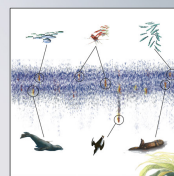
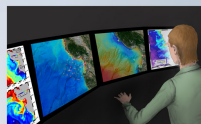
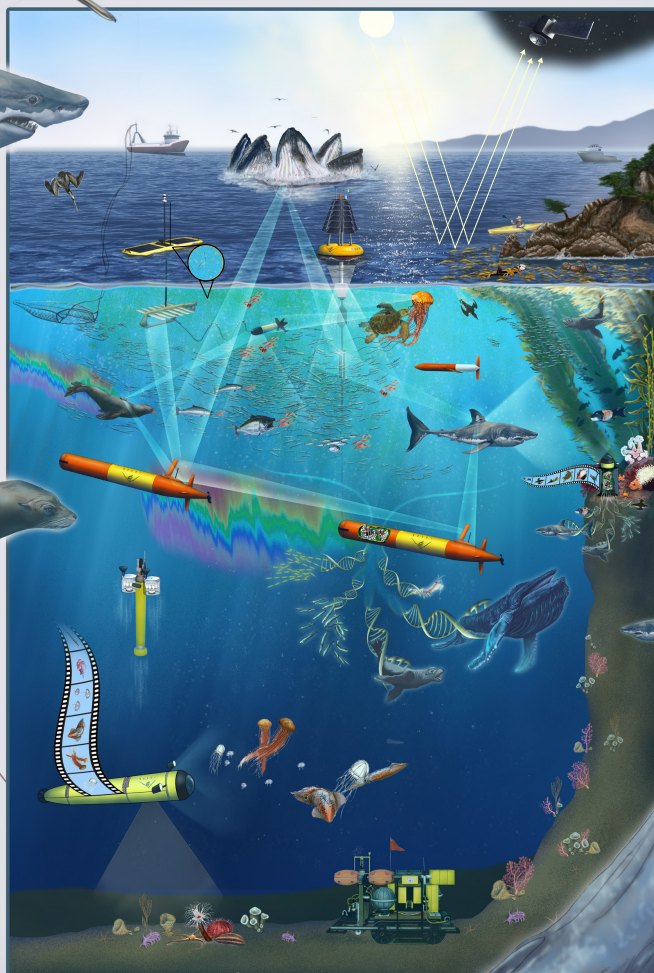
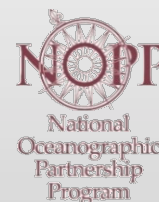
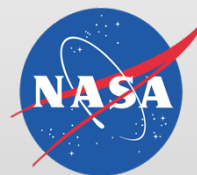


# Observing Life in the Sea



MBON All-Hands Meeting  
Silver Spring, MD  
May 03, 2016



# MBON

Marine Biodiversity  
Observation Network

Sanctuaries MBON

Monterey Bay,  
Florida Keys, and  
Flower Garden Banks  
National Marine Sanctuaries

Principal Investigators:  
Frank Muller-Karger (USF)  
Francisco Chávez (MBARI)



# *The Sanctuaries MBON pilot*

## *Outline*

- *Goals*
- *Data collection and management*
- *Outreach*
- *International dimensions*
- *Project successes and challenges*

# *The Sanctuaries MBON pilot: goals*

- Develop a practical and sustainable pilot MBON with the *National Marine Sanctuaries Program*
- Integrate, augment, synthesize information from ongoing programs
- Develop technologies for biodiversity assessments:
  - environmental DNA (eDNA)
  - Remote sensing time-series: *Seascapes*
- Integrate biological data into national/international databases
- Plan to transition to an operational system
- Help develop international connections for a global network

# *Why we do this:*

## *The importance of biodiversity*

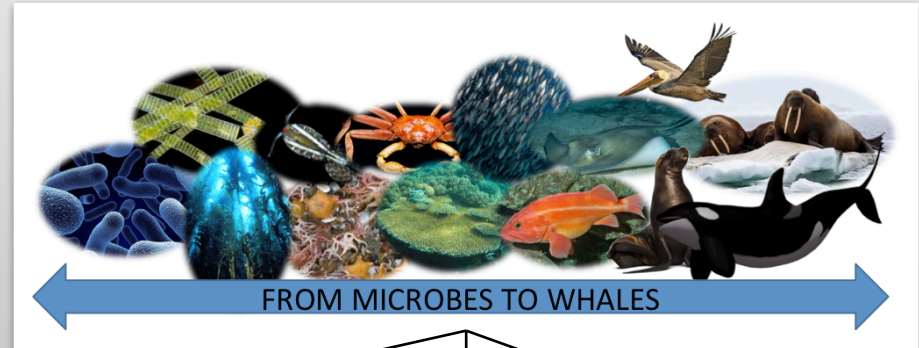
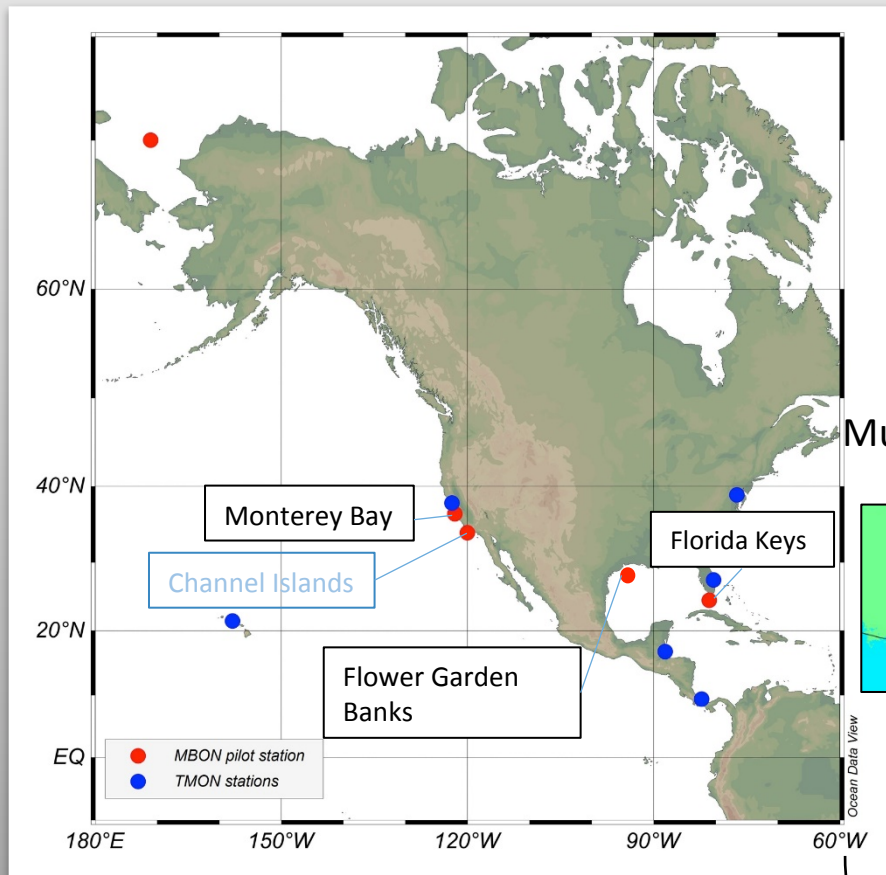
Diversity defines the function and health of ecosystems

Ultimately the right mix of species on Earth helps ensure our own survival

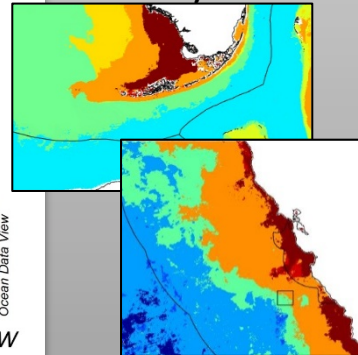
Understanding habitat and biological diversity and function is fundamental to define conservation strategies



# *The Sanctuaries MBON pilot concept*



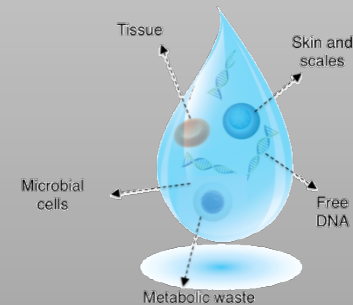
Multivariate seascape analysis



Data Integration:

- IOOS/GOOS
- I-OBIS
- GEO BON

eDNA



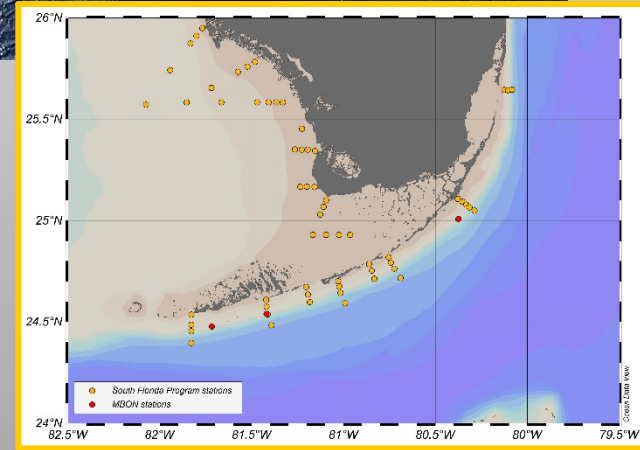
Web-based  
information system

Supports

- Sanctuary Condition Reports
- Resource managers and policy makers
- Scientists and educators

# *Field programs*

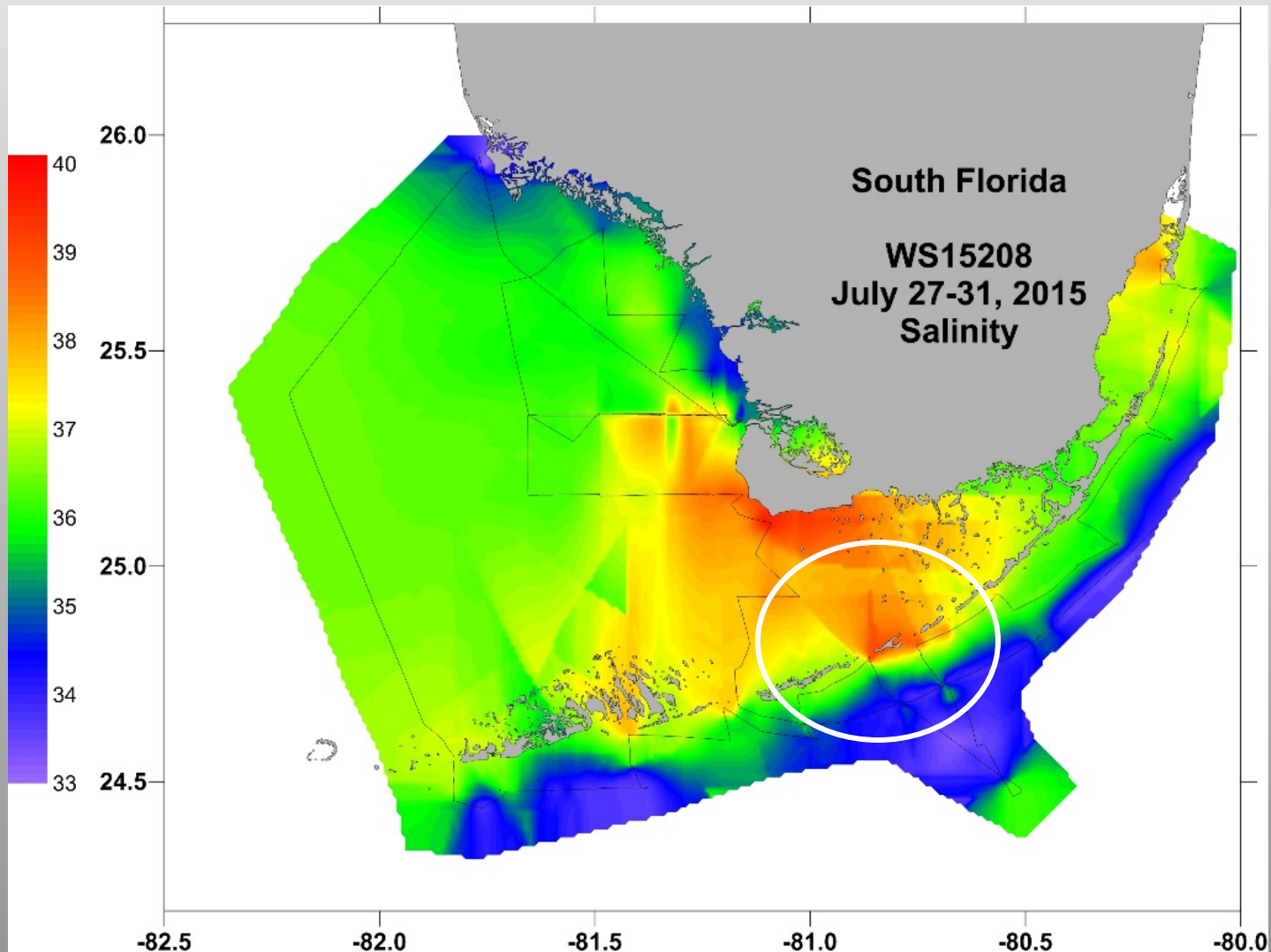
Complement Multiple Data Collection Efforts  
in Each Sanctuary



South Florida Program run by  
AOML partners:

- Chris Kelble—bio oc./prim prod
- Lindsey Visser
- Libby Johns – phys oc. analyses

# High salinity event during July 27-31, 2015, in Florida Bay and FKNMS

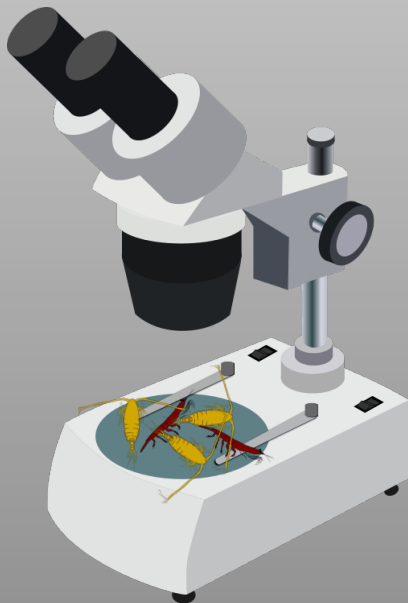




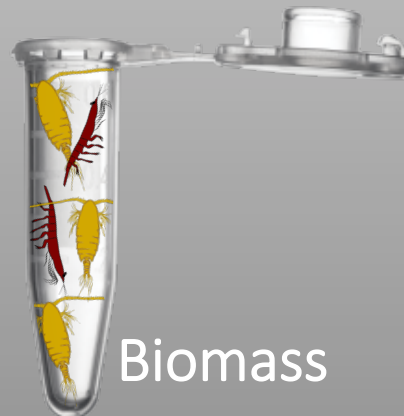
# *eDNA – A New Frontier*

Sanctuaries MBON eDNA: vertebrates, zooplankton, and microbes

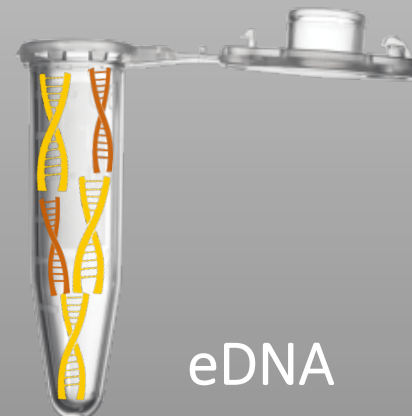
- Testing of eDNA extraction methods completed – manuscript in prep.
- Primers: selection completed for some organisms
- eDNA validation in progress (i.e. zooplankton and whales)



Microscopy:  
Taxonomy &  
counts



Biomass



eDNA

## **MBON Genomics Team**

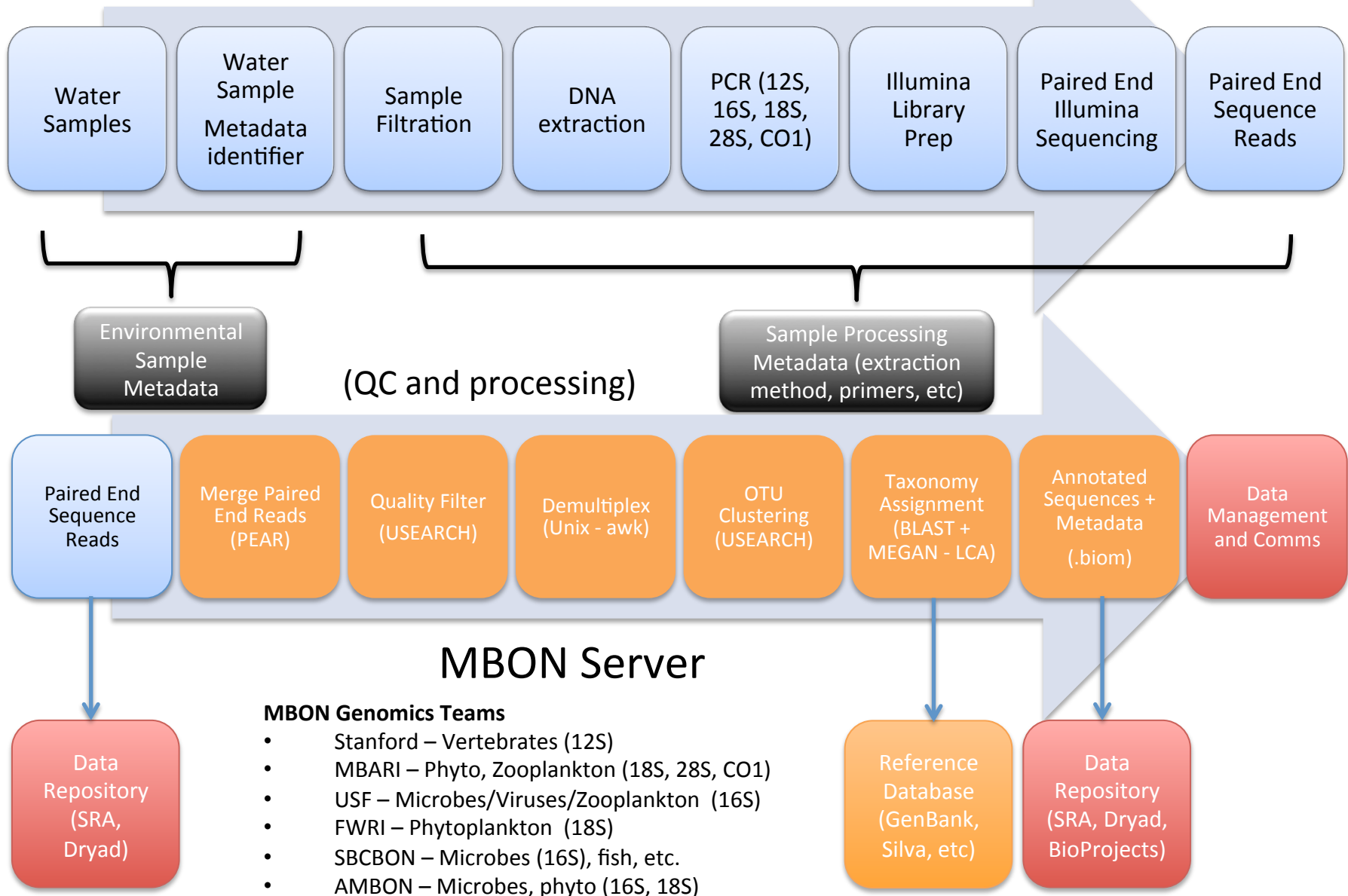
- Stanford – Vertebrates (12S)
- MBARI – Phyto, Zooplankton (18S, 28S, CO1)
- USF – Microbes/Viruses/Zooplankton (16S)
- FWRI – Phytoplankton (18S)
- SBCBON – Microbes (16S), fish, etc.
- AMBON – Microbes, phyto (16S, 18S)

## **Collaborations**

- X-MBON: Santa Barbara, Alaska MBON
- NOAA Omics Research: (K. Goodwin, J. Hendee)
  - Atlantic Oceanographic & Meteorological Lab
  - Southwest Fisheries Science Center (SWFSC)

# MBON Sequencing Work and Data Flow

(Field, laboratory and NGS)



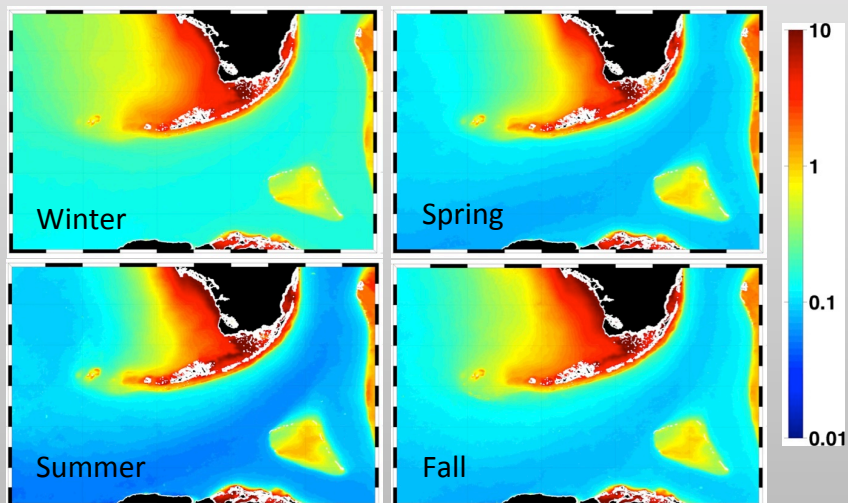


# *Remote Sensing of Seascapes*

# MODIS-Aqua 1-km seasonal climatologies (2002 -2015) for seascape analyses - FKNMS

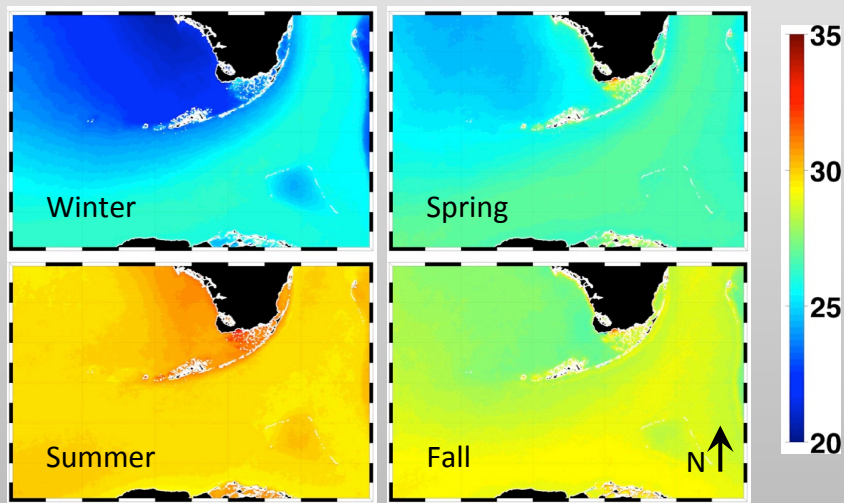
Chl-a

mg/m<sup>3</sup>



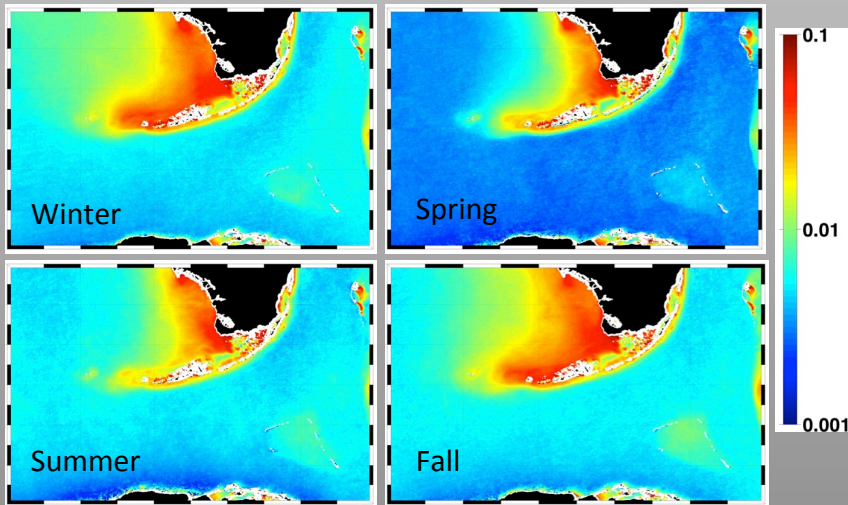
SST

°C



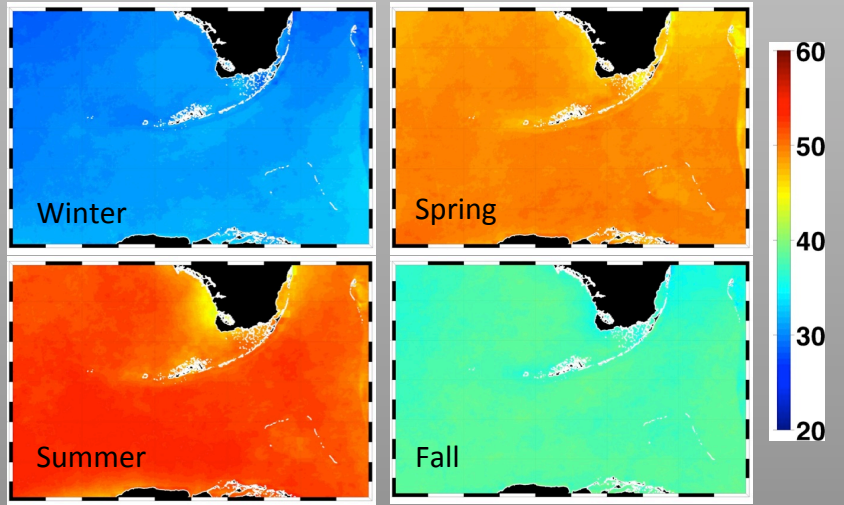
nFLH

mW cm<sup>-2</sup> um<sup>-1</sup> sr<sup>-1</sup>



PAR

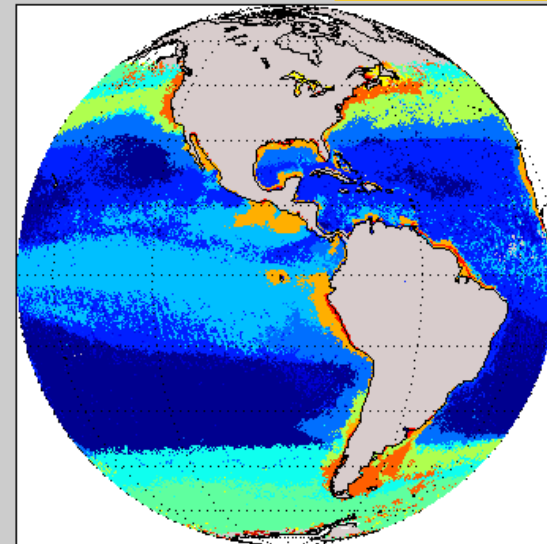
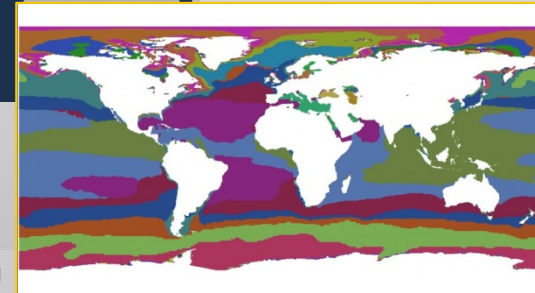
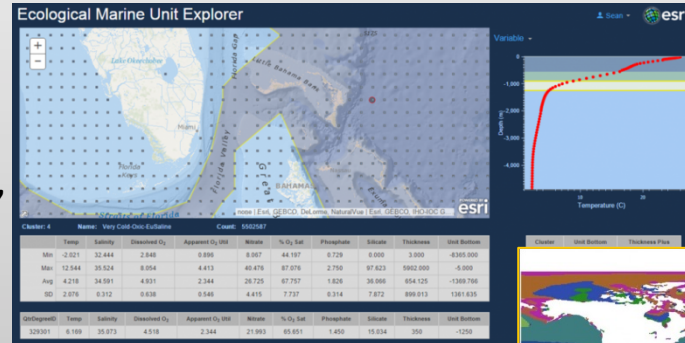
Einsteins m<sup>-2</sup> day<sup>-1</sup>



# Regional to Global Seascapes

In progress/Next steps:

- In situ validation
- Automate data flow between NASA, USF, WHOI, IOOS DMAC / Axiom
- Improving algorithms: Harmful Algal Blooms (HAB), carbonate system
- Expand high-resolution coverage:
  - Flower Garden Banks, AK-BON, Santa Barbara, other NMS
- Evaluate user metrics
- GEOBON and broader links:
  - Work with Roger Sayre (USGS) to link remote sensing Seascapes and Ecological Marine Units/EMU (USGS/esri)
    - Pole to Pole Biodiversity and Biogeography
  - Other partners/internationally

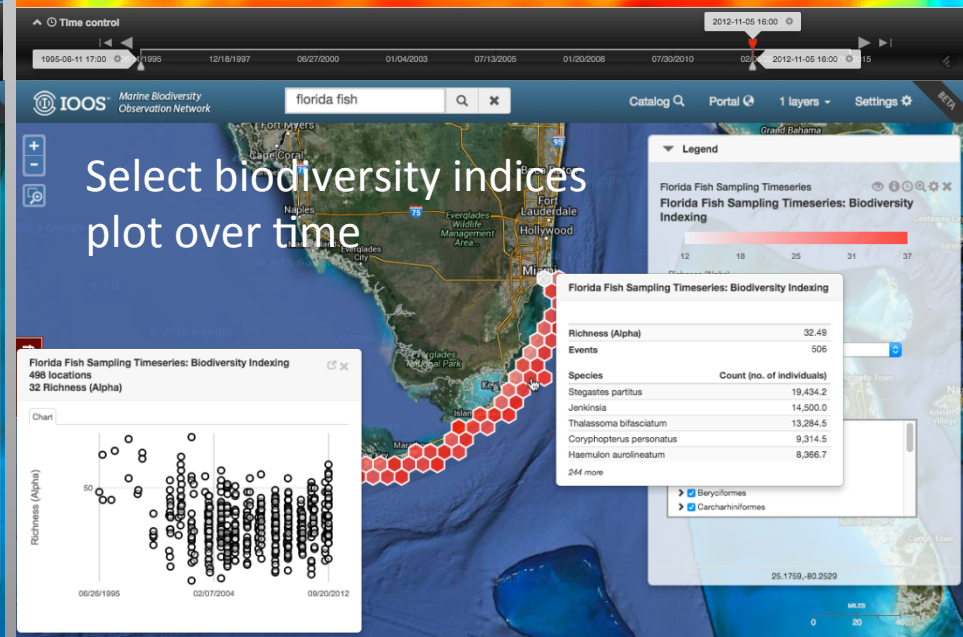
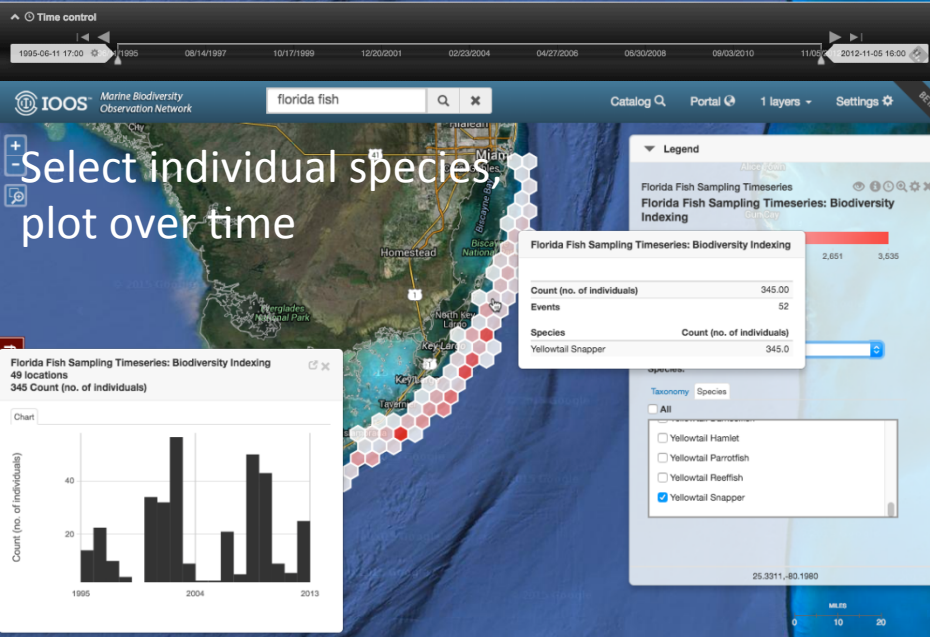
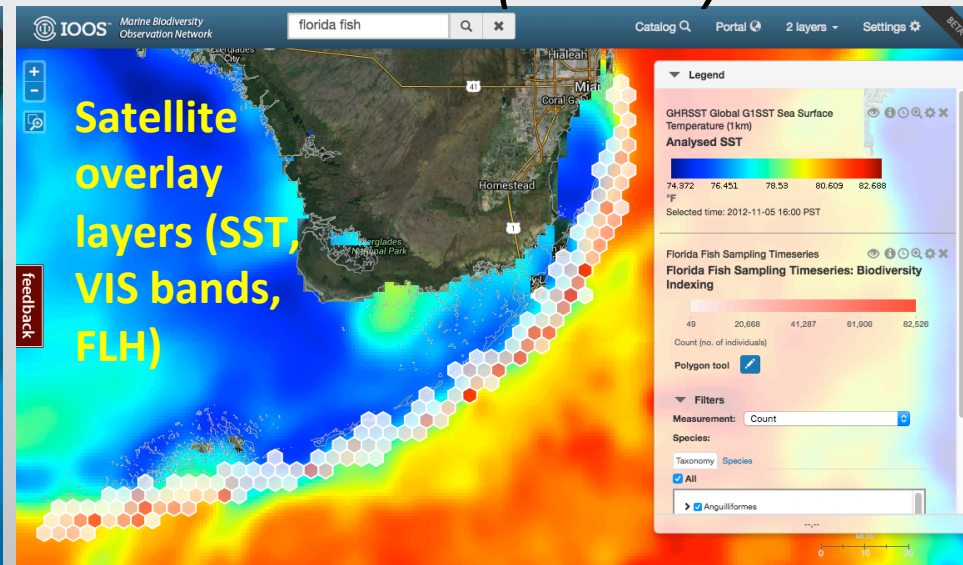
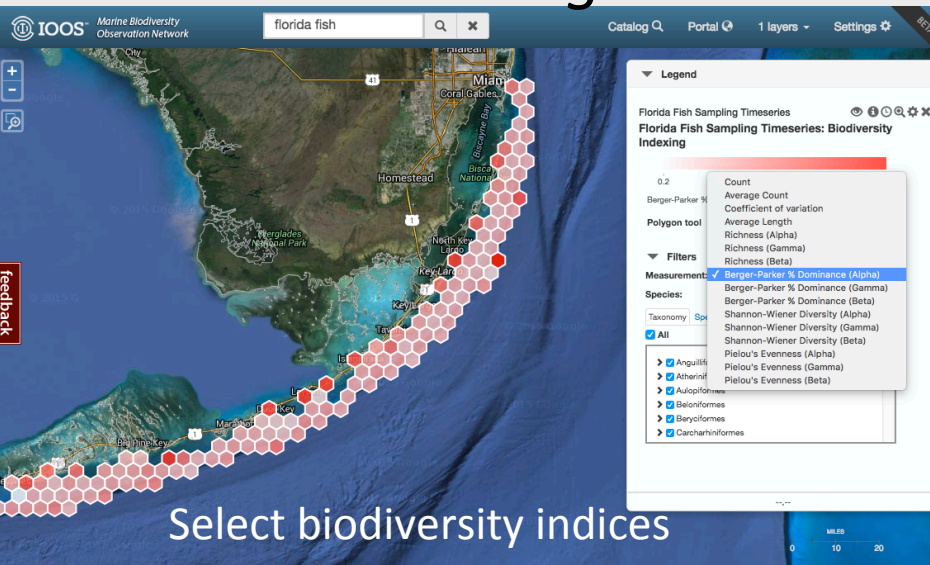


Surface ocean  
EMU

Surface ocean  
Seascapes



# Integrated Ocean Observing System (IOOS) Data Management and Communications (DMAC)



# Communications & Outreach

CJ Reynolds, Jennifer Brown

- Newsletter (distributed via [all\\_mbon@marine.usf.edu](mailto:all_mbon@marine.usf.edu))

## SANCTUARY MBON

Updates from the Florida Keys and Monterey Bay Projects

February 2016

### DMAC UPDATE

The DMAC team is revising the data management plan under the leadership of Dave Anderson at CeNCOOS. The Florida and Monterey Bay teams are working on enrollment of historical data sets for ingestion in close collaboration with Philip Goldstein with OBIS-USA. Axiom continues to make progress on data ingestion of Florida and California biological data sets and ingested a large number of Florida Keys National Marine Sanctuary (FKNMS) ecological data GIS layers and several time series data sets.

Eighteen years (1995-2012) of the Reef Visual Census (RVC) data have been transformed from their original forms into the standards-based forms used by OBIS-USA, such as Darwin Core and the Marine Bio-Geography (MBG) common terms definitions. Guidance for this effort was derived from the 'MBG 2.1 Enrollment Journal Florida Marine Sanctuaries Fish 2004 Draft 20140521' produced by Philip Goldstein. The transformed data and metadata were written into NetCDF files and installed in an ERDDAP server making them available through the network via human or URL-based interfaces.

Axiom and a team of Monterey Bay and Florida scientists are working on the development of a generalized biodiversity indices tool. Axiom is working with the RVC data set to prepare it for real-time biodiversity indices calculations. Software engineers have started to incorporate biodiversity indices calculations into backend server side analytical code. The prototype biodiversity indices tool is expected to be available for use with the Axiom tool in early March. Axiom (along with IOOS and OBIS staff) met with Barbara Block and team at Hopkins Marine station and discussed best paths forward to accessing ATN data relevant to MBON.

The RVC data is available through a GCOOS [ERDDAP server](#). The ERDDAP interface allows users to filter the data, produce maps, and deliver data and metadata in many different formats. Click [here](#). The "Make a Graph" page allows users to plot selected data and export the plots. You can enter constraints by hand or generate the plot directly from [here](#).

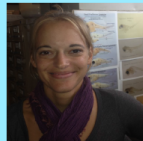
Another impressive dataset, the Historical NOAA CTD data for the Florida Keys (30 raw CTD data sets collected from the R/V Walton Smith from 2006-2015) have been incorporated into the MBON data management system. Data collected include temperature, salinity, beam attenuation, beam transmission, dissolved oxygen, surface and in situ irradiance (PAR). Underway systems collect near-surface temperature, salinity, meteorological and navigation data. Some cruises include current meter data. In the coming month, we will have products from these three-dimensional time series datasets mapped. Additional water quality data will be ingested from [http://data.ceoos.com/portal/](#) and other sources to visualize and analyze with the Axiom workspace.

A DMAC X-MBON team has been formed with participants from Alaska, Florida, Monterey Bay, Santa Barbara and the Smithsonian MarineGEO Tennessee.

Marine Biodiversity Observation Network Update Feb 2016 1

### Welcome

to the first MBON Project Update. In addition to the team updates, this issue focuses on Florida projects. The next issue will focus on California.



NEW MBON TEAM MEMBER:  
NOAA SEFSC

Kathryn Shultzski, Ph.D., Cooperative Institute for Marine and Atmospheric Studies, University of Miami, was hired in the fall of 2015 to work on the MBON project with John Larkin (NOAA SEFSC). Shultzski's expertise is in the study of processes affecting growth and survival during the early life history stages of fishes.

She is analyzing data sources of value for marine biodiversity research. The Reef Visual Census dataset was chosen because its standardized survey methods provide robust data on fish density and distribution in coral reef habitats throughout the FKNMS. Analysis will begin immediately and figures for a manuscript addressing the temporal and spatial patterns in biodiversity in the FKNMS will be produced.

Results show that in situ optics are effective for detecting specific phytoplankton functional type (PFT) in the Florida Keys. Specifically, specific absorption spectra of phytoplankton from samples collected at the three sites (July 27-31, 2015) indicate high levels of blue-green algae (very likely *Trichocapsa*) shown as absorption peaks at 545 nm. Time series of  $a^*_p(545)$  and complementary optical observations therefore serve as a practical tool for studying changes in biodiversity of lower trophic levels in this region and aid in the improvement of satellite ocean color algorithms for detecting shifts in phytoplankton community composition.

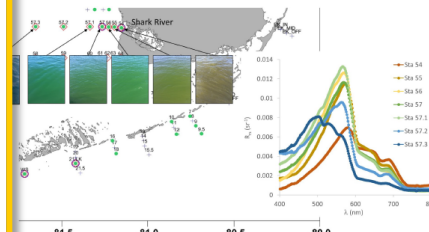
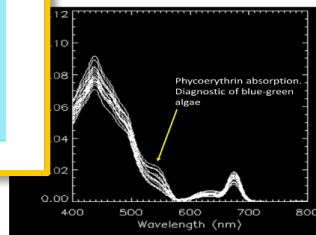


Figure 8. Chlorophyll-specific phytoplankton absorption ( $a^*_p(545)$ ) spectra of surface and bottom samples from the three MBON sites during July 27-31, 2015. Absorption peaks at 545 nm are indicative of the presence of the pigment phyocerythrin, and therefore of cyanobacteria in the



monthly samples in the Florida Keys near some of the major coral reefs. Samples are collected with the help of the USF remote sensing group and scientists at the FKNMS during cruises on the R/V Walton Smith and on small boats.

Currently, USF/FKNMS collect three samples from surface and bottom at each of the three key MBON stations - resulting in 18 samples per cruise. We already have 198 samples from the three stations and an additional 286 samples from the surrounding ocean!

### CS UPDATE

MBARI and USF have been working on a methods. We are testing whether we can choose the filter type and DNA extraction method to capture eDNA from multiple samples simultaneously (i.e. bacteria, phytoplankton, vertebrates).

Work is complete and data analysis manuscript are underway. Stanford is samples collected on an MBARI CANON fall 2015 to assess the spatial distribution of eDNA across and offshore locations.

Time-series at station M1 (6 cruises, 10 samples per cruise from 0-1000 m depth) yielded very low/absent (for 12S mtDNA eDNA), we have provided this time-series to successfully amplify plankton and zooplankton

for volume is related to DNA concentration in filters, our team collected samples at station M1 using flow filtration (FFF).

Comparing species richness across these volumes and to conventional filtration. We have processed these data and may repeat this experiment in another effort finalizing our results.

A team is also comparing two library sets for NGS to determine whether this is standardized across the three teams. Results should be available by month.

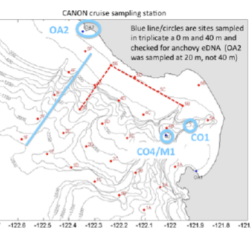


Figure 9. Fall 2015 CANON cruise sampling

The USF group has also collected samples for zooplankton morphological identifications, eDNA genomics, and for sequencing tissue of whole zooplankton communities. The goal is to ground truth the eDNA method for zooplankton and move forward to eventually use only eDNA to assess zooplankton diversity and seasonal oscillations in the Florida Keys.

Morphological zooplankton identification is almost done and we plan to have the sequencing ready for the Genomics Team (USF, FWC, Stanford, and MBARI) meeting at MBARI on Feb 10-12. This will enable comparison of zooplankton data between the Florida Keys and Monterey Bay. At the meeting, the genomics teams will decide on a final method for sample collection and data analysis going forward.

Marine Biodiversity Observation Network Update Feb 2016 7

standardized data analysis framework for different gene markers used by the MBON genetic teams. The USF/FKNMS genomics team has collected

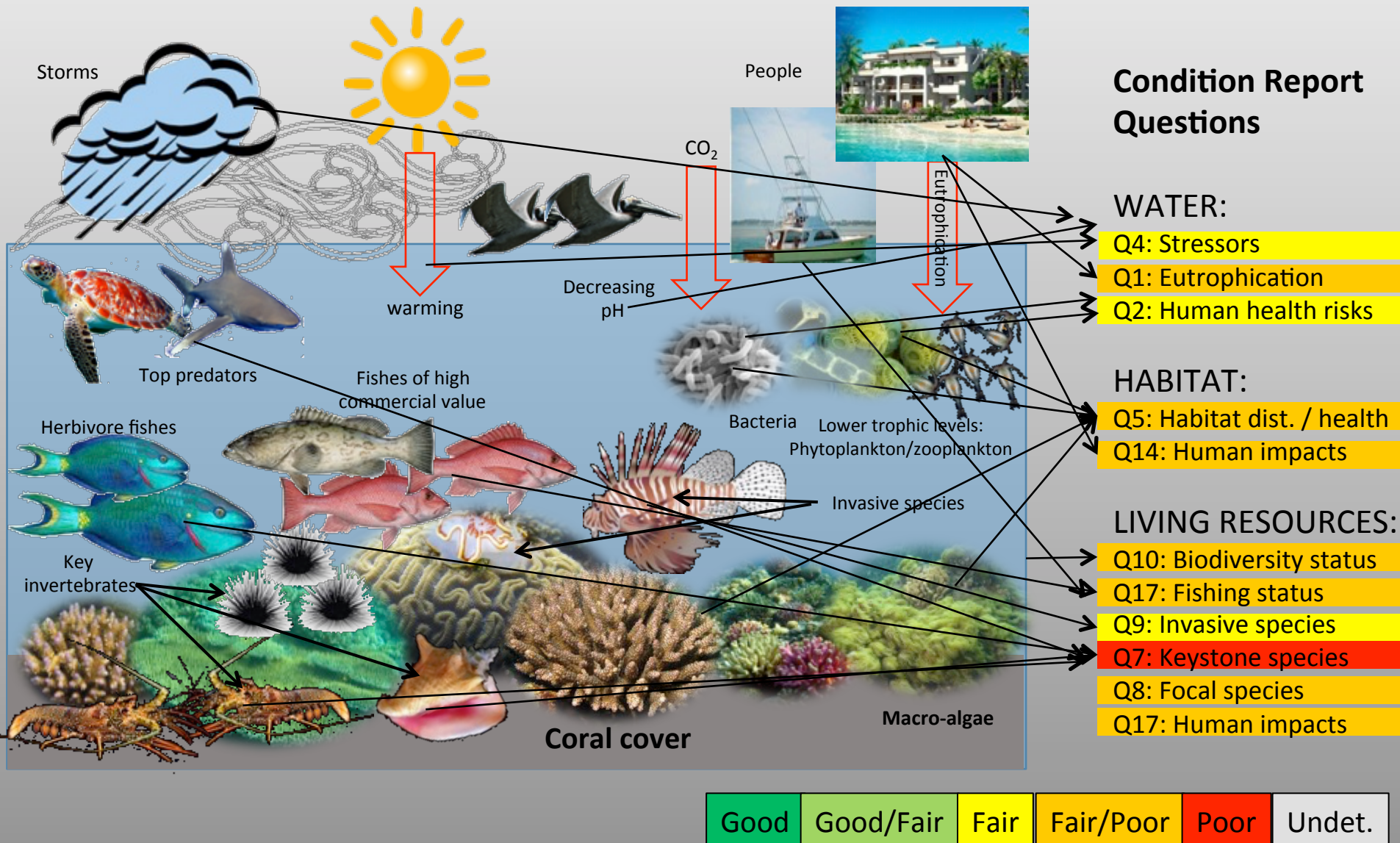


## *Next steps: Putting it all together*

- Build the decision-support tool to answer Sanctuary Condition Report questions



# Dynamic support for Condition Reports

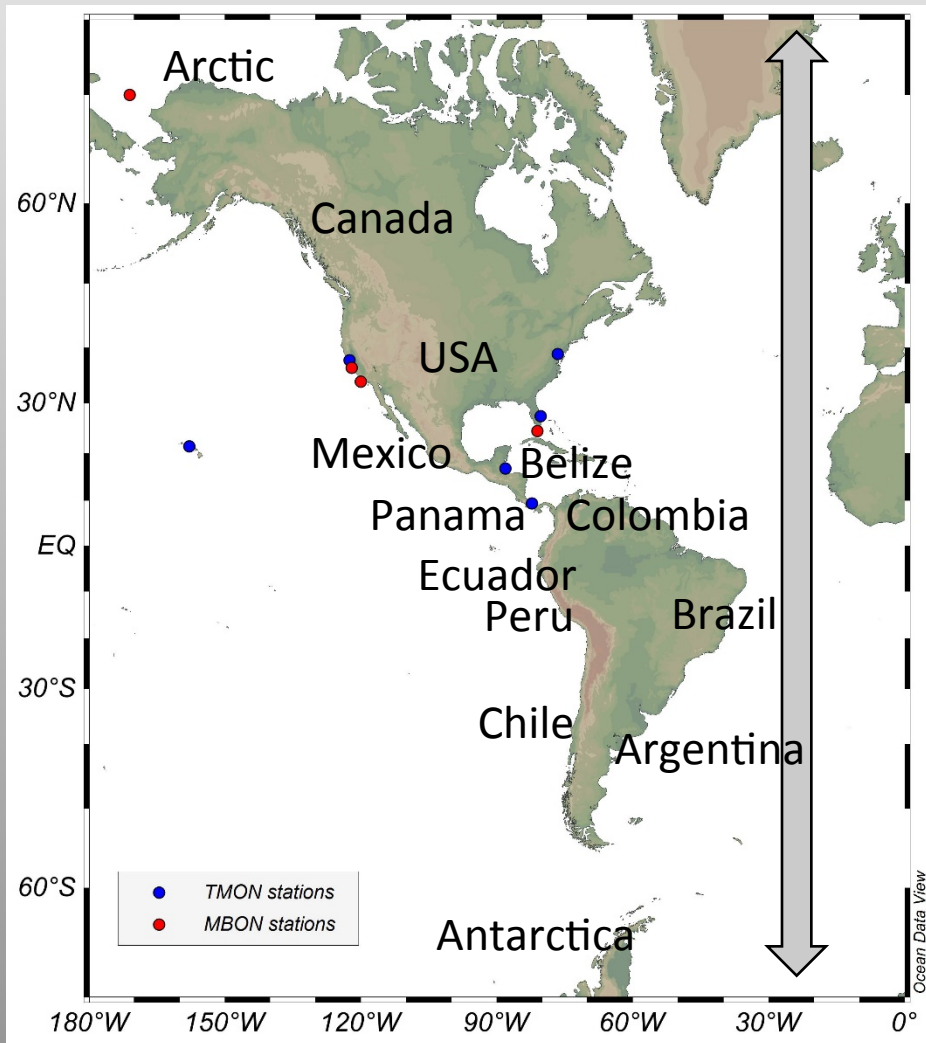


# MBON

Marine Biodiversity  
Observation Network



# *MBON beyond the US: GEO, GOOS, CBD*



## **GOALS:**

- **Pole-to-Pole MBON pilot**
  - the Americas
- **BON in a Box**

## Outreach and planning

- MBON presentations at GEO Plenary, Mexico (2015)
- MBON presentation at the Convention of Biological Diversity (Montreal, Apr 24, 2016)
- GEO BON Open Science Meeting (Leipzig, Jul 4-6, 2016)
- GEO MBON All-Hands Workshop (Leipzig, Jul 6-7, 2016)
- Pole-to-Pole in the Americas Workshop (Puerto Morelos, Mexico, Sep 26-30, 2016)
- MBON presentation at the GEO-XIII Plenary (St Petersburg, Russia, Nov 9-10, 2016)

# ***Successes and challenges within the Sanctuaries MBON***

## **Successes:**

- Conceptual framework for collaborative MBON:
- eDNA: collection and extraction methods tested
- Satellite-based, dynamic *seascape* products: automated pipeline
- Biodiversity field monitoring program implemented in both Sanctuaries
- MBON data used to update 2015 Monterey Bay NMS Condition Report
- Making links: NOAA *ocean acidification* program, NOAA *Omics*, State and Federal fisheries & environmental monitoring, NSF LTER (Everglades), IOOS and other observation programs
  - IOOS GCOOS has funded a Doctoral fellowship at USF to work MBON-LTER-SFP



## **Challenges:**

- **Development and maintenance of data system / visualization tool:**
  - The amount of work is staggering – many details
  - How to transition to a sustainable model?
- **eDNA validation at different trophic levels**
  - For ex. vertebrates in different regions
- **Curation and permanent archive of biological datasets from various sources:**
  - Identifying and understanding datasets is an ongoing effort
  - How do these data transition into a permanent archive? How do we maintain access needed for operational & research utility?
  - How do we engage monitoring programs to enroll data?
- **Communications flow on news and outreach**
- **Integrating the MBON observations into the FKNMS Condition Report-2017(?)**
- **Coordination of myriad moving parts with partners and X-MBON projects**
- **Building critical international partners and linkages for Pole-to-Pole**
- **Operational MBON**
  - path to sustainability not clear

# MBON

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Marine Biodiversity  
Observation Network