Advancing HAB Ocean Sensor Technologies

NATIONAL OCEAN SERVICE

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Silver Spring, MD
Harmful Algal Blooms – A National Problem
A National Response to HABs – NOAA’s Mandate

2014 - Harmful Algal Bloom and Hypoxia Research & Control Act

- Improve interagency coordination
- Conduct research
  - Understand causes & impacts
  - Develop better monitoring, prediction and response
- Understand roles of climate, nutrients, etc.
- Toxins in foods and water
- Methods to suppress/control, prevent.

- Event Response
- Reports to Congress

Breve Buster\Glider Karenia cell counts. G.Kirkpatrick Mote, NOAA ECO\PCMHAB & NCCOS

Satellite detection\tracking: Karenia & Microcystis blooms. R. Stumpf. NCCOS

Jellet & Mercury Science toxin kits. NCCOS and partners

SPATT toxin sampler. R.Kudela UCSC. NCCOS and partners
A National Response to HABs - Accomplishments

- Guidelines for freshwater toxins, health advisories
- Enhanced HAB Detection
  - low cost simple screening
  - Better regulatory confirmation
  - Real-time HAB sensors
- HAB modeling & forecast products
- HAB event response
- Understanding effects of HAB toxins on human, animal health

HAB-scope:” Karenia cell counts. G.Kirkpatrick Mote. NASA & NCCOS labs

“Tricorder:” Karenia cell counts. J.Paul USF. NOAA ECO\PCMHAB

POSSE: Alexandrium cell ID. L. Connell U.Maine. NOAA MERHAB
NOAA Mandate for National Ocean Observing System

Integrated Coastal & Ocean Observation System Act of 2009

Created IOOS, with NOAA as lead Federal agency “The purposes of this subtitle are to—

(1) establish a national integrated System of ocean, coastal, and Great Lakes observing systems, comprised of Federal and non-Federal components coordinated at the national level by the National Ocean Research Leadership Council and at the regional level by a network of regional information coordination entities, and that includes in situ, remote, and other coastal and ocean observation, technologies, and data management and communication systems, and is designed to address regional and national needs for ocean information, to gather specific data on key coastal, ocean, and Great Lakes variables, and to ensure timely and sustained dissemination and availability of these data...”
Consistent National Capability

Observations
Forecasts/Modeling
Data Management
User Products
Outreach and Education
Leverage and Link

Diverse Local Stakeholders
Ocean Technology Transition

- IOOS advances technology through the transition of ocean, coastal, and marine sensors and platforms to operations

> Sponsors the transition of emerging marine observing technologies;

> Where there is an existing operational requirement; and

> A demonstrated commitment to integrate into operations.

Transition Phases as Readiness Levels (RLs)

1. Basic principles have been observed and evaluated.
2. Technology concept and/or application have been formulated.
3. Analytical and experimental verification and characteristic proof-of-concept.
4. Component/subsystem model validation in a relevant environment.
5. System/subsystem/component validation in relevant environment.
6. System/subsystem model or prototype demonstration in a relevant environment.
7. System prototyping demonstration in an operational environment.
8. Actual system completed and “mission qualified” through test and demonstration operational environment.
9. Actual system “mission capable” through successful mission operations.

OTT Area of Focus
HAB Sensors – Ocean Conditions

- Nitrate sensor (U. Maine)
- Northeast Nutrient Observatory
- SST/HAB pigments (Satellites)
- Surface current data (HF radar)
HAB Sensors – Cells and Toxins

- In situ observations
  - cells
  - toxins

- Remote Detection
  - Proxy measurements
  - Satellites

- Rapid “hand-held” field tests
  - Toxins in water
  - Toxins in shellfish/fish
HAB Sensor Examples - ESP and IFCB

Advancing Harmful Algal Blooms, Water Quality, Ocean Observing, Aquaculture Missions

- Outer Coast, Puget Sound (IOOS OTT)
- Lake Erie (GLERL & NCCOS)
- Gulf of Maine (NCCOS MERHAB, PCMHAB and IOOS OTT)
- S. F. Bay (IOOS OTT)
- S. And C. California (NCCOS ECOHAB)
- Catalina Sea Ranch (NMFS)
- Texas Network (NCCOS PCMHAB)
- IFCB AUV (IOOS OTT)
- EcoMon (NMFS\CINAR)
- Martha’s Vineyard Observatory (NSF, ONR)
- Nauset Marsh (Sea Grant, NCCOS MERHAB)
HAB Sensors - ESP Story

• Gulf of Maine (2013-2014)
HAB Sensors - IFCB story

- WHOI Project (2015-2018)
- Research prototype field tested Salt Pond, MA early spring of 2016.
- Prototype IFCB-AV has successfully field tested in a JetYak vehicle in Woods Hole Harbor and Salt Pond
- Production of a pre-commercial IFCB-AV developed.
- Starting testing on a Liquid Robotics Wave Glider.
- Future tests in Gulf of Mexico
- San Francisco Bay Project (2014-2017)
  - Lab IFCB Tests Successful
  - IFCB successfully deployed in Santa Cruz Wharf and on a USGS vessel
  - Upcoming Deployment on Dunbarton Bridge
  - USGS and SFEI to fund project in 2017
HAB Sensors: IFCB story
Reduces Harmful Algal Bloom Impacts

- Efficient and Effective Shellfish Monitoring
  7 HAB early warnings since 2007

- Confidence in Shellfish Product Safety
  No shellfish recalls since 2008.

*Dinophysis spp.* Diarrhetic Shellfish Poisoning

*Karenia spp.* Neurotoxic Shellfish Poisoning
HAB Sensors: IFCB story

HAB Shellfish Harvesting Closures
March 7-April 12, 2008

Oyster Festival in Fulton, TX
March 7-9, 2008

Cash Prizes
Men’s & Women’s Raw Oyster Eating Contests
1st – Prize $200, 2nd – Prize $100, 3rd – Prize $50
Oyster Shucking Contest
1st – Prize $700, 2nd – Prize $200, 3rd – Prize $100
HAB Sensors: ESP and IFCB story

In situ measurement of phytoplankton cells and toxins

IFCB and 2G ESP in Nauset Marsh, Cape Cod Spring 2016

IFCB powered by solar panels and generator

Credit: Brosnan (WHOI)
## HAB Sensors: ESP Summary

### Active NOAA Program Investments
- NOS\NCCOS HAB Research
- IOOS Ocean Tech Transfer
- OAR GLERL, NMFS NW Fisheries Science Ctr.

### Partnerships Universities, States, Companies
- Woods Hole Oceanographic Institution, MBARI, U.C. Santa Cruz, USC, U. Washington, NANOOS, and NERACOOS.
- Washington Departments of Health and Fish & Wildlife
- McLane Research Laboratories, Inc.
- Taylor Shellfish, Lummi Indian Tribe

### ESP Capabilities
- Continuous, autonomous HAB species and toxin abundance + pathogen detection.
- 10 yrs of buoy, pier-based, and cabled underwater deployments.
- Data supporting NOAA and state science and management needs.
- 2\textsuperscript{nd} generation commercially available.
- New applications and next generation formats emerging.
HAB Sensors: IFCB summary

Active NOAA Program Investments

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<thead>
<tr>
<th>NOS\NCCOS HAB Research</th>
<th>HAB species\community</th>
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<tr>
<td>IOOS Ocean Tech Transfer</td>
<td>Water quality</td>
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<tr>
<td>OAR Sea Grant M.I.T. &amp; TX</td>
<td>Observations &amp; Tech Transfer</td>
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<td>NMFS Saltonstall-Kennedy</td>
<td>Ecological Forecasting</td>
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<td>Aquaculture</td>
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Partnerships Universities, States, Companies

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<td>Texas State Departments of Health Services and Wildlife</td>
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<tr>
<td>McLane Research Laboratories, Inc.</td>
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<td>Catalina Sea Ranch, LLC (new)</td>
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IFCB Status

- Continuous, autonomous ID & counts of phytoplankton species.
- 10 yrs of shipboard, pier-based, and cabled underwater deployments
- Data supporting NOAA and state science and management needs
- 1st generation commercially available
- New applications and next generation formats emerging
NCCOS HAB Programs

• FY17 PCMHAB and ECOHAB FFO closed, peer review underway
• Future FFOs for ECOHAB, MERHAB and PCMHAB programs likely to continue HAB sensor technology advances.

Disclaimer: plans are pending federal appropriations
Ocean Technology Transition

- FFO Open – Closes March 20, 2017
- Innovative proven tech
- Proof of Concept
- Proof of Operational Need
- Committed Sponsor

http://www.ioos.noaa.gov//project/ocean-technology-transition/
National HAB Forecasting and Sensor Networks

WA: research demonstration
CA: research demonstration
HABHRCA (2014) & IOOS Act are critical

TX: operational
Erie: 2016 initial operations
Gulf of Maine: research demonstration
C.Bay: research
FL/AL/MS operational
What can sensor industry and partners do?

• Support NOAA Operational HAB Forecasting System to provide early warning for HABs useful to industry

• Educate partners on how sensors can address about HAB-related disruptions to their businesses.

• Engage in developing of monitoring networks and foster regional collaborations.

• Develop regional collaborations

• Support regional Integrated Ocean Observing System associations—urge them to include HAB sensors
Thank You!

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