition for those involved in creating the biological global ocean observing system, and enhanced capacity for data aggregators.

**Recommendations by GOOS on initial components of the observing system.** The GOOS Bio-Eco Panel is best placed to recommend the initial components, such as networks of data collectors and data aggregators, of the observing system and should take on that role. The panel should also develop an endorsement process for best practices (BP) and the observing system architecture. Endorsement by GOOS will ensure that credibility is maintained and will help with effective communication in the context of policy processes. The endorsement process needs to be scoped for GOOS-relevant material. Endorsement would also naturally engender respect for components and build trust within the global monitoring program. This needs to be a “two-way street”, so that funding agencies are encouraged to recognise and fund projects that use the endorsed BPs to generate the EOVs within their data management strategy. This will enable the proposals to be objectively assessed with regard to claims that they address the SDG or UN Decade targets.

The projects will need to keep in mind the UN Decade criteria for endorsement of activities. An initial draft by the UN defines as activities for endorsement the following: (1) a scientific programme that is long-term, multinational and interdisciplinary operating at global or regional in scale, (2) a focused project of a limited duration involving 1-2 entities, (3) short term enabling activities that support the Decade or the above mentioned programmes or projects, and (4) contributions that support the Decade through donations of needed resources (funding, data, in kind, etc.). Some of the criteria that have been proposed to endorse these activities include that these support the achievement of research and development objectives of the Decade, that they start between 2021 and 2030, that they have a peaceful purpose, that they are multinational and multidisciplinary focusing on capacity development and the LDCs and SIDs, that they are built on and establish international cooperation, that they are linked with the SDGs and that they provide open and free data.

**Adequate recognition.** There needs to be improved or enhanced recognition for the data collectors and reviewers of the EOVs, Best Practices, and other activities carried out in the process of developing the biological global ocean observing system. Suggestions include communicating with journals to produce or elevate impact factors for data contributors and to ensure credit is given to reviewers of the BPs. The recognition should be set within the context of the reward systems and incentive structures that are set-up within each sector.

**Enhanced capacity for data aggregators (OBIS).** There needs to be an evolution and improvement in the capacity of OBIS so that it is interoperable with other national/regional data aggregators and can incorporate other biological EOV data types such as animal tracking, images and omics outputs. Interoperability is essential and will ensure that data are not lost.

### 5.5. Goal 4: Implement technological developments (Karen Evans / Anthony Bernard)

#### 5.5.1. General overview of implementing technological developments

In the context of this discussion, technology development encompasses the entire process: from data collection, sample processing, data management to product development (audience specifics / knowledge that is fit for purpose). A central feature of implementing technological developments is balancing innovation with relevance, sustainability and accessibility. New technologies should be based on a sound knowledge base, and implementation should be preceded by calibration to ensure...
compatibility and comparability. Technologies that can be automated and collect multiple data streams or data for multiple EOVs simultaneously (and meet above three considerations) should be considered and prioritised.

5.5.2. Innovation

*Technology transfer.* For efficient technology transfer there should be cross-pollination of ideas. We should learn from fields that have already had to overcome challenges, such as with dealing with large volumes of data and automation. Technologies should be regionally applicable and to achieve regional application innovations should be:

- Enabling
- Affordable
- Accessible (Start-up kits)
- Maintainable
- Scalable
- Backward compatible
- Recognise barriers to implementation
- Ensure open access – facilitates accessibility. Beyond data – can include equipment, expertise, workflows and data.

*New developments.* New developments should include:

1. Automation in workflows and processing, such as through machine learning and convolutional neural networks, self-learning (e.g. features of interest/importance), automated guidance and machine supervision (e.g. event detection and classification)
2. Data management systems, data storage facilities, and data architecture software could be used to integrate multiple data systems.
3. Robotics (AUVs, USVs) that are multi-sensor or multivariable
4. Satellites / remote sensing (New opportunities to exploit existing infrastructure, e.g. Allan foundation / coral surveys).
5. Imaging sensors
6. Ships of opportunities
7. EOV machines that can simultaneously sample many EOVs
8. SAIL drones
9. Drones – open source, easy to use and implement
10. ‘omics and eDNA
11. Environmental Sample Processors (ESPs)

5.5.3. Strategy for implementing technological developments

The strategy for implementing technological developments should be reliable, relevant, functional, and trustworthy. This could include the development of a review process that assesses if the technology is scalable and suitable which can help to build trust in platforms. In addition, technological advances must ensure long-term viability, which further links to the sustainability and scalability of new technologies. There is also a need to stagger implementation of new technologies, which can allow for calibration and ensure robust links to foundational science and knowledge.
In addition, the strategy for implementing technological developments should aim to reduce inequality through sharing of platforms, data, expertise and knowledge delivery. It should also work to change the culture of sharing and to build a GOOS equipment platform.

The strategy could include partnerships with entities in space, military, Artificial Intelligence, and applications of sound technologies. In addition, partnerships with stakeholders that may have existing initiatives could leverage existing initiatives and foster collaboration (e.g. “ships of opportunity” or building facilities on ships to support automated data collection) in the marine sector.

The strategy for implementing technological developments should ensure flexibility of EOV indicators to allow for adaptation. The panel could influence directions and up-take of new developments to ensure alignment with existing EOVs or potential future EOVs and indicators. In addition, technological developments could fill data gaps which is supported by the drive for globally relevant innovation and links to equality in observing capabilities.

5.5.4. Education & communication

Development in technologies should be utilized to effectively communicate. The knowledge produced through the EOV frameworks should be communicated in digestible formats and suited to the intended audiences. Outreach programs could generate interest in observing technologies and data by making outputs accessible to target audiences and sharing compelling stories. Education, outreach, and communication is intricately linked to further building trust and support for technology development in data and platforms.

5.6. Goal 5: Expand network coverage (Raphael Kudela / Lisandro Benedetti-Cecchi)

5.6.1. General overview of expanding network coverage

The discussion of expanding network coverage hinges on the assumption that we have already started our efforts with the more mature networks that already wanted to participate. Expanding network coverage can come from additional funding, making observing programs more cost-effective, or by coordinating existing efforts. This last point requires a strong emphasis on standardized methods and data for new sites. In addition, there is a need to consider expanding network in an inclusive way, such as through language and cultural diversity. As mentioned previously, expanding network coverage requires leveraging existing networks of data collectors, so it may also be important to network individual data collectors (orphan data collectors) that collect the data but are not a part of an existing data collector network to expand coverage and ensure that the data are included in the observing network.

5.6.2. Rationale for expanding network coverage

The discussion on the rationale for expanding network coverage included focusing on narratives, phenomena, and the value of adding jobs through EOVs. Expanding coverage is also important to global targets such as the Aichi targets. Overall, global observations need global engagement.
5.6.3. Identification and prioritization of gaps

The first step in expanding the network coverage is assessing the current coverage and identifying gaps (e.g. spatial gaps and missing variables). It is important to diagnose the cause of the gaps in sampling, such as lack of infrastructure or personnel capacity, cultural values, or other barriers to observing. Initial sites can become sentinel sites, with new sites or statistical models and satellite data filling in the gaps. In addition, EOV specific expert citizens or groups can help to fill gaps in coverage.

5.6.4. Benefits and barriers to joining the observing network

The benefits of being a part of an EOV network within the GOOS framework is to (1) improve impact and visibility and (2) enhance funding prospects. In addition, mandated data requirements would incentive participation. In addition, we need to facilitate removing barriers to join. We may need to combine the EOVs, both in terms of data synthesis but also observations and the platforms. A key role will be to have a “translator” to integrate disparate data streams and networks. The data collectors should be guided by best practices to ensure interoperability and intercompatibility of existing and new data (e.g. SCOR Working Groups on intercompare methods). There is a need to support validation of existing and new technologies and methods.

5.7. Goal 6: Advance the use and impact of observations (Marjo Vierros / Tristan Wellman)

5.7.1. Enhancing network coverage

To enhance the network coverage, efforts should work toward making the operations cost effective. This could include enhancing efficiency through automation, capacity building along the entire data value chain from data collection to end use, along with increasing the sharing of data, thus advancing towards open data through incentives, which would allow the maximum value of the current efforts to be utilized.

5.7.2. Enhancing engagement and communication

To enhance engagement and communication, a recommendation includes identifying a series of global science products to deliver in 10 years time, with at least one product for each EOV. These products can then be packaged for different policy processes. It may also be important to engage with existing indicator processes, such as Biodiversity Indicators Partnership (BIP), management organizations, and coalition of willing countries. In order to do this most effectively, the EOV networks need to understand how policy processes work and how EOVs can contribute to those processes. In addition, an understanding of the linkages between EOVs and datasets is essential. It is also important to provide consistent messaging relevant to policy processes so that there is a clear, unified message among biological EOVs. In order to enhance engagement, it is also important to respond to expressed needs by data users. This can be achieved by undertaking two-way communication on a continued basis between policy makers, data collectors and analysts to understand each others’ needs. Data products can be developed
to help with needs that are explicit, unexpressed, and projected future needs that may not be known yet. Specifically, one way to achieve a connection between the EOVs and policy is by developing personal contacts at agencies and with secretariats. Two important considerations to ensure the efficacy of translating the science generated within the framework of EOVs to policy of this is (1) that data products must be translated into the context of policy needs, thereby synthesizing observations into knowledge and products, and (2) must be tailored to respond to timelines of end-users (e.g. policy meetings, assessments).

5.7.3. Enhance use and understanding of data and technology

In order to enhance the use and understanding of data and technology observations need to be interoperable and follow FAIR data standards. Fitness-for-use metrics can be tailored for specific user groups, such as for data quality control, classification, and for quantifying uncertainty. Data must be contextualized to link and enhance data use and understanding, such as to core SDG data flows, and to increase the discoverability of data.

5.7.4. Data packaging and delivery

In order to package and deliver data efficiently, there must be explicit integration with data aggregators. For example, dashboards can provide a tailored view of observations (customization) for specific uses.

5.7.5. Demonstrations and case studies: Monitoring, tracking, and dissemination

Demonstrations and case studies are necessary to facilitate the successful use of EOV approaches. It is important to assess and show the impacts across various stakeholders.

In order to do this effectively, the use of EOVs must be monitored and tracked to understand and effectively communicate how the EOVs are used along with their impact. The process of tracking and dissemination can be enhanced through semantics and by the improved provenance of datasets throughout data aggregation. Therefore, we need unique ways to ensure that datasets that are a key part of EOV networks are tracked as they feed into aggregators & disseminators in order to show clear use from data collection to data aggregation to the development and use of data products tailored to specific end-users.
Figure 2. Roadmap of proposed activities for developing the biological global ocean observing system in the next decade
6. From Observations to End-Users: Advancing the use and impact of the observations

6.1. Updates on policy processes and conferences


The Aichi Targets are a set of the CBD goals which will be reported in 2020. The targets include a mix of biodiversity targets and sustainable use that are broad and suffer from limited indicators. They are included in national reports that are in the NBSAP (the national plan on how to implement the national commitments). There is an opportunity to refresh targets which is what the CBD post 2020 process is about. Indicators for CBD are through the Biodiversity indicator partnership (BIP) through WCMC. There is a peer-reviewed process that can provide credibility to the indicators. In addition, once the targets are identified, the indicators provide a monitoring and reporting tool. As an example of this process, the Reef Life Survey went through process of getting indicators included in the BIP (see section on Reef Life Survey Case Study), specifically related to the large reef fish indicator (biomass of large fish) and the reef fish thermal index.

The CBD is a party driven process. The targets will be presented at COP 15 in November/December 2020. The targets are very important for developing countries that are working to secure resources to conduct work on biodiversity. The themes identified by the Open Ended working group of CBD post 2020 included: biosafety, restoration, marine and coastal environments, area based conservation management (30% protected areas by 30), resource mobilization, transparent implementation, monitoring, reporting and review, capacity building and technical scientific cooperation. The IPBES has regional working groups within the context of the global assessment, although the marine component came in very late in the process. There is strong overlap with the biological EOV frameworks and the priority restoration of habitats in the CBD process, since habitats include mangroves, seagrass, salt marsh, oyster reefs and other marine habitats.

6.1.2. UN Decade of Ocean Science for Sustainable Development (the Decade) Update– Karen Evans

The premise for the Decade came out of the World Ocean Assessment and a number of other reports, which suggested that 2021-2030 should be the UN Decade of Ocean Science for Sustainable Development, with a 2 year planning process starting in 2018. The Decade has six societal objectives including a clean ocean, a healthy and resilient ocean, a predicted ocean, ad safe ocean, a sustainably harvested and productive ocean, and a transparent and accessible ocean, which pertains to equitable data and information access. In addition, the Decade would like to increase innovation and capacity development.

The implementation plan for the Decade needs to be completed and passed by the General Assembly (UN-GA). The regional workshops will inform the implementation plan and self-organized initiatives are providing input to the IOC through an endorsement process. All of these inputs will go into the implementation plan and will inform a number of sub-plans. The plans will be living documents so they can be continuously reviewed throughout the entire duration of the Decade.
The draft implementation plan will be ready for the global planning meeting in March which will be put forward to all stakeholders for input and feedback. The finalized document will be put forth to the UN-GA in 2020 as part of the omnibus resolution that the UN-GA considers each year and the final launch will occur in Berlin at the end of 2020. There will be a reporting mechanism to the IOC on the Decade.

6.1.3. World Ocean Assessment 2 (WOA 2) Update—Karen Evans

The World Ocean Assessment was “born” in the UN in 1992 and was brought up again in 2001/2002, and then agreed on by the UN in 2004. In 2005 there was a need for parties to understand the current state of knowledge, thus an “assessment of assessments” was undertaken to understand the current “landscape” of existing understanding. This was conducted by a pool of experts nominated into the group, although the WOA suffered from some shortcomings and lessons learned in the first phase.

In the GOOS and the BioEco Panel contributions to the Decade, how can we ensure that there is a pathway to the WOA, which will come out halfway through the Decade. A possible idea for a report could be to detail the progress in developing a global observing system. In regards to the process, the following questions were raised: (1) How can GOOS contribute to the process? and (2) Would we report against EOVs?

6.1.4. Expert Panel on a Sustainable Ocean Economy on biodiversity & IPBES Update – Patricia Miloslavich

*High Level Panel for A Sustainable Ocean Economy.* The goal of this panel is to produce outputs and end-products of blue papers, scientific synthesis report, and summary of recommendations. Blue papers and clusters include: ocean productivity, ocean as a catalyst for information and terrestrial reform, finance of ocean health and wealth, reinventing the human, and managing the ocean. The final goals are to deliver a set of commitments and monitoring needs to be supported.

*IPBES.* The goal of IPBES is to detail nature’s contribution to people. Process included status and trends in drivers of change which suggests that 75% of land in altered, 66% of ocean area is experiencing cumulative impacts, and global extinction rate has increased. The main causes are direct and indirect drivers, of which land and sea-use change were the most important drivers. If we continue business as usual then we will miss all targets that have been agreed upon. We need to articulate the need to produce better information to produce better interventions and better priorities.

6.1.5. Sustainable Development Goal 14 Update- Marjo Vierros

*Overview on SDGs.* SDG 14 have 10 targets that mirror the Aichi Targets which are related to pollution, ocean acidification (OA), sustainable fisheries, 10% protection, fisheries subsidies, blue economies, and increasing scientific knowledge, developing research capacity, and transferring marine technology.

*UN Ocean Conference.* The UN Ocean Conference was working as communities of ocean action—coral reefs, mangroves, marine and coastal management, marine pollution, ocean acidification, scientific knowledge, sustainable blue economy, sustainable fisheries. The monitoring of progress related to SDG 14 takes place at four levels: (1) governments as part of systematic follow-up to review at the high level
political forum (HLPF), (2) through the use of indicators, (3) through voluntary commitments and the communities of ocean action, and (4) through the June 2020 UN Ocean Conference. Thus, the UN Ocean Conference 2020 provides a valuable opportunity to showcase the EOVs and what they can do through case studies, such as for marine habitats and indicators.

6.1.5. Ocean KAN Update- Leopoldo Cavalieri

The Ocean Knowledge Action Network (KAN) is supported by the IOC, Future Earth, WCRP, and SCOR. Currently, the Ocean KAN is in the process of establishing an IPO (international project office), although the Ocean KAN may have more than one IPO distributed throughout various countries. The main objective of the Ocean KAN is to link knowledge generation, such as through science, with action, such as in related to international policy. There has been much discussion if the focus of the KAN should be on the knowledge production or action side. The Ocean KAN will use the convening power to bring new voices to global policy processes, such as the Decade, and will facilitate capacity development, knowledge mobilization, and learning and knowledge transfer. Leopoldo is currently mobilizing networks in Africa and Asia. One suggestion was the ocean KAN should build bridges between existing organizations and provide the glue between existing Future Earth projects.

In relation to the development of the biological global ocean observing system, the Ocean KAN could serve as a conduit for actionable information and data.

6.1.6. Working Group member contributions to the various policy processes

Frank and Tammy agreed to be the liaisons between GOOS BioEco and RAMSAR, Leopoldo agreed to link GOOS BioEco with the Ocean KAN and Future Earth, Patricia agreed to link GOOS BioEco with IPBES, and Nic agreed to connect GOOS BioEco with the CBD.

6.1.7. Ocean Obs 2019 Update- Nic Bax, Frank Muller-Kargar, Erin Satterthwaite

The goal of the Ocean Obs 2019 conference was to be a, “community-driven conference that brings people from around the world to communicate the decadal progress of the ocean observing networks an to chart innovative solutions to society’s growing needs for ocean information in the coming decade. The conference had four main themes: Information, Interoperability, Innovation, and Integration.

The session that Nic Bax, Patricia Miloslavich, and Sam Simmons led was entitled, “Integrated Ocean Observation III: Across disciplines and networks”. The goal of this session was to verify that the approach that we developed at the first Pegasus workshop had buy-in from the broader biological observing community. Since the biological observing community consists of many different entities, with different funding streams, and objectives, the GOOS BioEco Panel does not have hierarchical, top-down control. Thus, networks need to lead their own activities.

Overall, there was strong support for the criteria of observing networks. In addition, the proposed recommendations included: (1) increased regional and global coordination throughout the next decade focusing on partnerships and improved communication, observational capacity including improved data sharing and expanded funding base for sustained observations, (2) reporting progress toward the desired global ocean observing system through biennial reporting to the United Nations, using EOVs as a reporting framework, and (3) ensuring that observing networks contributing to the global ocean observing system provide updated metadata on progress toward full maturity under the FOO as well as their data to the relevant open and FAIR regional and global databases.
There were complementary sessions on integrated ocean observing and there is an opportunity to get these communities together to put a paper together with a roadmap.

6.1.8. Outputs: related to Ocean Obs & progress toward developing the biological global ocean observing system

The outputs discussed were (1) a manuscript synthesizing the papers from Ocean Obs with a clear pathway forward for the implementation of the biological global ocean observing system to detail where we are going and (2) a detailed account of the current biological observing capabilities worldwide that Erin Satterthwaite is working on developing.

6.2. Breakout Discussions: Advancing the use and impact of the observations in relation to international policy stakeholders, within the context of Ocean Obs, and at the regional/national/local levels

6.2.1. How to deliver to international policy stakeholders: Breakout Group 1 – Reported by Miloslavich

This discussion centered around how the biological monitoring data within the ECV/EOV/EBV frameworks will feed into the SDGs, Aichi Post 2020, UN Decade, IPBES, Expert Panel on a Sustainable Ocean Economy on biodiversity (Blue Papers), and other high-level policy needs.

The main recommendations on how to improve our delivery to policy stakeholders included the design and dissemination of a communication strategy with a clear and simple message (“making visible the invisible” or following the Census of Marine Life catchphrase of “making ocean life count”). Some further ideas included: (1) to target the reporting needs of the stakeholders and help facilitate this reporting through a trusted, transparent and robust process based on data, (2) prepare a one/two pager (or flyer) with success stories showcasing case studies and applications. These could be customized to fulfill a specific target or region or address specific priorities (e.g. CBD, Blue Economy, commercial sectors). Some examples mentioned were the plankton CPR information which was used to contribute to indicators adopted by OSPAR and the European MSDF, and the RLS fish indicators contributed to the BIP, (3) prepare communicational material (e.g. infographics) that communicated the EOV/ECV/EBV description/framework in a clear and easily interpretable way, (4) design and provide a web-search tool to facilitate the location of observing programs that may provide information on specific EOVs, geographic areas and targets, (5) help elevate the common denominator of indicators to a higher level – EOVs/EBVs bring the level of detail that is needed.

Another recommendation was to make use of opportunities to present in international fora to ensure a presence at different meetings, conferences and forums. This includes venues such as:

(1) Policy meetings (especially at the UN Oceans Conference) making sure to get the EOV/GOOS language into high level conversations (within the CBD, UN and other groups) and increasing/improving communication with policy makers and national governments/representatives. To prepare an itinerant booth with interactive activities such as videos in virtual reality. To prepare a statement for the UN Oceans Conference to be held in 2020 and disseminate across different means (panels, special sessions, interventions). Ideally, this statement should be pushed up through GOOS/IOC who are allowed formal interventions, and potentially also through Future Earth and the ISC.
(2) Scientific conferences, meetings, and briefings with scientists using a common language and a consistent message (meaningful content), and mainstreaming indicators and associated language in scientific publications. Encourage the design of virtual conferences for broader impact.

(3) Commercial sector linkages (e.g. aquaculture, fisheries, food industry) – making the case for a new emerging culture that will bring removal of species that were usually not targeted everywhere (e.g. sea cucumbers, jellyfish)

In order to broaden the impact of observations it was also suggested to bring the policy relevance of the observations to early career trainees through different capacity activities (e.g. POGO, GOA-ON, PICES, ICES, OTGA, IOI, MBON Pole to Pole, etc.). In addition, we can work with NGOs to bring other groups (beyond scientists) into the force, targeting those with the power to make changes at high levels (e.g. Nairobi Convention, the KANs).

6.2.2. How to frame our contribution to the Ocean Obs 19 vision: Breakout Group 2 -
Reported by Buttigieg

The OceanObs19 Conference Statement calls for wise management and governance of the planet's ocean observing system. Such management and governance rests upon objective and balanced advice from neutral representatives of multiple, and at times competing, initiatives and networks. The BioEco Panel seeks out such representatives to engineer the EOVs and to align global networks to a common vision - elevating each component's strengths while being frank about its weaknesses. In doing so, the Panel strives to fill the niche of a neutral broker and hub of expertise and perspective, catalysing shared development across networks.

The need to improve and accelerate the development of best practices across the "ocean value chain" was repeatedly discussed during OceanObs19 and is noted in the Conference Statement. The BioEco Panel is well aware of this need for the EOVs; thus, the Panel is working with the IOC-UNESCO Ocean Best Practices System (OBPS) to develop an endorsement process whereby the Panel can systematically and transparently bring a range of effective methods to the attention of the wider community. With input from the Panel and its associated networks, these methods will be refined and become the best practices to produce EOV-compliant data across scales and contexts.

The Conference Statement further notes the need to secure funds to realise a stable global ocean observing system. Many organisations (including governments, intergovernmental agencies, and funding instruments) subscribe to the vision of OceanObs19 (or related visions, such as that of the Ocean Decade), but have yet to create or contribute to funding structures to help accomplish them. Funding models - drawing from both public and private sources - must provide continuity of observations while supporting innovation within a sustained and sustainable model with multistakeholder benefit. The Panel supports this position, and notes that funding structures and criteria should emphasise the development, democratisation, and integration of existing networks over competitive models centred on transient projects. Further, the Panel encourages more rigorous evaluation of deliverables related to sustainable development or the creation of indicators: too often are these themes invoked with little to no practical or implemented outcomes.

Finally, the OceanObs19 Statement calls for the creation of indicators to report on societal development goals, such as the SDGs and the Aichi targets. The Panel notes that the development of EOVs is closely related to that of robust indicators in their emphasis on consistency, intercalibration, and relevance to issues of societal concern. The Panel intends to work closely with indicator development organisations.
such as the Biodiversity Indicators Partnership to build and share capacity across the networks it interlinks. Some of these networks already provide indicators to several national and regional stakeholders, and their successes will provide key guidance to the process at large. We further note that accepted indicators relevant to the BioEco EOVs are being considered for addition to the EOV specification sheets as supporting variables. In time, we intend the EOVs to provide input for new indicators, or be indicators in their own right. Importantly, we will work to ensure that any indicators so created will reflect if sustainable development maintains a sustainable biosphere across all scales.

6.2.3. Implementation of EOVs at the regional, national, and local levels: Breakout Group 3 – Reported by Bax

The focus of this discussion was on how the use of the information can be advanced at the local/national/regional levels to generate an improved local/national/regional implementation of the observations within the EOV framework. A guiding question was: what role can we (GOOS BioEco and Pegasus WG) play in these local/national/regional processes?

The group first identified the main organisations at regional and national level that could be important for the BioEco Panel to engage with:

<table>
<thead>
<tr>
<th>Regional Organisations</th>
<th>Local &amp; National Organisations</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>EuroSea project*</td>
<td>Scientists and data collectors (CD &amp; TT) – need to improve opportunities for engagement</td>
</tr>
<tr>
<td>UNEP Regional Seas</td>
<td>National reporting (through regional support)</td>
</tr>
<tr>
<td>Regional governance – eg. EU, PIFS</td>
<td>Easier to get buy-in at national level</td>
</tr>
<tr>
<td>GOOS Advisory Committee regional reps</td>
<td>Industry consultants – influence through best practice and EIA</td>
</tr>
<tr>
<td>LMEs (developing world focus)</td>
<td>Resource managers – influence through eg. permits require FAIR and open data</td>
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<tr>
<td>SIDS</td>
<td></td>
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<tr>
<td>CBD initiatives (eg. SOI and EBSA processes)</td>
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</tbody>
</table>
IOC Ocean Academy

RFMOs – ecosystem approach

MARPLOL – PSSA

Regional Science –
ICES/PICES/WIOMSA/IMPAC

Professional societies and annual meetings

GEO, Future Earth ??

* - note CSIRO/SPREP monitoring report that might have relevant approach

First Regional Priority – Euro Sea Project

Since the IPO for this program is coming through the EuroSea program, regional assessments may be a promising way forward. Specifically, the Euro Sea Project may be the first regional priority. Currently, there are consultations with Horizon Europe as part of the next funding call. An explicit recommendation was the need to go beyond science to understand the policy environment and mandates. The scientific elements need to be coordinated through the BioEco Panel EOV leads and there is a need to identify strategic linkages (eg. DG Mare and DG Research) and see how EOV language can be added to future funding calls. The specific elements to include are (1) an observing network analysis, (2) to identify existing reporting processes, (3) map the pathways of data to impact, (4) reduce the over-reporting burden, (5) map pathways of existing indicators in reporting frameworks and identify the role of EOVs. This will aid in demonstrating the value of EOVs and Best Practices in the policy environment, such as in the EIA.

Identification of candidate areas for the Second Regional Priority

Some candidate areas for the second regional priority area include: (1) West Africa since there is an clear indication of an observing gap (the Abidjan Convention, GOOS-Africa, others may be possible collaborators and entities to include), (2) the SW Indian Ocean (UNEP Regional Seas & WIOMSA), (3) Pacific SIDS (UNEP Regional Seas (SPREP) and PIFS). It is important to note that each of these has had a regional CBD EBSA workshop and perhaps regional workshops through the Decade.

Communication Strategy

The Panel needs to develop a communication strategy that provides:

- materials that all Panel members can use
- increased engagement of all Panel members to promote EOVs and the Panel’s work
- increase use of EOV language by other groups
7. Strategic next steps & follow-up actions: BioEco Panel Meeting

7.1. Initial discussion of next steps

The panel chairs agreed to take some leadership and work with the new project officers and to support the best practice endorsement process and to align to the mission of the Decade and IODE. One suggestion was that we may need to map out the fora (e.g. workshops, conferences) to continue to enhance the visibility of the EOV framework and garner support from the biological observing and international policy communities.

7.2. Update on EuroSea project: Regional priority

*Overview of EuroSea project.* The EuroSea project was put together by Emma and Glenn Nolan who run EuroGOOS. There is 3-4 years of funding support for the international project officer and support for a BioEco Panel workshop. Currently, the Panel is advertising for a replacement for the current IPO (Patricia Miloslavich), with 18 months support from CSIRO and 18 months support from EuroSea. The next phase of the project will be to continue the scientific work and continue to figure out how we facilitate the development of a data structure.

*Deliverables of EuroSea project.* The specific deliverables for the EuroSea project are (1) a map of BioEco Observing networks and capabilities, (2) a report on European BioEco networks detailing the metrics of the progress against a sufficient and sustained BioEco observing observing system, including for the MSFD, and (3) a final report of the EOOS implementation plan, progress, function of systems and recommendations for EOOS, European OO and GOOS GRAs from across the work package.

*BioEco Panel Workshop in 2020.* There is about $20,000 USD available for a BioEco Panel workshop through EuroSea funding. This could include a possible working group in Italy (possibly hosted by Lisandro). There may be opportunities to link travel to the BioEco Panel Workshop 2020 with other conferences and meetings, such as the Oceans from Space meeting in Italy (Oct 12-14) which could be an opportunity to highlight EOVs and remote sensing and the GeoPlenary week in South Africa the first week of November 2020.

7.3. Connection of broader GOOS to the Decade

Albert Fisher informed the BioEco Panel that GOOS needs to develop a process to produce a report on the State of the Ocean on a regular basis for policy audiences. IOC does not have a specific mandate to do for different policy audiences. Particular component contributing to ocean health metric. Plugging the components in, standardizing, and aligning them to build a sustainable system. Facilitated role. One of our strengths is coordinating components. Endorsement process and its aligned with GOOS goals.

A clear output that is needed based on this discussion was that the Panel will submit something to the Ocean Decade.
7.4. Discussion on criteria and process to endorse best practices for Ocean Best Practices (OBP) platform

Pier, Frank, and Nic are engaged in the OBP process and a part of the process is to archive the methods used for data collection in relation to observing. The OBP system consists of best practices and guidelines. The role of the panel is to endorse best practices and to serve as a facilitator to a larger group of experts. There was a discussion on how to best go through the Ocean Best Practices system and determine which are best for the biological EOVs. A recommendation was that there needs to be an EOV field included where contributors of best practices can identify if the best practices are relevant to the sampling of EOVs. In addition, details on EOVs, sub-variables, and methods would be helpful to ensure efficient sorting of the EOV methods. There will need to be a community of practice to help with review and endorsement of best practices. Specifically, this may entail both endorse for specific EOVs but also endorsing specific sections, such as the survey design or data analysis sections. Some other suggestions were that: papers could get archived from journals to the Ocean Best Practices system, there could be a process for endorsing papers relevant to EOVs (with a partial endorsement by GOOS), the Standard Operating Procedures (SOPs) could have minimum standards, communities could be encouraged to use a structured documents (xml) so that the specific parts of the EOVs could be found, and there could be specific sections for each EOV so someone can look at the Best Practices associated with each EOV.

7.5. Implementation strategy to achieve roadmap goals, EOVs, and support GOOS 2030 Strategy

This discussion focused around the Implementation strategy to achieve roadmap goals, EOV network development, and to support the GOOS 2030 Strategy, including identifying opportunities for new EOV implementation workshops. This may inform our communication strategy.

The key deliverables discussed in the context of the implementation strategy were:

1. **Manuscript on the current status of the biological observing system.** This paper will detail the overall level of the biological observing system with some specific EOV insight. Goal is to have the manuscript submitted between August 2020 and October 2020; Erin Satterthwaite leads
   - Possible to delve into the information for each of the EOVs more specifically (e.g. given the networks for fish where do you see the key areas for expansion)
   - This will provide the foundation for what we report to the IOC
   - EOV networks will consist of networks of networks of data collectors or individual data collectors
   - Priority networks to start with may be networks that are both networks of data collectors and data aggregators
   - Networks were identified as a key part of the Pegasus project

2. **Ocean Obs summary manuscript on integrated ocean observing.** This paper would be based on the outputs from the integration of observing systems in coordination with the other session leads (Maury/Gabrielle & Frank/Patricia); Nic Bax leads
3. **UN Decade summary document.** Summary document contributed to the UN Decade planning process based on a re-work of the BioEco flyer; Patricia Miloslavich leads

4. **Coordination structure plan.** Design and coordinate a coordination/governance structure plan. Here the term coordination is important to include to ensure that governance is thought of as collaborative versus hierarchical. This would be related to the internal coordination of networks and how the information feeds into the OBP system as well as the GOOS facilitated outcomes for the Ocean Health team.

5. **EOV Communication strategy:** The next international project officer will need to communicate to different audiences. Thus a communication strategy needs to be developed by the communications leader (person leading the strategy would come to the next BioEco Panel meeting and identify the best methods to obtain the necessary information).

6. **PEGASuS summary document:** Summary document generated from the outputs of the PEGASuS working group, specifically this workshop and the past workshop. Discuss how we are going to engage with the communication strategy. This will be the topic for the next meeting (Italy). Put summaries into a conducive form to develop a communication plan.

### 7.6. Implementation workshops summaries

Each EOV provided a summary of the EOV implementation workshops thus far. It was suggested that the international project officer should continue to support the implementation plan workshops.

7.6.1. **Macroalgae EOV implementation workshops**

Macroalgae EOV is advanced in implementation and has had two workshops to develop the implementation plans for the macroalgae EOV. Specifically, the macroalgae observing network has been developed.

7.6.2. **Benthic Invertebrate EOV implementation workshops**

The benthic invertebrates EOV has been a challenge to find a champion for. The World Conference on Marine Biodiversity in New Zealand which has a focus on inverts/deep sea may be a good place to identify a champion. Rick Stuart Smith is likely to be there so could possibly support. Tim O’Hara was mentioned as a possible person to support the further development. Another idea was that the benthic EOV serves as the link with DOOS, and therefore, to invite a person from DOOS to join the panel (action for Nic Bax to contact DOOS).

7.6.3. **Marine Mammal EOV implementation workshops**

The Marine Mammal EOV implementation workshops have not started but Sam Simmons presented at the World Marine Mammal Conference 2019 on the Marine Mammal EOV and invited people to get involved in the EOV network and to convene a workshop with the networks of data collectors. The next workshop could be aligned with the Biologging conference (Hawaii in Sept 2020) which will have a lot of the marine mammal distribution people there (and marine mammal distribution).
7.6.4. **Bird EOV implementation workshops**

The Bird EOV implementation workshops have not started but the World Seabird Conference in Hobart may be (Oct 19-23 2020) a good place to bring the community together and share the EOV framework with the global seabird community. Tammie Davis will bring back to BirdLife International the discussions from this workshop which invite them to lead this EOV.

7.6.5. **Fish EOV implementation workshops**

The Fish EOV implementation workshops have not started, although Anton agreed to get the BRUV people together (with Tim Langlois as a possible lead supporter). They have put in a funding application to bring stakeholders together around BRUVs (funding through Australian National Data).

There are three main methods that may inform how the communities develop: (1) visual census, (2) radio tracking, (3) video base. The radio tracking community is not Ant or Ricks specialty area so may need support for other EOVs that use the same methods (e.g. marine megafauna). It was noted that in relation to fish there isn’t something that is useful at the coarsest level, so the level of detail is important.

In regard to the visual census methods, Rick agreed to connect with a few groups who use compatible methods in order to provide an output that is useful between Reef Life Survey (RLS) and other networks. RLS is a data collector, a network of data collectors, and aggregators. In addition, there is a strong overlap with GCRMN at the tropical level, and temperate reefs are not being censused as much. Visual census ties in with the other two methods (radio tracking and video base). Lastly, with the visual census data there is competitive spirit to get data open, which is promising for implementation and moving toward more open, FAIR data.

Rick and Ant will plan for a workshop to get the key players together, to ensure the EOV network implementation is agreed upon and there is buy-in. They can use global archive to coordinate BRUV or visual surveys properly. Reef Life Survey will continue to put in proposals to add new sites to the global networks, will apply branding to RLS website and indicator reporting tool, and the EuroGOOS program may provide additional opportunities for expansion.

7.6.6. **Seagrass implementation workshops**

The Seagrass EOV will work for the next three years through the SCOR working group approved in September 2019.

7.6.7. **Plankton implementation workshops**

The Plankton EOV has discussed potential pilot projects. The GACS is planning on filling gaps. There are multiple ways to measure plankton which can prove challenging to coordinate efforts.

7.6.8. **Additional broader events**

Some additional events that were discussed that are relevant to biological EOV implementations may be: (1) Ocean Obs 2025 (Juliet Hermes), (2) GEO/MBON, (3) ESIP in July- Marine Data Cluster (OBP mentioning the EOVs), and (4) ISMAY for microbes and best practices (Aug 2020- Cape Town).
7.7. Specific case studies to demonstrate the value of EOVs

Since case studies to demonstrate the value of EOVs continued to arise throughout the working group some specific ideas were discussed here. The goal would be to effectively demonstrate the data streaming through the indicators affecting a policy and ensure that case studies are tailored to a specific audiences. Some ideas included:

- SeagrassNet/Watch - possibly through Emmett, Len McKenzie, and Fred Short
- BirdLife - Tammy Davies
- microgAMBI
- Reef Life Survey - Rick Stuart Smith
- Mangroves? MangroveWatch
- Ocean Tracking Network - Lenore Bajona?

There was also a discussion about explicitly linking to policy messages like the blue economy and blue carbon. A separate issue was raised on the need to include and integrate the Deep Ocean Observing System, which would be especially easy to integrate into microbes and deep sea invertebrates.

7.8. Funding strategy: what follows after the PEGASuS grant?

The EuroSea project will support the EOV efforts following the working group. Organizations CSIRO & AIMS & UW & University of Western Australia will be a part of this support. The EuroSea funding will persist until 2022. Ideally the group will have a mix of experience and capacity and the project officer will need to serve a large coordination role. We need to continue to seek more ways to have regional implementations. The International Climate Initiative (IKI) Grant system (German system) supports overseas work and there is a proposal ($20-30,000) possibly for some support with the GOOS BioEco Panel in the Northeast Indian Ocean.

Katy Hill may be taking the coordinating position with the G7 (all of the G7 countries agreed to have the coordinating center). G7 statement includes a section on why the member states wanted to support ocean monitoring.

Consultations with the Atlantic Ocean Research Alliance (AORA) and the European focused Atlantic efforts (Margaret Rey). It would be good to have a summary of the biological observations included in AtlantOS.

There is a gap in West Africa, and at the South Atlantic Regional Meeting for the Decade there were some clear players that may be important to include if interested such as Ghana for their data skills, Namibia, and MAVA (for the focus on seabirds, turtles, and other megafauna).

In addition, RevOcean works on data ocean flows. If we can connect to this work quickly we may be able to help catalyze this system. Distributed data system! Data Architecture workshop; develop data architecture (not centralized system).

The Vulcan foundation could support with habitats such as corals, seagrass, mangroves (e.g. Allen Coral Atlas - from Planet satellites). Frank suggested proposals to map wetlands globally (similar to the global coral reef atlas).

There is also support for the Ocean Obs RCN meetings (next is Feb prior to Ocean Sciences meeting). There are also POGO for workshops and trainings, which are not necessarily heavily subscribed. There is the Blue Action Fund which is supporting efforts in the Western Indian Ocean and
Western Africa (3 workshops to support development: 1 introduce concept; 1 to put equipment in; 1 to come back and collect data).

There was also the question raised by Nic Bax: “How easy does it feel to keep up with what the panel is working on?”. There was a general consensus that it is fairly easy since Patricia has been clear on deadlines and information with a clear flow of information. There are frequent and nice check-ins with gentle reminders that work well.

A broader discussion followed regarding why data is not included indicator frameworks (e.g. phytoplankton). Part of this is the need to clarify the purpose and use of EOVs, which is a framework for the scientific community to come together under. Sometimes there is confusion in the policy community on difference between EOVs and indicators and this needs to be cleared up. There is also a need to demonstrate the link between EOVs and pressures. In addition, there is a need to facilitate an interface layer so that the data streams are open and flow into a common system.

7.9. Panel leadership & membership

The panel leaders and membership were discussed including the leadership (co-chairs), EOV representatives, International Project Officer (IPO). There was a discussion on how (and who to lead) interaction with (e.g. OBIS, JCOMM-OPS/OCG, OBP, GCOS, IPCC) along with the reporting/commitment requirements of these organizations.

**International Project Officer.** The panel is hiring a new project officer in March to replace Patricia. The selection process for the new international project officer includes an Australian focus due to visa and monetary constraints of getting people overseas. The deadline has passed and the position sits in the University. There is internal advertisement then internal- moving expenses & visa expenses. A call for colleagues in Australia that would fit this position well was put out to the panel.

**Panel Renewal.** A few people are transitioning off of the panel namely, Patricia Miloslavich, Yun She, Valerie Allen, Sonia Batten, and Dan Costa. For a list of the other Panel members changes see the table below.

<table>
<thead>
<tr>
<th>EOV</th>
<th>Name</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Microbes</td>
<td>Pier Luigi Buttigieg</td>
<td>continuing</td>
</tr>
<tr>
<td>Phytoplankton</td>
<td>Frank Mueller Karger</td>
<td>renewal</td>
</tr>
<tr>
<td>Phytoplankton</td>
<td>Rafael Kudela</td>
<td>renewal</td>
</tr>
<tr>
<td>Zooplankton</td>
<td>Sonia Batten</td>
<td>terminating</td>
</tr>
<tr>
<td>Zooplankton</td>
<td>Sanae Chiba</td>
<td>renewal</td>
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<tr>
<td>Benthic Invertebrates</td>
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</tr>
<tr>
<td>Fish</td>
<td>Ant Bernard</td>
<td>joining</td>
</tr>
<tr>
<td>Fish</td>
<td>Rick Stuart Smith</td>
<td>joining</td>
</tr>
<tr>
<td>Marine Mammals/Megafauna (Fish)</td>
<td>Karen Evans</td>
<td>joining</td>
</tr>
<tr>
<td>Birds</td>
<td>Tammie Davies</td>
<td>Will consult</td>
</tr>
<tr>
<td></td>
<td></td>
<td>with BirdLife</td>
</tr>
<tr>
<td>Turtles</td>
<td>none defined</td>
<td>none defined</td>
</tr>
<tr>
<td>Marine Mammals /panel ambassadors</td>
<td>Sam Simmons</td>
<td>continuing</td>
</tr>
</tbody>
</table>

Leadership for interactions and connections with organizations. Nic Bax will support connection to JCOMMOPS/OCG. Frank, Pier, Nic will support a connection to the OBP. Frank will connect with GCOS in regards to plankton and marine habitat properties EOVs.

8. Summary of Outputs & Deliverables

Manuscript on the current status of the biological observing system. This paper will detail the overall level of the biological observing system with some specific EOV insight. Goal is to have the manuscript submitted between August 2020 and October 2020; Erin Satterthwaite leads

Ocean Obs summary manuscript on integrated ocean observing. This paper would be based on the outputs from the integration of observing systems in coordination with the other session leads (Maury/Gabrielle & Frank/Patricia); Nic Bax leads

UN Decade summary document. Summary document contributed to the UN Decade planning process based on a re-work of the BioEco flier; Patricia Miloslavich leads

Coordination structure plan. Design and coordinate a coordination/governance structure plan. Here the term coordination is important to include to ensure that governance is thought of as collaborative versus hierarchical. This would be related to the internal coordination of networks and how the information feeds into the OBP system as well as the GOOS facilitated outcomes for the Ocean Health team.

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**PEGASuS summary document**: Summary document generated from the outputs of the PEGASuS working group, specifically this workshop and the past workshop. Discuss how we are going to engage with the communication strategy. This will be the topic for the next meeting (Italy). Put summaries into a conducive form to develop a communication plan.

**Connection to Ocean Best Practices System**. Ocean Best Practices system needs a way to filter BPs by EOV, sub-variables, and methods.

**Foster connections with organizations & initiatives**. Nic Bax connect JCOMMOPS/OCG. Frank, Pier, Nic connect OBP. Frank connect GCOS.

**Generate case studies to demonstrate the value of EOVs from data to indicators**. BirdLife - Tammy Davies, Reef Life Survey - Rick Stuart Smith. Other could include SeagrassNet/Watch, Mangrove Watch, microAMBI, and the Ocean Tracking Network although contacts and support would need to be identified for these.

**Develop list of fora and WG attendees to coordinate representation of EOVs at important conferences, meetings, and other events**. This may be conducted by the IPO for conferences that would benefit from a general EOV communication along with each specific EOV lead to coordinate EOV specific conferences and efforts.

**Deliverables for EuroSea project**. The specific deliverables for the EuroSea project are (1) a map of BioEco Observing networks and capabilities, (2) a report on European BioEco networks detailing the metrics of the progress against a sufficient and sustained BioEco observing observing system, including for the MSFD, and (3) a final report of the EOOS implementation plan, progress, function of systems and recommendations for EOOS, European OO and GOOS GRAs from across the work package.

**Sociogram (network analysis) of existing biological observing efforts**. There was a consistent need to understand the actor landscape of the current biological observing initiatives and how they connect. Specifically understanding which data collectors are a part of which data collector networks and data aggregators. Also, understanding the flow of information from data collectors to end-users is important but the initial pass is likely to be conducted with the case studies (detailed above).