Global Ocean Observing System

unesco Intergovernmental Oceanographic Commission

WORLD METEOROLOGICAL ORGANIZATION

UN environment United Nations Environment Programme

International Science Council

The Macroalgal Canopy Cover and Composition Essential Ocean Variable

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A series supported by: BioEcOcean

In collaboration with: MBON Marine Biodiversity Observation Network

AIR CENTRE

Global Ocean Observing System

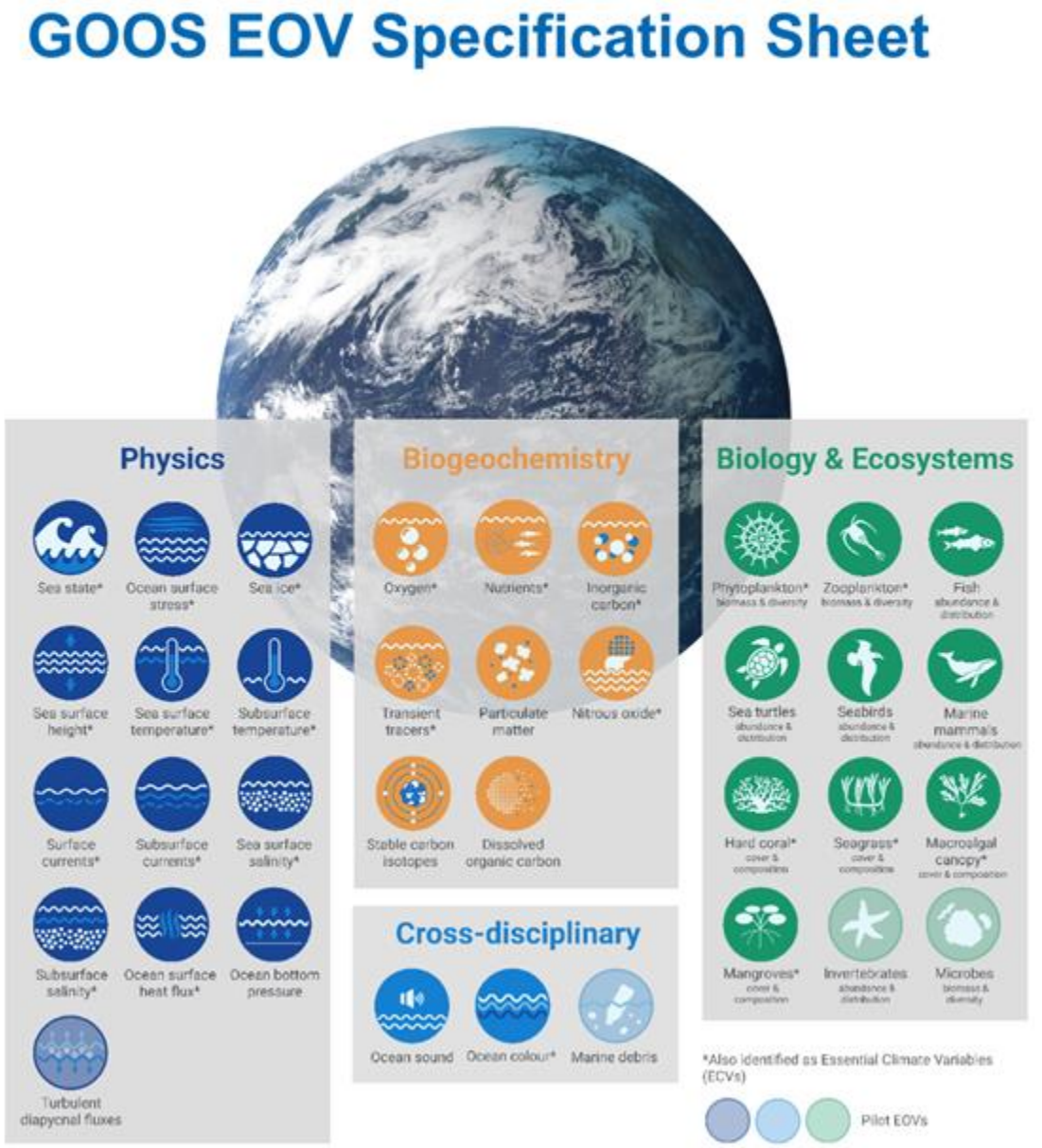
GOOS Essential Ocean Variables (EOVs)

EOVs make it easier to measure and compare ocean data from all corners of the world!

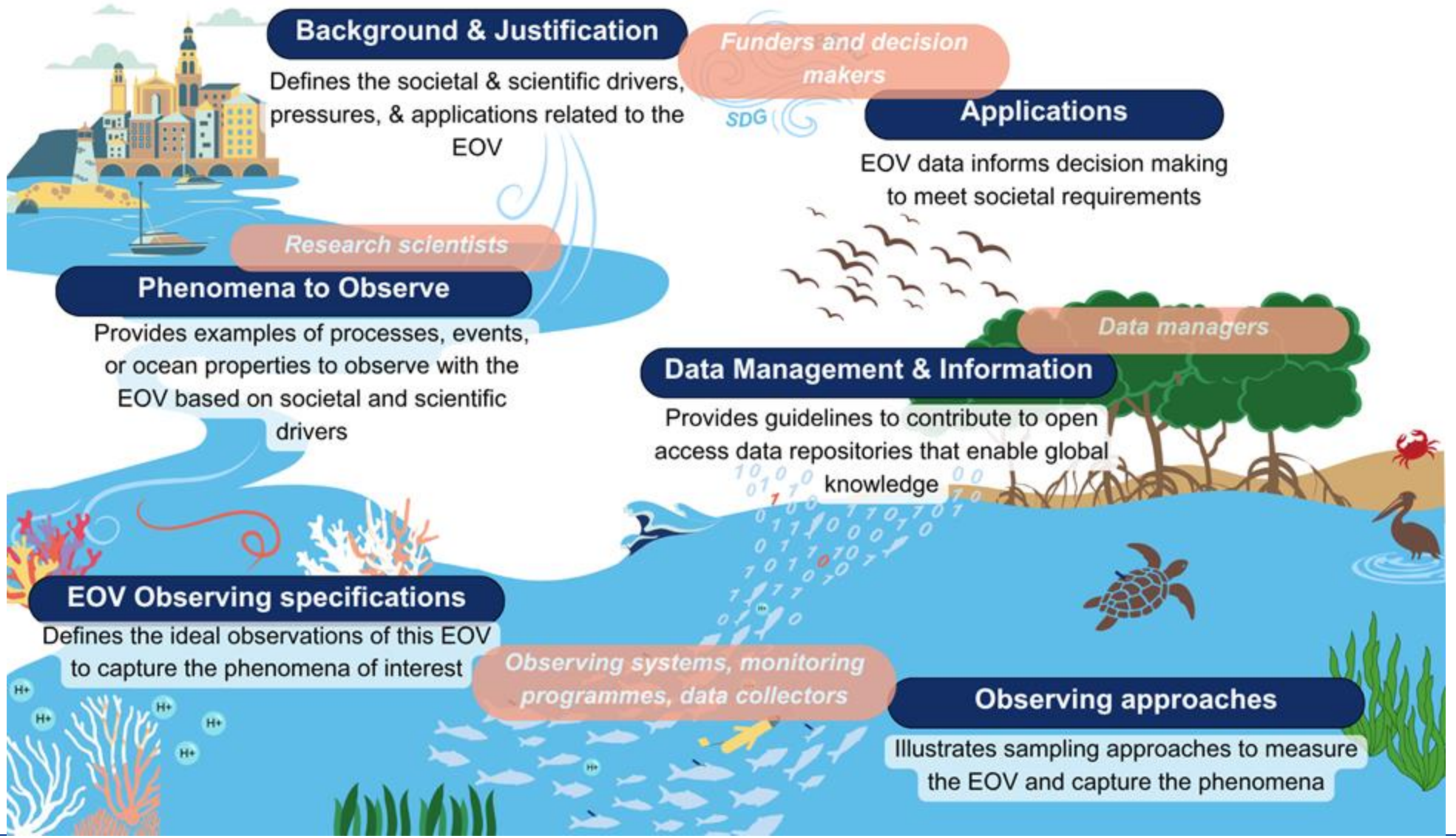
EOV specification sheet

Provides a common framework for coordination guiding the collection of ocean observations.

A tool to help standardise oceanographic data collection and analysis and contribute information on EOVs to the Global Ocean Observing System,



Essential Ocean Variable (EOV) Specification Sheets



EOV specification sheet components

Background and justification

The importance of the EOV, its impact and the observing networks

EOV information

Provides information on measurements to estimate the EOV, including basic measurements, additional supporting measurements and outputs (derived products)

Phenomena to observe

Example events or processes that can be observed by measuring the EOV

EOV specification sheet components

Observing specifications

Guidance on the resolutions at which EOV measurements should be available in a global system to inform and meet multiple needs

Observing approaches

Provides information on the most common and new methods for collecting data on the EOV, including links to protocols and Standard Operating Procedures

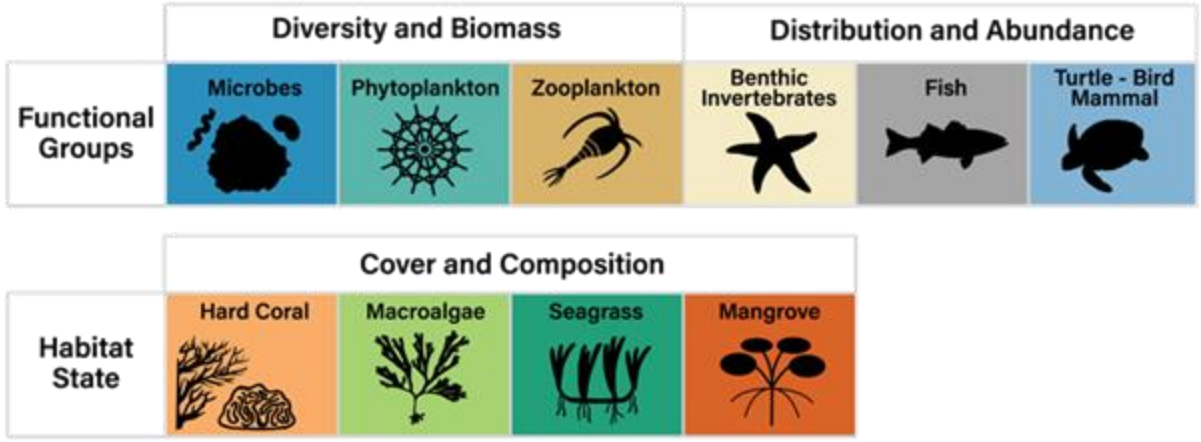
Data and metadata management

A step-by-step guide on how to contribute metadata and data to the global system via OBIS and the BioEco metadata portal.

Macroalgal canopy cover and composition EOV

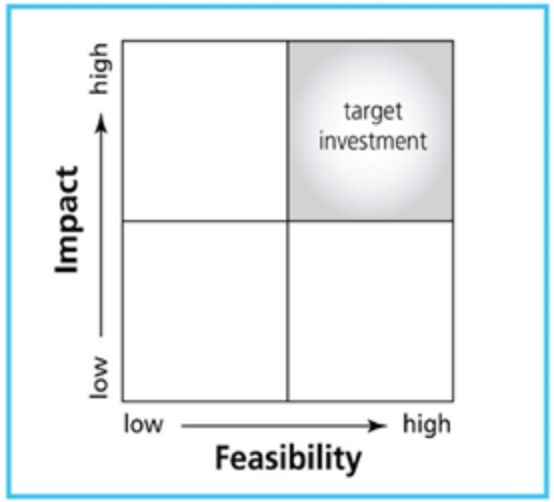
GOOS EOVs – BioEco Panel

One of the four habitat state EOVs



Essential Ocean Variables are defined to meet the following criteria Miloslavich et al. 2018):

- **Feasibility**
- **Impact**
- **Low cost**
- **Replicability**



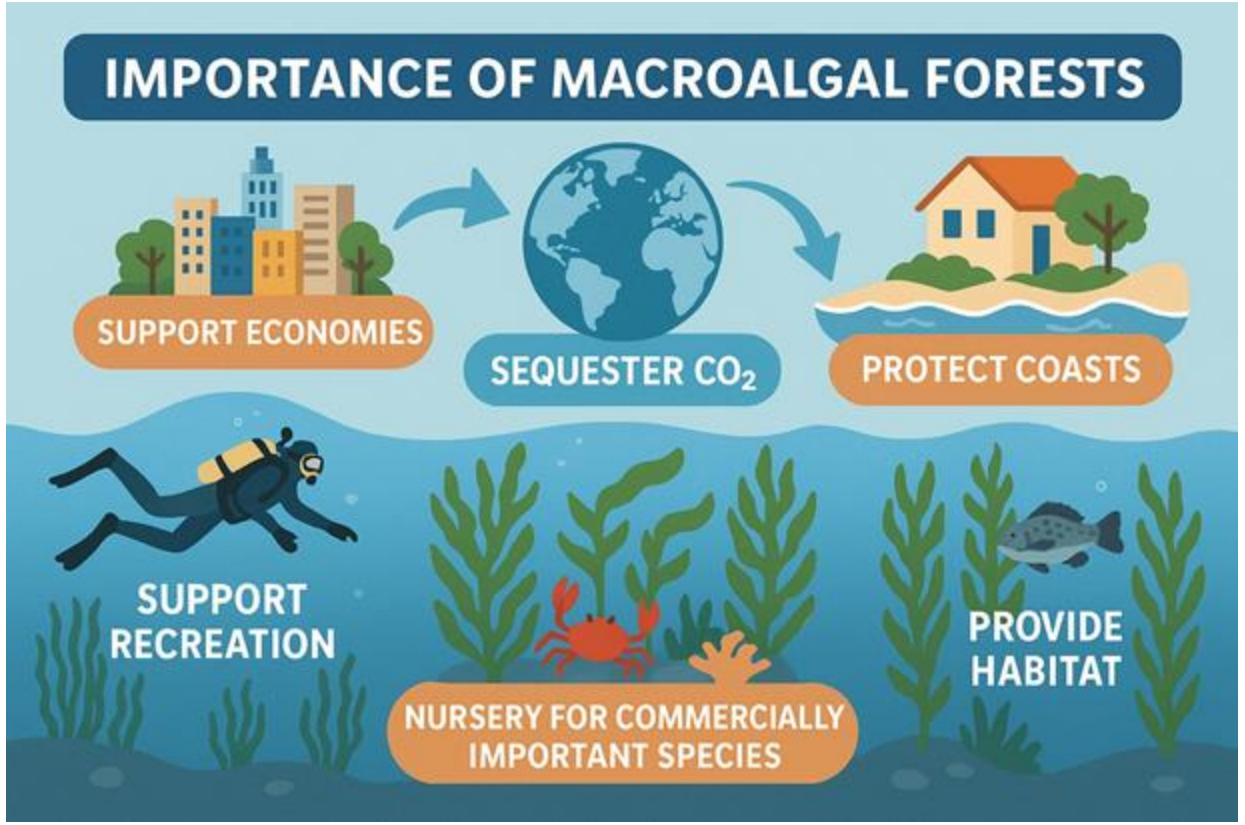
Macroalgal canopy cover and composition EOV

Critical services

- Support biodiversity
- Blue economy
- Climate regulation
- Nursery
- Protection from coastal erosion
- Recreation

Importance of sustained observations

Support sustainable management of ecosystems and conservation goals



Background

POGO meetings (Tasmania, 2018, 2019)
NCEAS (S. Barbara, 2022)

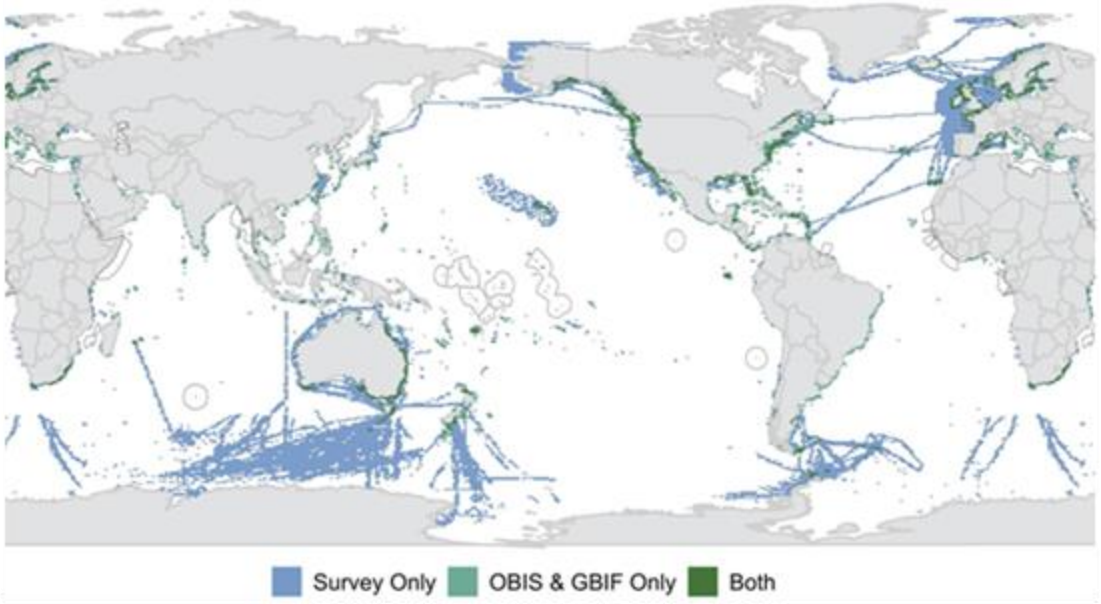
Review existing datasets
Review monitoring methods
Consolidate existing data (FAIR principles)
Standardization

Background

EXISTING BIODIVERSITY PROGRAMS

Survey:

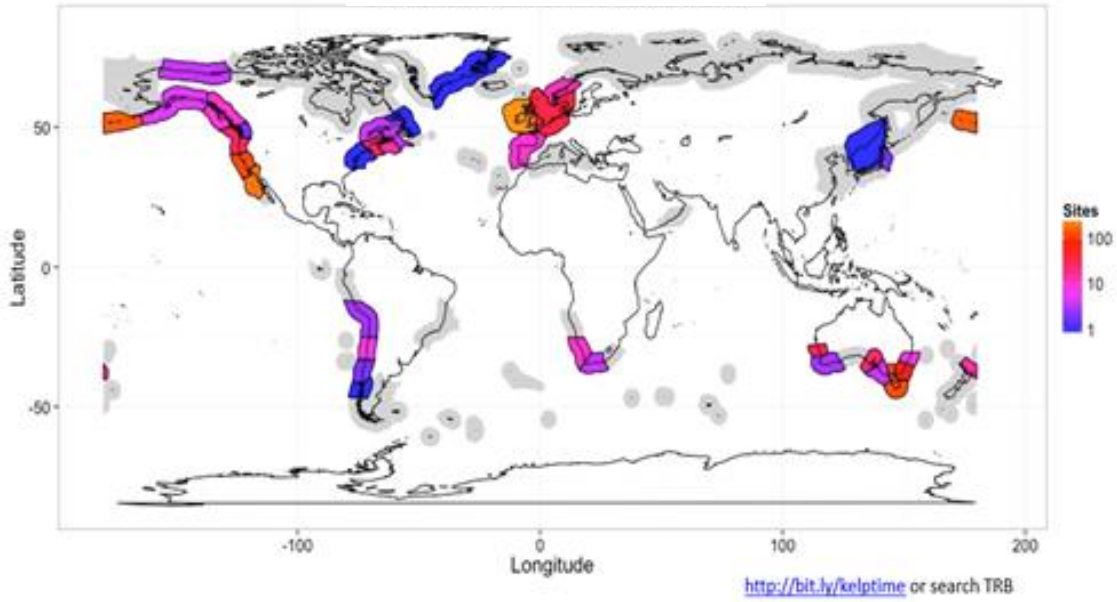
371 respondents, 203 active, long-term (>5 years) observing programs systematically sampled marine life. These programs spanned about 7% of the ocean surface area, mostly concentrated in coastal regions of the United States, Canada, Europe, and Australia



Satterthwaite *et al. Frontiers in Marine Sciences.* 2021

Background

Kelptime database:
454 sites monitored since 1954



42 monitoring programs for macroalgae in Europe run by 35 organizations

The EOV Specification Sheets: Subvariables

EOV SUB-VARIABLES

Key measurements that are used to estimate EOV

- Canopy percent cover
- Macroalgal stipe density
- Canopy species diversity
- Areal extent

The Macroalgae Specification Sheet

Supporting variables

Environmental: Nutrients, Sea surface temperature, Subsurface temperature, Sea surface salinity, Subsurface salinity, Dissolved organic carbon, Ocean colour and derived products

EOV related: Photosynthetic biomass, Canopy height, Plant size classes, Algal decomposition rate, Photosynthetic efficiency, Algal condition (e.g., signs of necrosis, fouling, and/or grazing), Extent of alternative habitats (e.g., barrens and turf beds), Species composition and abundance of understory assemblages

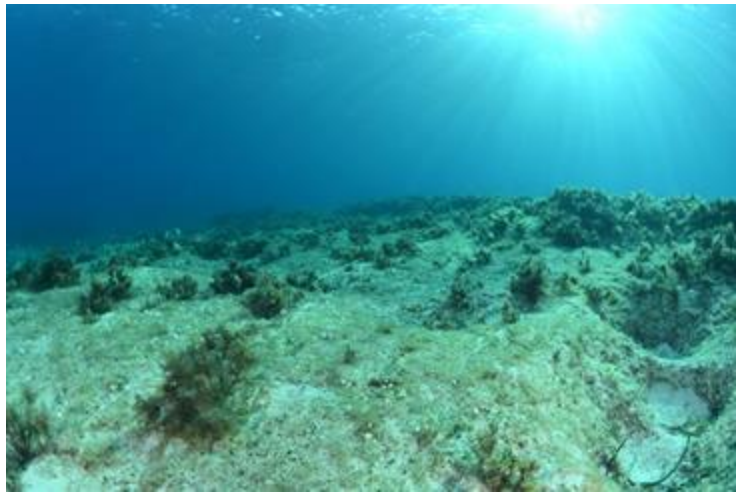
The Macroalgae Specification Sheet

PHENOMENA TO OBSERVE		Status and trends in macroalgal canopy cover	Severe events/ population collapse/ regime shift	Recovery/Resilience	Range Shifts
PHENOMENA EXTENT	HORIZONTAL	Local to regional	Local to regional	Local to regional	Regional to continental
	VERTICAL	Photic zone	Photic zone	Photic zone	Photic zone
	TEMPORAL	Decadal	Annual to decadal	Annual to decadal	Annual to decadal
RESOLUTION TO OBSERVE PHENOMENA	HORIZONTAL	10m – 1000km	100m – 100 km	100m – 100km	100 – 1000km
	VERTICAL	0.5m – 30m	0.5m – 30m	0.5m – 30m	0.5m – 30m
	TEMPORAL	3-10 years	1-2 years	3-10 years	1-5 years
SIGNAL TO CAPTURE		20% Change	40% Loss	40% Gain	20% Range Movement

https://goosocean.org/document/17515

The Macroalgae Specification Sheet

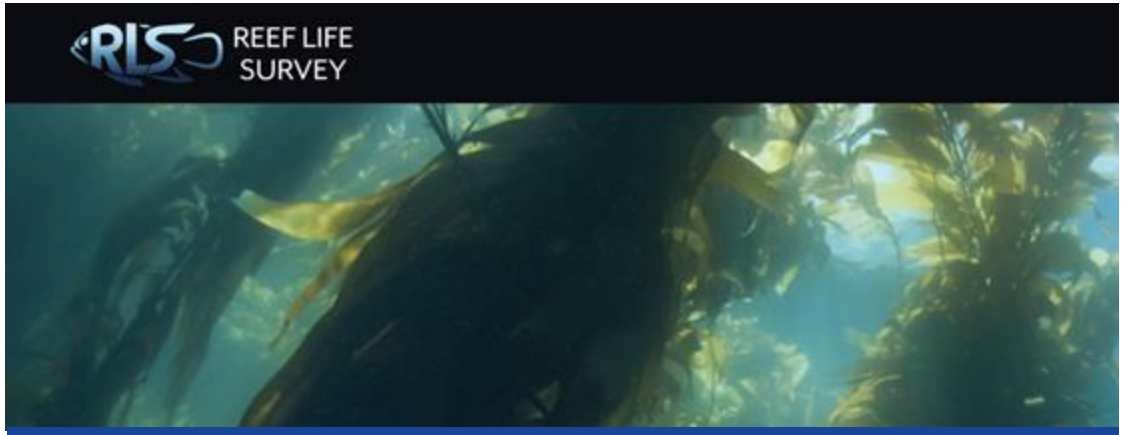
Phenomena to observe: habitat loss/regime shifts



Implementation: Standardised Operating Procedures for Two Kinds of Users

New Sampling Programmes

- Best practices needed to efficiently sample for the macroalgal EOV
- Standard field data collection tools needed
- Standard data entry forms and formats needed



Existing Sampling Programmes

- Data already collected or collection ongoing
- Best practices already established
- But data is not standardized and cross-compatible with other macroalgal EOV data

OBIS

OCEAN BIODIVERSITY INFORMATION SYSTEM

obis.org

world's largest open-access repository for **standardized** marine biodiversity data

>141,000,000
presence records

>5,700
marine datasets

More than **just** species occurrences

>181,480,000
measurements

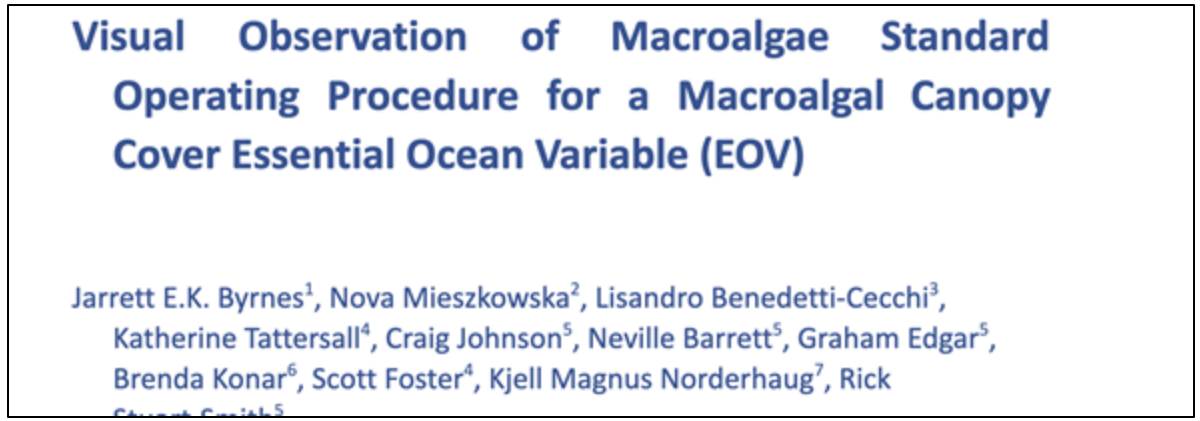
DNA-derived

Habitat,
Ecosystems
Abundance

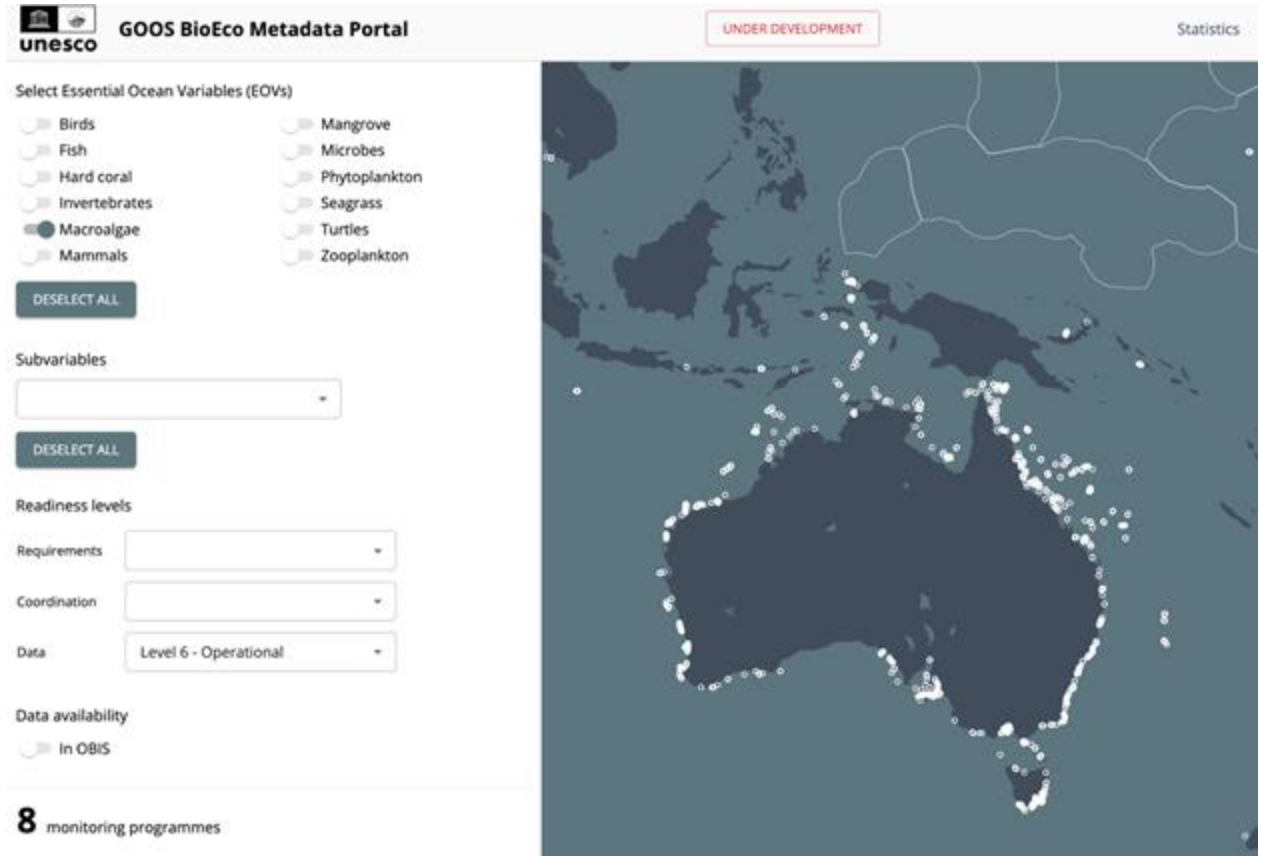
Satellite
Tracking
Image-derived

Implementation: Standardised Operating Procedures at Ocean Best Practices

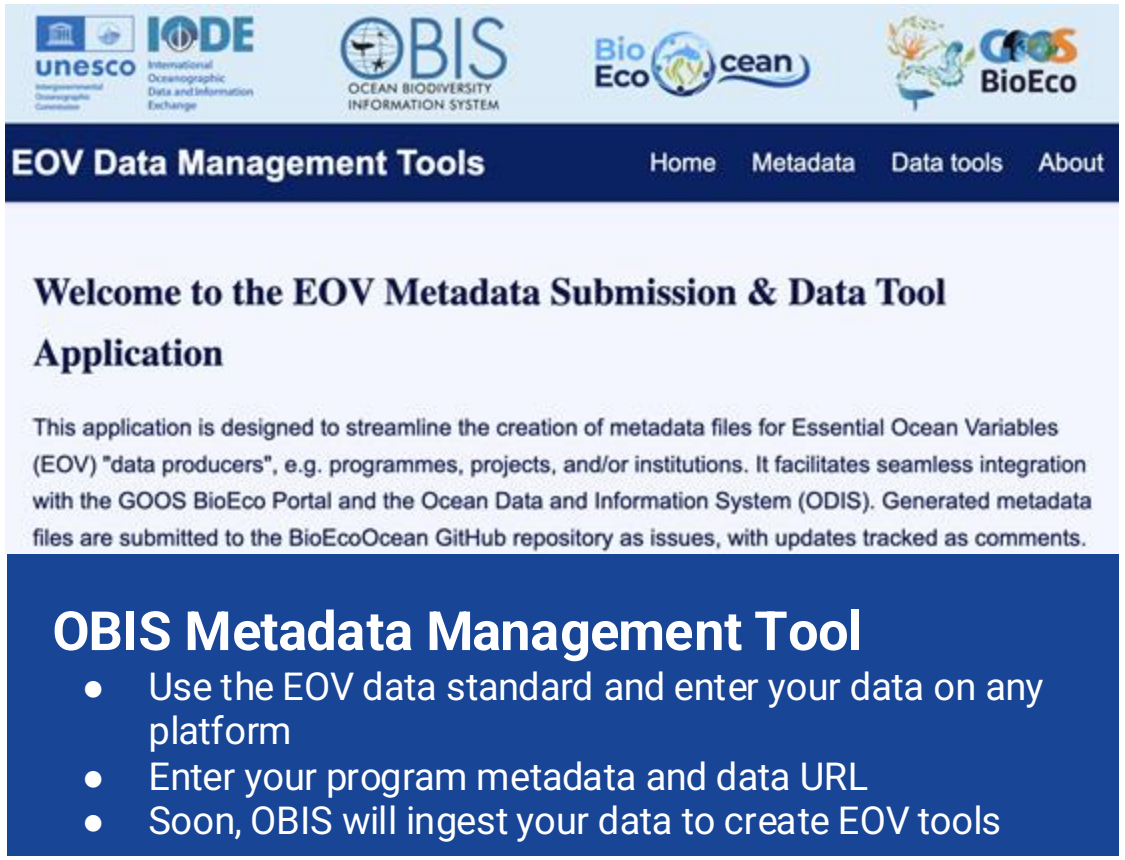
- Macroalgal EOV group developing best practices and data infrastructure
- Practices will be available on https://www.oceanbestpractices.org/
- Provides tools to start a new program
- Provides standardized data template compatible with any pre-existing program



Implementation: Data Deposition, Management, and Long-Term Vision



https://bioeco.goosocean.org/



OBIS Metadata Management Tool

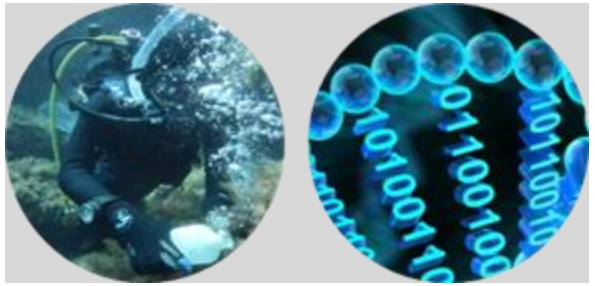
- Use the EOV data standard and enter your data on any platform
- Enter your program metadata and data URL
- Soon, OBIS will ingest your data to create EOV tools

https://eovmetadata.obis.org/

Moving Forward: Emerging Technologies

Automated biodiversity monitoring

AI-assisted imaging



eDNA

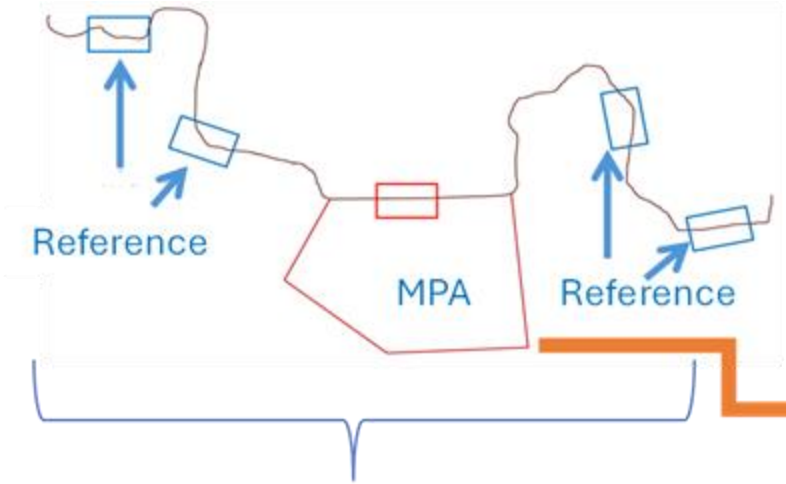
Way forward: Towards a global observing network of marine biodiversity

Local to regional scales

- **Articulate clear hypotheses** to guide the allocation of sampling units in space and time
- **Examine gradients or well contrasted conditions** of anthropogenic pressures, from MPAs to human-dominated areas
- **Generate a design-based counterfactual** for what you should observe in an intervention site (disturbed, protected) using principles of sampling design: replication, randomization, interspersion and independence of sampling units.
- **Use Power analysis** to anticipate the effects sizes that can be realistically captured by indicators

Scaling-up (data integration and iteroperability)

- Ensure standardization of methods across regions; remember that regional processes reflect regional priorities → heterogeneity



Use all data to assess local or regional impacts

Separate regional and global trends

- Local/regional data are used to assess specific impacts and context-dependency
- Data from most pristine locations (MPA) are combined to assess global trends

Combine data from most pristine sites to disentangle global drivers

Conclusions

- Clarify questions/hypotheses to decide how to allocate samples in space and time
- Use standardized protocols (SOP)
- Adopt FAIR principles
- Take advantage of new technologies (eDNA, imaging)

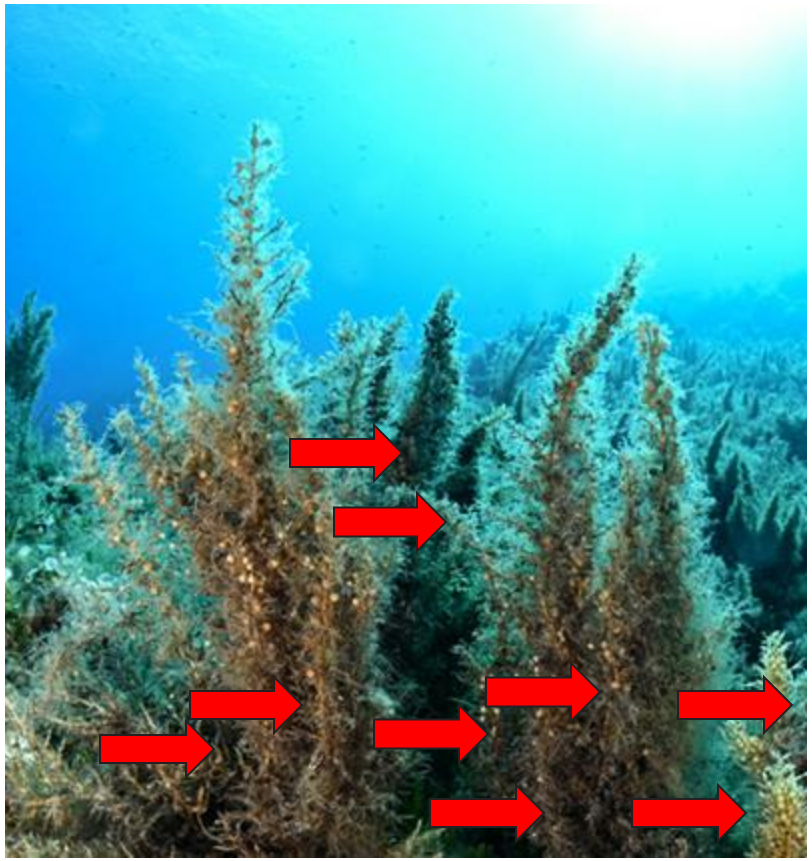
EOV Subvariables: Percent Cover

EOV	Macroalgal canopy cover and composition							
PHENOMENA	Status and trends in macroalgal canopy cover Severe events/population collapse/regime shift Recovery/Resilience							
EOV SUB-VARIABLE	Canopy percent cover				DEFINITION		The percent of a single sample unity covered by macroalgal canopy species.	
	Resolution			Timeliness	Uncertainty Measurement	Stability	Sampling approach	References
	Spatial Horizontal	Spatial Vertical	Temporal					
IDEAL	0.25m²	NA	Monthly	Monthly data deposition	±1%	10 years	Visual sampling via in-person transects, quadrats, or photo/video monitoring. For	Multi-Agency Rocky Intertidal Network Sampling Protocols Partnership for Interdisciplinary Studies of Coastal Oceans Kelp Forest Sampling Protocols

100%Canopy

EOV Subvariables: Macroalgal Stipe Density

EOV SUB-VARIABLE	Macroalgal stipe density				DEFINITION		The number of algal stipes per unit area. Some algae have single stipes (e.g., *Saccharina latissima*) while some have multiple (e.g., *Macrocystis pyrifera*).	
	Resolution			Timeliness	Uncertainty Measurement	Stability	Sampling approach	References
	Spatial Horizontal	Spatial Vertical	Temporal					
IDEAL	0.25 m^2	NA	Monthly	Monthly data deposition	±1%	10 years	Visual sampling via in-person transects, quadrats. Photo/video monitoring only useful if algae can be individuated.	SBC LTER Kelp Forest Community Structure Methods - Density of algae and invertebrates
DESIRABLE	1 m^2	NA	Annual	6 months	±3%	5 years		SBC LTER SBC LTER Kelp Forest Community Structure Methods - Density of giant kelp
MINIMUM	50 m^2	NA	Bi-annual	Annual	±5%	3 years		Multi-Agency Rocky Intertidal Network Sampling Protocols Partnership for Interdisciplinary



9 Stipes

EOV Subvariables: Canopy Species Diversity

EOV SUB-VARIABLE	Canopy species diversity				DEFINITION		The number of algal species (i.e, richness) or an abundance adjusted estimate of the number of algal species (e.g., Hill Numbers).	
	Resolution			Timeliness	Uncertainty Measurement	Stability	Sampling approach	References
	Spatial Horizontal	Spatial Vertical	Temporal					
IDEAL	0.25 m^2	NA	Monthly	Monthly data deposition	±1%	10 years	Visual sampling via in-person transects, quadrats. Photo/video monitoring only useful if algae can be individuated. Hyperspectral techniques might be used in the future for remote sensing approaches	See references for above two subvariables.
DESIRABLE	1 m^2	NA	Annual	6 months	±3%	5 years		
MINIMUM	50 m^2	NA	Bi-annual	Annual	±5%	3 years		

1 Species

EOV Subvariables: Areal Extent

EOV SUB-VARIABLE	Areal extent				DEFINITION		The spatial area of occupancy of macroalgal canopy.	
	Resolution			Timeliness	Uncertainty Measurement	Stability	Sampling approach	References
	Spatial Horizontal	Spatial Vertical	Temporal					
IDEAL	Global		Monthly	Real-time	±1%	10 years	Remote sensing approaches and large-scale biogeographic presence-absence surveys using either visual or eDNA methods.	Giant Kelp and Bull Kelp Canopy Dynamics from the Landsat Satellite Sensors (TM, ETM+, OLI), Santa Barbara Coastal LTER 2020 A DNA mini-barcode for marine macrophytes
DESIRABLE	Continental		Annual	6 months	±3%	5 years		
MINIMUM	Regional		Bi-annual	Annual	±5%	3 years		

50 Hectares