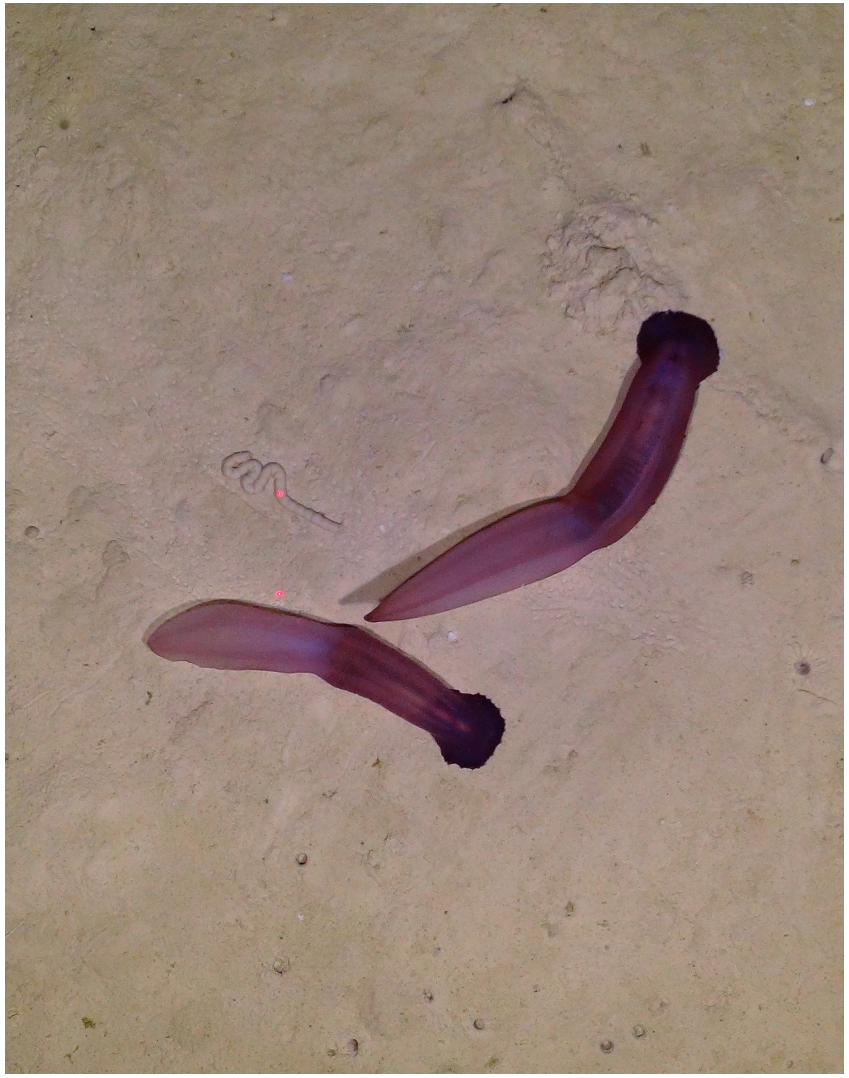
Introduction to EOV concepts & Biology and Ecosystems theme

Introduction

GOOS Expert Panel Tasks
Expert Panels are responsible for three main functions within their discipline:

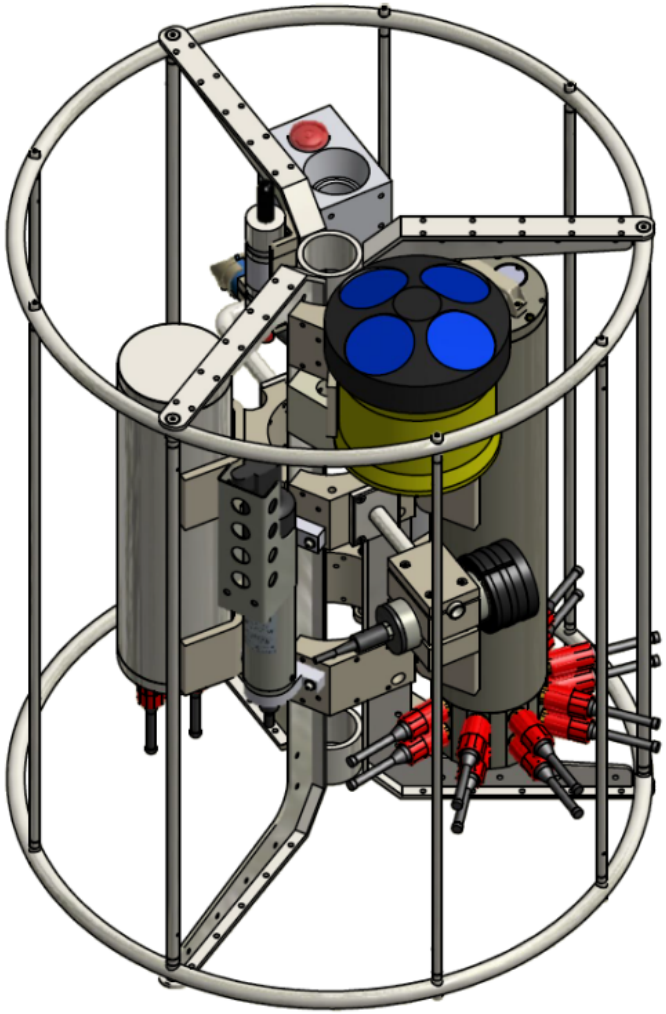
- Identification of and requirement setting for **Essential Ocean Variables** (EOVs);
- Development of EOV implementation **strategies and coordination of observations**;
- Promotion of standards and interoperability of **data and information products**.



DEEP OCEAN OBSERVING STRATEGY

Introduction

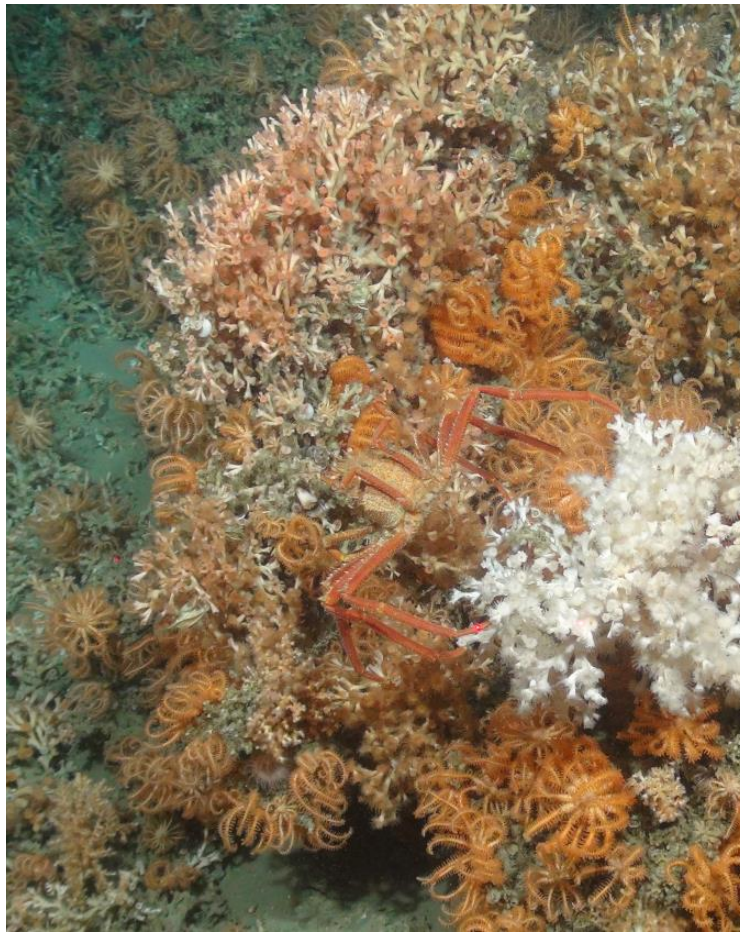
- **Avoid duplication of efforts**, across observing platforms and networks, and to;
- **Adopt common standards** for data collection and dissemination to maximize the utility of data;
- **Systems engineering approach** which evaluates the system based on requirements for EOV's and the technological and management readiness of the EOV's and their observing networks.



DEEP OCEAN OBSERVING STRATEGY

DOOS Objectives

- Examine the **existing, emerging and prospective GOOS EOV** specifications to add deep ocean context. This can help evolve what is already vetted and suggest specifications for new EOVs.
- Adding **deep ocean perspectives and characteristics** to existing 'GOOS-EOVs' where possible and
- Only suggest specific cases where deep ocean variables, which are thought to be **essential for specific societal or policy needs**, are missing in GOOS.
- **Collate information** from the individual EOV level to overall GOOS prospective for more detailed specification.
- **Disseminate added knowledge** and consensus to DOOS, GOOS and the OceanObs '19 delegation

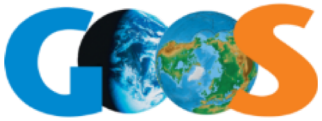


GOOS

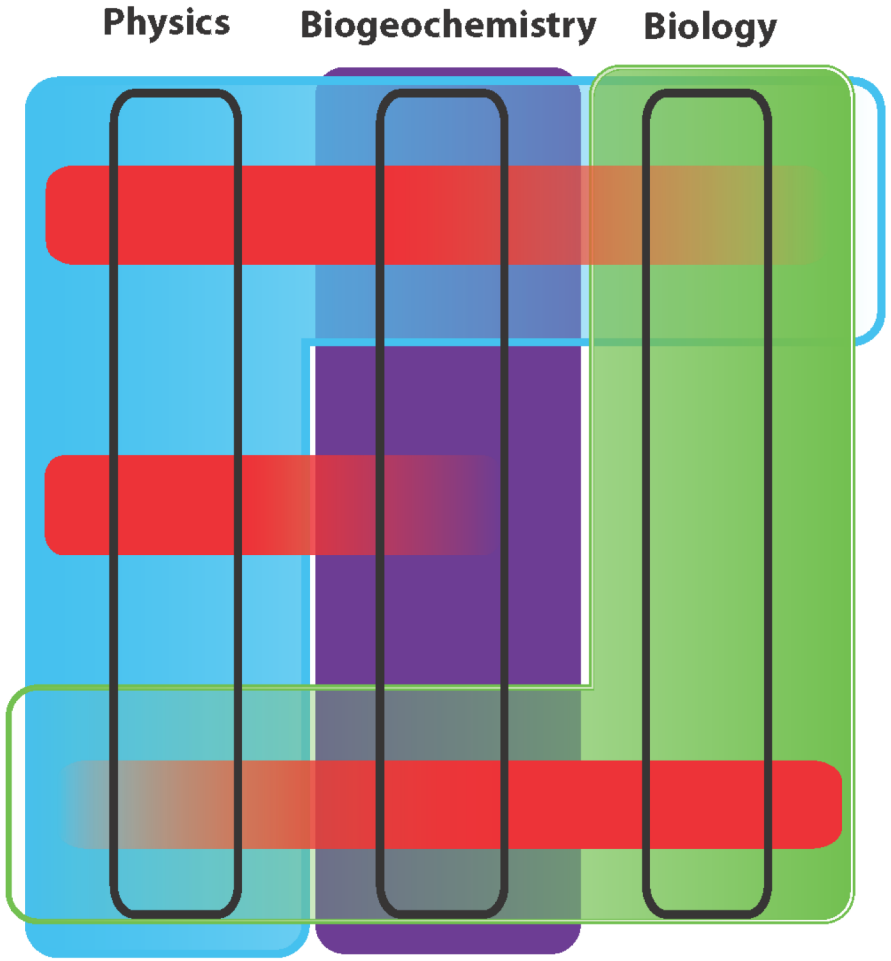
DEEP OCEAN OBSERVING STRATEGY

GOOS EOVs

PHYSICS	BIOGEOCHEMISTRY	BIOLOGY AND ECOSYSTEMS
Sea state	Oxygen	Phytoplankton biomass and diversity
Ocean surface stress	Nutrients	Zooplankton biomass and diversity
Sea ice	Inorganic carbon	Fish abundance and distribution
Sea surface height	Transient tracers	Marine turtles, birds, mammals abundance and distribution
Sea surface temperature	Particulate matter	Hard coral cover and composition
Subsurface temperature	Nitrous oxide	Seagrass cover
Surface currents	Stable carbon isotopes	Macroalgal canopy cover
Subsurface currents	Dissolved organic carbon	Mangrove cover
Sea surface salinity	Ocean colour *(Spec Sheet under development)*	Microbe biomass and diversity (*emerging)
Subsurface salinity		Benthic invertebrate abundance and distribution (*emerging)
Ocean surface heat flux		



GOOS separation of responsibility for disciplines (ocean variables)



GCOS-GOOS-WCRP
OOPC: Panel for Physics variables, and
Climate Theme Lead
RT Services Theme Lead.
Ocean Health Theme Support

GOOS **Biogeochemistry**: Panel for Biogeochemical Variables and
Climate Theme Support
Ocean Health Theme Support

GOOS **Biology**: Panel for Biology Variables, and
Ocean Health Theme Lead
Climate Theme Support

DEEP OCEAN OBSERVING STRATEGY

GOOS EOV status	Key
GOOS EOVs most directly applicable to coast and the surface	
GOOS EOVs most directly applicable to DOOS	
GOOS EOVs that are emerging and applicable to DOOS	
EOVs under consideration by DOOS	

	Physics														Biogeochem														Biology and Ecosystems												
	Sea state	Ocean surface stress	Sea ice	Sea surface height	Sea surface temperature	Surface currents	Sea surface salinity	Ocean surface heat flux	Subsurface temperature	Subsurface currents	Subsurface salinity	Ocean Bottom Pressure	Seafloor Fluxes	Ocean Turbulence	Oxygen	Nutrients	Inorganic carbon	Transient tracers	Particulate matter	Nitrous oxide	Stable carbon isotopes	Dissolved organic carbon	Ocean colour (Spec Sheet under development)	Seafloor labile organic matter	Seafloor respiration	Seafloor fluid and gas effluxes (focus on methane)	Litter including microplastics	pH	Phytoplankton biomass and diversity	Marine turtles, birds, mammals abundance & distribution	Seagrass cover	Macroalgal canopy cover	Mangrove cover	Zooplankton biomass and diversity	Fish abundance and distribution	Hard coral cover and composition	Microbe biomass and diversity	Benthic invertebrate abundance and distribution	Body size	Bioacoustics	Seafloor sponge habitat cover	Connectivity of species
What is the role of the deep-ocean in the Earth's energy imbalance and land/sea water redistribution on annual to multi-decadal time scales? This includes closing the heat and fresh water budget, the warming and freshening of the deep ocean, and their contribution to sea level change.																																									
How are natural and anthropogenic variations in climate connected to the global overturning circulation and its variability? This includes variations in deep and bottom water formation rates and water properties, circulation and deep ocean mixing, and geothermal heating, and impacts on deep sea ecology.																																									
How does deep pelagic ecology respond to natural variation and multiple climate change stressors, including warming, deoxygenation, acidification, changes in biological production, as well as industrial activities?																																									
How might natural and anthropogenic variations in climate influence the function of the solubility and biological carbon pumps, continental slope, nephloid layer transport and the sequestering of carbon in the deep ocean, and the supply of organic carbon food supplies to deep-sea communities?																																									
What drives observed variation in seafloor fluxes of heat, nutrients, tracers, oxygen and different carbon pools? How are these quantities connected to larger-scale ocean circulation? This includes long term links between seafloor fluxes and greater oceanic physical and biogeochemical processes.																																									
How might natural and anthropogenic change influence the functional importance of animals and microbes in the deep sea and the seafloor? What environmental variations do they experience in space and time? This includes consideration of benthic storms and currents, fluctuations in turbidity, T, pH, O_2, and POC flux. This will improve spatial planning and impact assessment for seabed mining, bottom trawling and oil and gas extraction.																																									

GOOS EOV status	Key
GOOS EOVs most directly applicable to coast and the surface	
GOOS EOVs most directly applicable to DOOS	
GOOS EOVs that are emerging and applicable to DOOS	
EOVs under consideration by DOOS	

Biology and Ecosystems

- Phytoplankton biomass and diversity
- Marine turtles, birds, mammals abundance & distribution
- Seagrass cover
- Macroalgal canopy cover
- Mangrove cover
- Zooplankton biomass and diversity
- Fish abundance and distribution
- Hard coral cover and composition
- Microbe biomass and diversity
- Benthic invertebrate abundance and distribution
- Body size
- Bioacoustics
- Seafloor sponge habitat cover
- Connectivity of species

	Physics (Sea state …)	Biogeochem (… r development) … focus on methane) …)	Phytoplankton biomass and diversity	Marine turtles, birds, mammals abundance & distribution	Seagrass cover	Macroalgal canopy cover	Mangrove cover	Zooplankton biomass and diversity	Fish abundance and distribution	Hard coral cover and composition	Microbe biomass and diversity	Benthic invertebrate abundance and distribution	Body size	Bioacoustics	Seafloor sponge habitat cover	Connectivity of species
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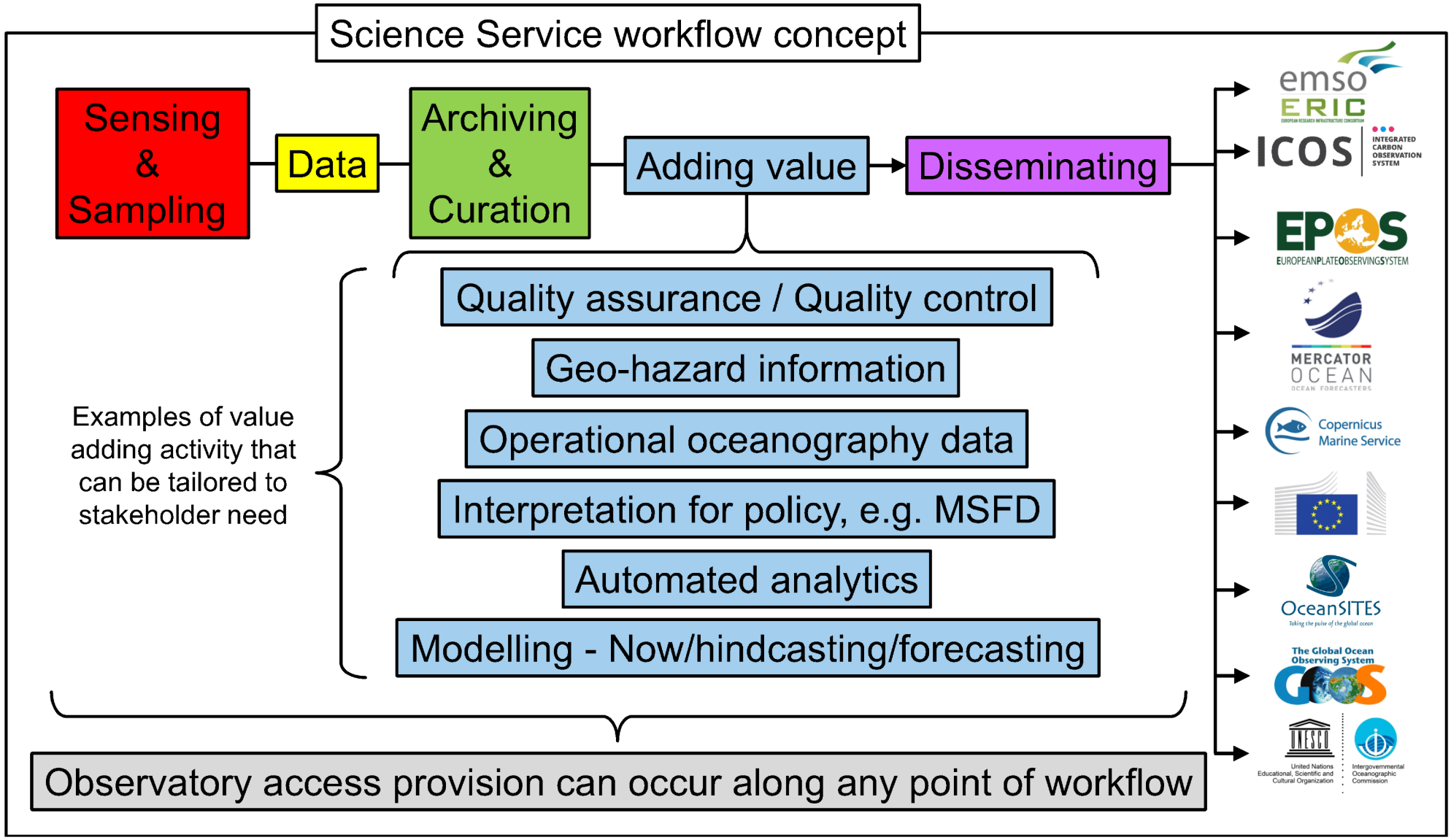


DEEP OCEAN OBSERVING STRATEGY

Essential ocean variables for global sustained observations of biodiversity and ecosystem changes

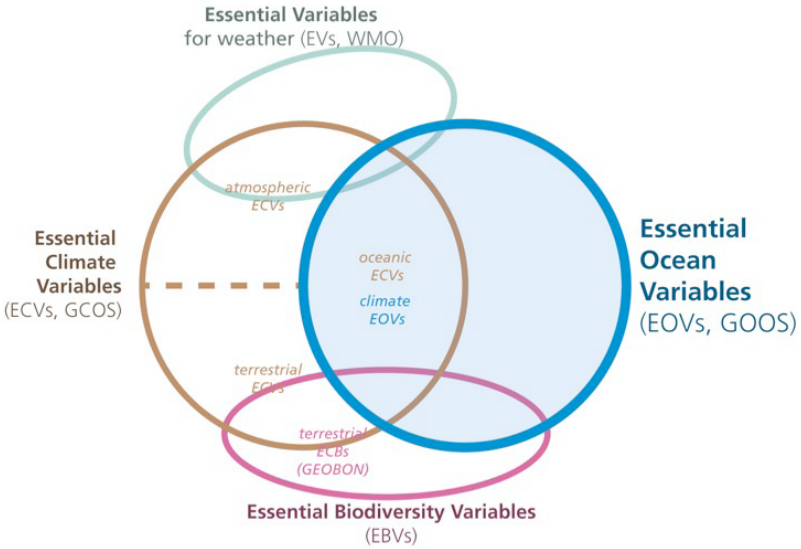
Glob Change Biol.
2018;24:2416–2433.

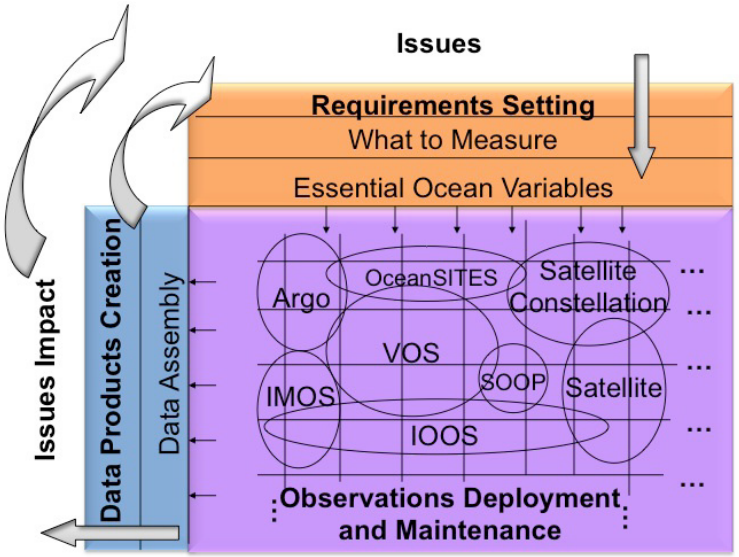
- Patricia Miloslavich,
- Nicholas Bax,
- Daniel Dunne
- Sam Simmons,
- Eduardo Klein,
- Ward Appeltans,
- Octavio Aburto,
- Melissa Anderson,
- Sonia Batten,
- Lisandro Benedetti-Cecchi,
- David Checkley,
- Sanae Chiba,
- Emmett Duffy,
- Albert Fischer,
- John Gunn,
- Raphael Kudela,
- Francis Marsac,
- Frank Muller-Karger,
- David Obura,
- Yunne Shin.

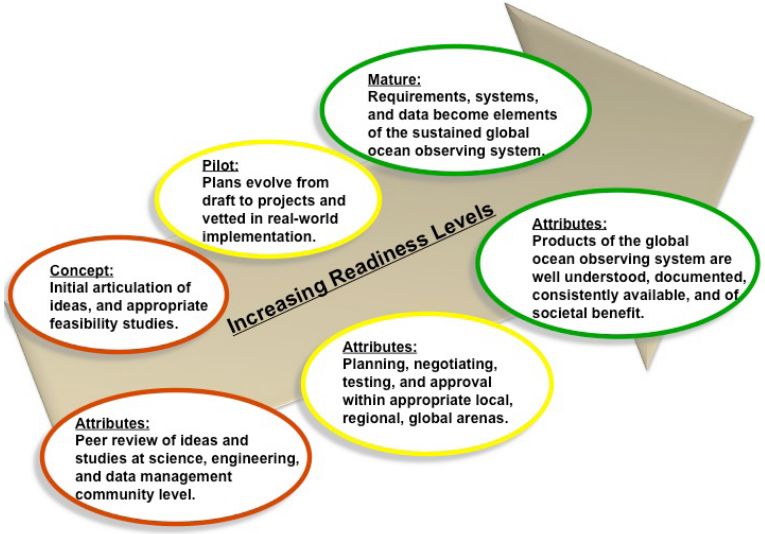
GOOS

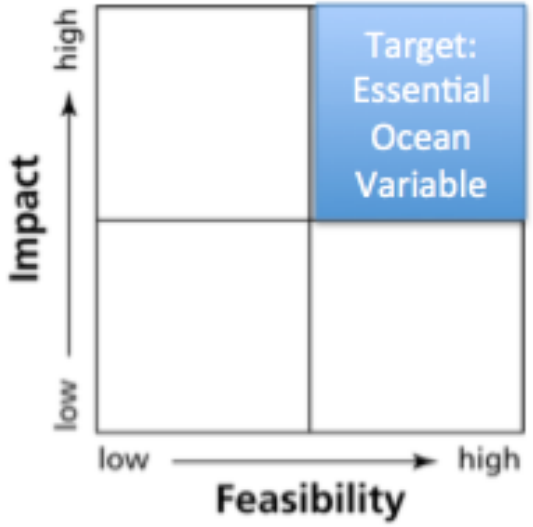
DEEP OCEAN OBSERVING STRATEGY

Framework for Ocean Observing





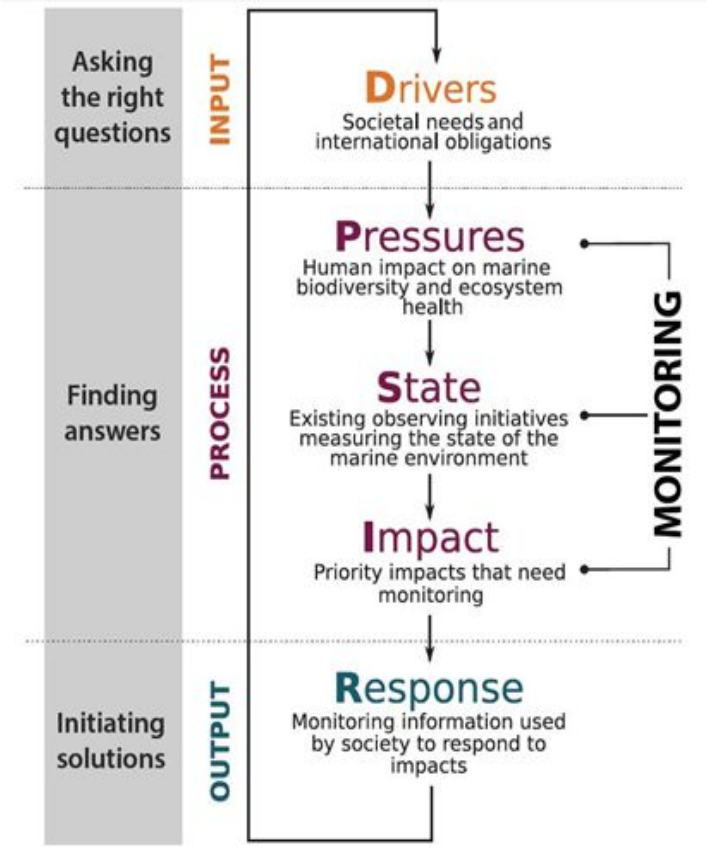




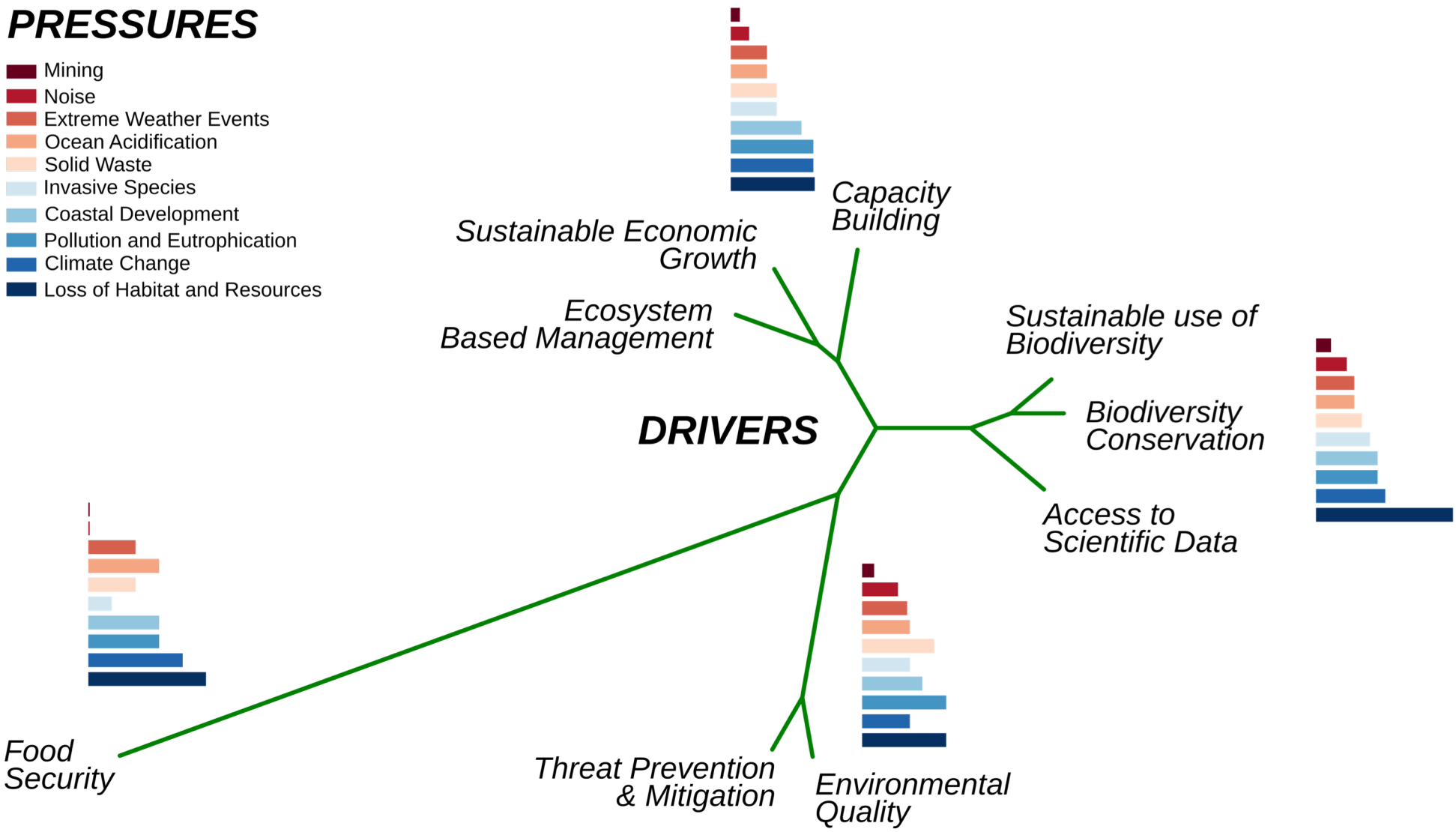
Driver-Pressure-State-Impact-Response (DPSIR)

Drivers of Impact used so far

- Sustainable use of biodiversity, biodiversity conservation, and knowledge,
- Environmental quality and threat prevention and mitigation,
- Capacity building, sustainable economic growth, and ecosystem based management, and
- Food security.



DEEP OCEAN OBSERVING STRATEGY



DEEP OCEAN OBSERVING STRATEGY

EOV Specification Sheet

Essential Ocean Variables (EOV) for Biology and Ecosystems:

Live coral

Authors: David Obura
Panel reviewers: Frank Muller-Karger, Lisandro Benedetti-Cecchi, Emmett Duffy, Sanae Chiba
Last updated Version 2017.

Background and Justification:

Hard corals are the principal architects of coral reefs, supporting the high biodiversity and productivity of shallow, tropical coral reef systems. Coral reefs are among the most biodiverse and highly valued ecosystems worldwide for their ecosystem goods and services. They are also one of the most threatened ecosystems of the world. Many people that depend on coral reefs live in low-income tropical countries. Healthy reefs are a foundation for their livelihood and food security; some products derived from coral reefs have global markets, including ornamental fish, cement, and tourism and recreation. Climate change, ocean acidification, fisheries, pollution, and coastal development are all significant threats to coral reefs. Hard corals are particularly vulnerable because they are slow-growing and susceptible to stress, particularly when there are synergies between natural and anthropogenic stresses. The health and areal extent of the hard coral community within a reef are direct indicators of the ability of a system to sustain the diversity of associated species, productivity, and valuable ecosystem services.

Multiple measures give fundamental information on the health of a coral reef: **live hard coral cover** and the areal extent of a reef are the most important indicators of whether a reef is in a coral-dominated state or not; the **composition and diversity of coral taxa** is an important index of reef health; **coral condition (e.g. bleaching, disease)** gives fundamental information on the health of a reef; the **size class structure (and recruitment) of hard corals** gives fundamental information on the resilience, disturbance history and recovery potential of a reef.

'Hard' and 'soft' corals are key taxonomic groups dominating hard and some soft substractes in subtidal habitats from the shallows to the deep ocean, and from the equator to polar regions. This wide range of habitats can be grouped into three principal assemblages: tropical hard coral communities (coral reefs), soft coral-dominanted habitats, and deep- or cold-water coral communities. This specification sheet is focused on the former – **tropical hard coral communities** – to meet the immediate need there. Parallel specification sheets have been developed for other hard- and soft-coral dominated habitats.

Table 1 EOV Information (definitions of terms in glossary)	
Name of EOV	Live coral
Sub-Variables[1]	- Live coral cover and areal extent - Coral diversity (species, genera and functional type; and alpha, beta or gamma) - Coral condition (diseases, bleaching, mortality (partial and full), predated, silted, other conditions/syndromes) - Total habitable substrate (less sand/silt substrates, structural complexity) - Coral size classes (recruits/small corals, size class distribution)
Derived products	- Maps of coral cover and areal extent - Inventories of coral diversity - Coral condition - Coral recruitment and size class distributions - Coral reef habitat classifications, mapped layers - Coral reef system health (with key fish, urchins, macroalgae EOVs) - Convention indicators – Aichi Target 10, SDG 14.2/5, IPBES
Supporting Variables	Water clarity / turbidity Temperature pH Total Alkalinity (TA) Salinity Nutrients (N and P) Sedimentation Herbivory
Additional Contact/Expert(s)	Frank Muller-Karger, Jorge Cortés, Aldo Croquer, Hugh Sweatman, Rusty Brainard

Table 2: Requirements Setting	
Responsible GOOS Panel	Biology and Ecosystems Panel

Societal Drivers	Sustainable use: biodiversity and resources Conservation: biodiversity and ecosystems Development: sustainable economic growth Knowledge: science / data access Capacity building Improve management: integrated ecosystem approach Threat prevention and impact mitigation Food security Environmental quality: health
Societal Pressures	Loss of resources: habitats / biodiversity Climate change Pollution / eutrophication Coastal development and alteration Ocean acidification Extreme weather events Invasive species Sedimentation Aquarium trade Coral Mining
Readiness Level	Global : Requirements : Mature (7) Observation system : Pilot (4/5) Data & information : Concept (1) Regional : to be developed through each regional assessment. • Caribbean : Requirements (7), Observation system (5), Data & Information (2) • Western Indian Ocean : Requirements (6), Observation system (3), Data & Information (1) • Central and Western Pacific (Pacific RAMP) : Requirements (7), Observation System (7), Data and Information (4) • Great Barrier Reef : Requirements (7), Observation System (7), Data and Information (5)
Scientific questions	1. What is the current status of coral reefs (extent, diversity, health) and of life on coral reefs? 2. How is life on coral reefs changing? 3. What are the natural and anthropogenic drivers of change on a coral reef? 4. How does the changing status and trend of coral reefs affect ecosystem function and the provision of ecosystem services and benefits?

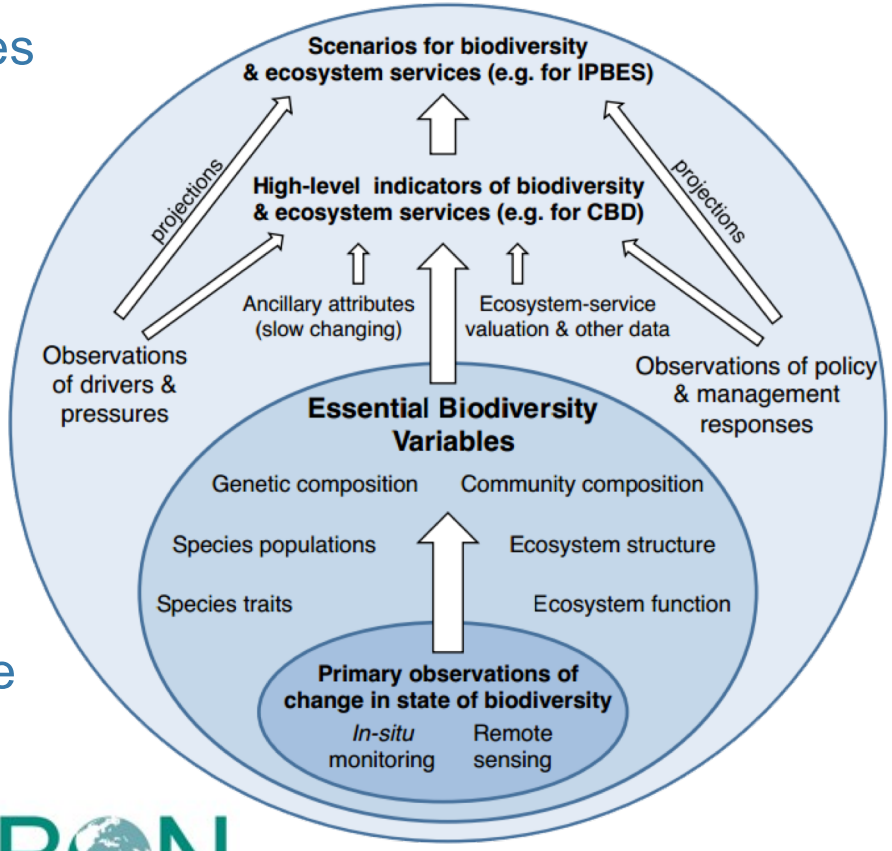
Phenomena to capture	**1- Status and trends (all subvariables)**	**2-Severe decline (all sub-variables, from coral bleaching, cyclones, COTs, other)**	**3- Recovery processes (recruitment, size transitions)**		
Complementary variables	Habitat type (Aiming towards having updates of the global coral millennium map and enhancing the WCMC atlas with habitat type)	**1) Immediate -** SST and bleaching forecasting data (NOAA Coral Reef Watch) - derivative of SST EOV? **2) Long term** - *trait EBVs (coral traits)* on bleaching/stress susceptibility, *genetic/genomic EBVs* indicative of stress	**1) Connectivity -** data on currents (derived from EOV?) and/or connectivity models. **2) Hydrodynamic residence time –** influences biogeochemistry of reef ecosystems. 3**) Net Accretion/Calcification and Bioerosion –** balance between production and removal of calcium carbonate, ability of reefs to persist		
Temporal Scales of the Phenomena	Years to Decades	Weeks to 2-3 years	Weeks to years to decades		
Spatial Scales of the Phenomena	Local, regional, global	Local, regional	Local, regional		
Magnitudes/range of the signal, thresholds to capture for the processes	1-2% ± annual changes	> 10%	> 10%		
Desired detection limit relative to signal	±10%	±20%	±10-20%		

Group on Earth Observation – Biological Observation Network

Criteria for Essential Biodiversity Variables

An ideal EBV should be

- able to capture critical scales and dimensions of biodiversity
- biological
- a state variable (in general)
- sensitive to change
- ecosystem agnostic (to the degree possible)
- technically feasible, economically viable and sustainable in time



GEO BON
Group on Earth Observations
Biodiversity Observation Network

GEO BON Strategy for development Of Essential Biodiversity Variables
Version 2.0
Produced by GEO BON Management Committee

GOOS

DEEP OCEAN OBSERVING STRATEGY

- Prospective GEO BON EBVs

EBV Class	Candidate EBV	Assessment at expert/stakeholder/ decision maker workshop	% of ecological features for which the variable is useful			
			All	Terrestrial	Marine	Freshwater
Species populations	Species distribution	Very useful at regional and State scales; can be measured with existing resources; high priority.	100	100	100	100
	Population abundance	Very useful at all spatial scales; additional resources are needed; high priority	72	100	–	71
	Population structure	Very useful at local and regional scales; substantial resources are needed; medium priority	47	28	100	43
Genetic composition	Co–ancestry	The four variables in this EBV class were regarded as one variable: genetic differentiation within species.	9	5	–	29
	Allelic diversity	As above; very useful at all spatial scales; substantial additional resources are needed; medium priority	–	–	–	–
	Population genetic differentiation	As above	31	3	100	36
	Breed & variety diversity	As above	–	–	–	–
Species traits	Phenology	Very useful at all spatial scales; additional resources are needed; medium to high priority.	31	41	–	33
	Body mass	An agreed assessment was not achieved.	–	–	–	–
	Natal dispersal distance	(dispersal); very useful at regional to State scales; additional resources needed; medium priority	4	–	–	20
	Migratory behaviour	Very useful at regional to State scales; additional resources are needed; high priority.	43	8	100	80
	Demographic traits	Very useful at all spatial scales; additional resources are needed; high priority.	23	31	–	20
	Physiological traits	Very useful at local to regional scales; additional resources are needed; medium priority.	74	100	–	73
Community composition	Taxonomic diversity	Useful at all spatial scales; additional resources are needed; medium priority.	94	100	100	73
	Species interactions	It was recommended that this be named "interaction" and regarded as part of ecosystem function.	62	100	–	20
Ecosystem function	Net primary productivity	Useful at all spatial scales; may be measured with existing resources; high priority.	69	59	100	67
	Secondary productivity	An agreed assessment was not achieved.	35	–	100	67
Ecosystem structure	Nutrient retention	An agreed assessment was not achieved.	57	67	47	47
	Disturbance regime	An agreed assessment was not achieved.	91	100	73	87
	Habitat structure	Useful at local to regional scales; additional resources are needed; medium priority.	84	92	73	73
	Ecosystem extent & fragmentation	(community); Very useful at all spatial scales; may be measured with existing resources; high priority.	84	90	100	53
	Ecosystem composition by functional type	An agreed assessment was not achieved	50	26	100	67

GEO BON

MBON

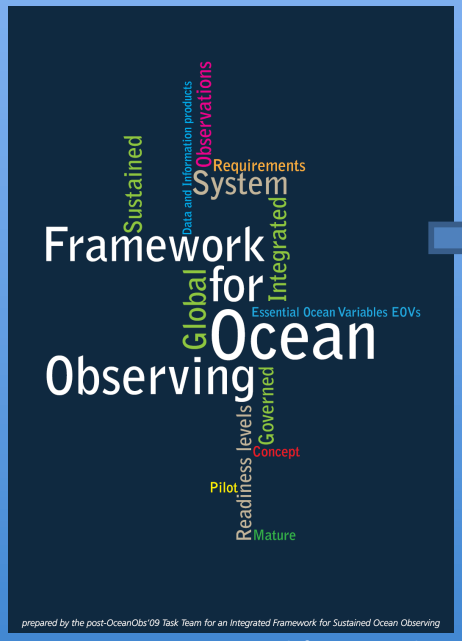
Marine Biodiversity Observation Network

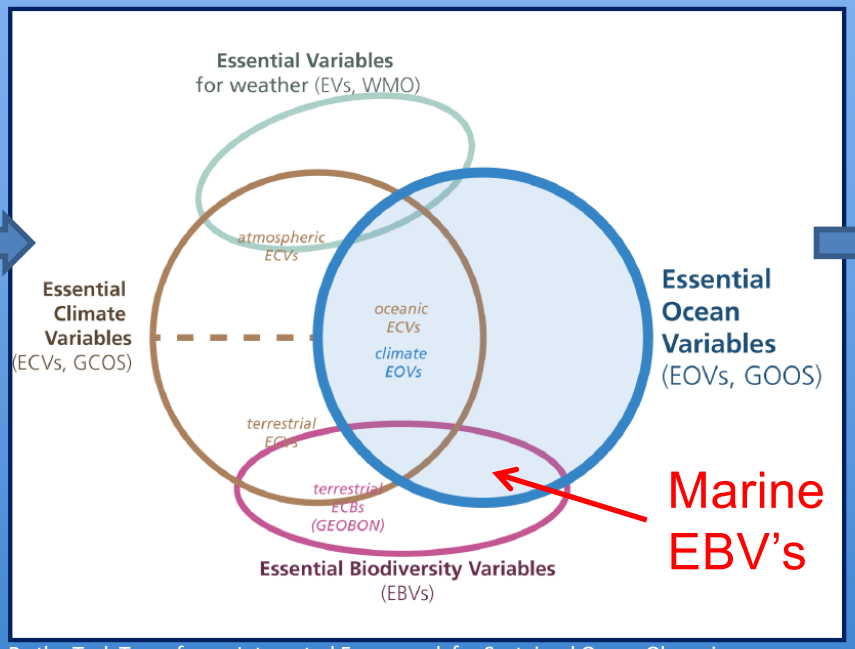
Contacts: GEO BON MBON co-chairs

-Frank Muller-Karger (carib@usf.edu)
-Isabel Sousa Pinto (ispinto@ciimar.up.pt)
-Mark Costello (m.costello@auckland.ac.nz)

Goals

- Identify indicators of change in life in the ocean
  - *Build a Community of Practice around biodiversity observations*
  - *Define Essential Biodiversity Variables (EBV) as sub-variables of Essential Ocean Variables (GOOS EOV)*
- Facilitate networking of programs (national/international)
- Document Best Practices, assist in capacity building
- Address user needs regarding biodiversity
- Plan for operational biological observations integrated into existing and planned physical & biogeochemical obs. systems





FOO, 2012. A Framework for Ocean Observing. By the Task Team for an Integrated Framework for Sustained Ocean Observing, UNESCO 2012, IOC/INF-1284, doi: 10.5270/OceanObs09-FOO

Image courtesy of Francisco Chavez / MBARI

Thanks for your attention!


2016 - 2015
Ocean Observation
Address societal drivers and pressures
Assess current state of ocean observations
Build upon the Framework for Ocean Observation and existing observing programs
Prioritize
2016 - 2017
Propose EOVs: relevant, credible, measurable
Biological Essential Ocean Variables
functional groups
Phytoplankton biomass and diversity
Zooplankton biomass and diversity
Fish abundance and distribution
Marine turtles, birds and mammals abundance and distribution
ecosystems
Live coral
Seagrass cover
Mangrove cover
Macroalgal canopy
Develop priority EOVs with science community
Validation
Complementary and supporting variables
Measurement requirements
Observing networks
Observing elements
Data and information management
Readiness for global implementation
2017 - 2018
Facilitate multidisciplinary collaboration across observation platforms
Integration
Maximize cost-efficiency
Avoid overlap
Standardize methods and data collection
Spearhead technological development
Address major challenges in data integration
2019 - 2018
Towards a sustained and targeted global ocean observation system
Implementation
A mature observation programme of a set of EOVs
Provide indicators of change
Globally coordinated and global coverage
Open access data
Support international reporting needs
Contribute to decision making at local, national, and global scales
Streamline GOOS into the future
Keep improving


Process
Review of International Conventions identify requirements
Societal needs and international obligations
Drivers
Pressures
State
Impact
Response
On marine biodiversity and ecosystem health
Establishing feasibility
Survey of Observing Programs spatial and temporal extent of biological variables
Observations addressing societal needs
Prioritize based on feasibility and impact of EOVs
Societal use of monitoring information
Initiate Solutions deliver to requirements
Sustained Ocean Observations

Efforts to Reference

- GEO BON / MBON
- Aichi targets for 2020 of the Convention on Biological Diversity
- UN SDG – incl. # 14 Life Below Water
- MSFD (Defra – Healthy and Biodiverse Seas Evidence Group [HBDSEG])
- Ocean Networks Canada
- Ocean Observatory Initiative
- OceanSITES
- GLOBIS-B (GLOBal Infrastructures for Supporting Biodiversity research), a global cooperation funded by the Horizon 2020
- EMSO data products – in development

GLOBIS-B

Table 1. Project partners and supporting research infrastructures of the GLOBIS-B project. The listed supporting research infrastructures represent those that have agreed to contribute to the GLOBIS-B project.

Acronym	Organisation	Geographic scope	Website
Project partners			
UvA	University of Amsterdam (Institute for Biodiversity and Ecosystem Dynamics)	Netherlands	http://ibed.uva.nl/
CU	Cardiff University (School of Computer Science and Informatics)	UK	http://www.cs.cf.ac.uk/
GNUBILA	gnúbila France	France	https://gnubila.fr/
CNR	Consiglio Nazionale delle Ricerche (Institute of Biomembranes and Bioenergetics)	Italy	http://www.cnr.it/sitocnr/home.html
FI-UAH	Universidad de Alcala (Instituto Benjamin Franklin)	Spain	http://www.institutofranklin.net/
MLU	Martin-Luther-Universität Halle-Wittenberg (German Centre for Integrative Biodiversity Research i-Div)	Germany	http://www.idiv-biodiversity.de/idiv/research/geo-bon/
Supporting research infrastructures			
Atlas	Atlas of Living Australia	Australia	http://www.ala.org.au/
BC-CAS	Biodiversity Committee of the Chinese Academy of Sciences	China	http://www.kepingma.com/index.html
CRIA	Brazilian Reference Centre on Environmental Information	Brazil	http://www.cria.org.br/
DataONE	Data Observation Network for Earth	USA	http://www.dataone.org/
ELIXIR	European infrastructure for biological information	Europe	http://www.elixir-europe.org/
GBIF	Global Biodiversity Information Facility	Global	http://www.gbif.org/
GEO BON	Group on Earth Observations Biodiversity Observation Network	Global	http://www.geobon.org
GBoWS	Germplasm Bank of Wild Species at Kunming Institute of Botany	China	http://english.kib.cas.cn/
LifeWatch	European Infrastructure for Biodiversity and Ecosystem Research	Europe	http://lifewatch.eu/
NEON	National Ecological Observatory Network	USA	http://www.neoninc.org/
SANBI	South African National Biodiversity Institute	South Africa	http://www.sanbi.org/
WDCM	World Data Centre of Microorganisms at WFCC-MIRCEN	Global	http://www.wdcm.org/

EOVs as ID'd at DOOS workshop, Dec. 2016

EOVs to evolve specifications, or add new ones, NB this list is to document suggestions, rather than specify what will be addressed in detail.		
	Supporting EOVs for BioEco	
BIOLOGY AND ECOSYSTEMS	BIOGEOCHEMISTRY	PHYSICS
Benthic variants for zooplankton and fish biomass and diversity	Nitrogen/phosphorus efflux/influx (Biogeochemistry)	Bottom currents (Physics)
Size-specific body size (mass); specific biomass	Chemical profiles of metals such as dissolved Mn (manganese) or particulate	Temperature (Physics)
Microbial biomass (diversity/activity)	Iron (Biogeochemistry)	Substrate (soft/hard, composition)
Bioacoustics/Biophony (animal sound)	Eh in water	Light (different wave lengths)
Cover of living habitats (e.g. chemosynthetic ecosystems such as seeps, vents, cold water coral and sponges grounds…)	CH4 in water and sediment profile (Biogeochemistry)	Ocean sound – (frequency, amplitude – time series)
Oxygen consumption: O2 sediment profiles /Sediment Community Oxygen Consumption (SCOC), see also methods like eddy correlation and chambers.	Sediment geochemistry	Geophony (Earth sounds)
Connectivity of species (life history groupings) (FST)	Quality of organic matter C/N	Anthrophony (human sound)
	Bioturbation Pb-210	Ocean bottom pressure?
	Particulate flux (labile and refractory, perhaps revisit existing EOV for particulate matter)	

GOOS BioEco EOV plan

Action Plan

- Identify the **societal drivers and pressures** that can be addressed by sustained, long-term observations of biological variables in the ocean
- Assess the **effectiveness** of the current state of ocean observations, both temporal and spatial
- **Facilitate** regional and global **integration** of existing biological observing networks to increase their value and reach
- Develop **new, global biological observing** networks as necessary to support sustained measurement of biological essential ocean variables
- **Improve the communication** of results from sustained monitoring of biological variables, thus increasing their contribution to decision making at local, national, and global scales

The Products

- A global **biological and ecosystem observation network** that provides more timely, consistent and informed scientific advice on the status of, and threats to, critical marine resources.
- A fit-for-purpose system that encourages **best practices** and **development of technology** to improve sampling strategies.
- A **collaborative international approach** that strengthens data sharing and interoperability, enhances capacity building, facilitates technology transfer, and increases future management options at all levels of government.

GOOS

DEEP OCEAN OBSERVING STRATEGY

DOOS Assessment

- Existing or prospective GOOS EOVs as initial focus
- Identifying the scientific and societal needs that require sustained biological and ecological oceanographic observations, considering international convention requirements,
    - develop list of which stakeholders or conventions to consider
- Evaluating the existing time series (including inputs of GOOS and DOOS workshops/surveys to date), and
- Studying the impact versus feasibility of the variables being currently measured and how their sustained observation would address societal needs.
- TRL table with expert input, citable score evidence including literature search through SCOPUS to have a metric on how many publications address the variables and the specific societal drivers and/or pressures as identified from the international conventions.
- Online survey exists from Duke, Van Dover Group.
- Expert consensus may be the best way in this case of deep ocean

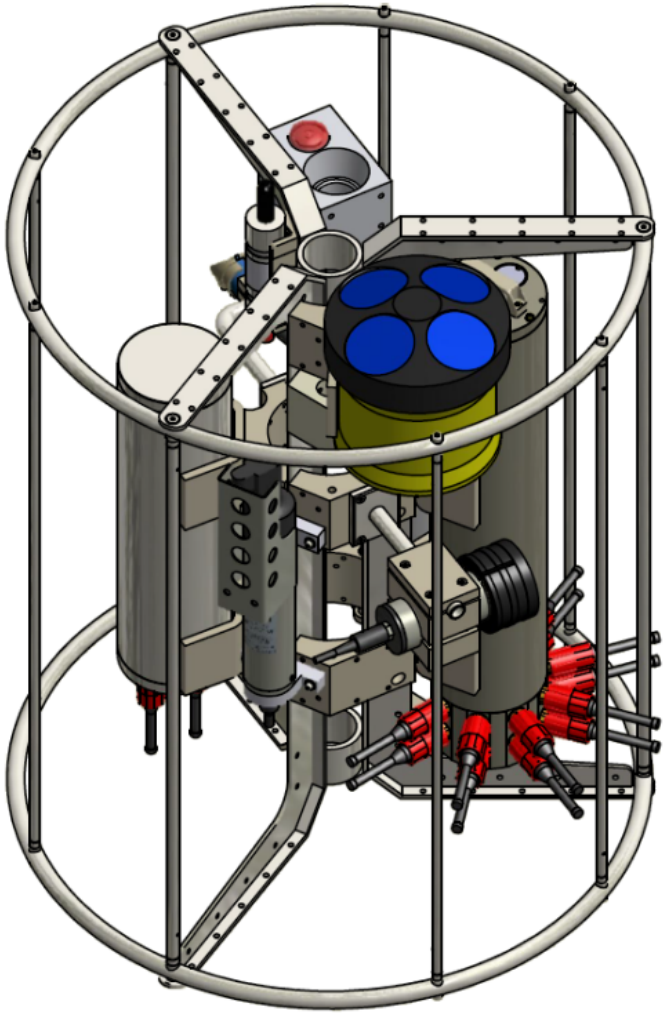
Milestones

- September 2017 - Summary of DOOS BioEco activity plan for discussion at DOOS SC
- Autumn 2017 (?) - Share DOOS EOV planning with GOOS, agree process for DOOS to influence GOOS EOV specification.
- Spring 2017 (?) – Provide DOOS and GOOS a written update on progress, agree process with GOOS for DOOS to make contributions to EOV specifications.
- Autumn 2018 (?) – Launch new DOOS-linked EOV material at OceanObs ’19.

European Multidisciplinary Seafloor and water-column Observatory DEVelopment

EMSODEV and EGIM

- EMSO Generic Instrumentation Module;
- Operable across all science and monitoring needs;
- Deployment from cabled to stand alone mode;
- Surface ocean mooring to seafloor lander;
- Provides standardisation for:
  - Sensors and detailed requirements;
  - Sensor arrangement;
  - Data and power handling;
  - Common framework for data management.

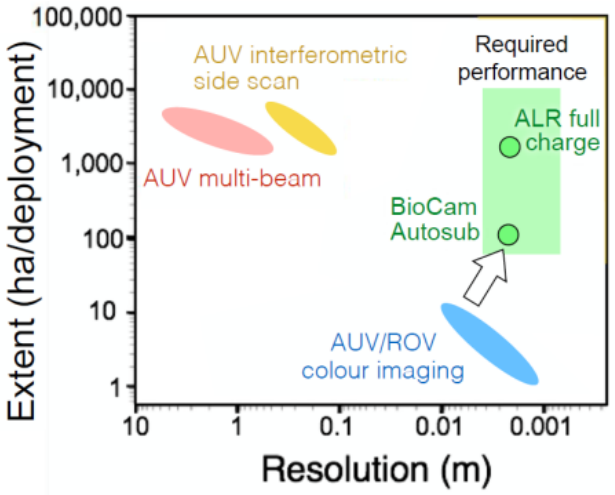


Type of sensor	Range†	Accuracy†
Conductivity	0 to 9 S/m	0.001 S/m
Temperature	-5 to +35°C	0.01 K
Pressure	0 to 600 bar	0.1 % FSR
Dissolved oxygen	0 to 500µM	5%
Turbidity	0 to 150 NTU	10%
Currents	0 to 2 m/s	2%
Passive acoustics	50 - 180 dB re 1 µPa	+/-3dB

GOOS EOVs

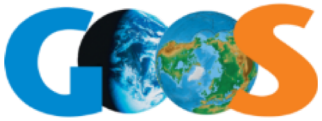
Readiness level: CONCEPT | PILOT | MATURE

PHYSICS	BIOGEOCHEMISTRY	BIOLOGY AND ECOSYSTEMS
Sea state	Oxygen	Phytoplankton biomass and diversity
Ocean surface stress	Nutrients	Zooplankton biomass and diversity
Sea ice	Inorganic carbon	Fish abundance and distribution
Sea surface height	Transient tracers	Marine turtles, birds, mammals abundance and distribution
Sea surface temperature	Particulate matter	Live coral
Subsurface temperature	Nitrous oxide	Seagrass cover
Surface currents	Stable carbon isotopes	Macroalgal canopy
Subsurface currents	Dissolved organic carbon	Mangrove cover
Sea surface salinity	Ocean colour *(Spec Sheet under development)*	Microbe biomass and diversity (*emerging)
Subsurface salinity		Benthic invertebrate abundance and distribution (*emerging)
Ocean surface heat flux		



Potential Roles of Contributors

- Represent/connect to key stakeholder groups and
- Adopt one or more EOVs to lead their specification with a deep-ocean perspective.
- Practically this would involve active contribution to the process of EOV suggestion / selection / specification / dissemination.
- A lot of the work will aim at Specification sheets (revising GOOS Spec. Sheets / developing DOOS Spec. Sheets).
- Quarterly teleconferences to exchange within the task team and report back to DOOS on progress and issues



Potential Contributors and Roles

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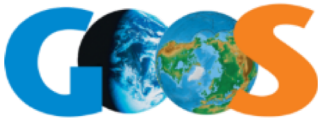

EOV Specification Sheet

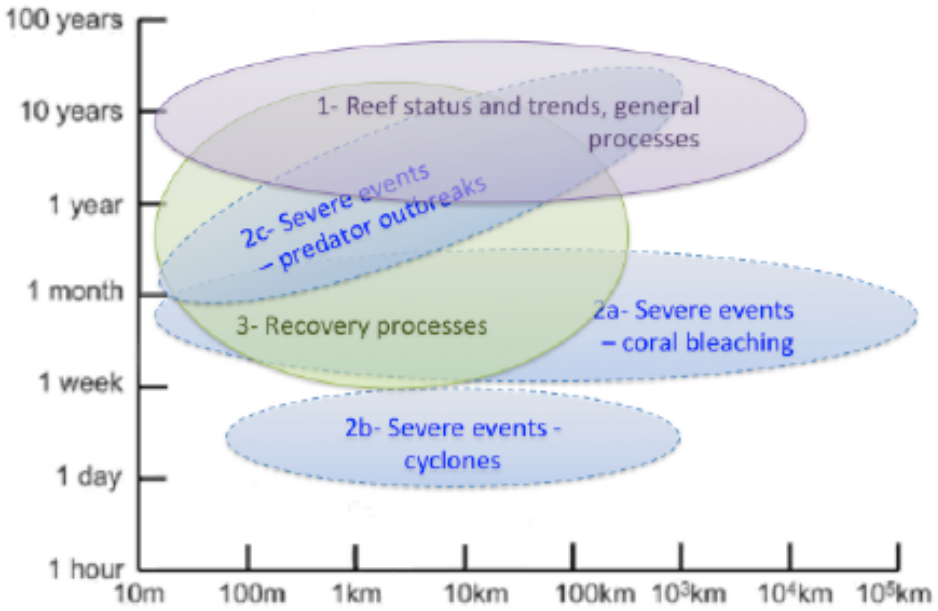

Figure 1: Draw Scales of processes to be addressed, and fill in the magnitude of the signal to capture.

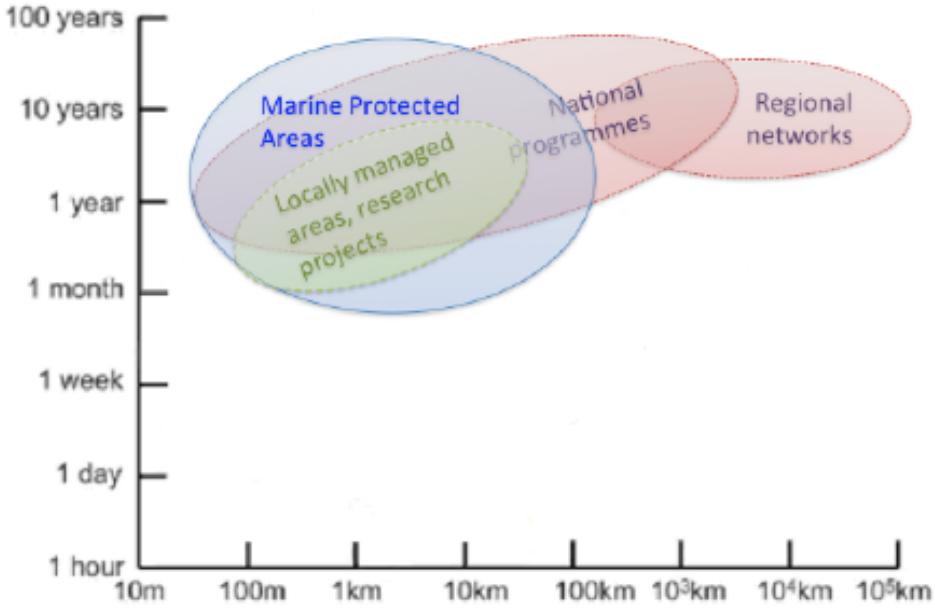

Figure 2. Draw in the well resolved observation scales of the component networks. If these scales are highly dependent on location or time, separate ovals could be drawn to capture this variability (e.g., one for the North Atlantic Ocean, and another for the Southern Ocean). If the capability changes greatly in recent times or will change in the near future (i.e., within five years), provide examples from two times. **This refers to the scales that can be resolved, rather than the scales by the network, rather than for individual observations.**

Also contain sections for:

- Current observing networks
- Future observing elements
- Data information and creation
- Links and references

DEEP OCEAN OBSERVING STRATEGY