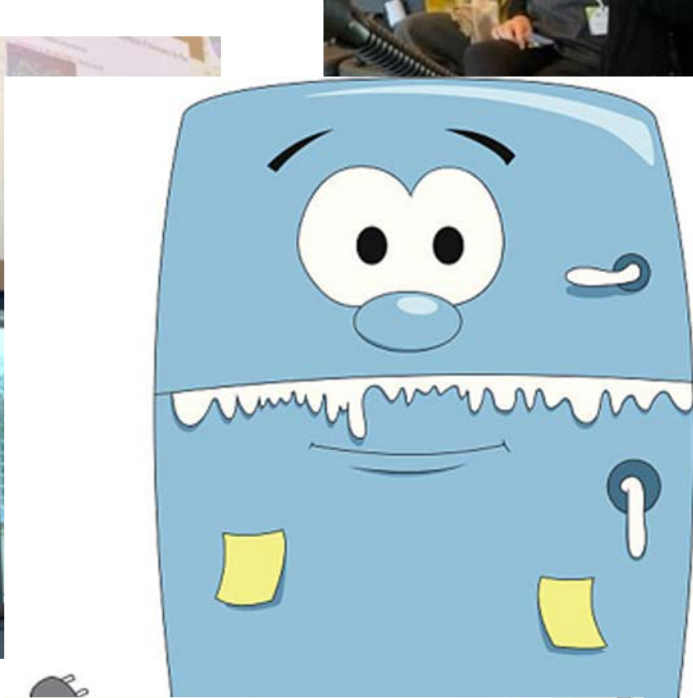


Priority list of marine biodiversity metrics to observe from space

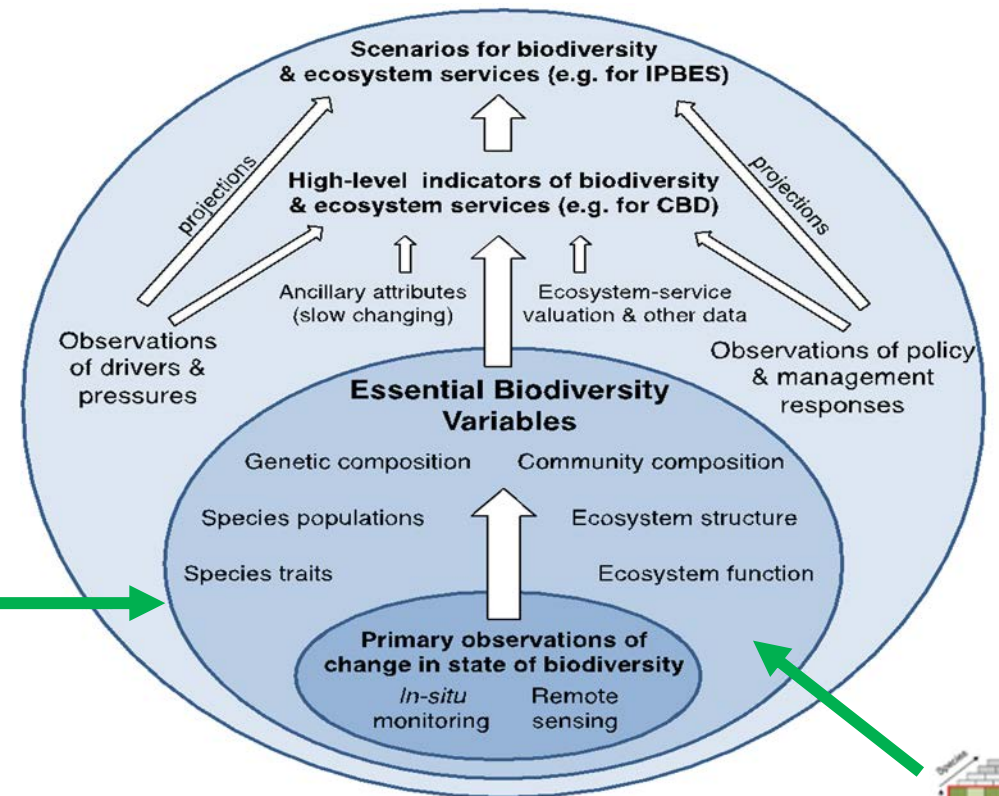
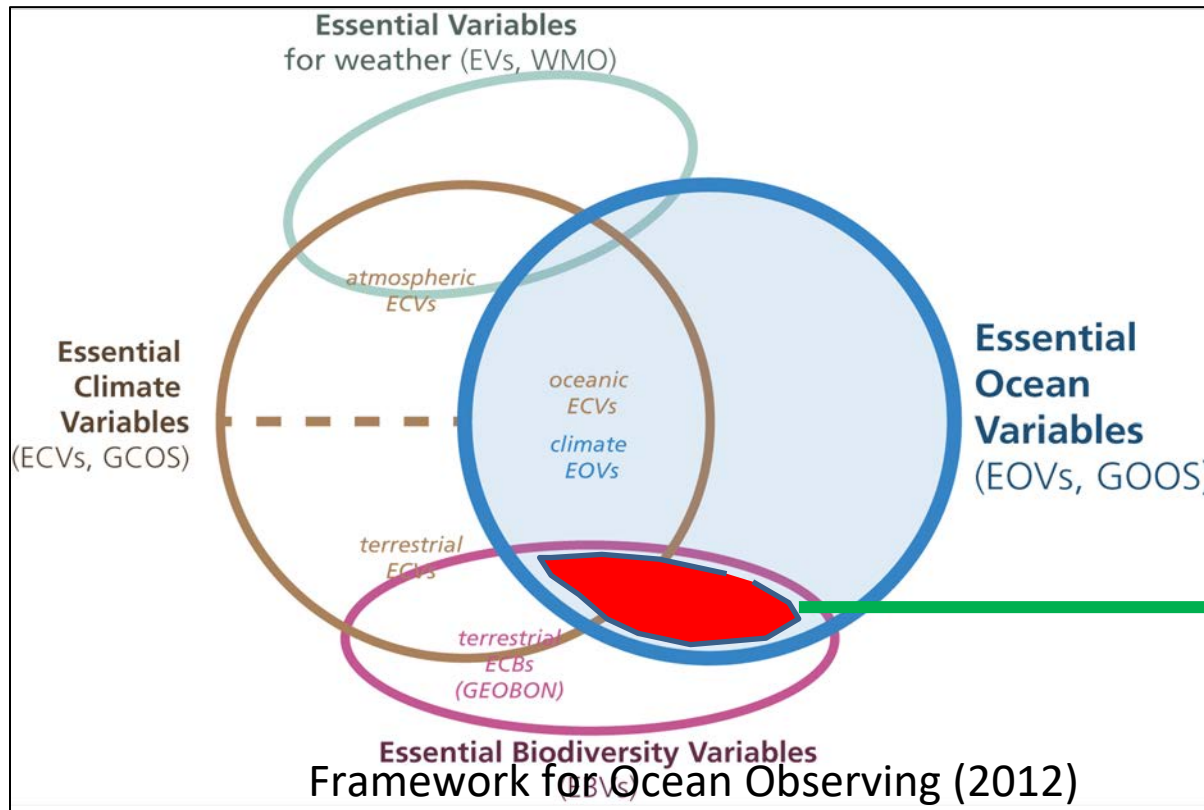
Chairs: Victor, Martinez Vicente, Frank Muller-Karger, Alice Soccodato, Emanuele Organelli

Presentations / discussion

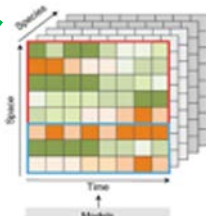
Title	Speakers
What are Essential Variables? Moving towards indicators	Victor Martinez (PML), Alice Soccodato (EMBRC), Frank Muller-Karger (USF)
Phytoplankton EOV: EBV class Community composition Seagrass Cover and Composition EOV)	Astrid Bracher (AWI) Heidi Dierssen (U. Connecticut)
EOV: EBV → Ecosystem structure	Maria Kavanaugh (Oregon State U)
Species distribution models: Aquamaps	Gabriel Reygondeau (U Miami)
Models → status/trends/forecast indicators	Camila Serra Pompei (MIT)



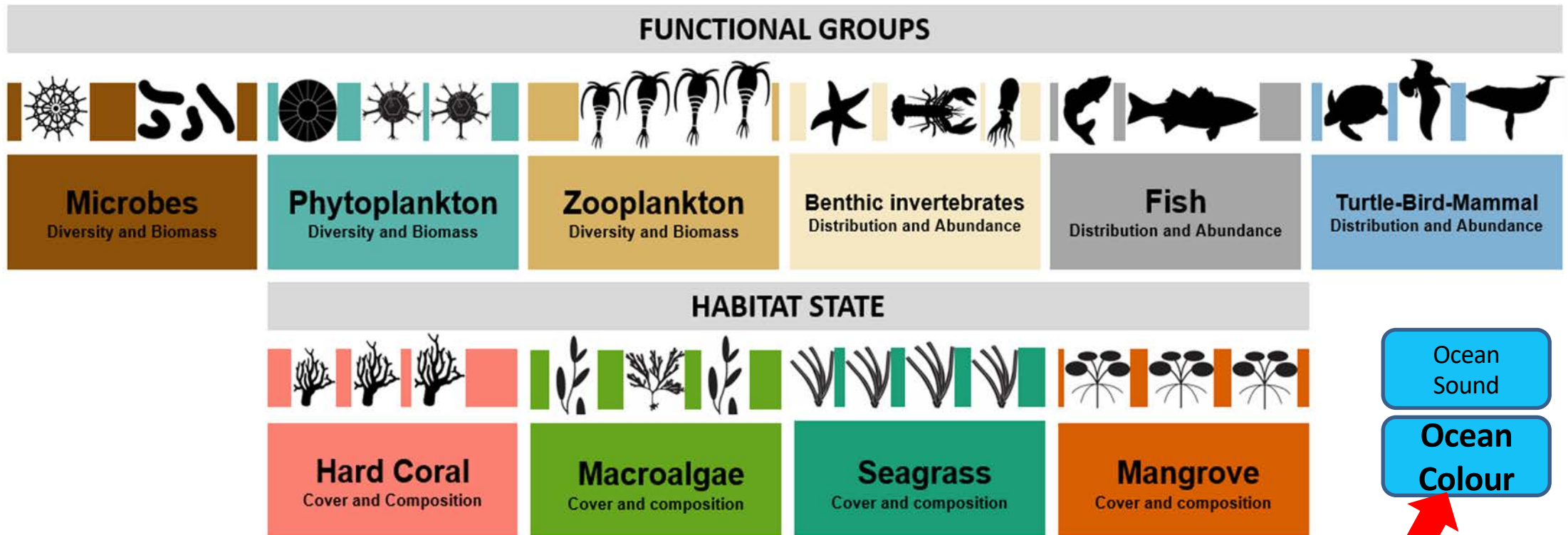
Essential Ocean Variables are observations needed to model and build the Essential Biodiversity Variables (EBVs → e.g., time series, data cubes)



GOOS EOVs



Biology and Ecosystem Essential Ocean Variables (EOVs)



Many Bio-Eco EOVs are now also Essential Climate Variables adopted by <https://gcos.wmo.int/en/essential-climate-variables>

Discussion and contributions (on general EOV)

- EOV, EBV, indicators: Basis for common language to inform policy
- Framework to standardize observing (in situ, remote sensing)
- Facilitates standardized / interoperable information management

Recommendations

Facilitate Co-design: Work more closely with key stakeholders

- Science:
 - Ecologists
 - Social scientists
 - Modelers
 - Forecasting and scenario assessments
 - Models to help plan research
 - Modelers need centralized product source for EOV/EBV assimilation/validation (e.g., Bio-Oracle.org; need uncertainty fields)
 - Better resolve land-ocean continuum
- Industry sectors
 - fisheries, energy, mining,
 - information management
- Monitoring/management:
 - Global Greenhouse Gas Watch (GGGW)
 - CO₂, Methane, Nitrous Oxide
 - National GGG accounting
 - International conventions
 - SDG, CBD/GBF (30x30 and other targets)
 - Ocean Use Planning, conservation

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Recommendations

Plan for continuity of research missions

New climate relevant datasets for EBV

Enable community collaboration on large questions about marine life:

- diversity,
- distribution (coastal, full water column / 4D: Lidar, Argo, models),
- abundance,
- productivity (need refined NPP estimates),
- evolution,
- impacts of marine life on climate
- multistressor impacts on life, ecosystems
- ecosystem baselines, shifts, cascading effects
- forecasting life
- land/ocean interactions

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Recommendations

Convene group to identify minimum set of EOV/EBV products:

- e.g., EOV subvariables of plankton, macroalgae, seagrass and other benthos, etc.
- 4H (spatial, temporal, spectral, quality)
- 4D (long, consistent time series)
 - Examples:
 - Phenology
 - Ecosystem functions

Increased focus coastal biodiversity and integrated land/ocean time series of biodiversity data cubes

- Improved coastal products (PFT, NPP, EOV extent)

Capacity sharing / development:

- Public ocean literacy: use space agency PR to engage public in excitement about discovery of life
- Professional development:
 - best practices (observing, management)
 - Publishing data (species, traits, abundance, etc.)

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Recommendations



IOCCG to develop CEOS biodiversity position paper

- Current CEOS focus largely terrestrial

CEOS Biodiversity:

[Biodiversity | CEOS | Committee on Earth Observation Satellites
https://ceos.org/ourwork/other-ceos-activities/biodiversity/](https://ceos.org/ourwork/other-ceos-activities/biodiversity/)

CEOS Global Stocktake: [CEOS & UNFCCC Global Stocktake
https://ceos.org/gst/](https://ceos.org/gst/)

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Synthesis of recommendations

- **Recommendation 1:** IOCCG to develop CEOS biodiversity position paper over the next year
- **Recommendation 2:** Community to summarise priorities (low hanging fruit) over the next year for agencies to support over the next 5 y in a paper derived from this workshop breakout and relevant projects.
- **Recommendation 3:** Agencies to support cross agency work on EBV/EOV to engage with stakeholders to refine needs/requirements
- **Recommendation 4:** Agencies & community ensure mission continuity and climate relevant dataset for biodiversity

Thanks to participants and speakers in the session!!



Ocean color-derived PFT

- Ocean color-derived PFT concept now over 20 y old, improving
- Products now available (e.g., Copernicus)
 - Operational products largely based on pigment observations
 - Need to improve uncertainties
- Recommendation
 - Agencies: need long term climate datasets with new requirements (more wavelengths)
 - Agencies: need mission continuity

Habitat EOVs: need global assessments

- Seagrass EOV: Hyperspectral is needed , but spatial resolution is limited
 - Complementarity with drones
- Macroalgae : floating is another EOV but observation requirements are different (e.g. Macyra Costa and C .Hu work)
- Recommendations:

recognition that global wetland and habitat EOV and EBV time series are needed (combined coral, mangrove, seagrass, macroalgae, etc)

Promote data standards and data publication culture

Ecosystem structure: a cross EOVS property

1. Ecosystem structure: **extent, distribution**, patch and front location, dominance, diversity, and novelty.
2. Need to address vertical structure. How do we best integrate multi-sensor (including LiDAR, Argo) and model data to quantify 4-D variability?
3. Need transparency and best practices for machine learning methods: IOCCG OWT Working Group.
4. Need validation case studies that embrace both ecological mechanism and optical rigor. Partnership (international) will be key.

Models

- Spatial distribution models need inputs from EO to incorporate temporal variability as inputs
- OAGCM+ biology