

**Biology and Ecosystems Panel**

**2021 Activity Report  
GOOS-276**

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## SUMMARY

Given increasing human use of the ocean and the associated expanding pressures, including cumulative effects being placed on the ocean, quantifying the status and trends of key indicators for the ocean and marine life is necessary. This is not only necessary for understanding how, when and to what extent pressures may be impacting species and habitats but it is also necessary for monitoring the success of mitigative and protective measures for ensuring ongoing sustainability of the use of the ocean. The Biology and Ecosystems (BioEco) panel of the Global Ocean Observing System (GOOS) has developed a 10-year Roadmap that aims to improve biological and ecosystem ocean observations in the global ocean.

The BioEco panel identified 11 Essential Ocean Variables (EOVs) using the Drivers, Pressures, State, Impact and Response (DPSIR) framework, and the Framework for Ocean Observing (FOO) criteria. The development and progress of each EOv however depends on available funding, technology and networks; thus the level of readiness of ocean observation for each EOv varies. Over the next 10 years, the BioEco panel will communicate value proposition (Goal 1), identify leadership and strengthen partnerships (Goal 2), promote best practices and Standard Operating Procedures (Goal 3), implement technological developments (Goal 4), expand network coverage (Goal 5), undertake capacity development (Goal 6), and contribute indicators to policy assessment at national and global levels (Goal 7).

In 2021, panel members convened numerous workshops, secured funding from the Scientific Committee for Oceanic Research (SCOR) to form scientific working groups, published findings in peer-reviewed publications and, engaged with national and regional organisations to build connections, synthesise best practices and Standard Operating Procedures amongst others. The panel also has a specific component which focuses on data and metadata management, and funds were secured to continue the development of the BioEco online portal which will highlight biological and ecosystem observing programs in the global ocean.

Whilst COVID travel restrictions still prevent the panel from meeting in-person, the virtual panel meetings are continually progressing the EOvs and have developed plans for EOv progress in 2022.

# GOOS BioEco highlights of 2021

## (1) Panel composition and renewal

The panel is co-chaired by Gabrielle Canonico (National Oceanic and Atmospheric Administration, NOAA, USA) and Nic Bax (CSIRO, Australia) with the following panel members:

1. Ward Appeltans for Data Management (IOC/UNESCO, Belgium)
2. Lisandro Benedetti-Cecchi for Macroalgae EOV (University of Pisa, Italy)
3. Pier Luigi Buttigieg for Microbes EOV (Alfred Wegener Institute, Germany)
4. Emmett Duffy for Seagrass EOV (Smithsonian, USA)
5. Raphael Kudela for Phytoplankton EOV (University of California in Santa Cruz, USA)
6. Frank Muller-Karger for Phytoplankton EOV (University of South Florida, USA)
7. David Obura for Hard Coral EOV (CORDIO, Kenya)
8. Lisa Maria Rebelo for Mangrove EOV (International Water Management Institute, Sri Lanka)
9. Rick Stuart-Smith for Fish EOV (University of Tasmania, Australia)
10. Anthony Bernard for Fish EOV (University of Cape Town, South Africa)
11. Samantha Simmons for Marine Mammal EOV (U.S Marine Mammal Commission, USA)
12. Karen Evans for Marine Mammal EOV (CSIRO, Australia)
13. Tammy Davis for Marine Birds EOV (BirdLife International)
14. Henry Ruhl for Benthic Invertebrates EOV (DOOS Representative, Monterey Bay Aquarium Research Institute, USA)
15. Peter Tyack for Ocean Sound EOV (University of St Andrews, UK)

In 2021, the panel had three virtual meetings in March, July and December. EOV leads presented updates on each EOV (as outlined in section 3), and the panel discussed plans to engage with regional coordinating programmes such as Asia-Pacific Marine Biodiversity Observation Network (AP-MBON), GOOS Regional Alliances and many others.

## (2) Developing the 10-year Roadmap

Following the OceanObs'09 Conference in Venice, Italy, a working group of international program representatives devised the Framework for Ocean Observing (FOO) which outlines requirements for ocean observations. The framework has been widely endorsed by the ocean observing community, and adopted formally by GOOS as a guiding document. Based on the FOO, the *readiness* level for each Essential Ocean Variables (EOV) varies and the Biology and Ecosystems panel is actively working to advance the capabilities of each EOV.

The Biology and Ecosystems panel developed a 10-year Roadmap that will evolve and advance observing systems in the global ocean in response to societal needs. The seven goals within the Roadmap described below can guide the panel to advance each EOV from their current state, as well as identify priority areas that need concentrated efforts (Figure 1).

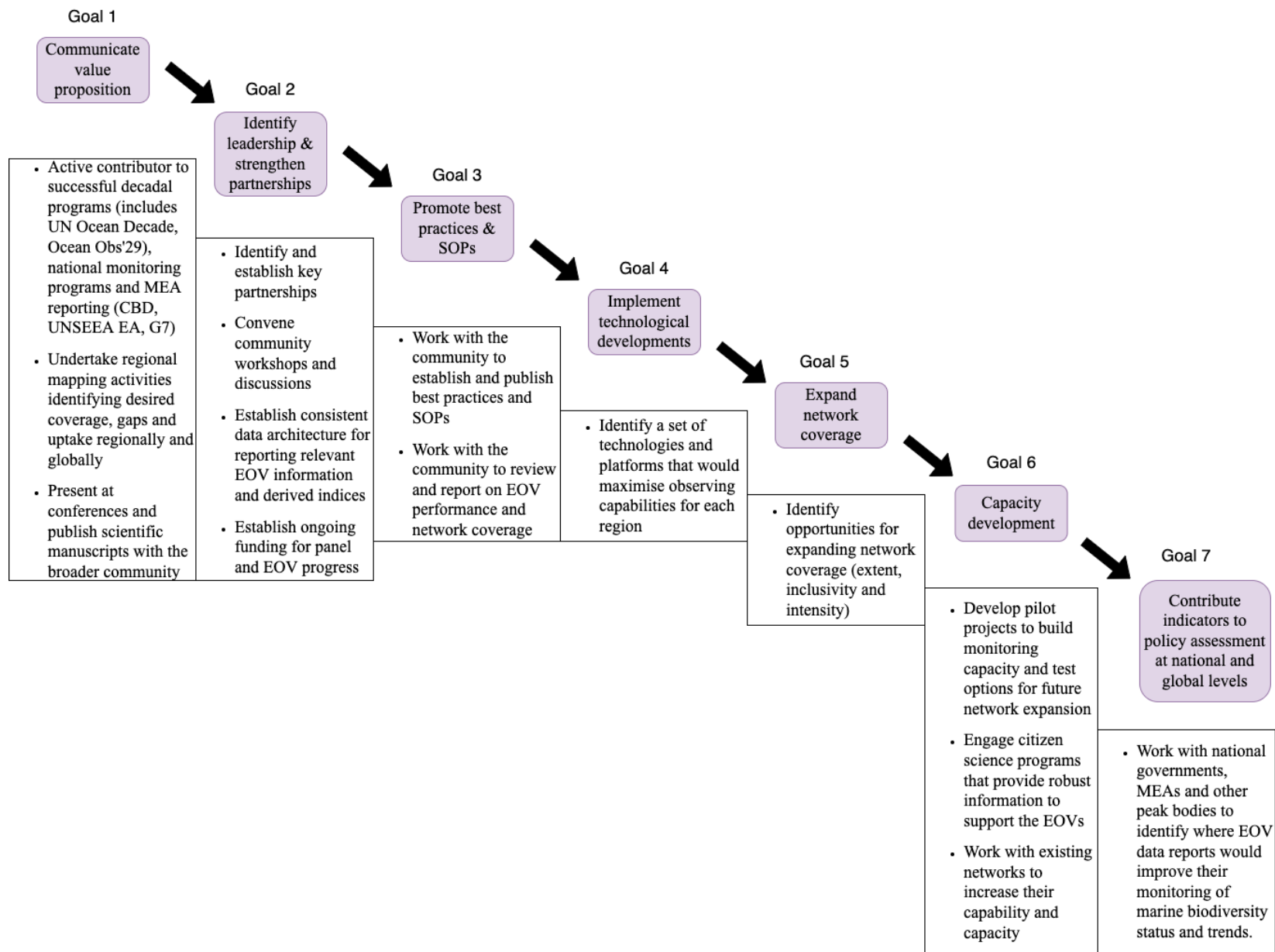


Figure 1: The Biology and Ecosystems panel 10-year Roadmap and example of activities that will be undertaken to achieve each goal.

### (3) Assessing the progress of the Essential Ocean Variables against the Roadmap

The Scientific Committee for Oceanic Research (SCOR) has funded three working groups on plankton, seagrass and fish that are actively working on achieving consensus on observing strategies, protocols, and data sharing practices.

- Frank Muller-Karger and Raphael Kudela, phytoplankton EOV co-leads, contributed to the SCOR WG #154, “Integration of Plankton-Observing Sensor Systems to Existing Global Sampling Programs” (P-OBS) (<https://scor-int.org/group/154/P-OBS>) led by Emmanuel Boss (University of Maine, USA) and Anya Waite (Dalhousie University, Canada).
- Emmett Duffy, seagrass EOV lead, and Lauren Weatherdon (UNEP-WCMC, UK) are chairing WG #158, “Coordinated Global Research Assessment of Seagrass System (C-GRASS)” (<https://scor-int.org/group/158/>).
- Anthony Bernard and Rick Stuart-Smith, Fish EOV by the co-leads, are chairing WG #164, “CoNCENSUS: Are global indicators of COastal and Nearshore benthic fish assemblage status in agreement if derived from disparate visual CENSUS techniques?” (<https://scor-int.org/group/concensus-advancing-standardisation-of-coastal-and-nearshore-demersal-fish-visual-census-techniques/>)

These working groups are at different levels of progress. P-OBS was approved in September 2017 and has had three working group meetings and produced multiple scientific publications. C-GRASS was approved in September 2019, and in 2021, C-GRASS developed an informal agreement with the World Seagrass Association to sustain the C-GRASS goals, planned community workshops and a best practices task force with UNEP-WCMC, synthesised in situ and remotely sensed data, worked with OBIS towards improving data representation from seagrass observing programs, produced an online 'Seagrass Sourcebook' for the community, transferred SeagrassNet database to Smithsonian to ensure long-term sustainability, and worked with A-SAVE (Pew, southeast US) to better inform seagrass habitat management. The CoNCENSUS working group was recently approved in October 2021 and are currently in planning stages.

Whilst CoNCENSUS is formulating plans for 2022, the co-leads continued to progress the Fish EOV by undertaking regional training workshop (WIOMSA) for baited remote underwater video stations (BRUVs)/ stereo-BRUVs, developed and endorsed the best practices for stereo-BRUVs, worked with the South African National Biodiversity Institute on developing plans to integrate EOVs into South Africa National Biodiversity Assessment, and contributed to Australian State of Environment report.

The Turtle-Bird and Marine mammal are a joint EOV and the team, Tammy Davis, EOV lead for seabirds, as well as Karen Evans and Sam Simmons, marine mammal EOV co-leads, convened an online workshop at the World Seabird Conference. During the workshop, the team identified additional monitoring programs that would feed into the online portal currently being developed by the BioEco panel to showcase ocean observing programs in the global ocean. Additionally, in July of 2020 the US Interagency Ocean Observation Committee (IOOC) established the Biology - Integrating Core to Essential Variables (Bio-ICE) Task Team to advance the integration of biological observations from local, regional, and federal sources using best practices to inform national needs and ultimately feed seamlessly into the Global Ocean Observing System, as appropriate. This year, Sam Simmons chaired the marine

mammals sub-group and the working group submitted best practices for acoustics and photo-ID to the Ocean Best Practices System (OBPS). More information about the task team is available here: <https://www.iooc.us/task-teams/bio-ice/>, including a downloadable PDF of the full scope of work.

For hard coral, the EOv lead, David Obura, was supported by UN Environment to develop the Global Coral Reef Monitoring Network (GCRMN) 6th report on the “Status of Coral Reef of the World”. This is the first report since 2008 and highlights the increasingly frequent mass global coral bleaching events, which has led to the loss of approximately 14% of the world’s coral since 2009. Please see the GCRMN website: <https://gcrmn.net/2020-report> to download the Executive Summary, individual chapters, and other resources.

Macroalgae EOv led by Lisandro Benedetti-Cecchi undertook a 3-day online workshop that attracted ~60 participants across Europe. The workshop discussed best practices and Standard Operating Procedures, integrating macroalgal surveys with seafloor macroplastics (a new EOv being developed by the Biogeochemistry panel), and data sharing practices. More details on this workshop can be found below. The panel is currently seeking representation for zooplankton and turtle EOv leads, and co-lead for mangrove EOv with a focus on in-situ monitoring.

Whilst the EOvs are at different levels of *readiness*, as highlighted above, the panel is actively making progress against all 7 goals of the Roadmap. Additionally, two new EOvs are being developed - Benthic invertebrates by Henry Ruhl and Ocean Sound by Peter Tyack. Progress against these EOvs will be reported as they develop.

#### (4) Improving Data Management

Effective data management is a multi-step process that includes activities such as metadata and data assembly, quality assurance and control (QA/QC), and data publication, which then enables the data to be accessed and utilised. To achieve this, data should follow the FAIR data principles - Findable, Accessible, Interoperable, and Reusable. The BioEco panel recognises the importance of effective data management and formed a [collaborative agreement](#) in 2016 with MBON and OBIS to:

- Foster wider systematic data sharing, curation, and aggregation under guidance of OBIS in order to streamline the feeding of integrated and quality controlled datasets into models and forecasts, and
- Build global capacity for data collection and data management by sharing best practices, manuals and guides.

With funding from PEGASuS and GOOS, OBIS has set up a geonode (<https://geonode.goosocean.org>) and portal interface (<https://bioeco.goosocean.org>), which currently holds information from 585 observing programmes. This task involved technical work as well as processing, formatting, quality controlling and importing the information and spatial layers. Online documentation for the programmes to edit and maintain their records via the geonode is also created and made available.

The overall aim of the BioEco Data team is to develop and manage an open access portal containing an interactive map along with metadata and spatial information of global ocean observing programs monitoring. The team further aims to establish and ensure a continuous flow of BioEco EOVS data from observing programmes into OBIS and the metadata on the observing programmes from the OBIS database into the BioEco metadata portal. This flow of (meta)data will ease the workload and time consumption of data providers, while controlling for duplication, quality and availability of metadata. In December 2021, the team recruited a GOOS BioEco Data Manager to perform the tasks, management and maintenance of the newly developed GOOS BioEco metadata portal, and the portal will be officially launched in June 2022.

## (5) Regional Implementation Projects

Regional implementation projects allow the panel to build connections with the community, improve coordination between programs and networks, and encourage data availability, interoperability and reusability, and contribute to a globally coordinated ocean observing system.

The findings from the Program for Early-stage Grants Advancing Sustainability Science (PEGASuS) initiative “Designing the observing system for the world’s ocean – from microbes to whales” (see the 2019 and 2020 annual reports) were published in *Frontiers in Marine Science* (Satterthwaite et al. 2021).

The Panel’s IPO is currently funded to 0.4FTE through the ~€12.3M EuroSea project (<https://eurosea.eu>). Funded by the Horizon 2020 Blue Growth (BG-07-2019-2020) program, EuroSea aims to improve and integrate European Ocean Observing and Forecasting systems for sustainable use of the oceans. EuroSea brings together European stakeholders (providers and key users of ocean observations and forecasting) in an interdisciplinary consortium (55 partners) for 4 years to work on 9 Work Packages (WPs). The project is coordinated from GEOMAR Helmholtz Centre for Ocean Research Kiel, Germany by Toste Tanhua (coordinator) and Andrea Franke (project manager).

The IPO’s tasks over the first 2 years (2021 and 2022) of the project are associated with Work Package 1 (Governance and Coordination of ocean observing and forecasting system with IOC/UNESCO, GEOMAR, EUROGOOS, SOCIB, IO PAN, IEEE, EMB, MET OFFICE). A key objective of Work Package 1 is to strengthen and extend the BioEco networks throughout the European seas by (1) mapping the current state of the networks that have a set of biological EOVS, and (2) developing global networks for ocean biology observations, including workshops to reach agreement on observation strategies, data sharing practices, and best practices (BPs) and standard operating procedures (SOPs), and strengthening engagement with national and international research and observation programs

The process of identifying monitoring programs within Europe started from the global survey undertaken as part of the PEGASuS project (Satterthwaite et al. 2021). The global survey identified 127 active marine monitoring programs in Europe. Active programs were defined as those that sampled at least once in a five year period. Through the EuroSea project, we cross-validated these 127 monitoring programs to determine if they are still active. Subsequently, we identified additional programs and contact information through web/social media searchers, GOOS national focal points in Europe and the EOOS Operations Committee. Through these two efforts combined, we identified a total of 296 unique marine monitoring programs that monitor at least one BioEco EOVS within European waters. Each monitoring program can



monitor either one essential variable, or in many cases, the monitoring program sampled two or more essential variables. For programs that sampled two or more essential variables, the sampling may or may not be occurring simultaneously. By far, monitoring for phytoplankton was the most abundant (225 programs) followed by fish, (169 programs), zooplankton (133 programs), benthic invertebrates (115 programs), marine mammals (79 programs), microbes (57 programs), birds (57 programs), macroalgae (47 programs), turtles (32 programs), seagrass (28 programs), and lastly hard coral (19 programs). There are no monitoring programs for mangroves in Europe as they grow in sheltered tropical and subtropical coastal areas across the globe. However, some countries (e.g., France) have overseas territories where mangroves are monitored.

Moving forward, the panel will work on building connections with these programs, developing networks, and undertaking workshops to reach agreement on observation strategies, data sharing practices, and best practices (BPs) and standard operating procedures (SOPs).

## (6) Workshop: Towards a Coordinated European Observing System for Marine Macroalgae

Marine macroalgae are submerged vegetated ecosystems in shallow coastal waters throughout the world. These productive habitats are refuge for a diverse range of animals, including commercial, and subsistence fisheries, and they also play an important role in storm protection and biogeochemical cycling and storage.

An online workshop was held from the 23rd to the 25th of November 2021 to bring various stakeholders together to engage in a conversation to ensure the conservation and sustainability of macroalgae into the future. The workshop was funded through EuroSea and thus the focus was on macroalgae within European waters. The workshop was co-chaired by Profs Lisandro Benedetti-Cecchi and Isabel Sousa Pinto (University of Porto, Portugal). Through a series of presentation by leading researchers, data managers/coordinators and representatives from the Directorate-General Marine Affairs and Fisheries (DG MARE) of the European Commission, this workshop encouraged and challenged the participants to identify key gaps (observation strategies/protocols, knowledge, coverage etc.), identify mechanisms to integrate with other monitoring programs, and develop key questions and recommendations for macroalgal monitoring in Europe.

Steps forward from this workshop include:

- Observing methods for seafloor plastics are the same as for macroalgae (i.e., visual scuba diving and ROVs). A key recommendation moving forward is to develop a pilot project that combines visual surveys with macrolitter monitoring. Initial exchange with Nova Mieszkowska on MarCLIM was facilitated during this workshop.
- Based on the programs currently being undertaken by workshop participants, 19% of the participants include eDNA in their survey. There are no common established protocols amongst participants but there is motivation to develop a common protocol and begin a pilot project. Key future steps forward are to develop standard operating procedures from sampling to data curation,

identify locations to undertake pilot projects and identify funding mechanisms to undertake the projects (funding will depend on scale of operations).

- More validation and standardisation is required to match in situ data with current satellite capability and a key focus should be developing this cross calibration.
- Various sampling methodologies and lack of consistent data flow impede our ability to answer pressing biodiversity questions on a larger spatial and temporal scale. An online platform should be established where all individuals monitoring macroalgae in Europe can communicate and liaise with each other about their monitoring protocols and activities.
- Various reasons drive the lack of data availability. To combat this efforts should focus on: 1) Developing training protocols by OBIS/EMODnet, 2) Making data deposition into an OBIS affiliated repository requirement for funding, and 3) Seek agreement on data models, workflows, and infrastructure required to support data aggregation to OBIS

## (7) Engaging in Ocean Decade programmes

On 5 December 2017, the [United Nations proclaimed a Decade of Ocean Science for Sustainable Development](#), to be held from 2021 to 2030. The vision of GOOS, and the BioEco panel, is strongly aligned to the vision of the Ocean Decade program and many BioEco panel members are actively involved in Ocean Decade Programs that was endorsed in the first call for actions as outlined below. Plans for each programme are currently being developed.

1. **Decade programme name:** [Marine Life 2030](#): A Global Integrated Marine Biodiversity Information Management and Forecasting System for Sustainable Development and Conservation

**BioEco panel members involved:** Emmett Duffy (National government partner/programme representative), Frank Muller-Karger (Programme contact/programme representative), Pier Luigi Buttigieg (Academic partner), Nic Bax (National government partner), Gabrielle Canonico (Programme contact/programme representative), Lavenia Ratnarajah (IGO partner), Ward Appeltans (IGO partner), David Obura (NGO partner), Rick Stuart-Smith (NGO partner), Henry Ruhl (Academic partner)

**Objectives:**

- O1: Nurture global capacity for sustainable ocean development.
- O2: Establish a global framework for coordination and integration.
- O3: Build lasting partnerships and collaboration.
- O4: Build the Ocean BioCode.
- O5: Nurture Centers for Ocean Collaboration.
- O6: Sustain the Marine Biodiversity Observation Network.

2. **Decade programme name:** [Ocean Biomolecular Observing Network \(OBON\)](#)

**BioEco panel members involved:** Luigi Buttigieg (Scientific advisory committee)

**Objectives:**

- O1: To build a coastal-to-open ocean multi-omics biodiversity observing system over the Ocean Decade
- O2: To develop and transfer capacity so as to initiate additional marine biomolecular
- O3: To enhance marine ecosystem models (including new modelling based on machine learning) by adding biomolecular components
- O4: To address pressing scientific, management, and policy questions linked to the state and dynamics of life in the ocean, including exploited resources and those affected by other pressures.

3. **Decade programme name:** [An Observing Air-Sea Interactions Strategy \(OASIS\)](#)

**BioEco panel members involved:** Frank Muller-Karger (Best practice and interoperability experiments theme team), and Lavenia Ratnarajah (Best practice and interoperability experiments theme team)

**Objectives:**

- O1: Improved scientific knowledge of ocean-atmosphere interactions, including critical physical and biogeochemical processes at the air-sea interface, needed to create ocean information for decision makers.
- O2: A step change in the observational capacity to monitor the atmospheric and oceanic boundary layers and air-sea exchange processes at all scales, with global coverage via satellites and basin-wide in situ networks connected to coastal sites.
- O3: A transformation in our ability to accurately predict weather, climate, and ocean environments, including ecological components, and to quantify the air-sea exchange of carbon dioxide based upon the step increase in ocean information.

4. **Decade programme name:** [CoastPredict - Observing and Predicting the Global Coastal Ocean](#)

**BioEco panel members involved:** Pier Luigi Buttigieg (Advisory committee)

**Objectives:**

- O1: A predicted global coastal ocean
- O2: The upgrade to a fit-for-purpose oceanographic information infrastructure
- O3: Co-design and implementation of an integrated coastal ocean

observing and forecasting system adhering to best practices and standards, designed as a global framework and implemented locally.

5. **Decade programme name:** [Ocean Observing Co-Design](#): evolving ocean observing for a sustainable future (ObsCoDe)

**BioEco panel members involved:** Frank Muller-Karger (Programme advisory group), and Emmett Duffy (Programme advisory group)

**Objectives:**

- O1: Integrate observing and modelling to support a sustainable ocean and society in ways that are measurably better
- O2: Make ocean observing and information appreciably more impactful through transformative co-design with the modelling community and key stakeholders
- O3: Establishing the international capacity and modular infrastructure to co-design and regularly evaluate the observing system
- O4: Entrain new observing and information technology across all elements of the programme

6. **Decade programme name:** [Observing Together](#): Meeting Stakeholder Needs and Making Every Observation Count

**BioEco panel members involved:** Emmett Duffy

**Objectives:**

- O1: Transform ocean data access and availability by connecting ocean observers and the communities they serve, through enhanced support to both new and existing community-scale projects.

7. **Decade programme name:** [Deep Ocean Observing Strategy](#)

**BioEco panel members involved:** Henry Ruhl (Requirement setting co-PI)

**Objectives:**

- O1: Extend deep-ocean observing capacities to the global scale as part of the UN Decade – addressing all deep-ocean-relevant Essential Ocean Variables and building on existing assets and networks.
- O2: Focus observations to meet requirements for ocean modeling.
- O3: Improve standardization of and access to deep ocean observing data, samples, models, and derived products.
- O4: Facilitate partnerships, collaboration, integration and capacity building across deep ocean observing communities, including deep-ocean exploration, seafloor mapping and private sectors, through the Deep Ocean Observing Strategy.

8. **Decade programme name:** [Challenger 150: A decade long programme of deep-sea research](#)

**BioEco panel members involved:** Frank Muller-Karger

**Objectives:**

- O1: Build capacity for deep-sea research globally
- O2: Expand deep-sea biological observations and sampling in all ocean basins, specifically focusing on underexplored regions.
- O3: Build fundamental ecological understanding of deep-sea ecosystems including ecosystem services delivered by the deep seas, and flows of benefits to society.
- O4: Increase use of deep ocean knowledge through development of effective 'knowledge to end-user' pathways, including use of decision-support tools in modelling deep sea management scenarios.

9. **Decade programme name:** [Ocean Practices for the Decade](#)

**BioEco panel members involved:** Frank Muller-Karger (Steering Group), Pier Luigi Buttigieg (Steering Group)

**Objectives:**

- O1: Identify required knowledge for sustainable development, and increase the capacity of ocean science to deliver needed ocean data and information
- O2: Build capacity and generate comprehensive knowledge and understanding of the ocean including human interactions, and interactions with the atmosphere, cryosphere and the land sea interface.
- O3: Increase the use of ocean knowledge and understanding, and develop capacity to contribute to sustainable development solutions.

-END-