NATIONAL MARINE SANCTUARIES

MBON
Marine Biodiversity Observation Network

...from microbes to whales
Biodiversity benefits:
- ecosystem function & resilience,
- chemical cycles,
- human health (food, materials, chemicals, recreation)
Biodiversity: the variety of life and habitats

- number of species,
- abundance and biomass,
- interactions (organisms & environment),
- variability of habitat

These ‘Essential Biodiversity Variables’ are really basic, but are very difficult to make
Essential Variables: EOV and EBV

- GOOS: GOOS panels (EOV)
- Group on Earth Observations (GEO): GEOBON – MBON
- National / academic programs

Marine EBVs as subset of EOVs

Need to be linked, and enabled to measure life
A collaborative NETWORK that links Databases and Datasets to produce Maps and Abundance Trends. Filters: Taxa, Space, Time.
Sanctuaries MBON
demonstration priority:

➔ US National Marine Sanctuary Condition Reports
National Marine Sanctuaries

FLORIDA KEYS NATIONAL MARINE MARINE SANCTUARY

MONTEREY BAY NATIONAL MARINE SANCTUARY
Environmental Data Integration

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

Ecological Marine Units
- E&O
- Socio-economics
- Ecosystem Valuation

Satellite Seascapes

MBON data portal and mapping tool
Environmental DNA:
eDNA

eDNA allows detection of diverse groups using many platforms
Milestone: MBON Standard Protocol

Filter 1L of Seawater (x3)
Extract DNA
Amplify & Sequence
Identify Target Organisms

0.2 µm PVDF
Qiagen DNeasy
Target Gene Markers
NCBI GenBank, etc.

Vertebrates
Invertebrates, some vertebrates, & phytoplankton
Phytoplankton & invertebrates, some vertebrates
Microbes (Bacteria & Archaea)

Sanctuaries MBON eDNA Team: FWRI, MBARI, Stanford, & USF
Djurhuus et al., in review
eDNA detected increased anchovy abundance

Preserved samples allow construction of long time series

In field trials 3G ESP successfully picked up anchovy eDNA
eDNA Recovers a Wealth of Biodiversity from the Florida Keys NMS

- Yellowhead wrasse
- Queen conch
- Moon jelly
- Copepods
- Spotfin butterflyfish
- Green sea turtle
- Caribbean reef octopus
- Chaetognaths
- Peanut worm
- Flecked box crab
- Spider crab
- Acorn barnacle
- Beaded sea cucumber
- Netted barrel sponge
- E. huxleyi
- Diatoms
- Beaded sea cucumber
- Netted barrel sponge
MBON and seascapes

- Dynamic biogeographic framework
- Ecosystem comparison
- Indicators and metrics
- Cruise planning, feature tracking
- Seasonal and Interannual dynamics

Conservation Goal
Example: Establishing a baseline of marine biodiversity

Seascape parameters
Synoptic variables via model or satellite that capture ecosystem dynamics

Spatiotemporal scale
Diurnal, seasonal, Interannual, climate local, mesoscale, basin, global

Covariance Analysis
Clustering, neural network, edge or gradient detection

Multivariate distribution:
Size spherical variance

Temporally evolving seascape:
e.g. Central California, USA with National Marine Sanctuary boundaries, showing areal extent of seascapes over time

High resolution validation and technological comparison: e.g. eDNA, in situ optics, pigments, plankton imagery

Inter- and intra-seascape metrics or analyses:
e.g. expansion, habitat diversity, occupancy, group differences, rarefaction, environmental drivers, self-organization scales.
Central California pelagic forage fish and Eastern Pacific climate

Forage fish: food for larger predators (fish, seabirds, marine mammals)

May-June SST & Forage Richness

High SST = High Forage Richness

High PDO = High Forage Richness
Seascape validation in south Florida waters

Phytoplankton absorption spectra ($a_{phy}$)

Phytoplankton pigments (HPLC)

Seascape validation: Seascapes show distinct phytoplankton communities

MARCH 2016
Regional to Global Seascapes

In progress/Next steps:

• Refine science questions
• Automate data flow between NASA, USF, WHOI, IOOS DMAC / Axiom
• COVERAGE: CEOS Ocean Variables Enabling Research and Applications for GEO
• Algorithms: HAB, acidification
• GEOBON and broader links:
  ➢ Link Seascapes and Ecological Marine Units/EMU (USGS/esri)
  ➢ Other partners/internationally
Example: diversity of fisheries and satellite seascapes in Large Marine Ecosystems (LME) of the Americas

Results:

Three megaregions

Between 1982 and 2010, seven LMEs diversified their fisheries

Engage users and support Products

- Quarterly Updates,
- Short videos,
- Podcasts,
- Sanctuaries MBON website,
- User oriented webinars and tutorials

Coming soon: Sanctuaries.marinebon.org

New videos

Story Map

eDNA Video
Societal Relevance

SUSTAINABLE DEVELOPMENT GOAL 14
Conserve and sustainably use the oceans, seas and marine resources for sustainable development

10 targets that require scientific information and capacity building on biodiversity
SDG14 Interactive web-based tool

Mapping tools  Taxa  Time series

Satellite seascapes

Support 14 LIFE BELOW WATER
Seven key pelagic forage groups for MBNMS from NMFS-SWFSC Rockfish Recruitment and Ecosystem Assessment Surveys as reported on CCIEA indicator website (Santora et al. in review)
Florida Keys Coral Reef Ecosystem

(Infographic approach)

1. Reef fish biodiversity
2. Trophic Groups (13)
3. Trophic level (4)
4. Exploited reef fish (9)
5. Stony corals
6. Sea fans
7. Sponges
8. Caribbean spiny lobster
9. Queen conch
10. Sea turtles
11. Black sea urchin
Florida Keys National Marine Sanctuary
Reef Fish Diversity

Shannon Reef Fish Diversity

- Protected
- Unprotected

Year

Effective Number of Species


Protected

Unprotected
A Global Collaboration: OBIS + GOOS (IOC) and MBON

GEO BON/MBON – GOOS BioEco – OBIS partnership
Building a globally coherent, consistent and coordinated sustained global ocean observing system to assess the state of the ocean’s biological resources and ecosystems

Observations
- R&D focus
- Bring new EOVs from concept to pilot
- Assist with the establishment of national and regional BONs

Products, Indicators, Assessments

Data & Products
- Open data sharing
- Data integration
- Data quality control
- Data harmonization
- Tools for data exploration, visualization and analysis

Biology & Ecosystems
- Focus on sustained observations
- Bring selected EOVs from pilot to mature
- Link with platforms and observing systems of GOOS and GRAs

e.g.: http://iobis.org/2016/12/15/goosgeobonobis/
Pole-to-Pole MBON of the Americas

- GEO Plenary, Mexico (2015)
- Convention of Biological Diversity (Montreal, Apr 24, 2016)
- GEO BON Open Science Meeting (Leipzig, Jul 4-6, 2016)
- Pole-to-Pole in the Americas Workshop (Puerto Morelos, Mexico, Sep 26-30, 2016)
- GEO-XIII Plenary (St Petersburg, Russia, Nov 9-10, 2016)
- Animal Telemetry Netw. – Mar,Aug’17
- Blue Planet – May 2017
- AmeriGEOSS – Jul 2017 Costa Rica
- OBIS, GOOS Workshops
- GEO Plenary-Oct 2017
- etc.

Co-chairs linking Africa, Europe, Asia-Pacific
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.
13 Hands-on STEM Lessons: Elementary, Middle, High Standards cross-referenced Science Festivals (4 annual)
Professional development of educators
Outreach to minorities
Santuaries MBON Co-Investigators:
-Frank Muller-Karger (carib@usf.edu)
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The US Sanctuaries MBON Team

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