The Global Ocean Observing System

GCOS

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Essential Ocean Variable Specification Sheet

Mangrove cover and composition

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EOV Specification Sheet curated by:

Biology and Ecosystems Panel

The Global Ocean Observing System

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

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Background and justification

Mangroves are intertidal, tree-dominated wetlands distributed along tropical and subtropical coastlines and estuaries around the world influenced by ocean tides. Mangroves mediate key biogeochemical fluxes (Kristensen et al. 2008), are highly productive (Zhang et al. 2024), and support rich biological communities (Sievers et al. 2023; zu Ermgassen et al. 2025). They protect coastal communities from erosion and flood damage from storm surges (Menéndez et al. 2020), filter terrestrial run-off (Ewel et al. 1998), supply timber, and generate significant revenue through ecotourism and biodiversity conservation (Costanza et al. 1997). The global value of mangrove ecosystems is estimated at nearly US$32 billion annually, which underscores their importance in combating climate change and supporting local economies (Costanza et al. 2014). Mangroves provide critical nursery habitat for marine species around the world (Sheaves et al. 2015). Globally, mangroves sequester and store more carbon per unit area than almost any other type of ecosystem (Donato et al. 2011). Estimates of the total amount of carbon stored by mangroves range about 511 MgC/ha (IPCC 2013) Despite growing appreciation for the economic value of mangroves, these forests have been severely threatened, with historical loss rates over 1% per year, however more recently this has declined to less than 0.2% per year globally, although some hotspots of loss remain (Friess et al. 2019). Mangrove conversion to aquaculture, agriculture, urbanization and infrastructure development, along with increasing sea level, have already resulted in the cumulative loss of more than 35% of global mangrove cover (Friess et al. 2019). Taking into account their ecological and social value, dynamic distributions, and severe recent losses to human impacts, mangroves require urgent management, including restoration, and monitoring.

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 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: Ecosystem structure, Ecosystem functioning   ECV: Marine Habitats

CBD: Target 1, Target 2, Target 6, Target 9, Target 21

SDG: 2 Zero Hunger, 3 Good Health and Well-Being, 8 Decent Work and Economic Growth, 13 Climate Action, 14 Life Below Water, 15 Life on Land   Other: Ramsar

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1. EOV information

ESSENTIAL OCEAN VARIABLE (EOV)	Mangrove cover, species composition, and extent
DEFINITION	The areal extent (km^2 or ha), canopy cover, species composition of mangroves that form the foundation of the habitat and ecosystem
EOV SUB-VARIABLES - key measurements that are used to estimate the EOV	Mangrove areal extent Canopy cover Mangrove species composition Mangrove species zonation
SUPPORTING VARIABLES - other measurements that are useful to provide scale or context to the sub-variables of the EOV	**Biological:** Mangrove height Mangrove diameter at breast height Canopy width Tree and seedling density by species **Environmental:** Soil porewater salinity Sediment characteristics (bulk density, organic carbon content, nutrient concentrations) Water salinity Water temperature Water nutrient concentrations (Nitrates, Nitrites, etc)

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	EOV related: Mangrove carbon stock estimate Fish species composition and abundance Bird species composition and abundance Invertebrate species composition and abundance Root epibiont cover and composition
DERIVED PRODUCTS - outputs calculated from the EOV and sub-variables, often in combination with the supporting variables	Mangrove distribution estimates (areal extent and fragmentation), species composition and dominance, mangrove biomass (above- and below-ground), carbon storage

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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 suggestions 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		Habitat status and trends	Changes in species composition	Carbon storage
PHENOMENA EXTENT	HORIZONTAL	Tropical and subtropical zones, regional, local	Tropical and subtropical zones, regional, local	Tropical and subtropical zones, regional, local
	VERTICAL	Intertidal to 250 m inland	Intertidal to 250 m inland	Intertidal to 250 m inland
	TEMPORAL	Annual to decadal	Annual to decadal	Annual to centuries
RESOLUTION TO OBSERVE PHENOMENA	HORIZONTAL	m to km	m to km	m to km
	VERTICAL	N/A	N/A	1 – 3 m (sediment depth)
	TEMPORAL	Annual to decadal	Annual to decadal	Annual to decadal
SIGNAL TO CAPTURE		<20% change	change in species cover (gain or lost)	NA
SUB-VARIABLES NEEDED TO MEASURE		Areal extent and canopy cover, species composition and zonation	Areal extent and canopy cover, species composition and zonation	Areal extent and canopy cover, species composition and zonation, tree height and diameter
SUPPORTING VARIABLES NEEDED		Historical land use change	Historical land use change	Global mean carbon storage values and emission factors from IPCC, sediment characteristics

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	MANGROVE COVER AND COMPOSITION							
PHENOMENA	Habitat status and trends, changes in species composition and carbon storage							
EOV SUB-VARIABLE	Areal extent or canopy cover				**DEFINITION**		Mangrove areal extent is the area in km^2 or ha occupied by mangroves within spatial boundaries of a specified area and the canopy cover is the proportion of substrate in a sample area that is covered by mangroves	
	Resolution			**Timelines s**	**Uncertainty Measurement**	**Stability**	**Sampling approach**	**References**
	Spatial Horizontal	**Spatial Vertical**	**Temporal**					
IDEAL	< 5m	N/A	annual	N/A	<10%	N/A	Remote sensing: satellite, GPS, drones	• GOFC-GOLD (2017) Methods and Procedures for Monitoring Essential Biodiversity Variables in Tropical Forests using Remote Sensing (http://www.gofcgold.wur.nl/documents/BiodiversitySourcebook/BiodiversitySourcebook.pdf)
DESIRABLE	< 10 m	N/A	annual	N/A	10%	N/A		
MINIMUM	< 30 m	N/A	decadal	N/A	10%	N/A		

								● Thomas et al. (2018) Mapping Mangrove Extent and Change (https://www.mdpi.com/2072-4292/10/9/1466) ● Global Mangrove Watch ● Bunting et al. (2022)

EOV SUB-VARIABLE	Mangrove species composition and zonation				**DEFINITION**		Mangrove species composition is the contribution of each mangrove species or functional group to mangrove abundance and/or extent and mangrove zonation is the systematic arrangement of mangrove species in distinct zones, which is primarily influenced by environmental gradients such as salinity, tidal inundation, and soil composition	
	Resolution			**Timeliness**	**Uncertainty Measurement**	**Stability**	**Sampling approach**	**References**
	Spatial Horizontal	**Spatial Vertical**	**Temporal**					
IDEAL	< 1 m	N/A	2-5 years	N/A	<10%	N/A	● Direct biomass measurements using survey transects ● Remote sensing	
DESIRABLE	< 10 m	N/A	2-5 years	N/A	10%	N/A		
MINIMUM	< 30 m	N/A	decadal	N/A	20%	N/A		

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PHENOMENA	Carbon storage							
EOV SUB-VARIABLE	Tree height and diameter			DEFINITION	Tree height is the vertical measurement from the base of the mangrove tree (ground or substrate level) to the highest point of its canopy (the uppermost leaves or branches) and diameter at breast height is the tree's trunk diameter measured at 1.3 meters above the ground level or the diameter of the mangrove trunk above the highest stilt root			
	Resolution			Timeliness	Uncertainty Measurement	Stability	Sampling approach	References
	Spatial Horizontal	Spatial Vertical	Temporal					
IDEAL	cm	N/A	seasonal	N/A	<10%	N/A	Direct biomass measurements using survey transects Remote sensing (area)	2013 Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands (https://www.ipcc-nggip.iges.or.jp/public/wetlands/pdf/Wetlands_separate_files/WS_Chp4_Coastal_Wetlands.pdf) Kauffman & Donato (2012) (https://www.cifor-icraf.org/publications/pdf_files/WPapers/WP86CIFOR.pdf) Howard et al., (2014) Coastal Blue carbon manual (https://www.thebluecarboninitiative.org/manual) Sanderman et al., (2018) (https://iopscience.iop.org/article/10.1088/1748-9326/aabe1c/pdf)
DESIRABLE	< 30 m	N/A	annual	N/A	10%	N/A		
MINIMUM	< 250 m	N/A	decadal	N/A	20%	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

APPROACH / PLATFORM	In-situ measurement	Remote sensing	Modeling
EOV SUB-VARIABLE(S) MEASURED	• Mangrove areal extent • Mangrove species composition and zonation • Tree height and diameter at breast height	• Mangrove areal extent • Mangrove species composition and zonation • Tree height and diameter)	• Mangrove areal extent Mangrove species composition and zonation • Mangrove biomass and C stock
TECHNIQUE / SENSOR TYPE	• Transect, circular plots, quadrants • Core sampling •	• Satellite based Optical and/or Radar (https://www.mdpi.com/2072-4292/14/15/3657) • UAV, LIDAR (https://www.sciencedirect.com/science/article/abs/pii/S0048969724036349)	• GIS • Modeling
SUGGESTED METHODS AND BEST PRACTICES	• 2013 IPCC Supplement for Wetlands (https://www.ipcc.ch/site/assets/uploads/2018/03/Wetlands_Supplement_Entire_Report.pdf) • Mangrove carbon sampling technique (Kauffman & Donato, 2012) (https://www.cifor-icraf.org/publications/pdf_files/WPapers/WP86CIFOR.pdf)	• Fatoyinbo et al. (2008) https://agupubs.onlinelibrary.wiley.com/doi/10.1029/2007JG000551 • GOFC-GOLD (2017) Methods and Procedures for Monitoring Essential Biodiversity Variables in Tropical Forests using Remote Sensing (http://www.gofcgold.wur.nl/documents/BiodiversitySourcebook/BiodiversitySourcebook.pdf) • Sanderman et al. (2018). A global map of mangrove forest soil carbon at 30 m spatial resolution.	• Duncanson et al. (2022) Aboveground biomass density models (https://www.sciencedirect.com/science/article/pii/S0034425721005654) • Belowground biomass calculations: • Howard et al., (2014) Coastal Blue carbon manual (https://www.thebluecarboninitiative.org/manual)

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	• Howard et al., (2014) Coastal Blue carbon manual (https://www.thebluecarboninitiative.org/manual)	(https://iopscience.iop.org/article/10.1088/1748-9326/aabe1c/pdf) • Thomas et al. (2018) Mapping Mangrove Extent and Change (https://www.mdpi.com/2072-4292/10/9/1466) • Bunting et al 2022, Global Mangrove Watch (https://www.mdpi.com/2072-4292/14/15/3657)	
SUPPORTING VARIABLES MEASURED	• Historical land use change, species zonation • Tree primary production • Sedimentation rates • GHG emissions • Soil type, characterization of grains, ground morphology	• Historical land use change, species zonation • Restoration of species richness	• Historical land use change, species zonation

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. 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.

[1] Wilkinson et al. 2016 https://doi.org/10.1038/sdata.2016.18
[2] ODIS, part of IOC-UNESCO's International Oceanographic Data and Information Exchange (IODE), is a global federation of data systems sharing interoperable (meta)data about holdings, services, and other resources to enhance cross-domain data accessibility.
[3] OBIS is a global biodiversity database and IOC-UNESCO IODE component, connecting +30 nodes, +1000 institutions, and 99 countries, interoperating with other major biodiversity hubs like GBIF and makes data visible in ODIS as an ODIS node.

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

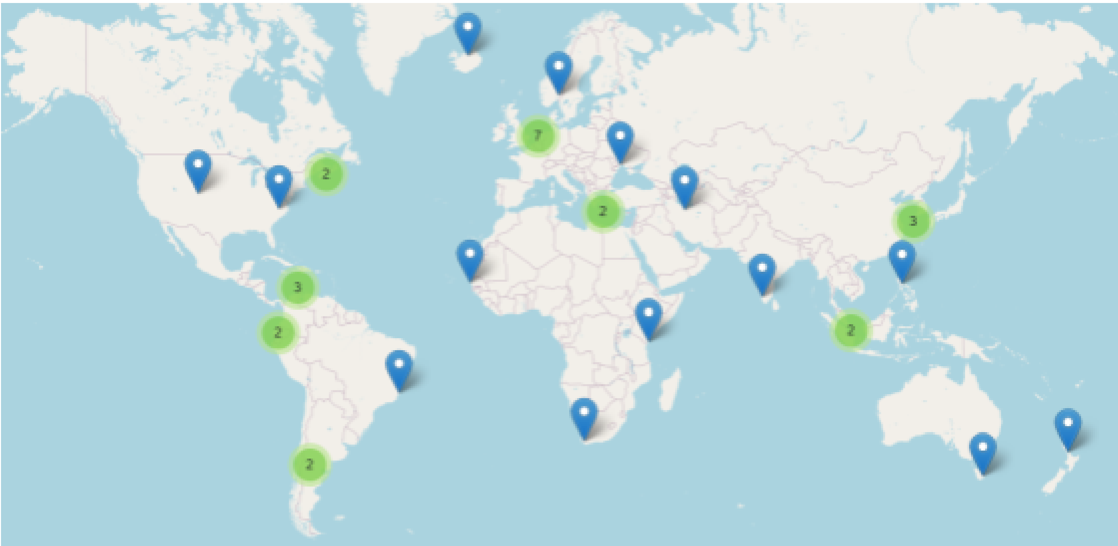

Figure 2. Map of OBIS Nodes. See https://obis.org/contact/ for a complete list.

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

  - Mangrove areal extent (https://www.globalmangrovewatch.org/)
  - Global mangrove height map (https://www.nature.com/articles/s41597-024-04213-z)
  - Mangrove height and biomass (https://mangrovescience.earthengine.app/view/mangroveheightandbiomass)
  - Mangrove carbon (https://shiny.si.edu/coastal_carbon_atlas/)

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Acronyms and Abbreviations

CBD: Convention on Biological Diversity

EBV: Essential Biodiversity Variables

ECV: Essential Climate Variables

EOV: Essential Ocean Variables

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

OBIS: Ocean Biodiversity Information System

ODIS: Ocean Data Information System

OCG: Observation Coordination Group

OOPC:Ocean Observations Physics and Climate Panel

SDG: Sustainable Development Goals

GOFC-GOLD: Global Observations of Forest Cover and Land-use Dynamics

IPCC: Intergovernmental Panel on Climate Change

UNFCCC: United Nations Framework Convention on Climate Change

UAV: Unmanned Aerial Vehicle

LIDAR: Light Detection and Ranging

IRGA: Infra-red gas analyzer

GHG: Greenhouse gas

R-SET: Rod- Surface Elevation Table

NPP: Net Primary Production

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.

Mangrove areal extent or canopy cover: Area in km2 or ha occupied by mangroves within spatial boundaries of a specified area

Mangrove cover: Proportion of substrate in a sample area that is covered by mangroves

Mangrove species composition: contribution of each mangrove species or functional group to mangrove abundance and/or extent

Mangrove zonation: the systematic arrangement of mangrove species in distinct zones, which is primarily influenced by environmental gradients such as salinity, tidal inundation, and soil composition

Mangrove height: vertical measurement from the base of the mangrove tree (ground or substrate level) to the highest point of its canopy (the uppermost leaves or branches)

Mangrove diameter: diameter of a mangrove tree's trunk measured at 1.3 meters above the ground level or the diameter of the mangrove trunk above the highest stilt root

Mangrove carbon storage: amount of carbon retained in the mangrove ecosystem, such as biomass, soils, sediments.

Mangrove carbon sequestration: the process by which carbon dioxide (CO_2) is removed from the atmosphere and converted into organic compounds, which are stored in plants, soils, oceans, or other carbon reservoirs in mangrove ecosystem

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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		Mangrove cover and composition
CORRESPONDING ESSENTIAL VARIABLES	ECV	Coastal habitat
	EBV	Species populations: Species occurrences, species abundances Species traits: Phenology of growth, salinity tolerance Community composition: community diversity (species and/or phylogenetic diversity) and composition, community functional (trait) diversity, composition and zonation Ecosystem structure: Habitat structure (canopy height and density, sediment type and structure) Ecosystem functioning: Primary production, carbon cycling and storage/sequestration (above and below-ground biomass, sediments), nitrogen cycling and storage, physical structure, secondary production of associated animals
GLOBAL INDICATORS EOV CAN CONTRIBUTE	**SDG**	Sustainable Development Goal 13: Climate Action Target 13.1: Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters Target 13.2: Integrate climate change measures into national policies, strategies and planning Target 13.3: Improve education, awareness-raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning Target 13.b: Promote mechanisms for raising capacity for effective climate change-related planning and management Sustainable Development Goal 14: Life below water Target 14.1: Reduce marine pollution Target 14.2: Protect and restore ecosystems Target 14.3: Reduce ocean acidification Target 14.4: Sustainable fishing Target 14.5: Conserve coastal and marine areas; Target 14.a: Increase scientific knowledge, research and technology for ocean health; Target 14.b: Support small-scale fishers Target 14.7: Increase the economic benefits from sustainable use of marine resources. Sustainable Development Goal 15: Life on land

		Target 15.1: Ensure the conservation, restoration and sustainable use of terrestrial and inland freshwater ecosystems and their services Target 15.2: Promote the implementation of sustainable management of all types of forests Target 15.3: Combat desertification, restore degraded land and soil, including land affected by desertification, drought and floods, and strive to achieve a land degradation-neutral world Target 15.5: Take urgent and significant action to reduce the degradation of natural habitats, halt the loss of biodiversity and protect and prevent the extinction of threatened species Target 15.6: Promote fair and equitable sharing of the benefits arising from the utilization of genetic resources and promote appropriate access to such resources, as internationally agreed Target 15.7: Take urgent action to end poaching and trafficking of protected species of flora and fauna and address both demand and supply of illegal wildlife products Target 15.9: Integrate ecosystem and biodiversity values into national and local planning, development processes, poverty reduction strategies and accounts
	CBD	Goal A: Protect and Restore Goal B: Prosper with Nature Target 1: Plan and Manage all Areas To Reduce Biodiversity Loss Target 2: Restore 30% of all Degraded Ecosystems Target 6: Reduce the Introduction of Invasive Alien Species by 50% and Minimize Their Impact Target 9: Manage Wild Species Sustainably To Benefit People Target 21: Ensure That Knowledge Is Available and Accessible To Guide Biodiversity Action
	CLIMATE	UNFCCC: Nationally Determined Contributions: seagrass extent US Global Change Research Program: Climate indicators: Marine species distribution
	RAMSAR	Target 8: National wetland inventories have been either initiated, completed, or updated and disseminated and used for promoting the conservation and effective management of all wetlands; Target 11: Wetland functions, services and benefits are widely demonstrated, documented and disseminated; Target 12: Restoration is in progress in degraded wetlands, with priority to wetlands that are relevant for biodiversity conservation, disaster risk reduction, livelihoods and/or climate change mitigation adaptation.
	UN Ocean Decade	Outcome 2: A healthy and resilient ocean where marine ecosystems are understood, protected, restored and managed. 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.
GOOS APPLICATIONS		Ocean health

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A2. Additional supporting material and literature

Suggested literature

Other material

A3. Readiness level assessment

Essential Ocean Variable Specification Sheet

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