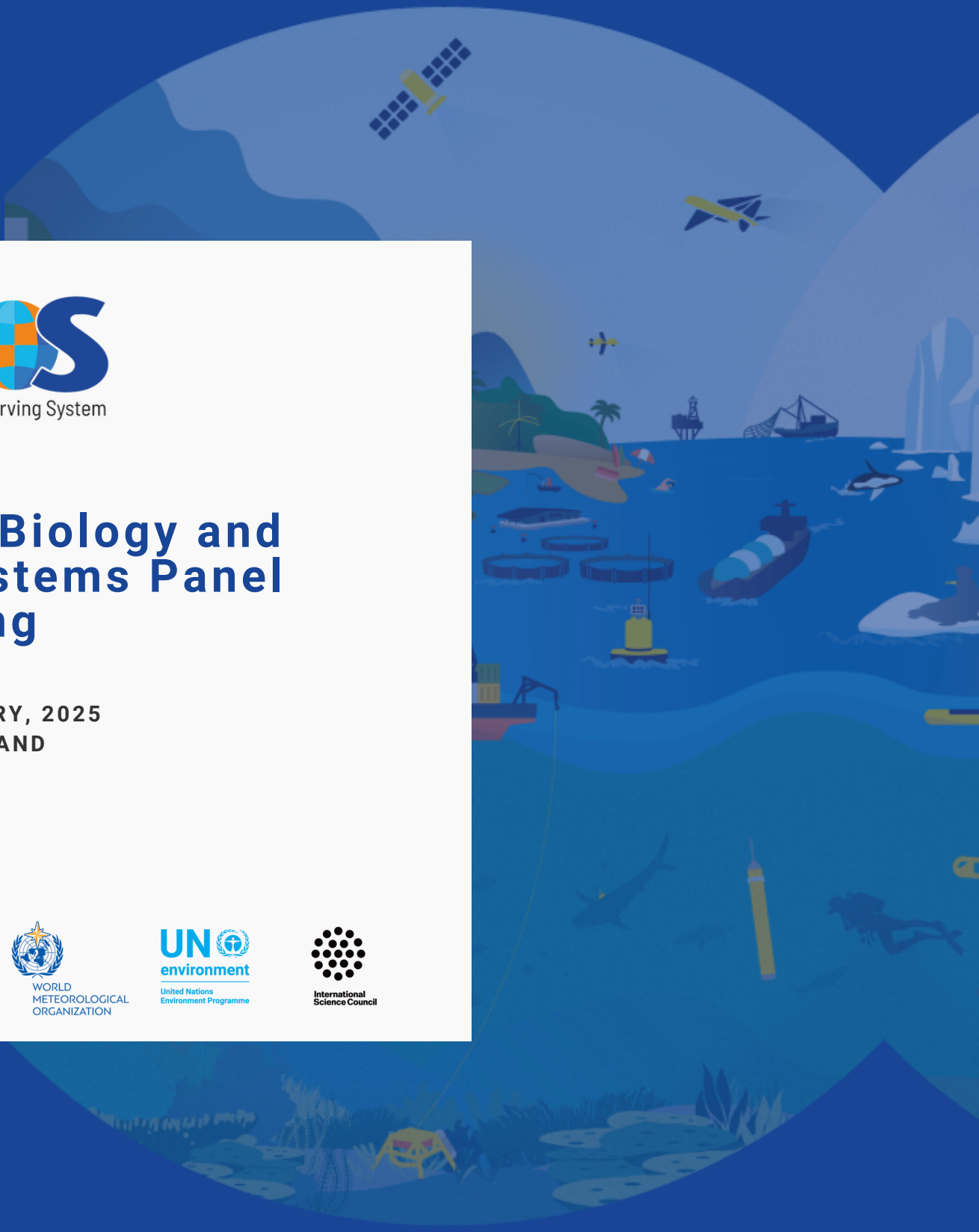
MEETING REPORT



Global Ocean Observing System

GOOS Biology and Ecosystems Panel Meeting

3-6 FEBRUARY, 2025
SOPOT, POLAND

unesco
Intergovernmental Oceanographic Commission

WORLD METEOROLOGICAL ORGANIZATION

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Global Ocean Observing System
Biology and Ecosystems Panel

Funded by the European Union

GOOS Biology and Ecosystems Panel meeting

February 3-6 2025
IO PAN - Sopot, Poland

Executive summary

The GOOS Biology and Ecosystems Expert Panel (BioEco Panel) met to progress key initiatives focused on advancing biodiversity observation planning, enhancing ocean data integration, and supporting the implementation of Essential Ocean Variables (EOVs).

Initial discussions centered on scoping the Global Ocean Observing System (GOOS) biodiversity observation plan (Biodiversity Plan), emphasising the need for improved coordination among existing networks and initiatives. The Panel identified priorities to strengthen partnerships, foster community engagement, and promote capacity development for enhanced global biodiversity monitoring. Complementing this, the Panel had an overview and discussed the IOC Digital Architecture initiative, which aims to create a federated, multi-disciplinary data system. This system will integrate platforms such as OBIS, ODIS, OceanOPS and the BioEco Portal to ensure data collected from diverse observing networks are interoperable, accessible, and aligned with FAIR data principles. A focus on adopting consistent metadata standards, controlled vocabularies, and data sharing frameworks was underscored to enable seamless integration across platforms.

Subsequently, the BioEcoOcean project and the BioEco Panel jointly conducted a workshop to advance the uptake and implementation of BioEco EOVs. The workshop introduced the BioEcoOcean Blueprint, a co-creative, question-driven resource designed to enhance collaboration, interoperability, and communication within the ocean observing community. Presentations from several BioEcoOcean Living Labs highlighted ongoing efforts to test EOV implementation across varied ecological and geographical contexts, helping to identify knowledge gaps and refine methodologies.

Data management formed a central theme of the workshop, with sessions focused on practical strategies for data preparation, standardisation, and sharing according to OBIS standards. Hands-on demonstrations facilitated participants' understanding of metadata requirements and tools for publishing and accessing biodiversity data,

supporting better integration within the IOC Digital Ecosystem.

The workshop emphasised the need to assess the Technical Readiness Level (TRL) of BioEco EOVs to measure the maturity of observing networks. The Panel recommended building and supporting communities of practice, standardising methodologies and data management protocols, expanding capacity development and training and ensuring FAIR and open data availability. Furthermore, the workshop recognised the importance of developing clear communication strategies, organising webinars in collaboration with partners like MBON, and exploring innovative AI tools to facilitate data translation and uptake.

These efforts reinforce the BioEco Panel's commitment to strengthening global ocean biodiversity observation and data integration. The combination of strategic collaboration, practical tools such as the BioEcoOcean Blueprint, and capacity-building initiatives are key to advancing a coordinated, sustainable, and effective global ocean observing system.

Table of contents

Overview of the week

Day	Topic	Comments
3/2/2025 - full day	BioEco Panel meeting	Dedicated for Panel related issues
4/2/2025 - full day	BioEcoOcean Day 1	Project overview and Blueprint workshop
5/2/2025 - full day	BioEcoOcean Day 2	Data workshop with Panel and project participants
6/2/2025 - half day	BioEcoOcean Day 3	Next steps
6/2/2025 - half day	BioEco Panel meeting	Debrief and next steps

The agenda for BioEco Panel meeting can be found here, and the presentations here.
The agenda for the BioEcoOcean meeting can be found here.

February 3, 2025 - Panel meeting

Welcome

Artur from IO PAN, host institution, welcomed the panel with a round table for introductions.

Actions update

An overview of past ACTIONS was provided.

- **Communications & Website Development**:
    - The panel's website is in progress. A poll to finalise the mission statement is ongoing, with reminders for members to vote.

    - Infographics are under development in collaboration with the Marco-Bolo project and they are in the final stages.
- **Update of EOV specification sheets**:
    - First drafts of specification sheets are complete and were reviewed by BioEcoOcean project colleagues. Feedback was later provided to EOV leaders for refinement of their specification sheet.

ACTION 2.25.1: All EOV leaders to refine the specification sheets using feedback provided by BioEcoOcean project colleagues by 30 March 2025.

ACTION 2.25.2: IPO to design a survey for each EOV to gather feedback from their specific EOV communities and to raise awareness by 30 March 2025.

- **Indicators Paper**:
    - A manuscript is being prepared by Karina and specific input from seagrass, macroalgae and phytoplankton EOVs is needed for the manuscript.

ACTION 2.25.3: IPO to contact relevant EOV leaders to review and contribute to the indicator examples. **Update: completed**

- **Essential Climate Variables (ECVs)**:
    - The Panel provided feedback on the ECV rationalisation, which will have a 2-year review.
    - Work on the GCOS implementation plan starts this year and the Panel will be asked to contribute.

ACTION 2.25.4: Members representing the Panel in GCOS/OOPC to provide update on key dates for input into the GCOS implementation plan at the next panel meeting.

- **Best Practices & Endorsement**:
    - Discussions with the Ocean Best Practice System to clarify endorsement criteria, particularly around community review processes. Further discussions needed on the panel's role in evaluating best practices.

IOC Biodiversity Strategy

NOTE: While the discussion during the panel meeting developed around a draft IOC Biodiversity Strategy, the IOC has changed its decision and will not proceed with a strategy. However, IOC continues to focus on building an internal framework that identifies how it can better coordinate its activities on biodiversity and better deliver to Member States. Therefore the discussions during the Panel meeting remains relevant to this purpose.

The Panel discussed the IOC Biodiversity Strategy that was under development (now discarded). That draft strategy aimed to respond to new international agreements, particularly the CBD Global Biodiversity Framework (GBF) and the Biodiversity Beyond National Jurisdiction (BBNJ), ensuring that IOC aligns with global commitments. Additionally, the strategy aimed to enhance internal coordination, streamline biodiversity-related projects, and improve how IOC reports to member states in a more transparent and coordinated way.

The need to ensure the IOC supports member states' reporting requirements for multilateral agreements and contribute to international monitoring frameworks by providing scientific services has been emphasised as being part of IOC's mandate.

The discussion highlighted the role of BioEco EOVs in biodiversity monitoring. Currently, the specification sheets are being updated and refined and will serve as a foundation to coordinate the observing community. Their input will be sought and gathered through tailored surveys, which will also help raise awareness about the EOV framework. A key priority for the IOC is the development of a unified data policy and data mobilisation strategy to ensure interoperability and open-access data sharing.

To enhance observational capabilities, the BioEco Panel should look at innovative technologies such as environmental DNA (eDNA), remote sensing, and autonomous sensors. These tools can help address gaps in biodiversity monitoring and improve data collection in remote or underrepresented areas.

The importance of interdisciplinary collaboration to bridge the gap between scientific communities and policymakers was highlighted. The draft strategy proposed the establishment of national teams that include experts in observation, data management, and policy. Furthermore, the IOC proposed work to strengthen partnerships with key stakeholders, including the private sector, Regional Fisheries Management Organizations (RFMOs), and initiatives like the Ocean Decade to expand the observing networks. An IOC Biodiversity Working Group was proposed in the draft strategy to oversee priority-setting, data policies, and transboundary biodiversity issues. **Update - The IOC will not pursue a strategy for biodiversity and therefore the plan for national teams may no longer be valid.**

Key challenges identified at the meeting included securing member state engagement and sustainable funding, particularly for capacity-building efforts in underrepresented regions. Improving coordination and demonstrating the collective impact of biodiversity initiatives was also highlighted as a priority.

Balancing global coordination with regional and national priorities, especially in areas beyond national jurisdiction, remains a critical concern. Ensuring equitable participation from all member states will be essential to the success of the strategy.

A unified vision of ocean health was emphasised as essential, with biodiversity positioned as a fundamental pillar for sustaining marine ecosystems and human well-being. The need for

effective communication tools that raise the profile of IOC, GOOS and the BioEco Panel was also discussed, with recommendations for the development of infographics, citizen science campaigns, and other outreach materials to enhance awareness among policymakers and the public.

IOC Digital Ecosystem

A summary of the IOC Digital Ecosystem workshop was presented. This workshop discussed a vision for a federated IOC Digital Ecosystem that integrates multi-disciplinary EOVs. This digital ecosystem leverages existing systems, such as OBIS, ODIS, OceanOPS, BioEco Portal and will also ensure there is no duplication of efforts. The Digital Ecosystem prioritises user-driven products, ensuring that data supports global assessments related to biodiversity and climate. This evolution is part of an IOC Executive Council decision that tasks GOOS and IOC *to create a functioning Digital Ecosystem to enable end user applications*.

Key technical elements were identified for having an effective data ecosystem:

- Metadata Standards: Establishing minimum requirements for provenance, licensing, and quality, with unique identifiers such as WMO numbers.
- FAIR & CARE Principles: Ensuring global data accessibility while respecting Indigenous data rights.
- Federated Systems: Using ODIS to connect distributed data sources while maintaining decentralisation.

The BioEco Panel will play a pivotal role in strengthening biological data integration, including promoting OBIS as the central hub for biological EOVs, collaborating with the Observation Coordination Group (OCG) to harmonise metadata standards across disciplines. It was highlighted that the implementation of unique identifiers, similar to WMO, would facilitate real-time biological dataflows, such as AniBOS. This network is currently working on getting QC real-time biological data flowing into OBIS. Real-time biological data would broaden applications for decision making, such as preventing vessel strikes or tracking wildlife disease, for example.

The next steps to advance the IOC Digital Ecosystem will be to present this joint vision at the IOC Assembly in June 2025 based on existing minimum viable product demonstrations. A working group will be formed and OBIS and ODIS will be part of this working group and can represent the BioEco Panel. However, panel members with interest in this working group were welcome to join. As part of this working group, closer links between OBIS and OCG will be bolstered with focus on agreeing on minimum metadata standards that are consistent between both, the BioEco Portal and OceanOPS with the potential for both systems to interface for services. The importance of unique identifiers was highlighted, particularly for real-time biological data.

ACTION 2.25.5: OBIS and BioEco Panel to work on minimum metadata standards that are consistent to OceanOPS, including provenance and licensing.

ACTION 2.25.6: Panel to articulate what would be the requirements in terms of data and metadata flows that can feed into the IOC digital ecosystem working group.

Biodiversity plan scoping

This session discussed the scoping and development of a GOOS Biodiversity Plan. **At the time of the meeting, the discussion was made within the context of a whole of IOC Biodiversity Strategy. However, since this meeting, IOC has decided not to have a strategy, but will continue to work on framing an IOC-wide approach to biodiversity.** There were discussions on whether the plan's primary aim should be to address the numerous mandates from national, regional, and international multilateral agreements related to biodiversity or to also incorporate broader scientific priorities for observation. If it is only the former, a stock take of the observing requirements needed to respond to mandated reporting requirements, and the status of the observations should be made to discuss with member states. While the BioEco EOVs were initially identified based on multilateral agreements, the agreements are written in a way that there is still flexibility in how these requirements are addressed.

Data management and data sharing were also emphasised as key components of the plan, including the need to prioritise the following:

- Establishing mechanisms for data uptake and accessibility, including automated procedures that simplify sharing data. This could involve considering a dedicated task team and exploring different ways to make EOV data available.
- Developing clear guidelines for minimum metadata requirements and the inclusion of quality flags.
- Addressing data sharing challenges and promoting a culture of open data within the biological and ecological communities. This could include strategies to incentivise and recognise data sharing.
- Exploring the use of unique identifiers for data and platforms to automate data sharing and improve data provenance.
- Promote the use of ODIS as a federated system to connect different data centres and the critical need of interoperability to ensure data from various sources can be integrated effectively.

Strategies to enhance coordination and strengthen partnerships to support the plan's objectives were discussed, including the need to systematically utilise GOOS structures such as the GRA's to advance the plan's goals. Strengthening partnerships with key organisations such as POGO and MBON were emphasised, recognising the value of leveraging their expertise and resources and collaborating closely.

The importance of establishing clear connections and feedback mechanisms between relevant groups, including the OCG and the BioEco Panel was highlighted as an important element to the GOOS Biodiversity Plan. Another key element was the need to ensure alignment with policy frameworks (e.g., CBD GBF, Ramsar Convention, FAO fisheries data) so BioEco EOV data feeds into national reporting and has impact. This will necessitate engagement at national and regional level to understand requirements and GOOS mechanisms could be leveraged.

The revised biodiversity plan should also prioritise long-term capacity development by moving beyond short-term projects and establishing sustainable funding mechanisms. To help attract funding, demonstrating the value of biodiversity observations, such as their role in natural resource management (e.g. fisheries), forecasting and conservation, will be key for securing government and stakeholder support. Practical projects can also be used as a mechanism to attract funding for specific tasks.

Clear success metrics should be defined in the Biodiversity Plan, including indicators and realistic goals for implementing and maturing BioEco EOVs, potentially aligning with OCG guidelines and network attributes. The plan should also embrace technological advancements by exploring collaborations for sensor and instrument development. Additionally, advocacy, education, and awareness strategies should ensure that biodiversity observations are widely understood and accessible.

Panel members were asked to provide input on specific actions that can be included in the plan and respond to requirements from IOC in this Miro Board.

Ocean acidification links with BioEco Panel

Kirsten Isensee from IOC-UNESCO presented on the Global Ocean Acidification Observing Network (GOA-ON) activities and plans. GOA-ON has three main goals: improving understanding of ocean acidification conditions, understanding ecosystem responses, and exchanging data and knowledge for modeling impacts.

A working group was formed to address the biological aspects of these goals and identified core parameters for regional and global comparisons. Three main tasks were established: informing chemical monitoring of biological needs, evaluating requirements for a biological monitoring program, and developing a theoretical framework linking chemical change to biological response.

To prove this theoretical framework, a project funded by the VeluxFoundation is underway, involving a postdoc who is identifying existing co-located biological and chemical data sets. This involves collaboration with resources like OBIS to find relevant data. A key challenge is identifying quality-controlled time series data with co-located chemical observations. It is possible that these collocated data may exist in different databases with varying quality control measures and will need help from the BioEco Panel to identify these datasets. There is a natural crossover between various initiatives, including GOA-ON, the Ocean Decade program, and the Velux project. The project aims to

develop tools and teaching materials for analysing time series data and potentially identify priorities for future biological and chemical monitoring.

An upcoming in-person meeting will focus on providing guidance to the postdoc in identifying and linking global data sets, planning future activities of the biological working group, and revisiting the theoretical framework linking chemical to biological responses. Collaboration and sharing of knowledge about existing time series data are encouraged.

After a workshop in February, Kirsten will contact the Panel to share the findings and discuss where other time series may exist and how the panel can interact with this program and the OA community

ACTION 2.25.7: Panel members to provide information to Kirsten on potential co-located QC chemical and biological time-series datasets they know exists

GOOS Biodiversity Plan writing workshop

The timeline for the Biodiversity Plan was presented:

1. Draft annotated outline - End of January 2025
   Who: GOOS BioEco exec with GOOS MT
2. Writing session with the BioEco Panel - 3 February 2025
   Who: GOOS BioEco exec and IOC biodiversity plan lead (Ward) with Panel
3. Discuss plan with Cross-Panel leadership (18 February) ; report on draft plan and timeline to GOOS SC (19-22 February)
   Who: GOOS BioEco exec
4. Community review and input to the draft plan - March 15 - April 15 2025
   Who: GOOS components, the GOOS steering committee, the GOOS sponsors, relevant parts of the IOC Secretariat [+ OTHERS]
5. Adjudicate comments and deliver to GOOS MT in advance of IOC-33 - April 15 - End April 2025
   Who: GOOS BioEco exec

The Panel broke up into smaller groups to work on the Biodiversity Plan draft for the rest of the day.

Update: The plan for the GOOS Biodiversity Plan was presented at the GOOS SC - 14 meeting. It was decided that the time for review of the plan was short and it was not necessary to present to IOC Executive Council. Instead an outline or executive summary can be appended to GOOS main documents.

ACTION 2.25.8: Biodiversity plan writing team to use the input in Miro Board and input provided during the writing workshop to develop a first draft for review

4-6 February - Joint meeting with BioEcoOcean

Participants were welcomed by Jan Marcin Węsławski, IOPAN Director.

An introduction of the BioEcoOcean project, an EU-funded initiative was made. The project aims to enhance the BioEco ocean observing capacity for advancing scientific understanding of the ocean and increase the utility of ocean observations. It is the second year of the project and focuses on biology and ecosystem Essential Ocean Variables (EOVs). Key objectives include:

- Accelerate and improve the implementation and usage of BioEco EOVs
- Developing common standards and protocols
- Ensuring interoperability with Essential Climate Variables (ECVs) and Essential Biodiversity Variables (EBVs).

The project also aims to strengthen global assessments and promote better data sharing and communication.

One of the project's deliverables is the updating of BioEco EOV specification sheets and the development of a guide for the specification sheet, which was recently delivered to the EU. The project emphasises the importance of data management, building on the Marco-Bolo project's data management plan, and making it more accessible to those unfamiliar with data terminology. The team is also working on communicating the benefits of coordinated monitoring systems and interoperability, aiming to create a more integrated and effective ocean observing network.

A significant focus of the project is the development of a "blueprint," a co-creative, question-based support tool designed to promote a holistic approach to ocean science. The blueprint aims to foster collaboration, interoperability, and effective communication among stakeholders. The aim is to launch the Blueprint on a digital platform offering interactive resources, training materials, and downloadable guides. The blueprint consists of several components that look through the entire ocean observing workflow.

The project also prioritises capacity building for diverse stakeholders involved in ocean observations. Six living labs, or demonstration sites, are being used to test and refine the blueprint, ensuring that the workflows from observation to policy application are operational and interconnected.

BioEcoOcean Living Labs overview

An overview of the BioEcoOcean living labs were provided outlining the BioEco EOVs they will be focusing on, the Blueprint component the living lab will help develop and the knowledge gaps they will be addressing.

Marine Organic Carbon Atlas Living Lab (MOCA)
MOCA Living Lab aims to bridge the gap between biogeochemistry and biology by creating a global data product focused on marine organic carbon, inspired by the success of the Surface Ocean CO_2 Atlas and the Global Ocean Data Analysis Project. The project will focus on essential ocean variables (EOVs) such as phytoplankton and zooplankton biomass and diversity, benthic invertebrate abundance and distribution, and seagrass and macroalgae composition. MOCA contributes to the development of the Blueprint by addressing knowledge gaps in the role of biology in the ocean carbon cycle, linking observational data with biogeochemical and ecosystem modeling needs, and ensuring data products are aligned with user requirements and metadata standards. A key science knowledge gap it addresses is the interaction between biological processes and carbon cycling, particularly in the Arctic, where it will pilot an atlas integrating remote sensing, in situ data, and modeling to improve assessments of carbon sequestration and benthic processes.

Pelagic Ocean Living Lab 1
This Living Lab focuses on zooplankton and the pelagic ecosystem, particularly at low trophic levels, including epipelagic and mesopelagic ecosystems. The EOVs it will focus on are zooplankton biomass (categorized by functional groups) and their role in the ecosystem, as well as Sea turtles and Fish abundance and distribution EOVs looking at predator-prey interactions. The project addresses knowledge gaps by improving existing zooplankton models, adding functional groups (e.g., gelatinous zooplankton) to better understand their role in marine food webs and carbon fluxes under climate change conditions, including marine heatwaves. The blueprint components it will help develop includes integrating long-term observational data, refining biogeochemical models, and producing forecasting tools to support marine management, conservation planning, and fisheries management.

Pelagic Ocean Living Lab 2
This Living Lab focuses on zooplankton biomass and composition EOV, looking at its role in the biological carbon pump, aiming to improve understanding of key processes that drive carbon sequestration. The Living Lab contributes to the development of the blueprint by reviewing critical processes, identifying knowledge gaps, integrating observations with trait-based models (such as SISSOMA, NUM and FEISTY), and improving data collection methodologies. It seeks to address knowledge gaps related to the efficiency of the biological carbon pump, particularly how different zooplankton functional groups influence carbon export and sequestration. By combining field data, laboratory experiments, and modeling approaches, the project aims to provide insights applicable to climate assessments, biodiversity conservation, and carbon cycle studies, with a focus on improving predictive models and ecosystem indicators.

Tuscan Archipelago Living Lab
This Living Lab focuses on monitoring and assessing biodiversity in rocky reef assemblages and seagrass habitats, focusing on macroalgal canopy and seagrass cover and composition and fish abundance and diversity EOVs. The study integrates traditional and emerging technologies, including imaging, eDNA, and artificial intelligence for species recognition, to improve the detection of biodiversity changes and ecosystem health. It contributes to the development of the Blueprint by enhancing components related to validation of emerging technologies, statistical power analyses, remote sensing, and early warning indicators. The research addresses critical knowledge gaps by evaluating the effectiveness of marine protected areas, understanding the influence of climate change and anthropogenic disturbances on marine ecosystems, and improving real-time monitoring through wireless underwater cameras and AI-driven data processing.

Atlantic Ocean Living Lab
This Living Lab focuses on the macroalgae cover and composition EOV, aiming to refine monitoring techniques to assess their extent, change, and health. They are contributing to the blueprint development by testing and adapting new monitoring methods, including eDNA, remote sensing via drones and satellites, and bioacoustics to evaluate ecosystem soundscapes. The primary knowledge gap they seek to address is the lack of efficient, scalable, and cost-effective monitoring methods for macroalgal forests, particularly in regions where traditional visual-based approaches fail due to poor water clarity. Their research will support improved mapping of these ecosystems, crucial for compliance with the EU's Nature Restoration Law, and enhance understanding of macroalgal forest health and biodiversity.

Baltic Sea Living Lab
This Living Lab focuses on integrated coastal monitoring, emphasising the refinement, reduction, and replacement of environmental sampling impacts while testing new technologies. The lab will focus on the seagrass, macroalgae, fish and benthic invertebrates EOVs, aiming to integrate sampling across these groups. This living lab contributes to the development of the blueprint by addressing cross-variable integration, standardising protocols, and supporting data sharing for regional and global products. The lab also explores multiple drivers of environmental and societal change, incorporating socioeconomic variables into EOV specification sheets to enhance understanding of system dynamics. Additionally, it supports the validation of emerging technologies and advances remote sensing observations, bridging knowledge gaps in multi-EOV monitoring, social-ecological interactions, and historical biodiversity data synthesis.

BioEcoOcean and EOV implementation

Participants were informed about the BioEco Panel's work on establishing the EOV framework to help with coordinating observations across regions to ensure comparability and scalability of

observations and enable a global assessment of the ocean. The importance of collaborative data collection across countries and regions to better understand ocean dynamics and climate solutions was highlighted.

BioEcoOcean Living Labs will be supporting this effort by testing the EOV framework and use the EOV specification sheets to guide their data collection, and ensure they follow metadata standards to contribute data that is comparable across different regions and platforms.

The EOV specification sheets are divided into sections designed to speak to different audiences. The specification sheets aim to provide clear guidance on what data to collect, how to collect it, and how to manage it effectively. It also provides information on the minimum metadata requirements as well as data management standards to ensure comparability.

The BioEco Panel provided the first draft to the BioEcoOcean researchers for review and feedback by the project consortium. Most reviewers found the specification sheets useful but suggested areas for improvement. The feedback highlighted the importance of data collection methodologies and the need for clear guidance on supplementary variables and observing approaches. Alignment between the EOV specification sheets and the “blueprint” was highlighted

The feedback received on the EOV specification sheets from the BioEcoOcean project review will be used to refine them and finalise the first draft. **See Action 2.25.1**

There was discussion about the need to think about providing guidance when multiple EOVs are observed, which is often the case. It was highlighted that guidance would be important on cross-disciplinary approaches and how to combine data from different EOVs to gain a more comprehensive understanding of ocean ecosystems. One suggestion is to look at use cases through a sampling platform lens, as there are multiple platforms that collect information on multiple EOVs (IMOS National Reference Stations BGC sampling can be an example case). The development of case studies could be done in collaboration with BioEcoOcean project using the Living Labs that are working with multiple EOVs as case studies and developing decision trees to help users navigate the complexities of collecting and integrating data from multiple EOVs.

The OCG networks have specification sheets for their networks and they will be looking at the new specification sheet template to check it’s suitability and adapt it. How OCG addresses this new specification sheet, can help guide the development of user cases through a sampling platform lens.

ACTION 2.25.9: The Panel to identify a couple of observing platforms that observe more than one EOV (i.e. imaging or eDNA) to develop guidance and serve as examples of how to combine several EOVs.

Suggestions to improve the specification sheets include:

- In section 1 of the specification sheet, add links to global data products that modellers can find useful.
- The specification sheets would be informative for young researchers, developing a short course on the EOVs and specification sheets would be advantageous.
- Consider ranking the observing approaches, perhaps giving a higher score to platforms that can collect multiple EOVs. This can provide the potential to link different EOVs by platform and may even point towards similar best practices.

ACTION 2.25.10: Panel IPO to reach out to GRAs, with support from GOOS, to help identify good regional products that the specification sheets could include and modellers could use.

Data Management workshop

The workshop focused on the full data value chain, from data collection to publication and accessibility. The importance of structured metadata and raw data management to in organise biological and ecological datasets was highlighted.

BioEco EOV data flows

Differences between how the biological EOV is organised compared to physical and biogeochemical data was outlined. Key differences included the use of ERDAPP by physics and climate communities for raw data publication, while biological data is inherently more complex, requiring a different approach. Additionally, the physical and biogeochemical data is organised mainly by platform through the OCG, which has 16 networks that are visible through OceanOPS.

OBIS is the preferred marine biodiversity platform for biological data, with its metadata handled by OBIS through the BioEco Portal. There are some observation networks that collect cross-disciplinary data such as the AniBOS network. This network sends the physical and bgc observations to the system via GTS and is currently working on the tracking animal occurrences to deliver in near real-time data to OBIS.

There is a general agreement that biodiversity data should be published in OBIS. However, metadata and datasets must be structured for interoperability. It was emphasised that existing platforms should not be disrupted if they are already functioning effectively.

There is a plan to improve the BioEco Portal to serve as a BioEco ocean observing monitoring tool, akin to OceanOPS, to provide oversight on who is collecting data, how, and where, and track program activity flagging inactive programs. Interoperability between the BioEco Portal and OceanOps will need to be ensured in order to facilitate annual reporting by GOOS through the OceanOPS report card.

A key topic discussed was the need for unique identifiers linked to datasets. OBIS informed that currently they were investigating various identifier schemes that could be applied, but have not yet made a final decision. It was highlighted that interoperability between the BioEco portal identifiers and WMO identifiers was essential to maintain consistency across global data systems.

Data and metadata repositories - OBIS, ODIS and the BioEco Portal

Participants were informed about OBIS, the datasets it holds and the type of datasets, which include DNA-derived data, bio-logging information, abundance, biomass, and habitat descriptions. The Ocean Data and Information System (ODIS) was also explained, emphasizing that it is a distributed metadata system where institutions and researchers can publish their metadata online in a structured format. Search engines and indexing systems, such as Google Dataset Search and the Ocean Info Hub, can then discover and compile this information into a "knowledge graph. The BioEco Portal, which will transition from a manual metadata entry system to one that automatically scrapes and integrates metadata from the web, will be connected to ODIS. This upgrade of the BioEco Portal is expected to be functional in the second half of this year, its success will depend on data contributions from the community.A newly developed app has been designed with support from the BioEcoOcean project to facilitate metadata submission to the BioEco Portal. The app provides an intuitive, form-based input system with required fields, hover-over info boxes, dropdown menus for licenses and update frequencies, and tools for adding spatial and temporal coverage. It allows updates via GitHub, ensuring version control and seamless integration with OBIS.

ACTION 2.25.11: Panel EOV leaders to promote and encourage monitoring programmes to add their metadata in the BioEco Portal. An App has been developed by OBIS to make it easy to add metadata into the BioEco Portal.

It was emphasised that EOV leaders should begin encouraging their communities to contribute their metadata to ODIS, even if researchers are not ready to format their data for OBIS. This important step helps index datasets and provides visibility into where data exists, even if it is not yet structured or published in OBIS. Knowing what data is available can help identify gaps and prioritise future contributions.

Another important topic was how OBIS is structured around regional and thematic nodes, which support regions and researchers work the data to meet standards and submit into OBIS system. For example, and OBIS thematic node is OBIS-SEAMAP, which serves as the global thematic node for marine mammals, sea turtles, seabirds, and sharks/rays. Researchers looking to contribute marine mammal or sea turtle data to OBIS should coordinate with the OBIS-SEAMAP team, which has the necessary expertise and community support. However, data can also be published through national or regional OBIS nodes, and new nodes can be established if needed. The vision is to make data submission to OBIS seamless and user-friendly, eliminating the need for direct assistance.

In addition to OBIS nodes, there are existing training materials, including manuals and YouTube videos, and the requirement for a login to upload data into IPT. Users can either submit data for OBIS processing or handle it themselves.

Integrating cross-disciplinary dataflows

Improving the organisation, accessibility, and integration of biological data collected by OCG networks was discussed. This can also be the case with programs that collect several types of datasets, with some of these considered ancillary. Ways to add complexity while maintaining usability of the system was explored, including the option of using unique identifiers to link related submissions across ecological variables. A parent-child structure was debated as well to reflect hierarchical data relationships and enhance clarity. Metadata completeness was a key concern, particularly ensuring datasets are properly linked to programs and easily discoverable by users. Standardised vocabularies and alignment with existing frameworks were emphasised, with commitments to updating classification systems.

Efforts to develop real-time ingestion of biological data collected by oceanographic networks were highlighted, addressing metadata consistency and data pathway challenges. Unlike physics data, which has established pathways, biological data integration requires new methods, such as those being pioneered for AniBOS datasets. The upcoming OCG meeting in April presents an opportunity to showcase this work as an exemplar, emphasising barriers to data entry, standardisation, and the need for broader participation. Collaboration across marine mammal, seabird, and sea turtle data communities was underscored as essential to aligning methodologies.

Regarding data quality control, there was recognition that while biological data undergoes rigorous quality assurance, when it is the focus of the data collection, the environmental data collected as ancillary information in some cases is not QCd. There was discussion about introducing flags or warnings in the data to indicate whether environmental data has undergone QC to make users aware. The idea of incorporating validation mechanisms for environmental measurements within the Ecological Metadata Language (EML) framework was acknowledged as an area for further development.

ACTION 2.25.12: Panel and OCG to identify unreported biological data from other OCG networks and do another pilot to start establishing the workflows for these observations.

ACTION 2.25.13: Panel executive to present the AniBOS work undertaken to OCG meeting, including identification of barriers to data entry and standardisation and any recommendations.

Recommendation 2.25.1: Explore the option of implementing data quality flags to ancillary environmental data to indicate whether these data have been QCd.

Control vocabularies

Another point during discussions focused on the importance of standardising measurement terminology within environmental and oceanographic datasets to ensure consistency and interoperability. The key recommendations included adopting common language for measurement types, aligning with existing agreed-upon standard names within EOVs, and using controlled vocabularies such as those from the British Oceanographic Data Centre (BODC). This would prevent inconsistencies and streamline data integration across platforms. Other benefits of using control vocabularies are improving accessibility, making datasets more interoperable and enables harmonisation of data when using standardised terms.

A significant point raised was the challenge of balancing human-readable terminology with the technical specificity of controlled vocabulary labels. Instead of using complex variable names directly in datasets, the proposal suggested using standardised but readable names while linking them to the relevant controlled vocabulary entries.

The discussion also touched on the importance of guidelines and training. Many users are unfamiliar with controlled vocabularies. EOV specification sheets could include recommendations for which controlled vocabularies to use, making it easier for researchers to adopt best practices.

ACTION 2.25.14: OBIS to add to the data management section of the EOV specification sheets recommendations on which control vocabularies to use so people submitting data can adhere to those standards.

Recommendation 2.25.2: When working with data adopt existing controlled vocabularies (e.g., BODC) to ensure interoperability across platforms and define commonly understood measurement names while linking them to controlled vocabulary references.

Publishing your data and metadata

There was focus on keywords and their role in making datasets discoverable, emphasising the need for researchers to manually add descriptive terms since a standardised vocabulary for EOVs is still under development. Keywords ensure datasets are easily found, cited, and reused. There were questions about automating metadata entries, with the IPT capable of inferring fields like geographic coverage and taxonomy from data files, though users should verify accuracy. The conversation shifted to citations and DOIs, with auto-generated citations and reservable DOIs ensuring proper attribution and accessibility, though acknowledging funders remains an area for improvement. A critical point was made about avoiding duplicate datasets to maintain data integrity, ensuring datasets are published only once. The need to encourage community participation by promoting the benefits of open data and collaboration was highlighted.

Recommendation 2.25.3: OBIS to consider adding a field to include funder information in the metadata description or external links section.

Data sharing

Ways to make data sharing more accessible, particularly for non-academic data owners who may find the process daunting were discussed. One key suggestion was to educate younger ecologists early on, helping them adopt data-sharing practices before they develop their own systems to help normalise the process. Options for incentivising data sharing were provided including tangible rewards, such as co-authorship in publications and showing that data sharing offers significant career benefits, increasing visibility that can lead to publications and citations, and contributing to broader scientific progress. Additionally, regional workshops could be held to demystify the data submission process, particularly for graduate students, while a competition might generate excitement and foster a sense of community.

Recommendation 2.25.4: The Panel should think about different ways to motivate the marine biological research community to share their data and highlight the value of data reuse, citations, and collaboration.

Accessing data from OBIS

A demonstration on how to access and analyse data from OBIS was provided. There are several tools available, the OBIS mapper to search the data based on scientific names, dataset names, locations, or marine regions. There is Google Colab if people prefer working in a coding environment, including instructions to install the necessary packages, such as the OBIS tools, to access the same data in a Python environment. There is an R OBIS package to query occurrence and dataset information.

When dealing with large datasets, aggregation can be done locally to manage data volume. Tools like API endpoints or R functions allow users to grid data at a chosen resolution, avoiding the need to download individual records. Time series data can be analyzed to track species movements over time, with the ability to create static plots or animated GIFs, providing insights into species connectivity and habitat use.Quality flags in OBIS data enable users to filter records based on criteria like date, depth, or geometry, ensuring high-quality data for analysis.

Discussion highlighted the need to clarify the boundaries of what data should be included in OBIS, especially for inferred or modeled data like species distribution maps. Citizen science records, such as visual observations, are being considered for inclusion, but clear guidelines are needed to ensure consistency and quality.

Data products

The development of OBIS data products like heatmaps, species distribution models, and climate projections was showcased, demonstrating their value for conservation and management. For example, the Shiny app (shiny.obis.org/diskmaps) allows users to explore species distributions

and habitat suitability interactively, while climate projections can help identify climate-resilient areas for MPAs.

The PacMAN decision support tool was introduced as a powerful resource for monitoring invasive species, using real-time data and risk scoring to inform management decisions. Expanding this tool to other regions and integrating additional data sources (e.g., eDNA, citizen science) could further enhance its utility.

Other products that would be desirable include:

- Connectivity and functional maps to track species movements, including plankton and small organisms, both horizontally and vertically to help identify migratory corridors.
- Heatmaps and species distribution models that can be showcased in the EOV specification sheets, with examples and links to guide users and demonstrate reproducibility.
- Tools to overlay species distribution maps with environmental data (e.g., salinity, oxygen levels) to help study combined pressures on ecosystems.

A key challenge is handling derived data products (e.g., abundance estimates) from raw data. These products should be captured and linked to the original datasets to ensure transparency and usability. Standardising controlled vocabulary for measurement types (e.g., percent cover) is also crucial for data harmonisation, and including recommended terms in spec sheets can guide data providers.

The session highlighted the importance of harmonising data collected using different methods. For example, guidelines for converting data from different measurement types (e.g., microplastics data from different nets) can enable the creation of global products. Similarly, absence data is critical for accurate species distribution modeling and understanding habitat changes over time.

Recommendation 2.25.5: BioEco Panel to encouraging the submission of absence records (e.g., zero counts) to OBIS to improve the quality of data products. This guidance could be provided in the EOV specification sheets.

Integrating data across EOVs from different disciplines (e.g., biology, physics) can enhance understanding of environmental impacts on species distributions. Case studies demonstrating the benefits of integrated observations and data products can drive community engagement and adoption.

Technical Readiness Level Assessment

The session began with a focus on assessing the **maturity of EOV networks** using a framework that evaluates key attributes like global scalability, community coordination, data management,

and capacity development. BioEco Panel EOV leaders were asked to assess the maturity of their EOV from their perspective in the Miro Board.

ACTION 2.25.15: EOV leaders that were unable to attend the meeting in Sopot, to complete the Miro Board maturity assessment. Link to the Miro Board can be found here.

A survey was proposed to assess the current state of EOV networks, using attributes that are consistent with OCG networks and maturity assessment. Currently OCG has a task team that is looking at the attributes and how to assess networks in a meaningful but simplified way. Outcomes from the OCG task team will be helpful for structuring the survey. GOOS NFP were identified as key connectors that can help engage with local and national observing programs.

ACTION 2.25.16: Panel IPO to engage with OCG metrics task team to consider the outcomes of their readiness level assessment metrics and help structure the survey to assess BioEco networks.

The improvement in the maturity of the BioEco EOV could be achieved through:

- Building communities of practice for each EOV emerged as a critical step for global coordination and maturing the BioEco EOVs. Leveraging existing networks like GRAs, GOOS NFP, MBON, and POGO can help strengthen EOV communities. MBON and POGO can provide infrastructure, training, and collaboration opportunities, reducing the burden on individual EOV leaders.
- Facilitate communication and collaboration among communities by establishing mailing lists or discussion forums ensuring that everyone is aligned and working towards common goals.
- Standardising best practices and data management across EOV networks is also essential for interoperability and global scalability. Developing and promoting standard operating procedures (SOPs) will ensure consistency in data collection, management, and sharing.
- Capacity development and training were identified as key priorities for engaging and retaining observers, especially in underrepresented regions. Organising workshops and training programs will help build skills and foster a sense of community among EOV observers. Securing funding to support participation from diverse regions is crucial for the success of these initiatives.
- Ensuring data is FAIR is critical and EOV networks must work to improve data accessibility, ensuring that data flows to the right repositories and is available for global use. This will enable the development of global products, such as distribution maps and connectivity maps, that address key scientific and management questions.

Blueprint for end-users

Several key initiatives aimed at enhancing an integrated ocean observing system was discussed. Suggestions include the creation of a series of webinars focused on EOVs, with the

goal of spreading knowledge and engaging the community. This could be in collaborating with MBON to amplify the reach of these webinars. The idea is to develop a comprehensive series for each BioEco EOV allowing people to learn more about each topic in detail.

ACTION 2.25.17: In collaboration with MBON, Panel and BioEcoOcean project to organise a webinar series to showcase the BioEco EOVs

Emerging structures and frameworks such as the International Platform for Ocean Sustainability (IPOS) should be engaged to ensure they are aware of IOC and BioEco Panel's work and establish collaboration to avoid duplication of efforts. The group agreed on the importance of coordinating with these new initiatives while maintaining a unique position for their work.

The development of the blueprint, a question-based resource, was seen as a critical tool for creating a more integrated ocean observing system, and is the main focus of BioEcoOcean . Participants brainstormed potential resources, including gathering existing tools as well as developing new ones to support the system. Suggestions included:

- Practical tools for data collection and management, such as field sheets and apps, were discussed as ways to simplify metadata and data collection and ensure compatibility with OBIS requirements.
- Capacity development and training were also emphasised, with a focus on creating user-friendly guidelines and platforms to help the community overcome challenges related to data management.
- Develop AI to facilitate data translation, for example an AI-driven tools to help convert existing data formats into required formats more efficiently.

Enhancing community engagement, improving communication was highlighted as essential to improve the uptake of BioEco EOVs. Internal and external communication through newsletters, webinars, and a dedicated BioEco panel website will be helpful tools to improve engagement with clear taglines to convey EOVs. Leveraging on the Ocean Decade will also help upscale the communication and outreach.

Recommendation 2.25.6: Plan a communication strategy discussion at the next Panel/BioEcoOcean in-person meeting.

EOV implementation

From specification sheets to implementation plans

Peter Tyack presented the development process of the Ocean Sound EOV Implementation Plan, highlighting the collaborative and inclusive approach taken by the International Quiet Ocean Experiment (IQOE) community. The Ocean Sound EOV is unique as it bridges disciplines,

measuring physical variables like sound pressure and particle motion, which have applications in climate monitoring, biodiversity assessment, and threat detection (e.g., vessel noise, earthquakes). The journey began with the IQOE, which aimed to study the effects of reducing anthropogenic noise on marine ecosystems. Over time, the focus expanded to include broader ocean observation goals, leading to the development of the Ocean Sound EOV specification sheet and, eventually, the implementation plan.

The process involved extensive collaboration across disciplines, including physical acousticians, bioacousticians, data scientists, and policy experts. Key steps included:

- **Broad community engagement**: Large workshops and meetings helped define the scope and goals.
- **Funding and support**: Organisations like POGO and SCOR provided critical financial and logistical support.
- **Iterative development**: The implementation plan went through 19 drafts, with input from a wide range of stakeholders.
- **Data standardisation**: A focus on developing and adopting standardised data formats and management practices was crucial for integrating ocean sound observations into global systems like GOOS.

The importance of cross-panel collaboration, particularly with the physics and climate panels, to highlight the broader applications of BioEco EOVs was emphasised, as well as the need for realistic timelines and community-driven efforts to ensure quality and inclusivity.

Best Practice

The *Ocean Best Practices System (OBPS)*, supported by IOC-UNESCO, was discusses, including the GOOS endorsement process as well as the new OBPS endorsement. The GOOS endorsement process prioritises internationally adopted practices, while *OBPS* can accommodate national, regional, or local best practices. It was highlighted the importance to ensure the methods and practices suggested in the EOV specification sheets are included in the OBPS repository.

2.25.18: All EOV co-leaders to ensure the methods and SOP suggested in their corresponding specification sheets are included in the OBPS repository.

Data Schemas

The discussion focused on data schema development for BioEco EOVs, particularly drawing from the experience of the Seagrass EOV which was highlighted as a model for other habitat-related EOVs. The schema includes detailed specifications for data collection, such as event core, extended measurements, and vocabularies, using Darwin core as standard. The group suggested that other habitat EOVs could replicate this approach.

There was discussion about the potential for creating method-specific schemas (e.g., for quadrats, imaging) that could be shared across multiple EOVs. This would streamline data collection and reduce redundancy.

Meeting wrapped up.

Annex 1. List of Actions

ACTIONS			
Meeting subject	**Action**	**Who is responsible**	Deadline
EOVs	**ACTION 2.25.1**: All EOV leaders to refine the specification sheets using feedback provided by BioEcoOcean project colleagues	All EOV co-leaders	30 March 2025
	ACTION 2.25.2: IPO to design a survey for each EOV to gather feedback from their specific EOV communities and to raise awareness	Panel IPO	30 March 2025
	ACTION 2.25.9: The Panel to identify a couple of observing platforms that observe more than one EOV (i.e. imaging or eDNA) to develop guidance and serve as examples of how to combine several EOVs.	Panel	TBD
	ACTION 2.25.10: Panel IPO to reach out to GRAs, with support from GOOS, to help identify good regional products that the specification sheets could include and modellers could use.	Panel IPO	April 2025
	ACTION 2.25.14: OBIS to add recommended control vocabularies for people submitting data to the data	OBIS	30 March

	management section of the EOV specification sheets		
	ACTION 2.25.15: EOV leaders that were unable to attend meeting in Sopot, to complete the Miro Board maturity assessment. Link to the Miro Board can be found here.	Panel members that did not attend meeting in Sopot	30 March
	ACTION 2.25.16: Panel IPO to engage with OCG metrics task team to consider the outcomes of their readiness level assessment metrics and help structure the survey to assess BioEco networks.	Panel IPO	April
	2.25.18: All EOV co-leaders to ensure the methods and SOP suggested in their corresponding specification sheets are included in the OBPS repository.	EOV co-leaders	30 March 2025
Indicators	**ACTION 2.25.3**: IPO to contact relevant EOV leaders to review and contribute to the indicator examples.	Panel IPO	Completed
GCOS	**ACTION 2.25.4**: Members representing the Panel in GCOS/OOPC to provide update on key dates for input into GCOS implementation plan.	Panel reps to GCOS	By May Panel meeting
Data	**ACTION 2.25.5:** OBIS and BioEco Panel to work on minimum metadata standards that are consistent to OceanOPS, including provenance and licensing.	OBIS and Panel members	TBD
	ACTION 2.25.6: Panel to articulate what would be the requirements in terms of data and metadata flows that	Panel	Q3/Q4

	can feed into the IOC digital ecosystem working group.		
	ACTION 2.25.11: Panel EOV leaders to promote and encourage monitoring programmes to add their metadata in the BioEco Portal. An App has been developed by OBIS to make it easy to add metadata into the BioEco Portal.	Panel and OBIS	ongoing
	ACTION 2.25.12: Panel and OCG to identify unreported biological data from other OCG networks and do another pilot to start establishing the workflows for these observations.	Panel and OCG	Q3/Q4
	ACTION 2.25.13: Panel exec to present the AniBOS work undertaken to OCG meeting, including identification of barriers to data entry and standardisation and any recommendations.	Panel Exec	
Ocean Acidification	**ACTION 2.25.7:** Panel members to provide information to Kirsten on potential co-located QC chemical and biological time-series datasets they know exists	Panel	TBD by OA group in IOC
Biodiversity Plan	**ACTION 2.25.8**: Biodiversity plan writing team to use the input in Miro Board and input provided during the writing workshop to develop a first draft for review	Panel writing team	Mach 15 2025 - completed
Communication	**ACTION 2.25.17:** In collaboration with MBON, Panel and BioEcoOcean project to organise a webinar series to showcase the BioEco EOVs	Panel, MBON and BioEcoOcean	June to December 2025
Recommendations			

Recommendation 2.25.1: Explore the option of implementing data quality flags to ancillary environmental data to indicate whether these data have been QCd.
Recommendation 2.25.2: When working with data adopt existing controlled vocabularies (e.g., BODC) to ensure interoperability across platforms and define commonly understood measurement names while linking them to controlled vocabulary references.
Recommendation 2.25.3: OBIS to consider adding a field to include funder information in the metadata description or external links section.
Recommendation 2.25.4: The Panel should think about different ways to motivate the marine biological research community to share their data and highlight the value of data reuse, citations, and collaboration.
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Recommendation 2.25.6: Plan a communication strategy discussion at the next Panel/BioEcoOcean in-person meeting.

Annex 2. Participants list

Name	Attending online or in person	Panel or project
Lina Mtwana Nordlund	In person	Panel (Seagrass) and Project (Coordinator; Baltic Sea Living Lab)
Ana Lara Lopez	In person	Panel IPO and Project
Ward Appeltans	In person	Panel (Data) and Project
Dimitrios Poursanidis	In person	Panel (Seagrass)
Patricia Pereira Serafini	In person	Panel (Seabirds)

Narissa Bax	In person	Panel (Coral)
Eduardo Amir Cuevas Flores	In person	Panel (Turtles)
Jarrett Edward Byrnes	In person	Panel (Macroalgae)
Lisandro Benedetti-Cecchi	Online	Panel (Macroalgae) and Project (Tuscan Archipelago Living Lab)
Virni Budi Arifanti	In person	Panel (Mangroves)
Peter Lloyd Tyack	Online	Panel (Ocean Sound)
Julie Christine Robidart	In person	Panel (Microbes)
Dipani Nitin Sutaria	In person	Panel (Marine mammals)
Rachel Przeslawski	In person	Panel (Benthic invertebrates)
Henry Ruhl	In person	Panel (Benthic invertebrates)
Claire Davies	In person	Panel (Phytoplankton)
Samantha Simmons	Online	Panel (Marine mammals)
Gabrielle Canonico	Online	Panel (co-chair)
Clive McMahon	In person	Panel (co-chair)
Artur Palacz	In person	Project (Marine Organic Carbon Living Lab)
Lucille Chapuis	Online	Panel (Ocean Sound)
Emma Heslop	In person	Project / GOOS
Peter Provoost	In person	IODE
Elizabeth Lawrence	In person	Project (Data Management)
Monika Kędra	In person	Project (Marine Organic Carbon Atlas: Benthic inverts)
Aleksandra Cherkasheva	In person	Project (Marine Organic Carbon Atlas: Phytoplankton)
Katarzyna Dragańska-Deja	In person	Project (Marine Organic Carbon Atlas: Phytoplankton)
Marcin Wichorowski	In person	Project (Marine Organic Carbon Atlas: Data Management)

Said Mohammed	In person	Project (Blueprint development)
Nina Lepola	In person	Project (Support)
Marja Koski	Online	Project (Pelagic Ocean Living Lab: Zooplankton & Carbon)
Isabel Sousa Pinto	In person	Project (Atlantic Living Lab; Macroalgae)
Deborah Borges	Online	Project (Atlantic Living Lab; Macroalgae)
Karolina Gorn	In person	Project (Data Management)
Monika Grabowska	In person	Project (Data Management)
Joana Soares	Online	Project (Stakeholder engagement)
Audrey Darnaude	Online	Panel (incoming co-chair)
Belen Martin Miguez	Online	Physics Panel
Maciej Telszewski	In person	BGC Panel
Patrick Lehodey	Online	Project (Pelagic Living Lab)

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