The Global Ocean Observing System

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Essential Ocean Variable Specification Sheet

Fish abundance and distribution

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EOV Specification Sheet curated by:

Biology and Ecosystems Panel

DETAILED INFORMATION ON HOW TO READ THE SPECIFICATION SHEET CAN BE FOUND IN THIS GUIDE

Background and justification

Monitoring fish abundance and distribution is essential to sustaining marine ecosystems, global food security, and economic stability. Fish are integral to ecosystem health maintaining the balance by playing a critical role as predators and prey in almost all marine ecosystems. Fish are a vital food source, improve livelihoods and wellbeing for millions of people, and hold cultural significance across diverse societies. Annual global marine fisheries landings are estimated at ~79 million tonnes, generating ~ $150 billion and supporting the livelihoods of 10-12% of the world's population, with marine finfish accounting for 85% of the total catch (FAO 2022). Fish also provide ~20% of the animal protein needs for over 2.9 billion people (Gaines et al. 2018). However, fish face increasing threats from climate change, overfishing, and habitat destruction, making it critical to have a clear understanding of their population dynamics in relation to these different anthropogenic pressures. Accurate and standardised data on fish population structure and distribution are key to sustainable management and protecting marine biodiversity. These measurements help managers and policymakers regulate negative and destructive activities thereby conserving fish populations and ensuring they contribute to the livelihoods and wellbeing of future generations.

Fisheries-dependent data, based on reported catches, provide valuable insights but often suffer from biases and gaps, particularly for non-target species, smaller fisheries, and developing nations. In contrast, fisheries-independent data, such as scientific surveys, offer more accurate and comprehensive assessments but are resource-intensive and challenging to conduct at larger scales. Consequently, most scientific surveys are limited to smaller spatial scales, with datasets collected using diverse methods to report on the status of fish populations and communities. This variability results in inconsistencies and challenges in standardising and integrating data into global repositories. Addressing this fragmentation highlights the importance of developing more coordinated and scalable approaches to effectively monitor, report and manage fish populations at regional and global levels.

The specification sheet serves as a guide for collecting and contributing information on the Fish Abundance and Distribution EOVs to the Global Ocean Observing System. Monitoring of this EOV helps to create resilient marine ecosystems, ensuring the sustainability of fish resources, and preparing for climate impacts on fish populations and fisheries. Contributing to this effort supports biodiversity conservation, sustainable food systems, and economic resilience, underscoring the value of reliable, wide-reaching data for the future.

Integration with Global Observation Frameworks

The Global Climate Observing System (GCOS) developed the Essential Climate Variable (ECV) framework to define necessary observations for monitoring Earth's climate (Bojinski et al., 2014). Some EOVs, including ocean physics, biogeochemistry, and biology/ecosystems variables (GCOS, 2022a; GCOS, 2022b), are also ECVs.The Essential Biodiversity Variables (EBVs) defined and curated by the Group on Earth Observations Biodiversity Observation Network (GEO BON) complement the GOOS biological and ecosystem (BioEco) EOVs (Miloslavich et al., 2018, Muller-Karger et al., 2018; Bax et al., 2019).

The EOVs represent the basic observations of a particular parameter or process. EBVs are time series of biodiversity observations across genes, species populations, communities, or ecosystems. Thus, EOVs may be seen as the building blocks for GEO BON EBVs. The EOVs can be used to synthesise the EBVs as time series of BioEco EOV sub-variables at one location, or as time series of gridded, mapped, or modelled EOVs (Jetz et al., 2019).

The GOOS Biology and Ecosystems Panel collaborates with the Physics and Climate and Biogeochemistry Panels to advance EOVs, advocating for the need for biological observations, information management, and applications. GOOS, MBON, GEO BON, and OBIS (a global open-access data and information system supported by IOC-UNESCO) work together to standardise guidelines and data management for EOVs, EBVs, and ECVs.

Current observing networks and coordination

Diverse networks and communities are collecting observations of biology and ecosystems EOVs at different scales and in different regions. An initial baseline survey conducted in 2019/20 identified 203 active, long-term (>5 years) observing programs systematically sampling marine life. These programs spanned about 7% of the ocean surface area, mostly concentrated in coastal regions of the United States, Canada, Europe, and Australia (Satterthwaite et al 2021). This information can be found in the GOOS BioEco Metadata Portal, which is continually updated. To consult the latest information, please visit: https://bioeco.goosocean.org

Contributes to (please click on the symbol for more information):

EBV:

SDG:

CBD:

Other:

1. EOV information

ESSENTIAL OCEAN VARIABLE (EOV)	Fish abundance and distribution
DEFINITION	Observed population structure and spatial distribution of different fish taxa (including jawless, cartilaginous and bony fishes) within a defined sampling unit
EOV SUB-VARIABLES - key measurements that are used to estimate the EOV	Fish abundance (number of individuals) Fish length frequency distribution Fish biomass (total weight) Fish ID / Species composition
SUPPORTING VARIABLES - other measurements that are useful to provide scale or context to the sub-variables of the EOV	**Environmental**: sea surface temperature, subsurface temperature at sampling depth, subsurface salinity, ocean currents, dissolved oxygen, water clarity, phytoplankton biomass and productivity, zooplankton biomass and diversity, habitat type, observation depth or depth range, **Management:** spatial management related variables (e.g. MPA, OECM etc), fishery related variables **Sampling observation parameters:** time, date, depth [range], geographic coordinates, sampling method, sampling units (area, volume, CPUE) **EOV related**: life history traits, life stage, reproductive strategy (r or k), reproductive status (maturity), trophic ecology, economic/fisheries importance, animal movement, behaviour, sex ratio
DERIVED PRODUCTS - outputs calculated from the EOV and sub-variables, often in combination with the supporting variables	Fish abundance, size and biomass indices Fish species and functional diversity indices Fish assemblage structure indicators (e.g.: community weighted means, community thermal index, size spectra) Food web indicators (e.g.: proportion of predatory fish, mean trophic level) Fish production (e.g.: MSY, Spawning biomass, recruitment) Fish habitat associations

2. Phenomena to observe - what we want to observe with this EOV

This section presents examples of priority phenomena for GOOS that can be (partly) characterised by this EOV's sub-variables. This list is not exhaustive but serves to provide general suggestion on how observation efforts can structure their planning and implementation to observe certain phenomena.

The GOOS application area(s) the phenomena are relevant for are depicted as follows: Climate , ocean health , operational services

PHENOMENA TO OBSERVE		Abundance status and populations trends	Phenological changes	Changes in species distributions
PHENOMENA EXTENT	HORIZONTAL	Local, regional and global (coast to open ocean)	Local, regional and global (coast to open ocean)	Local, regional and global (coast to open ocean)
	VERTICAL	Depth gradient (intertidal/surface to deep-sea)		Depth gradient (intertidal/surface to deep-sea)
	TEMPORAL	Seasonal to (multi) decadal	Seasonal to decadal	Seasonal to (multi) decadal
RESOLUTION TO OBSERVE PHENOMENA (context dependent)	HORIZONTAL	Local: <100 kms Regional: 100-1000 km Global: 0.5° or 1° grid cells	Local: <100 kms Regional: 100-1000 km Global: 0.5° or 1° grid cells	Local: <100 kms Regional: 100-1000 km Global: 0.5° or 1° grid cells
	VERTICAL	*Benthic/demersal species:* Coastal: 0-5m Continental shelf: 5-200m Deep-seafloor: 200 - deepest possible *Pelagic species:* Epipelagic: 0-200m Mesopelagic: 200-1000m Deep-pelagic: 1000m to deepest possible		*Benthic/demersal species:* Coastal: 0-5m Continental shelf: 5-200m Deep-seafloor: 200 - deepest possible *Pelagic species:* Epipelagic: 0-200m Mesopelagic: 200-1000m Deep-pelagic: 1000m to deepest possible
	TEMPORAL	Seasonal to periodic (4-5 year), continuous for exploited species	Monthly to seasonal	Seasonal to periodic (4-5 year), continuous for exploited species

SIGNAL TO CAPTURE	Statistically significant change of in abundance per taxa	Statistically significant shift in the time and/or location of spawning, ichthyoplankton abundance or recruitment	Statistically significant changes in species occurrence observations outside their known natural range
SUB-VARIABLES NEEDED TO MEASURE	Fish abundance, fish length and/or fish biomass and fish ID/species composition	Fish abundance, fish length and fish ID/species composition	Fish ID/Species composition
SUPPORTING VARIABLES NEEDED	Depth and/or depth range, geographic location, habitat, life history traits	Sampling time, date, location and depth; life history traits (size at maturity, reproductive status, ontogenetic habitat use)	Sampling time, date, depth and/or depth range, geographic location

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3. GOOS Observing Specifications or Requirements

This section outlines ideal measurements for an optimal observing system for this Essential Ocean Variable (EOV). It offers guidance on creating a long-term system to observe key phenomena related to the EOV. These values are not mandatory, and no single system is expected to meet all requirements. Instead, the combined efforts of various observing systems should aim to meet these goals. Observations at different scales are also valuable contributions to global ocean observation if shared openly.

EOV	Fish abundance and distribution								
PHENOMENA	Abundance status and trends, phenological changes and changes in species distributions								
EOV SUB-VARIABLE	Fish abundance				**DEFINITION**		Number of individuals of sampled population per species per sampling unit at a specific location. NOTE: requirements for estimates for exploited species focused on informing their management (CPUE, and others) are under the purview of FAO and national and regional management agencies.		
	Resolution			**Timeliness**	**Uncertainty Measurement**	**Stability**	**Sampling approach**	**References**	
	Spatial Horizontal	**Spatial Vertical**	**Temporal**						
IDEAL	Samples collected systematically within the same area/region. Number of replicate	Stratified samples collected systematically within the same area/region. Number of replicate samples informed by power analysis and	Multi-decadal data collected consistently with seasonal resolution within the same area/ region	Within a year	within 95% confidence limits	N/A	Capture surveys (e.g. bottom and midwater trawls, scientific angling, zooplankton nets, multinets,);	Autocorrelation: Legendre 1993 Spatial scales for fish abundance: Nuñez Riboni et al. 2021	

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	samples informed by power analysis and collected within the spatial decorrelation scale of the data in stratified random design	collected within the spatial decorrelation scale of the data to the deepest possible, in stratified random design					Acoustic surveys (e.g. multi-frequency acoustics); Visual surveys (e.g. transects, point counts, baited cameras) Combining techniques reference: Churnsie et al 2009	Koslow and Wright, 2016 Estimating uncertainty: Lynch et al 2018
DESIRABLE	0.5 ° grid cells with samples collected in a consistent sampling design and replicate samples where possible (10-20 replicate samples per spatial unit in random stratified design)	Where possible stratified sampling of 10-100m depth stratum to the deepest possible, replicate samples per depth stratum where possible (10-20 replicates samples per stratum for imaging and acoustics)	At least 10 years of data collected consistently seasonally or annually within the same area or region	N/A	within 95% confidence limits	N/A		
MINIMUM	1° grid cells with samples collected with consistent sampling design with replicate samples where possible (3-10 replicate samples per spatial unit in random stratified design)	Where possible stratified samples at 100-500m depth stratum to the deepest possible with replicate samples per depth stratum if possible (3-10 replicate samples per stratum for imaging and acoustics)	4-5 years of data collected consistently seasonally or annually within the same area or region	N/A	within 95% confidence limits	N/A		

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EOV SUB-VARIABLE	Fish biomass				**DEFINITION**		Total weight of a sampled population per species per sampling unit at a specific location. NOTE: requirements for estimates for exploited species focused on informing their management (CPUE, and others) are under the purview of FAO and national and regional management agencies.	
	Resolution			**Timelines**	**Uncertainty Measurement**	**Stability**	**Sampling approach**	**References**
	Spatial Horizontal	**Spatial Vertical**	**Temporal**					
IDEAL	Samples collected systematically within the same area/region. Number of replicate samples informed by power analysis and collected within the spatial decorrelation scale of the data in stratified random design	Stratified samples collected systematically within the same area/region. Number of replicate samples informed by power analysis and collected within the spatial decorrelation scale of the data to the deepest possible, in stratified random design	Multi-decadal data collected consistently with seasonal resolution within the same area/ region	Within a year	within 95% confidence limits	N/A	Capture surveys (e.g. bottom and midwater trawls, zooplankton nets, multinets, gillnets, scientific angling) Acoustic surveys (e.g. remote sensing, multifrequency acoustics) Visual surveys (e.g. transects, points counts, baited video) where fish length is estimated using observers or photogrammetry and converted to biomass using length-weight relationships	Autocorrelation: Legendre 1993 Spatial scales for fish abundance: Nuñez Riboni et al. 2021 Koslow and Wright, 2016 Estimating uncertainty: Lynch et al 2018
DESIRABLE	0.5 ° grid cells with samples collected in a consistent sampling design and replicate	Where possible stratified sampling of 10-100m depth stratum to the deepest possible, replicate samples per depth stratum where possible (10-20	At least 10 years of data collected consistently seasonally or annually within	N/A	within 95% confidence limits	N/A		

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	samples where possible (10-20 replicate samples per spatial unit in random stratified design)	replicates samples per stratum for imaging and acoustics)	the same area or region					
MINIMUM	1° grid cells with samples collected in a consistent sampling design with replicate samples where possible (3-10 replicate samples per spatial unit in random stratified design)	Where possible stratified samples at 100-500m depth stratum to the deepest possible with replicate samples per depth stratum if possible (3-10 replicate samples per stratum for imaging and acoustics)	4-5 years of data collected consistently seasonally or annually within the same area or region	N/A	within 95% confidence limits	N/A		

EOV SUB-VARIABLE	Fish length frequency distributions			**DEFINITION**	Lengths (total length or fork length) of all or a random subsample of individuals from a sampled population per sampling unit at a specific location. NOTE: requirements for estimates for exploited species focused on informing their management (CPUE, and others) are under the purview of FAO and national and regional management agencies.			
	Resolution							
	Spatial Horizontal	**Spatial Vertical**	**Temporal**	**Timeliness**	**Uncertainty Measurement**	**Stability**	**Sampling approach**	**References**

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IDEAL	Collected systematically and consistently within the same area/region	Stratified information to the deepest possible (Video and acoustics)	Multi-decadal data collected consistently with seasonal resolution in the same area/ region	Within a year	95% confidence	N/A	**Population size and species dependent** **Ship-based**: 300-400 individuals at 2.5 cm intervals **Video based**: 120 individuals/species at intervals suitable for the observed species, sample size dependent on species abundance **Acoustic**: estimates using broadband acoustics	Autocorrelation: Legendre 1993 Capture based: Miranda, 2007 Vokoun et al. 2001 Video-based: Adapted from Weerarathne et al. 2021 Acoustic: Moszynski & Stepnowski, 2007 Kibilius et al 2020
DESIRABLE	0.5 ° grid cells	N/A	Decadal data collected consistently annually	N/A	95% confidence	N/A	**Population size and species dependent** **Ship-based:** 150–425 fish for Proportional Stock Density (PSD) **Video based**: 100 individuals at intervals suitable for the observed species, sample size dependent on species abundance **Acoustic**: estimates using 4 frequencies (38, 75, 120, 200 kHz)	
MINIMUM	1° grid cells	N/A	4-5 years of data collected consistently	N/A	95% confidence intervals	N/A	**Population size and species dependent**	

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			every other year				**Ship-based**: 75–160 individuals for mean length estimation **Video based**: >=60 individuals at intervals suitable for the observed species, sample size dependent on species abundance **Acoustic**: estimates using 2 frequencies (38 & 120kHz)	

EOV SUB-VARIABLE	Fish species/Species composition				**DEFINITION**		Fish species identity or the presence and quantity of different fish species within a given location and time. It encompasses the taxonomic identification of species present, and the contribution of their abundance and size to the assemblage structure.	
	Resolution			**Timeliness**	**Uncertainty Measurement**	**Stability**	**Sampling approach**	**References**
	Spatial Horizontal	**Spatial Vertical**	**Temporal**					
IDEAL	Collected systematically and consistently within the same area/region	Stratified information to the deepest possible and within the	Multi-decadal data collected consistently with seasonal resolution in	within a year	ID to genus or species	N/A	Captured based: ichthyoplankton samples, fishing trawls, water samples for eDNA	

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		decorrelation scale	the same area/ region				Image based: Video and visual surveys	
DESIRABLE	0.5 ° grid cells	10-100m depth bins (image based only)	Decadal data collected consistently annually	N/A	ID to genus	N/A		
MINIMUM	1° grid cells	100-500 m depth bins (image based)	4-5 years f data collected consistently every other year	N/A	ID to family	N/A		

4. Observing approach, platforms and technologies

This table provides examples of approaches and technologies used to collect this EOV to help observe priority phenomena
NOTE: these approaches are for scientific surveys, fishery dependent data (catch landings) are under the purview of management agencies

APPROACH / PLATFORM	Ship base: Other	Ship base: trawl surveys	Ship base: other
EOV SUB-VARIABLE(S) MEASURED	Abundance, Length, Species Composition	Abundance, Biomass, Length, Species Composition	Abundance, biomass, length
TECHNIQUE / SENSOR TYPE	Zooplankton nets for ichthyoplankton	Trawl nets other nets	multi-frequency acoustics
SUGGESTED METHODS AND BEST PRACTICES	Multinets (e.g. MOCNESS, Hydrobios)	ICES, 2022	Demer et al 2015 Fielding, 2018

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	Smith and Richardson 1977		
SUPPORTING VARIABLES MEASURED			

APPROACH / PLATFORM	**Fixed point: diver survey/other**	**Fixed point: other**	**Fixed Point: Other**
EOV SUB-VARIABLE(S) MEASURED	Abundance, Biomass, Length, Species Composition	Abundance, Biomass, Length, Species Composition	Abundance, Biomass, Length, Species Composition
TECHNIQUE / SENSOR TYPE	Underwater transects	Underwater Point Counts	Baited surveys
SUGGESTED METHODS AND BEST PRACTICES	UVC (Reef life survey) DOV (Goetze et al. 2019) ROV (Monk et al. 2024)	SPC (Ayotte et al. 2011) RUV (Piggott et al. 2020) rotating RUVs (Pelletier et al. 2021)	benthic stereo-BRUVs: Langlois et al 2020, pelagic stereo-BRUVs: Bouchet et al. 2024
SUPPORTING VARIABLES MEASURED			

APPROACH / PLATFORM	**Autonomous: animal telemetry/tags**			
EOV SUB-VARIABLE(S) MEASURED	Animal movement, behaviour			
TECHNIQUE / SENSOR TYPE	Animal tracking Dart tags Satellite tags Acoustic telemetry			

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SUGGESTED METHODS AND BEST PRACTICES	Hoener et al 2018 Lowther et al 2015 Bradford et al 2009			
SUPPORTING VARIABLES MEASURED				

5. Data and information management

Access to data and information is at the core of an ocean observing system. This section provides essential information on how to contribute data to the GOOS

GOOS approach to data management is aligned with open data and FAIR (Findable, Accessible, Interoperable, Reusable)[1] practices. All EOV data and information is valuable, thus effective data management practices are essential to ensure it remains accessible and (re)usable for future generations.

In this section you will be directed to resources that explain how you can contribute data to global ocean observing and ensure your data and information is accessible, interoperable and sustained. This resource has instructions for different scenarios: an individual submitting data, or existing data centres connecting to the system.

Please follow these practices carefully, as BioEco EOV data FAIRness relies on compliance with these guidelines.

Before proceeding, please note these important points:

[1] Wilkinson et al. 2016 https://doi.org/10.1038/sdata.2016.18

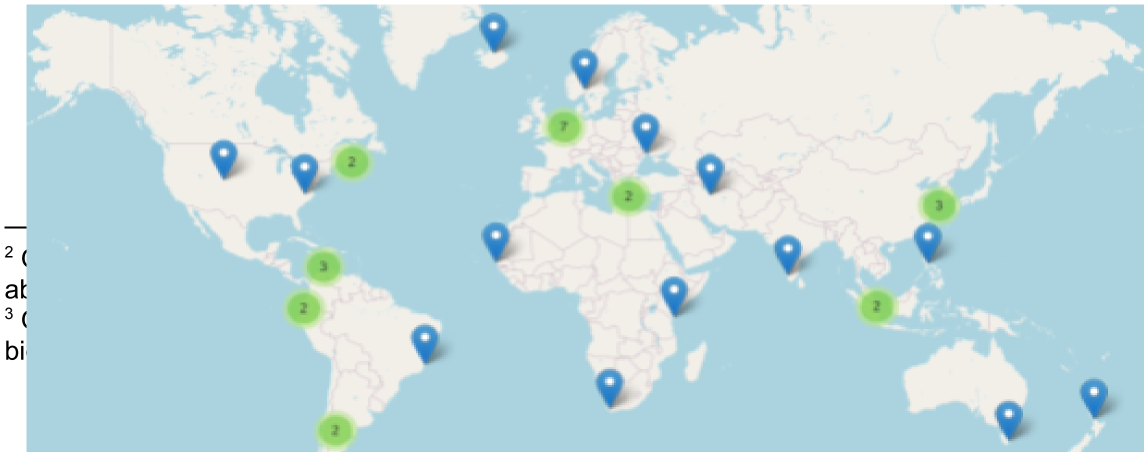
1. As a **minimum**, you must ensure information describing your EOV data (i.e. metadata) are visible in the Ocean Data and Information System (ODIS)[2]. Regardless of where the actual data is stored, evidence of its existence must be findable within ODIS.
2. BioEco EOV data is successfully managed if it is discoverable in the **GOOS BioEco Portal.** The BioEco Portal is the central point of access and coordination of BioEco EOV observing programmes. Data visible in ODIS will automatically be visible in the BioEco Portal and vice versa.
3. If data is published to OBIS[3], it will also be visible in ODIS and the BioEco Portal. You do not need to also add it elsewhere, unless there is extra information you would like to include.

The main data management steps are as follow:

1. Become discoverable: ensure the data producers (e.g., organisation, programme, project, etc.) and datasets are visible in ODIS
2. Prepare the required metadata about the data producer and the datasets
3. Publish EOV data (e.g. OBIS)
4. Verify discoverability in ODIS

Not all steps may be relevant for you, but **Step 1 is the minimum required** to ensure your data contributes to EOVs. .

TO CONTRIBUTE DATA AND METADATA TO THE GLOBAL OBSERVING SYSTEM, PLEASE GO TO: https://iobis.github.io/eov-data-management/



[2] (... DE), is a global federation of data systems sharing interoperable (meta)data ab...

[3] (... des, +1000 institutions, and 99 countries, interoperating with other major bi...

Contact the OBIS Secretariat (helpdesk@obis.org) for help setting up your data workflows. To publish BioEco EOV data from systems like NCEI or ERDDAP to OBIS, consider becoming an OBIS node or collaborating with one. The OBIS Secretariat can help guide you through the process of becoming a Node, or connect you with an appropriate OBIS node (Figure 2).

Help Resources

- EOV Metadata Submission tool: https://eovmetadata.obis.org/

ODIS
- General help https://book.odis.org/index.html
- Connecting to ODIS https://book.odis.org/gettingStarted.html
- ODIS Catalogue of Sources: https://catalogue.odis.org/
- Ocean Info Hub: https://oceaninfohub.org/
- Schema.org framework https://schema.org/

OBIS
- OBIS Manual: https://manual.obis.org/
- OBIS YouTube data formatting and publishing videos: https://www.youtube.com/playlist?list=PLlgUwSvpCFS4TS7ZN0fhByj_3EBZ5IXbF
- Darwin Core term reference list: https://dwc.tdwg.org/terms/
- WoRMS taxonomy: https://www.marinespecies.org/

- Spreadsheet template generator https://www.nordatanet.no/aen/template-generator/config%3DDarwin%20Core
- BioData Guide with example code for transforming datasets to DwC: https://ioos.github.io/bio_data_guide/

GOOS BioEco Portal
- Documentation https://iobis.github.io/bioeco-docs/
- Access https://bioeco.goosocean.org/

Data products:
https://aquamaps.org/
https://fishglob.sites.ucsc.edu/fishglob-metadata-and-data-details/-bottom trawl data and metadata
https://data.marine.copernicus.eu/product/GLOBAL_MULTIYEAR_BGC_001_033/description - mesopelagic micronekton
https://apps-st.fisheries.noaa.gov/dismap/ - distribution mapping and analyses portal
https://reeflifesurvey.com/ - reef life survey
https://www.seaaroundus.org/data/#/eez Sea around us
Global archive - fish image annotation

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Acronyms and Abbreviations

BRUV: Baited Remote Underwater Video

CBD: Convention on Biological Diversity

CCMS: Convention on the Conservation of Migratory Species of Wild Animals

CPUE: Catch Per Unit Effort

DOV: Diver Operated stereo Video

EBV: Essential Biodiversity Variables

ECV: Essential Climate Variables

EOV: Essential Ocean Variables

FAIR: Findable, Accessible, Interoperable, and Reusable

FAO: Food and Agriculture Organisation

GBIF: Global Biodiversity Information Facility

GCOS: Global Climate Observing System

GEO BON: Group on Earth Observations Biodiversity Observation Network

GOOS: Global Ocean Observing System

IOCCP: International Ocean Carbon Coordination Project

MBON: Marine Biodiversity Observation Network

MPA: Marine Protected Area

MSY: Maximum Sustainable Yield

OBIS: Ocean Biodiversity Information System

OCG: Observation Coordination Group

ODIS: Ocean Data Information System

OECM: Other Effective Area-based Conservation Measure

OOPC:Ocean Observations Physics and Climate Panel

ROV: Remotely Operated Vehicles

RUV: Remote Underwater stereo-Video

SDG: Sustainable Development Goals

SPC: Stationary Point Count

UVC: Underwater Visual Census

Glossary of terms

Derived products: outputs calculated from the EOV and sub-variables, often in combination with the supporting variables, that contribute to evaluating change in phenomena. For example, evaporation can be determined from sea surface temperature measurements; air-sea fluxes of CO2 can be derived from inorganic carbon EOV; fish stock productivity can be determined from fish abundance.

Indicators: An indicator can be defined as a 'measure based on verifiable data that conveys information about more than just itself'. This means that indicators are purpose dependent - the interpretation or meaning given to the data depends on the purpose or issue of concern. (BIP definition)

Measurement Uncertainty: the parameter, associated with the result of a measurement, that characterises the dispersion of the values that could reasonably be attributed to the measurand (GUM)1. It includes all contributions to the uncertainty, expressed in units of 2 standard deviations, unless stated otherwise

Phenomena: properties (e.g., of a species such as distribution), processes (e.g., of the ocean such as surface ocean heat flux), or events (e.g., such as algal blooms) that have distinct spatial and temporal scales, and when observed, inform evaluations of ocean state and ocean change

Stability: The change in bias over time. Stability is quoted per decade.

Supporting variables: other measurements that are useful to provide scale or context to the sub-variables of the EOV (e.g., pressure measurements to provide information on the depth at which subsurface currents are estimated, sea temperature to understand dissolved inorganic carbon, water turbidity to support estimations of hard coral cover).

Sub-variables: key measurements that are used to estimate the EOV (e.g., counts of individuals to provide an estimate of species abundance (such as fish, mammals, seabirds or turtles), partial pressure of carbon dioxide (pCO_2)to estimate ocean inorganic carbon, or wave height to estimate sea state).

Timeliness: The time expectation for availability of data measured from the data acquisition time.

Appendix - Additional information

A1. Applications

This table provides examples of applications of this EOV, including, contribution to other essential variable frameworks, multilateral environmental agreements, contribution to indicators and GOOS applications

EOV		Fish abundance and distribution
CORRESPONDING ESSENTIAL VARIABLES	EBV	Genetic composition: Genetic diversity (richness and heterozygosity), Genetic differentiation (number of genetic units and genetic distance), Effective population size Species populations: Species distributions, Species abundances Species traits: Phenology, Movement, Reproduction Community composition: Community abundance, Taxonomic/phylogenetic diversity
GLOBAL INDICATORS EOV CAN CONTRIBUTE	**SDG**	Sustainable Development Goal 14: Target 14.4: Sustainable fishing Target 14.a: Increase scientific knowledge, research and technology for ocean health; Target 14.b: Support small-scale fishers (artisanal harvesting of fish, shellfish in seagrass habitats) Target 14.7: Increase the economic benefits from sustainable use of marine resources. Target 2.3: Increase productivity and incomes of small-scale food producers including fishers SDG 8: Through employment and sustainable tourism Target 12.2: sustainable management and efficient use of resources SDG 13: combat climate change - fish as sentinels
	CBD GBF	Goal A: Protect and Restore Goal B: Prosper with Nature Target 1: Plan and Manage all Areas To Reduce Biodiversity Loss - IUCN Red list Target 2: Restore 30% of all Degraded Ecosystems - complementary indicators Target 3: Conserve 30% land, water and sea - species protection index Target 4: Halt species extinction - IUCN red list, proportion of populations within species with an effective population size, invasive alien species Target 5: Ensure Sustainable, Safe and Legal Harvesting and Trade of Wild Species - IUCN Red list, MSC fish catch, CITES Target 6: Reduce the Introduction of Invasive Alien Species by 50% and Minimize Their Impact Target 9: Manage Wild Species Sustainably To Benefit People - IUCN Red list, MSC fish catch Target 21: Ensure That Knowledge Is Available and Accessible To Guide Biodiversity Action

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	FAO	Resource demographic structure indicators (Length or age composition and average length or age; ratio of average length Ecosystem related indicators: Biomass of target and non-target species. Independently obtained variables through trawl and acoustic scientific surveys. Changes in distribution area.
	CCMS	Migratory bony and cartilaginous fish
	UN Ocean Decade	Outcome 3: A productive ocean supporting sustainable food supply and a sustainable ocean economy. Outcome 5: A safe ocean where life and livelihoods are protected from ocean-related hazards. Outcome 7: An inspiring and engaging ocean where society understands and values the ocean in relation to human wellbeing and sustainable development.

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A2. Additional supporting material and literature

Suggested literature

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Other material

A3. Readiness level assessment

Essential Ocean Variable Specification Sheet

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