• Partnership of 17 federal agencies

• Scientific, technical, and procedural standards to establish a national ocean, coastal, and Great Lakes observing system.

• 11 Regional Associations, the Alliance for Coastal Technologies (ACT) and the Southeastern University Research Association (SURA) to build this observing network.
From National to Global

IOOS
Integrated Ocean Observing System

The Global Ocean Observing System

GROUP ON EARTH OBSERVATIONS
Mission Areas:

- Improve predictions of *climate* change and *weather*, and their effects on coastal communities and the nation
- Improve the safety and efficiency of *maritime operations*
- More effectively mitigate the effects of natural *hazards*
- Improve national and homeland *security*
- Reduce *public health* risks
- More effectively protect and restore healthy coastal *ecosystems*
- Enable the *sustained use* of ocean and coastal resources.
IOOS Regions

Who
- State, Local, Tribal Government
- Profit & non profit industries
- Academia

11 Regions

Data Access

Observations

Models

Education Outreach

Produce | Integrate | Communicate
IOOS is a Team Sport

- IOOC
- IOOS Office
- IOOS Assoc
- IOOS Advisory Comm

Interagency Oversight IOOS Task Teams

Programmatic Operational Capacity Partnerships Champion Regional

Congress OMB Sponsor Events RA Coordination

Official Advice Recommendations
Observing Tools

HF Radar
Shore stations
Satellites
Drifters
Tide Stations
Gliders
Buoys
- Weather
- Water quality
- CO2
- Nutrient sensors
- HAB sensors
- Animal telemetry
Models
- Northeast Coastal Ocean Forecast system
- Wave Watch II Forecast system
Challenges

• Legacy observing systems to meet singular/specific mission needs.

• Lack of interoperability and common access to data

• Pockets of highly specialized observing, science, and data analysis

• Sparse data and modeling coverage in some geographies
IOOS: Advancing Communities past Challenges

HF Radar:

Gliders:

Animal Telemetry:

Wave Measurements:

Biological Variables & BIO TT:

WORKSHOP REPORT

Biological and Ecosystem Observations within U.S. Waters:
A Workshop to Inform Priorities for the U.S. Integrated Ocean Observing System®

Commended by the Interagency Ocean Observation Committee (IOOC) Biological Integration and Observation (BIO) Task Teams
IOOS Data is BIG data

**Petabytes of Open Data**

- 32,000 stations
- 119,515 sensors
- 37 national sensor networks
- 42,000,000 sensor observations *Per week*
Access to Data

Global Telecommunications System (GTS)

2 week cache of real-time observations

Access on 1 page: ioos.us

Standards

Quality Assurance

Access to model output

Blizzard 2016: CBOFS winds at 1/23 17:00 EST. Time-series of model output and buoy observations (1/20 - 1/23)
IOOS Regional Certification

Integrated Coastal and Ocean Observation System Act of 2009 (ICOOS Act)

• Formal recognition of IOOS Regional Associations
• Extends **civil liability** coverage for data use
• Establish minimum criteria for how a RICE operates
• Adherence to data management best practices
• Enhance delivery and quality of data and information

**Credible** – recognize NOAA’s responsibility for ensuring data quality and assumption of liability risk

**Reasonable** – develop program guidelines in accordance with RA capabilities as supported by IOOS Program funding
Applications and Needs
Post Storm: Response, Recovery, Long-term Planning

**Navigation Response Team**

**Shoreline Imagery**

**Oil Spill Response**

**Marine Debris**

**Analysis of the Storm**

**Promoting Resilience**
Saving Lives – supporting the US Coast Guard – Search and Rescue
Gliders
HR Radar
Modeling

IOOS Regional Assets support national mission: supporting gliders, surface currents from HF radar, and regional models
Improved forecasts to mitigate and respond to human health hazards, caused by harmful algal blooms and pathogens:

- Improved reporting of real-time meteorological and oceanographic conditions;
- Improving reporting of water quality parameters; and
- Creating better trajectory models.

Output imagery from the IFCB, October 11 SF Bay Deployment. Credit: Raphael Kudela

Deployment of PNW ESP, May 2016. Credit: Stephanie Moore
The lesson learned is that going forward, this approach to fisheries stock assessments work has to be done before fisheries are shut down, and economic losses are unnecessarily sustained, due to data poor management.

The return on investment is spectacular: $1,000 – 1!

- Greg DiDomenico, Garden State Seafood Association Executive Director and MARACOOS User Council Member
Economy: Shellfish Industry

Shellfish industry:

- $111 million on West Coast
- At risk from ocean acidification

Real-time data informs industry management decisions

CeNCOOS  NANOOS
Ocean Technology Transition

Fostering the transition of advanced observing technologies to operations mode.

West Coast Ocean Acidification

Harmful Algal Bloom
Gulf of Maine
North west United States

Detection
Arctic Freeze
Up
Real-Time

Imaging Flow CytoBot
in SF Bay – Industry

Operational Nutrient Observatory for the Northeastern United States – Industry Partner: WetLabs

The “Burk-o-lator” – developing low cost OA sensors

The logo of the IOOS (Integrated Ocean observing system) is also present, along with several logos of various institutions and organizations that are involved in ocean technology and research.
Alliance for Coastal Technologies (ACT)

Technology Evaluations, Technical capacity building, and information clearinghouse

Nutrient Sensor Challenge
(FY2015/2016)

Coastal & Ocean Modeling Testbed (COMT)
Testing model skill, transition to operations, and applied science for hypoxia, inundation, and ocean forecasts
Marine Biodiversity Observation Network (MBON)

Interagency support:
$15M from NASA, NOAA (IOOS and OER), and BOEM for 5 years (FY14-18)
$2M from Shell to launch Arctic MBON

Demo projects are:
• Integrating existing monitoring
• Filling spatial, taxonomic gaps
• Monitoring “microbes to whales,” “in-situ to satellites”
• Exploring technology applications
• Addressing data management
• Building MBON for the Nation
• Creating global MBON (with GEO, GOOS)
• Connecting with the Animal Telemetry Network

Credit: MBARI
New technologies and methods will lower the cost of observing while increasing space and time and space resolution.

MBON is:
- Refining eDNA methods - large, multi-institution partnership
- Leveraging OAR ‘omics work with MBON funds and in-kind (corals, ESP)
- Evaluating technologies for MBON: genomics, acoustics, bio-optical informatics and images, animal tagging, ESP

<table>
<thead>
<tr>
<th></th>
<th>Microbes/Phyto</th>
<th>Zooplankton</th>
<th>Fish</th>
<th>Top Predators</th>
<th>Benthos, habitat forming</th>
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</thead>
<tbody>
<tr>
<td><strong>Optics/Imaging</strong></td>
<td>X</td>
<td>X</td>
<td>X Benthic</td>
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<tr>
<td><strong>Acoustics</strong></td>
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<td>X active</td>
<td>X Tags, passive</td>
<td>X active</td>
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<td><strong>Genomics</strong></td>
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<tr>
<td><strong>Platforms with samplers</strong></td>
<td>AUVs, floats, moorings</td>
<td>AUVs, moorings</td>
<td>AUVs, moorings</td>
<td>AUVs, moorings, tags</td>
<td>AUVs, moorings</td>
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<tr>
<td><strong>Data and visualization</strong></td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
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</tr>
</tbody>
</table>
Sustaining MBON

- MBON observes marine life – how it’s changing, how it affects us.
- MBON is establishing long-term species status and trends and merging that with environmental information.
- MBON informs understanding of impacts from climate, ocean acidification, and human activity to species we depend upon.
- MBON directly supports:
  - Understanding biological impacts from ocean acidification, climate change
  - Management of National Marine Sanctuaries and marine protected areas
  - Protection of shallow and deep-water corals
  - Ecosystem-based science and management, including Integrated Ecosystem Assessments

*Private and federal funding is needed to sustain MBON.*
Economy: U.S. Ocean Enterprise

THE OCEAN ENTERPRISE
A study of US business activity in ocean measurement, observation and forecasting

Prepared by
ERISS Corporation
The Maritime Alliance
February, 2016
Ocean Enterprise - Results

- Generally optimistic
- Majority expect to grow
- Providers: anticipate growth
- Intermediaries: staying the same or uncertain

- 65% (provider/intermediary = 65%/42%) - environmental monitoring
- 61% (provider/intermediary = 61%/37%) - academic research
- 52% (50%/42%) - oil & gas
- 41% (39%/31%) - ports & harbors
- 36% (35%/27%) - hydrographic surveying
- 35% (27%/37%) - engineering
- 34% (28%/35%) - coastal protection
- 31% (50%/42%) - defense
- 30% (32%/17%) - weather & ocean forecasting
- 27% (27%/33%) - water & water quality
- 26% (25%/23%) - renewable energy
- 25% (21%/33%) - fishing industry
- 24% (23%/19%) - maritime security
- 19% (17%/19%) - construction surveying
- 15% (13%/17%) - cargo shipping
- 9% (8%/10%) - cruise or passenger ships
- 3% (2%/4%) - biotechnology

- 410 Companies
- $7B annual revenue
- 36 States
Questions

Enables decision making
Fosters Advances in Science and Technology

https://ioos.noaa.gov
https://www.facebook.com/usioosgov
@usioosgov
Challenges and Approaches

RNRF Charge:
Case studies highlighting the use of data and innovative technologies to answer questions and facilitate informed responses to environmental issues.

• What unique challenges were faced in collecting, storing and accessing relevant, high quality data? What approaches were key to success?
• Is data readily available for this need? What information would be valuable to have?
• What data science/analytical techniques were applied?
• How have partnerships facilitated data access and improved technological and analytical capabilities?
• How is this application being used as a decision-making tool for on-the-ground action?
Public Good: Supporting Hurricane Response
# U.S. IOOS By The Numbers

<table>
<thead>
<tr>
<th>Category</th>
<th>Number</th>
<th>Description</th>
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<tr>
<td><strong>Federal Partners</strong></td>
<td>17</td>
<td>Providing a Federal Backbone for IOOS</td>
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<tr>
<td><strong>RegionalAssociations</strong></td>
<td>11</td>
<td>Observing Assets and Data Feeds</td>
</tr>
<tr>
<td><strong>Alliance for Coastal Technologies</strong></td>
<td>1</td>
<td>A partnership supporting sensor evaluation and verification</td>
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<tr>
<td><strong>Coastal Ocean Modeling Testbed</strong></td>
<td>1</td>
<td>COMT - a conduit for research models to transition to operations</td>
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<tr>
<td><strong>Marine Biodiversity Observing Network</strong></td>
<td>1</td>
<td>MBON integrates marine biodiversity and ecosystem data</td>
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<td><strong>National Platforms</strong></td>
<td>697</td>
<td>Buoy, Water level gauges, Coastal and Estuary stations at the National level</td>
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<tr>
<td><strong>Regional Platforms</strong></td>
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<td>Buoy, Water level gauges, Coastal and Estuary stations at the Regional level</td>
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<tr>
<td><strong>Ocean Technology Transition Projects</strong></td>
<td>9</td>
<td>OTT supports transition of marine sensors to operations</td>
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<tr>
<td><strong>Animal Telemetry Projects</strong></td>
<td>15</td>
<td>Providing data on animal responses to the ocean and environment</td>
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<tr>
<td><strong>HF-Radar Installations</strong></td>
<td>140</td>
<td>High-Frequency Radar measures speed &amp; direction of ocean currents</td>
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<tr>
<td><strong>Glider Days</strong></td>
<td>41,820</td>
<td>1 Glider in the water collecting data for 1 day</td>
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<td><strong>QARTOD Manuals</strong></td>
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<td>Realtime Oceanographic Quality Assurance</td>
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<td><strong>Datasets</strong></td>
<td>&gt;15,000</td>
<td>Oceanographic Datasets available in the IOOS Catalog</td>
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<tr>
<td><strong>Servers</strong></td>
<td>42</td>
<td>Top-level domains hosting data access</td>
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**IOOS Integrated Ocean Observing System**
IOOS Office Primary Roles:

Provide Programmatic Leadership

Foster Operational Capability

Forge Robust Partnerships

Champion Regional and Stakeholder Interests

Budget History FY10-FY16

<table>
<thead>
<tr>
<th>Year</th>
<th>External Federal/Private</th>
<th>Other NOAA</th>
<th>IOOS Regional Observations</th>
<th>IOOS National Program</th>
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<td>FY 2016</td>
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