A global partnership for the systematic study of life in the sea...from microbes to whales.
Primary Messages

We want to assess impacts of oil spills, sargasso, and other events on local ecosystems, in a regional context

- Develop baseline of coastal and marine biodiversity against which to assess impacts
- Follow best practices advocated by the IOC
  - GOOS
  - IODE: OBIS, Best Practices, Ocean Teacher
- Join the Marine Biodiversity Observation Network (MBON) and GEO Blue Planet:
  - https://members.geobon.org/pages/index.php
Essential Biodiversity Variables (EBV)

Biodiversity:
the variety of life and habitats
- number of species,
- abundance, biomass,
- distribution
- interactions
- variability of habitat

Biodiversity benefits:

- ecosystem function & resilience,
- chemical cycles (oxygen, nutrients, carbon, etc.),
- human health (food, materials, chemicals, recreation)

Why measure Life in the Sea?
Coastal Habitat and Fisheries Impacts of Oil Spills and Sargassum Landings

Sargassum landing in Puerto Morelos: 19 March 2018 (Courtesy of Sergio Cerdeira, CONABIO/Mexico)

Plate 3: Industrial trawl net filled by *Sargassum hystrix var. fluitans*.


Figure 1: Oil stranded on the shoreline adjacent to a fishing village.

Images above from: THE INTERNATIONAL TANKER OWNERS POLLUTION FEDERATION LIMITED
Table 1.1. Established and emerging ocean-based industries

<table>
<thead>
<tr>
<th>Established</th>
<th>Emerging</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capture fisheries</td>
<td>Marine aquaculture</td>
</tr>
<tr>
<td>Seafood processing</td>
<td>Deep- and ultra-deep water oil and gas</td>
</tr>
<tr>
<td>Shipping</td>
<td>Offshore wind energy</td>
</tr>
<tr>
<td>Ports</td>
<td>Ocean renewable energy</td>
</tr>
<tr>
<td>Shipbuilding and repair</td>
<td>Marine and seabed mining</td>
</tr>
<tr>
<td>Offshore oil and gas (shallow water)</td>
<td>Maritime safety and surveillance</td>
</tr>
<tr>
<td>Marine manufacturing and construction</td>
<td>Marine biotechnology</td>
</tr>
<tr>
<td>Maritime and coastal tourism</td>
<td>High-tech marine products and services</td>
</tr>
<tr>
<td>Marine business services</td>
<td>Others</td>
</tr>
<tr>
<td>Marine R&amp;D and education</td>
<td></td>
</tr>
<tr>
<td>Dredging</td>
<td></td>
</tr>
</tbody>
</table>

2010: US$ 1.5-2.5 trillion

2030 Ocean economy: US$ >3 trillion
Vision

Develop a community of practice...

...to understand marine biodiversity and how it changes over time

...to ensure sustainable development
OBSERVING LIFE IN THE OCEANS FOR SOCIETAL BENEFIT
(- INFORMATION FLOW -)

INTERNATIONAL LINKAGES

Global Ocean Observing System

GOOS: ESSENTIAL OCEAN VARIABLES
Focus on EOVs driven by societal needs
- Global implementation -

Biodiversity Observation Network (BON)

ESSENTIAL BIODIVERSITY VARIABLES
Focus on EBVs driven by science questions and other user needs (policy, societal)
- National and regional implementation -

DATA INTEGRATION AND DISSEMINATION

+ other national, international data systems

OTHER DATA PROVIDERS AND USERS

✓ National Governments and Organizations
✓ International Organizations
✓ Non Government Organizations
✓ Research Institutions
✓ Citizen Scientists
### Global Ocean Observing System (GOOS) Essential Ocean Variables (EOVs)

<table>
<thead>
<tr>
<th>PHYSICS</th>
<th>BIOGEOCHEMISTRY</th>
<th>BIOLOGY AND ECOSYSTEMS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sea state</td>
<td>Oxygen</td>
<td>Phytoplankton biomass and diversity</td>
</tr>
<tr>
<td>Ocean surface stress</td>
<td>Nutrients</td>
<td>Zooplankton biomass and diversity</td>
</tr>
<tr>
<td>Sea ice</td>
<td>Inorganic carbon</td>
<td>Fish abundance and distribution</td>
</tr>
<tr>
<td>Sea surface height</td>
<td>Transient tracers</td>
<td>Marine turtles, birds, mammals abundance and distribution</td>
</tr>
<tr>
<td>Sea surface temperature</td>
<td>Particulate matter</td>
<td>Hard coral cover and composition</td>
</tr>
<tr>
<td>Subsurface temperature</td>
<td>Nitrous oxide</td>
<td>Seagrass cover</td>
</tr>
<tr>
<td>Surface currents</td>
<td>Stable carbon isotopes</td>
<td>Macroalgal canopy cover</td>
</tr>
<tr>
<td>Subsurface currents</td>
<td>Dissolved organic carbon</td>
<td>Mangrove cover</td>
</tr>
<tr>
<td>Sea surface salinity</td>
<td>Ocean colour <em>(Spec Sheet under development)</em></td>
<td>Microbe biomass and diversity <em>(emerging)</em></td>
</tr>
<tr>
<td>Subsurface salinity</td>
<td></td>
<td>Benthic invertebrate abundance and distribution <em>(emerging)</em></td>
</tr>
<tr>
<td>Ocean surface heat flux</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
A Global Collaboration: IOC (OBIS + GOOS) and GEO (MBON)

e.g.: http://iobis.org/2016/12/15/goosgeobonobis/
A collaborative NETWORK that links

Data collection  Databases  Datasets

Filters: Taxa  Space  Time

To produce:

Maps
Abundance
Trends
Societally-relevant products need linked data pipelines

At least 5 pipelines need to be linked:

- Satellite data (space agencies)
- In situ environmental data (NODCs)
- Genetic (GenBank/NCBI, RefSeq, Gene Home, SRA, etc.)
- Biodiversity (OBIS, GBIF, others)
- Socio-economic data

Maps, jurisdictions, census, economy
Environmental Data Integration

Case Studies
- Integration of 20y+ environmental and biological datasets
- In situ data collection

E&O
- Socio-economics
- Ecosystem valuation

Ecological Marine Units
Satellite Seascapes

eDNA testing
- Tissue
- Skin or scales
- Microbial cells
- Tissue DNA

Autonomous eDNA sensor

MBON data portal and mapping tool

Image of diver and underwater scene
Example: Mexico/CONABIO

http://simar.conabio.gob.mx
Role of IOCARIBE and Blue Planet

• A model for GOOS Regional Alliances to develop national coastal and ocean observing systems
15 GOOS Regional Alliances
Geographic scope of the Pole to Pole MBON of the Americas

Americas Caucus Member countries:

... and all others that may want to join.

- Latitudinal gradients and patterns of biodiversity
- Relationship between biodiversity and ecosystem functioning
- Effects of natural and human pressures on biodiversity
- Capacity building
- Standardized field methodologies
- 30+ researchers from 9 coastal countries
Capacity Building and Training Workshops: 
2nd Pole-to-Pole MBON Workshop

- Marine Biodiversity Workshop: from the Sea to the Cloud
- AmeriGEOSS Week, August 6-10, 2018, São Sebastião, Brazil
- Biodiversity observations in rocky shores and sandy beaches
Primary Messages

What we want: assess impacts of oil, sargasso, and other events on local ecosystems in a regional context

• Develop baseline of coastal and marine biodiversity
• Follow best practices advocated by the IOC
  – GOOS
  – IODE: OBIS, Best Practices, Ocean Teacher
• Join the Marine Biodiversity Observation Network (MBON) and GEO Blue Planet:
  – https://members.geobon.org/pages/index.php
...the biodiversity arm of Blue Planet

https://mbon.ioos.us/

Contacts: (GEO BON / MBON co-chairs)

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- Isabel Sousa Pinto (ispinto@ciimar.up.pt)
- Mark Costello (m.costello@auckland.ac.nz)
EBV and EOV are Complementary

EOV - Essential Ocean Variables
- Microbial biomass and diversity
- Phytoplankton biomass and diversity
- Zooplankton biomass and diversity
- Benthic invertebrates abundance and distribution
- Fish abundance and distribution
- TBM abundance and distribution
- Macroalgal canopy cover and composition
- Seagrass cover and composition
- Hard coral cover and composition
- Mangrove cover and composition

EBV - Essential Biodiversity Variables
- Primary productivity
- Secondary production
- Allelic diversity
- Taxonomic diversity
- Species distribution
- Population abundance
- Migratory behaviour
- Phenology
- Population structure by age/size class
- Habitat structure
- Ecosystem extent / fragmentation
- Ecosystem composition / functional type

Examples
- Rate of carbon fixation or oxygen production
- Plankton biomass per area/time
- Richness of Operational Taxonomic Units (OTU's), species presence/absence
- Bacterial counts and taxonomy, concentration of chlorophyll-a and accessory pigments, plankton abundance, phytoplankton functional groups distribution, fish abundance, marine mammals and birds abundance, emergent vegetation (wetland) distribution and cover, floating vegetation abundance
- Home range / Core habitat use emigration / Immigration
- Degree of coral spawning synchrony, fish spawning frequency, phytoplankton spring bloom dynamics
- Abundance of the young-of-the-year (YoY) of coastal and neritic fishes
- Live coral cover, seagrass cover, macroalgal canopy area, wetland extent
Ongoing/Developing Collaborations:

OBIS-GOOS-MBON
NSF OceanObs Network RCN
Animal Telemetry Network (ATN)
Ocean Acidification Network
Other IOOS RA’s
MarineGEO (Tennenbaum)

OBIS-GOOS-MBON Partnership: Belgium, Dec 2016
Linking Essential Biodiversity Variables (EBVs) and Essential Ocean Variables (EOVs)

Based on the Framework for Ocean Observing (OceanObs ‘09):

EOVs are central to GOOS strategic planning and implementation

Marine EBV are complementary to EOV
Mapping tools
Taxa
Time series
Satellite seascapes
The state of marine biodiversity monitoring

Near-surface taxonomic records (<20 m)
→ Many areas have no records
→ Less records in last 10 years: lag in reporting data to OBIS

OBIS: 47 million records (water column to benthos)

Data needed to satisfy ‘Drivers’
10 targets that require scientific information and capacity building on biodiversity

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Full name</th>
<th>Key activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>CBD</td>
<td>Convention on Biological Diversity</td>
<td>Aichi Targets</td>
</tr>
<tr>
<td>IMO</td>
<td>International Maritime Organisation</td>
<td>Protection of biodiversity and detection of invasive species</td>
</tr>
<tr>
<td>IUCN (WCPA, SSC)</td>
<td>International Union for the Conservation of Nature, World Commission on Protected Areas, Species Survival Commission</td>
<td>Protection of biodiversity</td>
</tr>
<tr>
<td>IPBES</td>
<td>Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services</td>
<td>Assessments of biodiversity</td>
</tr>
</tbody>
</table>

Societal Relevance
GEO Activity: Collaboration with USGS and ESRI Ecological Marine Units (EMU) and Seascape comparisons

1) Surface EMUs classified from interpolated NOAA WOA data
2) Seascape classified from satellite derived SST, chl-a, NFLH, PAR
Example: diversity of fisheries and satellite seascapes (SST, CHL, productivity) in Large Marine Ecosystems (LME)

Results:

Three megaregions (A, B, C)

Between 1982 and 2010, seven LMEs diversified their fisheries

Muller-Karger et al., 2017. Megaregions Among the Large Marine Ecosystems of the Americas. Environmental Development. [Link](http://dx.doi.org/10.1016/j.envdev.2017.01.005).
Figure 1.6. Value added of the ocean economy in 2030 in the business-as-usual scenario

Ocean Economy value: >US $3 trillion in 2030

Note: Artisanal fisheries are not included in this overview.

Source: Authors’ calculations based on OECD STAN, UNIDO INDSTAT, UNSD; Lloyd’s Register (2014; 2013); World Bank (2013); IEA (2014).
GOAL:
Increase observations of marine life building on GOOS, OBIS, and other networks:
- MarineGEO/Tennenbaum
- UNEP WCMC
- Americas (AmeriGEOSS)
- EuBON
- AsiaPacific
- Coral/GCRMN
- Africa
- CAFF (Arctic)
- National programs
- etc.