Summary of U.S. IOOS Regional Association Activities in the area of Ecosystem, Fisheries and Water Quality Observing

2012 U.S. IOOS and Ecosystem, Fisheries and Water Quality Observing

Ecosystems, fisheries, and water quality have been identified as priority issues for the RAs and their stakeholders, and the need for ecosystem-based management is common to all of the RAs. Physical and chemical coastal and ocean observations are necessary but not sufficient for resource assessment and management. U.S. IOOS supports ecosystem, fisheries and water quality observing through activities in the following areas:

Data standards:

- Reconciling community data and metadata standards for biological and ecological IOOS core variables
- Working with U.S. IOOS Regional Associations (RAs) on implementation of biological data and metadata standards and data access

Supporting development of a national observing capability:

- Providing resources (e.g. funding, expertise) to the RAs to enable support for a wide variety of ecosystem observation activities
- Supporting development of a U.S. Animal Telemetry Network
- Participating in workshops, symposiums and other meetings that improve overall coordination and understanding of ecosystems, fisheries, and water quality observing

The following table is intended as a high-level summary of RA activities (completed and ongoing) related to ecosystems, fisheries, and water quality. The table is organized primarily according to the observing, data management and communications (DMAC), and modeling subsystems.

Summary of U.S. IOOS Regional Association Activities in the area of Ecosystem, Fisheries and Water Quality Observing

Regional Association	Ecosystem, Fisheries & Water Quality Observing	Ecosystem, Fisheries, Water Quality Modeling	DMAC	NOAA/NMFS and Interagency Collaboration
AOOS	- Providing vessel charters, personnel time, data retrieval for OTN and POST acoustic monitoring efforts in Prince William Sound to identify tags on salmon, sharks, whales, and other organisms. -Ocean acidification monitoring -Marine animal tagging data acquisition - Support to Seward Line monitoring - Kachemak Bay CTD surveys	- Prince William Sound Demonstration Project – develop & run weather, hydrodynamic, wave, and ecosystem models	- Lead Spatial Tools for Arctic Mapping & Planning (STAMP) project. Developing decision support tools for potential commercial fisheries in the Arctic - AOOS Ocean Workspace in use by EVOS Long-term Monitoring Program and the Herring Research Program - AOOS Data Portal pages: Seabird Portal; PWS Herring Portal - Digitize and spatially enable several ADF&G data sets - Provide data management services to EVOS Long-term Monitoring Program & Herring Research Program	- Partnering with the ADF&G and NOAA to provide ocean and atmospheric conditions that influence the timing of the Yukon River Chinook salmon run. - Lead PI, Exxon Valdez Oil Spill Long-term Monitoring Program's 5yr project -
CaRA	-Bi-weekly sampling at, and annual refurbishing of, NOAA's Ocean Acidification Program MAPCO2 buoy at La Parguera -Continued implementation of water quality monitoring at Guanica Bay and La Parguera Marine Reserve and related remote sensing data product development for the region	Regional HYCOM-ROMS circulation model implementation (2km resolution) including nested subdomains (<500m res.). Model output will support Caribbean Fisheries Management Council (NOAA) fisheries reserve designation and management decisions.		-See HYCOM ROMS -Circulation studies in support or PR Northeast Corridor Marine Reserve Management by NOAA's Coral Reef Conservation Program and CZMP
CeNCOOS	-Maintain automated coastal shore stations for water quality; long term trends in temperature, salinity, sea level, chlorophyll fluorescence, and ocean acidification; and HAB monitoring, forecasting, and mitigation	Run state-wide and West Coast-wide data assimilating oceanic, and CeNCOOS-wide atmospheric, circulation models to forecast currents, winds, other	Working on creating surface current, wind, and sea surface temperature GIS layers for analyses and climatology.	-Provide regional oceanographic context for MPA monitoring – CeNCOOS supported the State of California's design of its MPAs and is supporting the assessment of them.

	- Laboratory analysis of water samples for HAB phytoplankton -Operate across-shore glider transects to monitor temperature, salinity, chlorophyll fluorescence, dissolved oxygen, currents and acoustic backscatter -Maintain and operate the HF radar surface current mapping network used to support search and rescue, marine operations, oil spill response, and ecosystem forecasting. - Supporting environmental impact studies for renewable energy platforms. -Leading U.S. IOOS Animal Telemetry Network Steering Team (Barbara Block) -Produce integrated surface current / sea surface temperature; and surface current / chlorophyll products	state variables, and eventually ecosystem parameters.		- Working with NMFS to determine the effect of MPAs on fisheries and ecosystems. -Working with NMFS to predict amount of offshore chlorophyll entering into Humboldt Bay (informs aquaculture about oyster growth) -CeNCOOS Trinidad Bay data will be used to anchor the Trinidad Head PaCOOS line run by Dr. Eric Bjorkstedt (NMFS), who is located in HSU's Telonicher Marine Laboratory
GCOOS	- Support regional real-time observation systems, including the High-Frequency Radar network, Water Level Monitoring Network, Harmful Algal Bloom Integrated Observing System, and Hypoxia Monitoring System - Develop an Integrated Water Quality Data Network for rivers to ocean with focus on state waters and local communities to leverage untapped observational resources for the GCOOS data stream	- Maintain and enhance a Model Resource Center to provide formatted data to modelers for HAB monitoring and shelf hypoxia forecasts, including non-federal datasets from buoys maintained by GCOOS partners at TAMU, TAMU-CC, LSU, LUMCON, USM, DISL, FSU, USF, SCCF, and Mote, and to provide access to regional and local model outputs from GCOOS partners. - Develop an Ecosystem Nutrient Model pilot project	- IOOS Biological Data Project - SW Florida Integrated Water Quality Pilot Data Network: integrating the data from the mouths of rivers through the estuaries into the coastal and deep ocean - Develop capability to integrate animal telemetry data into the GCOOS data streams - Develop capability to integrate biological, HAB, and other relevant data from gliders into the GCOOS data streams - Develop capability to integrate beach quality data into the GCOOS data streams	- Work with GOMA: Water Quality, Nutrient Reduction, and Ecosystem Integration and Assessment Priority Issue Teams - Lead development of HAB Integrated Observing System plan - Work with the NOAA NCCOS CSCOR & NCDDC on the NGOMEX Hypoxia Program activities to plan the Hypoxia Monitoring Implementation Plan - Work with the NOAA GoM Regional Collaboration Team on ecosystem and living marine resources issues

			- Maintain capability to integrate phytoplankton imaging data into the GCOOS data streams in support of HAB monitoring	- Work with the UNIDO-GEF Mexico-U.S. GoM Large Marine Ecosystem Project (NOAA SEFSC is a co-chair) on Gulf-wide HABs and ecosystem issues - Work with the Gulf of Mexico Research Initiative to integrate data sets dealing with restoration of the Gulf of Mexico environment
GLOS	- Tributary Monitoring Project - Expand, enhance, and coordinate the Great Lakes network of monitoring and observing systems to provide a comprehensive assessment of the Great Lakes ecosystem for use in monitoring Beneficial Use Impairments in high priority Areas of Concern - Developed a MODIS specific algorithm to locate and map the extent of HABs; mapped using MODIS satellite data as input estimates of optical water properties for Lake Michigan - Supporting monitoring activities that provide oxygen levels, water temperature, and wave heights to the Cleveland Division of Water. This information acts as a warning system to allow the utility to avoid drawing in hypoxic waters or enabling it to treat affected water appropriately.	-Facilitate development of the Ecosystem Forecasting Modeling Framework pilot for Lake Michigan - The Model Inventory allows users to search for models, applications, people, and organizations. Reviews of modeling and assessment tools are provided and some direct access to models.	- Make the Huron to Erie Connecting Waterways Forecasting System available online - The Great Lakes Testbed: a bi-national effort establishing protocols for integrating measurements of chemical, physical, and biological parameters on both sides of the border in the Great Lakes Basin - Develop a decision support and data management system that addresses GLRI goals and high priority user needs including those of municipal water systems managers (intake and sewage), beach managers, and others	- Partnered with the Great Lakes Fishery Commission to launch the Great Lakes Acoustic Telemetry Observing System (GLATOS) tool to answer fisheries management and ecology questions in the Great Lakes
MARACOOS	-Utilize HFR network to monitor river plumes for water quality impacts on recreational beaches. -Repeat coastal glider missioned focused on dissolved oxygen monitoring for the New Jersey	-Butterfish model to avoid by-catch in the Loligo squid fishery -Dynamic preferred habitat nowcast for butterfish and loligo squid with input from real-time satellite, HF radar data.	-Developing a fisherman's web portal with data layers from our region asset map that is specific to the needs identified by the industry.	-Working with NMFS to develop observatory based habitat models and ecosystem indicators for critical species distributed throughout the Mid-Atlantic Bight

	Department of Environmental Protection and Environmental Protection Agency Region II -Provide HFR data in western Long Island Sound to complement buoy mounted ADCPs to support the development of improved understanding of the effect of the transport of nutrients from the East River to the Sound.	-Providing 3-D environmental information to fisheries resource managers, commercial and recreational fishers. -Provide HFR data in LIS and Block Island Sound to evaluate wave and current forecasting for ecosystem mapping in Long Island Sound.		-Funding from NMFS S&T for butterfish modeling work -Working on a process to get industry data collected by the NMFS/NEFSC to inform MARACOOS products -Working with CT and NY Sea Grant to provide temperature and current data to Sea Grant sponsored researchers.
NANOOS	-Partner with NERRS to provide real-time water quality data to shellfish growers - Coordinate with POST to improve telemetry observations -Support NOAA's Ocean Acidification Program by providing observational data from the La Push, WA mooring. - Sustain existing buoys and gliders in the PNW coastal ocean, in coordination with national programs. Maintain these essential assets providing regional observations, with focus on hypoxia, HABs, ocean acidification, climate change detection and modeling input. -Maintain observation capabilities in PNW estuaries, in coordination with local and regional programs to aid sustainable resource management, water quality assessment and sub-regional climate change evaluation. -Collection and providing data and information of fluorescence, salinity, density, water temperature, transmissivity, and oxygen. -Participating in the Animal Telemetry Network Steering Committee.	-Collaborate with the modeling community to assist in facilitating the assimilation of HF data into regional circulation models to support analysis and modeling of HAB transport. -Provide model output for products on web, e.g., Tuna Plots for ocean fishers, circulation forecasts for tracking HABs.	-Animal tagging data management	

	Providing water quality data for Shellfish growers. -Maintain and operate the HF radar surface current mapping network used to support search and rescue, marine operations, oil spill response, and ecosystem forecasting for the Oregon Coast. -Providing information and data products oriented towards commercial and recreational albacore tuna fishing communities.			
NERACOOS	-Support monitoring of surface and bottom boundary layer acidification. -Support URI and Subchem to develop a regional nutrient monitoring capacity and to enhance existing buoys in Narragansett Bay so the data can be delivered in real-time -Support buoys in LIS for hypoxia and water quality -Support buoy that is monitoring water quality in Great Bay, NH -NERACOOS data provides information for NH DES nutrient criteria effort to protect eelgrass habitat in Great Bay, NH -NERACOOS and observations and modeling support regional HAB research, monitoring and forecasting -Supports satellite detection and water sampling for *Alexandrium* in the Bay of Fundy -Support for Environmental Sampling Processor deployment	-Facilitate development of an ecosystems forecast model to aid in understanding acidification and fisheries. -Data from NERACOOS buoys are assimilated into regional ocean forecast system (NECOFS) and utilized for assessing model accuracy. -By supporting the NECOFS, UMASSD is able to run other models like FVCOM/UG-RCA to provide an assessment of the water quality condition in Mass Bay and NPZD-based ecosystem model for 1995-2010 for the Gulf of Maine, also allowing for UMASSD to create 20 year hindcast in support of ecosystem based modeling. -Hypoxia monitoring and modeling in Long Island Sound for NY and CT waste load allocations.	-Right whale detection data management -- sightings posted on NERACOOS website in partnership with Cornell and used with maritime transportation to avoid ship strikes-State and regional programs use historical and real-time data from NERACOOS in management of environmental agencies and lobster, shrimp, and other fisheries. -Developing a regional data management framework to facilitate integration of data in support of ecosystems, fisheries, and water quality.	-Support for the Northeast Channel buoy, initially set up with gomoos and nmfs. -NEFSC provides ship time for buoy operations -Support OA mooring and data analysis in collaboration with PMEL -Providing support for OA in Stellwagen Bank with bottom boundary layer acidification observatory. -NERACOOS buoys are used to house acoustic fish sensors for the NMFS and bat detection sensors for DOE. -Developing exhibit to highlight right whale research in NOAA SBNMS -Collaboration and participation with NEP and NERRS in the region -Participation in Northeast Indicators Community of Practice

	-Supports nutrient monitoring in the Northeast Channel, part Atlantic Zone Monitoring Program (AZMP). -Working to develop an Integrated Regional Sentinel Monitoring Program -Developed regional data portal to provide access to regional observations in support of ecosystems, fisheries, and water quality. -Proposal submitted to EPA LISS for water quality monitoring enhancements to support the hypoxia management in Long Island Sound.			-Participates in the Working Group on the Northwest Atlantic Regional Sea (WGNARS) -Collaboration with agencies through regional partnerships like NROC and NART on initiatives such as the Regional Planning Initiative
PacIOOS	-Hawaii Tuna Tracking Project -Expanded and now maintaining a tracking array and network of automated acoustic receivers (e.g., tracking of sharks in Palau) -Supplying real-time observations of biological, chemical, and physical water parameters to improve the understanding of ocean acidification, more effectively protect healthy coastal marine ecosystems, and enhance the response to marine events that impact human health. - Operations and maintenance of CO_2 buoys, water quality sensors, wave gliders, and HF radars. - Partnering with NOAA to provide select tracks of information on monk seals in the Hawaiian Islands. - Contributing a suite of sensors to a new coral observing station added in Lao Lao Bay, Saipan in the Northern Mariana Islands in support of the Coral Reef Early Warning System (CREWS).	Operations of ocean circulation model.	-Animal tagging data management -IOOS Biological Data Project	-IOOS Biological Data Project pilot with Pacific Islands Fisheries Science Center to integrate reef fish data, including abundance, from multiple partners
SCCOOS	-Provide monitoring, tracking, and prediction tools for harmful algal blooms, outfall and stormwater plumes, and surfzone contaminants.	-Climate scale reanalysis of ocean state to provide a physical context and products for ecosystems and fisheries analysis.		Connectivity reanalysis with high-resolution (1 km) ocean circulation model output and direct observations of surface

	-Maintain and operate the HF radar surface current mapping network used to support search and rescue, marine operations, oil spill response, and ecosystem forecasting. -Deploy and maintain oxygen and carbon dioxide (O2/pCO2) sensors to Automated Shore Stations to initiate ocean acidification Monitoring. -Operate glider operations for monitoring harmful algal blooms (HABs) and coastal discharge plumes in San Pedro Bay and Santa Barbara Channel.			currents from HF radar for use in oil spill risk analysis and marine protected areas monitoring.
SECOORA		-SABGOM nowcast/forecast model of ocean circulation for the entire Gulf of Mexico and South Atlantic Bight -East Coast of Florida (ECF) domain model is now running in Nowcast/Forecast (3 days forecast) mode. -Provide SC DHEC a decision support tool for beach/shellfish water quality advisories	-IOOS Biological Data Project -Added Everglades Monitoring Network Marine Monitoring Network data to SECOORA DMAC system -SECOORA DMCC participation on Eye on Earth system demo project -SECOORA Biological and Habitat GIS Web Site: providing biological data to researchers who want to link biological data with oceanographic data. The specific data sets that were requested to create this prototype were habitats and species distribution models.	- Develop data products derived from satellite and in situ observations for fisheries stock assessment (ROFFS, University of Miami CIMAS, and SAFMC)

Assumptions:

- All RAs are providing physical and chemical data that is or can be used to support fisheries and ecosystem management, such as providing oceanographic information (currents, temperature, salinity, etc.) to parameterize ecosystem models. This includes water quality data, dissolved oxygen, nutrients, etc.

Acronyms:

- OTN – Ocean Tracking Network (Canadian funded project)
- POST – Pacific Ocean Shelf Tracking network (now under OTN)

Marine Life PWG- Background Doc #2 (2018 RA/IOOS Biological Core Variables)

Each RA please answer as follows:
First column: Is your RA spending any money to collect or otherwise make available these variables, including through your data portal?
Second column: Does anyone in your region collect these variables, or hold the data in a repository (current or historical)?

JN: The first Q is unclear if the spending money applies to the second half of the sentence. I assumed so. If not, some N wouud be Y.

IOOS Biological Core Variables	AOOS		CariCOOS		CeNCOOS		GCOOS		GLOS		MARACOOS		NANOOS		NERACOOS		PacIOOS		SCCOOS		SECOORA	
													See Q above				***					
Fish species/abundance	Y	Y	N	Y	N	Y	N	Y	N*	Y	N	Y	N	Y	N	Y	Y	Y	N	Y	Y	Y
Phytoplankton species/abundance	Y	Y	N	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	N	Y
Zooplankton species/abundance	Y	Y	N	N	Y	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y		Y
Coral species/abundance	N	Y^	N	Y	N	Y	N	Y	N/A	N/A	N	Y	N	Deep sea	N	Y	Y	Y	N	Y	Y	Y
Invertebrate species/abundance	Y	Y	N	Y	Y	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y		Y
Marine mammal species/abundance	Y	Y	N	Y	N	Y	N	Y	N/A	N/A	Y	Y	N	Y	N	Y	Y	Y	N	Y	Y	Y
Microbial species/abundance/activity	N	Y@	N	N	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y		Y
Sea birds species/abundance	Y	Y	N	N	N	Y	N	Y	N*	?	N	Y	N	Y	N	Y	N	Y	Y	Y	Y	Y
Sea turtles species/abundance	NA	NA	N	Y	N	Y	N	Y	N/A	N/A	N	Y	N	?	N	Y	Y	Y	N	Y	Y	Y
Submerged aquatic vegetation species/abundance	Y*	Y*	N	N	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	Y	Y	N	Y		Y
Biological vital rates	N	Y+	N	Y	N	Y	N		?	?	N	Y	N	Y	N		N	Y	N	Y		Y
Nekton diet	N	Y#	N	N	N	Y	N	Y	?	?	N	Y	N	Y	N		N	Y	N			Y
Sound	Y	Y	N	N	N	Y	N	Y			N	Y	N	Y	N	Y	Y	Y	N	Y		Y

Comments:

AOOS * This is confusing, do you mean alage? If so, YY
If this means eel grass, kelp, etc...then YY as well...but be more specific

AOOS + Arctic IERP is collecting zooplankton vitality experiments
AMBON is collecting eDNA
There is tons of seabird productivity data collected across the state by federal agencies (FWS, NPS,USGS). The same is true for fish by state and federal agencies.

AOOS # Arctic IERP and AMBON are doing some of this work

AOOS @ AMBON program is collecting microbe data. It's been slow processing

AOOS ^ Agencies and oil companies have data on cold water corals

*** For first column, do you mean are we paying anyone to collect this data? Or are you asking if we serve the data on our data portal (ie, we pay someone to maintain our portal and pull in datasets, so indirectly, we pay to make these data available). If the

Marine Life PWG- Background Doc #3 (2018 Framework for Defining IOOS Contribution to Biological Observing)

The IOOS Contribution to Biological Observing ("IOOS Biology")
IOOS Biological Work Session Summary Report
September 18-19, 2018, Annapolis, MD

IOOS conducted a Work Session at the 2018 IOOS Fall Meeting to explore how IOOS can address the growing need for biological observations at the local, regional and national levels. The Work Session was the first time that the IOOS Program Office staff and Regional Association (RA) Directors discussed this topic in some length. It was the beginning of a discussion that will continue over the next few years. This short report summarizes the major points of the discussion including defining the unique role that IOOS can play in providing biological observations and the recommendations for moving forward. For more information on the IOOS 2018 Fall Meeting, see this link.

IOOS biological activities range from the detection of microbes to whales. Sensors on buoys, autonomous gliders, and satellites observe different aspects of the marine and Great Lake ecosystems. Video cameras record activities on the seafloor. Acoustic receivers monitor the movement of tagged animals. New, state-of-the-art technologies such as Imaging Flow Cytobots (IFCBs) and Environmental Sample Processors (ESPs) detect and identify specific phytoplankton species in real time. Data management is central to all that IOOS does including biology. Working with programs like the interagency Marine Biodiversity Observation Network (MBON) , Animal Telemetry Network (ATN), Marine Mammal Health Monitoring and Analysis Platform and others, IOOS is fostering the adoption of data standards that promote accessibility, integration and interoperability of disparate data sets. The Alliance for Coastal Technologies provides validation, testing and demonstrations of biological sensors and technologies. Despite these efforts, the need for more high resolution biological observation, more affordable sensors, forecasts and data products remain. The purpose of the work session was to identify some practical and actionable steps for moving forward.

Vision and Mission for the IOOS Role in Biology

Attendees reviewed the vision and mission that the IOOC Task Team had developed for the role that IOOS should play in biology and developed the following statements:

Vision: Diverse, healthy, vibrant, marine and Great Lake ecosystems that support robust, resilient coastal economies and communities.

Mission: To promote collection and sharing of information on marine ecosystems through integration of biological, biogeochemical, and physical observations and models and by leveraging partnerships, infrastructure and operations across disciplines and sectors.

IOOS Biology: Current Status and Unique Contributions

At the regional level, IOOS addresses the need for biological observations through its role as a community convener by bringing together data providers, researchers, managers, industry and stakeholders to understand the needs, set priorities and work together to find practical and sustainable solutions. The RAs support a variety of projects related to biology including the monitoring and detection of harmful algal blooms, long-term fisheries sampling, coral bleaching, ocean acidification, detection of fish and protected species, biodiversity and emerging technologies such as eDNA, remote sensing, and advanced image analysis. Several RAs work with citizen science groups to provide data services such as monitoring manatees in Florida and capturing local and traditional knowledge in the Arctic. See this link for a summary of current RA activities related to biological observations. The RAs routinely work with stakeholders to refine and update their needs for biological information.

At the national level, several efforts are moving IOOS forward with respect to biology. The Interagency Ocean Observing Committee (IOOC) convened a Biological Integration and Observations Task Team in 2016 that refined and expanded the list of IOOS core biological variables. The IOOS Program Office has been instrumental in linking IOOS and the RAs with interagency efforts on biology such as the Marine Biodiversity Observation Network (MBON) and Animal Telemetry Network (ATN).

Part of the work session was devoted to discussing the role that IOOS plays in biology and its unique contribution. Many agencies have specific mandates related to biology such as federal, tribal and state fisheries management agencies or agencies dedicated to protecting public health through seafood safety or beach alerts. Workshop attendees grappled how could IOOS best contribute to the need for biological observations with so many players already involved and determined that there are several key ways IOOS can contribute. IOOS is unique in that it serves multiple missions, reaches across 17 federal agencies and has robust national network of 11 regional systems that can tailor solutions to the regional context. IOOS provides the ability to integrate across agencies, across disciplines and across spatial, temporal and taxonomic scales.

Participants identified several attributes that IOOS contributes to biology. For example, IOOS:

- Provides timely, relevant and operational information to promote ecosystem understanding, detect changes and decision-making,

- Integrates across agencies, disciplines, jurisdictions, geographies, and the public and private sectors,
- Serves as a trusted and neutral broker,
- Delivers reliable data that meets national standards through 11 certified Regional Information Coordinating Entities,
- Offers partners opportunities for fiscal management and for leveraging resources to sustain observations.
- Integrates, aggregates and provides ready access to data from disparate sources,
- Establishes and nurtures relationships with stakeholders across the nation,and
- Provides high resolution observations and information needed to address national missions with local and regional relevance.

The demand for biological information comes from a variety of stakeholders. Federal, tribal or state agencies that have specific mandates to manage species or to protect public health. Researchers are eager to improve understanding of the ecosystems and thereby improving our ability to understand and predict events. Beach goers want to avoid unhealthy conditions caused by harmful algae blooms. The range of stakeholders fall into four broad categories:

1. Managers/Agencies: Federal, tribal, state
    a. Public health: e.g., HABs, beach water quality, seafood safety
    b. Regulatory: e.g., offshore energy and mineral (BOEM); aquaculture; water quality (EPA)
    c. Management: Fisheries management (NMFS, regional councils, tribes, states) protected species (MMC, NMFS).
    d. Placed-based management: Sanctuaries, NERRS
2. Researchers: Process studies (e.g., NSF funding research, research cruises); integration of *in situ* data with remote sensing for ecosystem understanding and forecasting (e.g., NASA programs)
3. Public/private stakeholders: commercial and recreational fishermen, aquaculture, general recreation, education, tourism
4. NGOs: Surfrider, World Wildlife Fund, The Nature Conservancy

<u>Recommendations</u>

The following are recommendations identified at the working session for how IOOS can address the need for biological observations, data services and information products. They are mostly short term actions that IOOS can take to develop collaborations, fill gaps and to enhance data interoperability.

1. Document key stakeholder needs for biological information at the regional level

RESPONSIBLE PARTY: RAs with support from PO
TIMELINE: Ongoing - To be completed by all RAs by Oct 2019

2. Emerging Technology: Develop mechanisms for technology transfer and lessons learned about emerging technology for biology.
    a. Review results of the Ocean Technology Transfer project such as those involving the Imaging Flow Cytobots (IFCBs) and Environmental Sample Processors (ESPs) and make recommendations for how the technology could be expanded to other regions.
        1. Identify potential funding to integrate existing IFCB efforts into an operational network, expand deployments to other regions, and develop appropriate workflows. Engage with IFCB experts.
        2. Address data services and classification needs
    b. Identify how the IOOS PO can foster transitioning technology to operational status or transfer of lessons learned from the results of the OTT projects. IOOS should coordinate with partners such as NCCOS, MBON and others to move technology that is ready forward into operations.

RESPONSIBLE PARTY: Targeted Working Group of RAs and IOOS PO
TIMELINE: Call with IFCB RAs about lessons learned - by Jan 2019
Process for lesson learned with OTT

3. Harmful Algal Blooms: Advance IOOS efforts in coordination with NOAA and other agencies to detect and respond to HABs
    a. Develop a short white paper that outlines the contributions of IOOS in detection and forecasting of HABs and it's partnerships with NCCOS, CO-OPS, research institutions and others. The paper should identify the need for filling observational gaps, data management and communication, modeling and forecasting and explore developing a "R&D transfer node" that would provide one-stop shopping for information.
    b. Prepare for possible supplemental funding
    c. Address HAB related data management needs

RESPONSIBLE PARTY: Small working group fo RAs and PO to draft concept paper
TIMELINE: Jan 2019

4. Fisheries Data: Expand access to fisheries data for partners.

a. Work with Frank Schwing of NMFS to develop partnership with RAs and NMFS to locate, access, host, and make accessible fisheries data to IOOS regions and partners.
b. Explore role that IOOS can play in NMFS' Integrated Ecosystem Assessments (IEA):
    i. Understand work underway with California Current and Florida Keys Integrated Ecosystem Assessment (IEA) programs as an example of how IOOS can contribute
    ii. Explore partnership with IEAs in additional regions, including support for web-based tools and conceptual models for regional indicators

RESPONSIBLE PARTY: Ops Division RAs,
TIMELINE: Initial call with NMFS (Nov 2018), Call with all RAs planned for Jan 2019, Project Proposal by late spring 2019 in prep for FY 20

5. Ocean Noise: Explore IOOS role in observations of ocean sound
    i. Identify RAs current role in ocean sound, identify stakeholder needs, and explore possibility of site-specific demonstration project(s) to integrate sound data into products, with NMFS as user.
    ii. Exploring possible collaborations with NOAA and Interagency efforts (Gabrielle)
        1. Ocean Noise and Marine Life Task Force (Fed Agencies-Gabrielle and Bill IOOS reps)
        2. NOAA Ocean Noise Reference Network (Jason Gedamke) and NOAA Ocean Noise strategy
        3. BOEM - Atlantic - for offshore wind and leasing, biodiversity around structures

RESPONSIBLE PARTY: Ops Div and RAs
TIMELINE: Call with Jason Gedamke at NMFS and RAs in Dec 2018, 2nd call with BOEM, RAs and other in Jan 2019

6. Data Management: Promote data standards and best practices
    a. Adopt and advance Darwin Core and ERDDAP
        i. RAs conduct regional Darwin Core and ERDDAP training (working closely with the IOOS PO and OBIS)
        ii. The SOS-ERDDAP transition includes discussion of biological data
    b. Invest in regional capacity to ingest and distribute biological data
        i. Continue $15K per region for biodata integration and stakeholder engagement
        ii. Engage IOOC on shared language around data standards/requirements for federally-funded activities

c. Articulate purpose and audience for various portals for regional and national portals.
d. Develop an IOOS Biological Data Portal that links existing biological portals (e.g., OBIS, MBON, ATN, RA, etc) to minimize duplication and confusion
    i. Develop clear statement of the roles of OBIS (global), MBON (national and global) and IOOS.
    ii. Key themes new ideas, next steps
e. Develop business model for data services for data integration, seek ways to encourage data sharing through permit requirements (interagency activity including NMFS PARR, BOEM studies, ATN)
f. Initiated a data archeology effort
    i. Advocate with other agencies and parts of NOAA that RAs are able to do this. Labor intensive but there are tools to help
    ii. Need agency policy to push openness of data.
    iii. Incentivize data sharing- give PIs a DOI Need better story to convince PIs to contribute

RESPONSIBLE PARTY: Ops Div/RAs scoping group to review and prioritize recommendations
TIMELINE: Convene by Feb 2019

7. Data product development and sharing: Enhance biological information products
g. Explore multi-regional products. Identify existing products that can be easily shared, explore shared development of Apps
h. Product development training. Training on end-to-end best practices on how to develop a product with outside experts.
i. Develop synthesized products that provide seamless product integration (e.g., whale movement across regions)
j. Explore new business models for products such as "Willingness to Pay, Service Level Agreements, etc. Engage market expert to provide recommendations.
    i. Enhance visualization for products

RESPONSIBLE PARTY: Ops Div, RA scoping group to review and prioritize recommendations with above
TIMELINE:

7. Address need for hyperspectral and higher spatial and temporal data for biology in coastal zone and Great Lakes - drones, aircraft, satellite
a. Understand how NASA is addressing this in their long range planning
b. Work with ACT to implement recommendation from their drone workshop

RESPONSIBLE PARTY: Subject Matter Experts, ACT, others

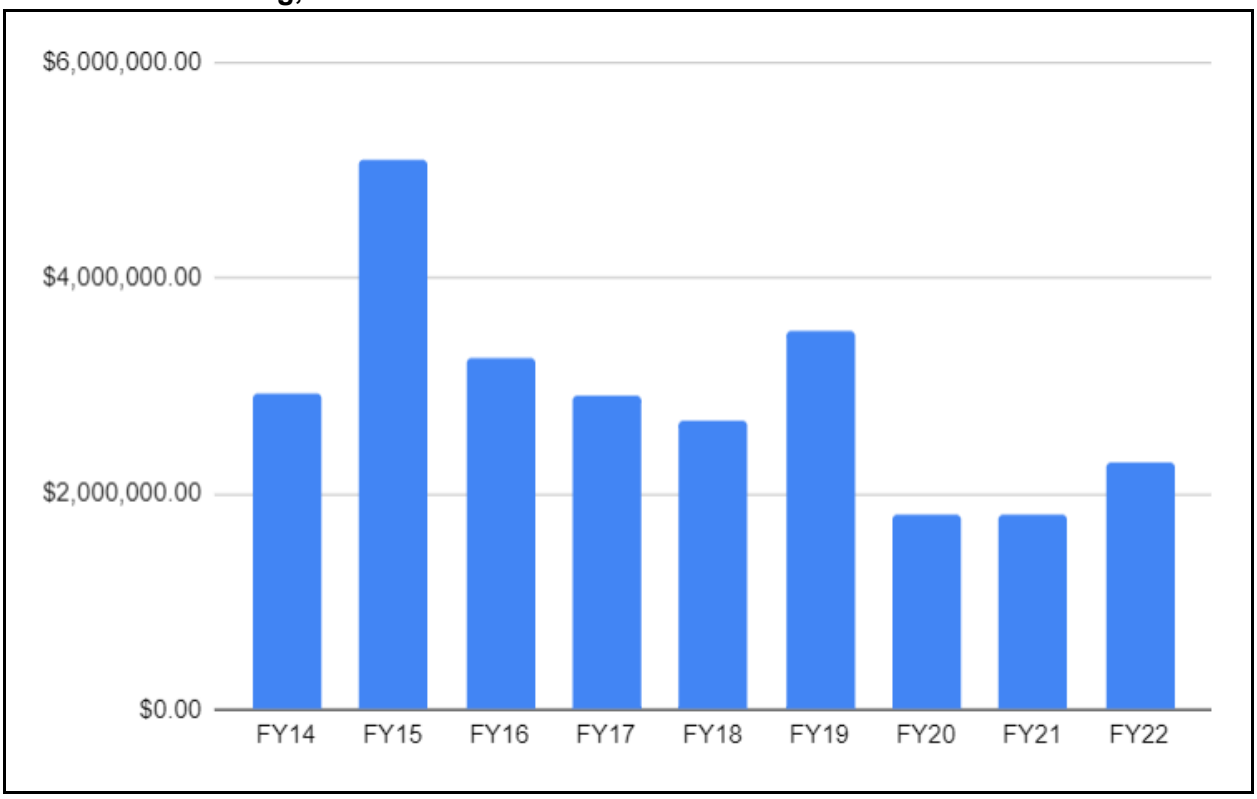
TIMELINE: 2019

8. Integrate existing local observing and citizen science into regional portals with linkage to the global. (Possible foundation proposal)
   RESPONSIBLE PARTY: RAs, PO, others
   TIMELINE: 2019

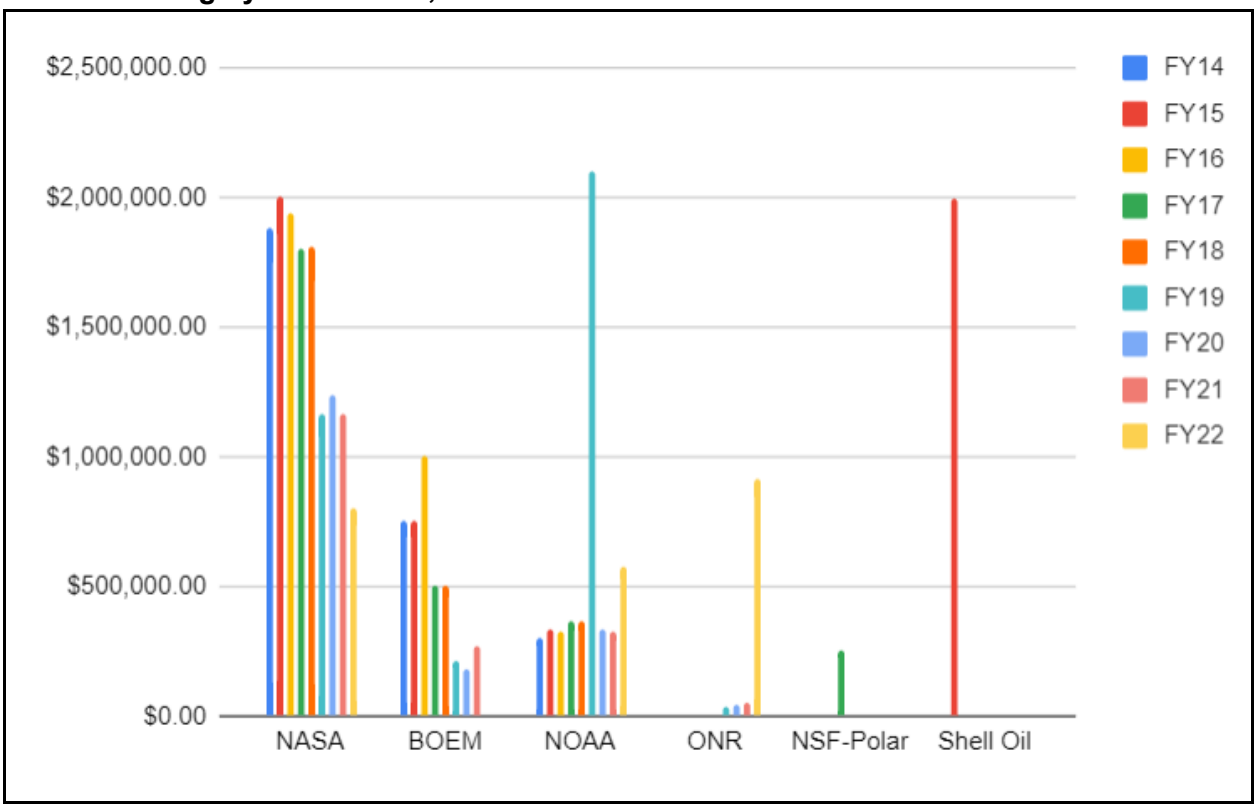
9. Convene community workshop and writing team to develop IOOS Biology implementation plan that engages Federal agencies, RAs and subject matter experts.
   RESPONSIBLE PARTY: Ops Div with RAs
   TIMELINE: TBD FY 20

10. Global engagement - enhance communication with GOOS; engage IOOS PO with RAs and relevant GOOS regional bodies at Ocean Obs 19.
    RESPONSIBLE PARTY: Ops Div with RAs
    TIMELINE:

Total MBON Funding, FY14-22



MBON Funding by Contributor, FY14-22



ATN Funding by Contributor, FY18-22