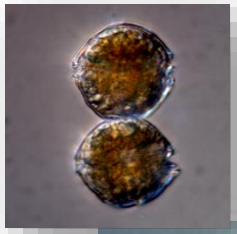
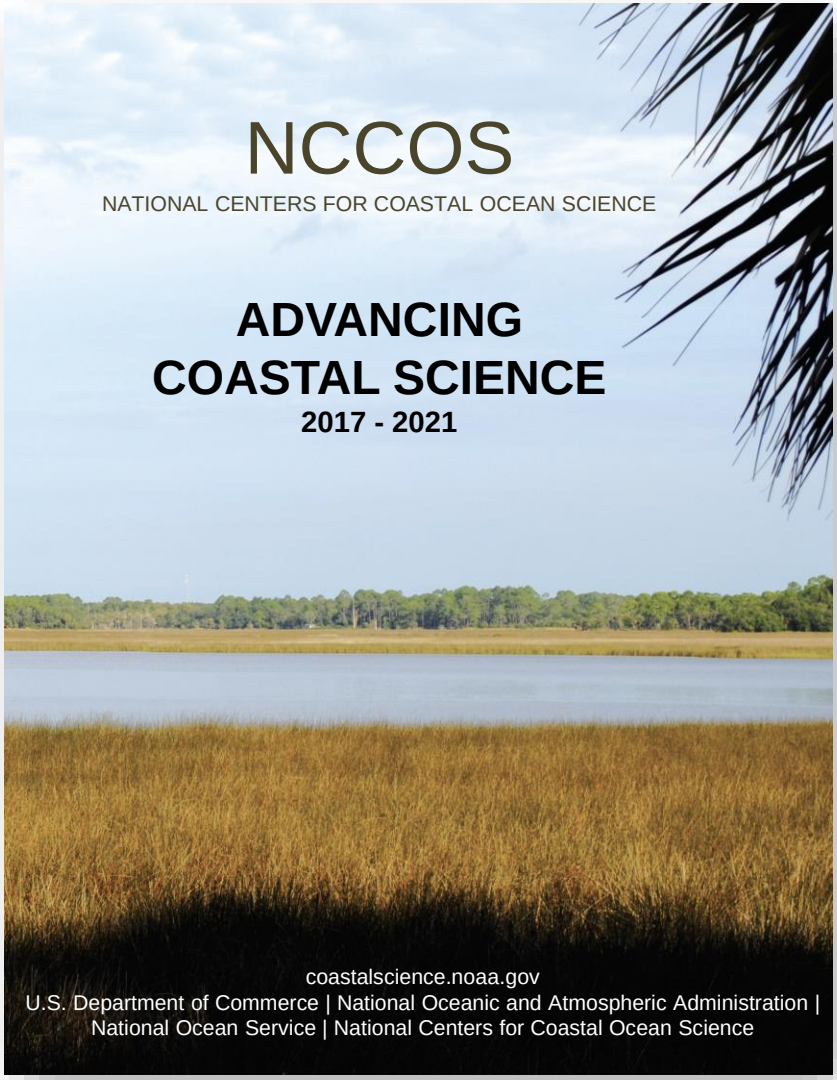
NCCOS HAB DETECTION & FORECASTING



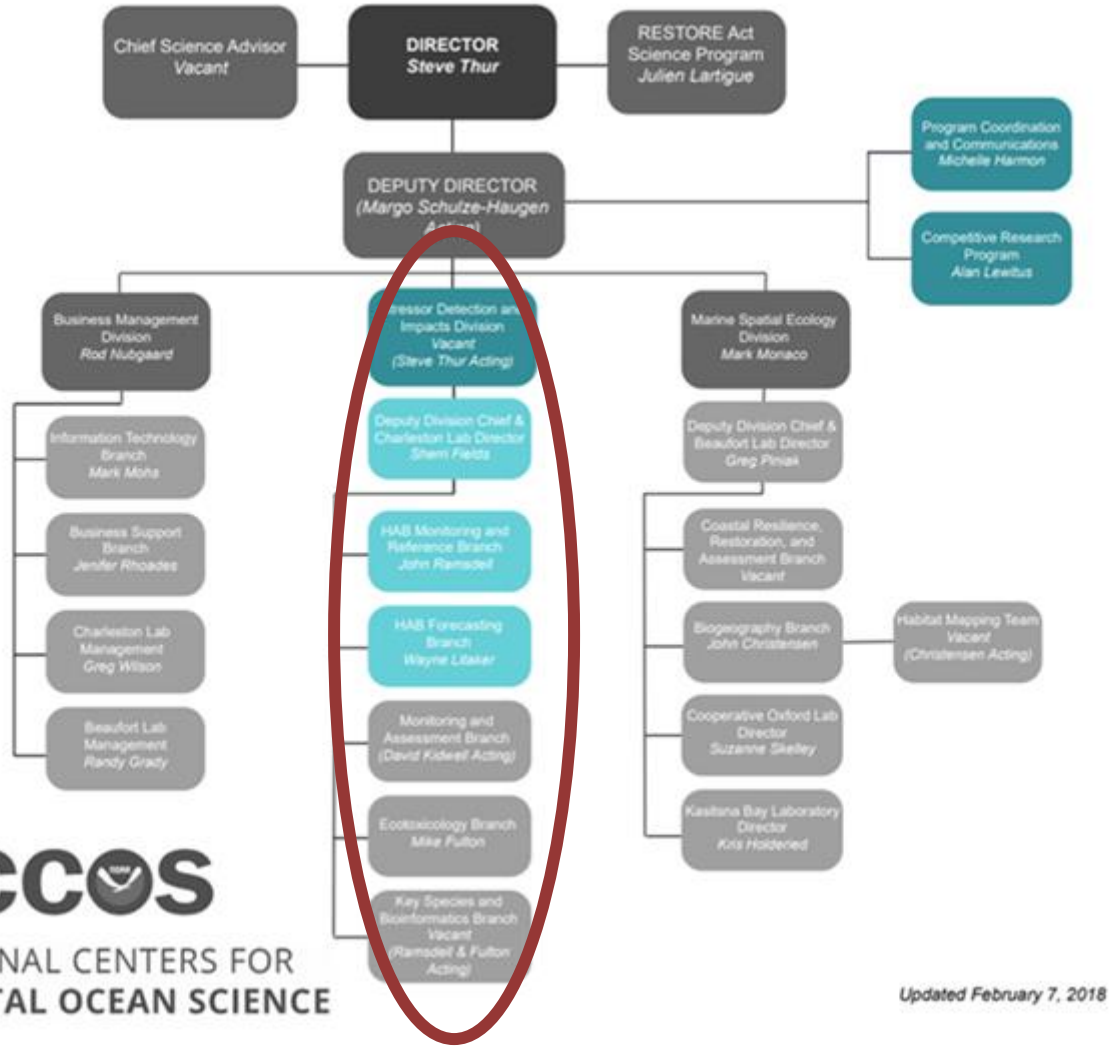
Sherri L. Fields
NCCOS Charleston Lab Director &
Deputy Division Chief
Stressor Detection & Impacts Division

Outline

- Division Overview
- HABHRCA Directive
- Role Under Strategic Plan
- People & Places
- Implementation Plan



Overview: SDI Organization



Overview: Stressors

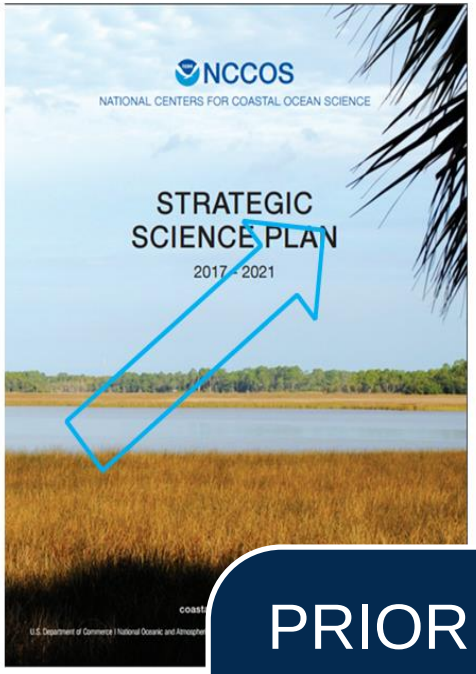
- Alter state of ecosystem
- Include
  - Harmful algal blooms
  - Chemical contaminants
  - Nutrients
  - Pathogens
- Impacts
  - Species
  - Ecosystems
  - People
  - Economies

HABHRCA Authorization

- Increase the availability to appropriate public and private entities
  - Analytical facilities & technologies
  - Reference and research materials
  - Operational forecasts
  - Mitigate adverse impacts of HABs
- Working cooperatively and avoiding duplication

Mission: Our Purpose

Deliver ecosystem science solutions for stewardship of the nation's ocean and coastal resources



Vision: Our Future

Science serves to sustain thriving coastal communities and economies

PRIORITY: Stressor Impacts &Mitigation

SDI

CRP

SUBPRIORITIES

Harmful Algal Bloom Detection & Forecasting

Bioeffects of Contaminants & Nutrients

HAB Forecasting Branch

HAB Monitoring & Reference Branch

SDI: HAB Detection & Forecasting

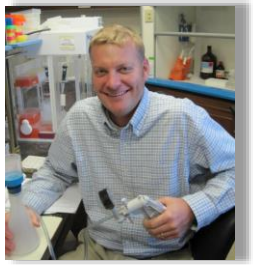
HAB Forecast Branch

- Conducts applied research needed to inform ecological forecasts
- Advances satellite methods for detecting HABs
- Develops and delivers ecological forecasts
- Helps stakeholders mitigate HAB impacts

HAB Monitoring & Reference Branch

- Develops monitoring technology
- Validates methods (human & autonomous)
- Validates measurements
- Serves as reference laboratory
- Trains managers and volunteers

SDI People



HAB Forecast Branch

- Supervisory Research Ecologist (1)
- Fish Biologist (molecular biologist) (1)
- Oceanographer (5)
- Physical Scientist (1)
- Contract Oceanographer (5)
- Contract Meteorologist (1)
- NRC Post Doc (1)

HAB Monitoring and Reference Branch

- Supervisory Research Physiologist (1)
- Research Chemist (3)
- Chemist (1)
- Research Oceanographer (2)
- Laboratory Technician (2)
- Contract Oceanographer (2)
- Contract Mass Spectrometrist (1)

SDI Facilities

"….R&D essential to accomplishing NOAA's missions depends on sophisticated research facilities and hardware, including laboratories, instrumentation..... " NAO 216-115A

NCCOS Program Office and Headquarters — Silver Spring, MD.

- Offices and state of the art computational facilities
- Recognized internationally for work on HAB, contaminants and Marine spatial ecology

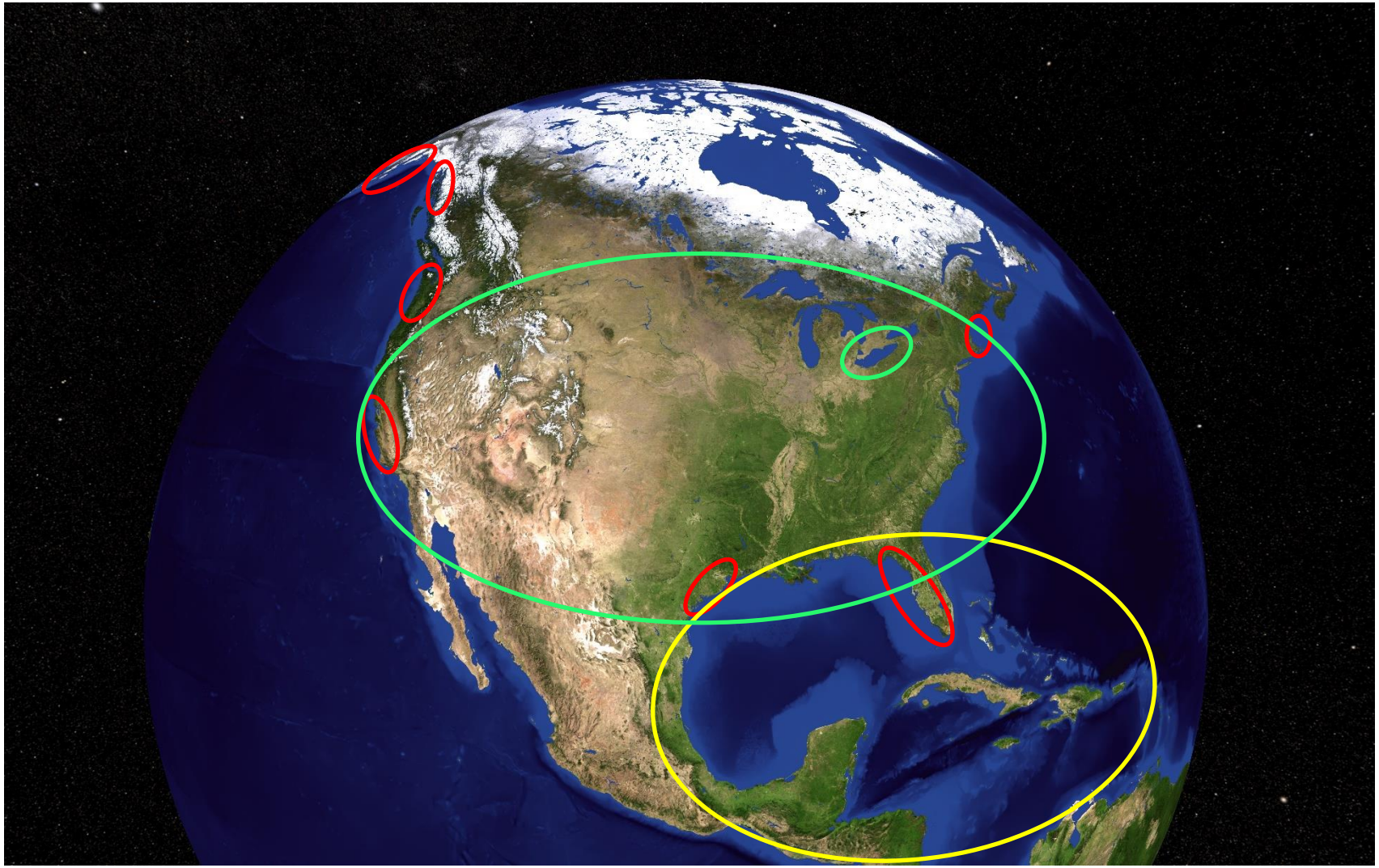
The NOAA Beaufort NC Laboratory

- Shared with NOAA Fisheries and National Estuarine Research Reserve
- Recognized research on harmful algal blooms, seagrasses, coral reefs, seafloor mapping, aquaculture, and salt marsh ecology.

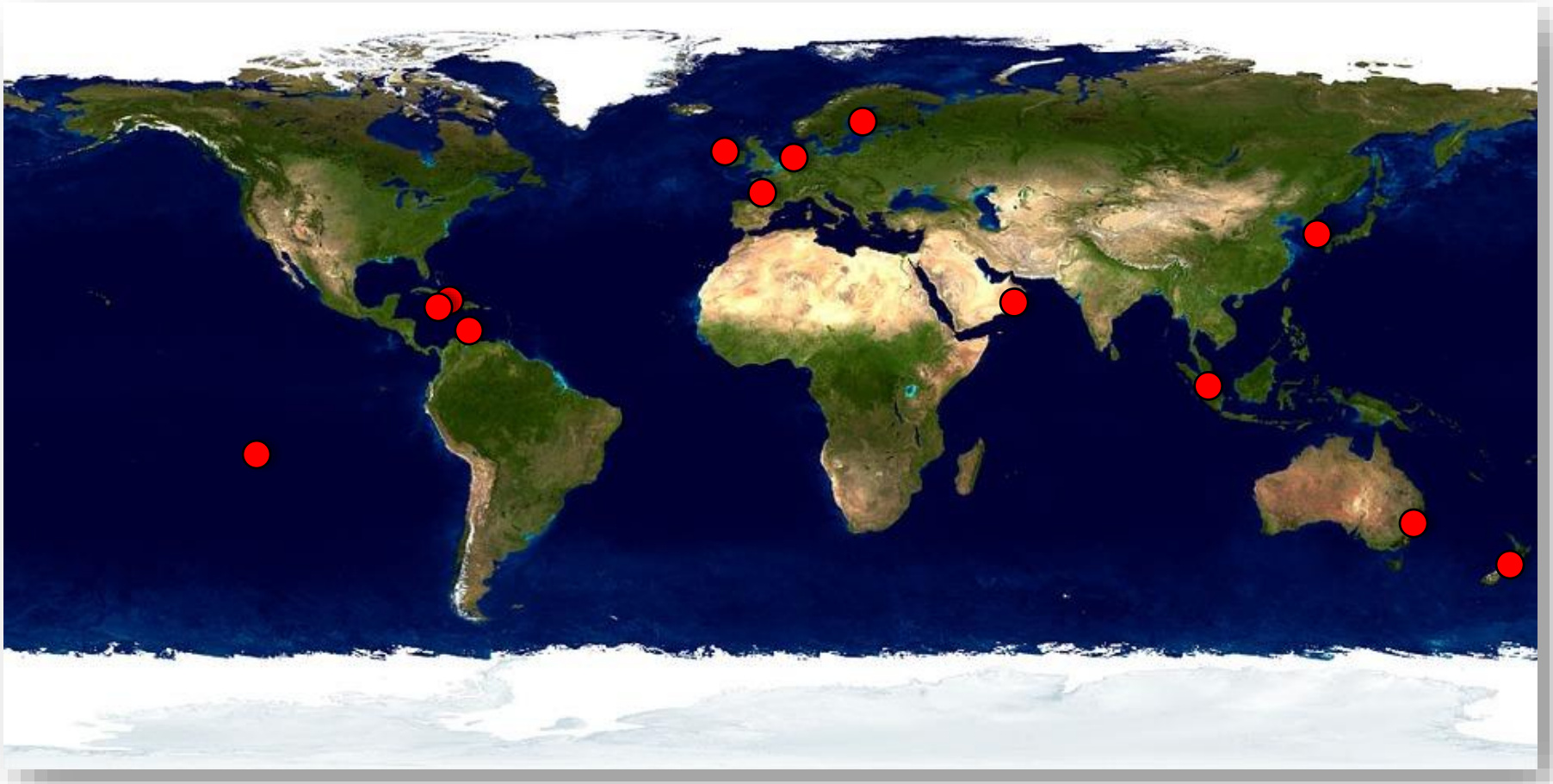
NCCOS's Charleston SC Laboratory and Hollings Marine Laboratories (HML)

- Charleston lab: Recognized for HAB research, chemistry, toxicology, molecular, microbiology, and ecology
- HML: partnership between NCCOS, the NIST, MUSC, SC Dept. Natural Resources, and the College of Charleston

Where We Work Nationally



Global Collaborations



NCCOS HAB Implementation Plan

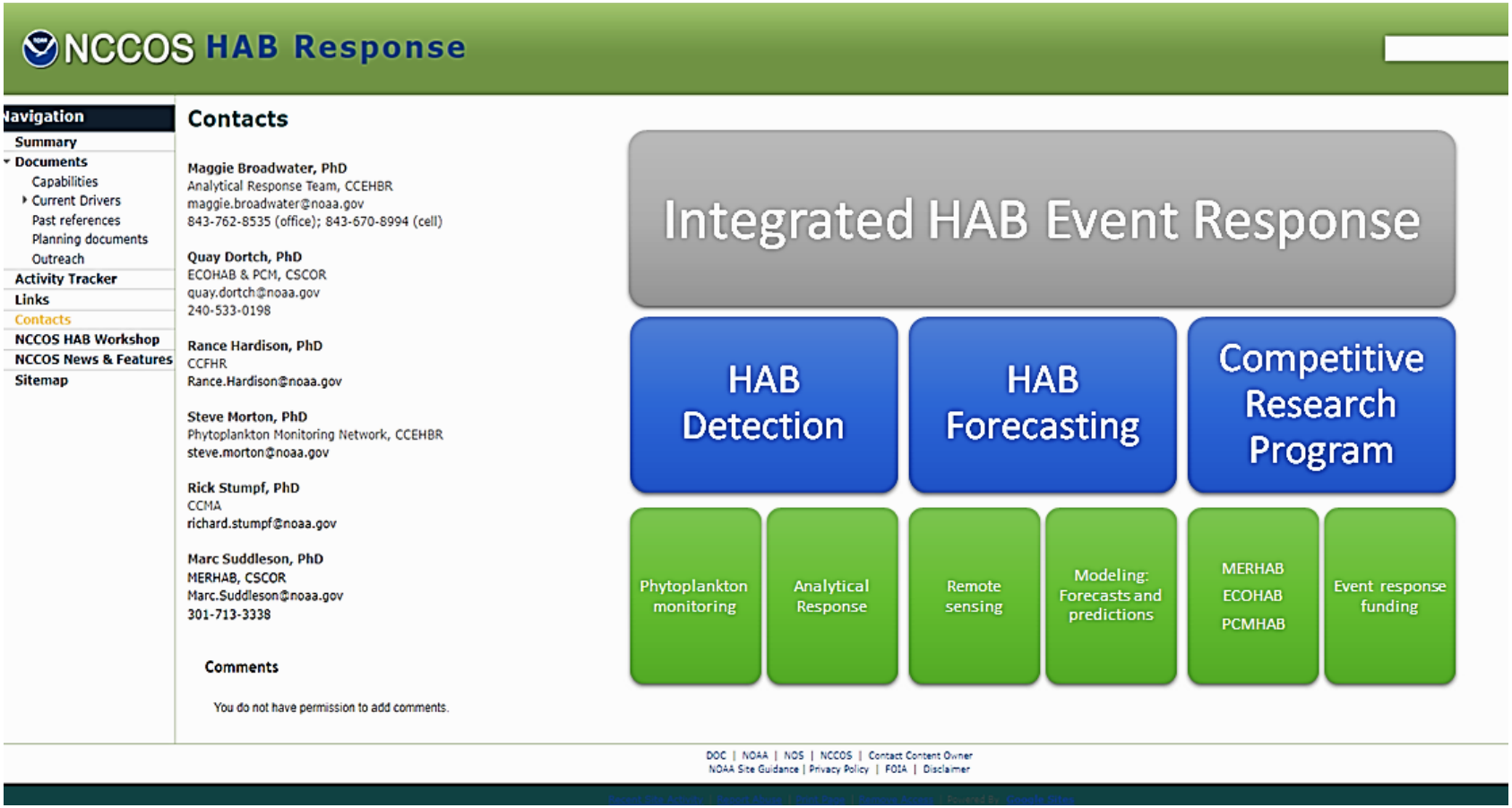
Focus Area 1
- Lake Erie HAB Forecast
- Gulf of Maine Forecast
- Gulf of Mexico Forecast
- Assess R&D forecasts for potential transition

Focus Area 3
- Phytoplankton Monitoring Network
- Expand customer accessibility to HAB observations
- Phytoplankton monitoring network technologies

Focus Area 4
- Second Generation ESPs
- Third Generation ESPs
- Flow Cytobot
- Multiple toxin sampling and detection
- Address detection technology gaps

Focus Area 5
- Assure harmonized standard methods and reference material
- Publish guidance seafood safety mangers
- Analytical method development
- Reference material calibration
- Promote user laboratories

Internal collaboration



Next Up

- Dr. Wayne Litaker, Chief, HAB Forecasting Branch
- Dr. John Ramsdell, Chief, HAB Monitoring & Reference Branch

Harmful Algal Bloom Forecasting Branch

To develop and maintain products useful for the American public

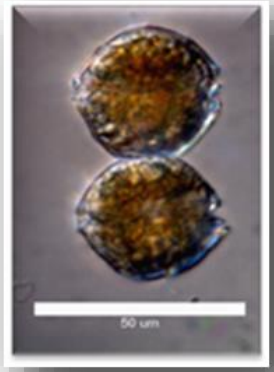
- Seek stakeholder engagement
- Evaluate if significant HAB issue present
- Can we fill critical gaps not provided by others
- Engage community involved in research activities and participate providing observations

To accomplish this we:

- Participate in maintenance and growth of observations networks
  - Ever improving satellite surveillance
  - Utilization and improvement of robust computing platforms,
- Cross-NOAA coordination and engagement with regional decision makers and partners
  - IOOS, Regional Associations [RAs]
  - Non-governmental organizations [NGOs] and academic institutions) who drive product development and implementation
- Conduct laboratory and field research essential to inform forecast products

Overview

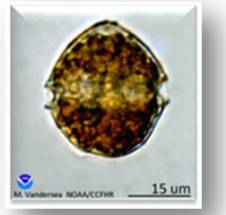
- Projects involving ecological, toxicological and molecular expertise
  - Alaska paralytic shellfish poisoning
  - Ciguatera fish poisoning
- Future Directions
  - Transition activities
  - Chesapeake Bay
  - North Carolina
  - Layer on National map for aquaculture



Issue: *Alexandrium* & Paralytic Shellfish Poisoning in Alaska

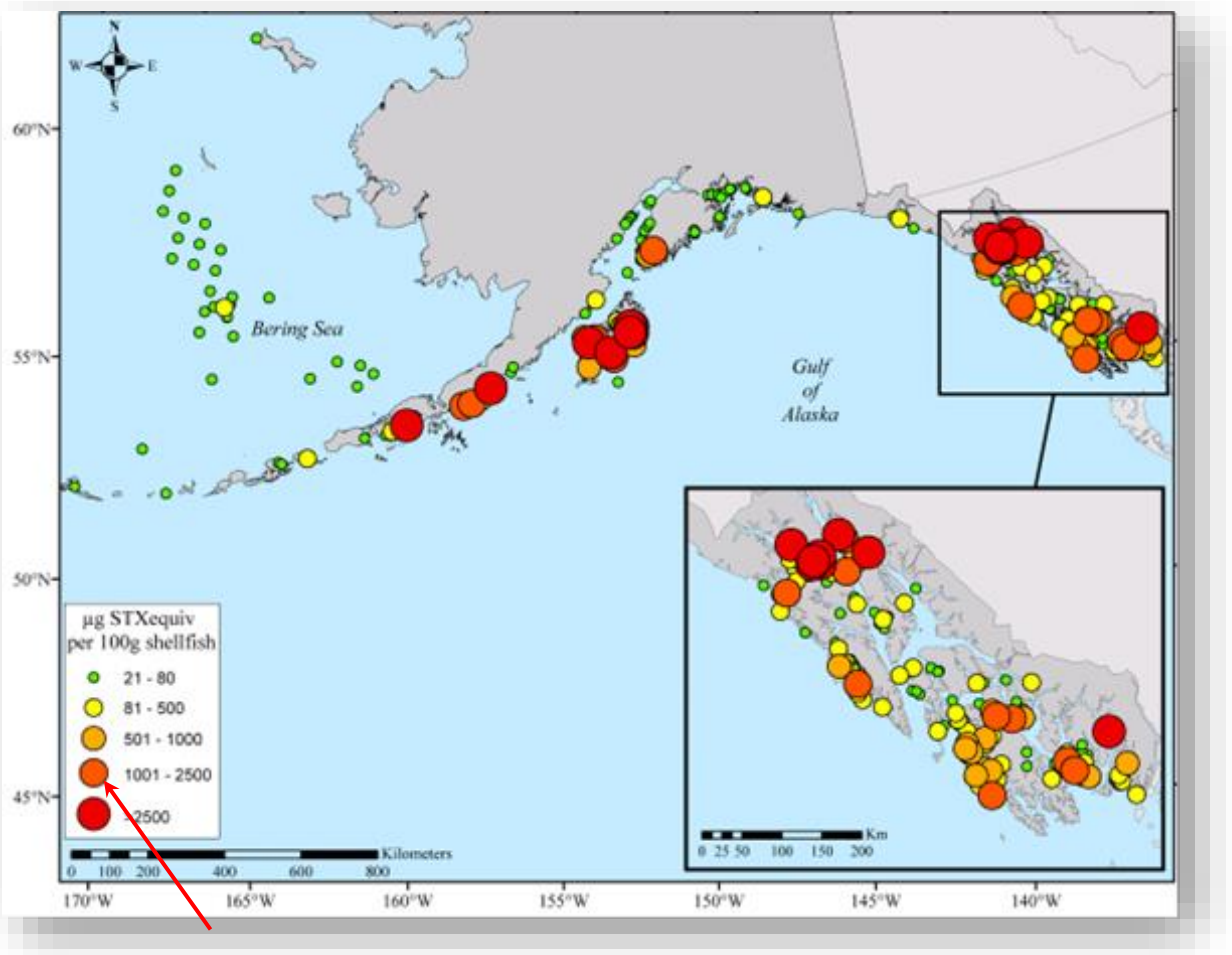
Paralytic Shellfish Poisoning

- *Alexandrium* species
- Saxitoxins (>20 forms)
- Potent neurotoxins



Effects

- Human illness, only place US results in death
- Shellfish closures
- Economic burden
- Marine mammals & seabird mortality?



Potentially lethal > 500 µg STX equivalents per 100 g shellfish

Partners

AOOS Alaska Ocean Observing System

North Pacific Research Board

Kachemak Bay Research Reserve

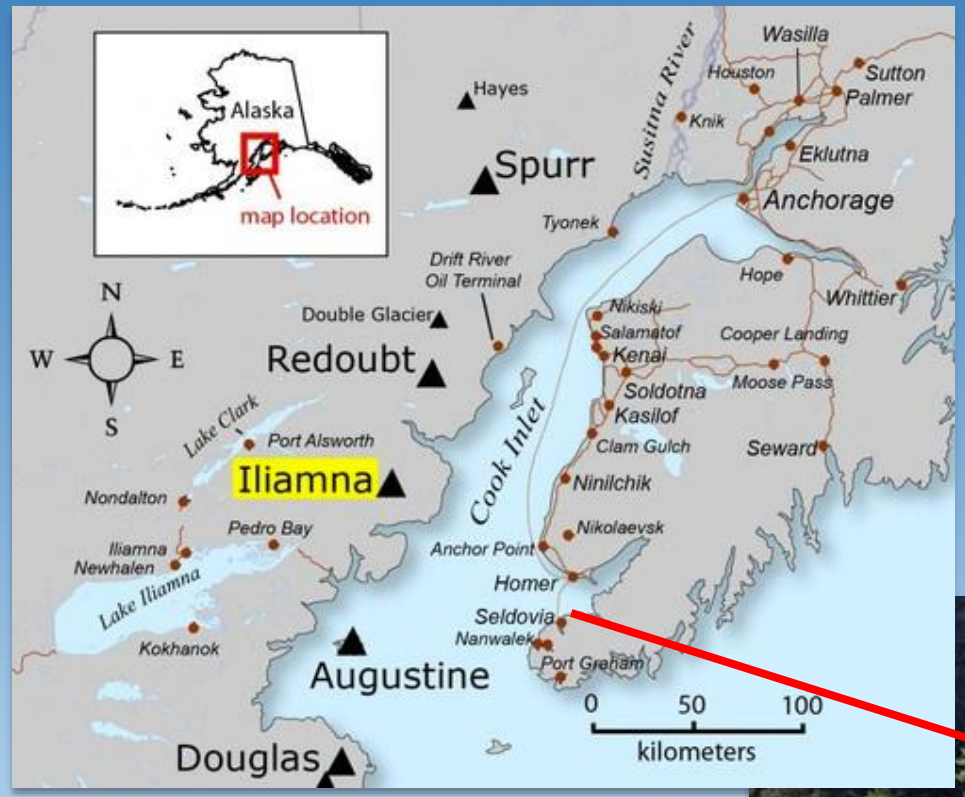
University of Alaska Fairbanks

Sea Grant Alaska

University of Alaska Southeast — learn · engage · change

Seldovia Village Tribe — Tradition Integrated with Technology

Aleutian Pribilof Islands Association

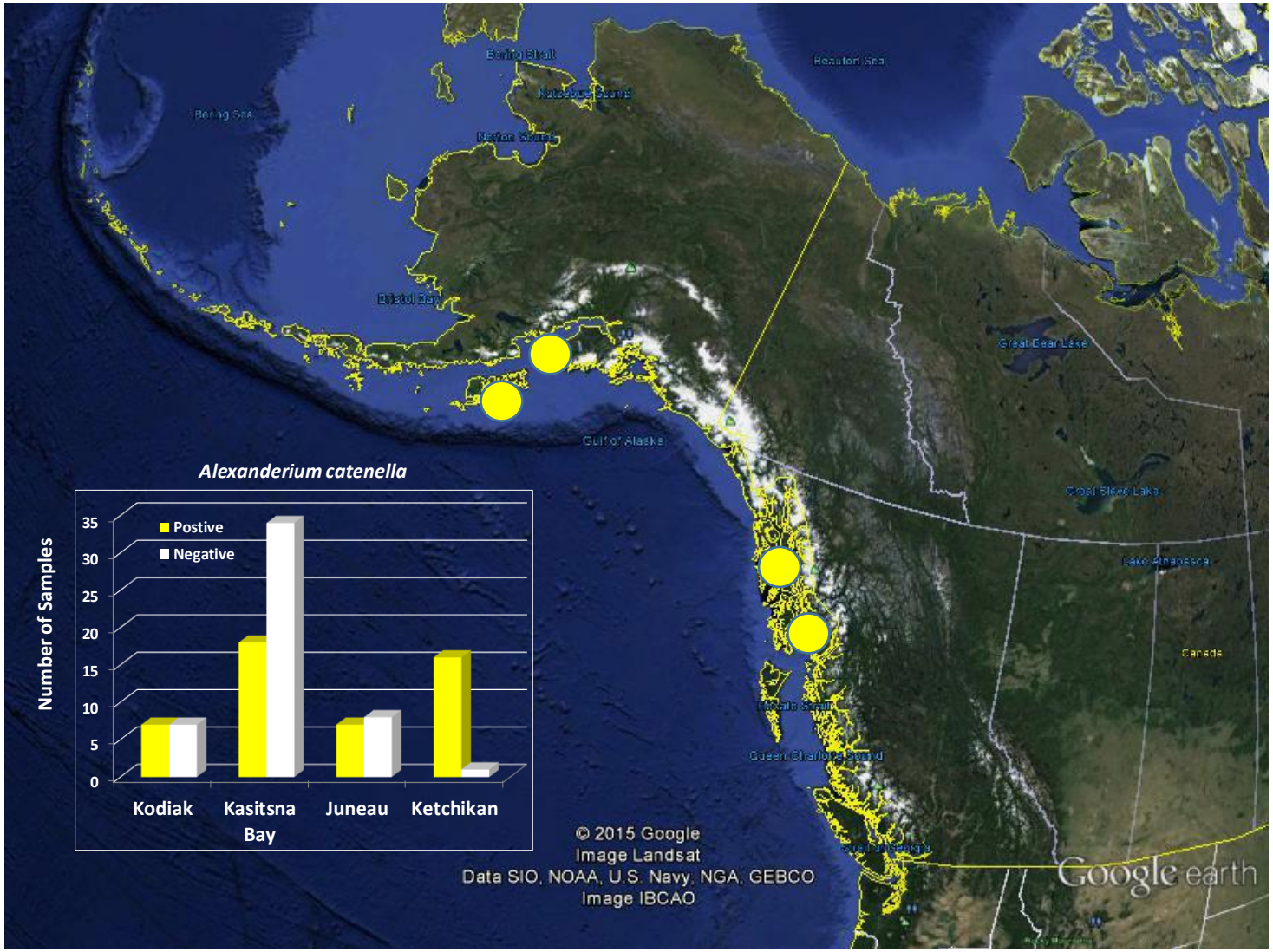


NOAA Beaufort Laboratory, NC

NOAA Kasitsna Bay Laboratory, AK

We Developed Methods for Mapping & Detection Toxic Species in AK

- *A. catenella**
- *A. ostenfeldeii*
- Developed species-specific qPCR assays
- Widely distributed



Distribution & Abundance of *Alexandrium catenella* in Kachemak Bay & Lower Cook Inlet

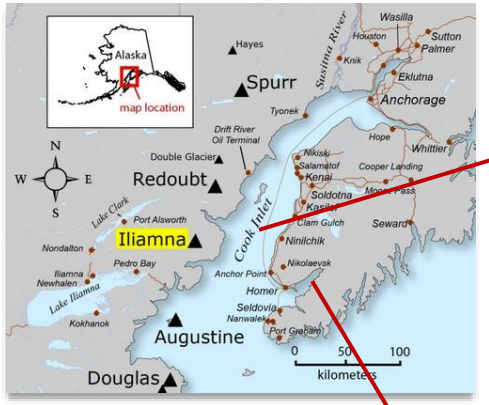
Objectives:

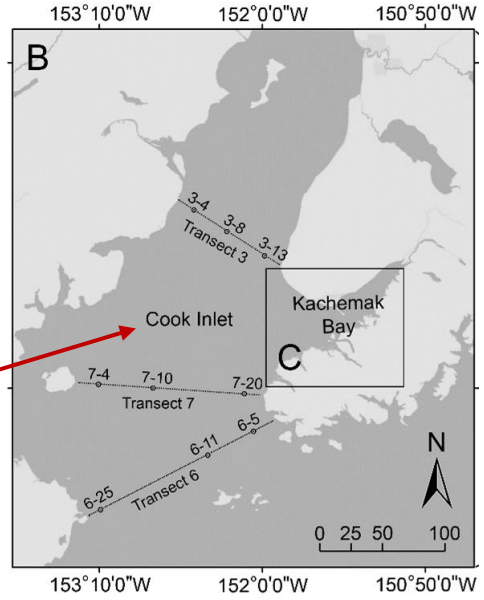
Use qPCR assay to:

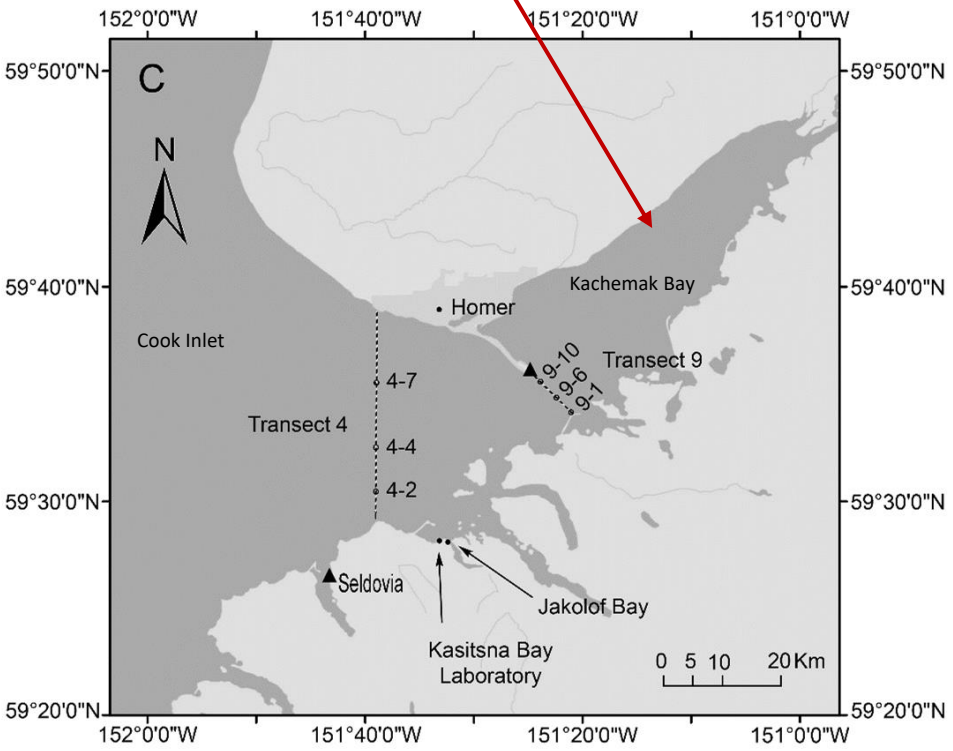
- Characterize distribution & abundance
- Document local bloom seasonality
- Governing environmental factors

2012 – 2016

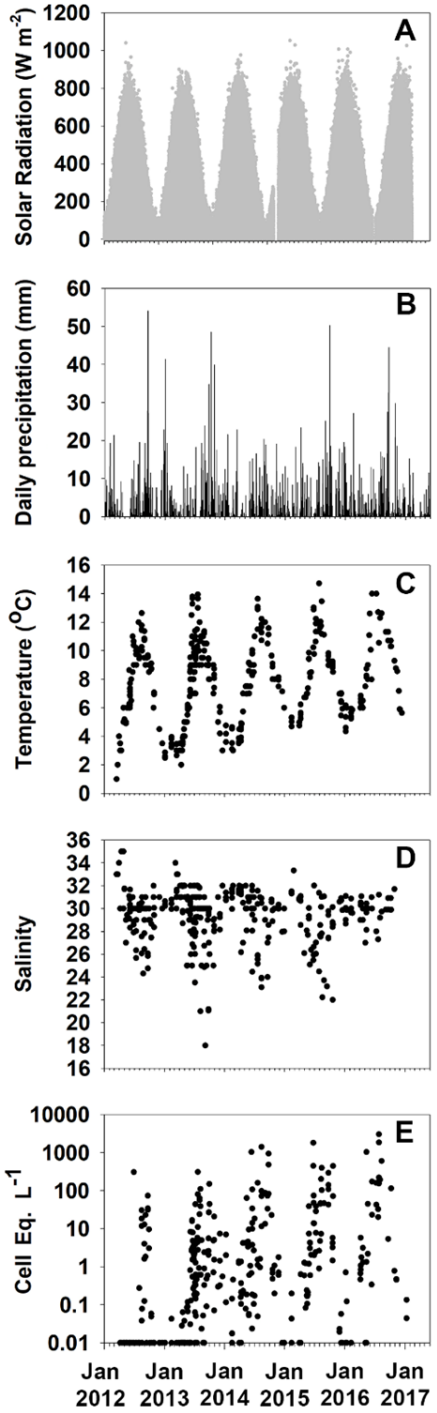
During North Pacific warming event







Seasonal *Alexandrium* bloom cycle



Solar Radiation

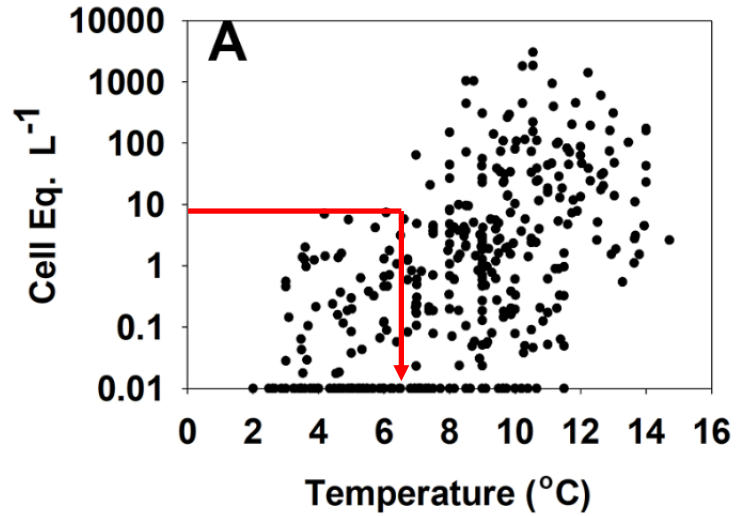
Daily Precipitation

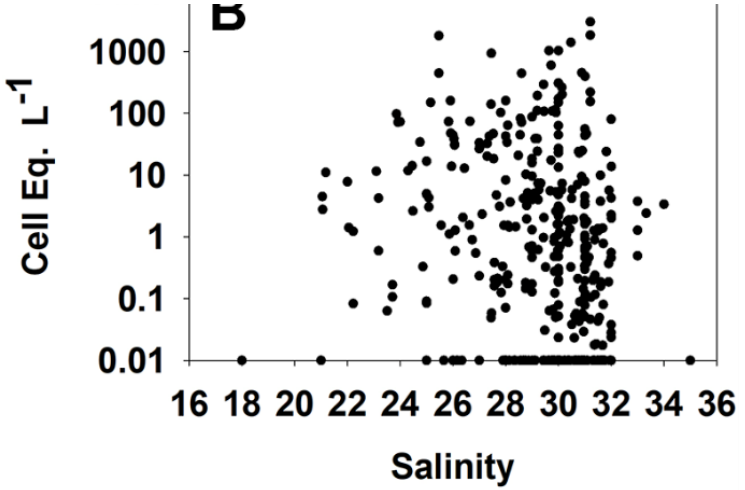
Water Temperature

Salinity

Alexandrium

Drivers? **Temperature** **Salinity**

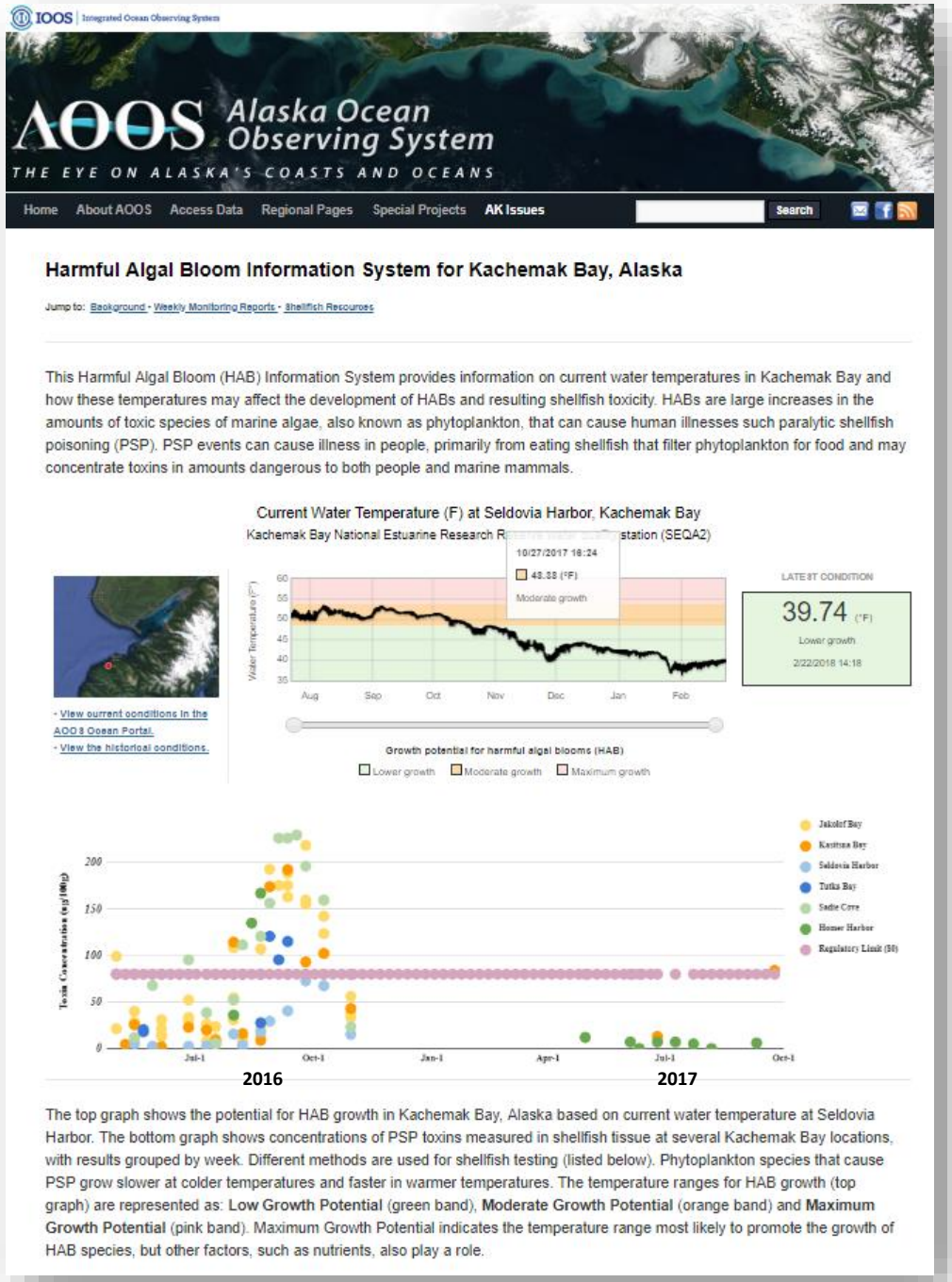


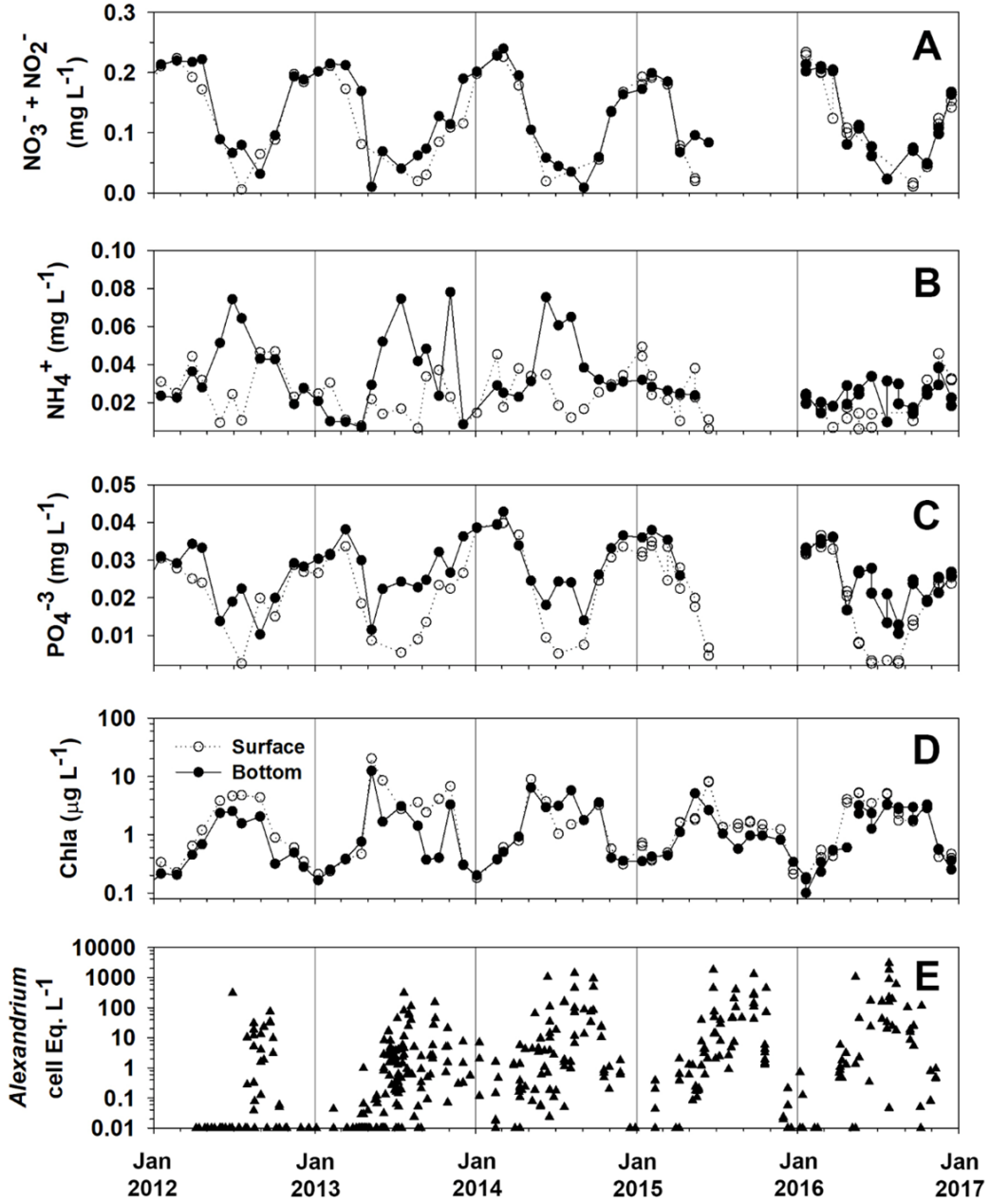


Our model led to HAB Risk Assessment Tool

Forecast Webpage **http://www.aoos.org/k-bay-hab/**

- Allows estimated risk
- Lets multiple user groups post toxicity data real time
- Direct link to customers





Nitrate + Nitrite

Ammonium

Phosphate

Chlorophyll

Alexandrium

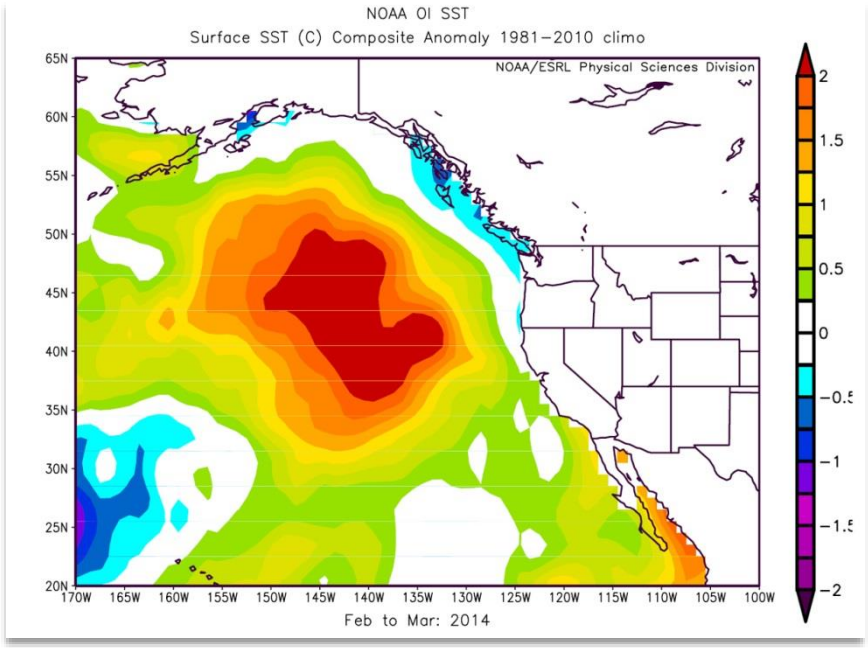
Alexandrium blooms Kachemak Bay

- Start April - May
- After main phytoplankton bloom
- Peak in Aug-Sep (Temp.)
- Nutrients not limiting

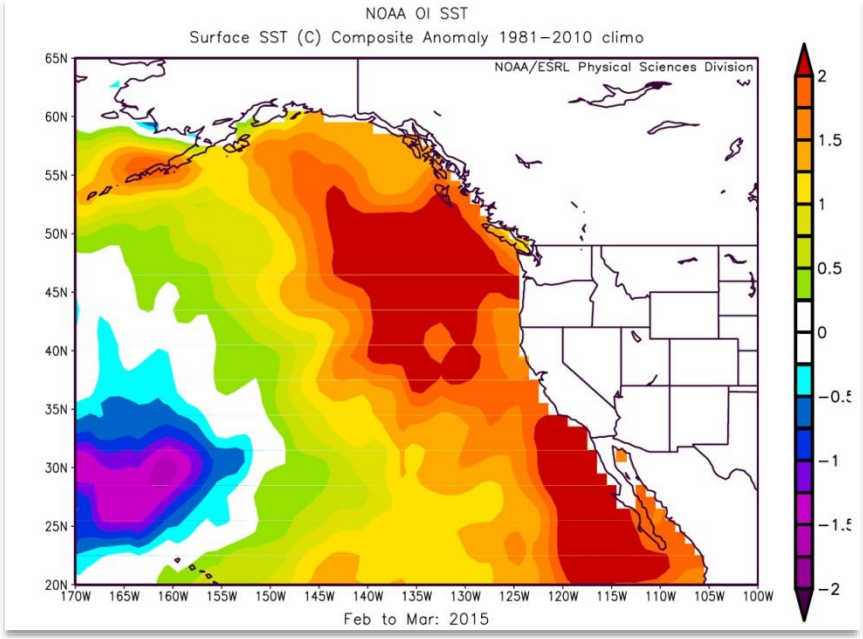
Other Drivers ?

- Hydrodynamics
- Cyst beds
- Grazing

2014

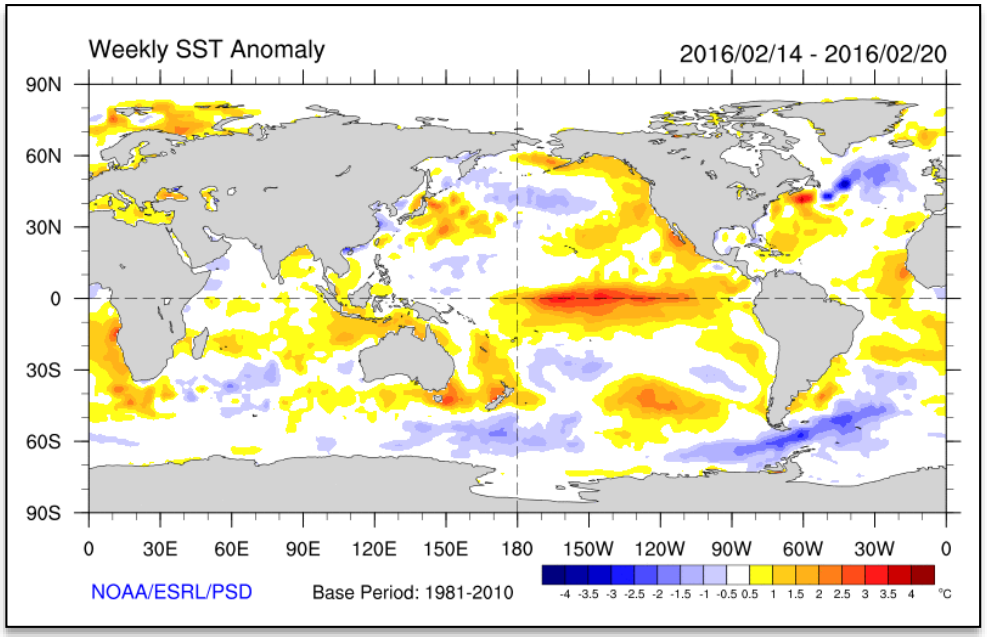


2015



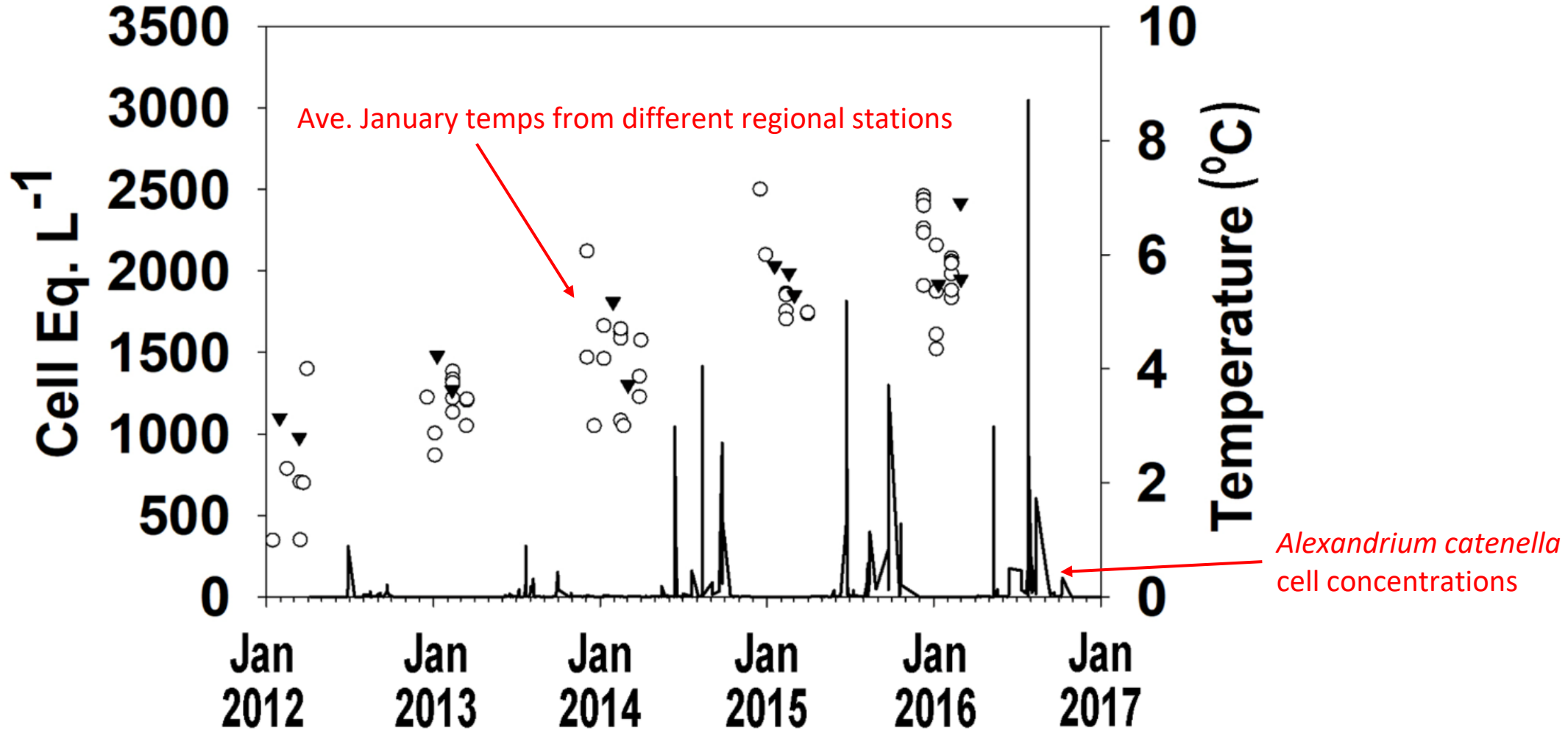
The warm water blob

2016



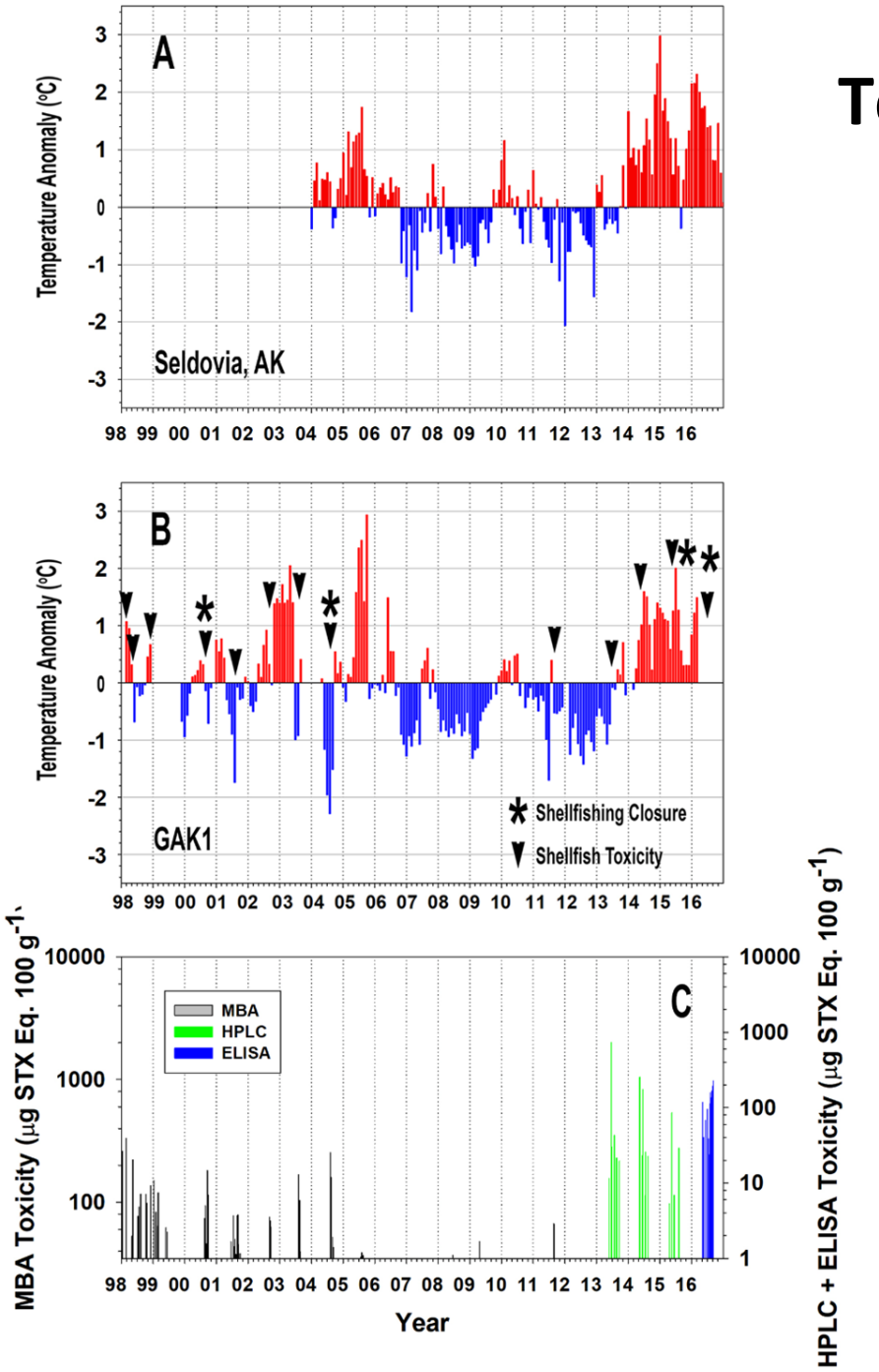
SDI HAB forecasting

Regional Warming vs Bloom Intensity



Alexandrium **response to increase in temperatures over course the study**

Temperature anomalies and PSP Risk



- >0.5 - 1^{o}C temperature anomalies associated with increased toxicity and closure shellfish beds in K-Bay
- Means small changes temperature significantly increase risk PSP

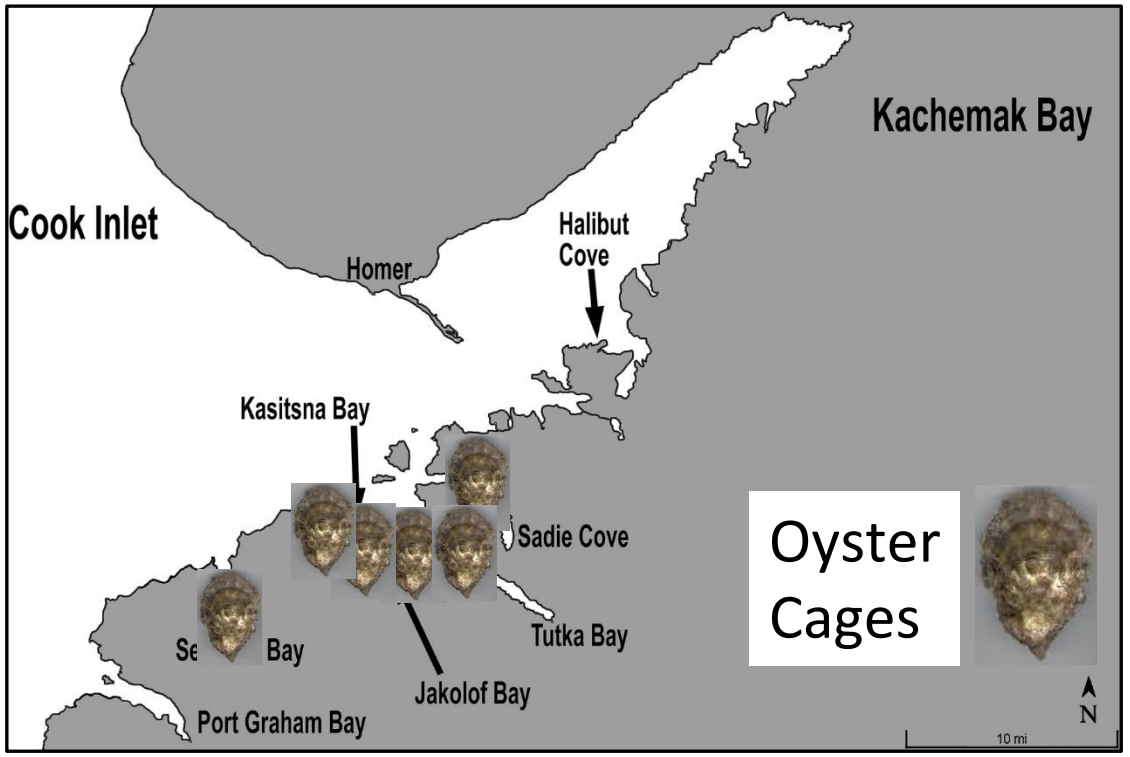
FY14 and FY16 Portfolio Project: Risk Assessment in Kachemak Bay

Objectives

- Improve HAB Monitoring and identify environmental drivers of *Alexandrium* abundance.
- Test bagged shellfish as monitoring tool.

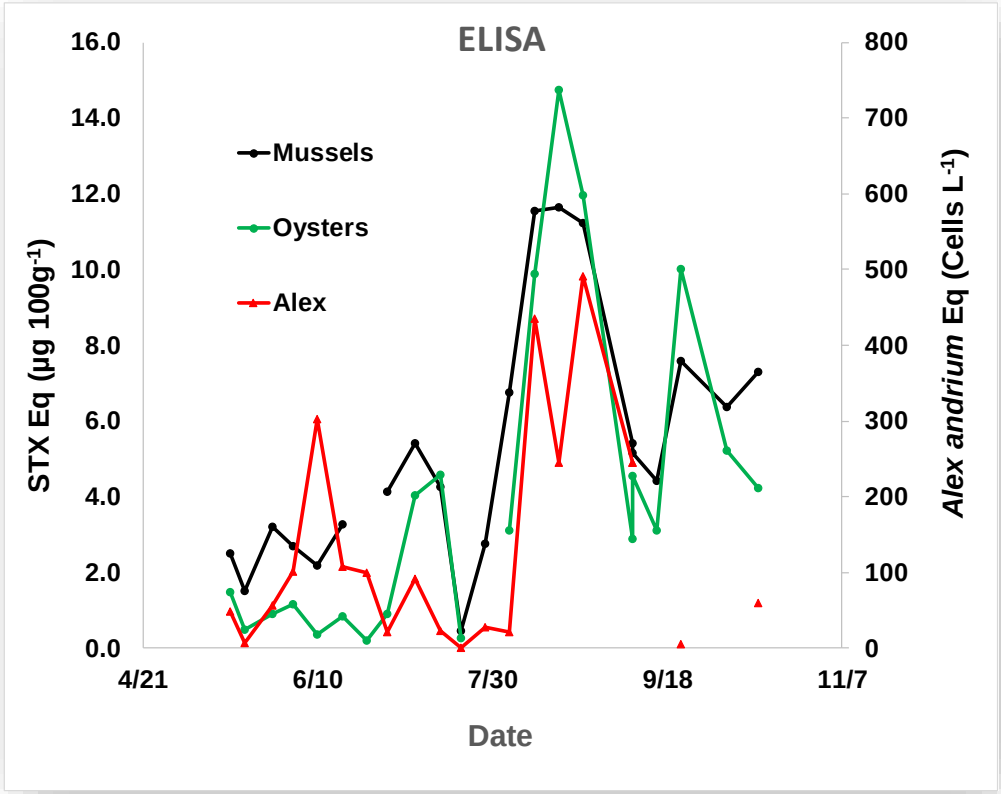
Toxicity Monitors

2016

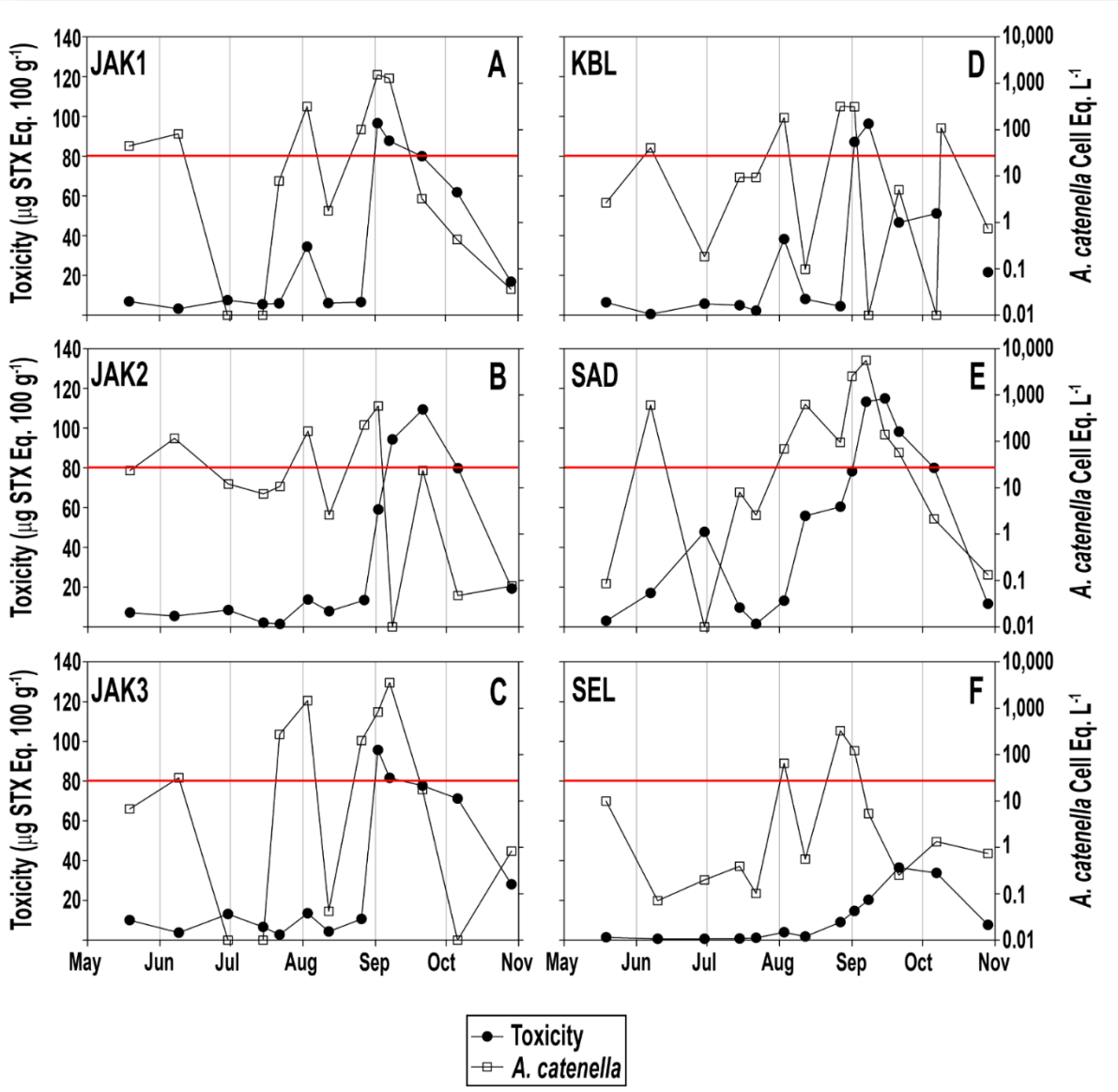


Used mussels and oysters as sentinel species

2014



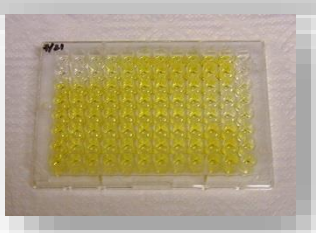
2016



- 100 *Alexandrium* cells L^{-1} toxicity increases substantially
- ~500 (400 – 600) *Alexandrium* cells L^{-1} toxicity increases above regulatory limits

Rapid Test Kit Testing in Old Harbor, Ouzinkie and Kodiak City

SeaTox Research Inc



Measure 5-10 minutes, easy to run with minimal training

Kachemak Bay Research Reserve

Aleutian Pribilof Islands Association

Sea Grant Alaska

Train shellfish sampling groups in Kodiak Communities for monthly sample collection of Butter Clams in Old Harbor, Ouzinkie, and Kodiak City.

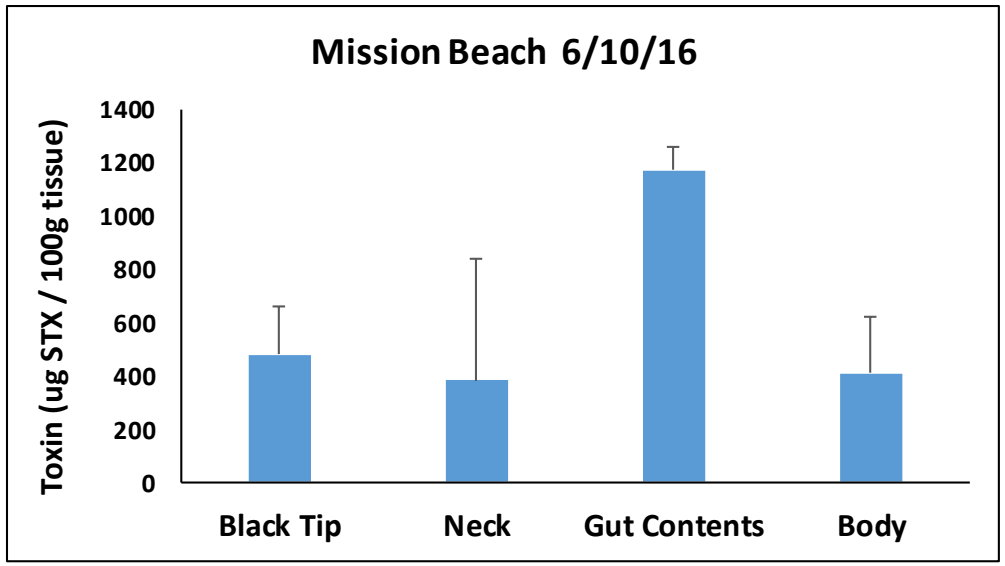
- Project kickoff workshop – Aug 2016
  - Ouzinkie, Old Harbor site visits
  - Coordination of sample collection
  - Receive samples & ship to Beaufort Lab for analysis

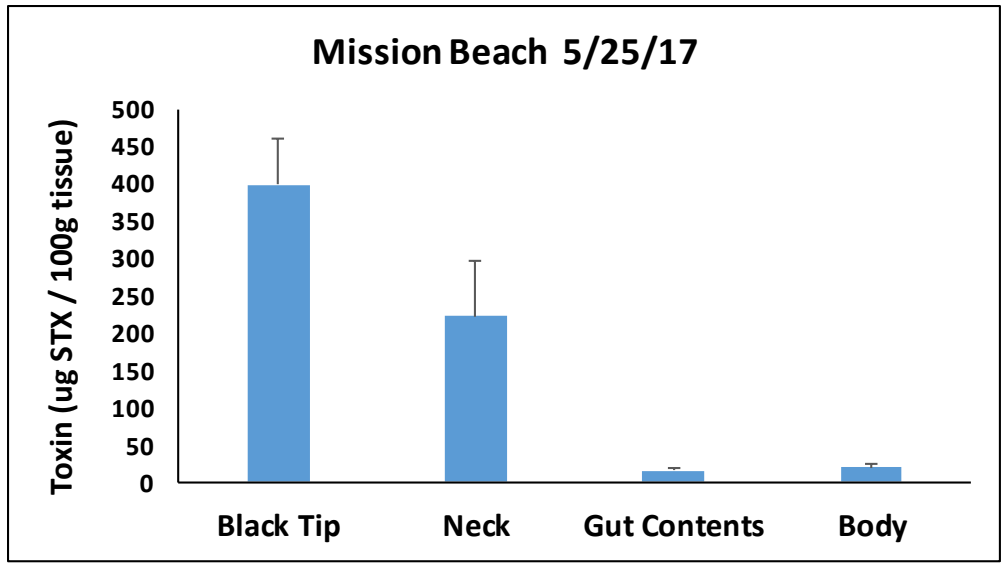
Slated to go out twice this year to do more training, particularly with respect to the tissue study described next.

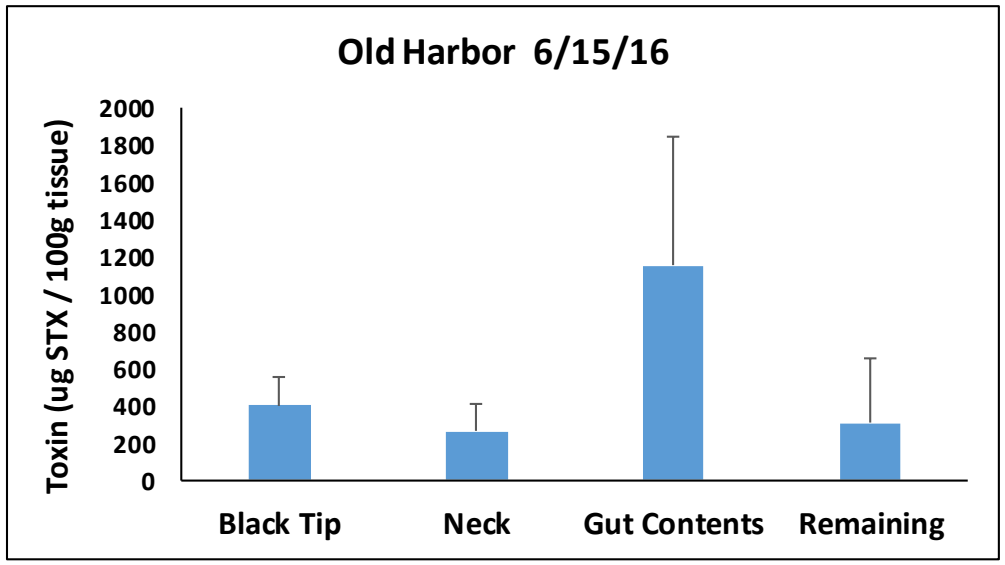
Cleaning & Shucking

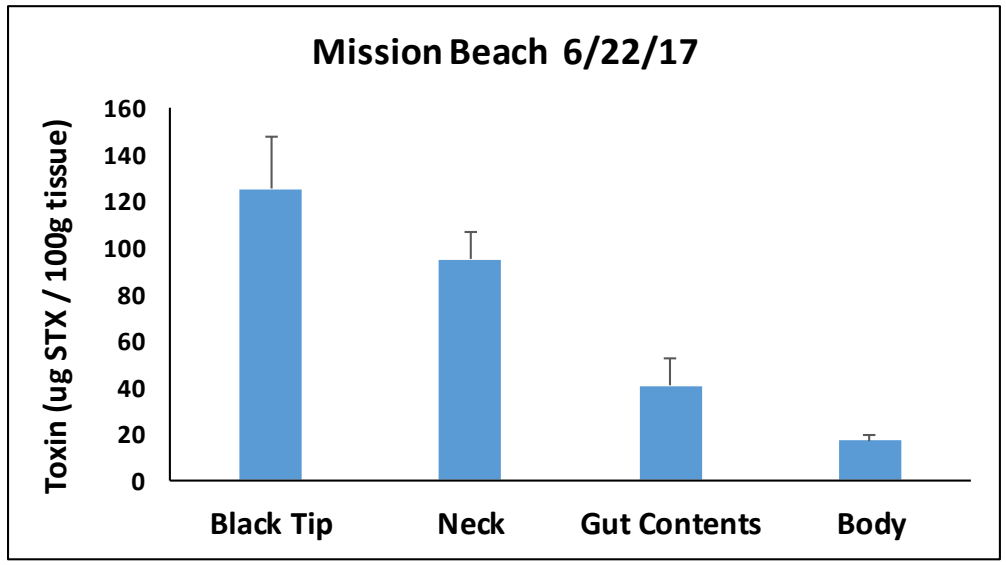
Tissue Separation

Saxitoxins in Butter Clam Tissue



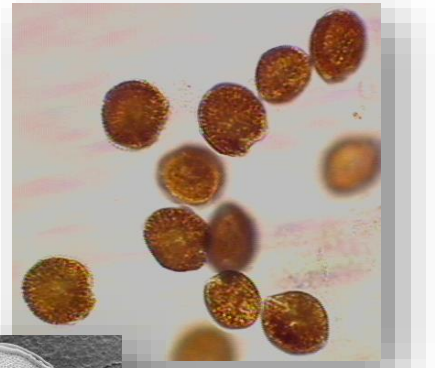


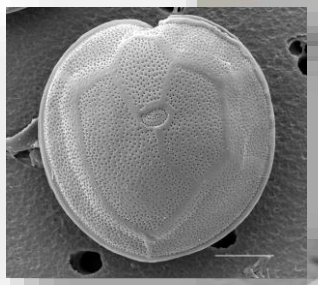


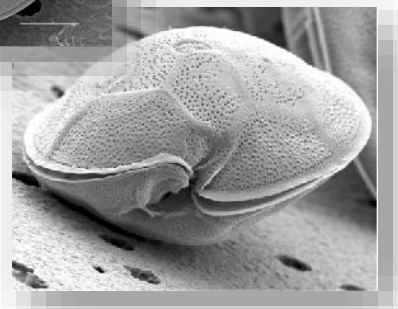


Issue: Ciguatera Fish Poisoning - CFP

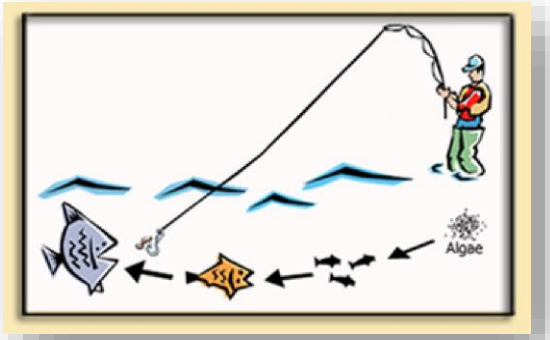
- CFP most common non-bacterial seafood related illness
- ~ 50,000 estimated cases annually
- Ciguatoxins (CTXs) produced by benthic microalgae, genera *Gambierdiscus* and *Fukuyoa*
- Concentrates in marine food chain
- Symptoms include gastrointestinal distress, mild to severe neurological and cardiovascular symptoms, rarely death

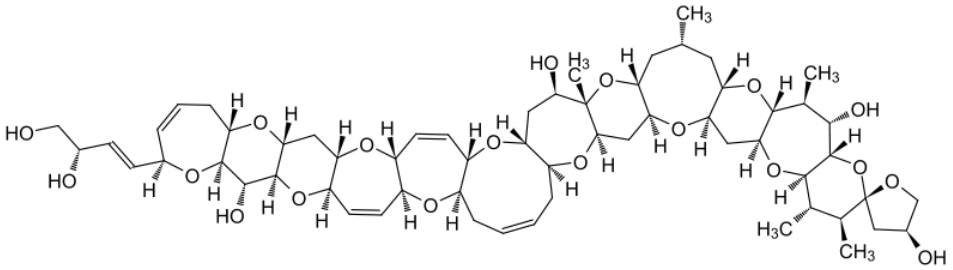






Gambierdiscus cells





Ciguatoxin CTX1B (many congeners)

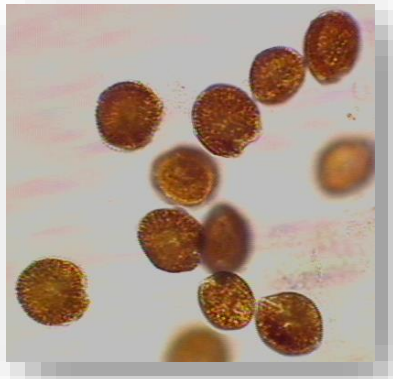
CSCOR

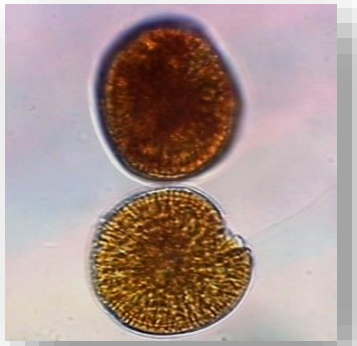
Unknowns

- How many species exist and how are they distributed?
- Are some species more toxic than others?
- Best sampling method?
- Can toxin screening methods be improved?

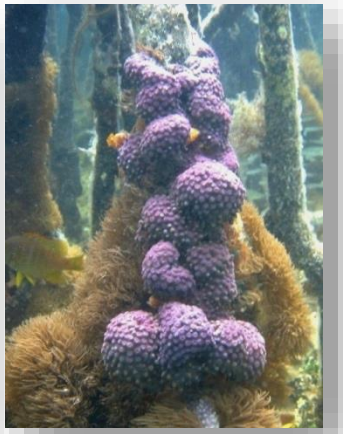
Partners

Gambierdiscus

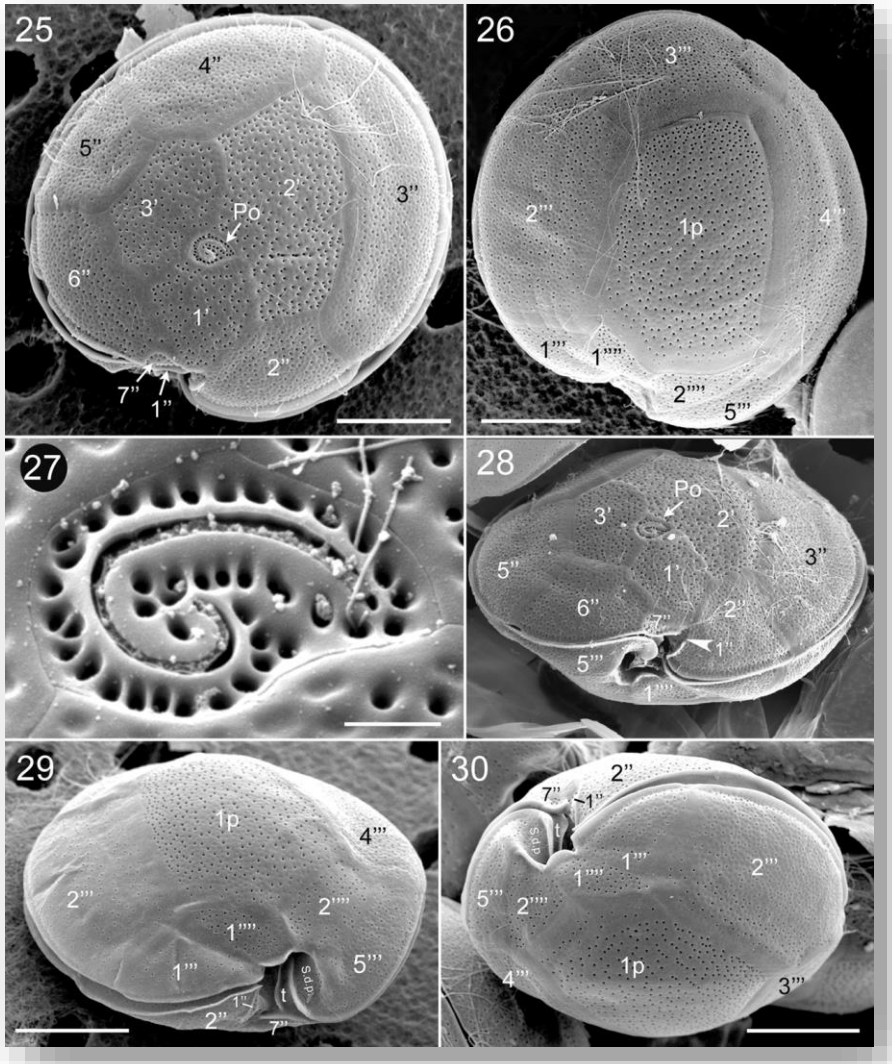


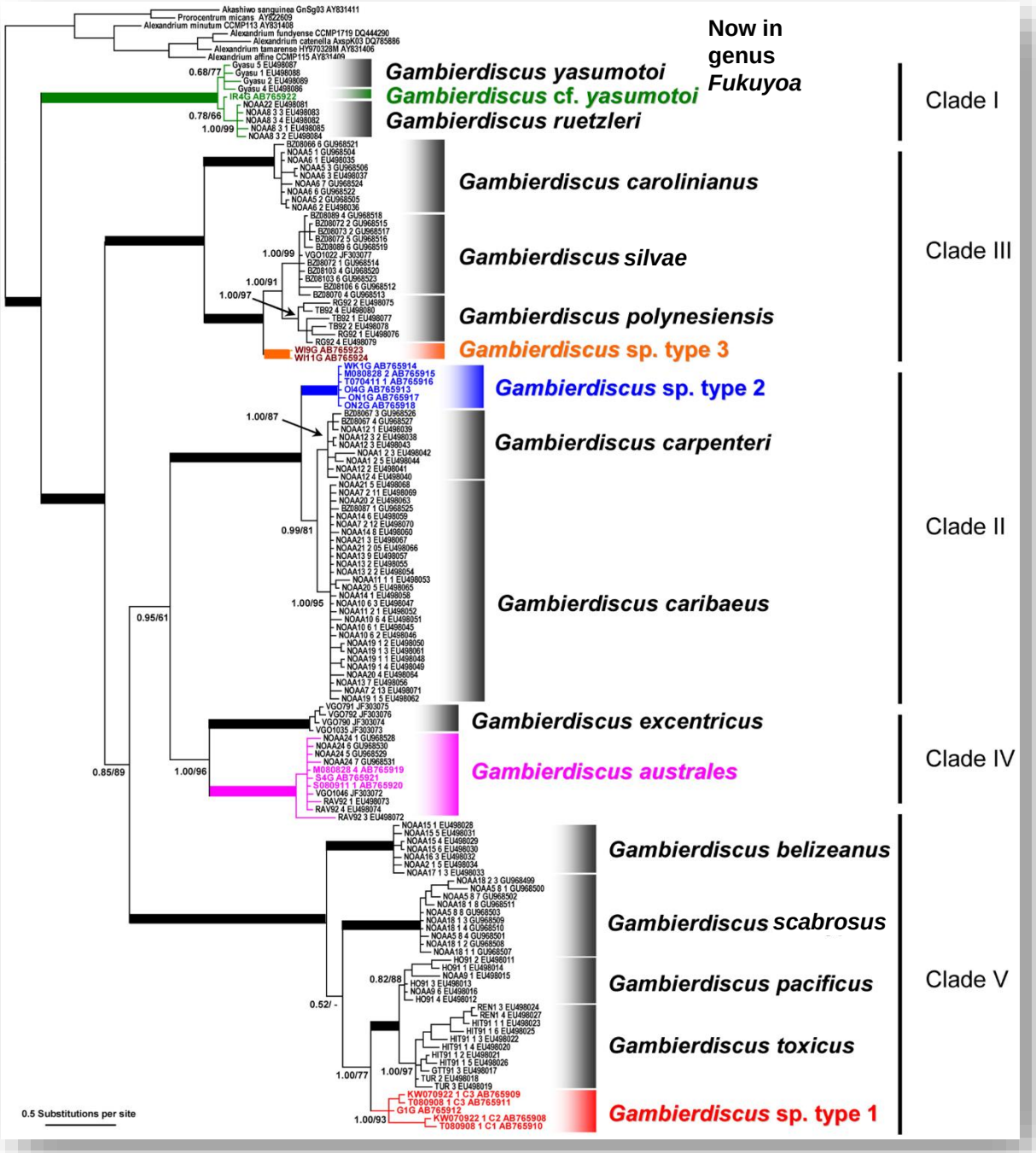


Gambierdiscus habitats



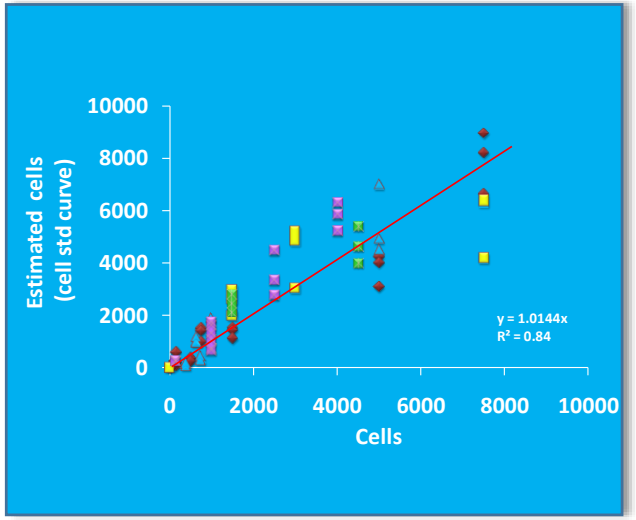
Revised Taxonomy





Established Caribbean *Gambierdiscus* Distribution

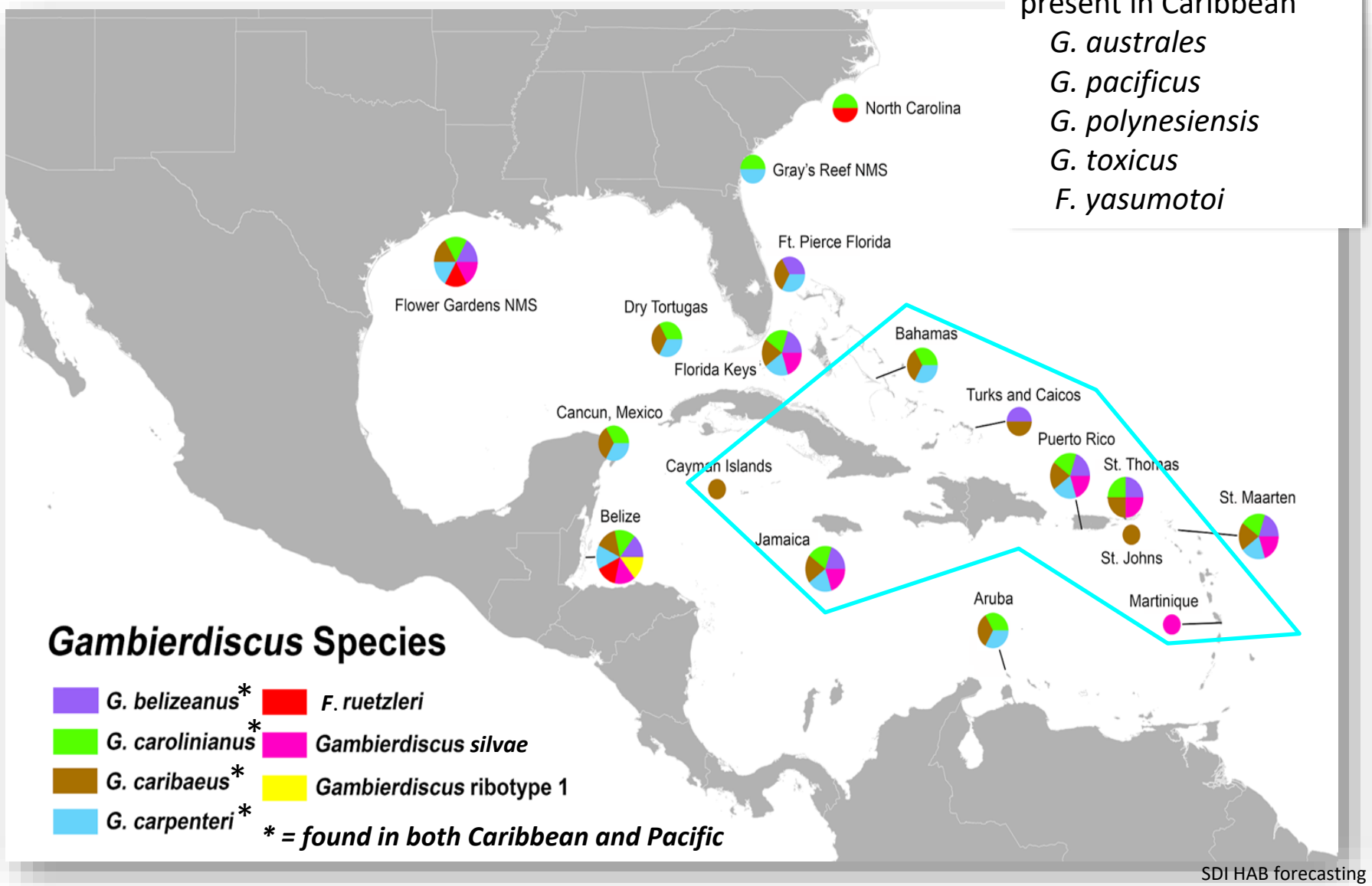
Developed species-specific PCR assays



Vandersea et al. 2012, J. Phycol.
Litaker et al. 2018, submitted J. Phycol.

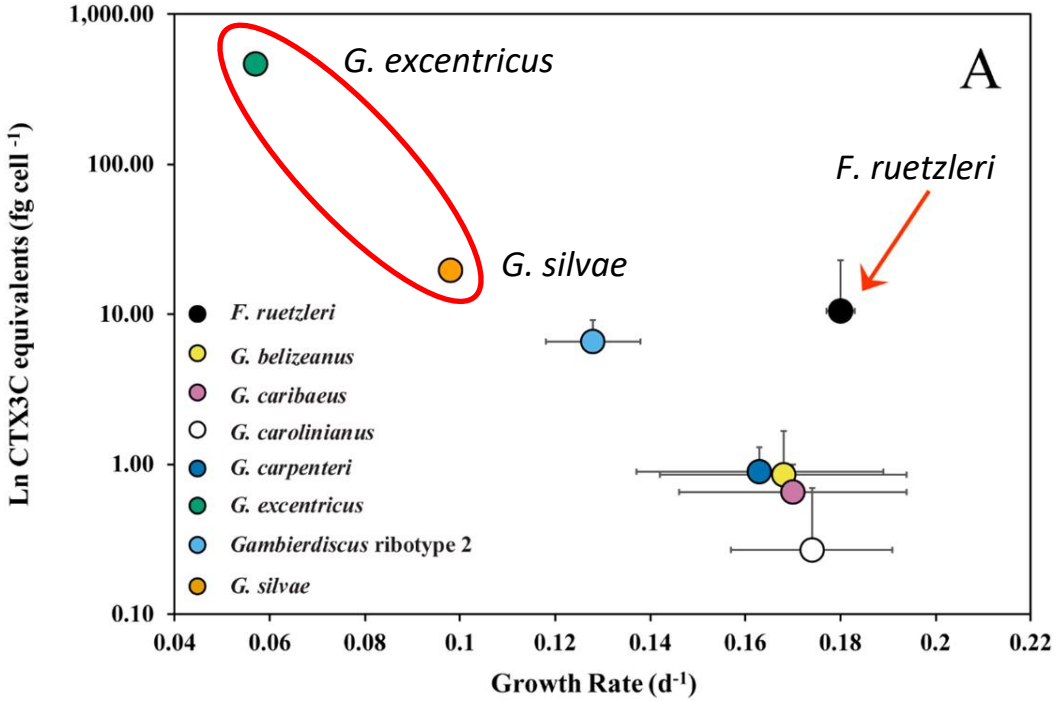
- Species indistinguishable by light microscopy
- Have to use molecular identification
- Found widely distributed

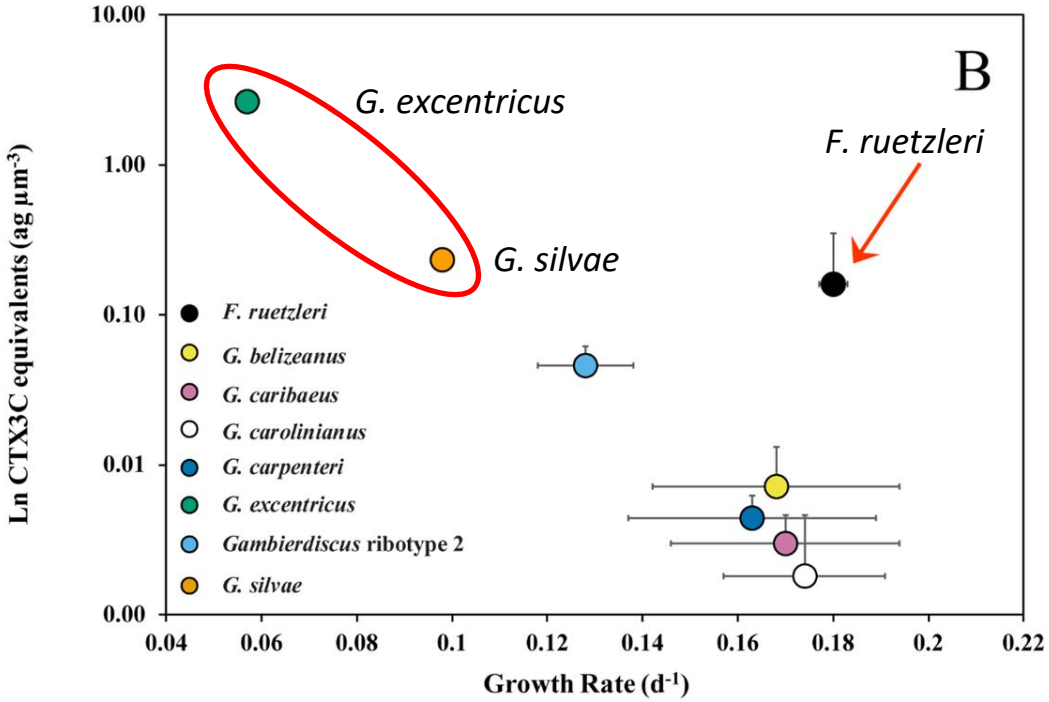
Pacific species not present in Caribbean
- *G. australes*
- *G. pacificus*
- *G. polynesiensis*
- *G. toxicus*
- *F. yasumotoi*



Determined Species toxicity

- *G. excentricus* and *G. silvae* most toxic
- Developed species-specific PCR assays
- Test if abundance of high toxicity species correlates with CFP occurrence





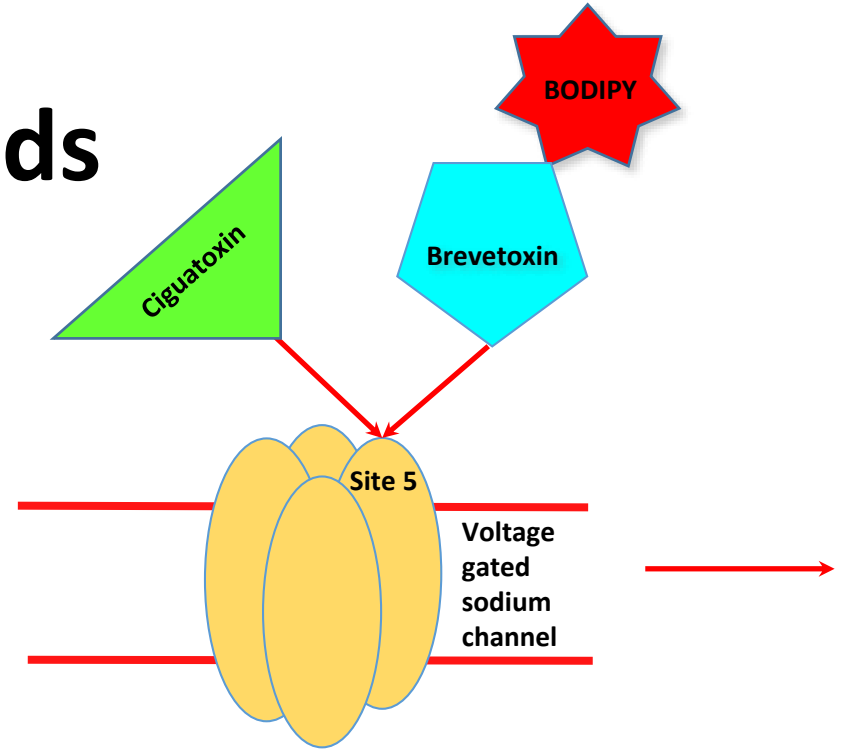
Litaker et al. 2017, PLoS ONE
Pisapia et al. 2017, Marine Drugs
Pisapia et al. 2017, Harmful Algae

Alternative Toxin Detection Methods

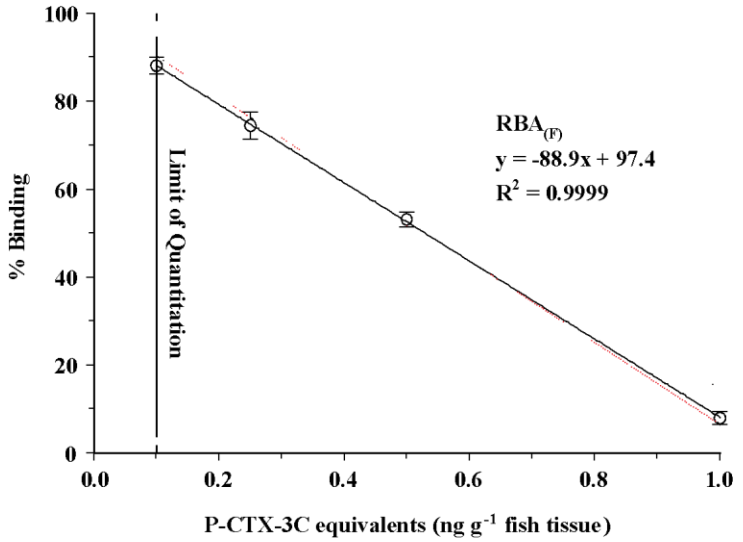
- Ciguatoxins difficult & expensive to measure
- Looking for alternatives screening methods
- Co-developed fluorescent receptor binding assay for ciguatoxins
- Commercialized by SeaTox Research Inc

(http://www.marbionc.org/gallery/detail.aspx?id=2274946)

- Rapid calcium flux assay for detecting ciguatoxins and maitotoxins



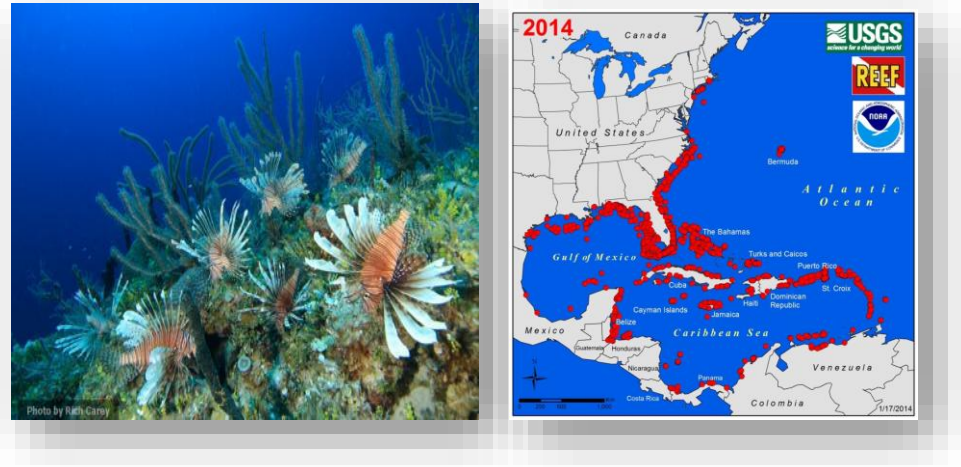
Ciguatoxins compete with BODIPY-labeled brevetoxin-2



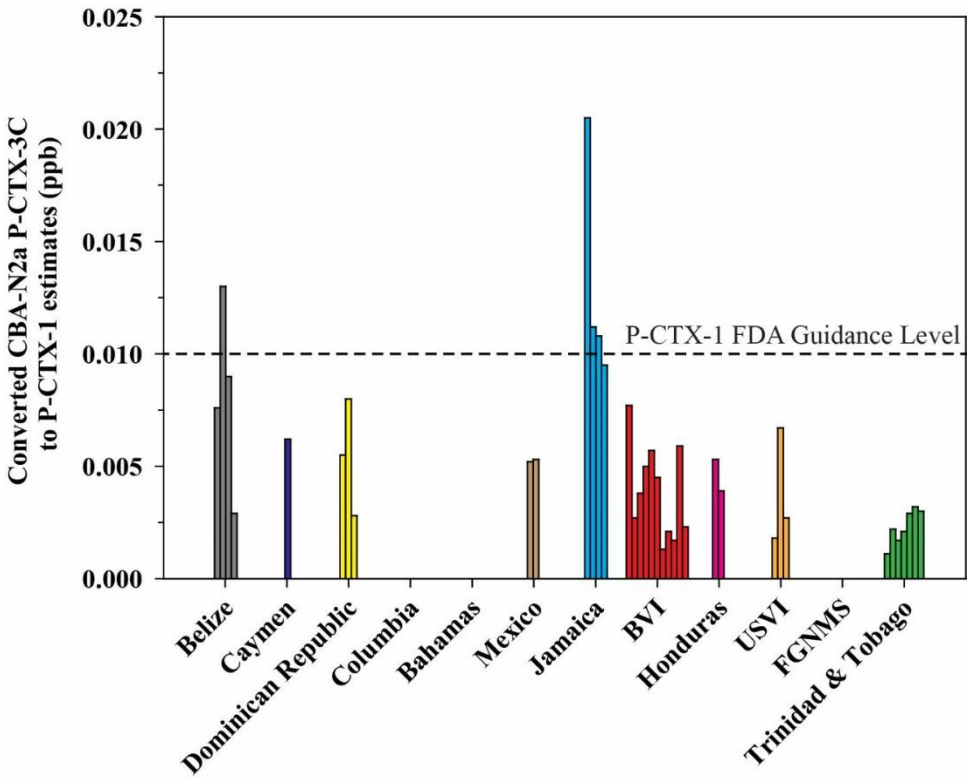
Litaker et al. 2014, ICHA proceedings
Hardison et al., 2016 PLoS ONE
Lewis et al., 2016 PLoS ONE

Are Invasive Lionfish Ciguatoxic?

- Lionfish causing reef destruction
- Good to eat so - can fishery be developed as control mechanism?
- Depends on how likely are they to become ciguatoxic?
- Tested 293 Lionfish (13 locations, 74 sampling sites) in the Caribbean and Gulf of Mexico
- Found, lionfish in most parts Caribbean likely safe, particularly with moderate consumption (NOT A RECOMMENDATION)
- Management must be nuanced

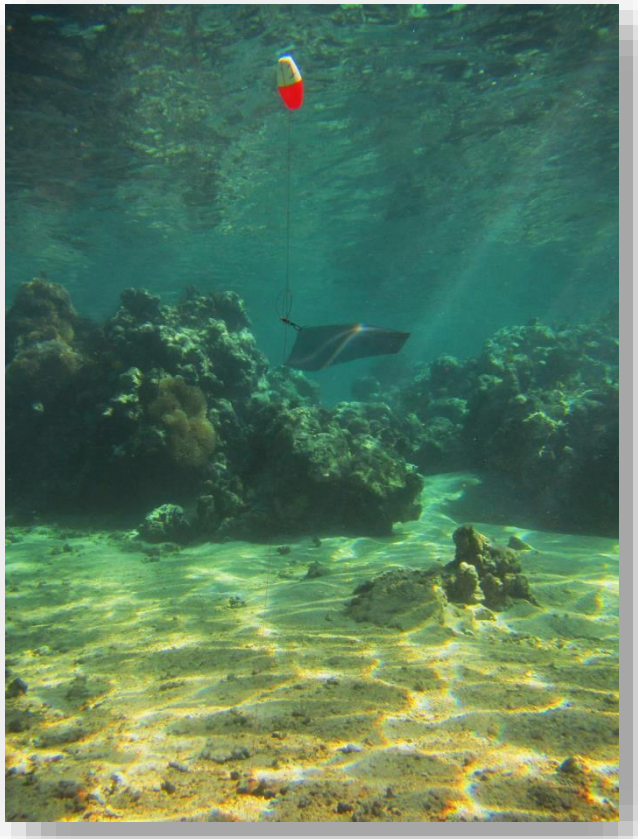


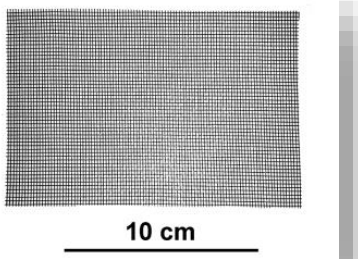
Lionfish and rang extension since first introduced Caribbean and Gulf of Mexico

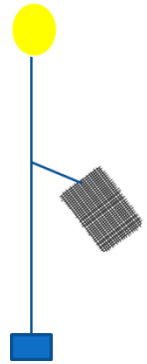


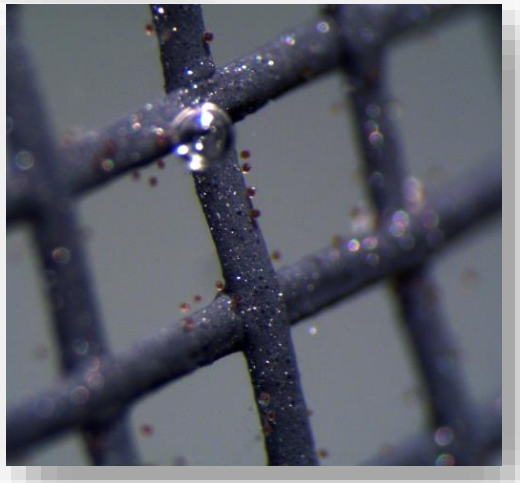
Hardison et al., 2018 accepted PLoS ONE
Darius et al. 2017, Toxins

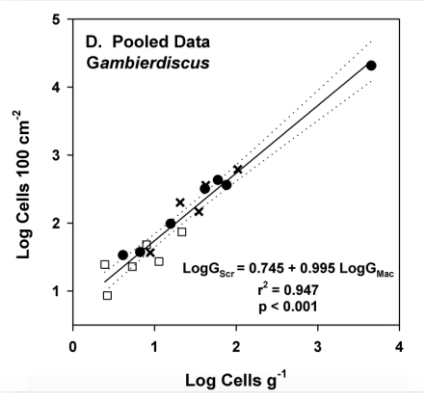
Improved Sampling Method Using Artificial Substrates

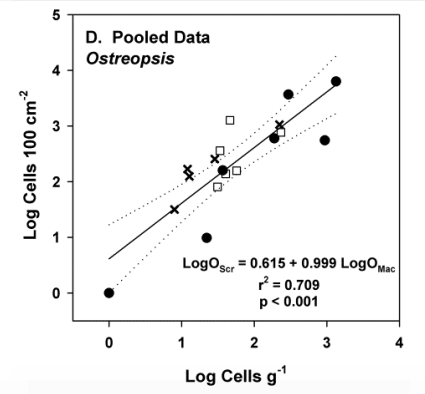


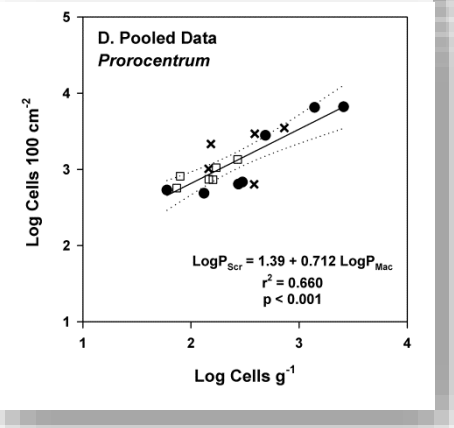












- 24 h incubation
- Simple to use
- Replication / non destructive
- Clean samples
- Obtain cells cm^{-2} (cells $100cm^{-2}$)

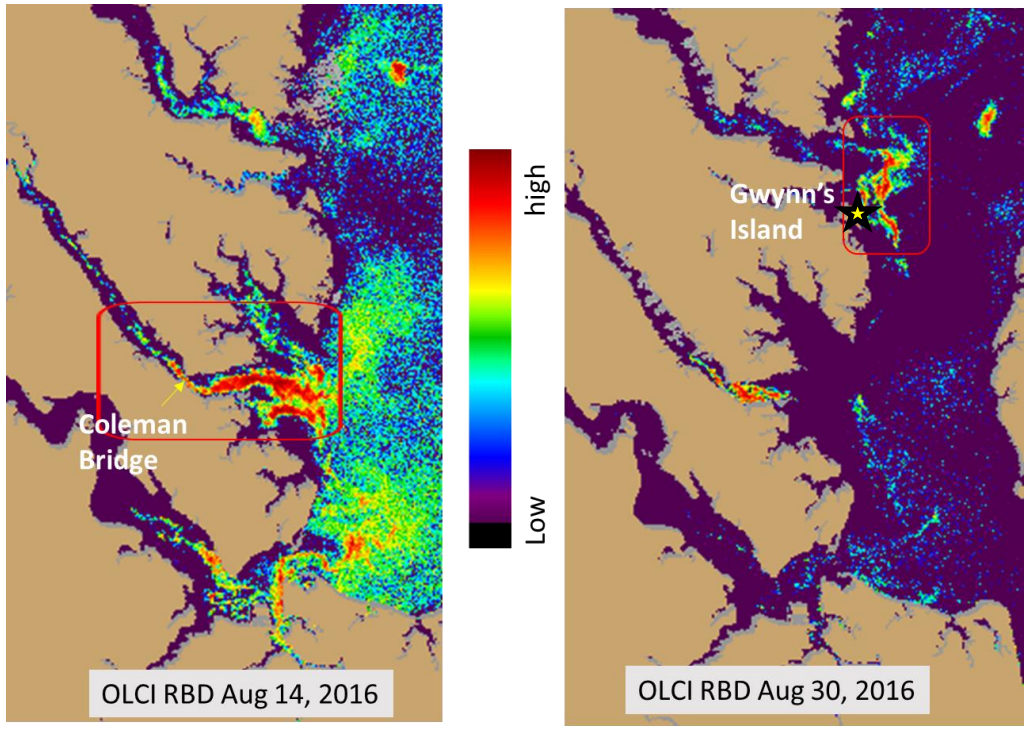
Kibler et al. (2014) Harmful Algae
Leaw et al. (2018) In press Harmful Algae
Method now used worldwide

New Directions: Chesapeake Bay

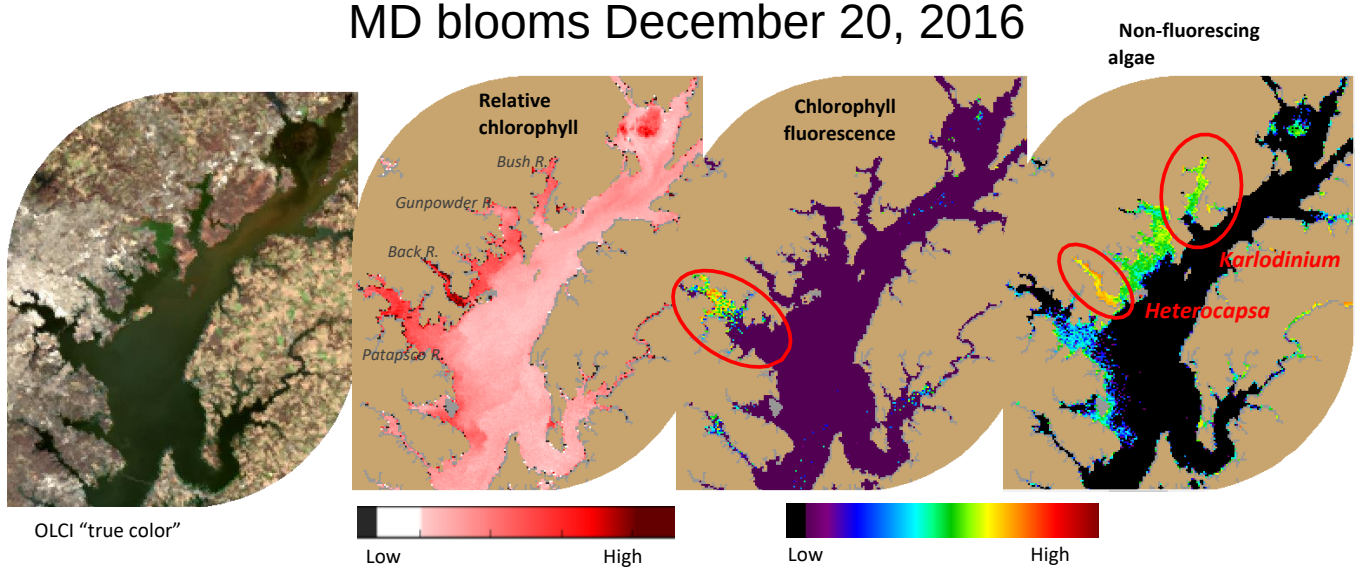
M. polykrikoides Aug 10, 2016

A. monilatum Aug 29, 2016

Emerging HABs threaten oyster aquaculture industry



MD blooms December 20, 2016



Ocean and Land Colour Instrument (OLCI) from ESA is providing higher resolution (300 m) imagery for tributary monitoring

*Photos courtesy of Dr. Wolfgang Volgelbein, VIMS

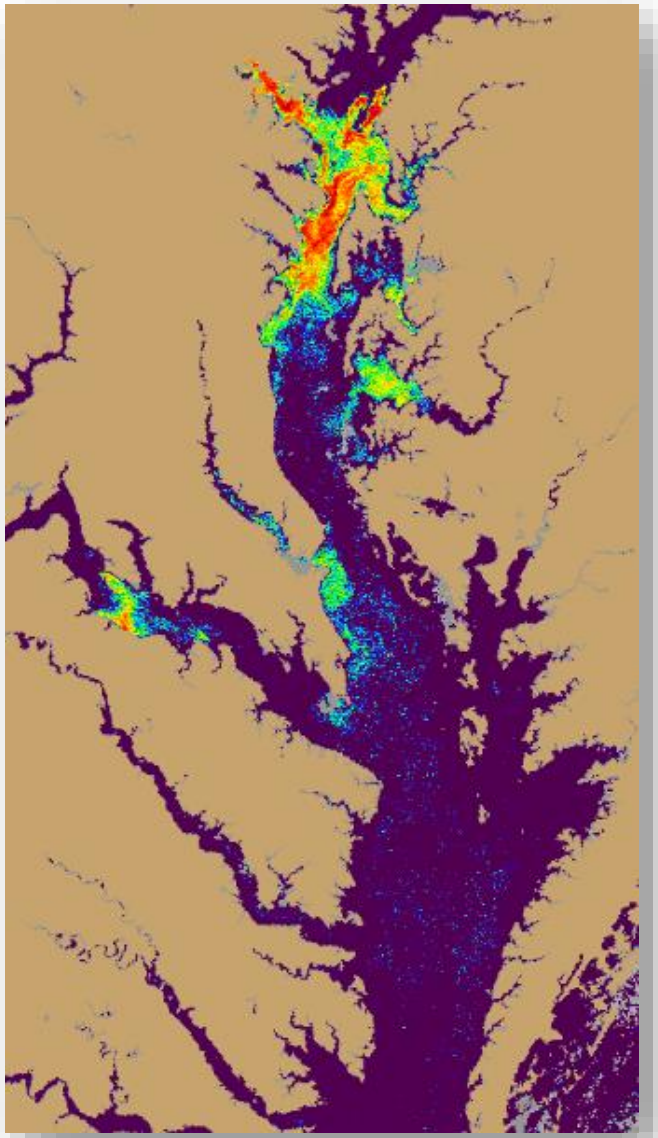
*Modified Copernicus Sentinel data processed by EUMETSAT, Sentinel 3 L1b, sample data was produced and used for this work, in support of Sentinel 3 evaluation

Develop Habitat Model

- Blooms can be hard to distinguish
- FY18 activities
  - Provide satellite imagery to states and universities
  - Collect spectral data to improve satellite algorithms
  - Conduct lab culture studies needed to improve algorithm development
  - Imitate development habitat based model to identify blooms

Stakeholders

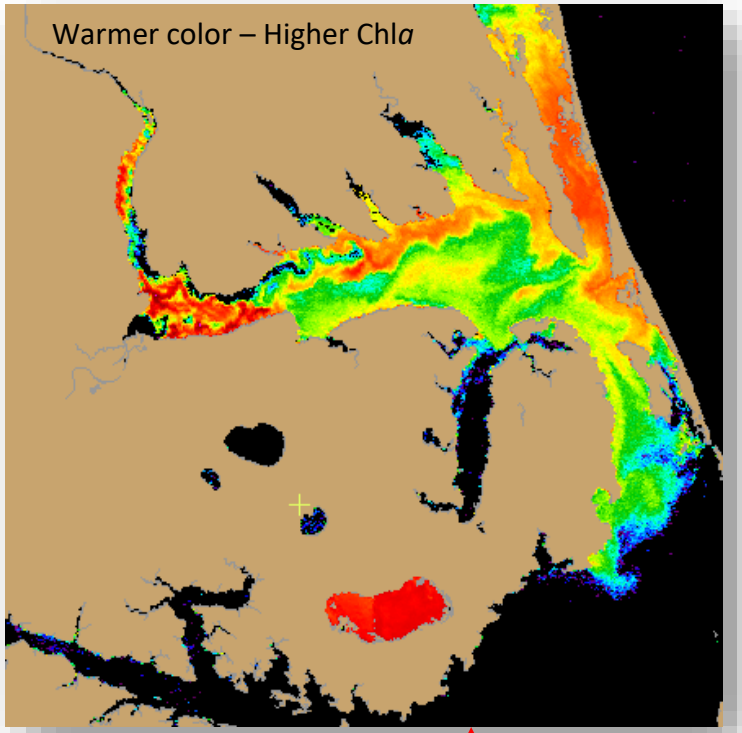
- VIMS, VA and MD State Departments of Environmental Quality



Blooms occurring in upper Chesapeake Bay

HAB Monitoring in NC

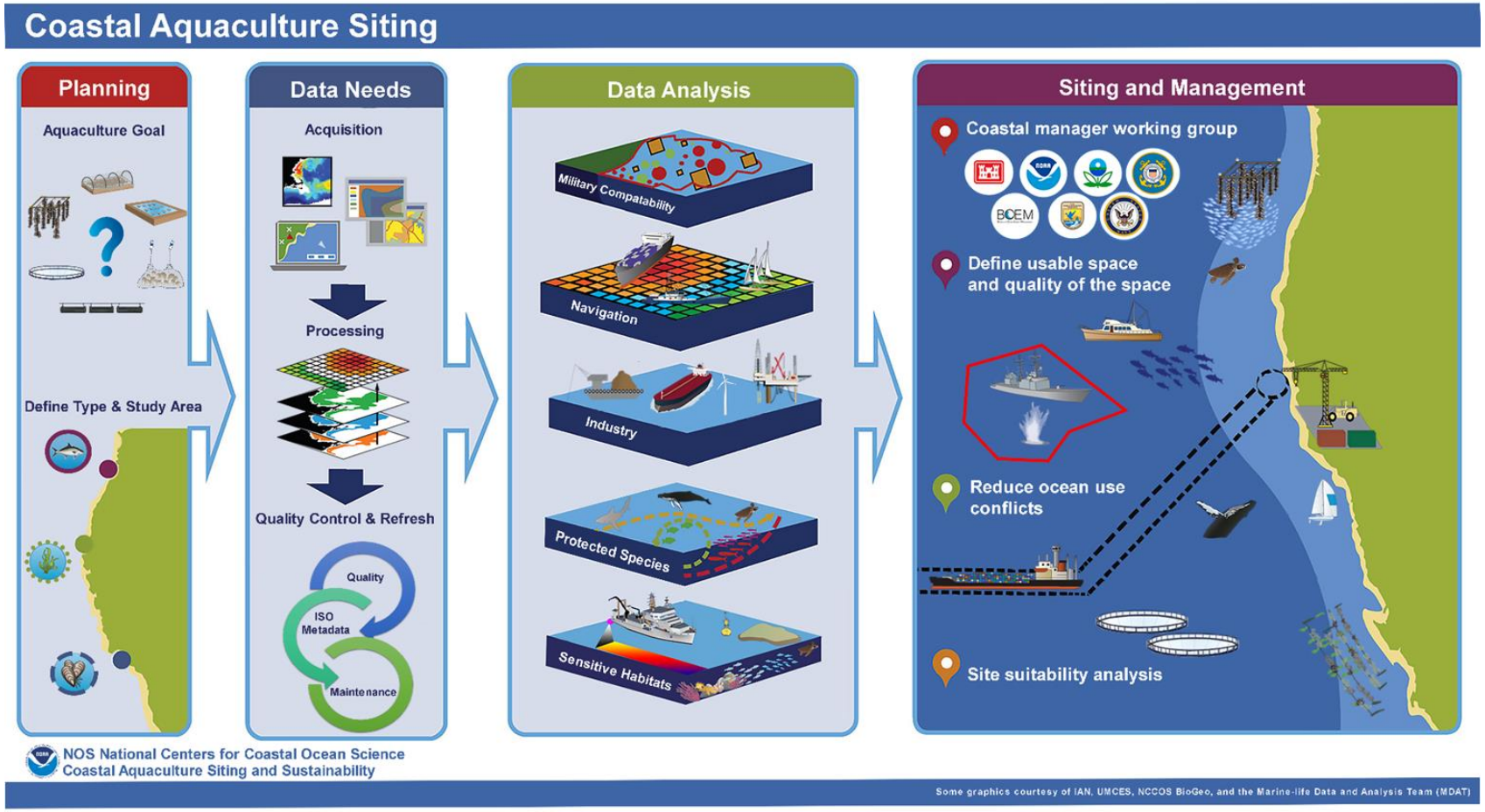
- Provide imagery to stakeholders in Albemarle Sound, NC
- Collaborate with NCSU on testing passive sampling devices for toxins
- Develop web site automatically delivers these data to the public



True Color Image

HAB Layer for National Aquaculture Planning Tool

- HABs can devastate offshore aquaculture facilities
- Crucial that HAB information is included in National Plan



HAB Monitoring & Reference Branch Overview

NAO 216-115A: RESEARCH AND DEVELOPMENT IN NOAA: Section 3.08

Accountability: NOAA's R&D will be regularly evaluated and adjusted based on objective reviews.

John Ramsdell, Branch Chief

QUALITY

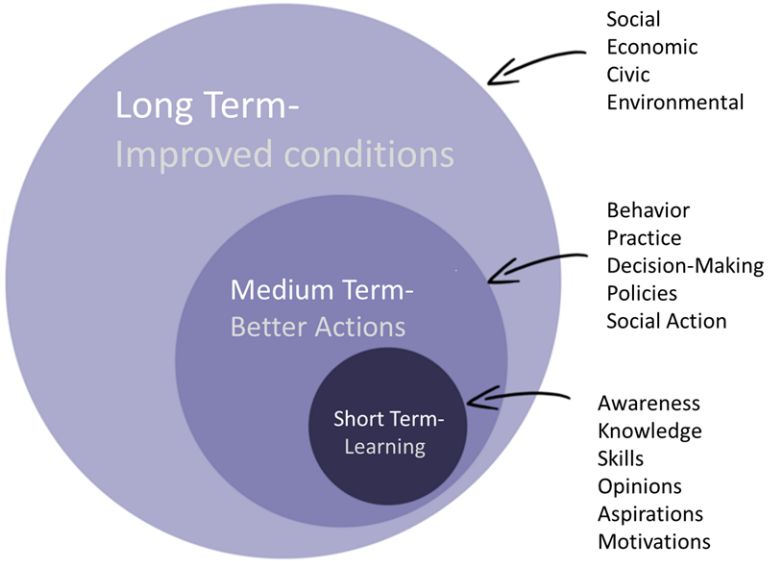
A measure of soundness, accuracy and reproducibility of a specific body of research

PERFORMANCE

An ability to manage to produce identifiable results, both effectively and efficiently

RELEVANCE

In essence this criterion asks for "what would not have happened if NCCOS did not exist, and how much would society have missed?"



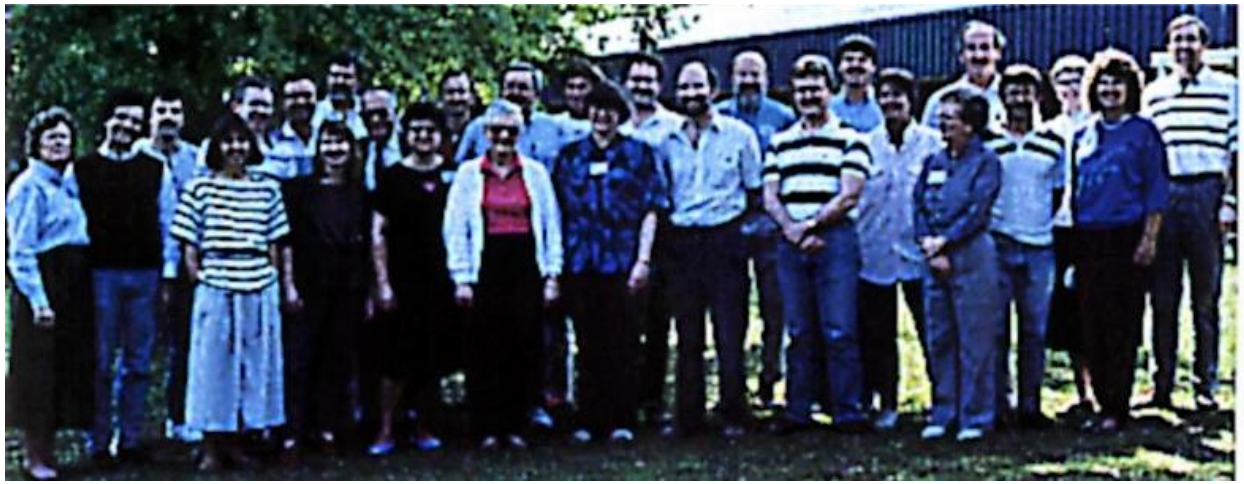
OVERVIEW

A Federal Program on Maine Biotoxins Since 1992

HARMFUL ALGAL BLOOM AND HYPOXIA RESEARCH AND CONTROL ACT OF 1998
R E P O R T
OF THE
COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION
on
S. 1480

"Before 1992, the Federal government did not expend much direct effort on HABs. Some funding was spent on a case-by-case basis if a new HAB occurred, but there was neither a pro-active orientation, nor a significant ongoing program dedicated to the HAB problem. Overall, federal funding levels were very low relative to the scope, complexity, and importance of HABs. As concerns about the problem increased in the 1990's, the Federal government began to devote greater attention to HABs. In 1992, NOAA sponsored a workshop with the HAB research community to develop a National Plan.

The workshop yielded a national research agenda and the creation of a Marine Biotoxins Program in NOAA."



Why an Intramural Research Program

The purpose of an intramural research program is to conduct, in government laboratories, distinct, high-impact research that cannot be readily funded or accomplished in traditional academia.

Such as work that:

- addresses emerging public health issues or threats;
- requires quick mobilization of existent capability and resources;
- requires the cooperation of local, state, tribal, or international governments;
- requires validation to meet regulatory standards;
- assures transition of research to application.

OVERVIEW

NOAA's Intramural Research

Where NOAA Invests in Research

NOAA maintains both intramural and extramural research investments.

Some programs invest the majority of their R&D funding internally, at labs and science centers with federal employees. Other programs invest the majority of their funding to external R&D partners, at universities, industry, and other research institutions.

Rick Spinrad
NOAA's Chief Scientist
2012-2017

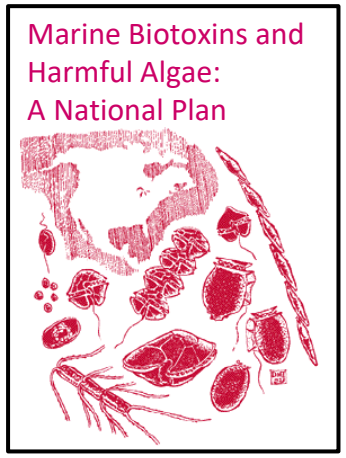
NOAA Administrative Order (NAO) 216-115A

provides the principles around which the determination should be made about where to invest research funding based on the expected time to maturity of research investments.

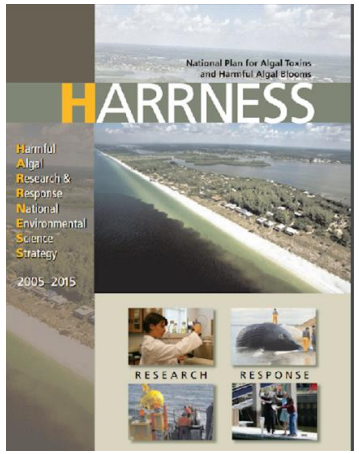
- Internal investments allow direct engagement between the users and researchers.
- External investments allow flexibility and 'course-corrections' through grants and contracts.

An Intramural Research Program Prioritizes to Changing National Needs

OVERVIEW



Isolate toxins, characterize structures and action
Develop specific tests for toxins
Develop forecasting capabilities
Determine source and fate of toxins in food webs
Develop management and mitigation strategies
Improve databases for HAB events
Develop communication programs
Provide rapid response to toxic outbreaks



Improved detection of HAB toxins and species
Improved monitoring and forecasting
Improved protection of human health
Improved protection of endangered species
Improved prevention and mitigation strategies
Improved economic cost estimates of HAB events
Improved economics for shellfish safety
An educated and informed public

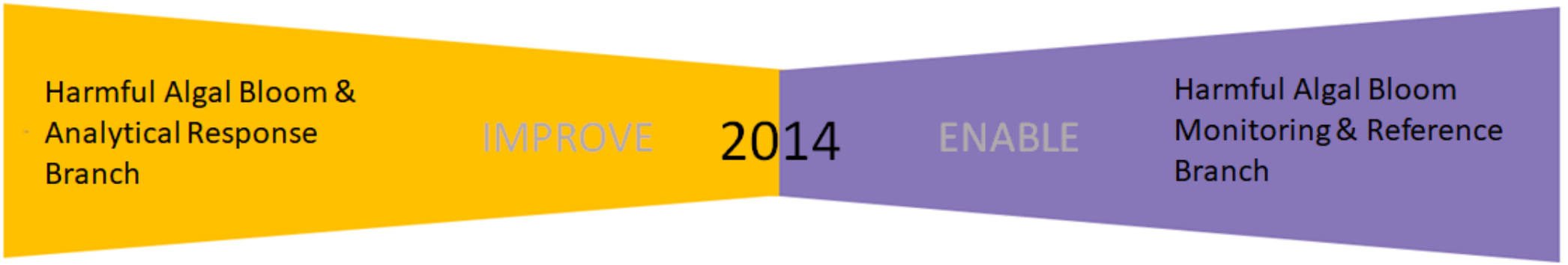
1992 DEVELOP 2005 IMPROVE 2014 ENABLE

HABHRCA Act of 2014 requires NOAA under sec. 603A(f) to: Increase the availability to appropriate public and private entities of (A) analytical facilities and technologies, (B) operational forecasts, and (C) reference and research materials;

Work cooperatively and avoid duplication of effort with other offices, centers, and programs within the National Oceanic and Atmospheric Administration, other agencies on the Task Force, and States, tribes, and nongovernmental organizations to coordinate HAB and hypoxia activities and research.

An Intramural Research Program Prioritizes to Changing Organizational Requirements

OVERVIEW



Phytoplankton Monitoring Network → Human Observation

Sensors → Autonomous Observation

Develop more smaller more versatile technologies and expand customer accessibility to monitoring data and capacity for utilization

Analytical Response Team

Technology Transfer

→ Analytical Methods and Reference

Genomics

Toxicology

Advance existing NCCOS expertise in concert with other federal agencies participating in the HABHRCA to support the development of standardized methods and training for testing laboratories and validation of their use to assure accurate and reproducible measurements.

Close program on animal models for HAB disease and toxicokinetics

Program transferred to support OR&R needs for DWH NRDA

OVERVIEW

An Intramural Research Program Tracks to the Strategic Plan

NCCOS will focus its efforts by providing forecasting and detection products that empower communities to take action on HAB issues

Purpose

The NCCOS HAB sub-priority strategically supports NOAA responsibilities described in Section 603A(f) of HABHRCA. The National Science and Technology Council Subcommittee on Ocean Science and Technology's Comprehensive HAB and Hypoxia Research Plan and Action Strategy outlines Federal agencies' roles and responsibilities, identifies challenges, and recommends actions to address these events.

Over the next three to five years NCCOS will specifically focus on the following priority areas:

FOCUS AREA 1: Early warning forecasts of HAB extent, trajectory, and toxicity, so managers can implement early action (e.g., changes in water treatment protocols, targeted closures of certain fisheries or shellfish harvests) to more (cost) effectively and efficiently mitigate the impacts of HABs;

FOCUS AREA 2: Scenario predictive models of HAB abundance and toxicity that establish their relationship to causative factors, to improve management strategies for preventing and mitigating HABs and their ecosystem (including socioeconomic) impacts, and assess the effectiveness of prevention and control practices;

FOCUS AREA 3: Volunteer observation opportunities through the Phytoplankton Monitoring Network human infrastructure to educate citizens, test new technologies, and inform managers of the onset of toxic bloom events; **STEVE MORTON: 1:00 PM Today**

FOCUS AREA 4: New detection technologies, such as test kits, autonomous sensors, and portable field instruments that enable local observations to support operational and demonstration forecasts, and provide states, municipalities and tribal nations with the ability to identify and quantify HAB species and toxicity; **GREG DOUCETTE: 1:20 PM Today**

FOCUS AREA 5: Analytical methods and reference materials which leverage existing NCCOS expertise, will be advanced in concert with other federal agencies participating in the HABHRCA IWG to support the development of standardized methods and training for testing laboratories and validation of their use to assure accurate and reproducible measurements nationwide. **MAGGIE BROADWATER: 1:40 PM Today**

QUALITY

HAB Monitoring and Reference Branch- Quality Measures

A measure of soundness, accuracy and reproducibility of a specific body of research

Rigour - A certain level of experience and training that provides an appropriate level of circumspection.

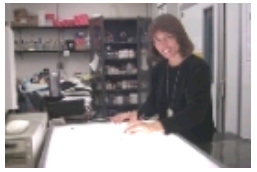
Reproducibility - The use of multiple approaches to address a question.

Routine - The management of quality.

Robustness - That which is credibly inferred from the application of our findings.

Rigour - A certain level of experience and training that provides an appropriate level of circumspection

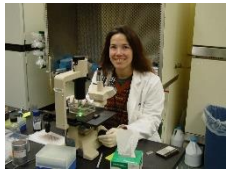
QUALITY



Expert- No longer relies on rules, guidelines or maxims. Intuitive grasp of situations based on deep tacit understanding. Analytic approaches used only in novel situations or when problems occur. Vision of what is possible. Has an authoritative or deep holistic understanding, deals with routine matters intuitively, able to go beyond existing interpretations, achieves excellence with ease. Dreyfus, S E (1981) Four models v human situational understanding: inherent limitations on the modelling of business expertise USAF Office of Scientific Research, F49620-79-C-0063.

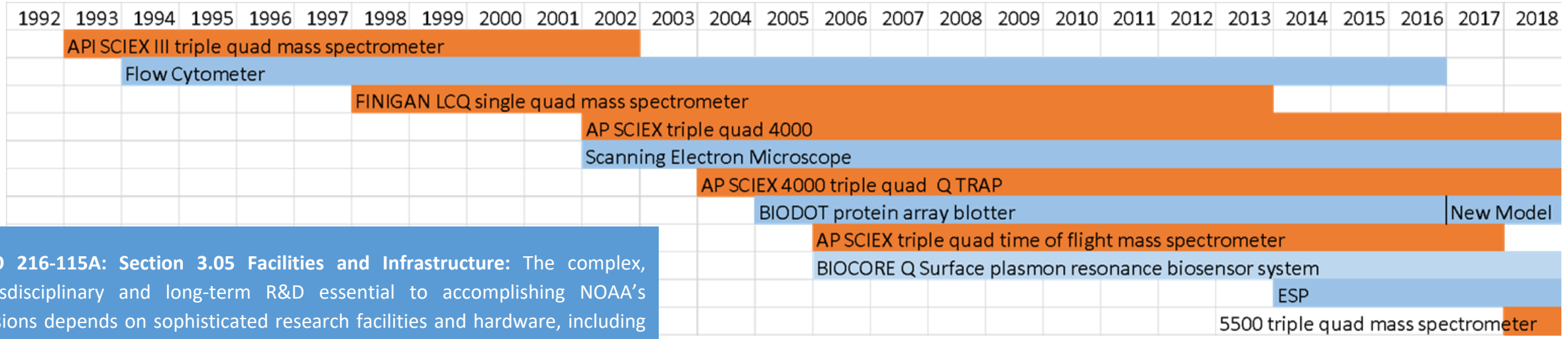
1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
RAMSDELL		SUPERVISORY RESEARCH PHYSIOLOGIST																								
DOUCETTE		RESEARCH OCEANOGRAPHER																								
VAN DOLAH		RESEARCH CHEMIST																								
MOELLER		RESEARCH CHEMIST																								
LEIGHFIELD		CHEMIST																								
MORTON							RESEARCH OCEANOGRAPHER																			
FIRE													CHEMIST (contractor)													
MIKULSKI								OCEANOGRAPHER (contractor)										(term FED)								
FURQUAY								OCEANOGRAPHER (contractor)										(term FED)								
WANG											MASS SPECTROMETRIST (CONTRACTOR)																
BROADWATER																RESEARCH CHEMIST											

Current contractors have received NOS EOY/Team member of the year 2014, 2016 and 2017



QUALITY

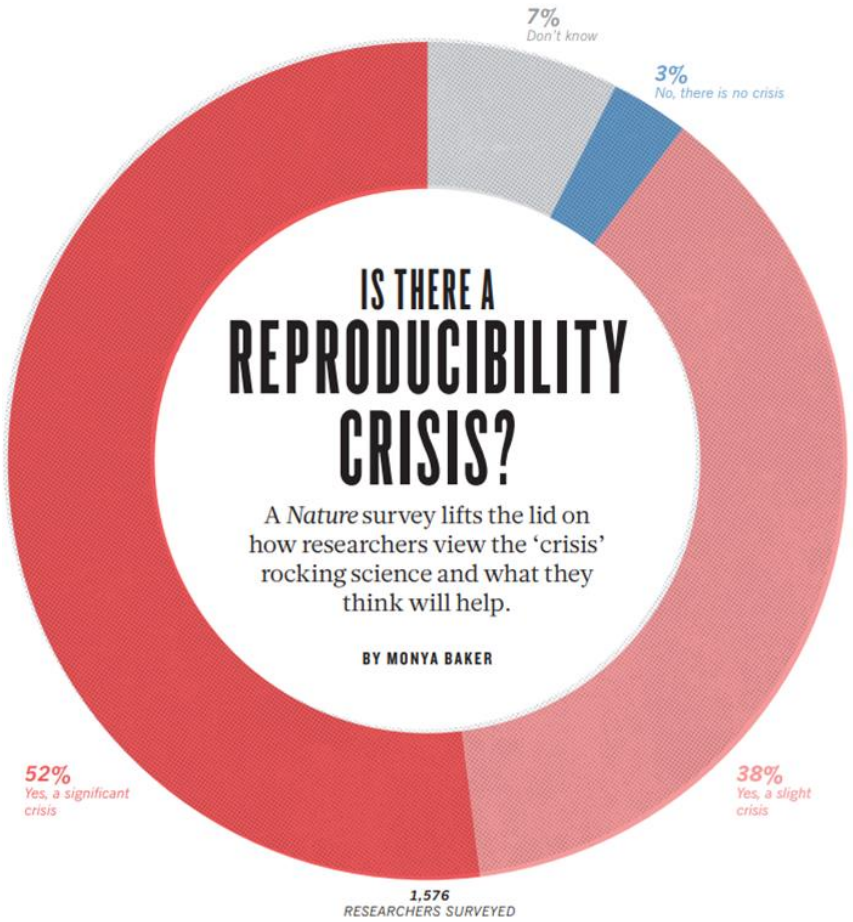
Analytical equipment and specialized laboratories. A fleet of mass spectrometers, high resolution microscopes and sensing platforms is expertly maintained by our scientific staff to maintain peak performance and lifespan.

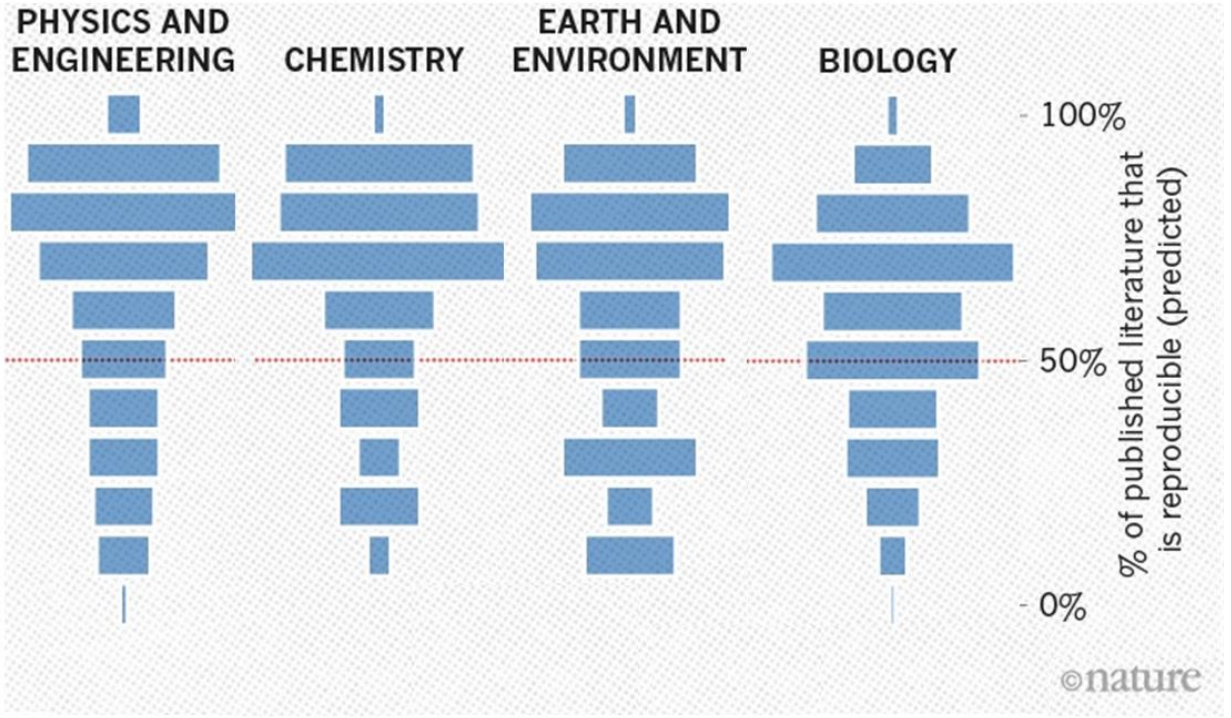


NAO 216-115A: Section 3.05 Facilities and Infrastructure: The complex, transdisciplinary and long-term R&D essential to accomplishing NOAA's missions depends on sophisticated research facilities and hardware, including laboratories, instrumentation, ships, aircraft, satellites, moored platforms, autonomous vehicles, high performance supercomputing, test beds, proving grounds, data repositories, computer models and information systems

Reproducibility - The use of multiple approaches to address a question.

QUALITY





Several studies across many fields estimate that
only around 40% of published findings can be replicated reliably

Routine - The management of quality.

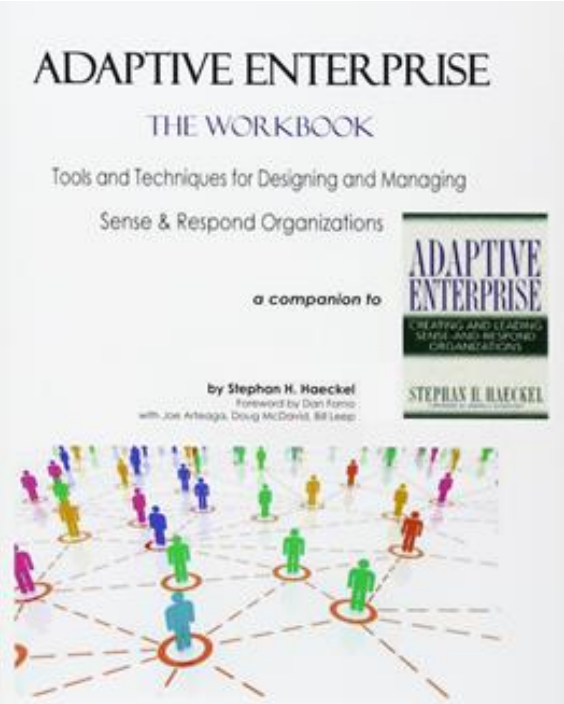
QUALITY

Toxin Analysis Management Team (TAMT)

This team is a multidisciplinary group of scientists who determine what analyses, if any, any will be performed and to assign staff responsibilities. The TAMT also assures all final reports for quality and accuracy prior to its release to the originator of the request.

The S&R design and success of the Analytical Response Team in defining the cause of marine animal mortality events drew the attention of the IBM Advanced Business Institute (ABI) Stephen Haeckel, Director of Strategic Planning, familiar with red tides as a coastal resident an authority on sense and respond business design, and author of “Adaptive Enterprise” (Harvard Business School Press, 1999). Mr. Haeckel and worked with the team to design to TAMT.

The largest S&R implementation to date is a multi-billion dollar systems integration project involving 3,000 people. The smallest is a seven person organizational design for responding to what the United States National Oceanic and Atmospheric Administration calls “coastal mortality events.” - Stephen Haeckel



Published in 2016 the Workbook features the NOAA Team as one of three case studies

Routine - The management of quality.

QUALITY

2001 LEIGHFIELD → 2006 FIRE → 2014 BROADWATER

TAMT Meeting 18 December 2017

Participants: Maggie Broadwater, Tod Leighfield, Steve Morton, Zhihong Wang, John Ramsdell, Bennie Haynes, Wayne McFee, Peter Moeller, Greg Doucette

Absent:

Agenda

Projects/Research	
DSP Shellfish (Zhihong)	Need calibrating standards (AZA, DSP). In-matrix RM, vs. calibrant RM. 5 species -- high recovery in mussels -- differences among species and locations FDA (Jon Deeds) - ISSC method used East coast shellfish; we are seeing issues with WA shellfish. Potential solution: tiered analysis with support from federal labs? Screening/confirmation. Project has another year. NRC: Mussel only -- OA, DA, PSP
Ohio EPA RBA Tech transfer (Greg)	Award has been made (Heather Raymond, OH EPA) Indirect funding for materials & supplies via BGSU (Davis). Jan 1 start? JR: EPA interest in collaborating via MOU; EPA funds or supplies monitoring. Also support new methods and RBA for freshwater samples. Can support Fed work on freshwater samples. New scintillation counter to support this project?
NIST Geoduck clam reference material (Tod/Zhihong)	PSP (RBA), DSP (LC/MS), and maybe DA (LC/MS). Under analysis for As. 480 jars @ 12g ea. Shelly L. communicating with users. PSP RBA: "reference value" (1 lab) vs. "certified value" (3 labs). Note NIST definitions may differ from NRC. TL: suggest reference values on 3 toxins DSP - follow ISSC method for PSP, DSP toxins DA - reference publications Funding for DA, DSP?
PM Discretionary project	Discuss in Jan TAMT. LC/MS, bioassay access or support? Need to measure toxins released during process? Mcx Single quad LC/MS, PDA detection, vs. EPA ELISA method. MC-LR, MC-RR, need total toxicity -- Abraxis ELISA. Time course, ~ 30 samples. Need ~ 6 plates. Greg replacing used kit.

Announcements	
TAMT	Monthly -- 2pm on the 3rd Monday (except MLK, Pres)
HML Power outage	Tomorrow
Shutdown Preparation?	Friday -- nothing for now
Holiday schedule	Peter, Jenn, JR on Wed/Thurs Tod to check with Greg W re: HVAC in 227.
Records Management Training	Due Dec 31
STEMFest	Brittlebank Park, Feb 3 Contact: Steve, Sean Morton
HAB/Hypoxia Science Review	Feb 26-28 in Silver Spring
NOAA Research Council (Tod)	1 year task force to examine "research small infrastructure" (lab/field equipment and maybe small boats). JR: how can we recover funds for replenishing infrastructure. Ref: NIST Amortization scheme to move forward, replace. Inventory, mechanisms going forward.
EPA Film Crew (Kevin Hollerbach)	Possibility of EPA sponsored film crew to outline how PMN interfaces with ART and toxin detection Film crew may video sample ID, toxin detection, etc. Potentially Sitka also.
Travel	
Maggie	GoMRI VI PI Meeting Feb 20-23
John and others	Silver Spring Feb 26-28
Steve	Note: Add Sitka travel to travel sheet.

Discussion	
IAEA/Tech transfer (Tod)	Training: IAEA Fellow from Kenya?
AK Collaborative work	May workshop
(Tod/Steve)	Mar/April - Sitka people visiting Chas for training
PMN (Steve)	AOP freshwater milestone (~ 22 PMN fw sites)?
Facilities & safety (Bennie)	Lab safety inspections due COB today Facilities issues - new track-it system. Major issues with State responsibilities for CCEHBR building. BH: email JR with lighting issues.
Sensors (Greg)	Mcx assay for 3G ESP (SPR method - Tina)] Addressing logistical issues in Lake Erie Faisal - volunteer position half-time? Assays (DSP, PbTx)
LC/MS Instrumentation (Tod/Zhihong)	All ok
Purchasing	Multi-year service contracts expiring Mar. TL: speak with Ed. Combining CCEHBR & HML. Need to sync dates going forward.

Robustness - That which is credibly inferred from the application of our findings.

QUALITY

Northern Gulf of Mexico Bottlenose Dolphin Unusual Mortality Event Algal Toxins Report
Date: 15 January 2014

Documented by: Maggie Broadwater
NOAA National Ocean Service, Marine Biotoxins Program
219 Fort Johnson Road, Charleston, SC 29412
(843) 762-8535 <maggie.broadwater@noaa.gov>

A. Suspected Event and Sample Details
Liver (n = 83) and fecal (n = 39) samples from 83 Bottlenose dolphins (*Tursiops truncatus*) stranded in the Northern Gulf of Mexico from Marc March 2014 were submitted to NOAA Marine Biotoxins Program. Samples were assigned NOS ID numbers (NG141-264) upon receipt in prep for toxin extraction and analysis. A complete sample list is given in the data summary below (section F).

B. Findings
Brevetoxins were observed in feces (161 ng/g) from one animal stranded near Orange Beach, AL in October 201[illegible]. Domoic acid was detected levels (trace – 6 ng/g) in feces from three animals, stranded in Alabama (n = 1) and Louisiana (n = 2) from Febru[illegible]ary 2012 – March 2014. Okad was detected in liver (n = 6, trace – 0.8 ng/g) and feces (n = 1, 0.7 ng/g) from seven animals, stranded in Alaba[illegible]ma (n = 1) and Louisiana (n = between June 2010 and March 2014. Two animals were concurrently exposed to multiple toxins: brevetoxins (161 ng/g) and domoic acid (trac observed in feces from 26DISL101713, stranded near Orange Beach, AL in October 2013, and domoic acid (6 ng/g) and okadaic acid (0.7 ng/g) observed in feces from JDM-20140310-LA001, stranded near Golden Meadow, LA in March 2014. Complete results are presented in Table 1 a Figures 1-3 (section F).

C. Brevetoxin (PbTx) Analyses
1. Preparation of Samples: Samples (~ 2 g) were homogenized and extracted three times in 3 volumes of acetone, filtered (0.45 µm Acrodisc filter), evaporated, resuspended in 80% aqueous methanol (6 mL), twice solvent partitioned with hexane (3 mL), and the methanolic fraction collected and and resuspended in 100% methanol (1-2 mL). Extracts were stored at -20ºC until analysis. Samples were prepared for analysis by Bennie Haynes.
2. ELISA Methods: Extracted samples were analyzed using a direct competitive enzyme-linked immunosorbent assay (ELISA) for PbTx, follow methods outlined by Maucher *et al.* (2007). The ELISA utilizes cross-reactivity of PbTx to anti-PbTx antibodies to determine PbTx-like activity in sample. Quantitation is determined via competition between PbTx in the sample and PbTx conjugated to a signal enzyme for binding to anti-antibodies. Analyses were conducted by Maggie Broadwater.
3. ELISA Results: Brevetoxin-like activity was detected in 11 of 112 samples analyzed. The limit of detection for this assay was 2.0 ng PbTx pe sample.
4. LC-MS Methods: ELISA-positive samples were cleaned on C18 solid phase extraction cartridges (Agilent) and analyzed by liquid chromatography/mass spectrometry (LC-MS) for parent brevetoxins and metabolites. Liquid chromatography separations were performed on C8(2) 150 × 2 mm column using an Agilent Technologies Model 1100 LC system. Mobile phase consisted of water and acetonitrile with 0.1% acid additive with gradient elution. The mobile phase flow rate was 0.2 mL/min. The eluant from LC was analyzed by an AB Sciex 4000 QTRAP triple quadrupole/linear ion trap mass spectrometer equipped with a TurboV™ interface. The analysis of brevetoxin congeners and metabolite mass spectrometry was achieved by multiple reaction monitoring (MRM). Toxin congeners monitored included: brevetoxin-B(A), dihydrobreve B(A), tetrahydrobrevetoxin-B, hydrolysis product of dihydrobrevetoxin-B(A), hydrolysis product of oxidized brevetoxin-B, brevetoxin-B2, S-desoxybrevetoxin-B2, cysteine conjugates of brevetoxin-A. Detection limits were 0.25, 1.4, and 1.2 ng/ml for dihydrobrevetoxin-B, S-desoxybrevetoxin-B2, and brevetoxin-B2, respectively, with signal-to-noise ratio slightly above 3. Standards were prepared in methanol. Reter time of other toxin congeners was determined by injecting an algal extract with known toxin congeners. Toxin congeners positive by MRM sc were also examined by enhanced product ion spectra for further confirmation. LC/MS analyses were performed by Z.Wang.
5. LC-MS Results: Brevetoxin congeners (dihydrobrevetoxin-A, dihydrobrevetoxin-B, S-desoxybrevetoxin-B2, and brevetoxin-B2) were detect LC-MS in feces from 26DISL101713 (NOS ID NG159), stranded near Orange Beach, AL in October 2013. Brevetoxins were not observed in the ELISA-positive samples.

D. Domoic Acid (DA) Analyses
1. Preparation of samples: Samples (~2 g) were extracted by adding four volumes of 50% aqueous methanol to the sample volume, homogenizing, and then probe sonicating on ice for 2 min. Extracts were centrifuged at 3400 x *g*, and the supernatant collected and filtered (0.45µm, Acrodisc syringe filter) prior to analysis. Sample clean-up was performed by solid-phase extraction (SPE) using Agilent 200 mg C18 columns. Samples were prepared for analysis by Bennie Haynes.
2. LC-MS Methods: The methanolic extracts were analyzed for the presence of domoic acid using tandem mass spectrometry coupled with liquid chromatographic separation (LC-MS/MS) by Dr. Zhihong Wang, following methods described in Wang et al. (2012). This method utilized reversed phase chromatography, using an Agilent 1100 HPLC coupled to an AB-SCIEX API-4000 triple quadrupole mass spectrometer in ESI+ mode. Chromatographic separation was performed on a Phenomenex Luna C18(2), 5µm, 150 mm x 2 mm column. Mobile phase consisted of water and acetonitrile with 0.1% formic acid as an additive. Retention time of DA in samples was determined based on the retention time observed with a certified DA reference standard from the Institute for Marine
2
Biosciences, NRC Canada (Halifax, NS). The detection of domoic acid by MS was achieved by Multiple Reaction Monitoring (MRM) method with Turbolonspray interface. Four MRM transitions from protonated domoic acid were monitored: *m/z* 312 → 266, *m/z* 312 → 248, *m/z* 312 → 193, and *m/z* 312 → 161.
3. LC-MS Results: DA was detected in 3 of 89 samples analyzed; the three feces samples were from animals stranded in Alabama and Louisiana between February 2012 and March 2014. The detection limit was 2.5 ng DA per gram sample, with a signal-to-noise ratio above 3; the limit of quantification (LOQ) was 5 ng per gram sample, with a signal to noise ratio above 10.

E) Diarrhetic Shellfish Poisoning (DSP) toxins analysis
1. Preparation of samples: Samples (~ 2 g) were extracted by adding four volumes of 100% methanol to the sample volume, then homogenized and probe sonicated on ice for 2 min. Sample extracts were centrifuged at 3400 x *g*, and the supernatant was washed with hexane. Sample clean-up was performed on all extracts by solid-phase extraction (SPE) using Strata X polymeric reversed phase (30 mg, 1 mL) columns. Samples were extracted by Bennie Haynes; sample clean-up was performed by Dr. Zhihong Wang.
2. LC-MS Methods: Samples were analyzed for the presence of okadaic acid (OA), dinophysistoxins (DTX-1 and DTX-2), and pectenotoxin-2 (PTX-2) using liquid chromatography (LC; Agilent 1100 series HPLC, Palo Alto, CA) coupled with tandem mass spectrometry (MS; AB Sciex, Foster City, CA). For [illegible] toxins, LC separation was performed on an X-Bridge C18 (150 × 3 mm, 5 µm) column (Waters, Milford, MA) using a mobile phase of water (A) and acetonitrile/water (90:10, V/V) (B), both containing 6.7 mM ammonium hydroxide under gradient elution at a flow rate of 0.4 ml/min. Gradient elution was used to separate OA, DTX-2, DTX-1, and PTX-2: 32% B was held for 0.5 min, with a linear increase to 50% B at 9.5 min and then to 80% B at 10.5 min and held for 6.5 min, increased linearly to 90% B at 17.5 min and held at 90% B for 3 min; mobile phase was returned to 32% B at 21 min and held for 7 min. Mobile phase was used within one week of preparation. MS detection was in multiple reaction monitoring (MRM) mode using a 4000 QTRAP mass [illegible] OA and DTX-2 with MRM transitions of m/z 803.5 →113.1 and 255.1; for DTX-1 with MRM transitions of m/z 817.5 → 113.1 and 255.1; for PTX-2 with MRM transitions of m/z 876.5 →213.1 and 823.5). LC/MS analyses were performed by Dr. Zhihong Wang.
3. LC-MS Results: Okadaic acid was detected in 7 of 75 samples analyzed (six livers and one fecal sample) at levels from trace – 0.8 ng per gram sample. Dinophysis toxins (DTX-2 and DTX-1) and pectenotoxin-2 (PTX-2) were not detected in any of the samples. Detection limits were 0.4, 0.5, 0.4, and 0.3 ng/g for OA, DTX-2, DTX-1, and PTX-2, respectively. Limits of quantitation were 0.6, 0.7, 0.7, and 0.3 ng/g for OA, DTX-2, DTX-1, and PTX-2, respectively.

References
Maucher JM, Briggs L, Podmore C, Ramsdell JS (2007). Optimization of blood collection card method/enzyme-linked immunoassay for monitoring exposure of bottlenose dolphin to brevetoxin-producing red tides. *Environ. Science and Technology* 41(2):563-567
Van Dolah FM, Fire SE, Leighfield TA, Mikulski CM, Doucette GJ (2012). Determination of Paralytic Shellfish Toxins in Shellfish by Receptor Binding Assay: Collaborative Study. *Journal of AOAC International* 95(3):795-812.
Wang Z, Broadwater MH, Ramsdell J (2015, in preparation). Analysis of diarrhetic shellfish poisoning toxins and pectenotoxin-2 in Bottlenose dolphins (*Tursiops truncatus*) by liquid chromatography–tandem mass spectrometry. To be submitted to *Journal of Chromatography A*.
Wang Z, Maucher-Fuquay J, Fire SE, Mikulski CM, Haynes B, Doucette G, Ramsdell J (2012). Optimization of solid-phase extraction and liquid chromatography-tandem mass spectrometry for the determination of domoic acid in seawater, phytoplankton, and mammalian fluids and tissues. *Analytica Chimica Acta* 715:71-79.

Robustness - That which is credibly inferred from the application of our findings.

QUALITY

Federal Data Quality Act, NOAA Section 515 Information Quality Guidelines Pre-dissemination Review

The principal procedural requirements pertaining to quality of information disseminated by are set forth under the Federal Data Quality Act (Section 515 of the Treasury and General Government Appropriations Act for Fiscal Year 2001). NOAA Section 515 Information Quality Guidelines (NOAA, 2006) apply broadly to all information that the agency disseminates.

A key requirement of the Section 515 Guidelines is a "Pre-dissemination Review" that ensures the utility, integrity and objectivity of information released.

I. Name/Title of information product:
II. NOS Office/Division disseminating information product: NCCOS/
III. Document how the following **standards for utility** are met by the information product:
    A. The content of the information is helpful, beneficial, or serviceable to its intended users, or that information supports the usefulness of other disseminated information by making it more accessible or easier to read, see, understand, obtain, or use.
    B. The data product is disseminated in a manner that allows it to be accessible and understandable to a broad range of users.
IV. Document how the following **standards for integrity** are met by the information product:
    A. All electronic information disseminated by NOAA adheres to the standards set out in Appendix III, "Security of Automated Information Resources," OMB Circular A-130; the Computer Security Act; and the Government Information Security Reform Act.
    B. Confidentiality of data collected by NOAA is safeguarded under legislation such as the Privacy Act and Titles 13, 15, and 22 of the U.S. Code.
    C. Additional protections are provided as appropriate by 50 CFR Part 600, Subpart E, Confidentiality of Statistics of the Magnuson-Stevens Fishery Conservation and Management Act, NOAA Administrative Order 216-100 – Protection of Confidential Fisheries Statistics.
V. Document how the following **standards for objectivity** are met by the information product:
    A. The data are collected according to documented procedures or in a manner that reflects standard practices accepted by the relevant scientific and technical communities.
    B. Data collection methods, systems, instruments, training, and tools are appropriate to meet the requirements of the intended users and are validated before use.
    C. NOAA's standard operating procedures (SOPs) are reviewed on a regular basis and modified as practices and procedures evolve. Deviations from current SOPs are documented and occur only if valid scientific reasons exist for such a deviation.
    D. The data undergo quality control prior to being used by the agency or disseminated outside of the agency.
    E. The quality control/quality assessment of NOAA data is an on-going process. Describe any applicable evolution and/or improvement in survey techniques, instrument performance and maintenance, and data processing.
    F. NOAA strives for transparency regarding data collection procedures, level of quality, and limitations. Metadata record descriptions and explanations of the methods and quality controls to which original data are subjected are included or available upon request.

HAB Monitoring and Reference Branch- Performance Measures

PERFORMANCE

An ability to manage to produce identifiable results, both effectively and efficiently

S M A R T E R

Specific | Measurable | Attainable | Relevant | Timely | Evaluate | Reward

The Commerce Alternative Personnel System (CAPS) links employee compensation to measures of work quality or goals. Performance pay increases are tied to performance appraisals and employees' rank within a pay pool, and are added to employees' basic pay. Bonuses are also linked to performance.

AWARDS
Honorary (Gold, Silver, Bronze)
Administrators Award
Technology Transfer Awards
Distinguished Career
NOAA/NOS Employee of the Year
Time Off Award
Cash In Your Account
On The Spot
Special Act

NCCOS 2018 Annual Operating Plan (submitted 10-7-17)

MILESTONE 1 | Coastal and Marine Spatial Ecology: Integrate and apply socioeconomic and biophysical information to improve multi-use planning in the Gulf of Mexico, Choptank Complex Habitat Focus Area, and Lake Michigan.

MILESTONE 2 | Stressor Detection and Impacts: Support OR&R in its mission of protecting NOAA trust resources from threats caused by oil spills, oil dispersants and other contaminants by determining oil toxicity on corals and in estuaries, and establishing baselines in the Arctic.

MILESTONE 3 | Social Science: Conduct social science research to support the Sanctuaries nomination process, BOEM wind energy planning, and to understand economic impacts of whale ship-strike reduction options on the shipping industry.

MILESTONE 4 | Ecological Forecasting: Enhance ecological forecasting capabilities for HABs to reduce respiratory illness hazard from Gulf of Mexico Red Tide, paralytic shellfish poisoning in Alaska, fish kills in aquaculture facilities, and to detect cyanobacterial blooms nationally.

MILESTONE 5 | Climate Resilience: Increase capacity for long-term coastal planning by improving tools and products for modeling impacts of sea-level rise and assessing vulnerabilities of marshes, dunes, and beaches to sea level rise and coastal storms.

MILESTONE 6 I HAB Detection Technologies: Validate and transition HAB detection and monitoring products to provide identification and toxicity measurements for regional observing networks, states, municipalities and tribal nations.

MILESTONE 7 I RESTORE: Address identified management needs and science gaps in the Gulf of Mexico ecosystem through a competitive awards process that drives scientists and resource managers to address challenges and apply the results.

PERFORMANCE

DELIVERABLES REPORTABLE FROM INVESTIGATOR TO SUPERVISOR

1. Execute deployment of OAR-GLERL ESP for microcystin detection to span a significant portion of bloom season and generate near-real time data supporting development of Lake Erie toxicity forecasts (GLERL, NCCOS, CILER collaboration); 3rd and 4th Quarters, FY17;

2. Conduct multiple offshore deployments of NMFS-NWFSC ESP and CCEHBR DA sensor in PNW, and complete demonstration of near-real time data dissemination to managers and other stakeholders via NANOOS DVS (UW-NWFSC IOOS OTT project); 3rd and 4th Quarters, FY17;

3. Deploy surface plasmon resonance sensor for DA detection in Monterey Bay on Long-Range AUV-based 3rd generation ESP as part of first science mission for this observing technology (MBARI, U Maine, U Washington partners); 4th Quarter, FY17;

4. Conduct optimization of microcystin and PST sensors for ESP to improve the accuracy of toxin quantification for diverse algal assemblages and toxin profiles, and continue development of multiplexed DA-PST sensor for 2G ESP; all quarters, FY17.

1. Implement PMN platform for freshwater toxins through NOAA-EPA Agreement in high priority regions identified in FY17 EPA. **DELIVERABLE:** Utilize trip to EMD Workshop trip to Washington DC to meet with EPA Office to Water to update of the progress of the freshwater PMN in the first quarter;

2. Expand customer accessibility to HAB observations by enhancing data serving capacity and visualization of the PMN database in collaboration with the National Center for Environmental Information. **DELIVERABLE:** Integrate volunteer observations from the Maine and California phytoplankton monitoring networks into NOAA's PMN ERDDAP database;

3. Distribute PMN platform to Alaskan Arctic tribal members to monitor HABs in partnership with Southeast Alaska Tribal Ocean Research and NOAA Education **DELIVERABLE:** Introduce the Southeast Alaskan tribal monitoring network to high school classes through outreach materials and lesson plans to the Sitka Tribe by the third quarter;

4. Develop strategy with the NOAA Office of Education to expand citizen science monitoring into the Arctic communities of Alaska in support of the White House's Arctic Science Ministerial by the fourth quarter. **DELIVERABLE:** Distribute PMN platform to Alaskan Arctic tribal members to monitor HABs.

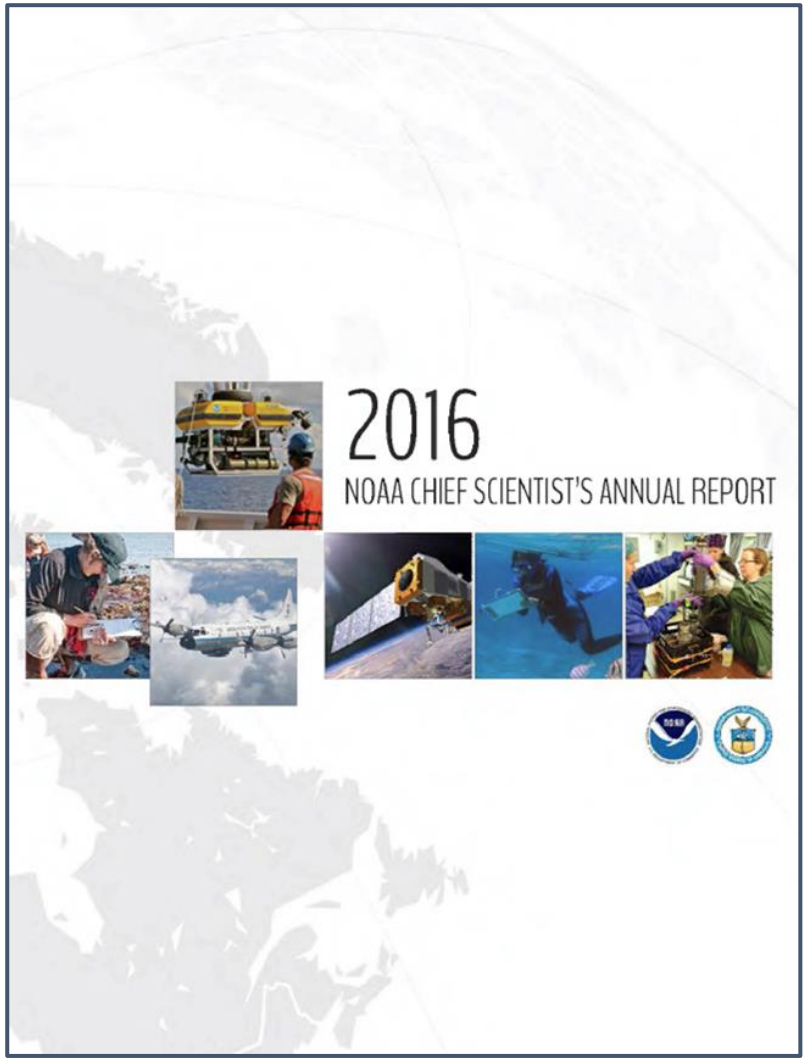
DELIVERABLES REPORTED BY SUPERVISOR TO NCCOS

PERFORMANCE

DELIVERABLE	PROGRESS	DATE	IMPACT
THIRD QUARTER			
Report AOP Milestone: A tribal monitoring network for coastal HABs will be established using standardized phytoplankton monitoring protocols for the Sitka tribes of Alaska. Nine Sitka tribes will each operate a phytoplankton monitoring siteto monitor harmful algae that threaten subsistence harvests with paralytic shellfish poisoning.	Completed: 05/17/2015 Nine of nine sites in operation. Update 11/1/2014 Six of nine sites in operation. Workshop in May to bring on three remaining sites	5/17/2015	The Sitka Tribe now has capability to monitor HABs in shellfish growing areas to take action to restrict harvesting when toxins are likely to contaminate shellfish. They have taken the next steps to test shellfish for PSP toxin and formed SE Alaska Tribal Toxins Partnership with help of NCCOS scientists.
Report AOP Milestone: A citizen monitoring network for freshwater HABs will be established using phytoplankton monitoring protocols in communities in the Great Lakes. Twenty citizen monitoring sites will be operational in the third quarter to provide early warning of cyanobacteria harmful algal blooms spanning the western to eastern basins of Lake Erie.	Completed 7/22/2015 Human Observing Network Sites Operational : 4th Update, 6/23/2015 Roll out program with six sites in Lake Erie with training workshop in Monroe, MI and four sites requested by EPA in region 8 operational on 6/26/2015 . Workshops held in Toledo, OH on 6/25/2015. 4/10/2015 Workshop delayed due to prolonged winter condition EPA/NOAA roll out still on schedule. 2/2/2015,MOA with EPA cleared 12/15/2014.	7/22/2015	The Great Lakes has new capability to monitor cyanoHABs for early warning. This capability also provides in the water validation for NOAA's GL Ecological Forecast. Michigan Sea Grant has joined the effort to expand the human observing network to include Lake St. Clare, one of the potential initiation sites of harmful algal blooms.
Report AOP Milestone: Optimize shellfish toxin sensor to improve FY15 Gulf of Maine Red Tide Forecast	ESP with fully operational PST sensor deployed in Gulf of Maine first week of May with 8 measurements conducted thus far - low levels of PSTs detected intermittently with mission scheduled to end mid-June and results consistent with Alexandrium data reported by HAB sensor on ESP; 2nd Update, 4/10/2015: technical issue resolved, sensor working on instrument, to be canned up next week for deployment in early May. 1st Update, 3/10/2015: an unknown technical issue has arisen with the ESP instruments that is currently prohibiting proper operation of the PST sensor/assay. This is not an issue with the PST sensor/assay, but a mechanical issue with the ESP that must be resolved satisfactorily in order to proceed with deployment of the sensor on an ESP this Spring in the Gulf of Maine.	5/7/2015	Data on Alexandrium toxicity and cell abundance transmitted from the ESP's offshore location will be distributed to coastal resource and fisheries managers and help provide an early warning of impending shellfish toxicity in the area. This ESP and two additional instruments detecting only Alexandrium cells will be deployed alongside instrumented buoys operated by the IOOS-Northeastern Regional Association of Coastal and Ocean Observing Systems (NERACOOS), providing valuable physical and chemical data. Collectively, this information will supplement weekly experimental red tide forecast updates based on predictive models, with the aim of transitioning to an operational NOAA HAB forecasting system for the Gulf of Maine.
FOURTH QUARTER			
Report AOP Milestone: Produce domoic acid sensor for the Northwest Enhanced Moored Observatory (NEMO) as part of IOOS-funded project to integrate toxin detection with the existing network of moored oceanographic sensors in the Juan de Fuca eddy	Completed 8/3/2015: Domoic acid sensor calibrated on Environmental Sample Processor (ESP) platform located at NOAA's Northwest Fisheries Science Center (NWFSC) in Seattle, Washington on. ESP test deployment initiated successfully on 8/6/2015 in Puget Sound, WA. 3rd Update, 6/11/2015: hardware & software modifications completed on ESP to integrate DA sensor; initial test runs successful with sensor calibration to follow; plans for August deployment in Puget Sound being finalized; 2nd Update, 4/10/2015: Trial deployment of sensor in new mooring system set for Puget Sound in August 2015; 1st Update, 2/10/2015: Parts ordered for modification of NWFSC ESP instrument to accommodate DA sensor for deployment on NEMO; installation and bench testing scheduled for 3Q FY15 in collaboration with NWFSC and MBARI.	8/3/2015	Washington state, along with the entire West Coast, has experienced an unprecedented harmful algal bloom (HAB) event this year related to DA-producing Pseudo-nitzschia. Advancing the ability to provide near real-time data on HAB cell and toxin levels via ESP deployments now and in the future will not only help to provide early warning of resource contamination, but in combination with physical and chemical data from regional ocean observing systems (e.g., NANOOS) can support predictive models needed to forecast Pseudo-nitzschia blooms and impacts in the Pacific Northwest.

PERFORMANCE

DELIVERABLES REPORTED TO CONSTITUENTS BY NOAA



Theme Chapters

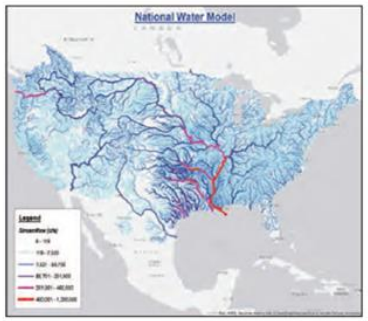
Integrated Earth System Processes and Predictions 16
Environmental Observations and Data 24
Decision Science, Risk Assessment, and Risk Communication 36
Water Prediction 44
Arctic 48

PERFORMANCE

Strengthening our Nation's Water Security and Reducing Vulnerability to Climate Change & Variability

Increased Capability in Water Prediction Nationwide

On August 16, 2016, NOAA's efforts to build a "Weather-Ready Nation" took a major step forward with the National Weather Service's launch of a new, highly sophisticated National Water Model (NWM).



This new system is a continental-scale water resources model based on the Weather Research and Forecasting Hydrology (WRF-Hydro) architecture developed by the National Center for Atmospheric Research (NCAR) and represents NOAA's first foray into high performance computing for water prediction.

Unprecedented in its reach, this new National Water Model leverages NOAA's investment in atmospheric prediction and data from over 8,000 U.S. Geological Survey (USGS) stream gauges to produce flow simulations for 2.7 million stream reaches, extending water resources information to the homes and businesses of 100 million Americans who live in coastal communities.

Using this model, NWS forecasters now have access to data for 700 times more locations than previously available. For the first time, communities will receive hourly, weekly, and monthly water forecasts based on output from the National Water Model.

This information will help businesses, community leaders, first responders, emergency managers, and state and local governments make more informed decisions to protect lives and livelihoods.

Tracking Precipitation to Provide Flash Flooding Forecasts at the Neighborhood Level

The Flooded Locations and Simulated Hydrographs (FLASH) project advances the state of flash flood prediction through newly developed rainfall estimation tools and hydrologic models.

FLASH begins with rainfall rates measured by radar and uses a sophisticated modeling system to track what every raindrop is doing on the ground: whether it infiltrates into the soil or flows across impervious roads, parking lots, and waterways. The system models where water will go and when and where it will become a flood, with updates as frequent as every two minutes — a key attribute for cities that can flood quickly.

In FY16, research indicated that the FLASH system doubles accuracy of the current operational system and improves the spatial resolution by 500%, which can indicate specific locations of flash flood impacts downstream, saving lives and mitigating damage to property.

These new high-resolution tools will provide reliable flash flood forecasts at the neighborhood level as well as provide up to six hours of forecast lead time, affording critical time for community response. FLASH improves National Weather Service forecasters' abilities to identify rare, severe flash floods from minor ones, enabling them to communicate this information to local emergency managers and the public.

The FLASH forecasts are particularly useful over small, fast-reacting headwater basins and in urban catchments, complementing the new National Water Model for flash flood modeling and prediction.

Better Toxin Detection for Harmful Algal Blooms

Toxins produced by harmful algal blooms (HABs) accumulate in marine resources and are a major cause of human seafood poisoning, which impacts subsistence harvests, economic development, and international trade.

Overabundance of harmful algae can result in phenomon known as red tide.

Tests, known as receptor binding assays, developed by NOAA scientists to measure levels of HAB toxins have recently been accepted by the Interstate Shellfish Sanitation Conference.

This standardized test for regulatory users helps secure the food supply against these potent algal-based toxins and is in various phases of implementation in testing laboratories worldwide.

In Alaska, NOAA scientists trained staff at the Sitka Tribe of Alaska Environmental Regulatory Laboratory on the extraction and detection of HAB-related paralytic shellfish toxins. Implementation of this NCCOS-developed technology by the Sitka tribe will mitigate the threat of toxic shellfish consumption from traditional subsistence shellfish harvesting to members of the Southeast Alaska Tribal Toxins partnership.

The development of HAB toxin detection methods, specifically receptor binding assays, also has a domestic and international component for their implementation.

Domestically, the use of this method is currently being evaluated by relevant public health agencies in Washington and California. Internationally, NOAA has an agreement with the International Atomic Energy Agency to support the use of this method worldwide.

In-situ Water Collection Instrument Sequences Samples in Near Real Time

In September 2016, for the first time, an Environmental Sample Processor (ESP) was deployed in a freshwater system. The ESP—a "lab in a can" designed by Monterey Bay Aquarium Research Institute (MBARI) — autonomously collects water samples, then extracts and analyzes them for harmful algae abundance and their related toxins in near real-time.

In collaboration with NOAA's National Centers for Coastal Ocean Science (NCCOS) and the Cooperative Institute for Limnology and Ecosystems Research (CILER), NOAA's Great Lakes Environmental Research Laboratory is developing the capability to monitor for microcystins, the dominant toxins in western Lake Erie harmful algal bloom (HAB) events, in real-time.

The goal is to combine the ESP toxin data with NOAA's other Lake Erie HAB forecasting products to act as an early warning system for drinking water managers.

Environmental Sample Processor (ESP) deployment.

In 2014, over 400,000 residents of Ohio were deprived of municipal drinking water after HAB contamination was detected in drinking water drawn from Lake Erie.

This suite of tools will provide critical data on bloom location, toxicity, and predicted movement before the water reaches municipal water intakes.

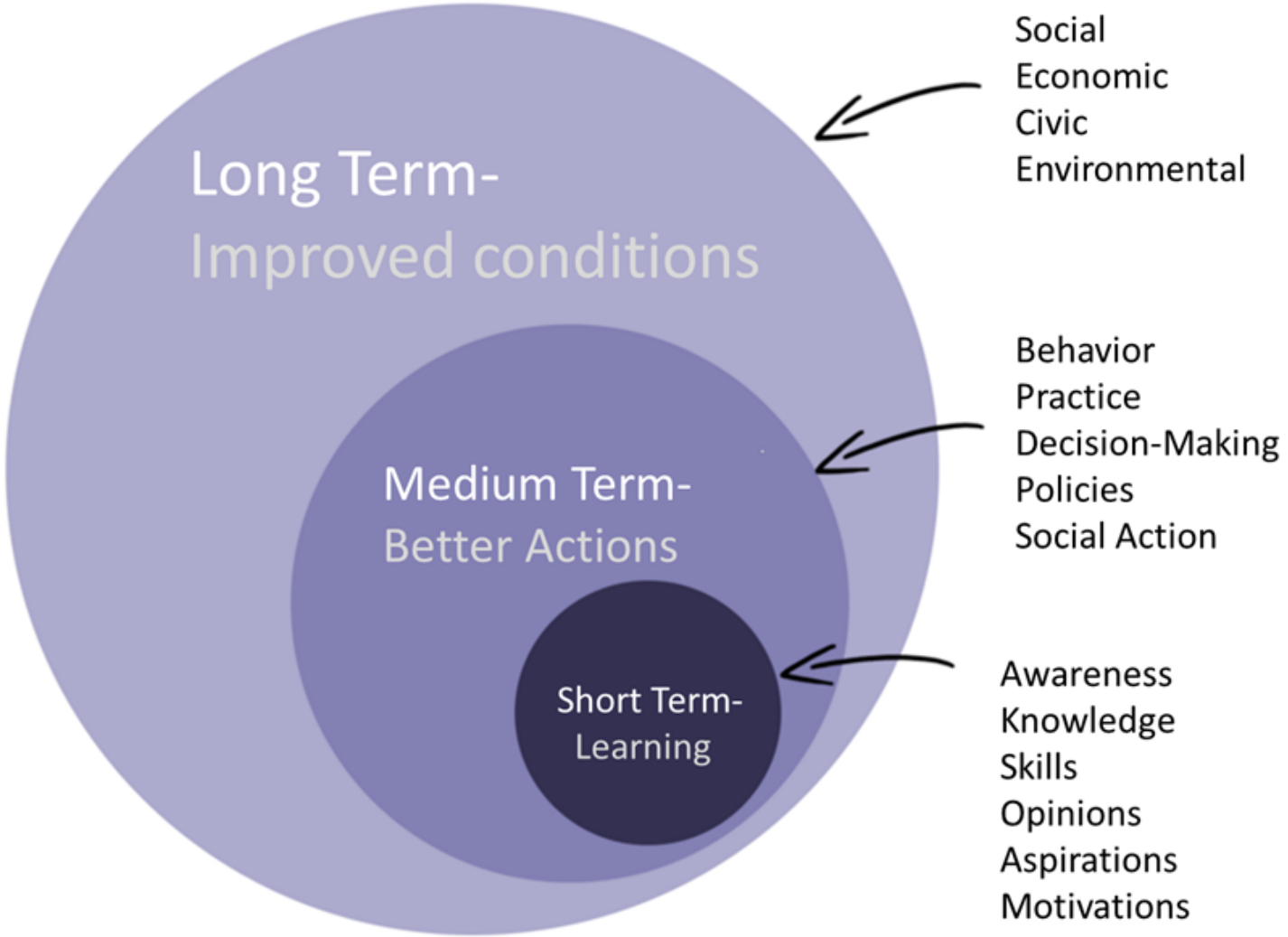
HAB Monitoring and Reference Branch- Outcomes are our Relevance Measure

RELEVANCE

"what would not have happened if NCCOS did not exist, and how much would society have missed?"

OUTPUT: The important products we create (e.g. standard methods, analyses, tools, workshop reports, data, models, services, training).

OUTCOMES: The *differences* made by the outputs that benefit our customers, the resources they manage and the people that utilize and benefit from these resources.



RELEVANCE

OUTCOME STORIES ARE QUALITATIVE MEASURES OF OUTCOMES

Our outcome Stories document changes in:

- Learning,
- Better Actions and,
- Improved conditions

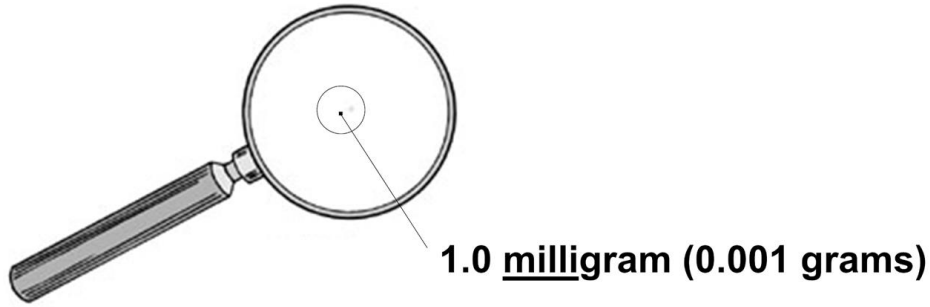
that emerge from NOAA internal investment in our efforts of direct engagement between users and researchers [NOA 216-115A: RESEARCH AND DEVELOPMENT IN NOAA].

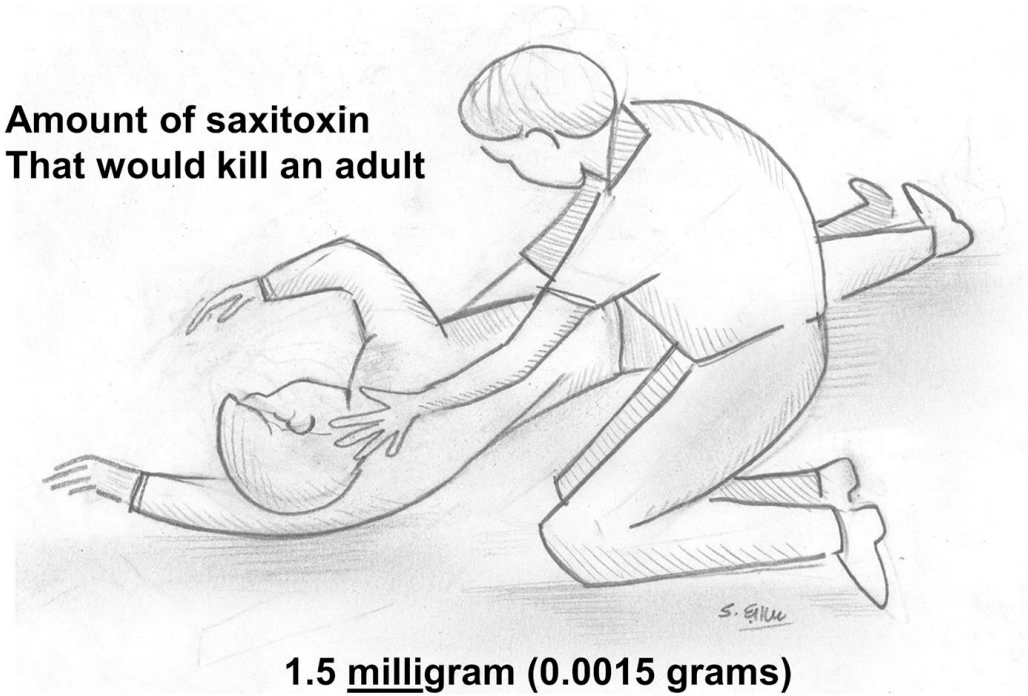
Any story captures an outcome at a specific point in time;
Outcomes continue to evolve for years after project completion

RELEVANCE

HAB Monitoring and Reference Branch- Case Outcome Story

Paralytic shellfish poisoning (PSP) is a world-wide, sometimes fatal seafood poisoning caused by potent algal neurotoxins that accumulate in shellfish. Both U.S. and international shellfish commerce regulations require testing for PST. The only approved testing method in the U.S. had been the mouse bioassay, until the Interstate Shellfish Sanitation Conference (ISSC) voted to accept a receptor binding assay, developed by NCCOS scientists, as an official method. This approval is the culmination of over a decade of effort to replace live animal testing for PSTs.





Timeline for transition to application for PSP high throughput receptor assay

RELEVANCE

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
DELIVERABLE	RL 1-2: basic and applied research					RL 3-5: proof-of-concept and system validation					RL 6: Demo in relevant test environment									RL 7: Demo in operational environment				RL 8-9: Finalized system/deployed routinely			
NEED	The original impetus for developing the method was a desire within the U.S. and internationally to develop assays to replace the existing live animal testing protocol, the mouse bioassay, used for regulatory testing of shellfish.					The transfer of the technology to developing countries begin when the Philippines experienced several human fatalities due to paralytic shellfish poisoning, and requested assistance from the U.N. for establishing testing procedures.					Within the U.S., individual states have requested training on the method at NCCOS (Florida, California) and a private company contracted to perform testing for FDA in offshore waters similarly requested training and assistance in setting up the assay in their lab									Regulatory approval is needed for the technology to be used in an operational environment.				Materials required to readily available by operational vendors and routine deployment demonstrated by operations			
IMPEDIMENT	Saxitoxins in shellfish have 23 different metabolites nearly impossible to determine by analytical methods.					Chemical Weapons Convention Ban prohibited transport of saxitoxin. Radiolabeled saxitoxin was not longer available.					In order to be accepted for regulatory use, extensive collaborative testing of methods is required, this requires single and interlaboratory validation studies requiring study design and carefully prepared materials									Regulatory approval and operational laboratories.				Receptor preparation requires homogeneity and worldwide access Routine deployment requires full operation by users			
RESOLUTION	The PSP receptor based assay was developed as an alternative to the mouse bioassay that eliminates the need for live animal testing for marine toxins. The PSP receptor assay detects each toxin in proportion to its potency and provides a summed total toxicity measurement.					STX calibration standard exempt from NRC regulations, FDA develops new radiolabel synthesis and IAEA opens import of radiolabeled saxitoxin. NCCOS conducts extensive evaluation of new products.					IAEA sponsors AOAC studies. NCCOS coordinates studies and prepares materials for multiple studies.									FDA works with NCCOS to establish regulatory approval				Test and validate Porcine preparation, [11-^{3}H] STX and NIST Reference Material 8642 calibrating solution			Set up laboratory in Alaska tribal nation; Encourage states to adapt method into regulatory laboratories
PARTNER	Wallac-Perkin Elmer					IAEA and FDA					CDPH			Testing Laboratories						FDA, ISSC, Resource Access International				Sigma-Aldrich, ARC, FDA, NIST		SEATOR, CDPH	
OUTPUT	The assay was also developed in high throughput format permitting analysis in an 8 x 12 array using a six-probe instrument designed by Wallac Corporation. The PSP receptor assay was published in 1997 with a comparison to the mouse bioassay					The International Atomic Energy Agency supported scientists from seven Southeast Asian nations, Philippines, Malaysia, Indonesia, Vietnam, Thailand, Pakistan, and China, to receive technical training and technology transfer on receptor assays for the family of toxins responsible for paralytic shellfish poisoning (PSP).					Optimization study published by CDPH and NCCOS J AOAC Int. (2003) 86 (4):737-741			Preliminary Interlaboratory Study (5 labs, seven shellfish samples)			AOAC International Collaborative Study (15 labs, 21 shellfish samples, multiple species from around the world SLV published J AOAC Int. (2009) 92:1706-1713			International Collaborative Study approved by AOAC and published J AOAC Int. (2012) 95(3):795-812		FDA guides ISSC approval and CODEX acceptance NCCOS transfers technology to Resource Access International		Saxitoxin kit for receptor binding assay: 50µCi [11-^{3}H]STX, 100µg saxitoxin dihydrochloride (RM) 60 vials porcine brain homogenate,		NCCOS guide and train operation of toxin testing laboratory in for SEATOR Publication of Regulatory Use by CDPH Food Addit Contam Chem Anal 2018 35(1):144-158.	
OUTCOME	An alternative to the mouse bioassay that eliminates the need for live animal testing for paralytic shellfish poisoning					NOAA, IAEA, and the FDA are concerted actions to develop and to validate a radioligand based method, the receptor binding assay (RBA).					California is the first state to evaluate PST receptor assay for future regulatory use			23 Member States in Africa, Asia, the Pacific region and Latin America are trained to use PST receptor method					AOAC Official Method of Analysis		U.S. Regulatory Approval Commercial Operation supports shellfish harvest in Gulf of Maine		All materials are commercially available worldwide		STAERL laboratory operation California independently published commercial materials provide accurate determination of PSTs in shellfish	

Outcomes from PSP receptor assay case report

RELEVANCE

Proposal for Task Force Consideration at the ISSC 2017 Biennial Meeting

a. ☒ Growing Area
b. ☐ Harvesting/Handling/Distribution
c. ☐ Administrative

Submitter	Pacific Rim Shellfish Sanitation Association
Affiliation	Sitka Tribe of Alaska
Address Line 1	456 Katlian St
Address Line 2	
City, State, Zip	Sitka, AK 99835
Phone	907-747-7356
Fax	907-747-4915
Email	michael.jamros@sitkatribe-nsn.gov
Proposal Subject	Matrix Expansion for the Receptor Binding Assay (RBA) for Paralytic Shellfish Poisoning (PSP) Toxicity Determination to Allow Use with Geoduck
Specific NSSP Guide Reference	Section IV, Chapter II.14 -- NSSP Approved Laboratory Tests (p. 261 Table 2. Approved Methods for Marine Biotoxin Testing -- footnote 2, and/or p. 263 Table 4. Limited Use Methods for Marine Biotoxin Testing -- footnote 5)
Text of Proposal/ Requested Action	This submission presents the 'Matrix Expansion for the Receptor Binding Assay (RBA) for Paralytic Shellfish Poisoning (PSP) Toxicity Determination to Allow Use with Geoduck' for consideration as an NSSP Approved Method for Marine Biotoxin Testing for PSP in Geoduck. The RBA is a competition-based assay that

Learning → Better Actions → Improved Conditions

Product Details

Saxitoxin kit for RBA testing

Tested for applicability under regulatory use
California Department of Public Health
Food Additives & Contaminants: Part A 2018

Specifications

Specific Activity:	
Synonym:	Saxitoxin kit for RBA testing includes 50uCi of STX [11-3H], 100ug STX dihydrochloride, 60 porcine b
Solvent:	Methanol (for 3H) | Ethanol (for unlabeled)
Concentration:	0.05 mCi/ml | 0.1 mg/ml
CAS Number:	Not available
Shipped in dry ice:	Yes
Exclusive:	ARC Exclusive
Reference:	Former ART 1301, ARCD 0741, ARCD 1301 components included

Ask a question about this product.

IAEA International Atomic Energy Agency

RBA for Red Tide Control: A Field Update

RELEVANCE

Afternoon presentations of outcomes showing changes in knowledge, practice and societal behavior

PRIORITY AREA 3: Volunteer observation opportunities through the Phytoplankton Monitoring Network human infrastructure to educate citizens, test new technologies, and inform managers of the onset of toxic bloom events; **STEVE MORTON: 1:00 PM Today**

NOS-EPA Agreement on HABs in freshwater lakes - ANTONIO BRAVO: 2:20 PM Today

PRIORITY AREA 4: New detection technologies, such as test kits, autonomous sensors, and portable field instruments that enable local observations to support operational and demonstration forecasts, and provide states, municipalities and tribal nations with the ability to identify and quantify HAB species and toxicity; **GREG DOUCETTE: 1:20 PM Today**

Monitoring and observations of HABs in Lake Erie- TIM DAVIS: 2:00 PM Today

PRIORITY AREA 5: Analytical methods and reference materials which leverage existing NCCOS expertise, will be advanced in concert with other federal agencies participating in the HABHRCA IWG to support the development of standardized methods and training for testing laboratories and validation of their use to assure accurate and reproducible measurements nationwide; **MAGGIE BROADWATER: 1:40 PM Today**

Building Capacity – Tribal laboratory networks and response capabilities- CHRIS WHITEHEAD: 3:45 PM Today

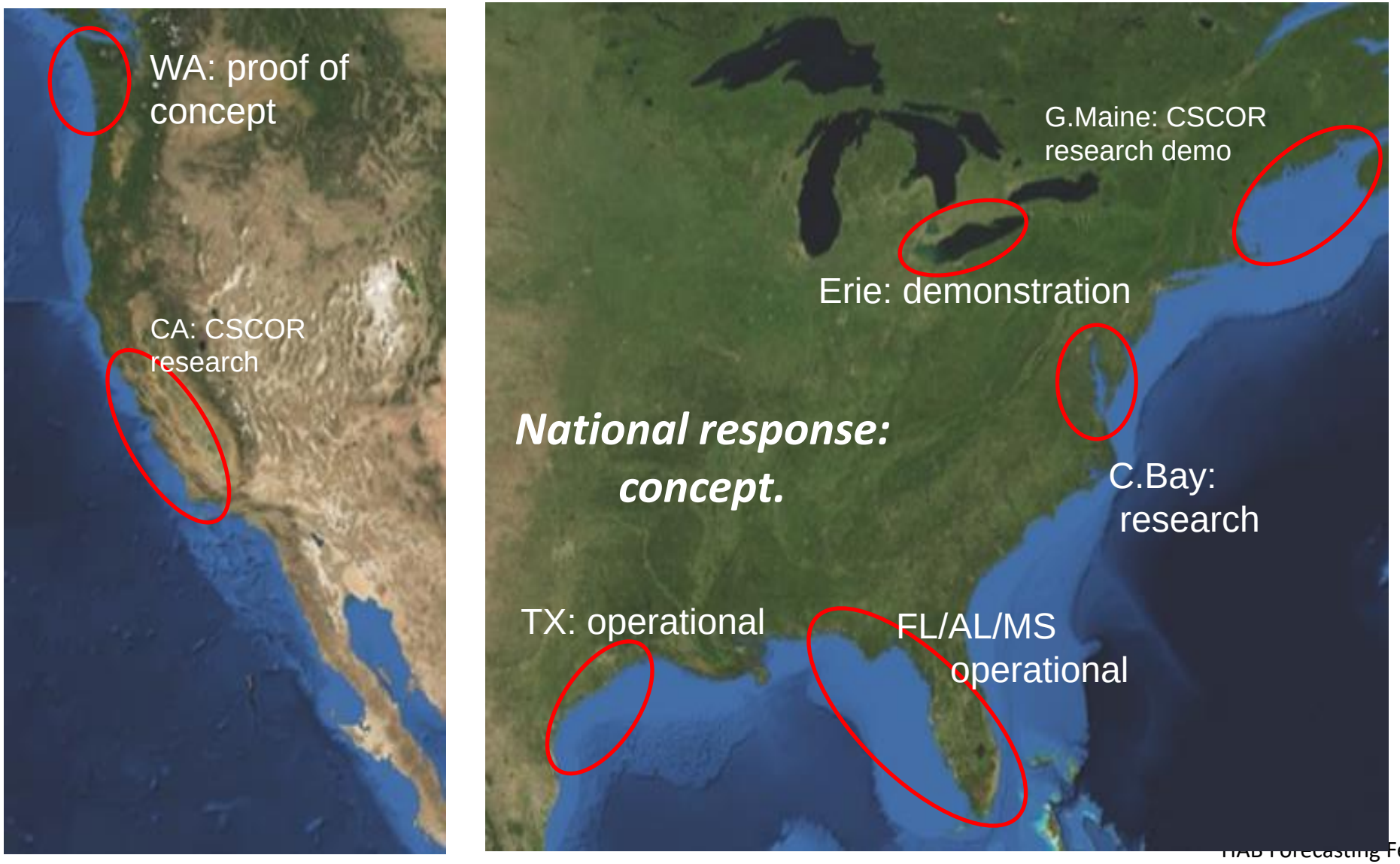
Building Capacity – International laboratories and NOS-IAEA Agreement – John Ramsdell 4:00 Today

Satellite imagery in HAB forecasting

Transition, operations, outreach

Rick Stumpf
NCCOS SDI HAB Forecasting Branch

In 2012, what were we doing?



Gulf of Mexico

We developed the bulletin content starting in 1999

New product and concept (Stumpf et al., 2001, 2003)

Chlorophyll “bloom” anomaly (ecological indicator)

Enhanced with Ensemble approach (Tomlinson et al., 2004; 2009)

Resuspension correction for Texas (Wynne et al., 2008)

Upwelling forecast (Stumpf et al., 2003) model (Lanerolle et al. 2005; Stumpf et al., 2008)

Harmful Algal Bloom Forecast System, shift from SeaWiFS original to MODIS in 2010

Page 1

Gulf of Mexico Harmful Algal Bloom Bulletin

21 September 2004

National Ocean Service/NCCOS and CSC

NESDIS/CoastWatch and NDBC

Last bulletin: September 17, 2004

Analysis

HAB Forecast:

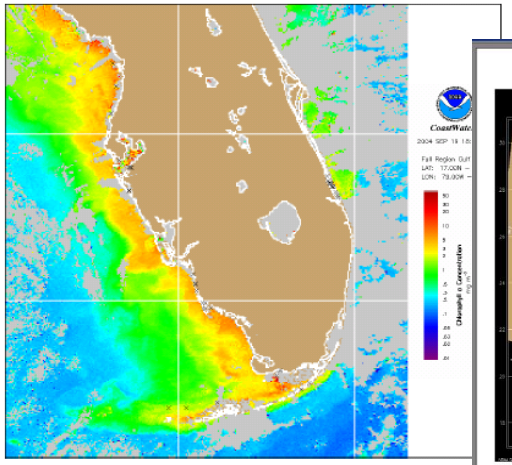
No harmful algal blooms have been found along Florida's coast. Recent tropical storms have caused sediment resuspension and non-harmful blooms, which may cause discolored water.

Analysis:

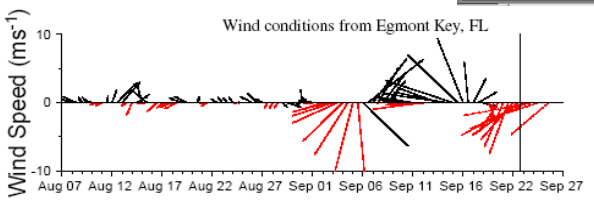
Samples taken last week from southwest Florida near Sarasota, Fort Meyers, and Naples showed no Karenia brevis. Imagery shows elevated chlorophyll along much of Florida's west coast: concentrations over 4 micrograms per liter off Cape San Blas and Cedar Key; over 5 micrograms per liter near Clearwater, Sarasota, Naples; and over 7 micrograms per liter Everglades City.

Winds have favored upwelling in southwest Florida for several days and are forecasted to continue for the rest of the week and through the weekend. These conditions are conducive to HAB formation, so this area should be monitored. Sampling here is recommended. Conditions in the panhandle don't favor HAB formation.

Bronder, Stolz



Chlorophyll concentration from satellite with possible HAB areas sh
tion sampling data from September 12, 2004 shown as red squares (h
monds (low b), red circles (low a), orange circles (very low b), yellov
(present), and black "X" (not present).



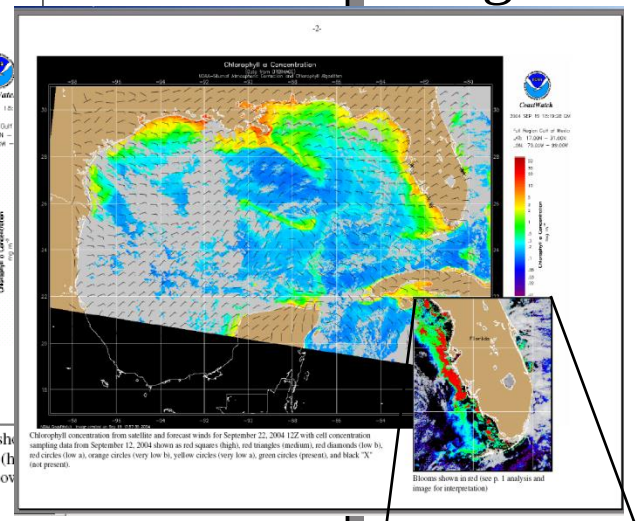
Wind speed and direction are averaged over 12 hours from measurements made on buoys. Length of line indicates speed; angle indicates direction. Red indicates that the wind direction favors upwelling near the coast. Values to the left of the dotted vertical line are measured values; values to the right are forecasts.

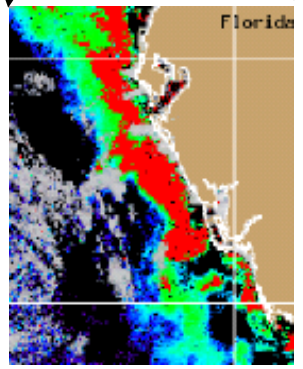
Southwest Florida: Winds have been northeasterly for the past few days, and are forecasted to shift to easterly then northeasterly over the next couple of days. The NWS Marine Forecast calls for easterly winds until Thursday, then northeasterly winds over the weekend. Florida Panhandle: Winds have been northeasterly for the past few days, and are forecasted to become easterly for the next couple of days.

Please note the following restrictions on all SeaWiFS imagery derived from CoastWatch.

1. These data are restricted to civil marine applications only; i.e. federal, state, and local government use/distribution is permitted .
2. Distribution for military, or commercial purposes is NOT permitted.
3. There are restrictions on Internet/Web/public posting of these data.
4. Image products may be published in newspapers. Any other publishing arrangements must receive OrbImage approval via the CoastWatch Program.

Page 2

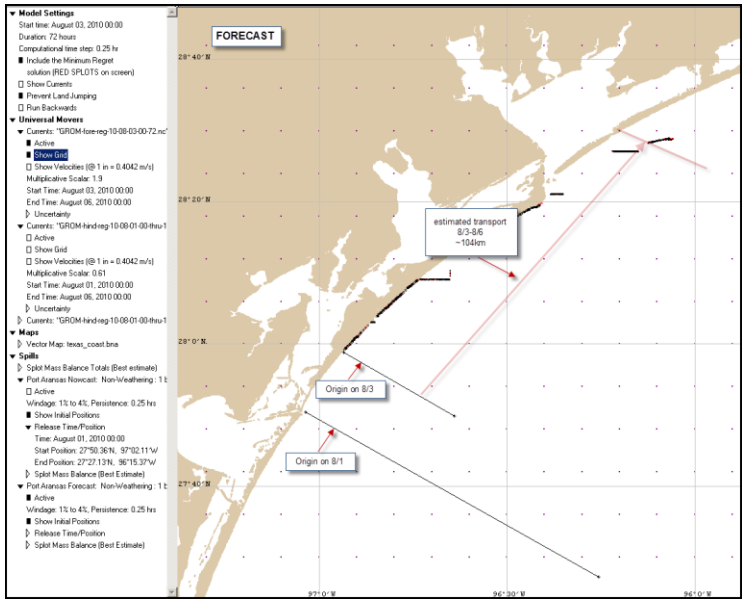




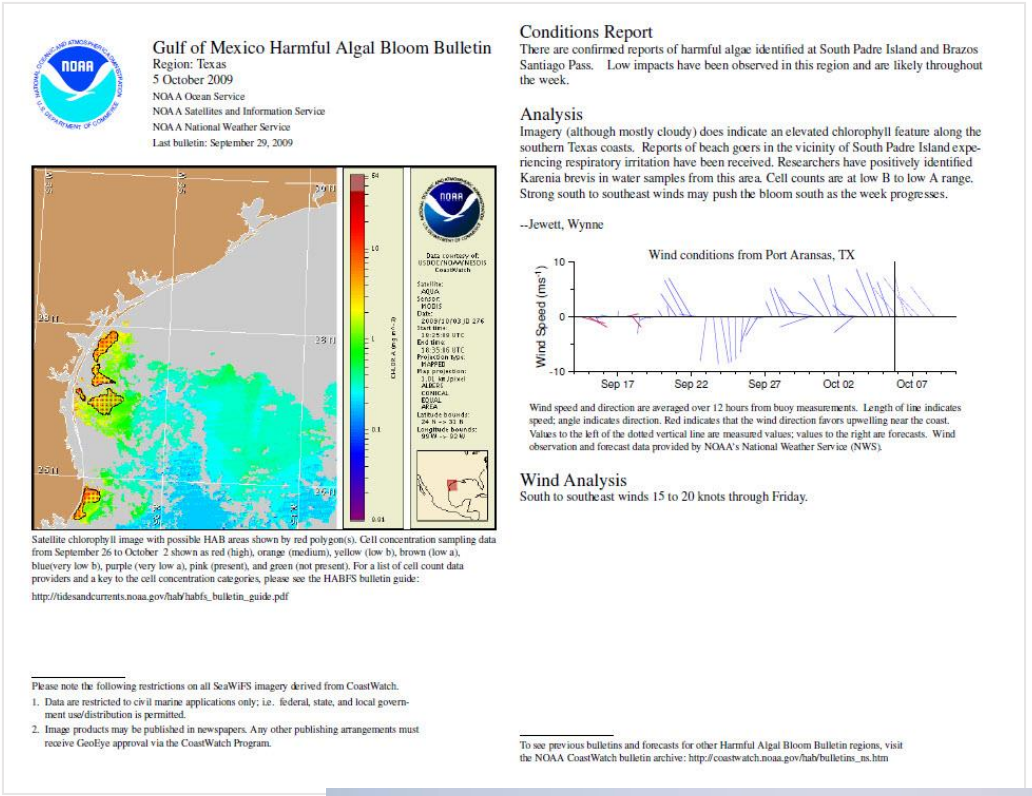
http://www.tidesandcurrents.noaa.gov/hab/

Texas Operational, Sep 2010

- *Demonstration started in CCMA in 2005. Bulletins distributed across Texas, coordinated closely with the state.*



Transport along coast:
Using TGLO model,
TABS buoys for model adjustment,
and GNOME for transport.



Gulf of Mexico Harmful Algal Bloom Bulletin
Region: Texas
5 October 2009
NOAA Ocean Service
NOAA Satellites and Information Service
NOAA National Weather Service
Last bulletin: September 29, 2009

Satellite chlorophyll image with possible HAB areas shown by red polygon(s). Cell concentration sampling data from September 26 to October 2 shown as red (high), orange (medium), yellow (low b), brown (low a), blue(very low b), purple (very low a), pink (present), and green (not present). For a list of cell count data providers and a key to the cell concentration categories, please see the HABFS bulletin guide:
http://tidesandcurrents.noaa.gov/hab/habfs_bulletin_guide.pdf

Please note the following restrictions on all SeaWiFS imagery derived from CoastWatch.
1. Data are restricted to civil marine applications only; i.e. federal, state, and local government use/distribution is permitted.
2. Image products may be published in newspapers. Any other publishing arrangements must receive GeoEye approval via the CoastWatch Program.

Conditions Report
There are confirmed reports of harmful algae identified at South Padre Island and Brazos Santiago Pass. Low impacts have been observed in this region and are likely throughout the week.

Analysis
Imagery (although mostly cloudy) does indicate an elevated chlorophyll feature along the southern Texas coasts. Reports of beach goers in the vicinity of South Padre Island experiencing respiratory irritation have been received. Researchers have positively identified Karenia brevis in water samples from this area. Cell counts are at low B to low A range. Strong south to southeast winds may push the bloom south as the week progresses.

--Jewett, Wynne

Wind conditions from Port Aransas, TX

Wind speed and direction are averaged over 12 hours from buoy measurements. Length of line indicates speed; angle indicates direction. Red indicates that the wind direction favors upwelling near the coast. Values to the left of the dotted vertical line are measured values; values to the right are forecasts. Wind observation and forecast data provided by NOAA's National Weather Service (NWS).

Wind Analysis
South to southeast winds 15 to 20 knots through Friday.

To see previous bulletins and forecasts for other Harmful Algal Bloom Bulletin regions, visit the NOAA CoastWatch bulletin archive: http://coastwatch.noaa.gov/hab/bulletins_ns.htm

Supporting routine cleaning of Flow Cytobot, at Aransas Pass , a research instrument that provided initial identification of the last three blooms.
Goal: demonstrate enhancement of forecasts.

Gulf of Mexico

We developed the bulletin content starting in 1999

CoastWatch implementation for G.Mexico (1999, 2002)

national anomaly with NOAA-20 (Coastwatch/OceanWatch)

New product and concept (Stumpf et al., 2001, 2003)

Chlorophyll “bloom” anomaly (ecological indicator)

2015, Enhanced with Ensemble approach (Tomlinson et al., 2004; 2009)

Resuspension correction for Texas (Wynne et al., 2008)

Upwelling forecast (Stumpf et al., 2003) model (Lanerolle et al. 2005; Stumpf et al., 2008)

What's next for Florida and Texas

- The problem. Respiratory forecast for Karenia red tide.
- NASA Public Health and Air Quality Program funded project.
- Why now? Technology and models
  - Smartphones
  - Resolution: NWS drastically increased model and forecast resolution (WRF, NDFD, etc.)
  - We were busy for a bunch of years (more later)

Satellite, HABscope and modeling for respiratory irritation in *Karenia brevis* (red tide) outbreaks

GCOOS
GULF OF MEXICO
COASTAL OCEAN
OBSERVING SYSTEM

NOAA
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

TAMU
OCEANOGRAPHY

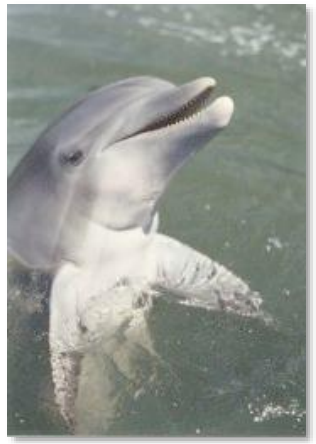
MOTE MARINE LABORATORY

NASA
Applied Sciences Program
NASA Earth Science

Florida Red Tide

Toxic *Karenia brevis* blooms

- Around Gulf of Mexico from Mexico to Florida.
- Late summer/early fall to year long
- Brevetoxins, sodium channel activators
- Toxin kills fish, birds, dolphins and manatees
- Neurotoxic shellfish poisoning
  - Commercial is closely monitored, recreational must follow warnings
- Economic losses in Florida and Texas
- **Respiratory illness in humans**



Toxic Aerosols

- Toxins can aerosolize - particles 3-20 µm range
- Healthy people: upper airway irritant. Coughing water eyes, sinus pain
- People with chronic respiratory illness (like asthma)
    - Toxins are a trigger
- Swimming risk not well known
    - Anecdotal, skin rashes, swelling of lips and eyes

Effects of Exposure

Asthmatics 9% of population

One hour walk on the beach during a red tide; 5 days for pulmonary function reach baseline

54% increase in ER respiratory (asthma, pneumonia, bronchitis)

Sarasota County alone, ER costs increase up to $4 million, depending on bloom severity

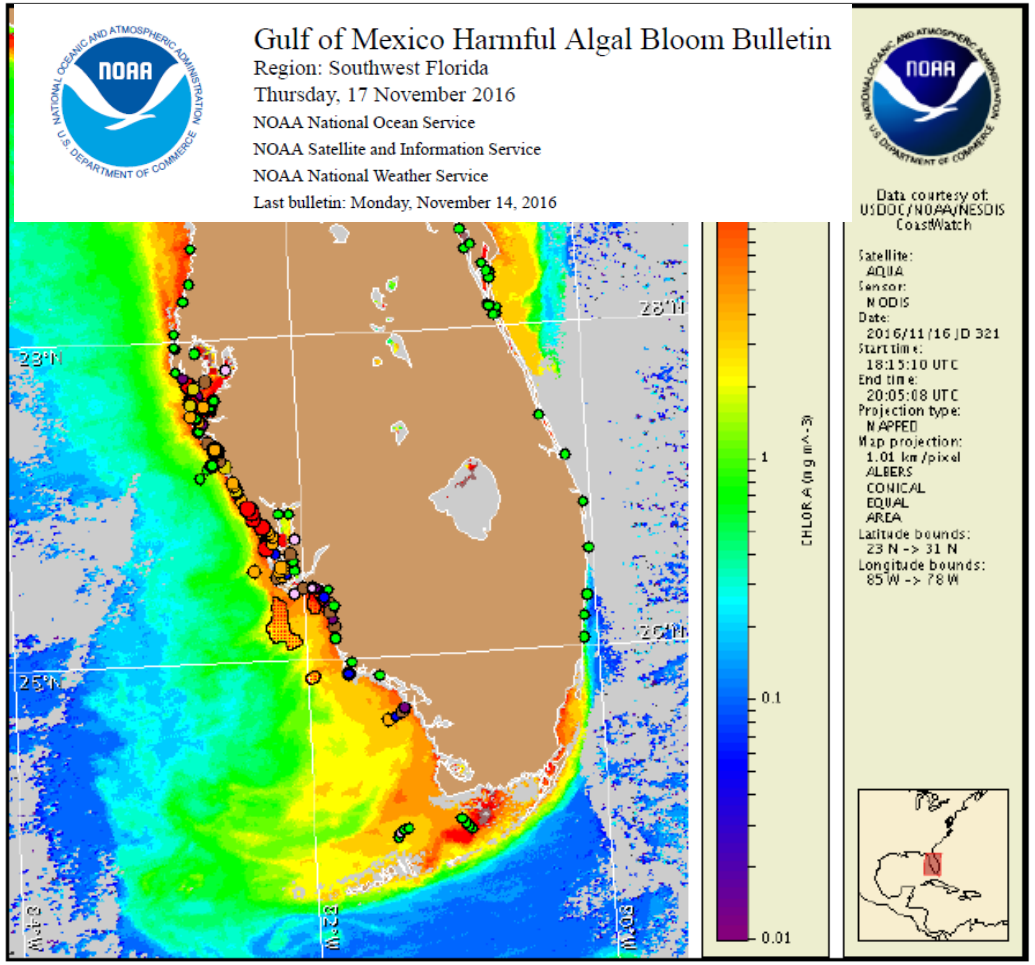
Lifeguards (occupational healthy group) - no pulmonary function measurable effect

Loss revenue to area businesses ($6 million/month per county)

Critical need to accurately warn the public

Everyone reacts, useful indicator exposure

NOAA HAB forecast system bulletin



Satellite chlorophyll image with possible *K. brevis* HAB areas shown by red polygon(s), when applicable
Points represent cell concentration sampling data from November 7 to 15: red (high), orange (medium),

Conditions Report

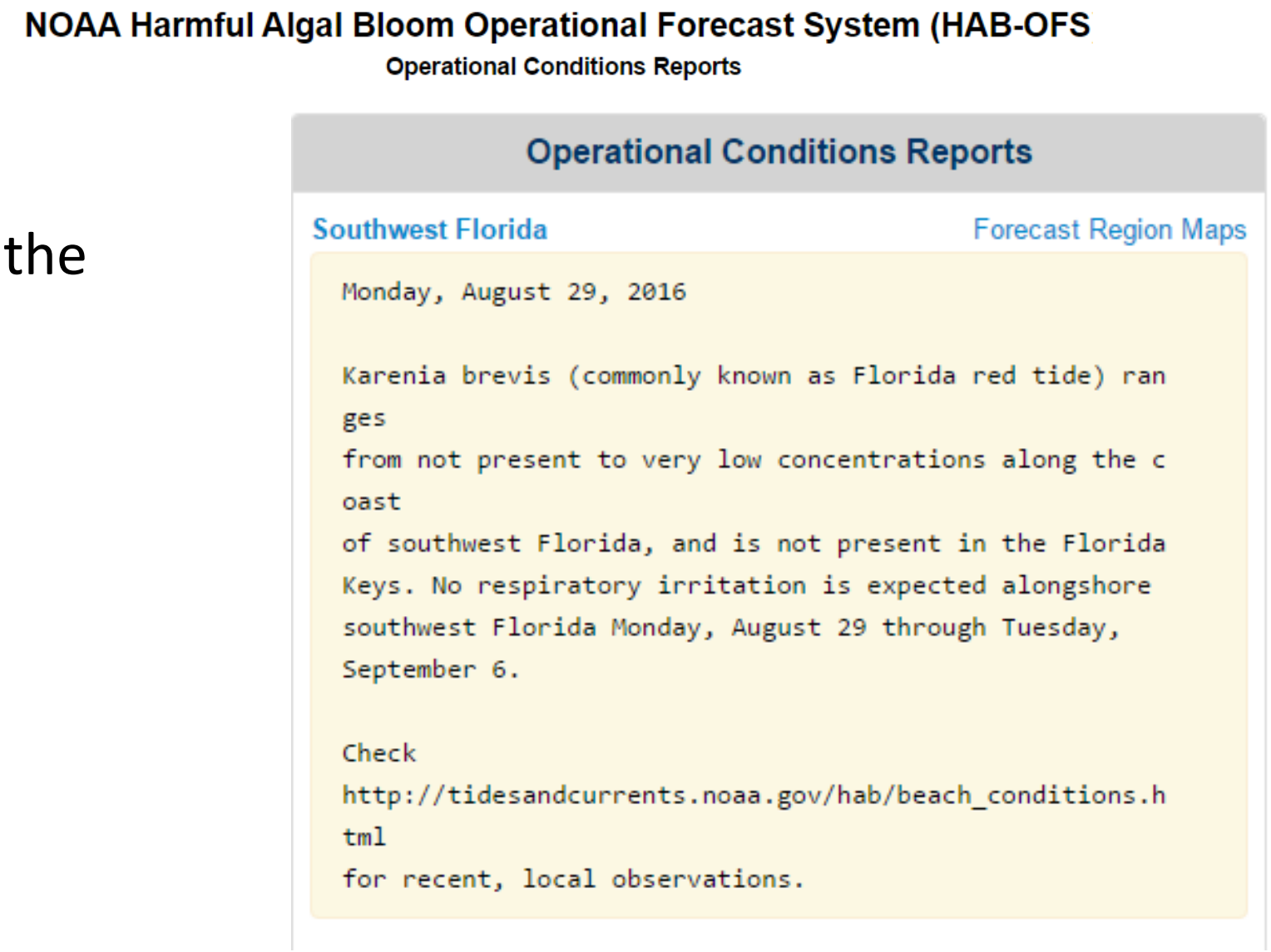
Not present to high concentrations of *Karenia brevis* (commonly known as Florida red tide) are present along- and offshore portions of southwest Florida, and not present in the Florida Keys. *K. brevis* concentrations are patchy in nature and levels of respiratory irritation will vary locally based upon nearby bloom concentrations, ocean currents, and wind speed and direction. The highest level of potential respiratory irritation forecast for Thursday, November 17 through Monday, November 21 is listed below:

County Region: Forecast (Duration)
Southern Pinellas: Low (Th-M)
Southern Pinellas, bay regions: Moderate (Th-M)
Northern Manatee, bay regions: High (Th-M)
Southern Manatee: Very Low (Th-M)
Southern Manatee, bay regions: Moderate (Th-F, M), High (Sa-Su)
Northern Sarasota: Moderate (Th-M)
Northern Sarasota, bay regions: High (Th-M)
Southern Sarasota: Low (Th-M)
Southern Sarasota, bay regions: High (Th-M)
Northern Charlotte: Low (Th-M)
Northern Charlotte, bay regions: High (Th-M)
Southern Charlotte: Low (Th-M)
Southern Charlotte, bay regions: High (Th-M)
Northern Lee: Low (Th-M)
Northern Lee, bay regions: Moderate (Th-M)
Central Lee: Low (Th-M)
Central Lee, bay regions: Moderate (Th-M)
Southern Lee: Very Low (M-Th)
Southern Lee, bay regions: Low (Th-M)
Northern Collier: Low (Th-M)
Central Collier: Very Low (Th-M)
All Other SWFL County Regions: None expected (Th-M)

NOAA started demo in 1999. In 2004, bulletin made operational in Florida.
tidesandcurrents.noaa.gov/hab/beach_conditions.html

Current respiratory warning

- Warnings are by the county and vague over the day.
- Blooms are patchy and winds change.
- How patchy?



NOAA Harmful Algal Bloom Operational Forecast System (HAB-OFS

Operational Conditions Reports

Operational Conditions Reports

Southwest Florida — Forecast Region Maps

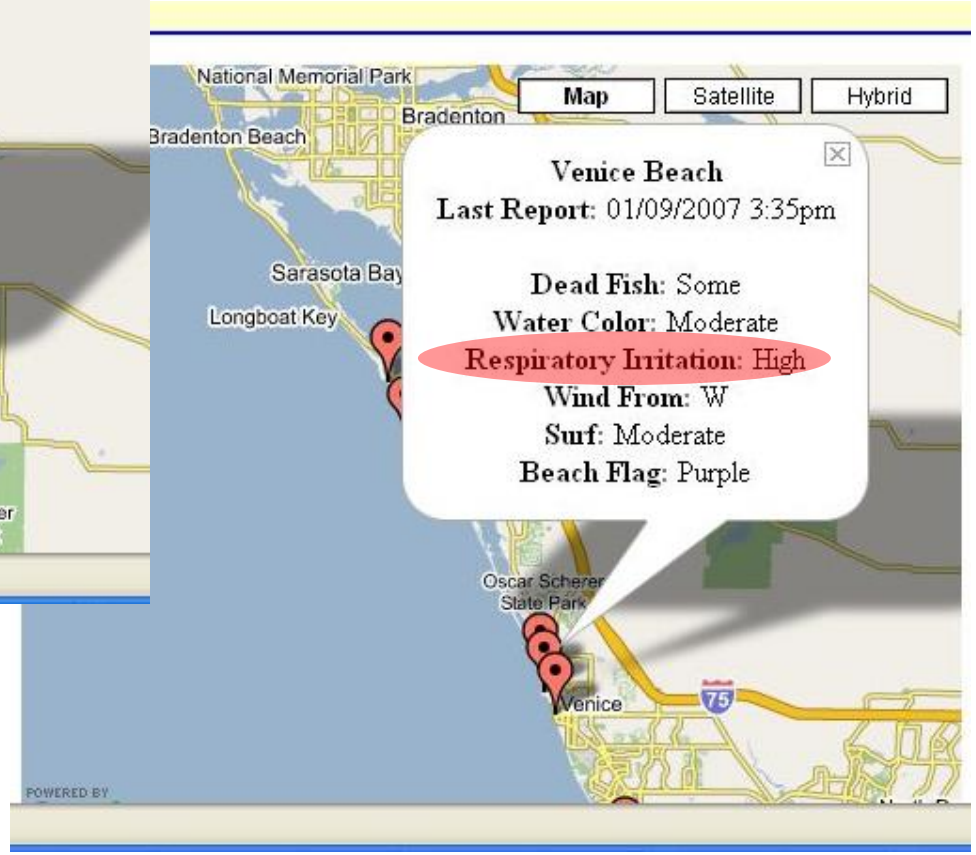
Monday, August 29, 2016

Karenia brevis (commonly known as Florida red tide) ranges from not present to very low concentrations along the coast of southwest Florida, and is not present in the Florida Keys. No respiratory irritation is expected alongshore southwest Florida Monday, August 29 through Tuesday, September 6.

Check http://tidesandcurrents.noaa.gov/hab/beach_conditions.html for recent, local observations.

Cell concentration patchy from beach to beach

Wind speed and direction variable



County level forecast right 78%

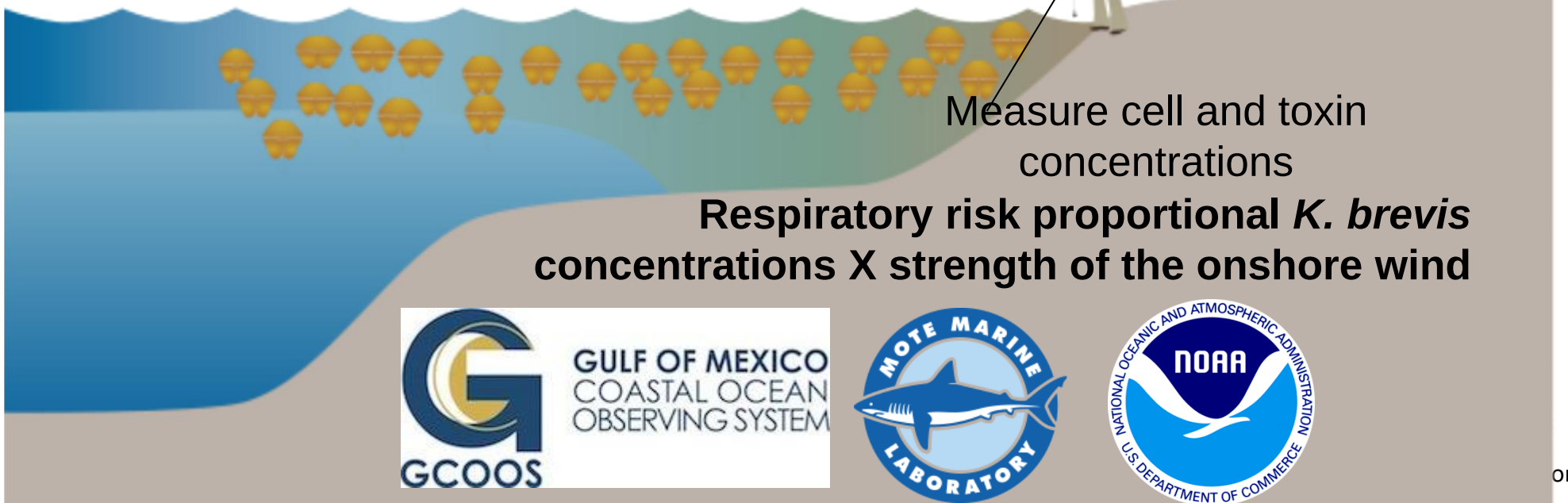
Applied to individual beaches, right 20%

Strategy: Use satellite data to inform sampling to improve resolution with volunteer monitoring. goal of "every beach, every day"

Satellite identifies Bloom area

Local wind field models

Provide near real-time exposure levels



Measure cell and toxin concentrations

Respiratory risk proportional *K. brevis* concentrations X strength of the onshore wind

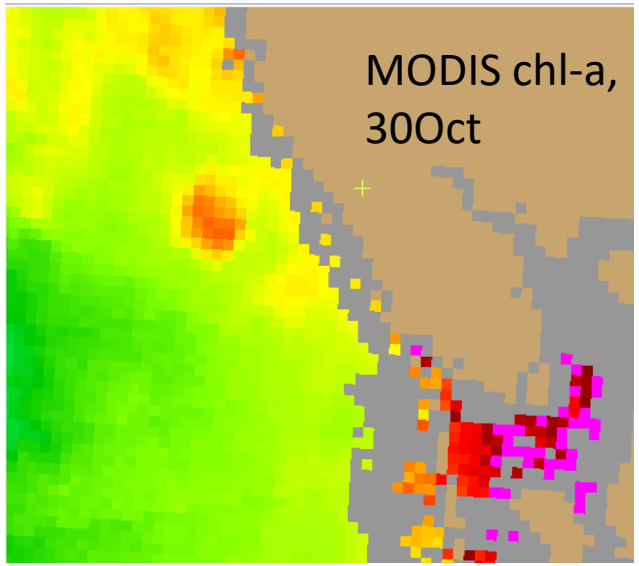
GULF OF MEXICO COASTAL OCEAN OBSERVING SYSTEM GCOOS

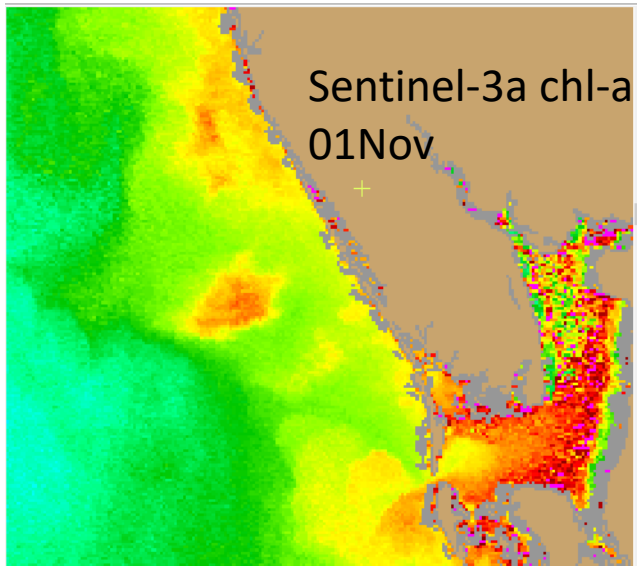
MOTE MARINE LABORATORY

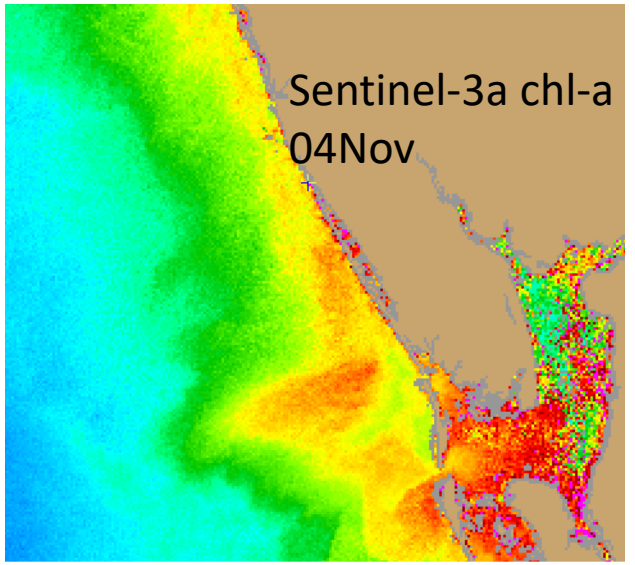
NOAA NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION U.S. DEPARTMENT OF COMMERCE

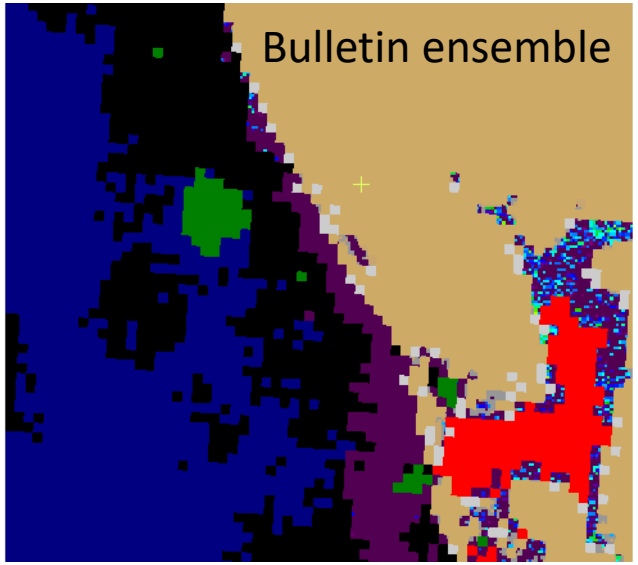
orecasting Feb 2018

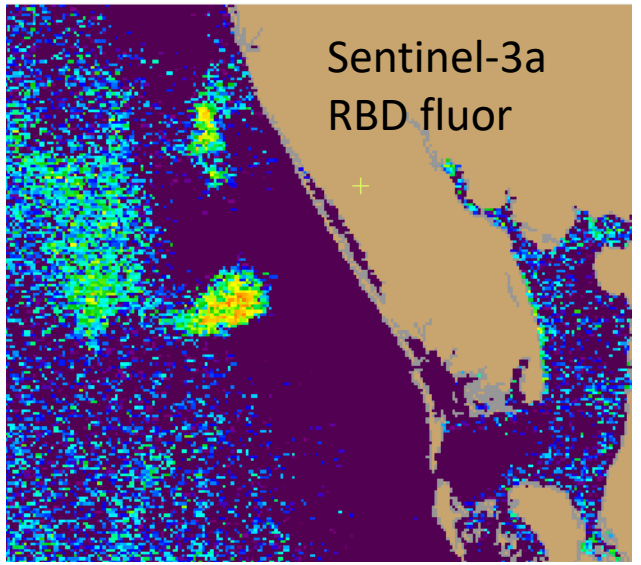
Satellite bloom detection 2017, real time

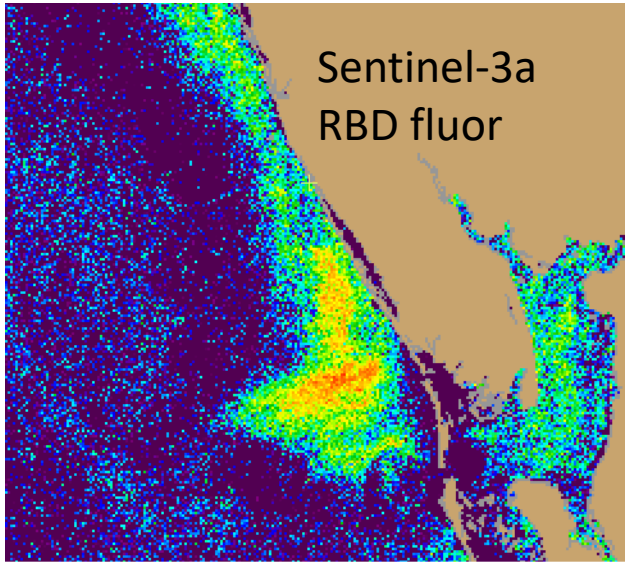












Feb 2018

Entire package of monitoring: satellite, field, and models

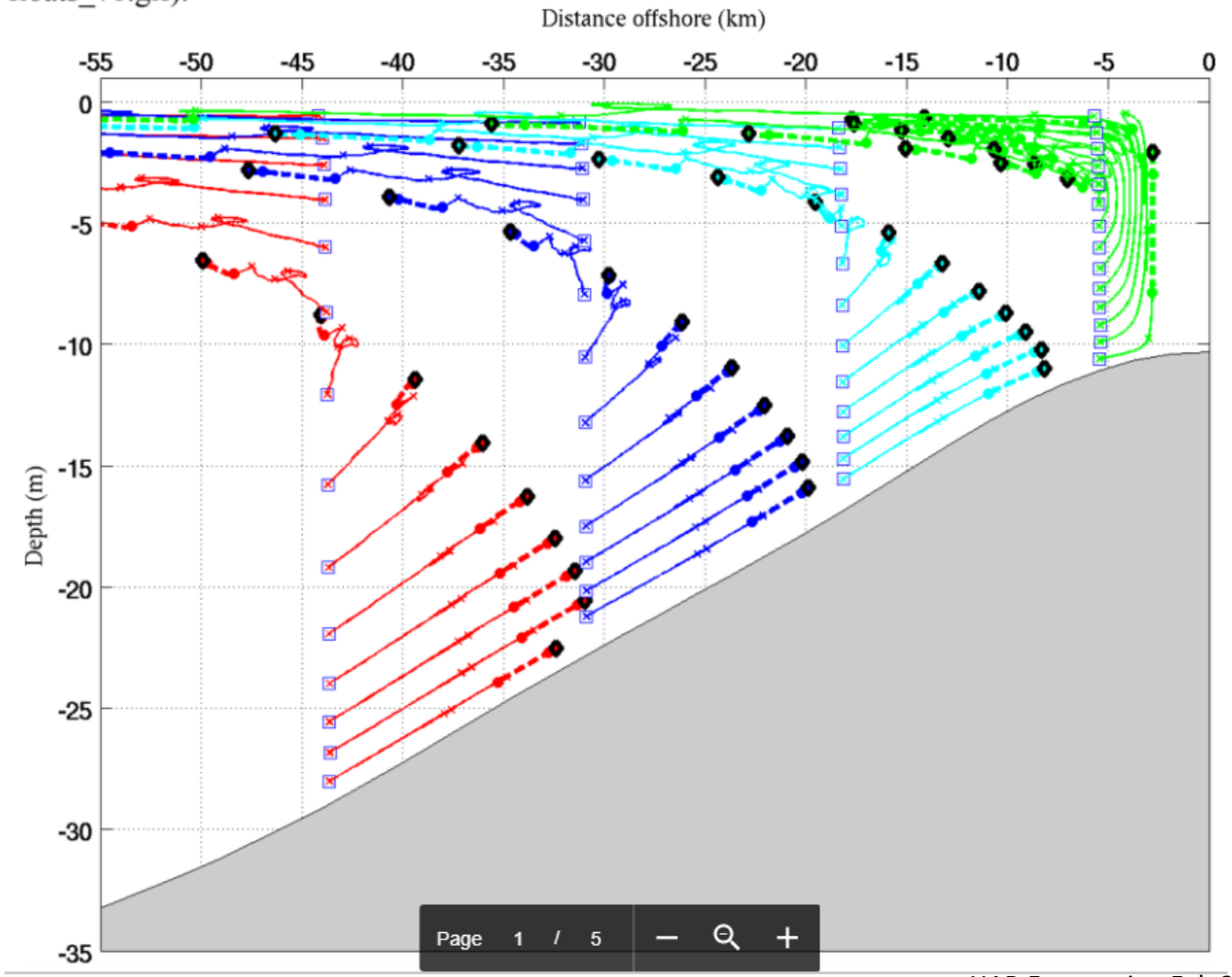
- Upwelling model, addresses ecological conditions
- Are conditions favorable for a bloom to be Karenia?

Simulation Period: **October 16 12am- November 2 12pm, 2017**; Particle Release date: **October 195, 2017**

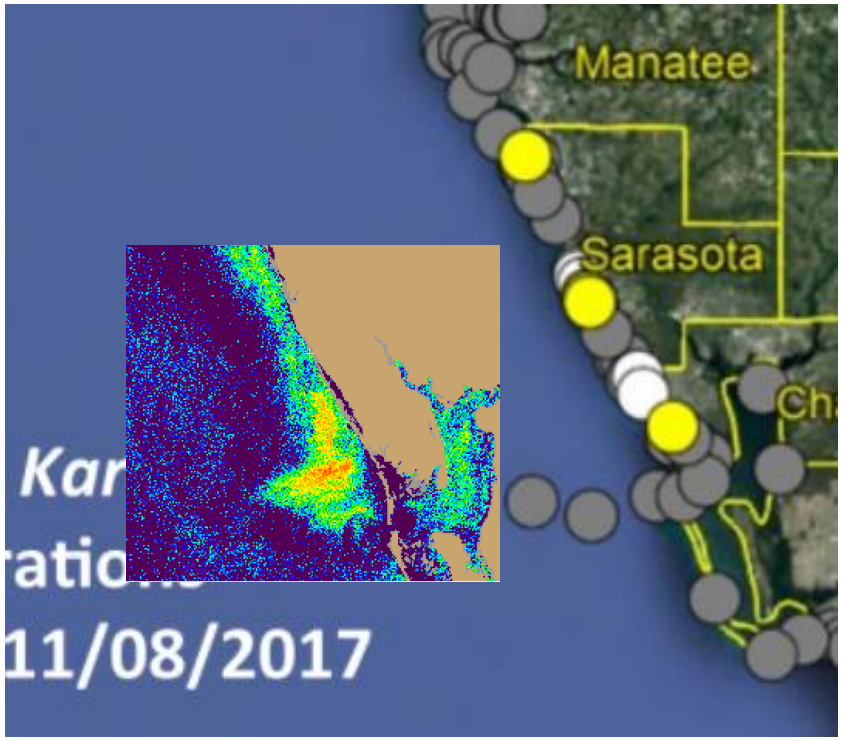
s highlighting the coastal upwelling are described below (see appendix for model details).

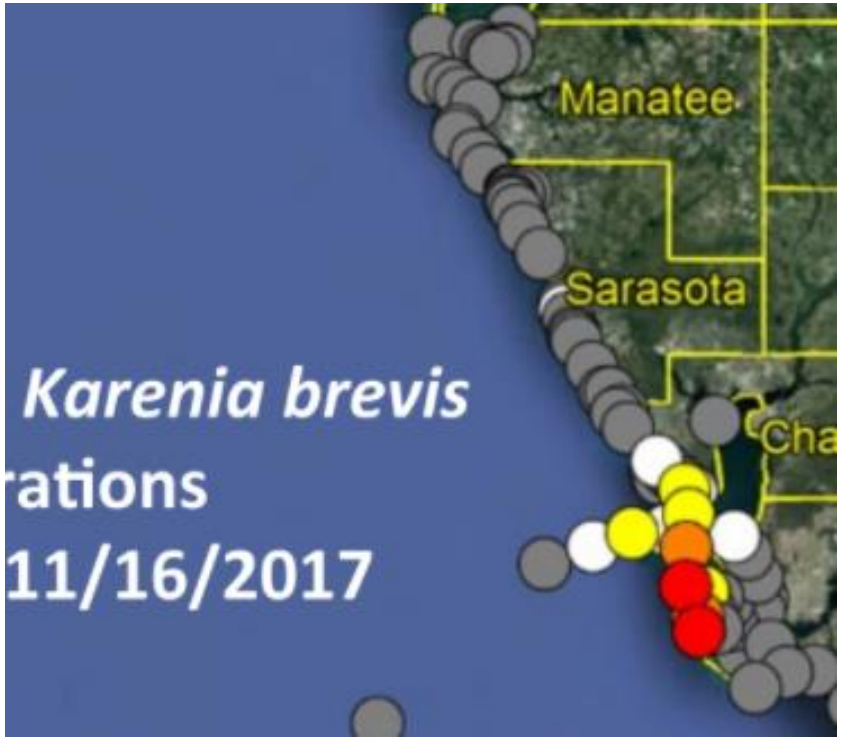
s

le trajectories was upwelling-favorable for the past 7 days, and such upwelling trend will contin
floats_v1.gif).



Development of bloom follows upwelling model and satellite detection





3-D model 11/03 (From FWRI)

predict southern, offshore movement of surface waters and southern, onshore movement of subsurface waters from Pinellas to Lee counties over the next three days.

Volunteer Observer System

- Portable scope system for volunteers
- Prototype completed. 3D print mounting
- iPod extraction & GPS
- Portable WiFi communication for data
- Automated detection, shape and swimming used to quantify cells

https://www.youtube.com/watch?v=tpA6x9FvBJE

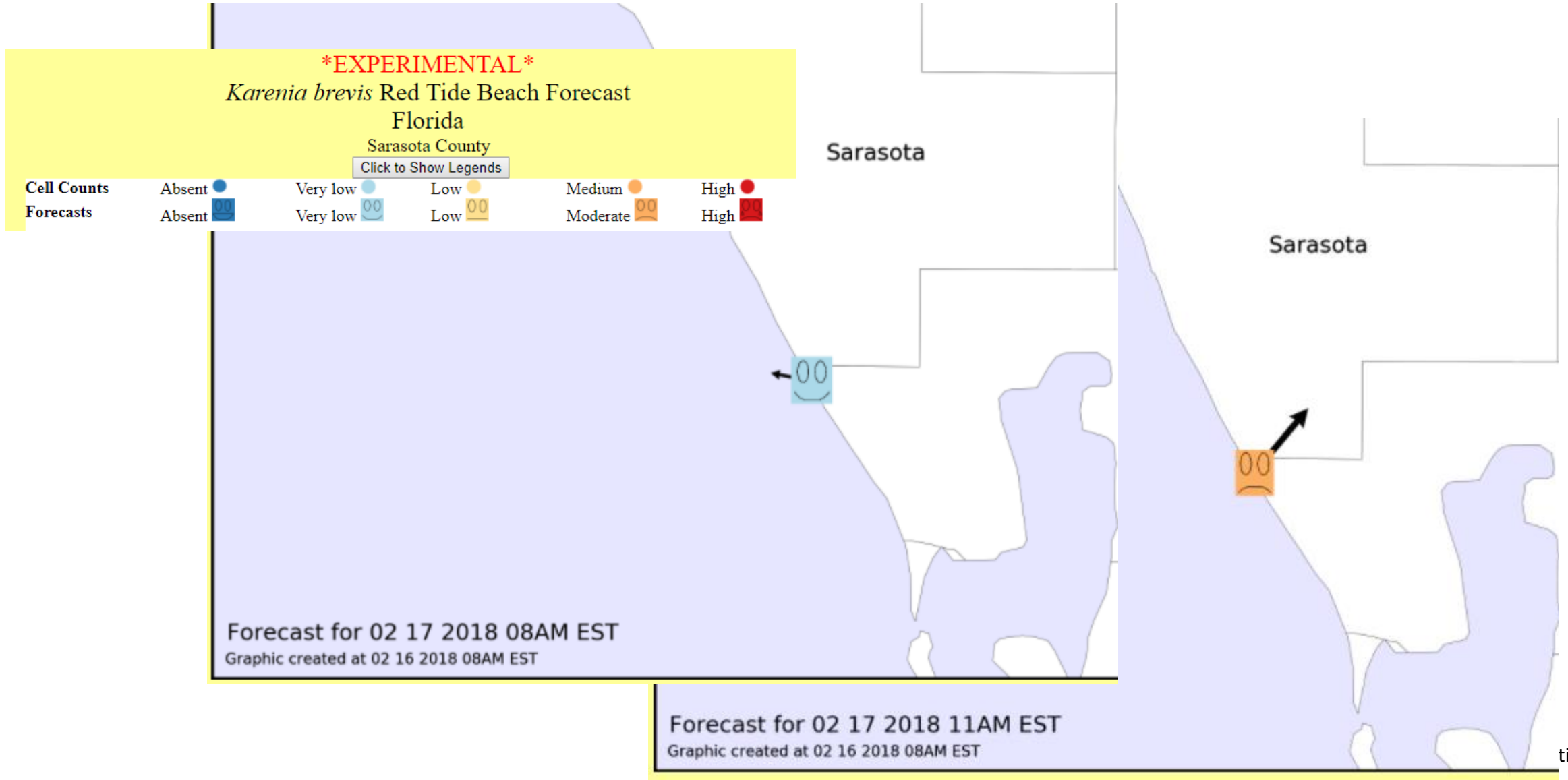
Volunteer Networks

Mote Marine Lab, Education Dept

Texas Red Tide Rangers (program of Texas Sea Grant and Texas Parks & Wildlife Dept, TPWD)

Example HABscope detection

HABscope data now available within ½ hour updates every 3 hrs. Goal: “every beach, every day”.



ting Feb 2018

Upcoming papers (with TAMU, Mote)

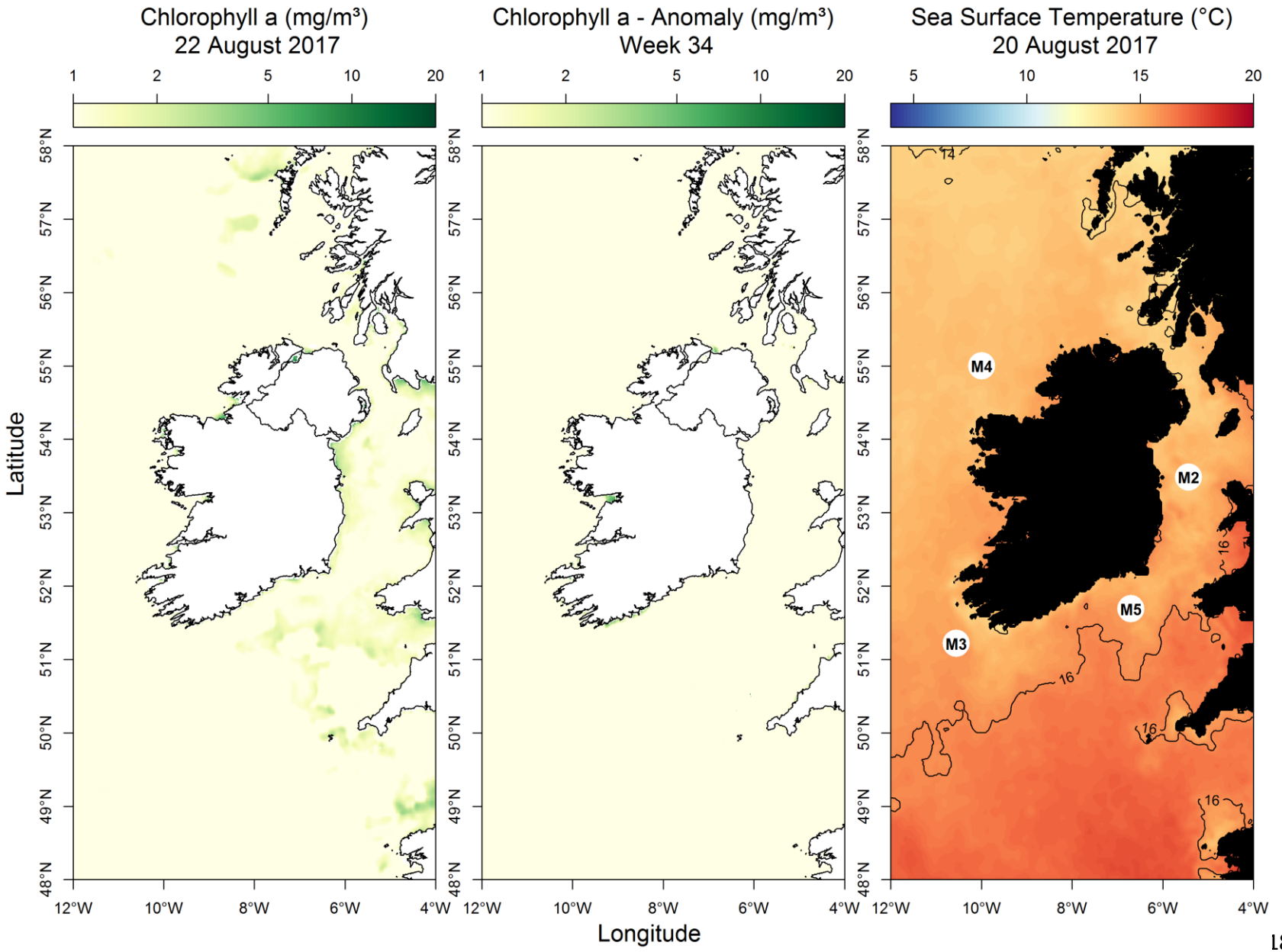
- HABscope method
- HABscope community
- Severity metric for Florida (with wind impacts)
- Respiratory model evaluation

https://www.star.nesdis.noaa.gov/sod/mecb/color/ocview/ocview.html

Live forecasts using our methods are being applied elsewhere.

Advice on how to use the method and scripts to facilitate to develop the tool was provided to EU scientists.

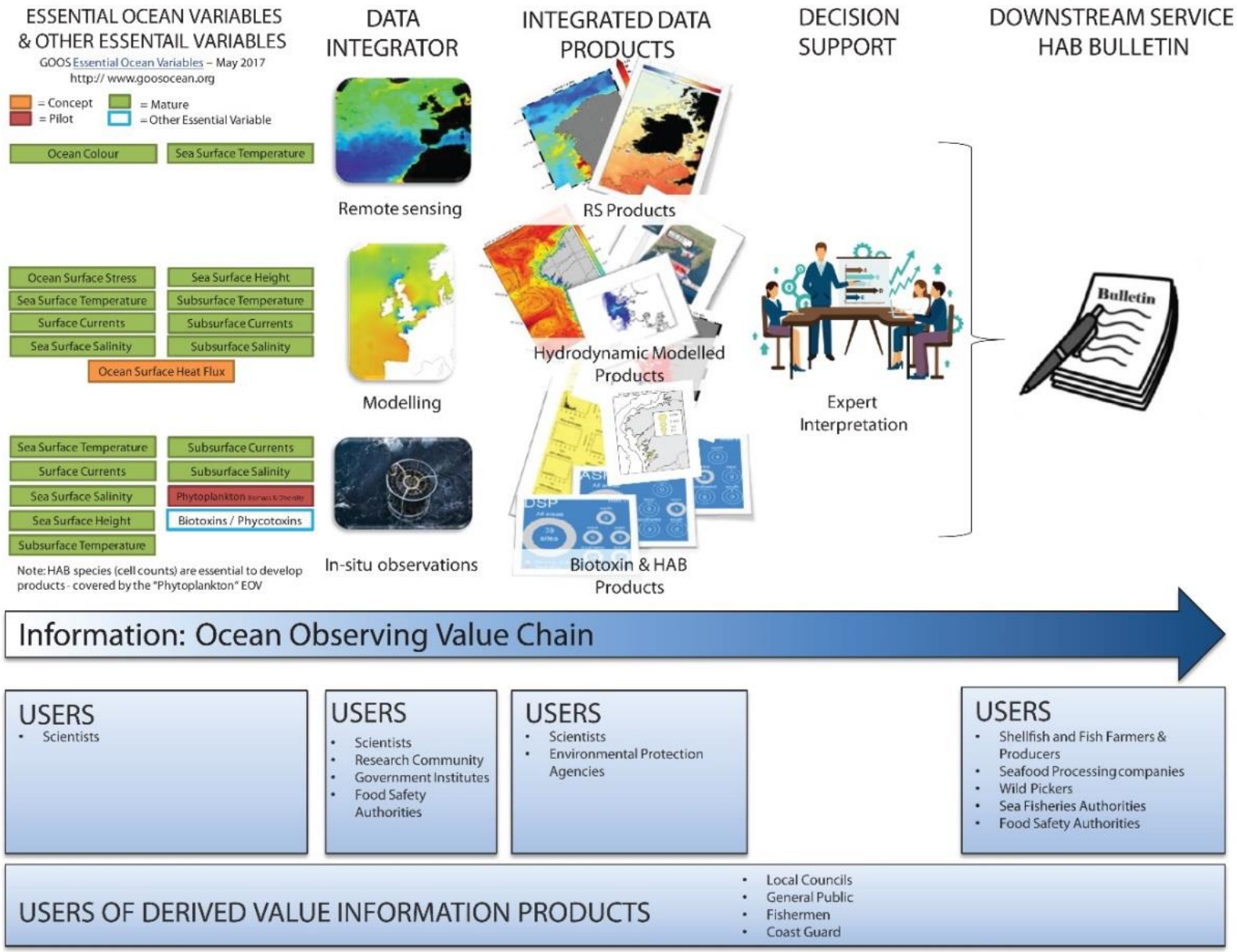
Marine Institute
Foras na Mara



NOAA – EU collaboration in the design, implementation and benefit sharing of downstream services

- Advisors to the the EU FP7 ASIMUTH project (2011-2013) Scientific Steering Committee on structure & content of the HAB bulletin, initiated knowledge exchange and know-how related to satellite data processing

- In the recently started JPI climate ERA4CS CoCliME project (2017-2020) the existing HAB bulletin process is being used as a basis for developing a climate service for the aquaculture industry. Michelle Tomlinson, as a member of the Scientific Advisory Board, will continue to provide advice to EU colleagues



Cyanobacteria. Starting with Lake Erie

In 2011. Total annual phosphorus was likely cause of blooms.

Limited estimate of intensity

Weekly bulletin for blooms. Converted from 1 km MERIS to 300 m MERIS in 2010, 2011.

Lake Erie weekly Bulletin in 2011

Experimental
Lake Erie Harmful Algal Bloom Bulletin
2011-008
08 September 2011
National Ocean Service
Great Lakes Environmental Research Laboratory
Last bulletin: 22 July 2011

Bloom from satellite

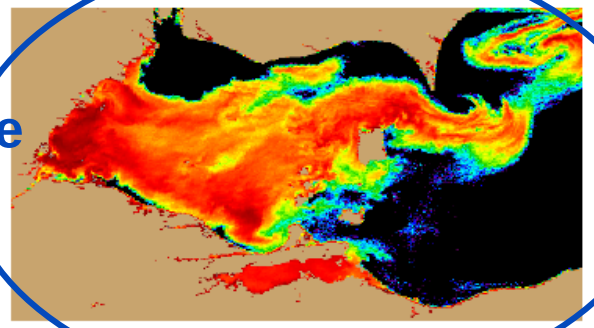


Figure 1. MERIS image from the European Space Agency. Imagery shows the spectral shape at 681 nm from September 03, where colored pixels indicate the likelihood of the last known position of the *Microcystis* spp. bloom (with red being the highest concentration). *Microcystis* spp. abundance data from shown as white squares (very high), circles (high), diamonds (medium), triangles (low) , + (very low) and X (not present).

forecast

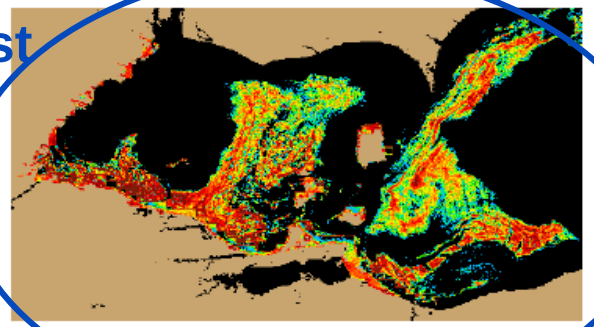


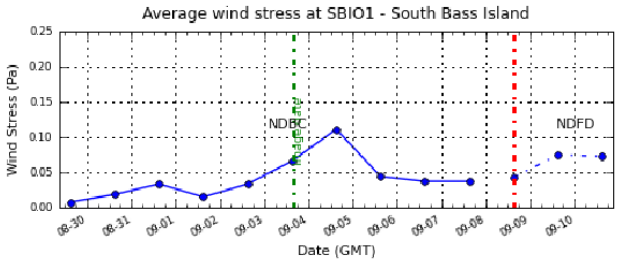
Figure 2. Nowcast position of *Microcystis* spp. bloom for September 08 using GLCFS modeled currents t move the bloom from the September 03 image.

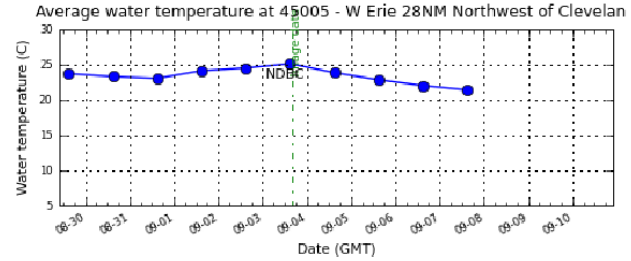
Conditions: A massive *Microcystis* bloom persists throughout most of Lake Erie's Western Basin.

Analysis: As indicated in satellite imagery from Saturday (9/3/2011), an enormous *Microcystis* bloom was present in western Lake Erie. The southern extent of the bloom was remotely observed along the coast of Ohio from Maumee Bay to Catawba Island. The northern extent of the bloom was observed to be consistent along the Michigan coast from Northern Maumee Bay to the mouth of the Detroit River. The eastern-most portion of the bloom was observed past Point Pelee and to the northeast up in to Rondeau Provincial Park.

At the mouth of the Detroit River, a five day nowcast shows a southward suppression of the western-most portions of the bloom. However, the bloom is likely to still persist in much of the Western Basin. The nowcast also suggest the bloom has spread to the east of Sandusky and into the Cleveland area. **(Note: Due to a lack of clear imagery the bloom has not been remotely observed in the Cleveland area.)** A three day forecast also suggests that the bloom will persist to the north of Cleveland through the weekend. Water temperatures remain above 20 degrees Celsius and are forecast to decrease into the weekend; however, conditions remain favorable for bloom growth.

Briggs, Wynne





2012. Stumpf, Wynne, Baker, and Fahnenstiel, PLoSONE. Interannual variability of cyanobacterial blooms in Lake Erie.

Impact over the next several years

Started collaborations

Heidelberg University National Center for Water Quality Research

nutrient data and knowledge

Ohio Sea Grant and the Stone Laboratory

outreach, education, annual with seasonal forecast

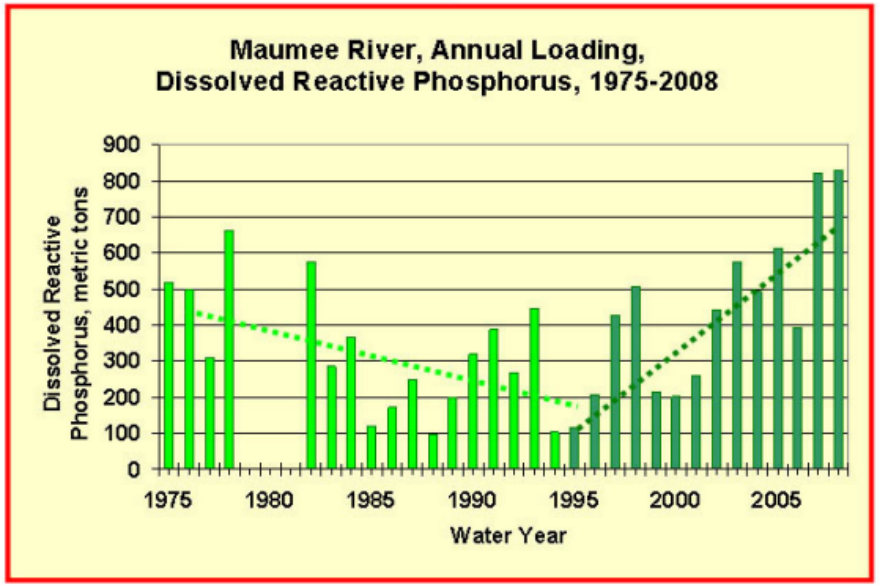
ready for renewal of NOAA GLERL Cyano program in 2013

research synergism, models, field, remote sensing

Impacts: 2010 Ohio Lake Erie Phosphorus Task Force

2010 Annual load emphasized

Annual discharges are variable but have increased during the study period.



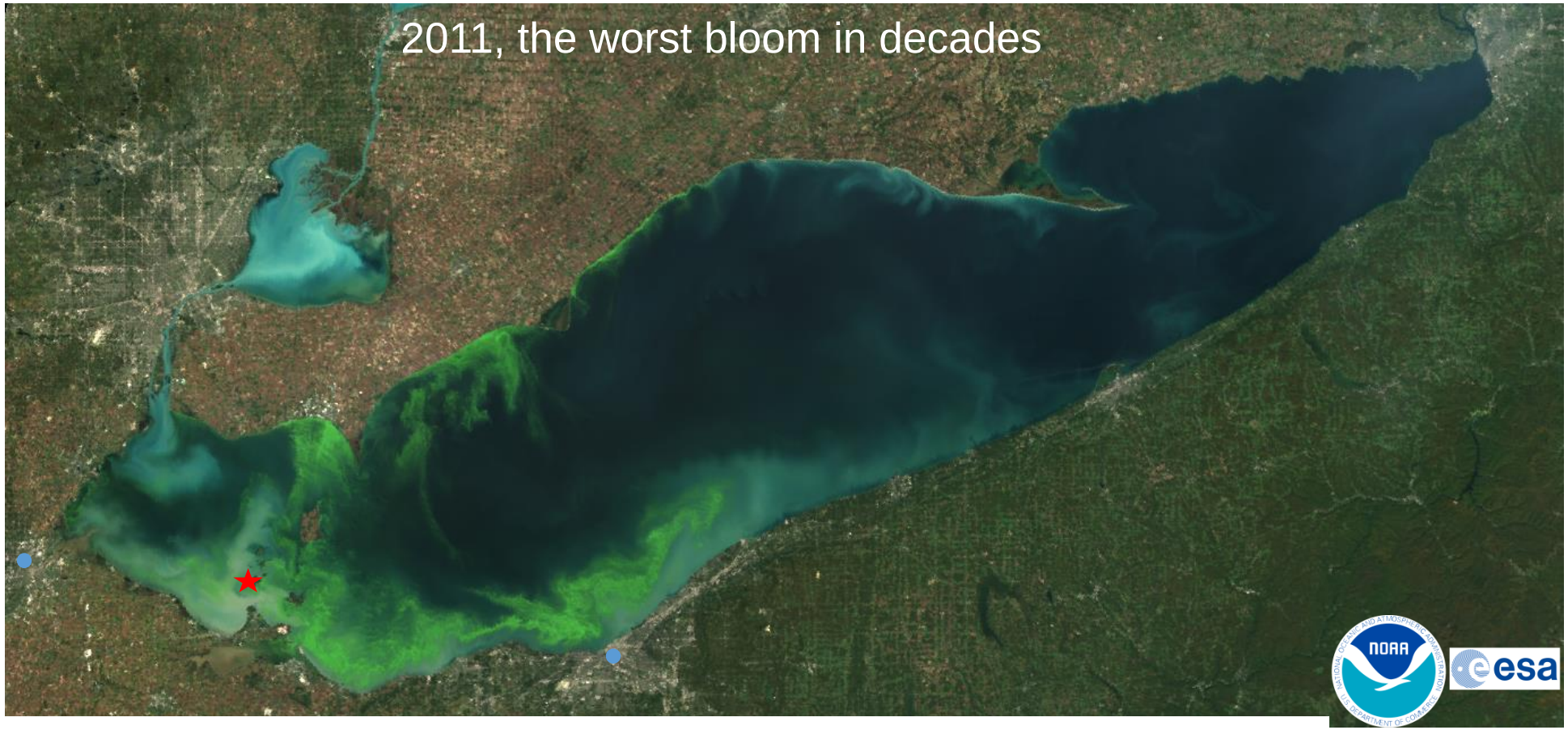
Annual FWMCs of DRP decreased through the mid-1990s but then increased.

April 2010

Ohio Environmental Protection Agency
Division of Surface Water

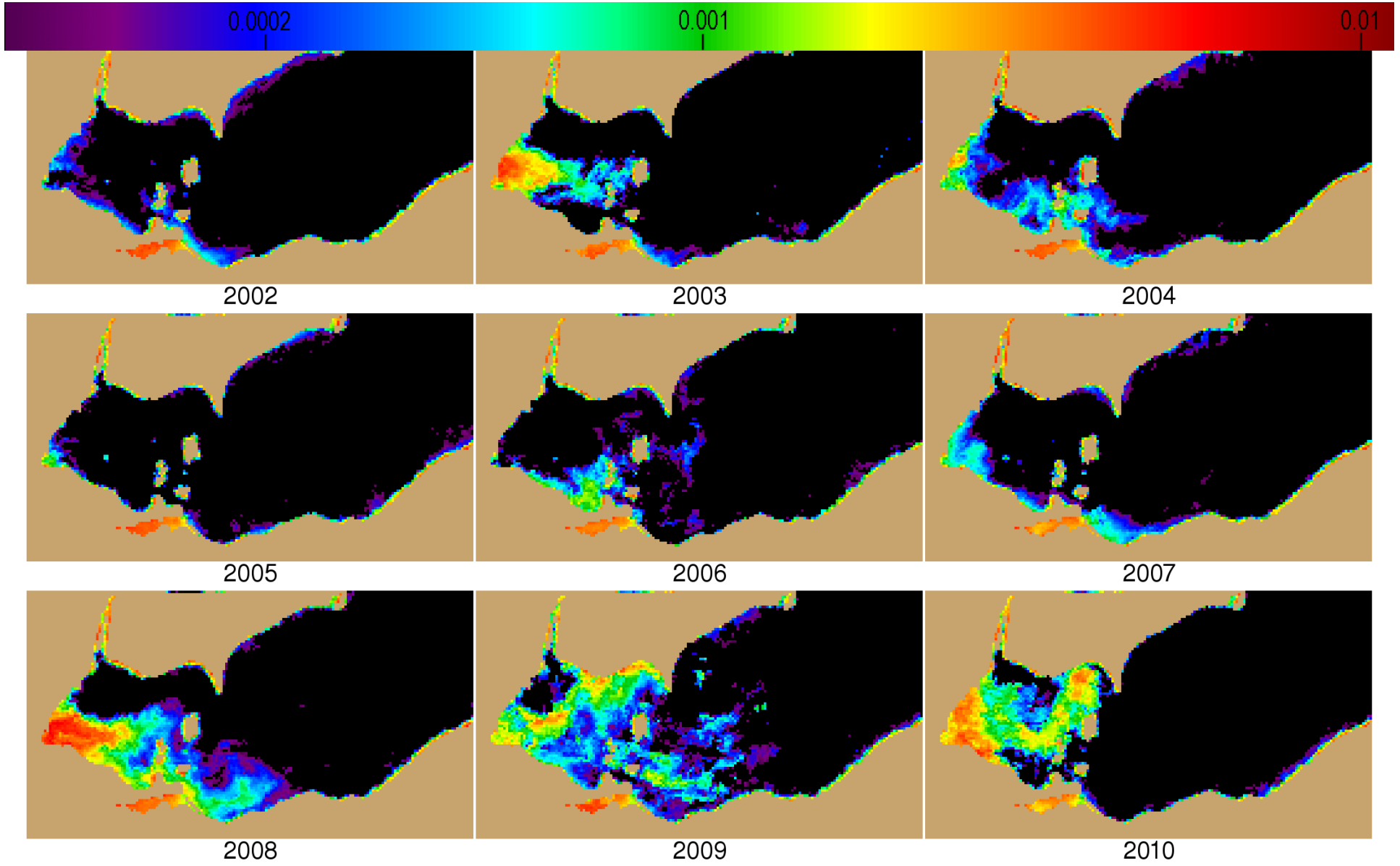
Ohio Lake Erie Phosphorus Task Force Final Report

2011 cyanobacteria bloom



Outdoors Insider: Report says Lake Erie algae worse now than in the 1960s

10 years of MERIS data, we determine annual bloom peak



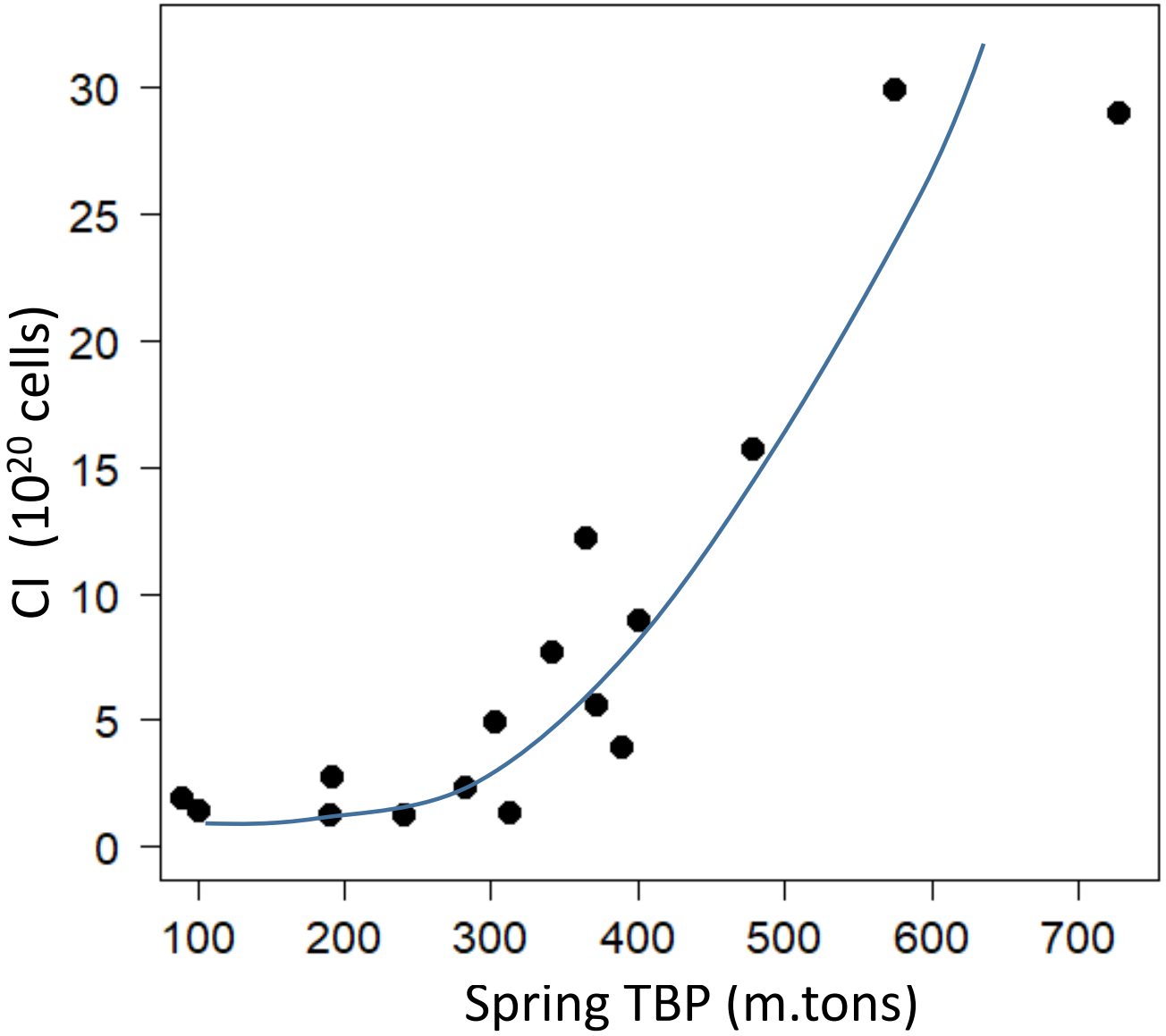
2012 PLoSONE paper: Spring Phosphorus Load Matters

Not winter, not annual,

But spring.

This is the updated model,

(adapted from 2016 paper)



Seasonal Forecast 2012-2017

- Was annual or spring P load key?

- 2012, Nature provided a natural experiment.
  - High discharge/load in winter, dry spring

2012 paper: Is it spring load?
2011-2012 Nature's Experiment

Forecast:

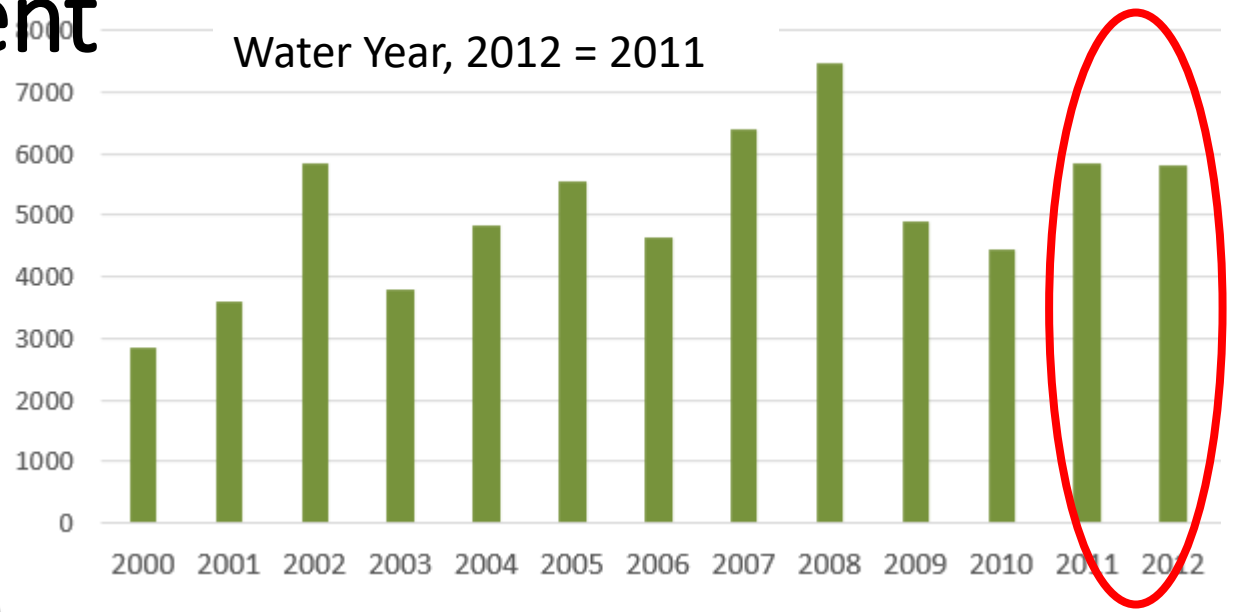
STATE

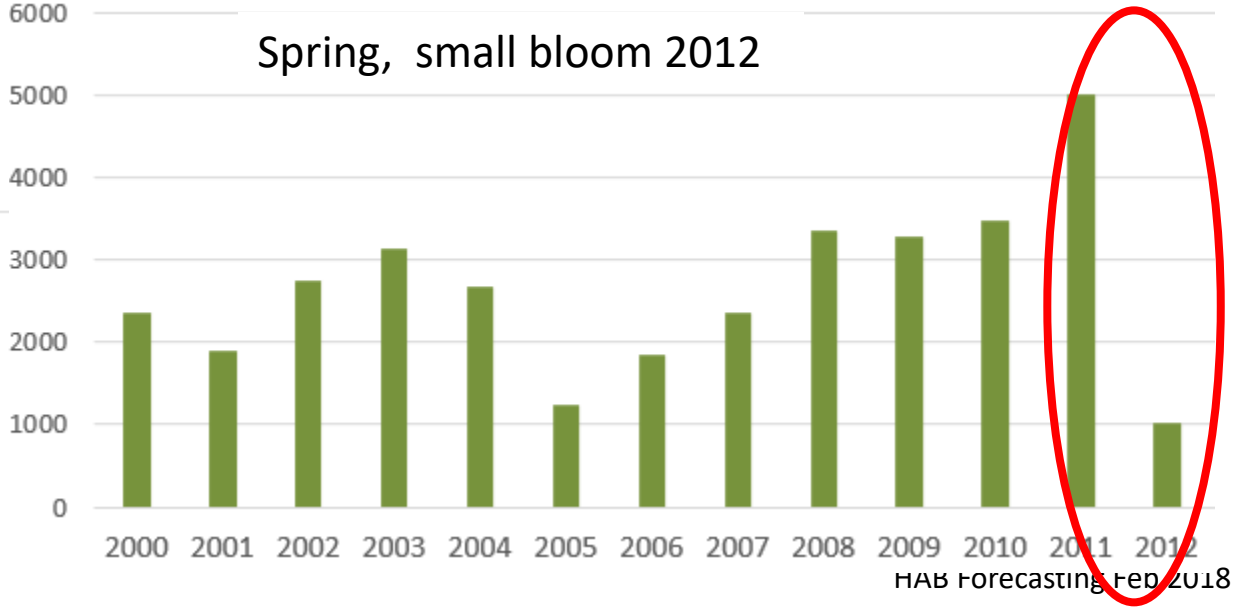
Lake Erie algae bloom expected to be smaller by summer's end

Researchers seeking long-term answers

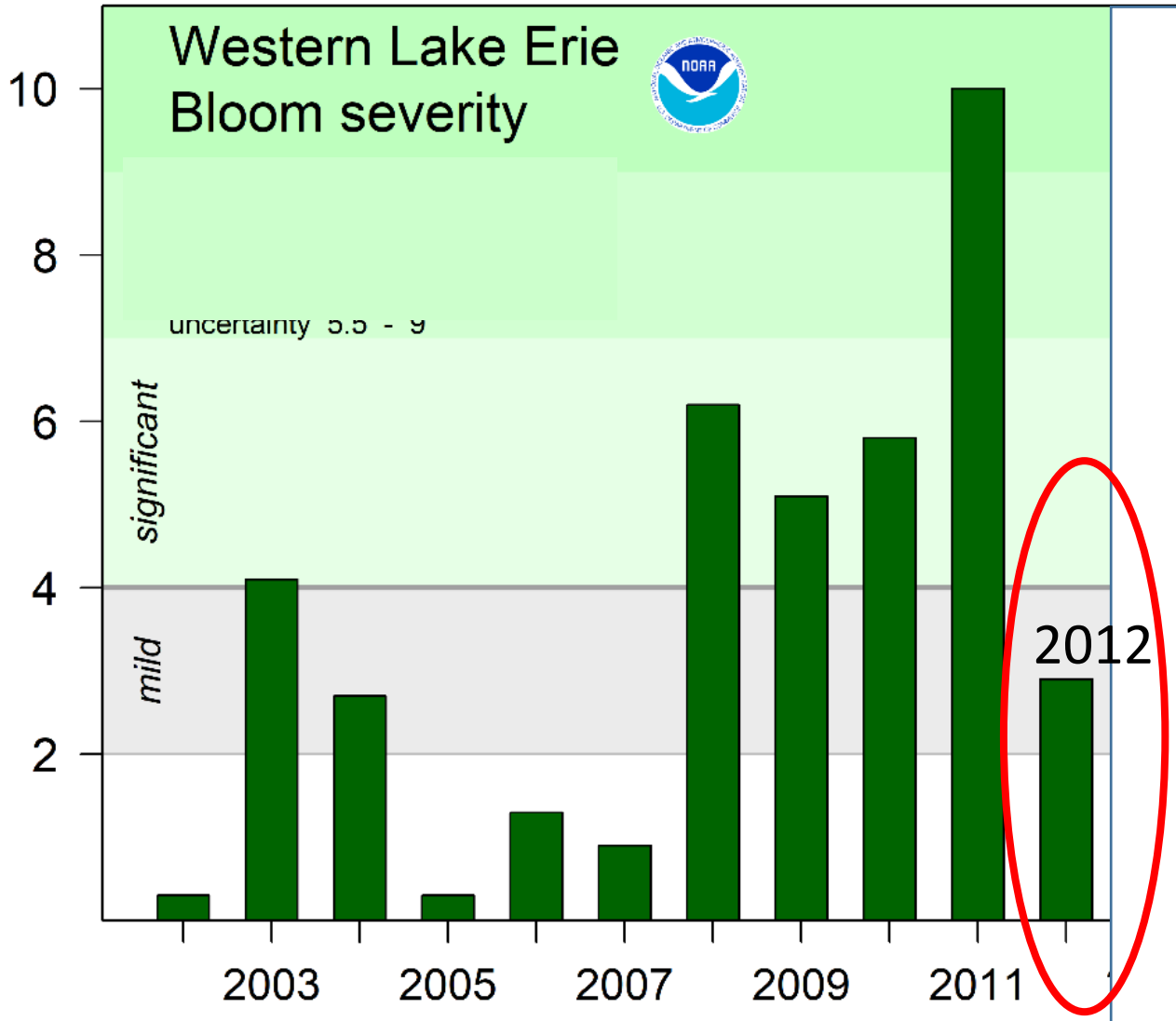
By SOPHIE BROACH | BLADE STAFF WRITER

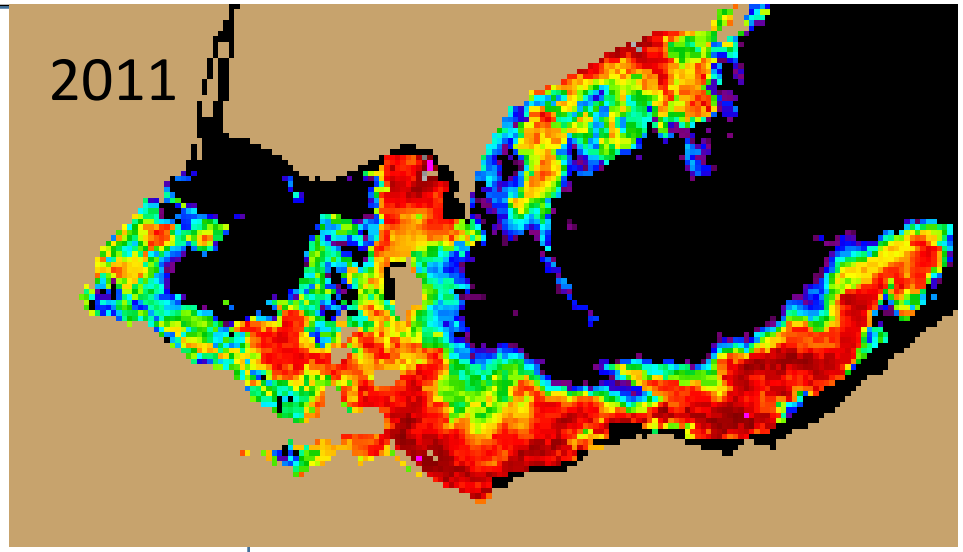
Published on July 6, 2012 | Updated 6:22 a. m.

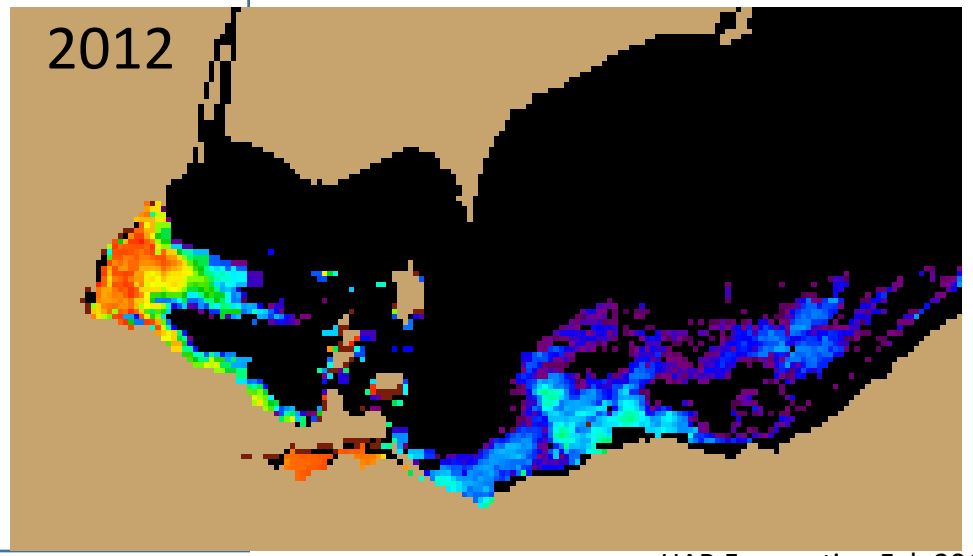




2012 was mild bloom. Spring load matters







2013 Task Force

Ohio | Department of Agriculture
Department of Natural Resources
Environmental Protection Agency
Lake Erie Commission

Targets for spring specifically,
37% of TP, 41% of DRP spring
as well as annual

For the Maumee River, the Task Force recommends targets for spring loads (defined as 1 March to 30 June) and annual loads (water years, 1 October to 30 September) for both total phosphorus and dissolved reactive phosphorus based on 11 years (2002-12) of observation and models that have proved to be highly accurate. Spring phosphorus loading in particular has been shown to be highly predictive of subsequent HAB size.

Ohio Lake Erie
Phosphorus Task Force II
Final Report

Great Lakes Water Quality Agreement (U.S. Canada)

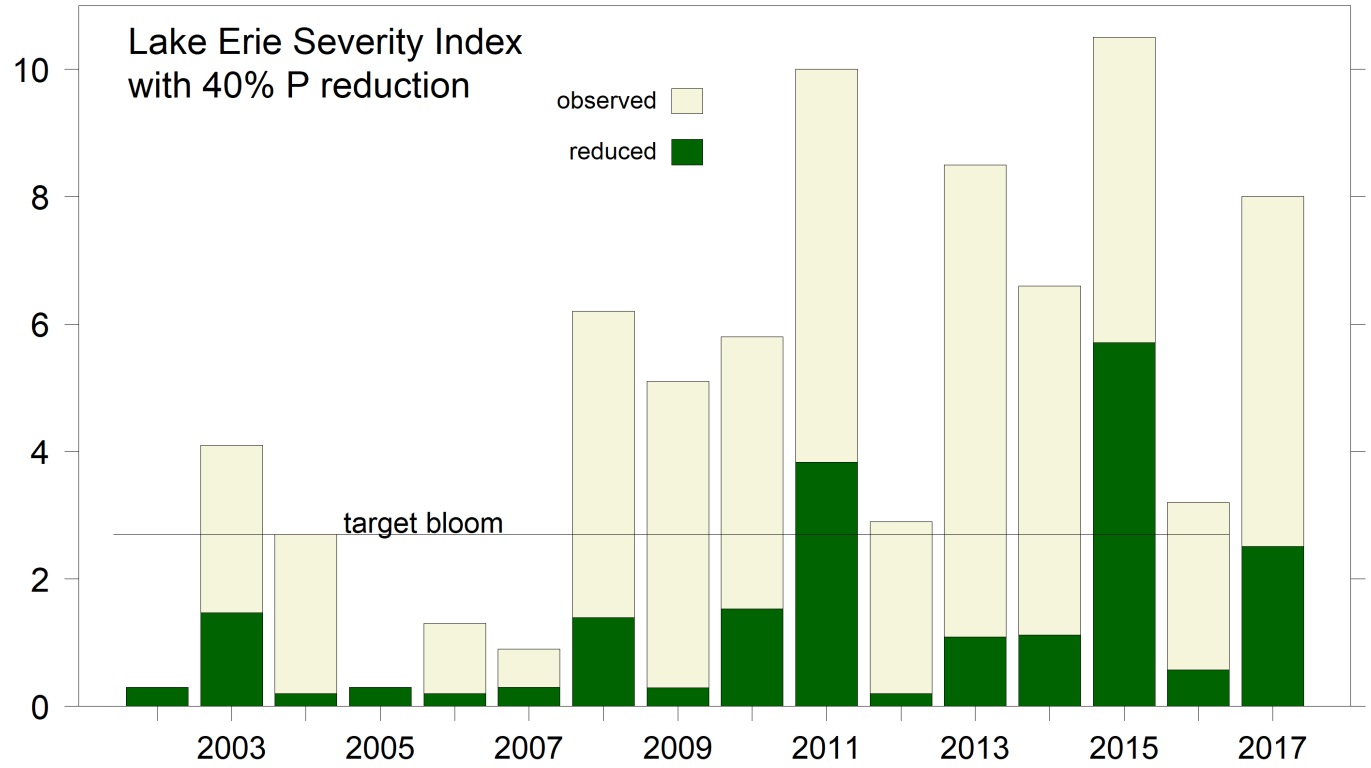
Great Lakes Water Quality Agreement

Nutrient Annex 4 Objectives and Targets Development Task Team

Multi-Modeling Report - Final

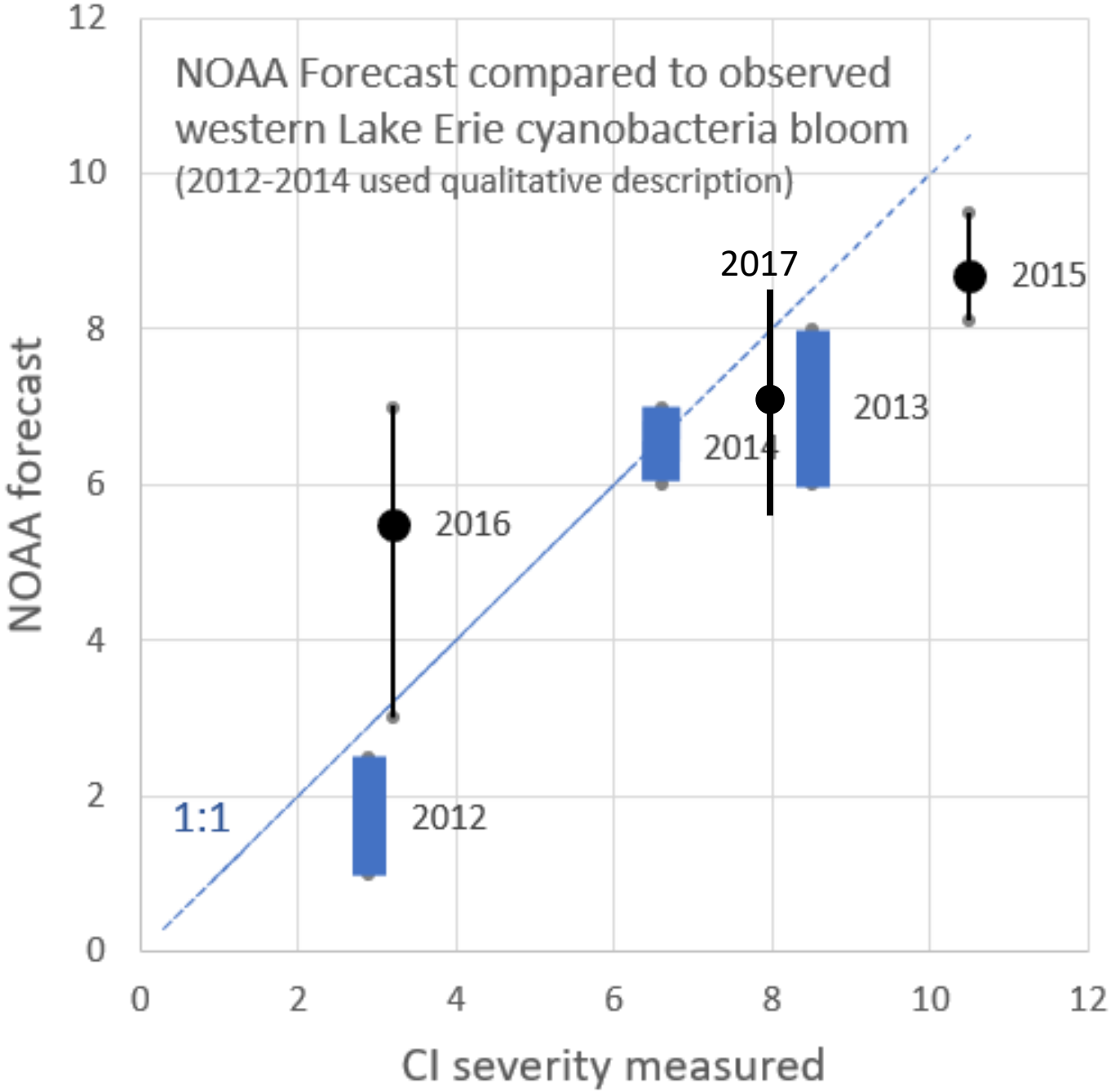
40% reduction in spring TP and SRP loads for all watersheds

And for Maumee River specifically.



Rep Kaptur (Ohio 9th) asked: "How have we done?"

- 2013 led to adjustment
- Change to severity index in 2015 (request of Ohio Tourism)
- 2016 was forecast to be smaller than 2015. That much was right
  - Our standard model correctly forecast (and the ensemble was pushing higher), but we didn't have enough confidence after 2012 bloom!



Back to 2012. MERIS in the Bulletin

Experimental
Lake Erie Harmful Algal Bloom Bulletin
2011-008
08 September 2011
National Ocean Service
Great Lakes Environmental Research Laboratory
Last bulletin: 22 July 2011

Bloom from satellite

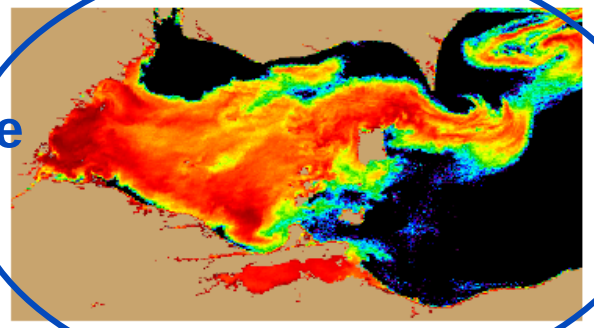


Figure 1. MERIS image from the European Space Agency. Imagery shows the spectral shape at 681 nm from September 03, where colored pixels indicate the likelihood of the last known position of the *Microcystis* spp. bloom (with red being the highest concentration). *Microcystis* spp. abundance data from shown as white squares (very high), circles (high), diamonds (medium), triangles (low) , + (very low) and X (not present).

forecast

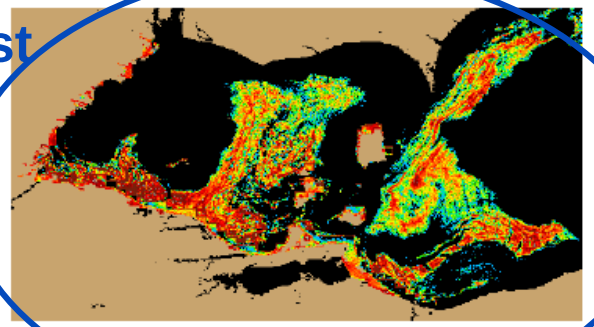


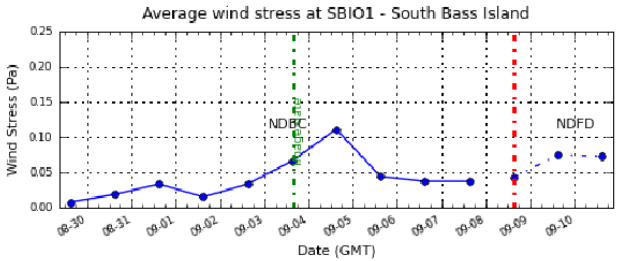
Figure 2. Nowcast position of *Microcystis* spp. bloom for September 08 using GLCFS modeled currents t move the bloom from the September 03 image.

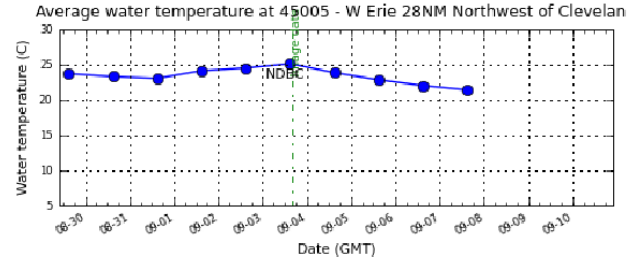
Conditions: A massive *Microcystis* bloom persists throughout most of Lake Erie's Western Basin.

Analysis: As indicated in satellite imagery from Saturday (9/3/2011), an enormous *Microcystis* bloom was present in western Lake Erie. The southern extent of the bloom was remotely observed along the coast of Ohio from Maumee Bay to Catawba Island. The northern extent of the bloom was observed to be consistent along the Michigan coast from Northern Maumee Bay to the mouth of the Detroit River. The eastern-most portion of the bloom was observed past Point Pelee and to the northeast up in to Rondeau Provincial Park.

At the mouth of the Detroit River, a five day nowcast shows a southward suppression of the western-most portions of the bloom. However, the bloom is likely to still persist in much of the Western Basin. The nowcast also suggest the bloom has spread to the east of Sandusky and into the Cleveland area. **(Note: Due to a lack of clear imagery the bloom has not been remotely observed in the Cleveland area.)** A three day forecast also suggests that the bloom will persist to the north of Cleveland through the weekend. Water temperatures remain above 20 degrees Celsius and are forecast to decrease into the weekend; however, conditions remain favorable for bloom growth.

Briggs, Wynne





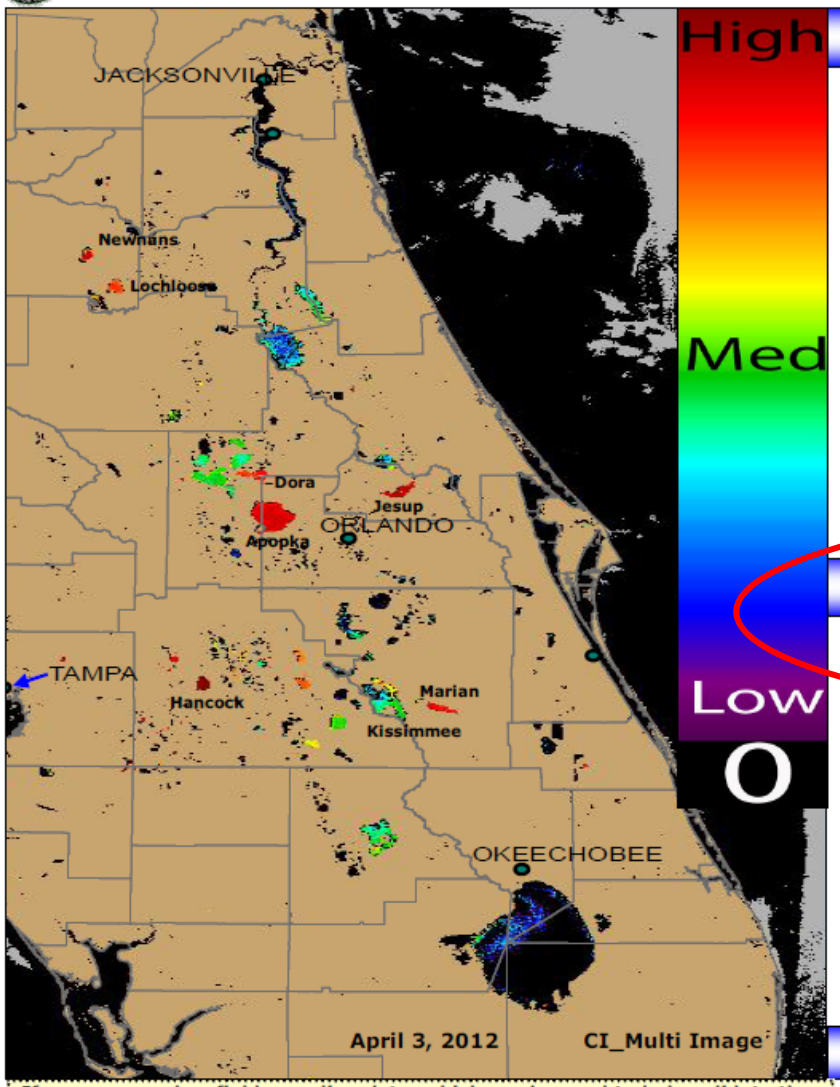
Ready for expansion. Florida, Ohio, Chesapeake

Florida Dept of Health Experimental Bulletin

2012

Experimental Cyanobacteria Health Bulletin: April 3, 2012

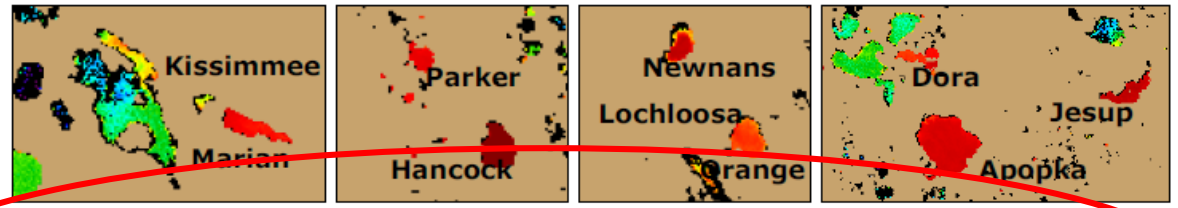
To report an illness related to a marine toxin or algal bloom please contact the Florida Poison Information Center-Miami Aquatic Toxins Hotline at 1-888-232-8635.
For questions about the report: contact Becky Lazensky, FL-DOH, at 352-955-1900. Images/data were obtained from Florida Water Management Districts, The National Oceanic and Atmospheric Administration (NOAA), NOAA National Climatic Data Centers and National Weather Centers. Support to produce this report was received through a NOAA/NASA Agreement (Number: NNH08ZDA001N)



If your agency has field sampling data, which can be used to help validate the MERIS imagery, Contact Becky Lazensky at: 352-955-1900

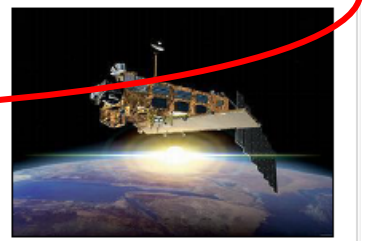
Cyanobacteria HABs Conditions Report: April 3

- Lakes Kissimmee and Marian (Osceola County) displayed medium and high estimated cyanobacteria concentrations
- Lakes Parker and Hancock (Polk County) displayed high estimated cyanobacteria concentrations
- Newnans, Lochloosa, & Orange Lakes (Alachua & Marion Counties) and Jesup, Dora, and Apopka Lakes (Seminole, Lake, and Orange Counties) displayed high estimated cyanobacteria concentrations



ENVISAT SATELLITE IS DOWN-Impacts on MERIS Images

On April 8th, communications between the European Space Agency (ESA) and the Envisat satellite were lost. The Envisat satellite platform carries the MERIS sensor which captures the images featured in this bulletin. This will impede the production of MERIS satellite imagery until repairs are made or a new satellite is launched. The last MERIS image we have is the April 3rd image. NOAA may provide alternative MODIS imagery until communications are re-established. We will keep everyone updated on the progress. For more information visit: http://www.nature.com/news/workhorse-climate-satellite-goes-silent-



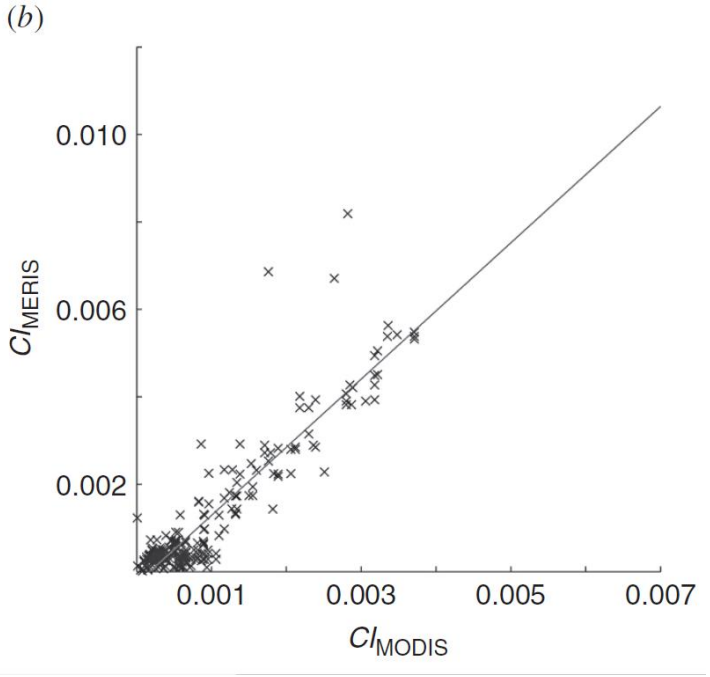
Envisat (Photo courtesy of European Space Agency)

Algal Bloom on the Caloosahatchee River-Update: April 13th

Olga, FL: An ongoing cyanobacteria bloom was reported in the Caloosahatchee River. Samples

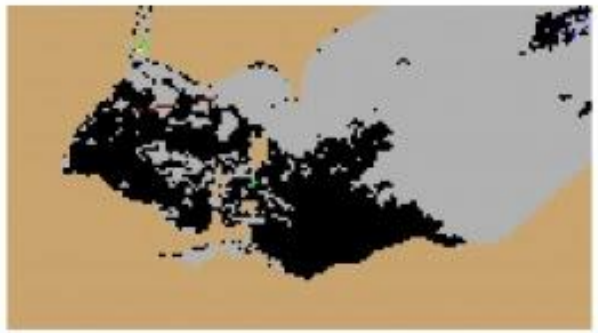
We had never tried MODIS

- Envisat contact lost 8 April 2012,
- End of mission on 9 May 2012.
- Bulletin up on 05 June 2012.
- Wynne et al. 2013

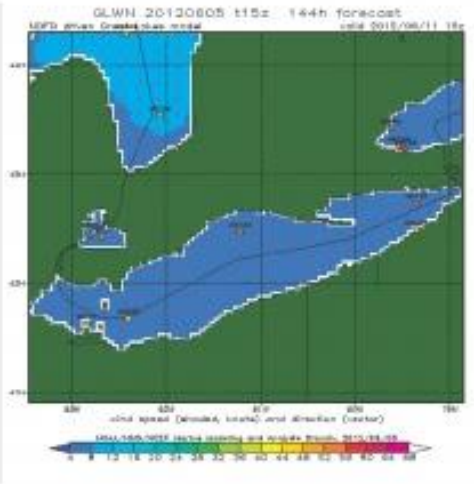


Experimental Lake Erie Harmful Algal Bloom Bulletin
National Centers for Coastal Ocean Science and Great Lakes Environmental Research Laboratory
05 June 2012; Bulletin 1

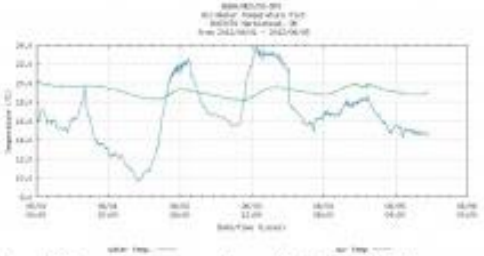
There is no reported Harmful Algal Bloom at this time. It is unlikely that one will develop within the next week. The particle tracking forecast will return when there is a feature to forecast in the imagery.
- Tim Wynne



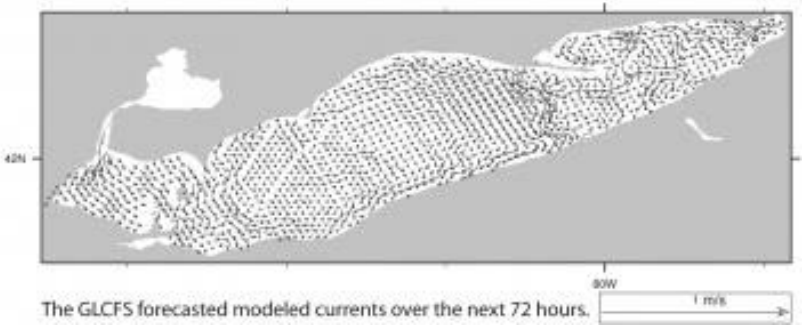
MODIS Cyanobacterial Index from 3 June 2012. Black is unlikely to be a bloom; Gray is clouds



NDFD forecast wind conditions from 11 June 2012.
From: NOAA/National Centers for Environmental Prediction (NCEP)



Air and Water Temperature from Marblehead, OH.
From: NOAA/Center for Operational Oceanographic Products and Services (CO-OPS).



The GLCFS forecasted modeled currents over the next 72 hours.

2014 was a bad year on Lake Erie

URGENT NOTICE TO RESIDENTS OF TOLEDO & LUCAS COUNTY WHO RECEIVE WATER

DO NOT DRINK THE WATER
DO NOT BOIL THE WATER

Chemists testing water at Toledo's Collins Park Water Treatment Plant
for microcystin in excess of the recommended "DO NOT DRINK" 1 microgra
This notice applies to ALL customers of Toledo water.

Photo copyright
Dave Zapotosky
Toledo Blade.

2015 was not a good year, either

The Columbus Dispatch

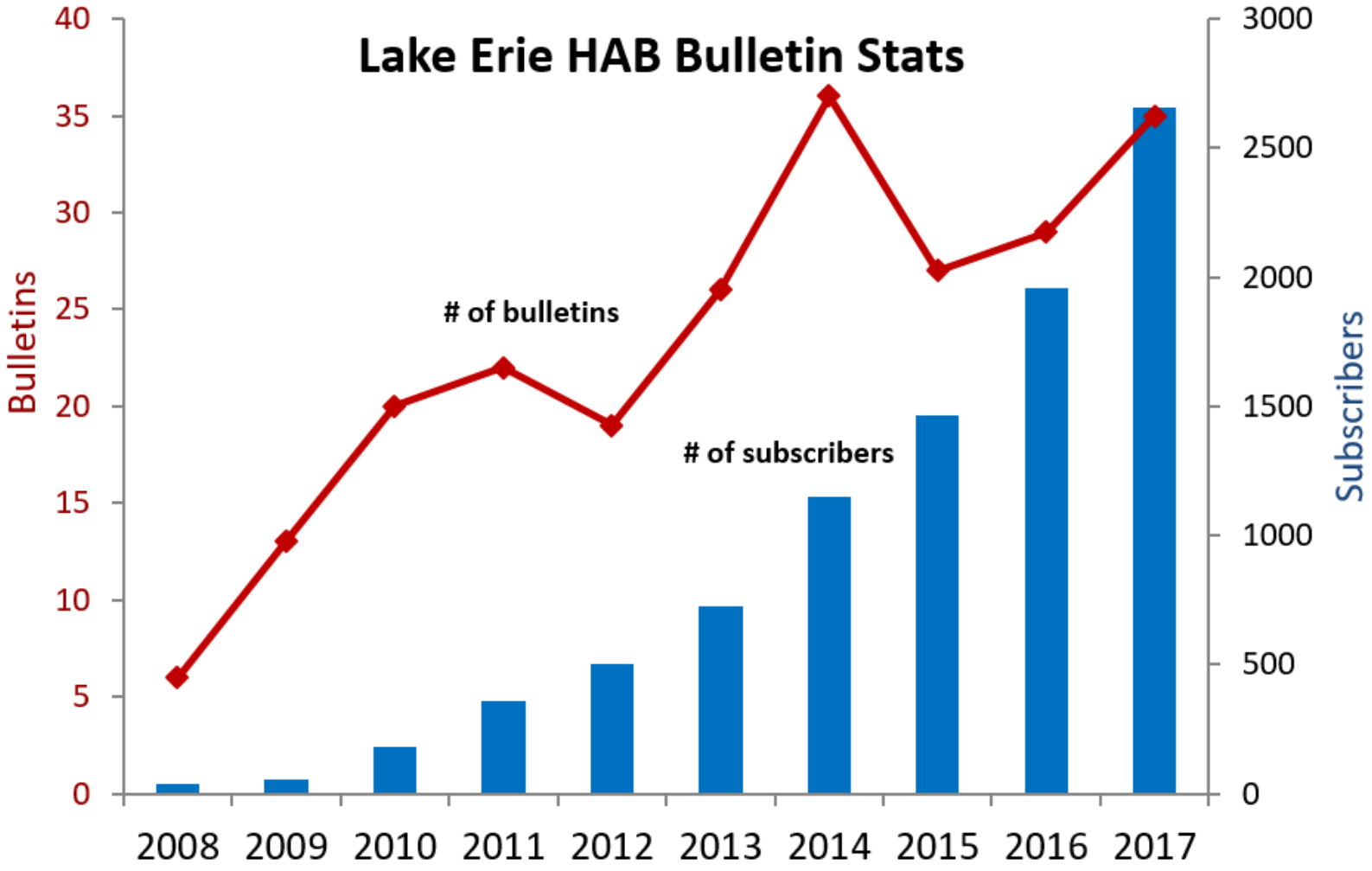
Summer's toxic-algae bloom on Lake Erie was the worst on record

Multi-million loss for tourism and water treatment.

*"**I've seen a 25 percent drop in revenue this season**,"* captain Paul Pachowski, President of the Lake Erie Charter Boat Association.

"People don't call to ask **'how is the fishing?'***, they ask* **'how is the algae?'***"*

Lake Erie Bulletins over time



Reused in local media

Register

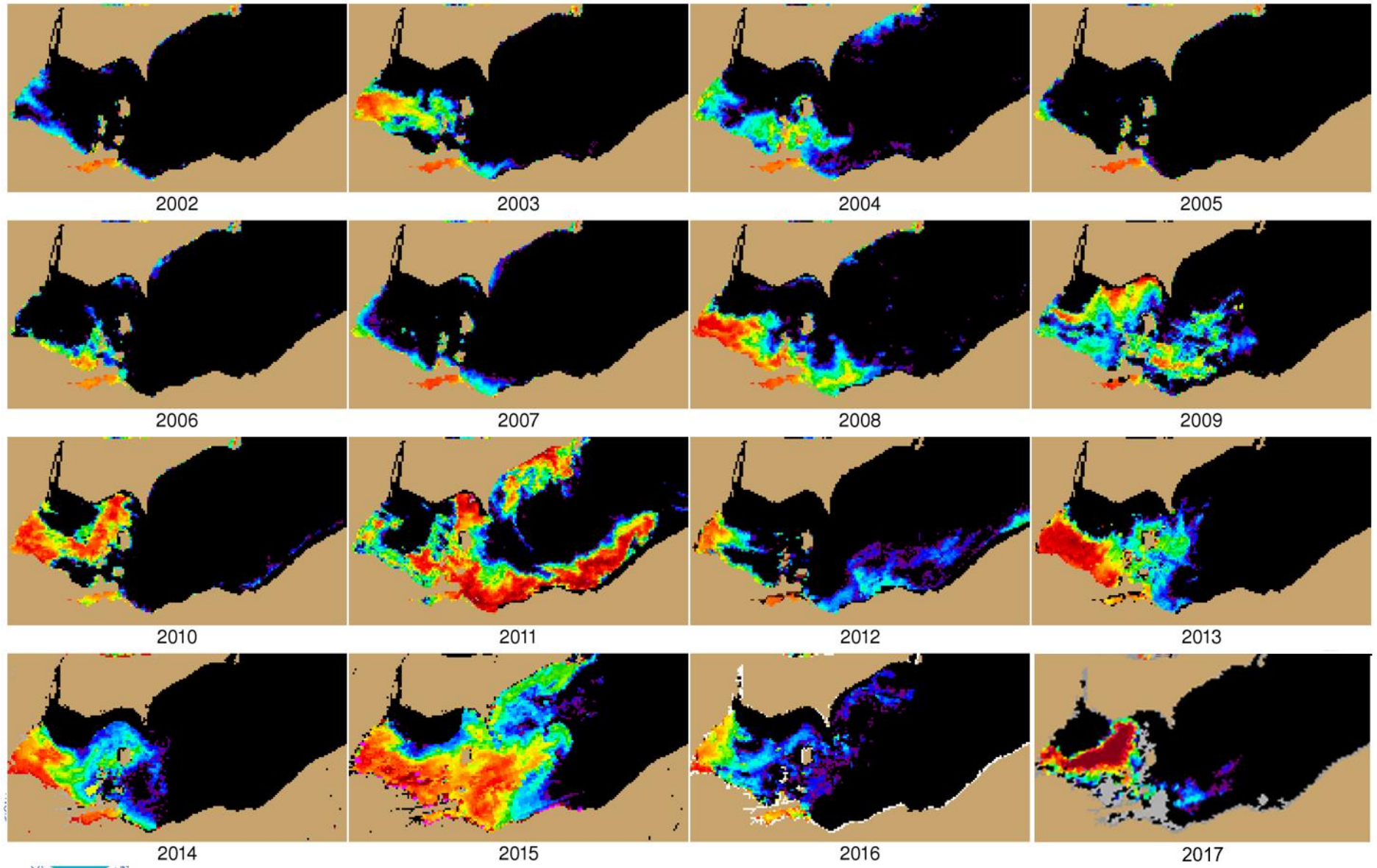
Harmful algal blooms reported in two locations

7/31/2017 5:31 PM

The more recent bloom from the Microcystis cyanobacteria, the main source of harmful algal blooms, has developed in the western basin off the Ohio and Michigan coast, extending from Maumee Bay north past Stony Point, according to NOAA's "Lake Erie Harmful Algal Bloom Bulletin," an email newsletter sent out on Monday and Thursday.

Winds that are forecast for this week are expected to push the bloom toward the Bass Islands, the bulletin said.

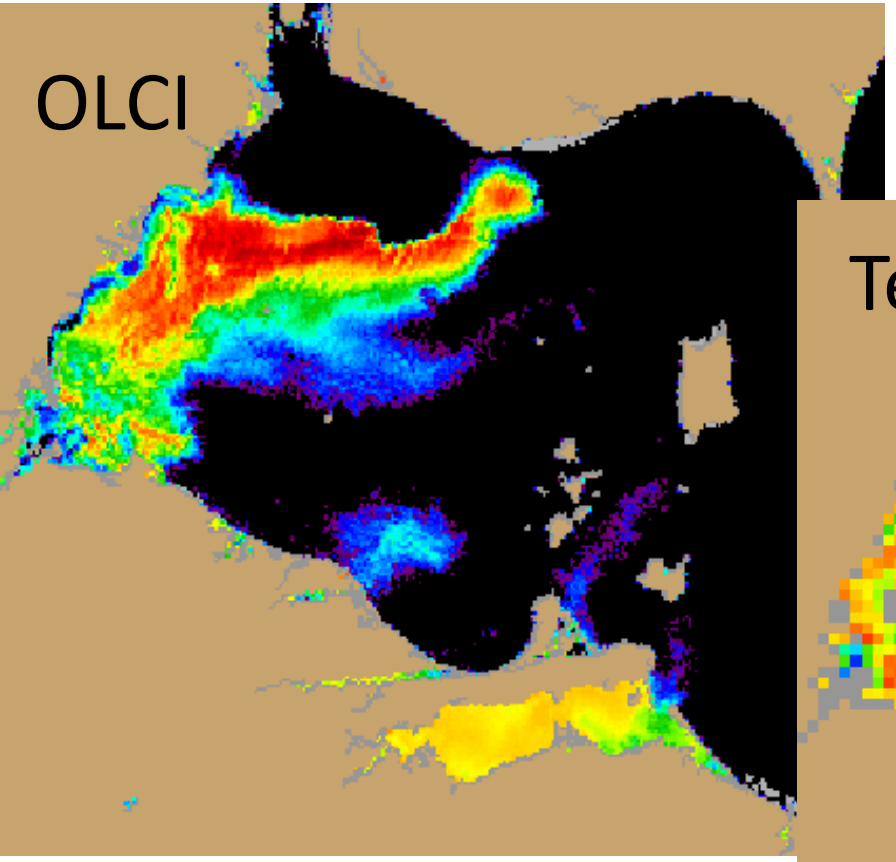
MERIS/MODIS combined. Next steps: OLCI and 3-D model implementation

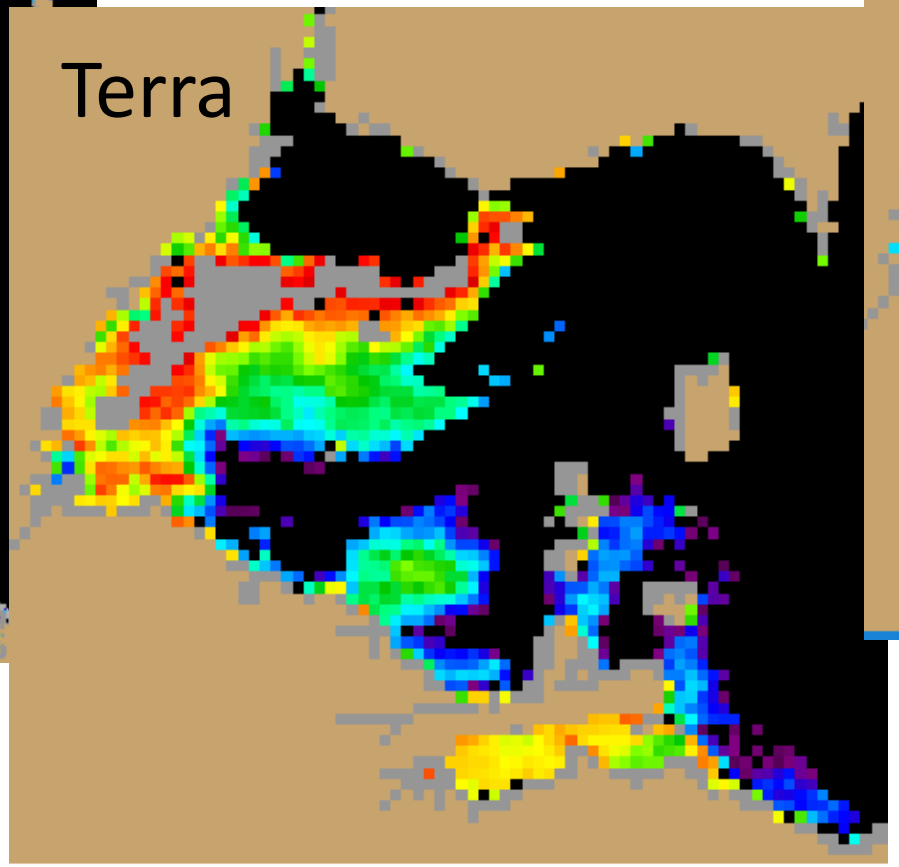


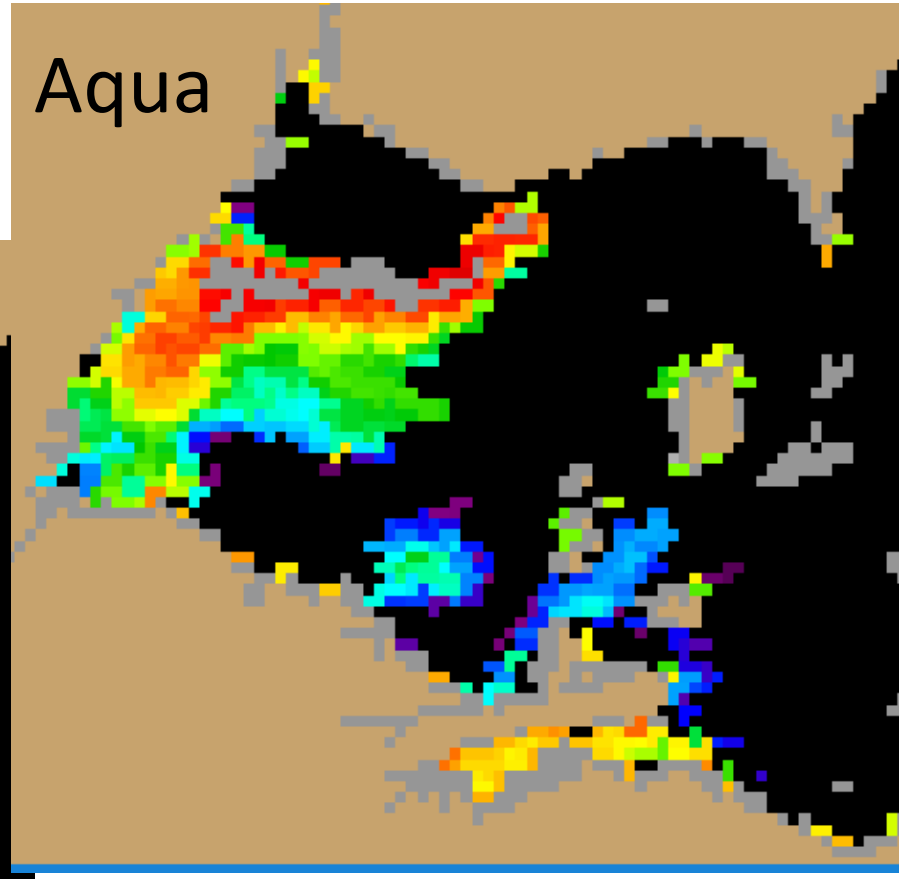
Lake Erie peak bloom severity from MERIS (ESA) and MODIS (NASA)

CI product for 10 August 2017, Lake Erie

OLCI 1614 GMT, Terra 1626 GMT, Aqua 1808 GMT

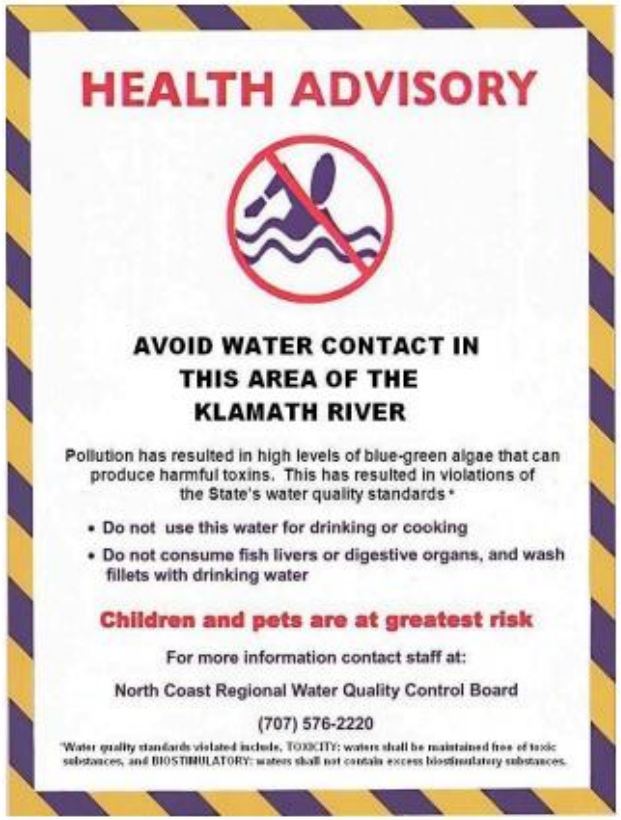






Aqua and Terra saturate

Can Lake Erie help us monitor cyanobacterial blooms in the rest of the country?



Lake Okeechobee algae bloom threatens to worsen water woes

SunSentinel

WATER

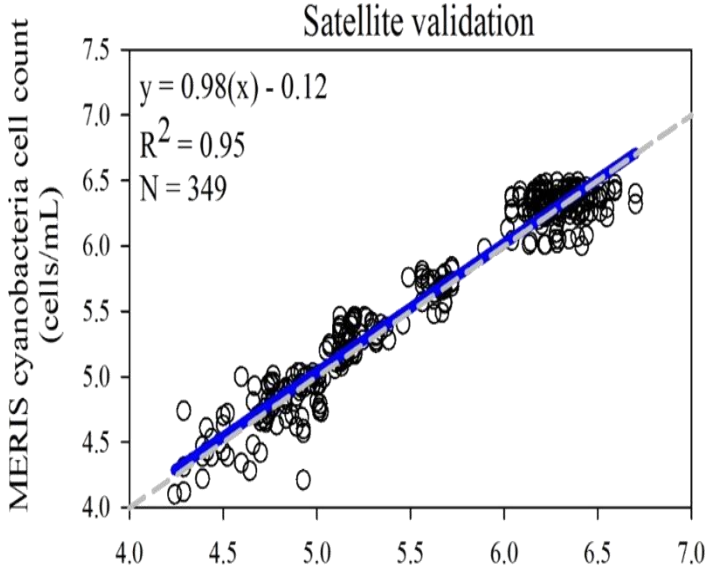
Toxic algae bloom closes Utah lake, sickens more than 100 people

Algae bloom, bacterial spike close several South Florida beaches

BUSINESS By Jennifer Sorentrue - Palm Beach Post Staff Writer

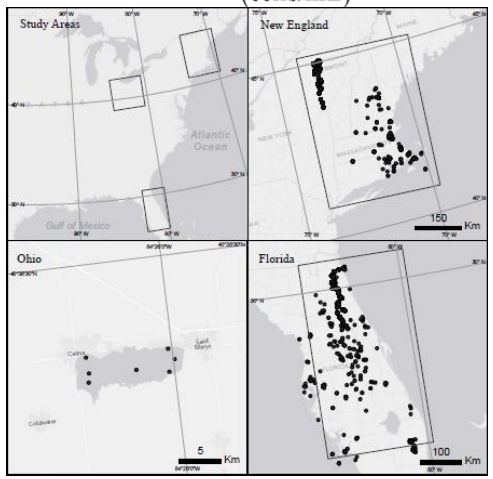
Updated: 5:39 p.m. Tuesday, June 28, 2016 | Posted: 5:27 p.m. Tuesday, June 28, 2016

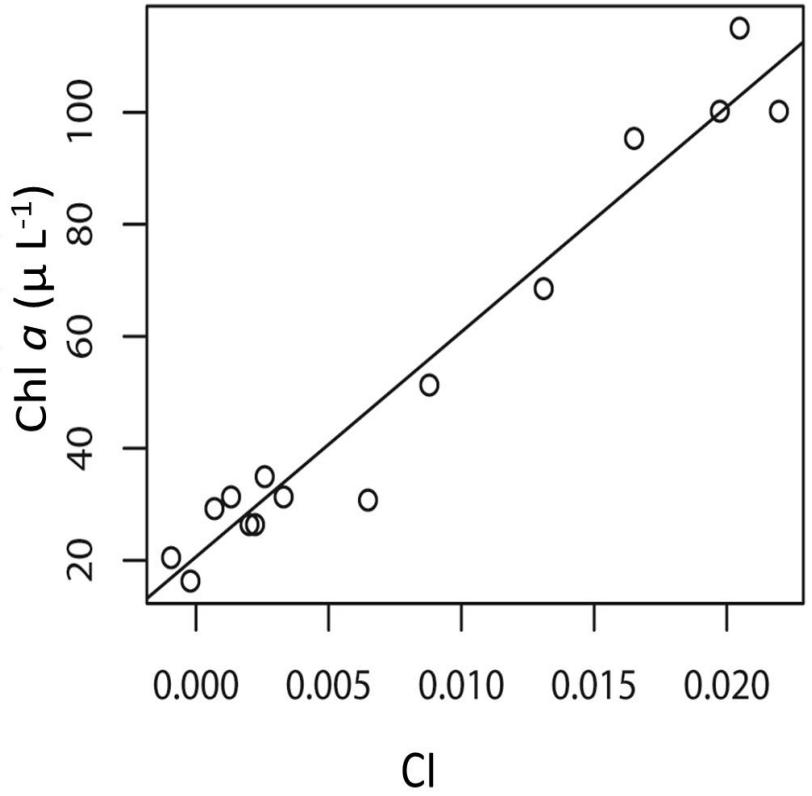
Example quantification for CI, Lake Erie transferred to many other lakes



EPA analysis

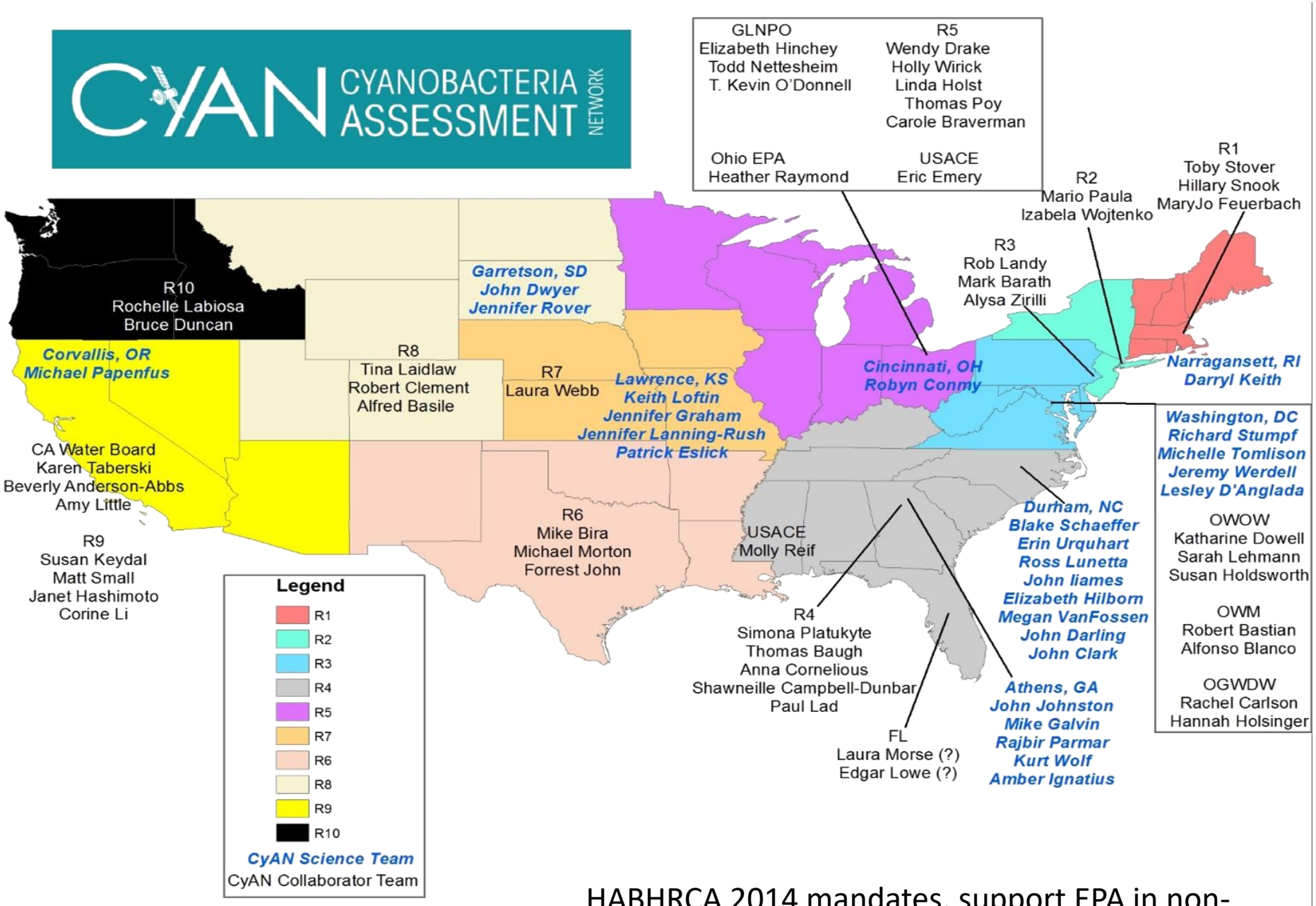
Lunetta et al., 2014





Relationship to chl-a

Tomlinson et al., 2016



HABHRCA 2014 mandates, support EPA in non-Great Lakes freshwater, develop monitoring and forecasting

CyAN successes

- Ohio
- California
- Florida
- Wisconsin
- Utah

THE GAZETTE

LOCAL MEDINA COUNTY NEWS

Elevated toxins found in Chippewa Lake

By Ashley Fox | The Gazette

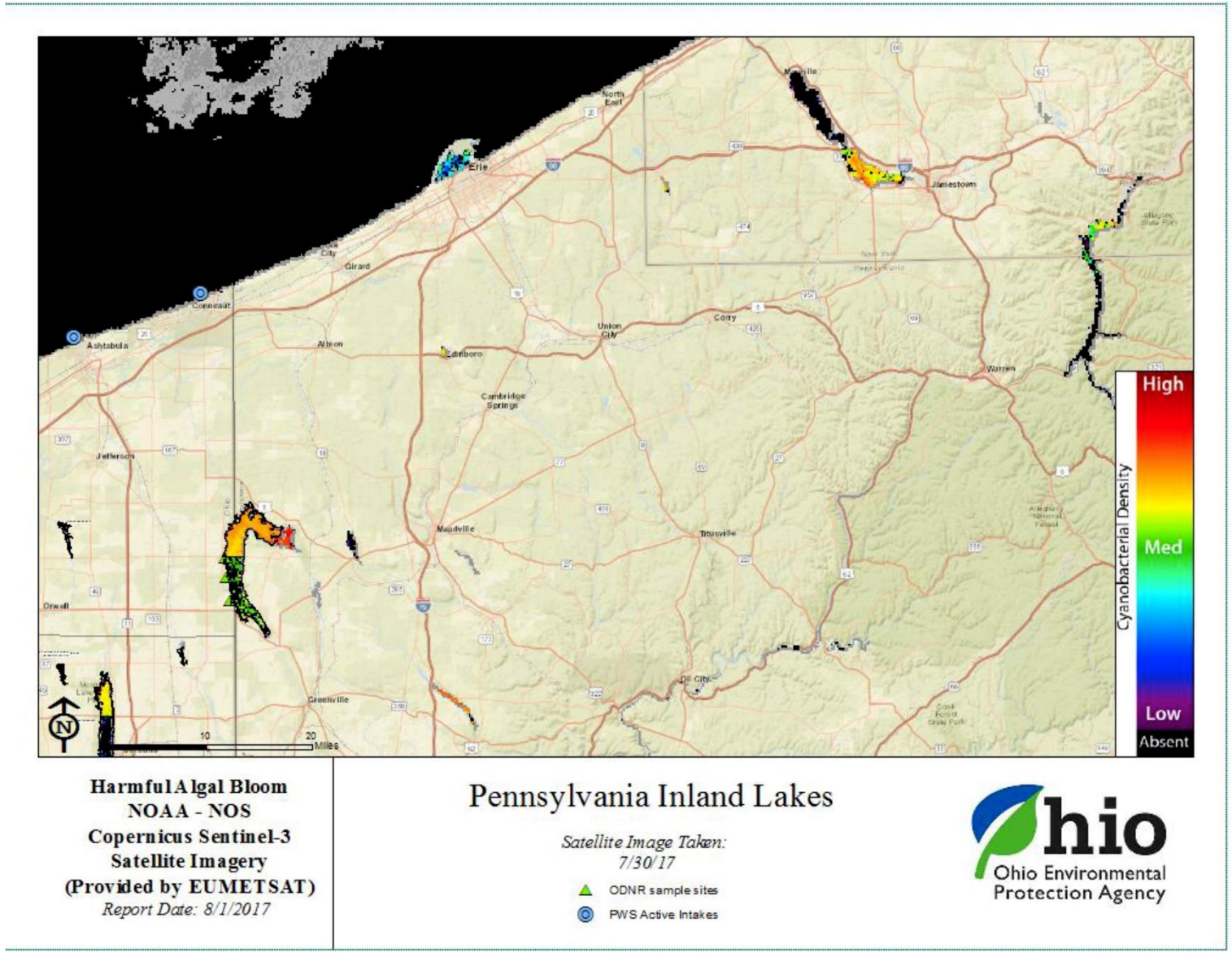
http://www.medina-gazette.com/Medina-County/2017/06/14/Elevated-toxins-found-in-Chippewa-Lake.html

Advisories have been posted about high toxin levels recorded at Chippewa Lake. ASHLEY FOX / GAZETTE

Test results from a water sample taken June 8 showed levels of **10.5 parts per billion of cyanobacteria**. The Ohio Department of Health's recommended threshold for posting a public health advisory is 6ppb, Village Mayor Joanne Dodaro said **officials were alerted** about the bloom **by the Ohio Environmental Protection Agency after it was detected by a satellite**.

Ohio

- Ohio EPA using geoTIFFs in ArcGIS
- Supporting Ohio Parks
- Supporting PA for parks near Ohio



Lake Okeechobee

South Florida Water Mgmt District

(SFWMD, Softmud)

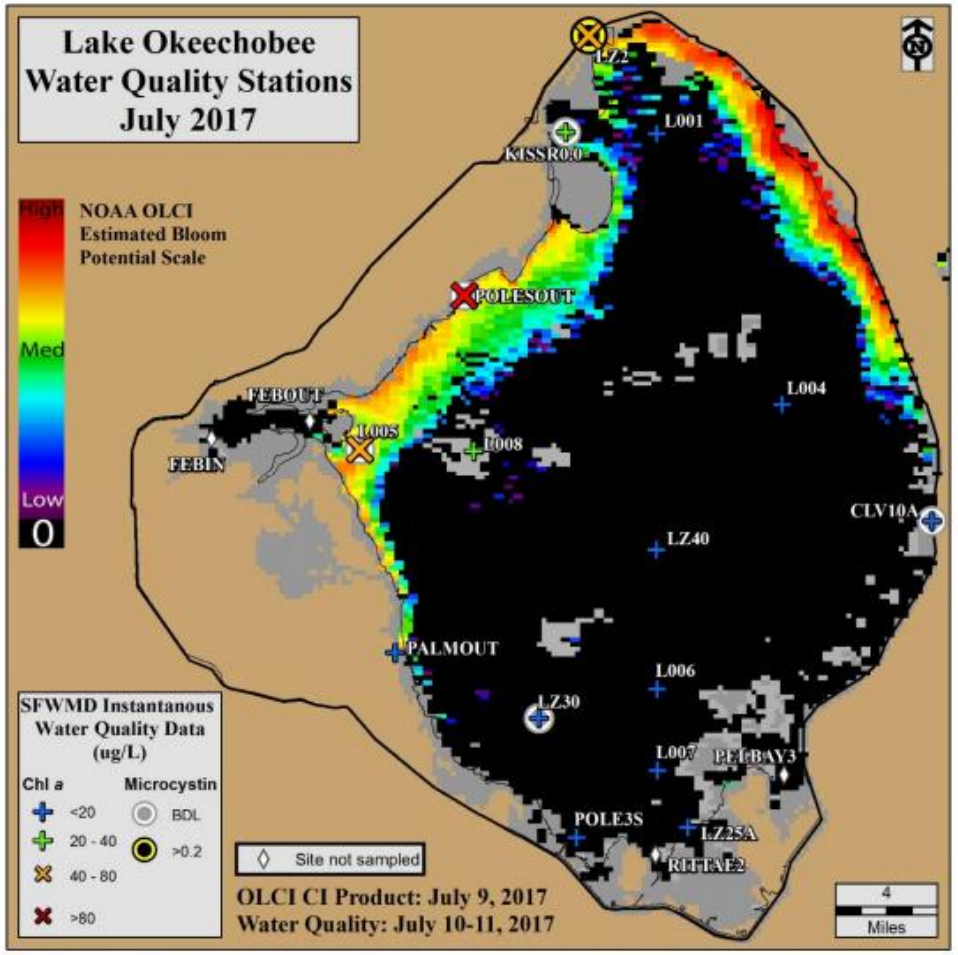
www.sfwmd.gov/news-events/meetings

Aug 03, 2017 board meeting

SOUTH FLORIDA WATER MANAGEMENT DISTRICT

Lake Okeechobee Water Quality

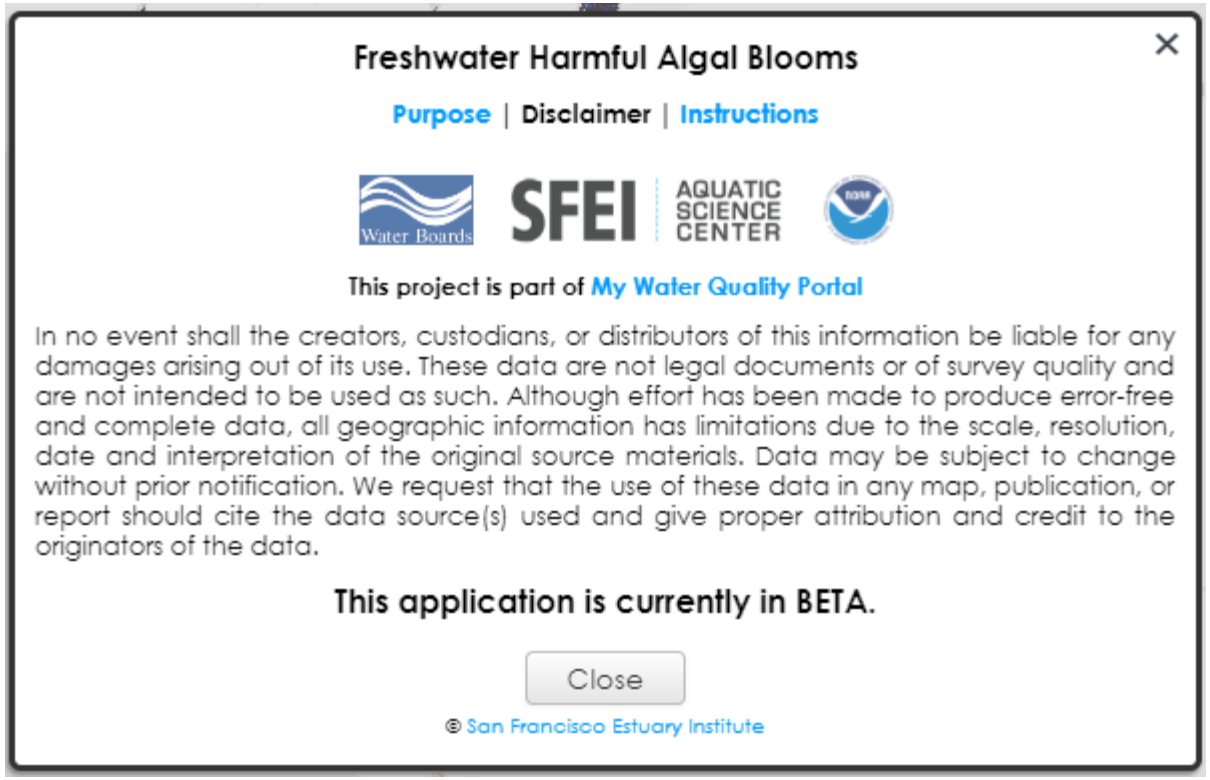
July 10 - 11, 2017		
Site	**Chlorophyll a (ug/L)**	**Microcystin (ug/L)**
Nearshore Stations		
FEBIN	Not Sampled	
FEBOUT	Not Sampled	
KISSR0.0	34.8	0.2
LZ2	44.2	0.3
LZ25A	5.2	
PALMOUT	6.5	
PELBAY3	Not Sampled	
POLE3S	5.5	
POLESOUT	102.0	0.2
RITTAE2	Not Sampled	
Pelagic Stations		
L001	12.1	
L004	5.3	
L005	54.5	0.2
L006	5.9	
L007	2.5	
L008	23.9	
LZ30	15.5	0.2
LZ40	6.1	
CLV10A	13.2	0.2

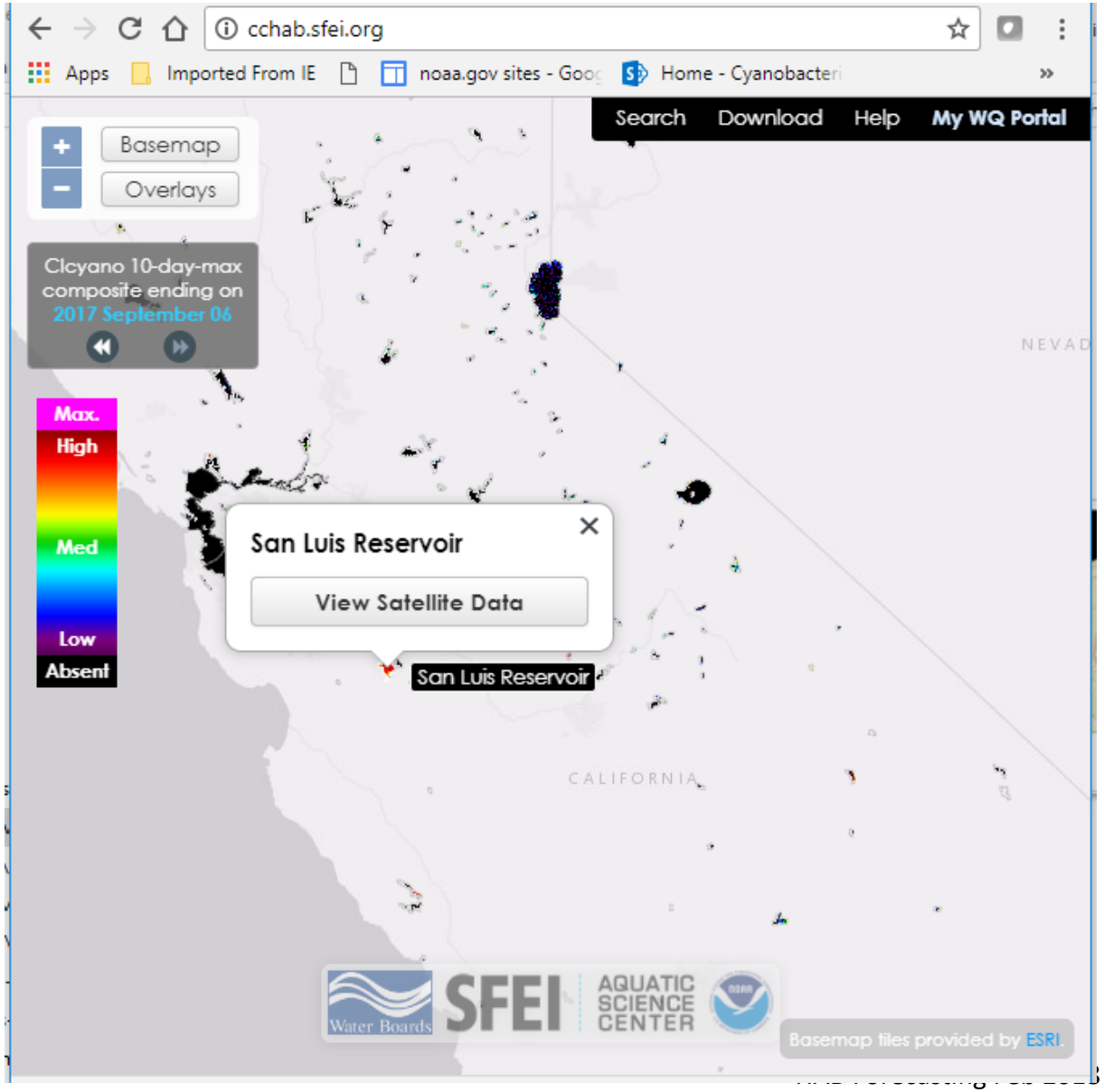


California, SFEI in support of CA Water Board

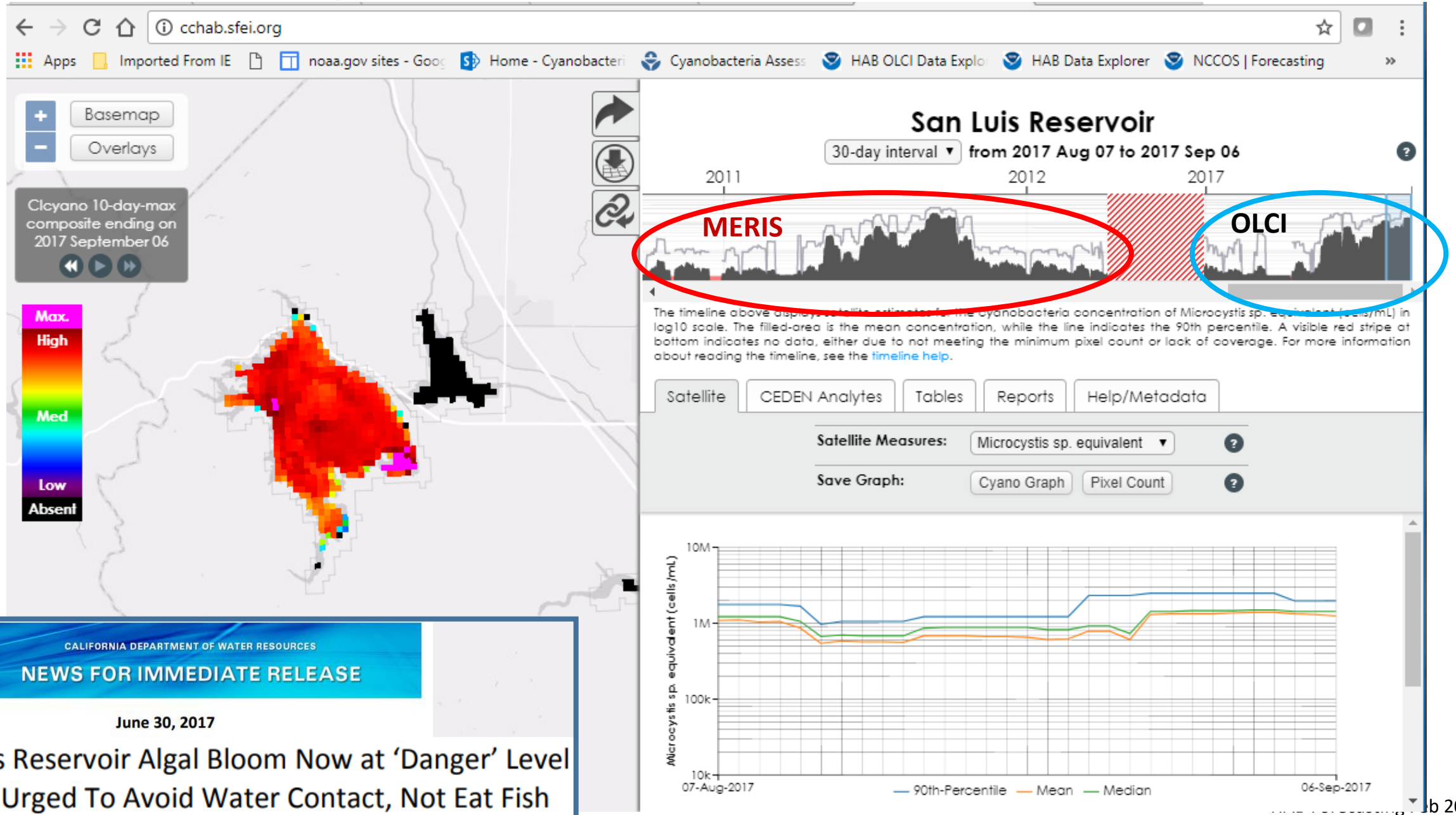
Web tool for freshwater HAB monitoring and assessment for lakes across the state.

cchab.sfei.org/





cchab.sfei.org/ uses OLCI and MERIS for California



CALIFORNIA DEPARTMENT OF WATER RESOURCES

NEWS FOR IMMEDIATE RELEASE

June 30, 2017

San Luis Reservoir Algal Bloom Now at 'Danger' Level
Public Urged To Avoid Water Contact, Not Eat Fish

Utah Lake
supporting EPA region 8 and Utah DEP

FOX 13 SALT LAKE CITY

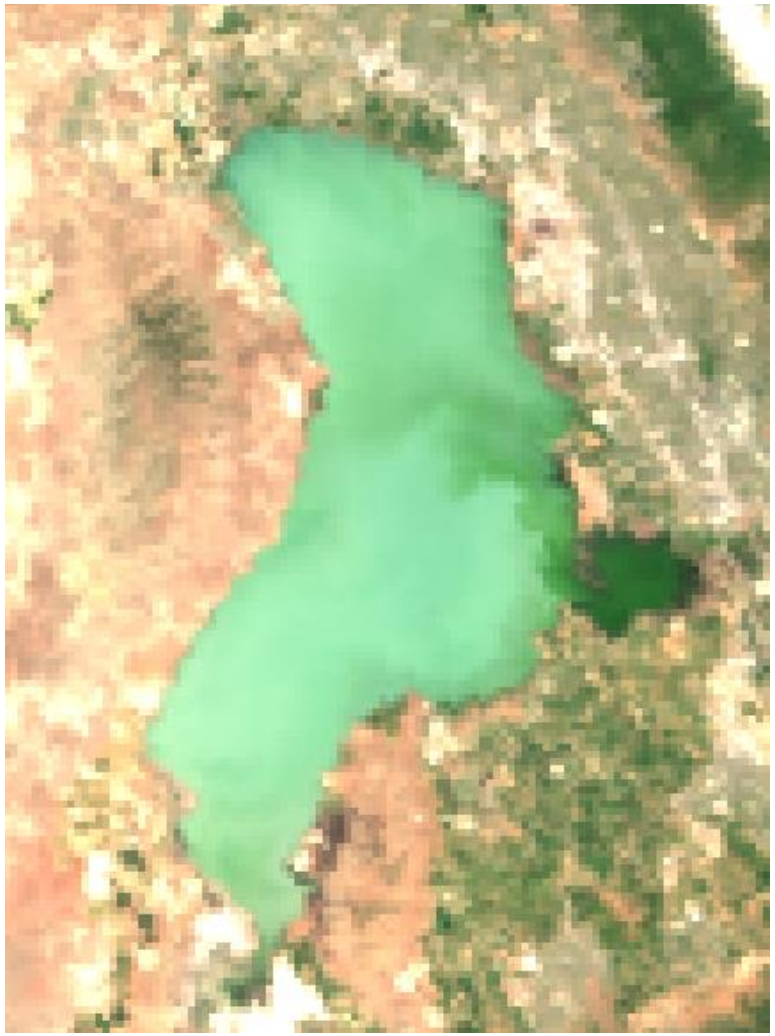
Algal bloom in Utah Lake's Provo Bay begins spreading north

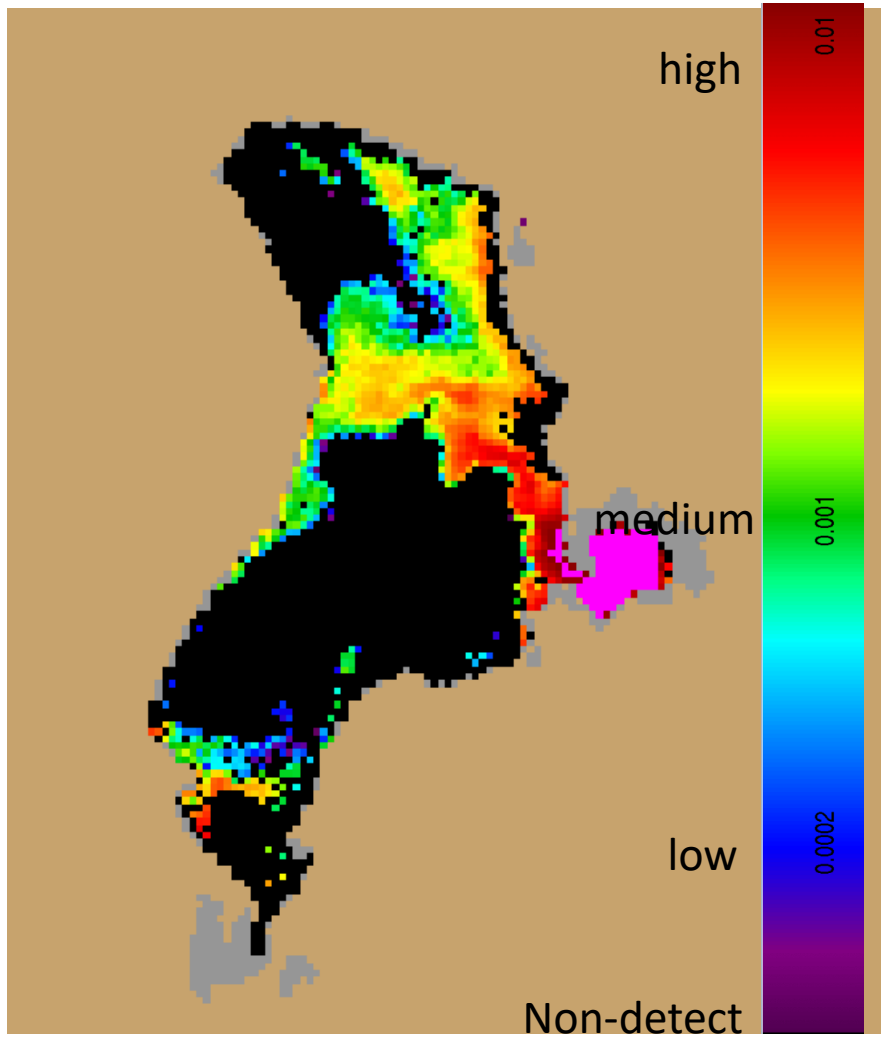
POSTED 4:45 PM, JUNE 30, 2017, BY MARK GREEN, *UPDATED AT 04:48PM, JUNE 30, 2017*

Satellite images show the bloom heading north, following a similar pattern to that seen with last year's bloom that shut down Utah Lake. The press

June 29, 2017

(one of the largest freshwater lakes in western U.S.)

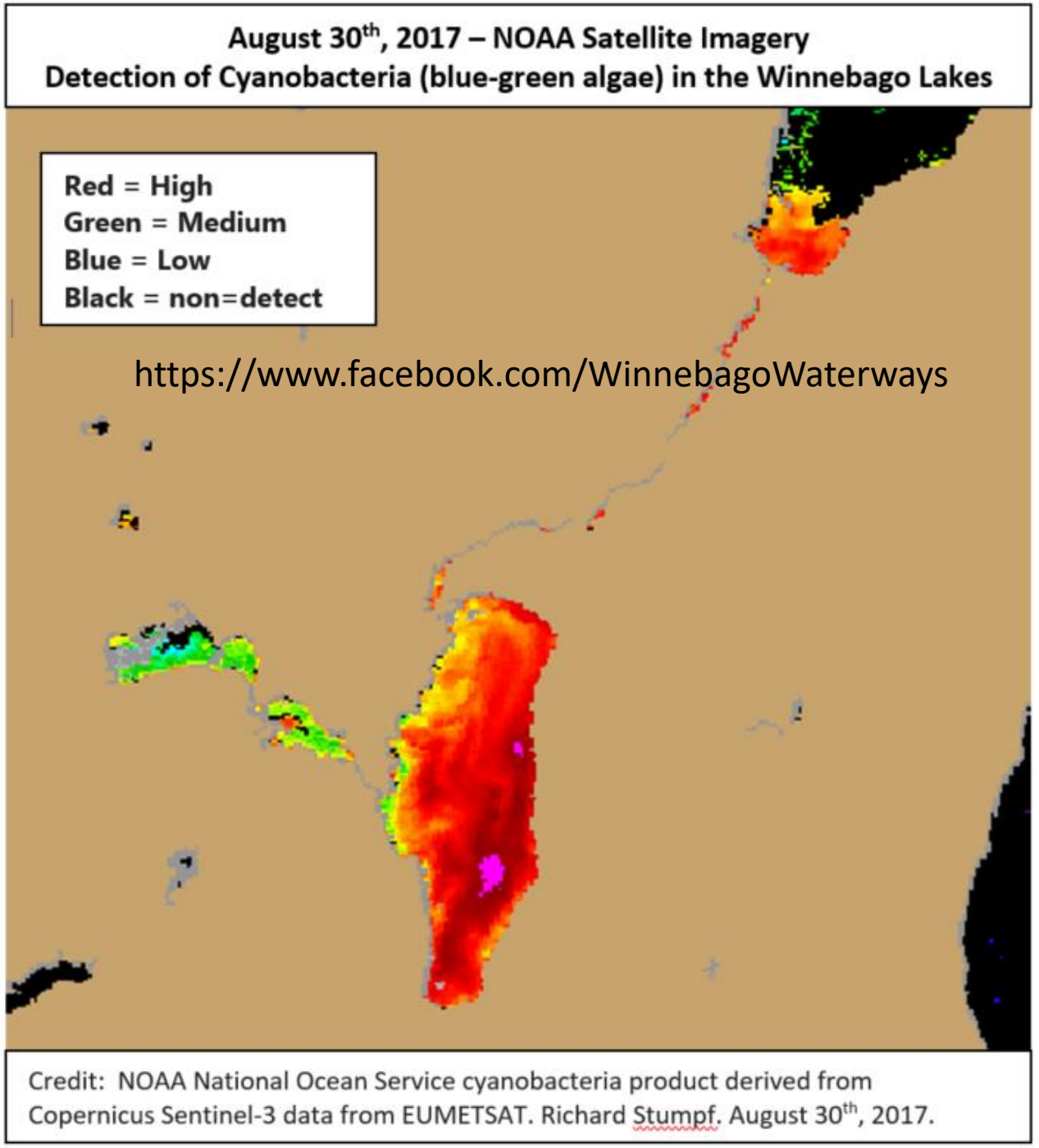




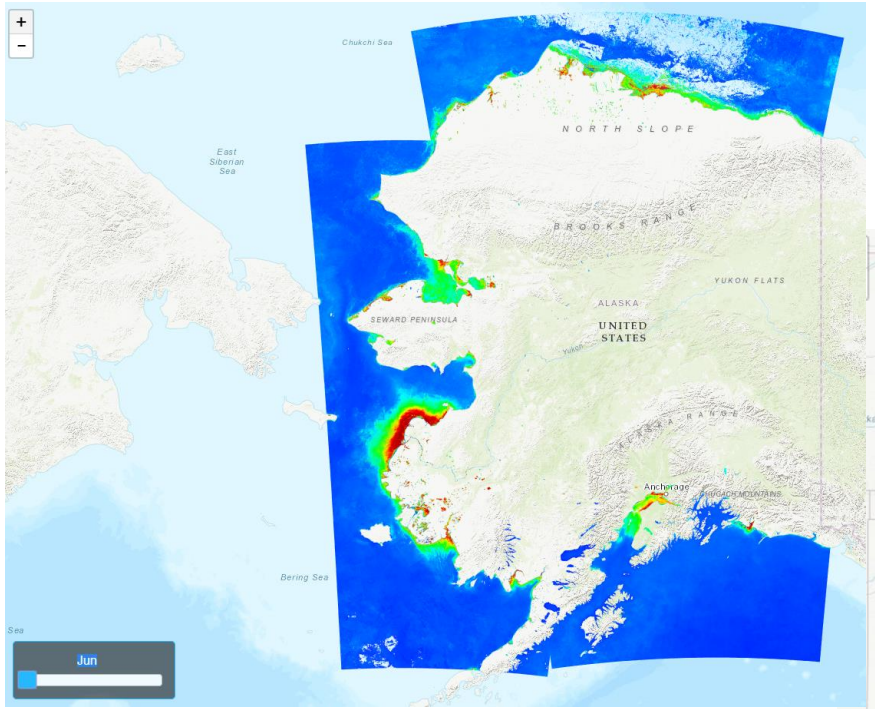
Wisconsin, CyAN intersects with GLRI

- Wisconsin DNR
- Univ. Wisconsin
- Lake Winnebago Mgmt
- Public Water Suppliers

Planning for sampling

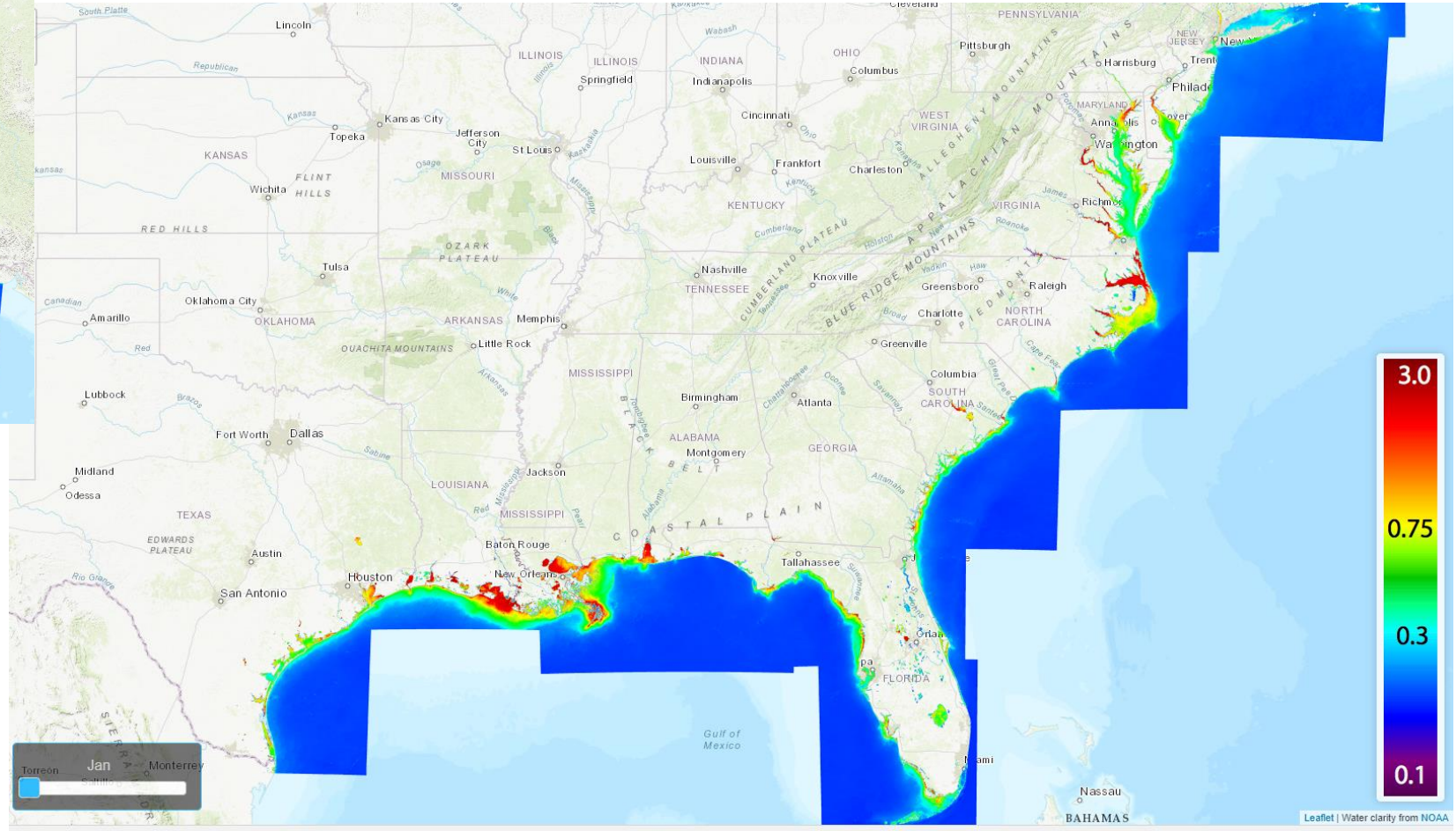


Collateral benefits of our program. Other products, retrospective and real-time



Water clarity climatology for lidar mission planning

www.ngs.noaa.gov/RSD/topobathy.shtml



HAB Subpriority Focus Area 3: Volunteer observation opportunities through the Phytoplankton Monitoring Network (PMN) to educate citizens, test new technologies and inform managers of onset of bloom events

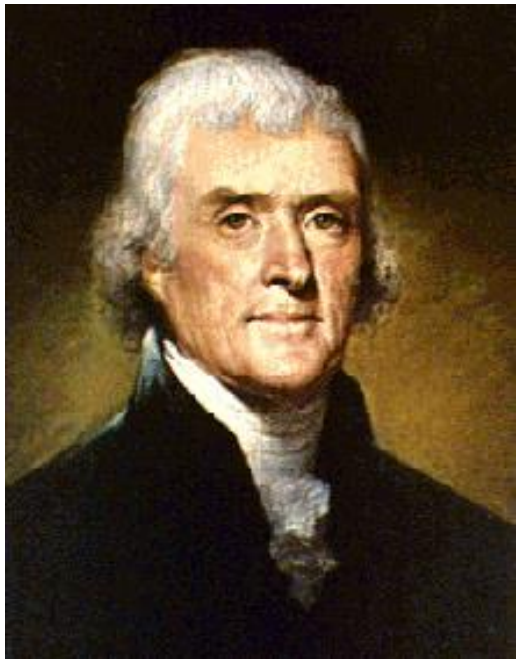
Promoting a better understanding of Harmful Algal Blooms by way of volunteer monitoring.

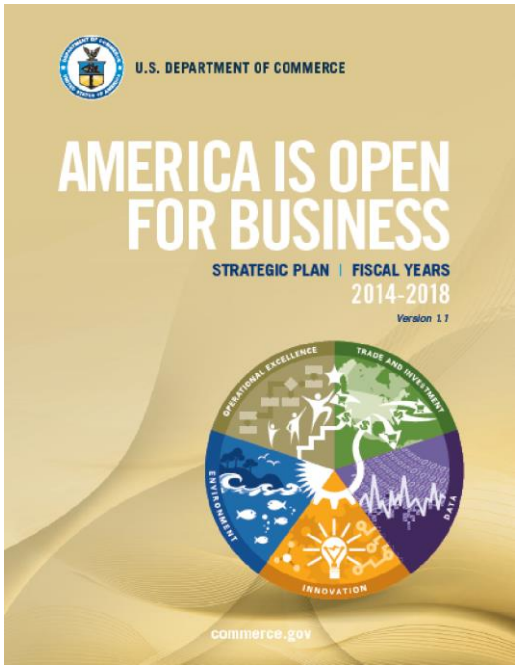
Steve L. Morton, Ph.D.
Research Oceanographer
SDI Division
HAB Monitoring & Reference Branch

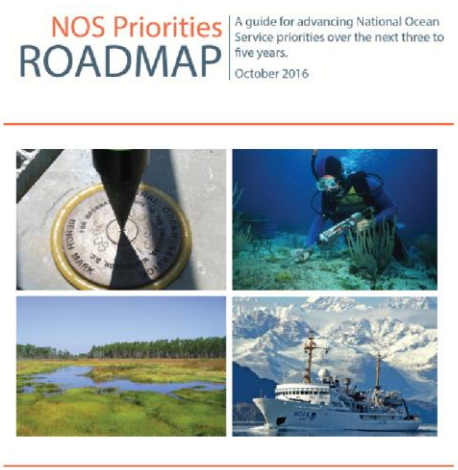
NOAA National Centers for Coastal Ocean Science

http://www.chbr.noaa.gov/pmn/

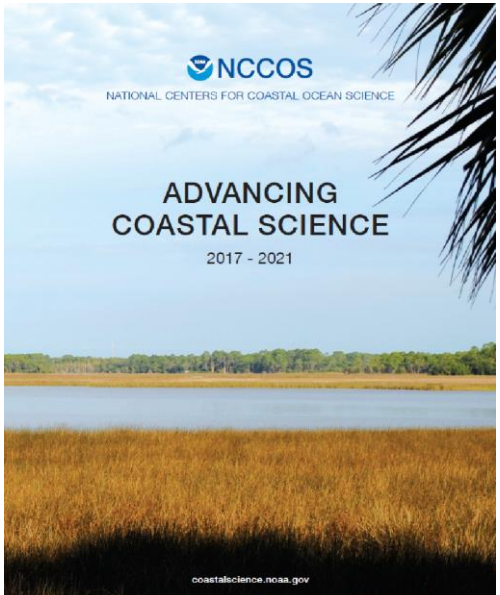
Foundation of citizen science in NOAA







Thomas Jefferson in 1776 launched the volunteer weather observers in Virginia which expanded to five states and then nationwide to the development of the Cooperative Observer Program.



NATIONAL CENTERS FOR COASTAL OCEAN SCIENCE

Science Serving Coastal Communities

PHYTOPLANKTON MONITORING NETWORK

Credit: Gary Freitag and Barbara Morgan

PMN aims to educate the public on harmful algal blooms (HABs) while expanding the knowledge of phytoplankton that exist in coastal waters through research based monitoring.

OVERVIEW

Volunteer Equipment

OVERVIEW

Volunteers are loaned all sampling equipment *except* light microscopes for monitoring!

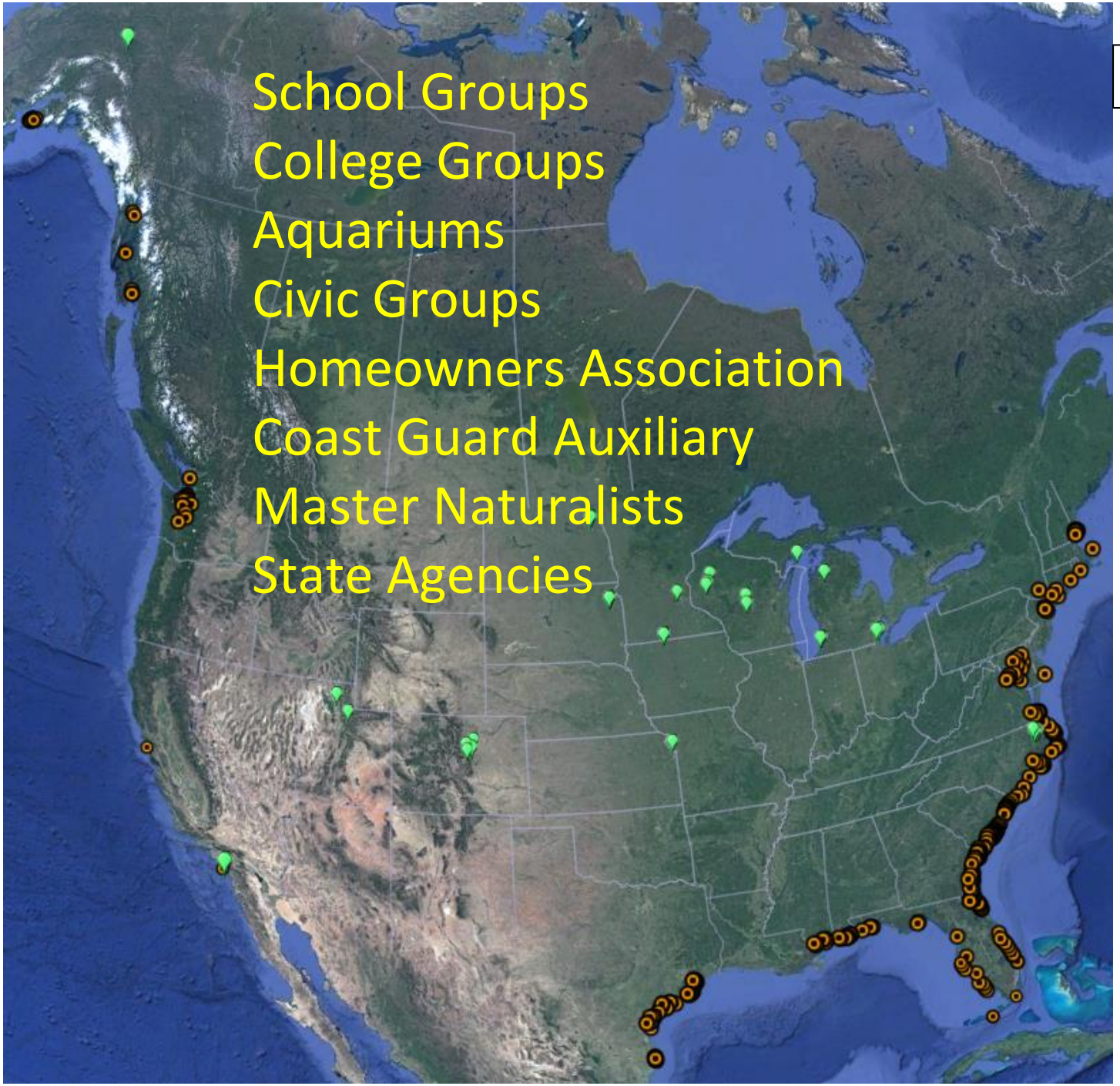
Photo credit: Elizabeth Zerai

- Refractometer
- 20 µm mesh plankton net
- Thermometer
- 5 gridded slides
- Cover slips
- 250 mL bottles
- 1L bottles
- 15mL of Lugol's solution for preservation

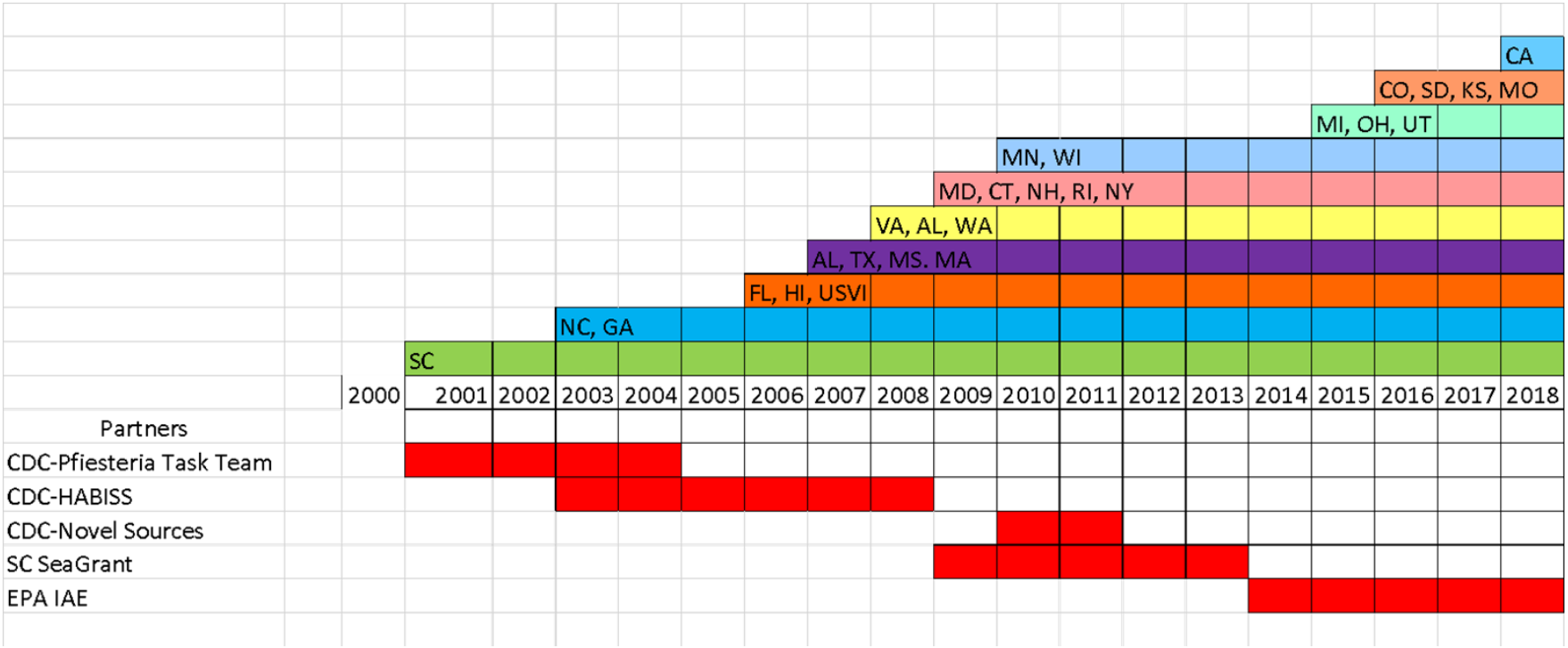
*Region specific volunteer manual

*The PMN manual has data sheets, phytoplankton ID sheets, and HAB information specific to volunteer's local coastal waters.

OVERVIEW


School Groups
College Groups
Aquariums
Civic Groups
Homeowners Association
Coast Guard Auxiliary
Master Naturalists
State Agencies

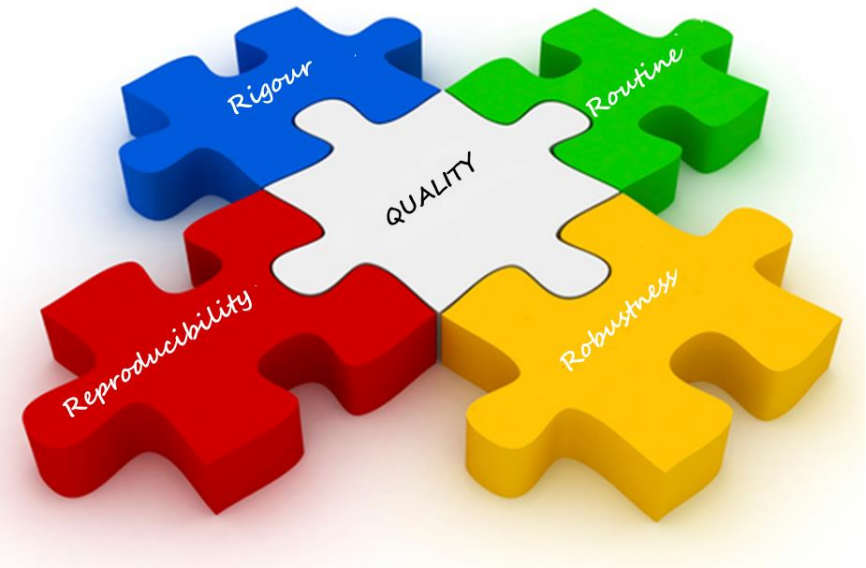
PMN Development Timeline



OVERVIEW

Quality Measures

A measure of soundness, accuracy and reproducibility of a specific body of research



Rigour - A certain level of experience and training that provides an appropriate level of circumspection.

Reproducibility - The use of multiple approaches to address a question.

Routine - The management of quality.

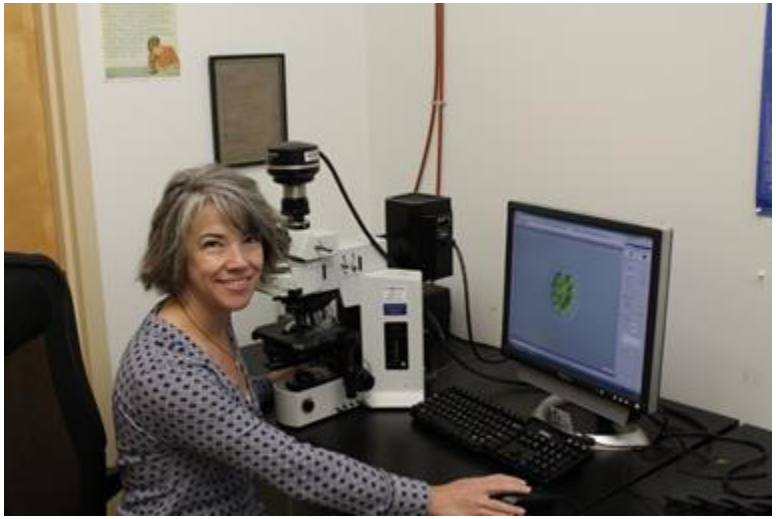
Robustness - That which is credibly inferred from the application of our findings.

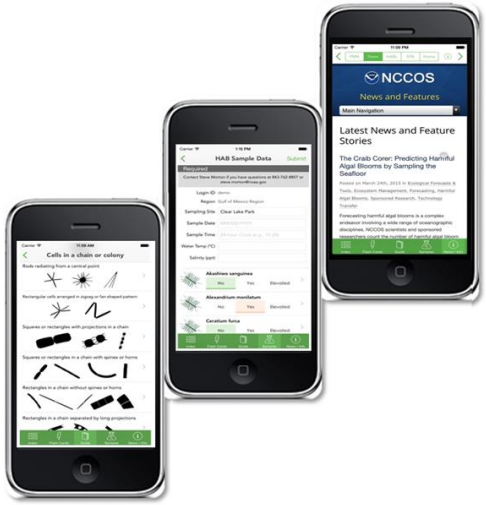
QUALITY

Use of Technology

Rigour: combination of staff experience & use of tools delivers quality results:

Interfacing users with technology

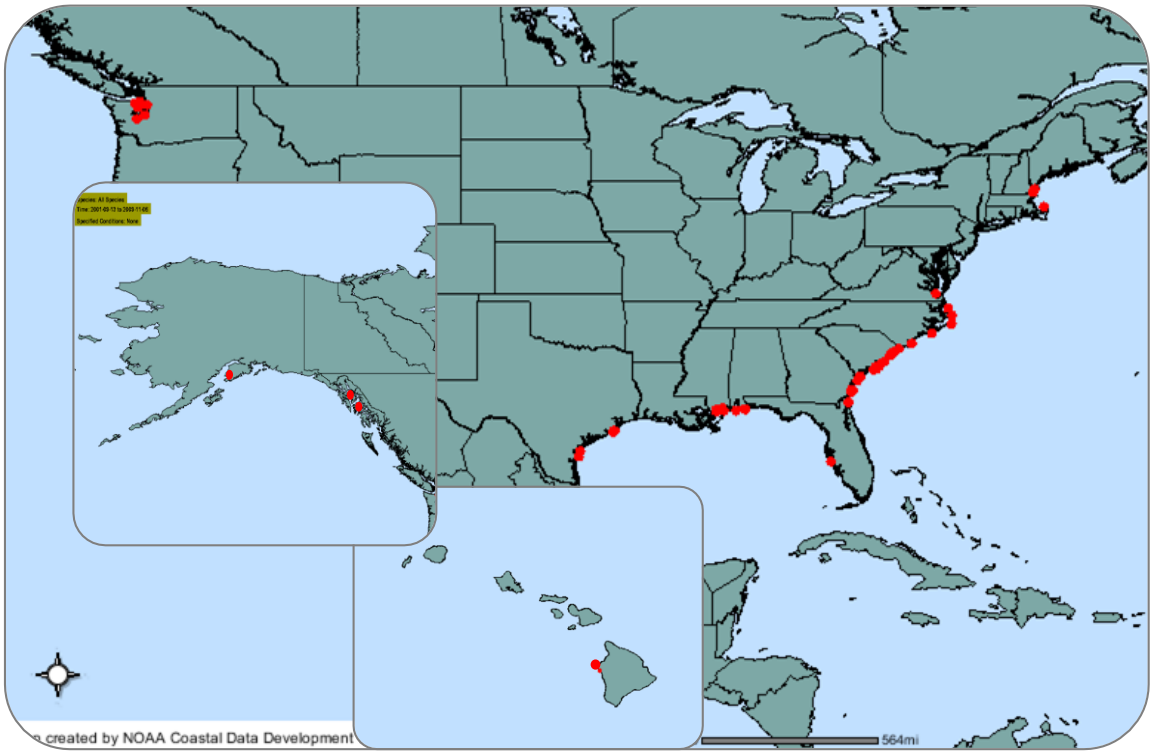




QUALITY

Phytoplankton Monitoring Network

Bloom Events from 2001 – 2017



Volunteer Reported Blooms > 200

Non-harmful species > 150

Potentially toxic species = 37

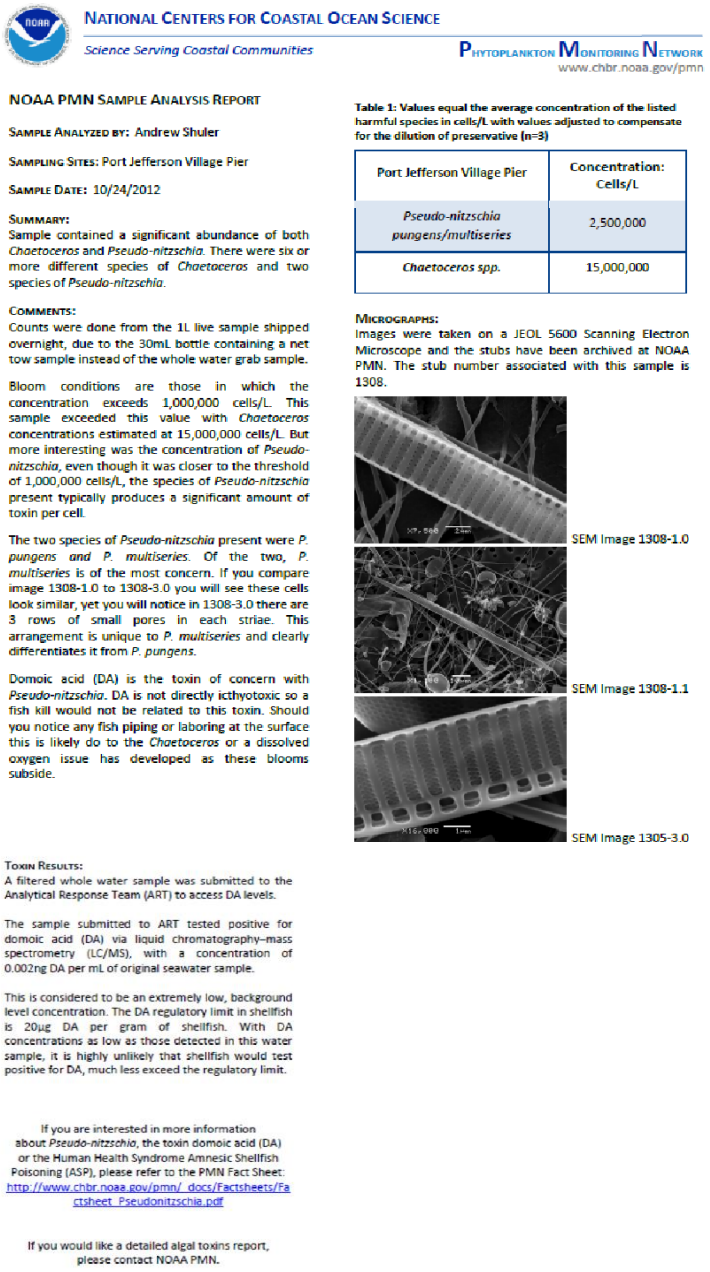
Confirmed toxic events = 12

- 9 Domoic Acid
  - Texas = 3
  - Mississippi = 2
  - North Carolina = 2
  - Alaska=2
- 1 Okadaic Acid
  - Texas
- 2 Saxitoxin
  - Alaska

Reproducibility: A large volunteer network and lab-based toxin analysis uses multiple approaches to identify toxic blooms

QUALITY

PMN Data Reports



NATIONAL CENTERS FOR COASTAL OCEAN SCIENCE
Science Serving Coastal Communities
PHYTOPLANKTON MONITORING NETWORK
www.chbr.noaa.gov/pmn

NOAA PMN SAMPLE ANALYSIS REPORT

SAMPLE ANALYZED BY: Andrew Shuler

SAMPLING SITES: Port Jefferson Village Pier

SAMPLE DATE: 10/24/2012

SUMMARY:
Sample contained a significant abundance of both *Chaetoceros* and *Pseudo-nitzschia*. There were six or more different species of *Chaetoceros* and two species of *Pseudo-nitzschia*.

COMMENTS:
Counts were done from the 1L live sample shipped overnight, due to the 30mL bottle containing a net tow sample instead of the whole water grab sample.

Bloom conditions are those in which the concentration exceeds 1,000,000 cells/L. This sample exceeded this value with *Chaetoceros* concentrations estimated at 15,000,000 cells/L. But more interesting was the concentration of *Pseudo-nitzschia*, even though it was closer to the threshold of 1,000,000 cells/L, the species of *Pseudo-nitzschia* present typically produces a significant amount of toxin per cell.

The two species of *Pseudo-nitzschia* present were *P. pungens and P. multiseries*. Of the two, *P. multiseries* is of the most concern. If you compare image 1308-1.0 to 1308-3.0 you will see these cells look similar, yet you will notice in 1308-3.0 there are 3 rows of small pores in each striae. This arrangement is unique to *P. multiseries* and clearly differentiates it from *P. pungens*.

Domoic acid (DA) is the toxin of concern with *Pseudo-nitzschia*. DA is not directly icthyotoxic so a fish kill would not be related to this toxin. Should you notice any fish piping or laboring at the surface this is likely do to the *Chaetoceros* or a dissolved oxygen issue has developed as these blooms subside.

TOXIN RESULTS:
A filtered whole water sample was submitted to the Analytical Response Team (ART) to access DA levels.

The sample submitted to ART tested positive for domoic acid (DA) via liquid chromatography–mass spectrometry (LC/MS), with a concentration of 0.002ng DA per mL of original seawater sample.

This is considered to be an extremely low, background level concentration. The DA regulatory limit in shellfish is 20ug DA per gram of shellfish. With DA concentrations as low as those detected in this water sample, it is highly unlikely that shellfish would test positive for DA, much less exceed the regulatory limit.

If you are interested in more information about *Pseudo-nitzschia*, the toxin domoic acid (DA) or the Human Health Syndrome Amnesic Shellfish Poisoning (ASP), please refer to the PMN Fact Sheet: http://www.chbr.noaa.gov/pmn/_docs/Factsheets/Factsheet_Pseudonitzschia.pdf

If you would like a detailed algal toxins report, please contact NOAA PMN.

Table 1: Values equal the average concentration of the listed harmful species in cells/L with values adjusted to compensate for the dilution of preservative (n=3)

Port Jefferson Village Pier	Concentration: Cells/L
Pseudo-nitzschia pungens/multiseries	2,500,000
Chaetoceros spp.	15,000,000

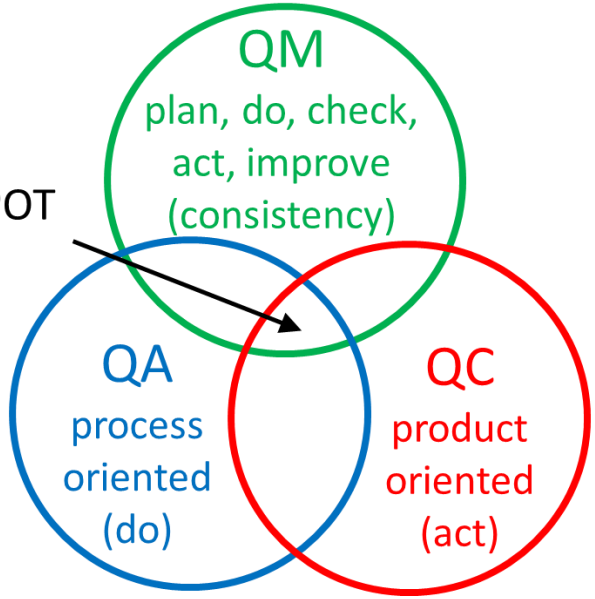
MICROGRAPHS:
Images were taken on a JEOL 5600 Scanning Electron Microscope and the stubs have been archived at NOAA PMN. The stub number associated with this sample is 1308.

SEM Image 1308-1.0

SEM Image 1308-1.1

SEM Image 1305-3.0

SWEET SPOT



Routine: Quality of data reporting is maintained through an emphasis on a QA, QC, QM process for reports.

QUALITY

360° recognition of PMN quality

- 2016 NOS Team member of the Year
- 2016 NOAA Administrator's Award
- 2015 Bronze Medal Award
- 2008 Bronze Medal Award

- First Flight H.S. won the Governor's Award for Environmental Stewardship
- MTS and IEEE Grants (totaling $15,000)
- Students presented at Oceans 15 and 16

Sitka Tribe of Alaska awarded Outstanding Achievement Award and the Environmental Excellence Award at the 2017 Alaska Forum on the Environment

QUALITY

PERFORMANCE

SMARTER

Specific | Measurable | Attainable | Relevant | Timely | Evaluate | Reward

DELIVERABLES REPORTABLE TO SUPERVISOR

SDI WEEKLY - Activities and Accomplishments
NCCOS | Stressor Detection and Impacts Division
Week of November 6-10, 2017

The SDI Weekly is a list of SDI's current and upcoming activities, accomplishments and relevant news, to be sent out every Friday, to inform NCCOS. It includes related activities from staff in the NCCOS Competitive Research Program (CRP, formerly CSCOR). If you have questions, please ask the contacts in the item of interest, Tracy Gill, or the SDI and CRP branch chiefs; thanks.

Nov. 8 | **New** Three Federal Funding Opportunities (FFO) released on Grants.gov
(1) Understanding Coral Ecosystem Connectivity in the western Gulf of Mexico (Due: Feb 9, 2018)
(2) Coastal Hypoxia Research Program (Due: Jan 30, 2018)
(3) Identification and application of acidification thresholds in coastal ecosystems (Letters of Intent Due: Dec 8, 2017)
Contacts: Kimberly.Puglise@noaa.gov (FFO #1 and 2), Beth.Turner@noaa.gov (FFO #3) (CRP)

Nov. 6-8 | **New** Dr. Cheryl Woodley of NCCOS Charleston is an invited participant of a Coral Disease Workshop organized by resource agencies of the State of Florida and hosted by Nova Southeastern University Oceanographic Center in Dania Beach, FL. The workshop is in response to an ongoing coral disease outbreak along the Florida Reef Tract since 2014, that has affected 23 species with a tissue-loss disease of unknown etiology. The meeting objectives are to discuss intervention and treatment methodologies and associated constraints, create a FL Reef Tract-wide sampling plan, and develop plans for interdisciplinary analysis of existing and future samples. These discussions will engage veterinarians, permitting agencies and animal health experts regarding data needs and strategies to engage in field-based interventions within existing regulatory frameworks. Contact: Cheryl.Woodley@noaa.gov (SDI/Key Species & Bioinformatics)

Nov 3-4 | **New** Jen Maucher-Fuquay of the NOAA's Phytoplankton Monitoring Program held a comprehensive volunteer training workshop at North Carolina State University's Center for Marine Sciences and Technology in Morehead City. Participants included Carteret County educators, NC Aquarium and North Carolina State University Center for Marine Sciences and Technology (CMAST) staff. The first session covered marine phytoplankton protocols and IDs, with a plankton tow demonstration and identification of phytoplankton. The second session focused on the relatively new freshwater monitoring program and its protocols, with additional microscopic identification of fixed and fresh samples. Contact: Steve.morton@noaa.gov (SDI/HAB Monitoring and Reference).

Nov. 1-2 | **New** NCCOS Charleston staff Sherri Fields, Marie DeLorenzo, James Daugomah, and Steve Morton attended the NOAA Diversity and Inclusion Summit. The goal of the Summit was to foster a culture of inclusion within NOAA that will lead to a more diverse and successful workforce. There were speakers from NOAA , as well as guest speakers, with respect for others being a key theme. The presenters shared their personal perspectives and experiences, as well as tools and resources to use for promoting diversity and inclusion. Contact: Marie.DeLorenzo@noaa.gov (SDI/Ecotoxicology).

Oct. 26 - Nov. 2 | **New** Several discussions have been held regarding a possible Great Lakes pilot study to determine if dreissenid mussels can be used effectively to monitoring microplastic pollution. Mark Banaszak Holl, professor at University of Michigan gave an invited presentation to NCCOS, OAR, and ORR scientists on work being done in his lab to measure microplastic dreissenid mussels under controlled laboratory conditions. Follow-on discussions with staff from NOAA's Marine Debris Program, NOAA/OAR/Great Lakes Environmental Research Laboratory and NCCOS Great Lakes Mussel Watch has resulted in an agreement to collaborate. The Great Lakes Mussel Watch team will share archived mussel samples with the Banaszak Holl laboratory who will determine if microplastics can be detected in these mussel samples exposed to WWTP outfall. A follow on Great Lakes field pilot study is planned for summer of 2018 with financial support provided by ORR/MDP. Contact: Ed.Johnson@noaa.gov (SDI/Monitoring and Assessment).

Oct - Nov. | The NCCOS Mussel Watch Program (MWP) has been conducting a series of regional studies on contaminants of emerging concern (CECs), in order to assess the feasibility of including some of these contaminants in the long-term monitoring program. Previous efforts included pilot studies in the Southern California Bight, the Great Lakes, Chesapeake Bay and Charleston Harbor. This year, a similar effort is being conducted in the Gulf of Mexico, where the collection of

PERFORMANCE

PMN AOP 18

Transition the National Phytoplankton Monitoring 2-G SmartPhone App to operations with new capabilities for freshwater HABs and volunteer data entry **Q2| Ramsdell** (Morton) COMPLETE

Operational Phytoplankton Monitoring sites in Native Alaska priority areas expanded to 7 tribal sites in Kodiak Island and 4 sites in the arctic areas of Alaska **Q4| Ramsdell** (Morton)

Develop a model-based and monitoring-friendly tool (hand-held "tricorder") that can be used by managers to predict *K. veneficum* bloom toxicity and fish kills in brackish aquaculture facilities and shallow coastal areas. Transition tricorder to Readiness Level 7-8 for integration into the Phytoplankton Monitoring Network and GCOOS. **Q4 | Lewitus** (Wickman)

Enhanced data serving capacity and visualization of the PMN dataset

Developed as part of the Presidential mandated Big Earth Data Initiative

- Discover: improve metadata in archives to make datasets more discoverable by popular search engines (e.g., Google or Bing)
- Access: Develop better web accessible APIs by improving geospatial coordinate handling and response formats
- Use: Improve compatibility with commercial GIS software (e.g., Esri)

Environmental Research Division Data Access Program (ERDDAP) database developed by NOAA-NCEI

- Easier Access to Scientific Data
- Output data into many formats

RELEVANCE

Examples of Data Usage

USGS science for a changing world

Downloaded all estuarine salinity data for tide gauge models

UNIVERSITY OF SOUTH CAROLINA

Uses HAB distribution in Southeast for use in *Vibrio* model

NATIONAL INTEGRATED DROUGHT INFORMATION SYSTEM NIDIS Drought.gov U.S. Drought Portal

Downloaded all phytoplankton data to determine ecological changes due to drought

ROFFS™ ROFFER'S OCEAN FISHING FORECASTING SERVICE, INC.

Warns end users to HAB conditions

NOAA FISHERIES SERVICE Northeast Fisheries Science Center NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

PMN data to be included in the FY18 annual State of the Ecosystem report

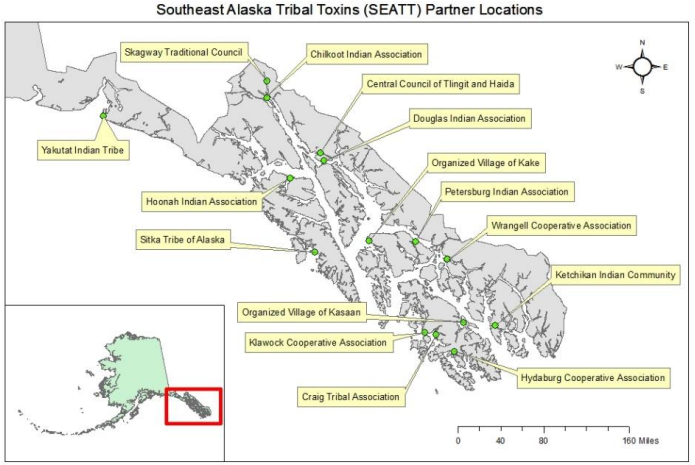
RELEVANCE

Outcome Story: Alaskan Tribal monitoring of toxic phytoplankton

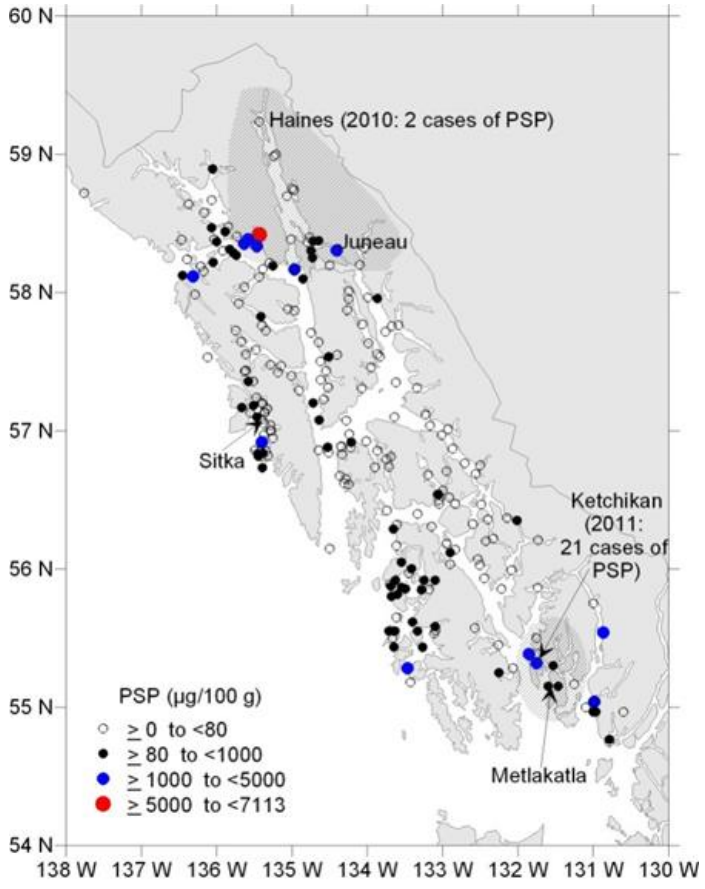
SEATOR
Culture
Science
Community
Southeast Alaska Tribal Ocean Research

SARDFA
Southeast Alaska Regional Dive Fisheries Association

Utilization of PMN sampling and identification techniques was the first step in the creation of the Southeast Alaska Tribal Ocean Research (SEATOR) program



Outcome: Enable tribal communities to harvest traditional shellfish sources safely and mitigate the threat of harmful algal blooms through phytoplankton sampling coupled with toxin detection

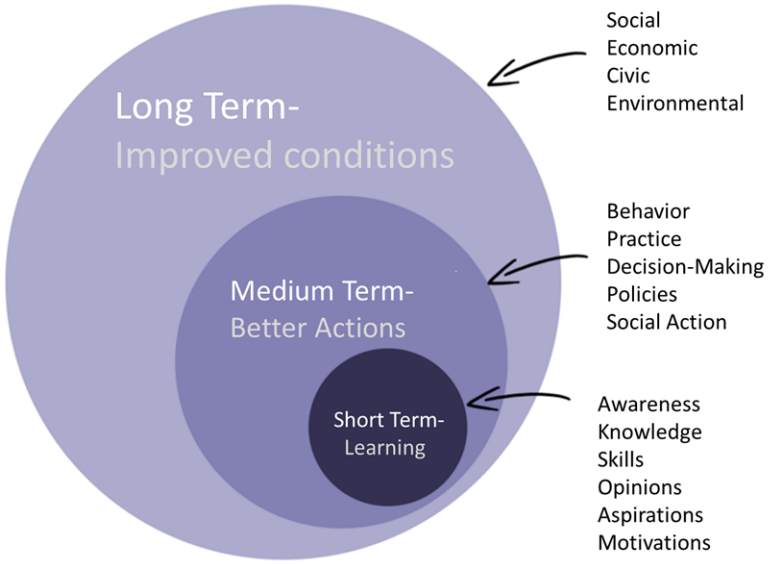


Maximum PSP toxins (1991-2011)
PSP cases (2010-2011)

During summer 2017, similar PSP toxin concentrations were observed as 2010-2011. Due to the alerts posted to the tribal communities participating in the SEATOR program in 2017, no deaths or illness were reported.

Outcome Summary
Phytoplankton Monitoring Network

NOS-EPA
Agreement of HABs
in Freshwater Lakes
Antonio Bravo
2:20 pm today



Building Capacity-
Tribal Laboratory
Networks and
Response Capabilities
Chris Whitehead
3:45 pm today

Societal Benefits: PMN provides a cost effective method to educates constituent groups on HAB while providing researchers usable environmental data and phytoplankton observations

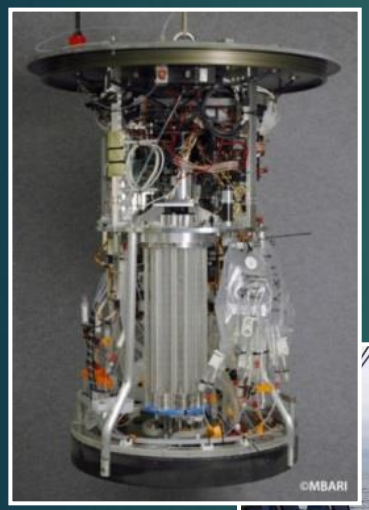
HAB Sub-Priority Focus Area 4:

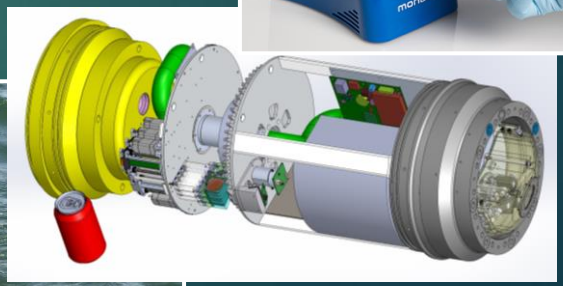
HAB Detection Technologies Supporting Forecasts, Providing Early Warnings, and Improving Our Understanding of HAB Dynamics

Gregory J. Doucette, Ph.D.

Research Oceanographer

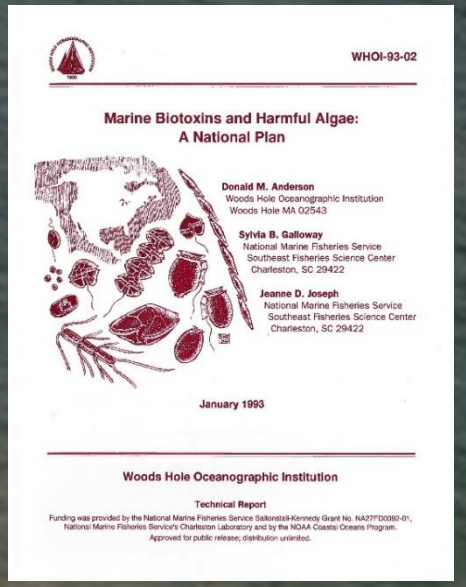
HAB Monitoring & Reference Branch





Intramural HAB Detection R&D Program - Aligned with National Priorities

Concept for autonomous, in-situ detection of HAB species and toxins has its roots in the meeting that produced the document, "Marine Biotoxins & Harmful Algae: A National Plan" (Charleston, SC; 1992)



WHOI-93-02

Marine Biotoxins and Harmful Algae:
A National Plan

Donald M. Anderson
Woods Hole Oceanographic Institution
Woods Hole MA 02543

Sylvia B. Galloway
National Marine Fisheries Service
Southeast Fisheries Science Center
Charleston, SC 29422

Jeanne D. Joseph
National Marine Fisheries Service
Southeast Fisheries Science Center
Charleston, SC 29422

January 1993

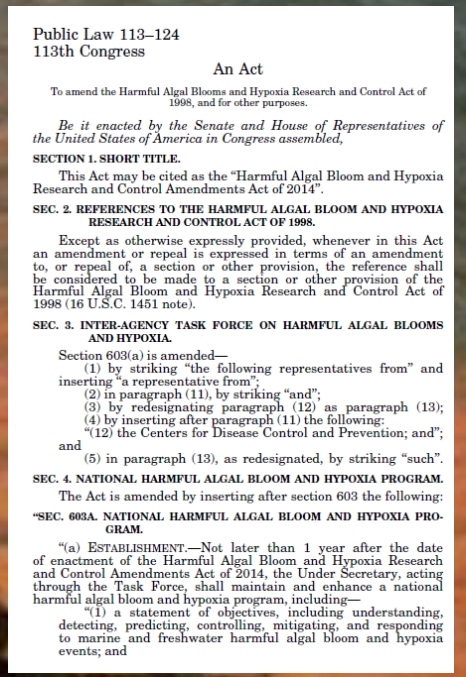
Woods Hole Oceanographic Institution

Technical Report

Funding was provided by the National Marine Fisheries Service Saltonstall-Kennedy Grant No. NA27FD0092-01, National Marine Fisheries Service's Charleston Laboratory and by the NOAA Coastal Oceans Program.

Approved for public release; distribution unlimited.

HABHRCA Re-Auth. 2014 (*Amend. Act 2017*); Section 603A. (f) (3): develop and enhance, including with respect to infrastructure, *which shall include unmanned systems*, as necessary, critical observations, monitoring,…and operational forecasts relevant to harmful algal blooms and hypoxia events



Public Law 113–124
113th Congress

An Act

To amend the Harmful Algal Blooms and Hypoxia Research and Control Act of 1998, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,

SECTION 1. SHORT TITLE.

This Act may be cited as the "Harmful Algal Bloom and Hypoxia Research and Control Amendments Act of 2014".

SEC. 2. REFERENCES TO THE HARMFUL ALGAL BLOOM AND HYPOXIA RESEARCH AND CONTROL ACT OF 1998.

Except as otherwise expressly provided, whenever in this Act an amendment or repeal is expressed in terms of an amendment to, or repeal of, a section or other provision, the reference shall be considered to be made to a section or other provision of the Harmful Algal Bloom and Hypoxia Research and Control Act of 1998 (16 U.S.C. 1451 note).

SEC. 3. INTER-AGENCY TASK FORCE ON HARMFUL ALGAL BLOOMS AND HYPOXIA.

Section 603(a) is amended—

(1) by striking "the following representatives from" and inserting "a representative from";

(2) in paragraph (11), by striking "and";

(3) by redesignating paragraph (12) as paragraph (13);

(4) by inserting after paragraph (11) the following:

"(12) the Centers for Disease Control and Prevention; and"; and

(5) in paragraph (13), as redesignated, by striking "such".

SEC. 4. NATIONAL HARMFUL ALGAL BLOOM AND HYPOXIA PROGRAM.

The Act is amended by inserting after section 603 the following:

"SEC. 603A. NATIONAL HARMFUL ALGAL BLOOM AND HYPOXIA PROGRAM.

"(a) ESTABLISHMENT.—Not later than 1 year after the date of enactment of the Harmful Algal Bloom and Hypoxia Research and Control Amendments Act of 2014, the Under Secretary, acting through the Task Force, shall maintain and enhance a national harmful algal bloom and hypoxia program, including—

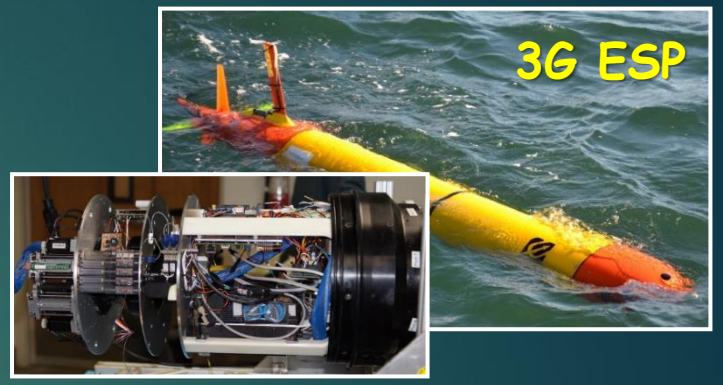
"(1) a statement of objectives, including understanding, detecting, predicting, controlling, mitigating, and responding to marine and freshwater harmful algal bloom and hypoxia events; and

OVERVIEW

© PJS Franks

The Vision: in late 1990s, NOAA partnered with MBARI to develop technology enabling the autonomous, in-situ detection of HAB species & toxins
The Environmental Sample Processor (ESP), centerpiece of NCCOS' HAB sensor development effort, aimed to address several long-standing challenges fundamental to effective HAB management & research
❖ "being there"
- autonomous, in-situ sample acquisition, processing, analysis
❖ "always on"
- extended, unattended offshore operations
OVERVIEW
adapted from C. Scholin
©MBARI

August 2000 *first* autonomous, subsurface HAB species detection; toxin detection in lab on archival material

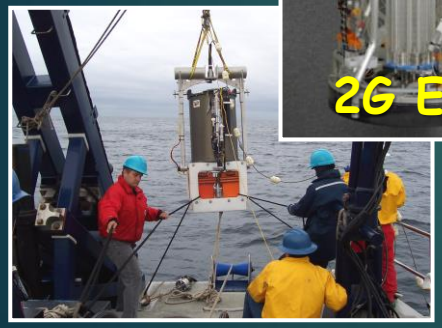


3 February, 2016 *first* HAB toxin detection in a long-range autonomous underwater vehicle

2000

2016

R&D Milestones for Environmental Sample Processor HAB Toxin Detection

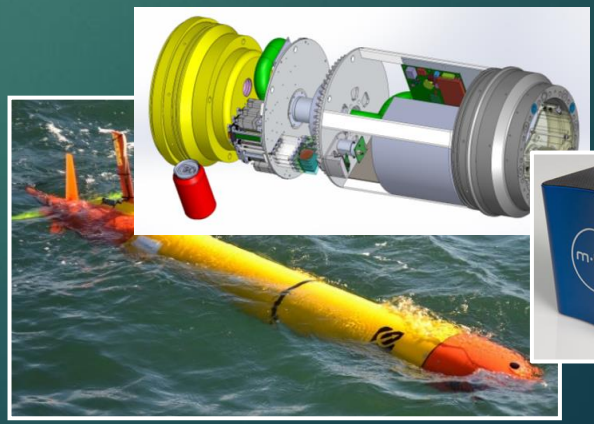


2006

11 April, 2006 *first* HAB toxin detection on an autonomous system below the ocean's surface

201?

R&D for waveguide-based Next Generation ESP



OVERVIEW

Every HAB toxin measurement made by an ESP instrument deployed in our Nation's coastal waters or Great Lakes, and reported in near-real time to a resource manager or other stakeholder, is made possible by detection technologies developed by our NCCOS intramural research program
NCCOS
= ESP Deployment Locations

Over two decades, NCCOS' intramural research program to develop autonomous HAB species/toxin detection technology has demonstrated a commitment to quality, performance, & relevance

QUALITY

A measure of soundness, accuracy and reproducibility of a specific body of research

PERFORMANCE

An ability to manage to produce identifiable results, both effectively and efficiently

RELEVANCE

In essence this criterion asks for "what would not have happened if NCCOS did not exist, and how much would society have missed?"

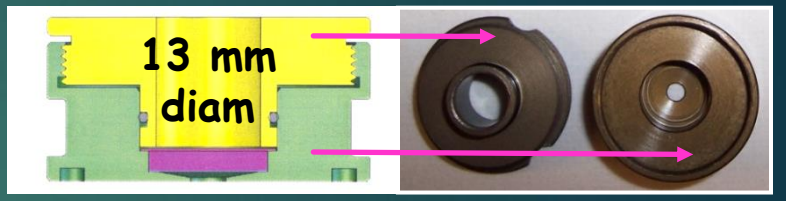
Let's dig a little deeper…

OVERVIEW

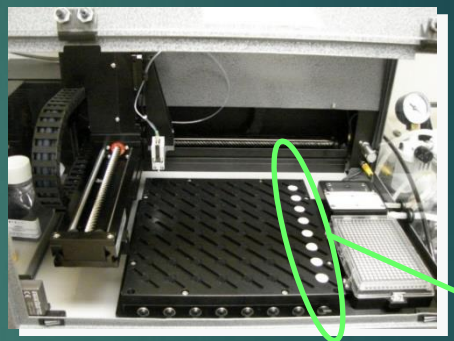
Science & Engineering – Technologies that Yield Consistently High-Quality, Actionable Data

- Work with MBARI engineers on design of hardware for ESP toxin sensor; assist McLane Research Labs to validate 'short puck' format for toxin sensor – *45% more samples per deployment (64 vs. 44)*
- Design & improve sensors for DA, PSTs, MCY; internal controls & replication; sensors "tuned" to optimize range/sensitivity - *reflects needs of resource & public health managers*
- Calibrate all toxin sensors using CRMs prior to ESP deployments - ensures quality of quantitative near-real time data provided to managers to *support decision making*

ELISA Small Array Format Puck

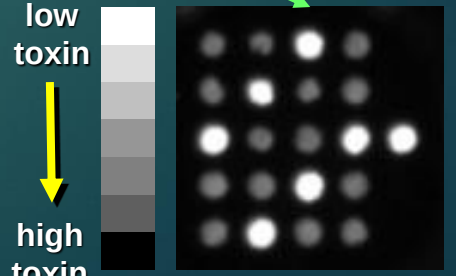


BioDot Protein Arrayer



'short puck' format

Pre-deployment Calibration



ELISA Toxin Array

QUALITY

Quality Management, Assurance, and Control Ensure Successful Mission Outcomes

- Concept of Operations (CONOPS)
- iterative improvements to harden & increase reliability of extended ESP operations

ESP Concept of Operations

Deployment name: ***ESPfriday Washington Coast*, May 2017, habda**

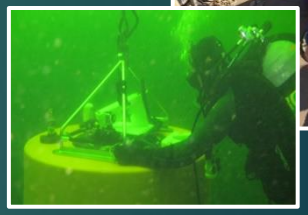
Objectives:

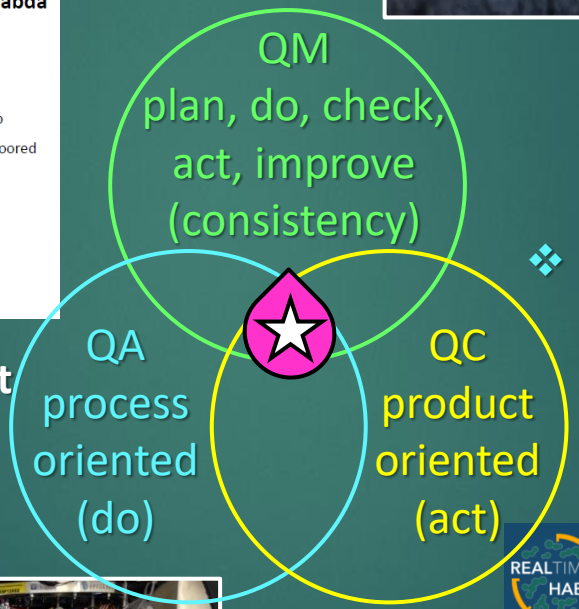
1. Third operational deployment of ESP on WA coast for IOOS OTT project
2. Monitor Pn and DA in Washington coastal waters
3. Deliver near real-time data to end-users via NANOOS NANOOS "Real-time HABs" web app

Deployment platform (mooring, drifter, pier, on shore, benthic, etc): Northwest Enhanced Moored Observatory (NEMO) sub-surface APL-designed mooring

Deployment locations:

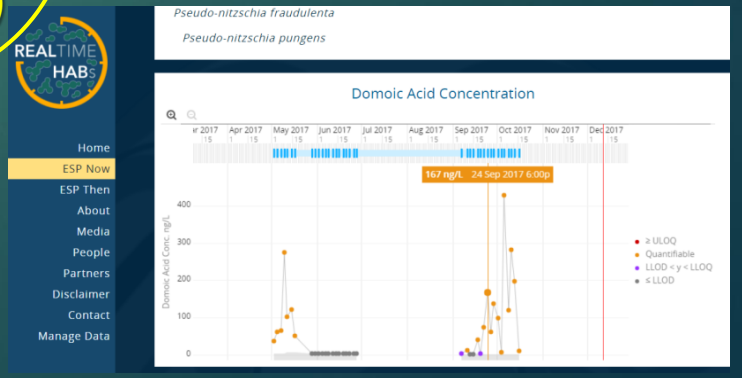
Location: Washington coast
Lat/Long: 47.9740°N, 124.9550°W (see Figure 2)
Target ESP Depth (m): 18 m (water pumped from ~2 m to ESP intake)
Bottom Depth (m): 100 m





- extensive sensor array/reagent quality & performance checks
- pre-deployment sensor calibration (CRM) & full-phase testing

- all sensor data analyzed & quality ensured prior to product being released to managers in *near-real time* via web-based tools

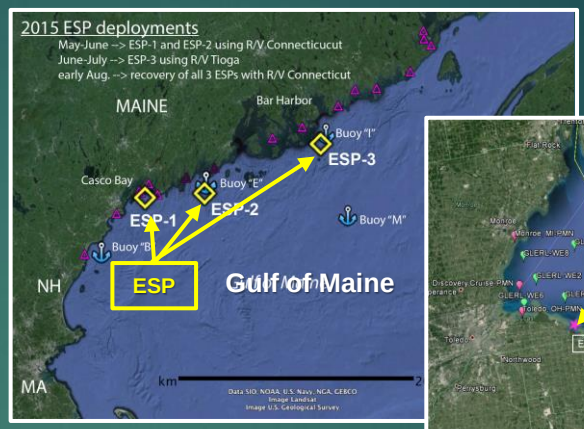


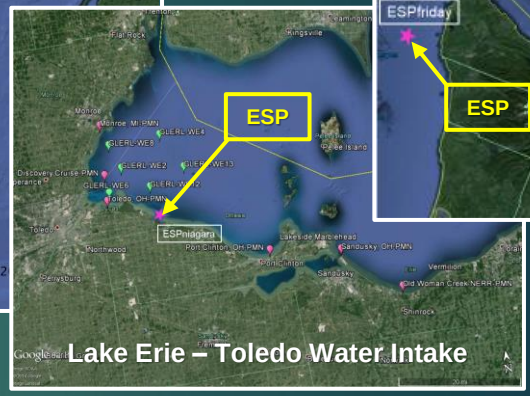
QUALITY

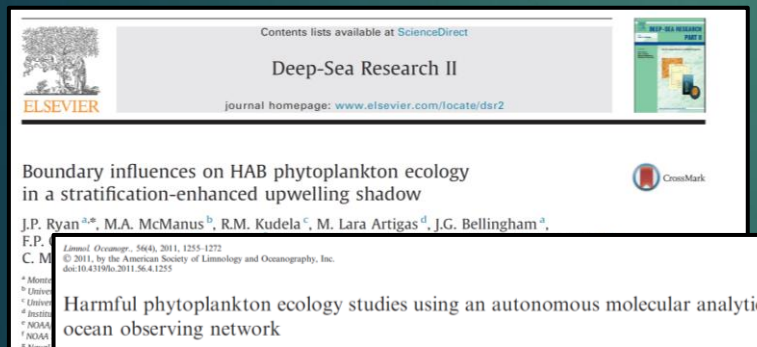
Reliable Detection Technology Performs in Multiple U.S. Coastal Regions & the Great Lakes

Our outputs target:

- Early warning of HAB toxicity to shellfish & water managers
- Near-real time data support operational & experimental regional HAB forecasts
- Insights on HAB & toxin dynamics improve predictive models





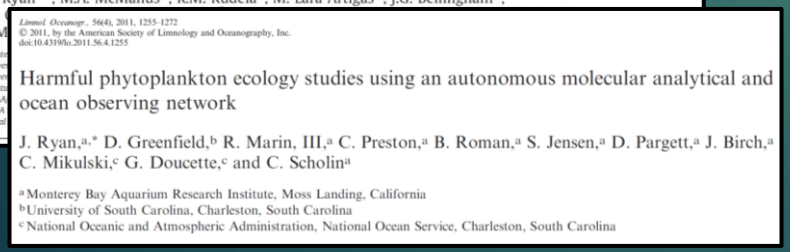

Contents lists available at ScienceDirect

Deep-Sea Research II

journal homepage: www.elsevier.com/locate/dsr2

Boundary influences on HAB phytoplankton ecology in a stratification-enhanced upwelling shadow

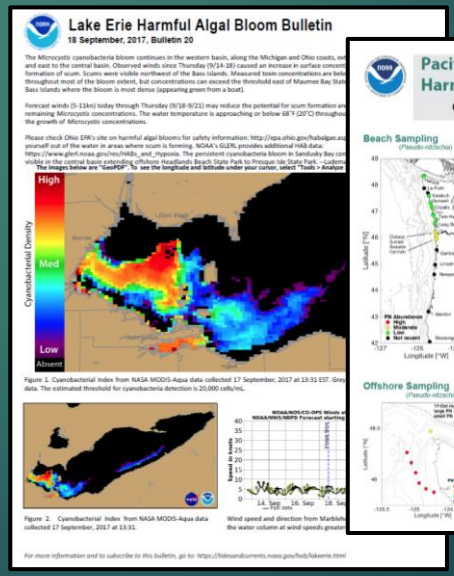
J.P. Ryan [a,*], M.A. McManus [b], R.M. Kudela [c], M. Lara Artigas [d], J.G. Bellingham [a],

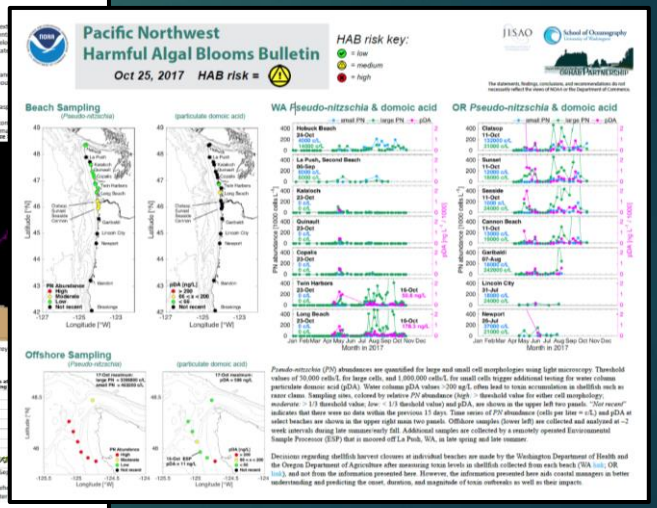

Limnol. Oceanogr., 56(4), 2011, 1255–1272
© 2011, by the American Society of Limnology and Oceanography, Inc.
doi:10.4319/lo.2011.56.4.1255

Harmful phytoplankton ecology studies using an autonomous molecular analytical and ocean observing network

J. Ryan,[a,*] D. Greenfield,[b] R. Marin, III,[a] C. Preston,[a] B. Roman,[a] S. Jensen,[a] D. Pargett,[a] J. Birch,[a] C. Mikulski,[c] G. Doucette,[c] and C. Scholin[a]

[a] Monterey Bay Aquarium Research Institute, Moss Landing, California
[b] University of South Carolina, Charleston, South Carolina
[c] National Oceanic and Atmospheric Administration, National Ocean Service, Charleston, South Carolina





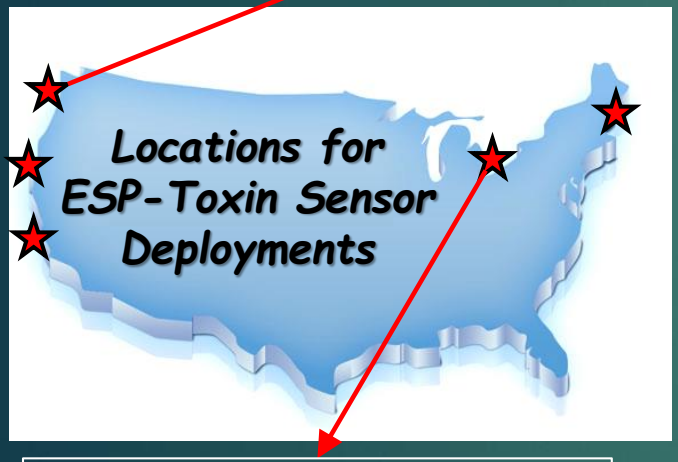
PERFORMANCE

In-situ, NRT observations of MCY will support toxicity models

Reliable Detection Technology that Performs in Multiple U.S. Coastal Regions & the Great Lakes

4 deployments - WA coast

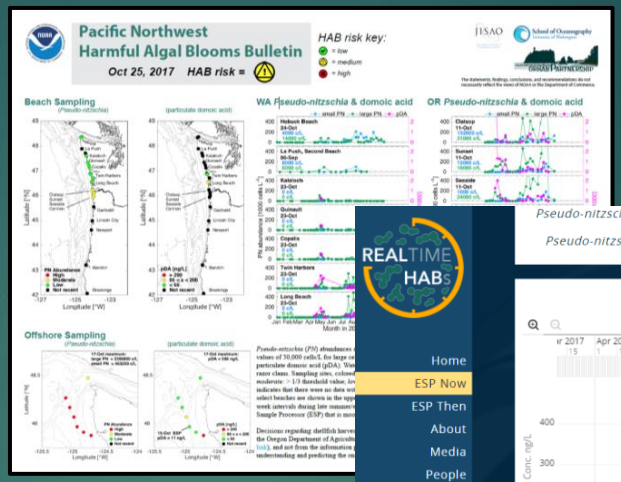
- Data displayed in near-real time on NANOOS NVS
- Supports PNW Experimental HAB Bulletin



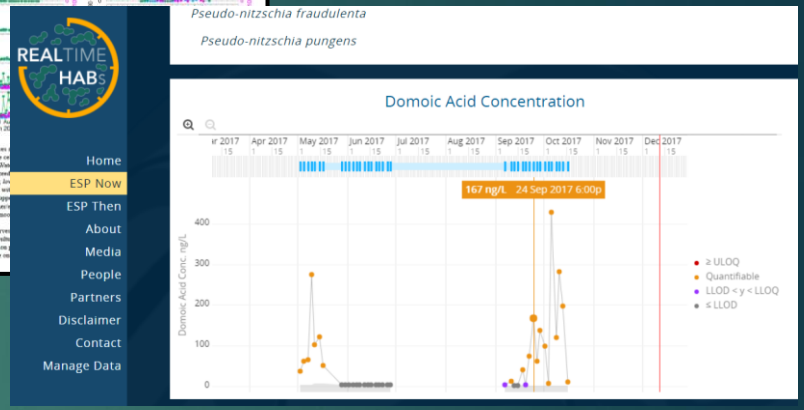
3 deployments - upstream of Toledo water intake

- Toxicity early warning to water managers
- Supports development of L Erie HAB toxicity forecast

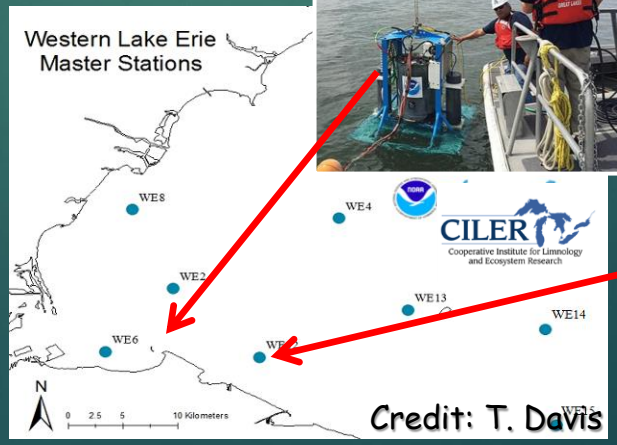
PERFORMANCE



Near-real time HAB species & toxin disseminated to resource managers via NANOOS NVS & included in Experimental PNW HAB Bulletin



First reporting to managers of toxin levels at surface and drinking water intake depths in near-real time



Reliable Detection Technology Yields Deliverables that Track to NCCOS AOP Milestones and the HAB Sub-Priority Area Implementation Plan

FY17 MILESTONE 6 I HAB Detection Technologies. Protect public safety and improve HAB and toxin detection and modeling by…supporting deployment of toxin sensors on ESPs; …

- Provide continual development, upgrades, and operations of PST, microcystin and domoic acid sensors in Gulf of Maine, Great Lakes, and West Coast

Delivered

FY18 MILESTONE 6 I HAB Detection Technologies: Validate and transition HAB detection and monitoring products to provide identification and toxicity measurements for regional observing networks, states, municipalities and tribal nations.

- 2G-ESP microcystin sensor is demonstrated in an operational environment via deployment upstream of Toledo, OH water intake, with near-real time toxin data provided to stakeholders through GLOS HABs Data Portal in demonstration mode and used to support GLERL-NCCOS toxicity forecast development

On-Track

HAB SUB-PRIORITY IMPLEMENTATION PLAN: PRIORITY AREA 4. New detection technologies, such as test kits, autonomous sensors, and portable field instruments that enable local observations to support operational and demonstration forecasts, and provide states, municipalities and tribal nations with the ability to identify and quantify HAB species and toxicity.

- **STRATEGY:** Expand detection capability to more advanced platforms on smaller, faster and less costly devices that can sense multiple toxins and are accessible to diverse user groups.

R&D: Field-Portable Detection Technologies

PERFORMANCE

Detection Technology R&D: Relevant and Responsive to the Needs of Managers and Coastal Communities – Transitioning Research to Ops, Apps, Commercialization (R2X)

Technology Readiness Level

1 2 3 4 5 6 7 8 9

~1998: R&D initiated in response to the need for near-real time data on HAB species & toxin levels for managers, coastal communities, and researchers

2000: 1G ESP demonstrated as proof-of-concept; proceeded with improved re-design for 2G ESP

2006: 2G ESP/toxin sensor build completed and "mission qualified" with near-real time species/toxin detection in operational environment (Monterey Bay)

2007-2017: 2G ESP/toxin sensor (DA, PST, MCY) "mission proven" through multiple successful mission operations in five U.S. coastal regions

2G ESP commercial sales by McLane Research Labs

***2016:** 3G ESP System/subsystem/component validation in relevant environment – end-to-end DA detection in MB*

5

Broadly Relevant to NOAA Mission

RESEARCH
TRLs 1-2

DEVELOP
TRLs 3-5

DEMONSTRATE
TRLs 6-8

DEPLOY
TRL 9

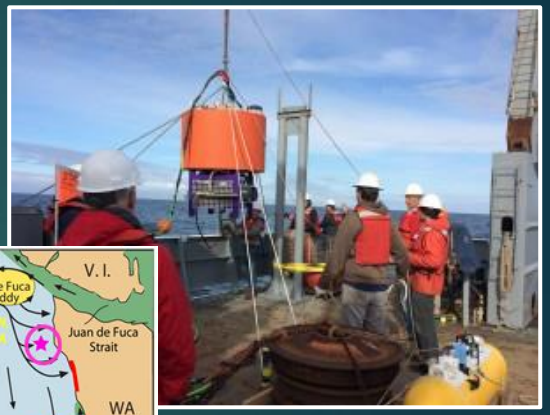
Tailored to Requirements

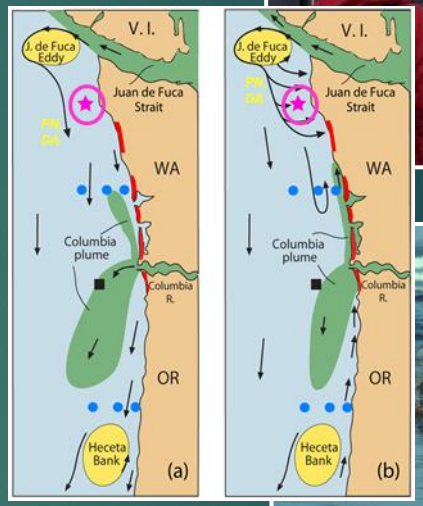
RELEVANCE

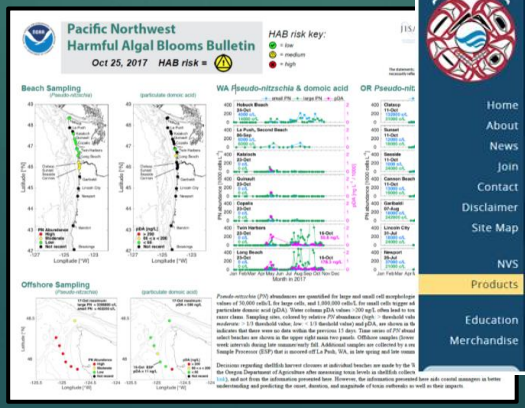
adapted from D. Lee

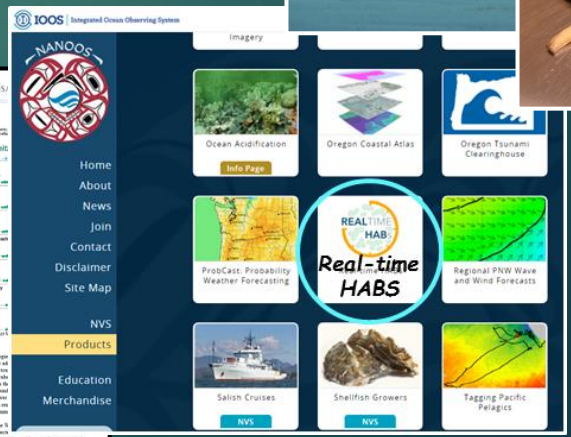
Essential for HAB Detection Technologies to Provide Beneficial Outcomes for Managers and Coastal Communities

- ***The Need/Request:*** lack of a rapid & effective means to assess toxicity associated with offshore blooms threatens shellfish harvests
- ***The Response:*** develop, validate, implement ESP DA sensor to deploy offshore for early warning of elevated bloom toxicity
- ***The Output:*** DA data for offshore toxicity source disseminated to managers in near-real time and included in the Experimental PNW HAB Bulletin



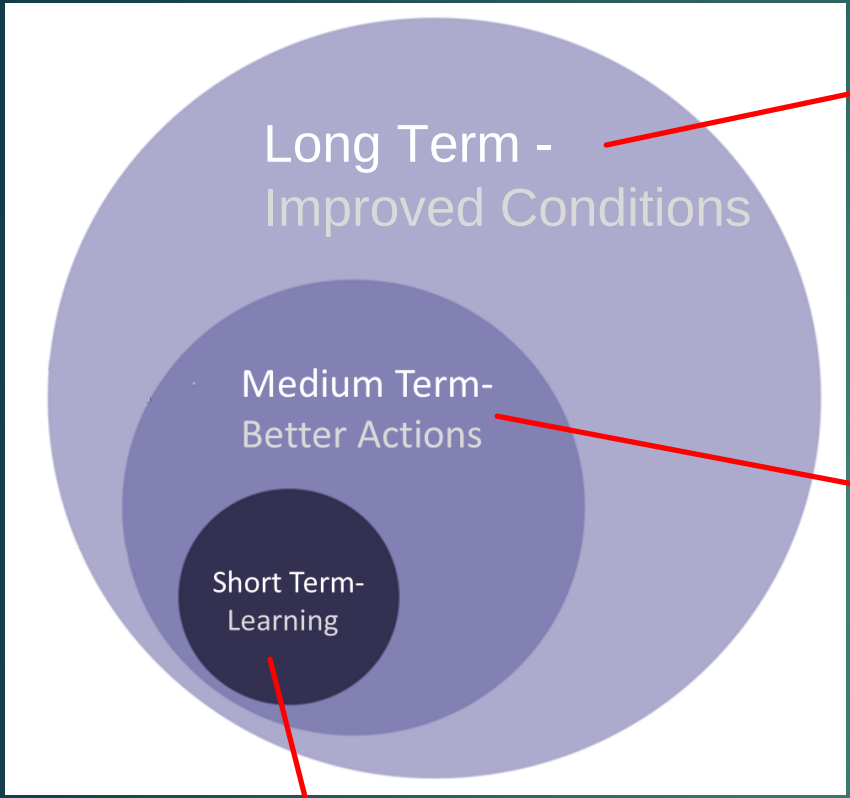






RELEVANCE

Essential for HAB Detection Technologies to Provide Beneficial Outcomes for Managers and Coastal Communities



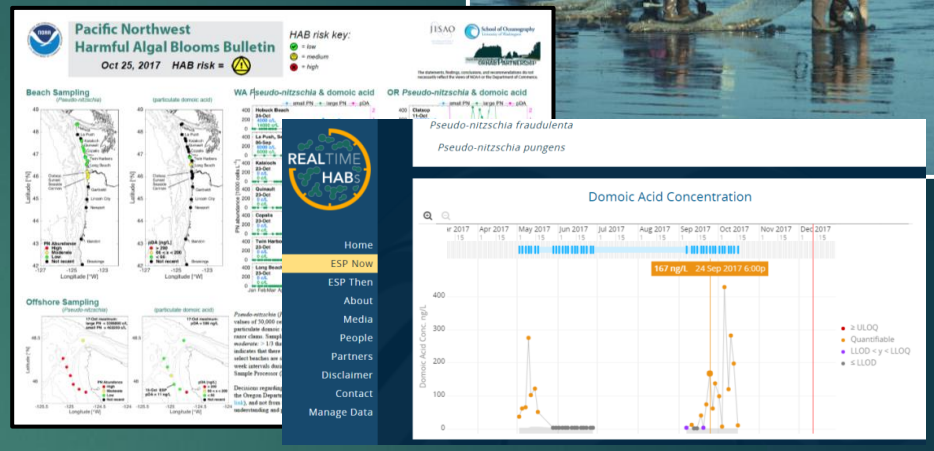
Long-term: **data from ESP network integrated with HAB Bulletin; more accurate shellfish toxicity forecasts improve seafood/economic security for WA coastal residents**

Medium-term: **In 2017, ESP & other actionable data contributed to decision to increase daily razor clam catch limit - record digger trips; $5.3 million was injected into local economies**

Short-term: **WA resource managers have learned that new knowledge of offshore HAB toxicity is available and can be factored into decision making process**

RELEVANCE

HAB Detection Technologies:
Making a Difference to Coastal Communities



Innovative

Responsive

IOOS Integrated Ocean Observing System

m·bio DIAGNOSTICS

MBARI

Queen's University Belfast

NCCOS National Ocean Service

GLERL

Seattle Sensor Systems CORPORATION

noaaresearch

CIGLR

NOAA FISHERIES

Collaborative

Societal Benefits: enables proactive decisions essential for protecting public health and reducing severity of socioeconomic/sociocultural impacts

Making a Difference

WHO are we making a difference to?

The impacts of events such as the 2015 West Coast HAB on local communities and peoples lives are real…

Sociocultural & Economic Impacts

- Community identity
- Emotional wellbeing

"We all gather around razor clamming days or [go] crabbing together as part of an identification point for why we live here"

"…lose that social interaction that binds our community together" (LB15, 2016)

4th generation fisherman (Crescent City, CA)

"You can read Facebook posts from crabber's wives [and] you can tell it's not all good in the household" (LB3, 2016)

"It was pretty stressful, the whole thing. I think I grew gray hairs, I mean it was bad" (CC3, 2016)

…people in these communities are relying on better observations, early warnings, and forecasts to help managers reduce the severity of these HAB impacts on their lives and livelihood

Ritzman et al. *In prep.* Moore et al. *In prep.*

The future: *focus on continuing to transition NCCOS intramural HAB detection R&D into useful products that will benefit our customers*

R&D Milestones for HAB Toxin Detection

202?

R&D to realize smaller, faster, less costly devices for HAB monitoring & management

NCCOS NOAA

VISION:

Science Serving Coastal Communities

HAB Detection and Forecasting Subpriority
Focus Area 5:
Analytical Methods and Reference Materials

Maggie Broadwater, PhD
HAB Monitoring and Reference Branch
Stressor Detection and Impacts Division
Charleston, SC

Program evaluation criteria

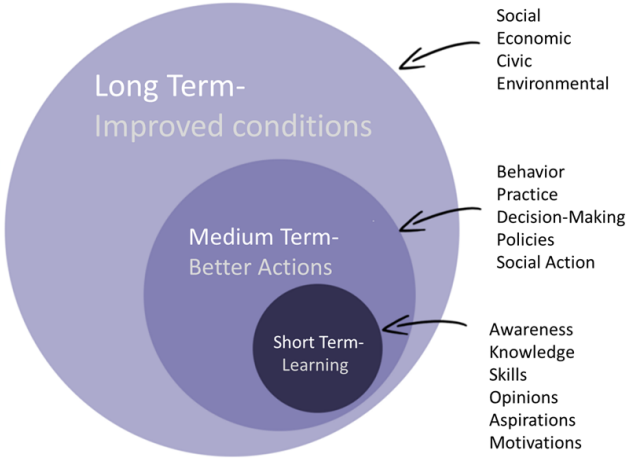
Quality

Do we provide quality data?
How do we assure our data are accurate and valid?
Is the information we provide communicated appropriately?

Performance

Is our program managed effectively and
efficiently? Do we utilize collaborations and partnerships?
Do we achieve desired results? How do we track our progress?
Can we adapt as priorities change? Do we have the flexibility
to respond to unexpected events or opportunities?

Relevance



Does our science matter?
Why do we do what we do?
Is it useful? Who uses it, and what for?

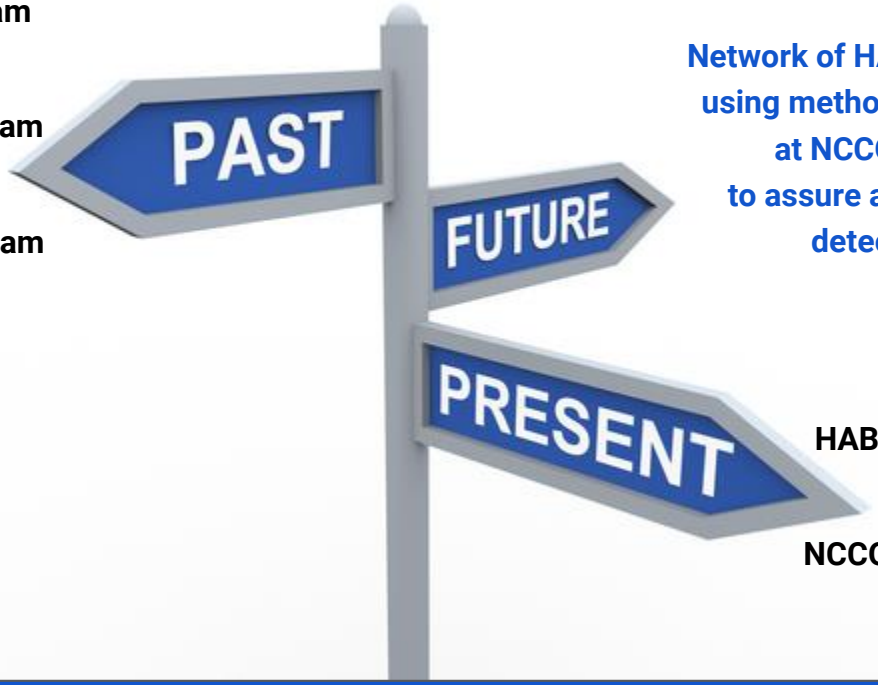
Where have we been and where are we going?

NOAA Marine Biotoxins Program (MBP)

NCCOS Analytical Response Team (ART)

Toxin Analysis Management Team (TAMT)

Marine Biotoxins workshop at NCCOS Charleston (Beaufort joined in 2015)



Network of HAB toxin testing laboratories using methods developed and validated at NCCOS and other agencies to assure accurate and reproducible detection of HAB toxins.

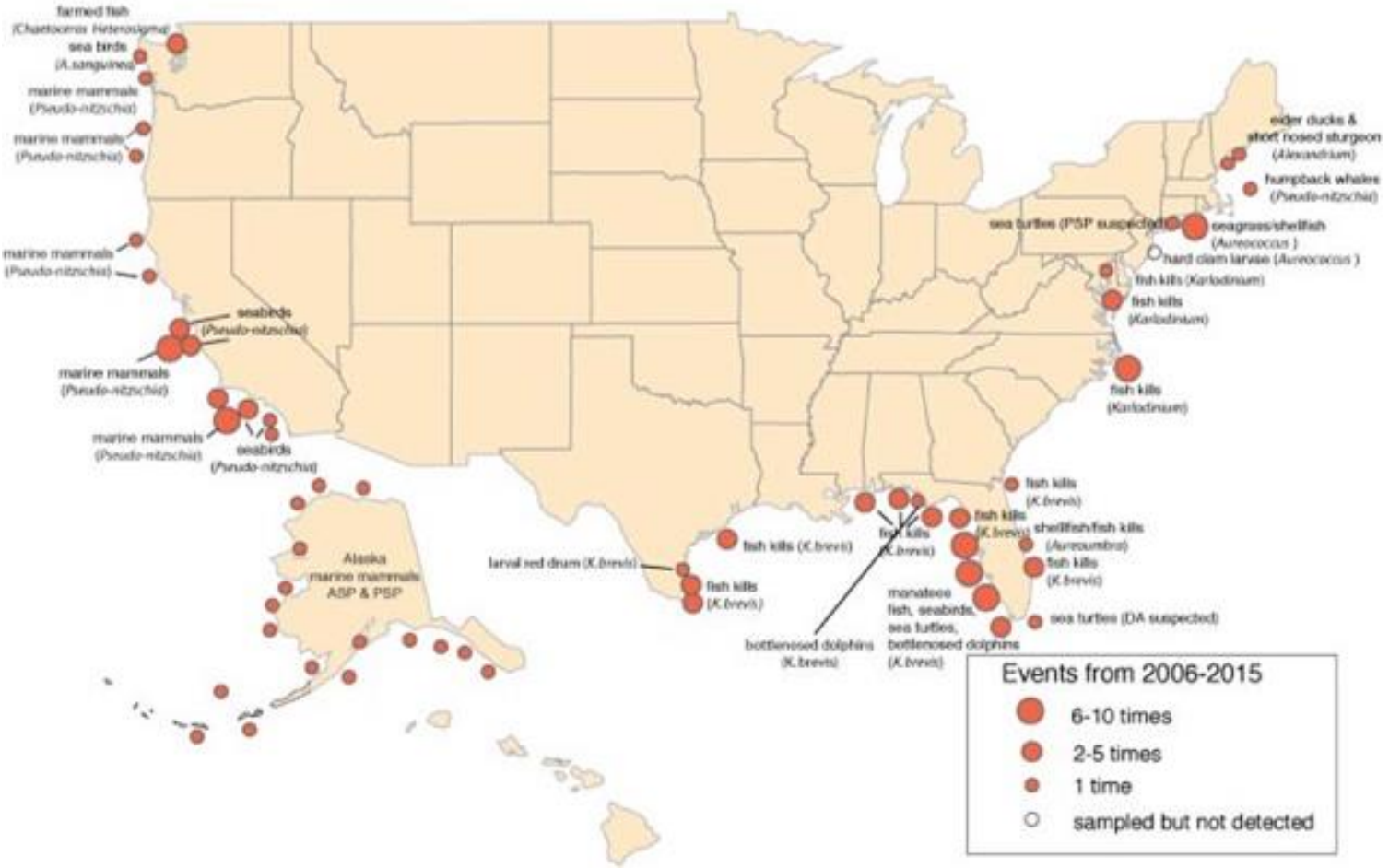
HABHRCA Interagency Working Group (IWG)

NCCOS Integrated HAB Event Response

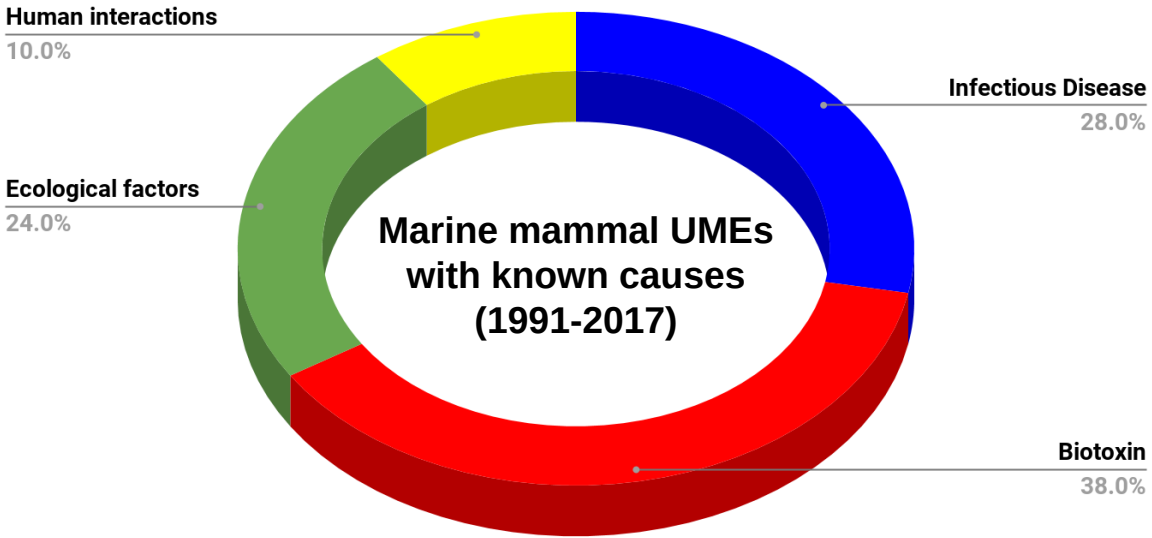
NCCOS HAB Workshop

Continuous improvement, validation, harmonization of toxin detection methodologies.
Collaboration within and among government agencies for continuity of operations and services.
Adaptation to societal needs and organizational change.

HAB Mortality Events in the U.S.



History: NCCOS Analytical Response to HABs



- Method development
- Analytical Response Team
  - Toxin Analysis Management Team (Field experts, SMEs)
  - Two-tiered analysis
- Phytoplankton Monitoring Network (PMN) support
- Marine animal Unusual Mortality Event (UME) support

NCCOS HAB toxin analysis support for marine mammal injury assessment

Natural resource damage assessments: support and consultation for oil spill events and hazard training courses

- Assessment: Deepwater Horizon, Texas City Y, Refugio
- Guidelines for Assessing Exposure and Impacts of Oil Spills on Marine Mammals (NOAA Response & Restoration)
- NOAA Science of Coastal Natural Disasters (HAB module)

Texas City Y OS Sample Analysis Plan:

NOAA proposes the following "rule out" set of laboratory analyses as part of this 2015 Sample Analysis Plan:

Biotoxin tests will be conducted to determine if a dolphin may have been exposed to a toxic algal bloom that was occurring in Texas at the time of the spill, which could have contributed to its cause of death.

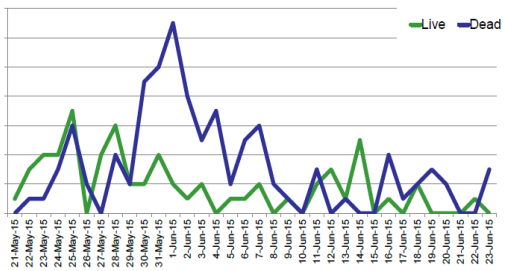
Feces and stomach content samples will be analyzed using methods previously described and commonly employed (Maucher et al., 2007; Fire et al., 2008; Fire et al., 2011; Venn-Watson et al., in review) to determine if common disease symptoms or causes of mortality are indicated.

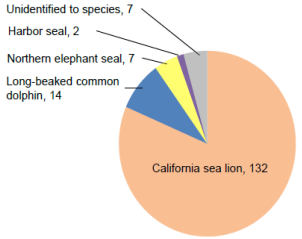
REFUGIO NATURAL RESOURCE DAMAGE ASSESSMENT

MAMMALS

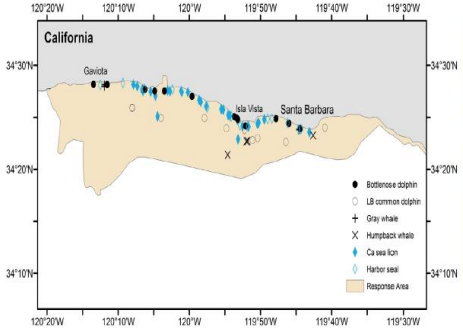
Wildlife response: Mammals collected alive: 63
23 rehabilitated and released
Mammals collected dead: 99
Total estimated mortality: **Pending**

Timeline of live and dead mammals collected





Pre-assessment survey: Marine mammal species sighted during the 2-7 June 2015 survey (left) designed to document coastal bottlenose dolphins (right) in the spill response area. Photo-identification data for coastal bottlenose dolphins will be analyzed to estimate the number of dolphins in the area after the spill.



2015: Integration of NCCOS HAB Response Efforts

NCCOS HAB Response

Search this site

Navigation
- Summary
- Documents
  - Capabilities
  - Current Drivers
  - Past references
  - Planning documents
  - Outreach
- Activity Tracker
- Links
- Contacts
- NCCOS HAB Workshop
- NCCOS News & Features
- Sitemap

Contacts

Maggie Broadwater, PhD
Analytical Response Team, CCEHBR
maggie.broadwater@noaa.gov
843-762-8535 (office); 843-670-8994 (cell)

Quay Dortch, PhD
ECOHAB & PCM, CSCOR
quay.dortch@noaa.gov
240-533-0198

Rance Hardison, PhD
CCFHR
Rance.Hardison@noaa.gov

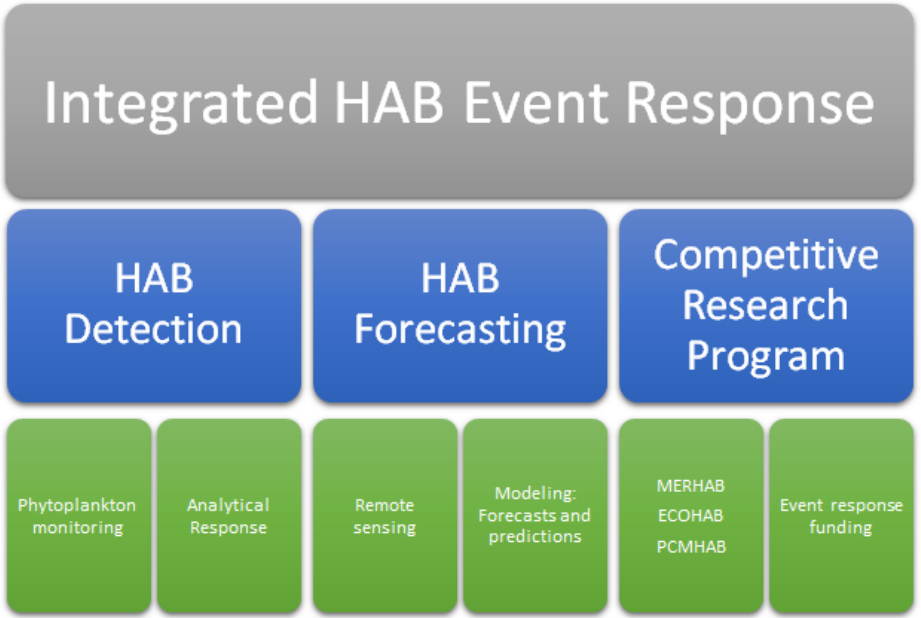
Steve Morton, PhD
Phytoplankton Monitoring Network, CCEHBR
steve.morton@noaa.gov

Rick Stumpf, PhD
CCMA
richard.stumpf@noaa.gov

Marc Suddleson, PhD
MERHAB, CSCOR
Marc.Suddleson@noaa.gov
301-713-3338

Comments

You do not have permission to add comments.



avigation
Summary
Documents
Capabilities
Current Drivers
Past references
Planning documents
Outreach
Activity Tracker
Links
Contacts
NCCOS HAB Workshop
NCCOS News & Features
Sitemap

Activity Tracker

Details of NCCOS HAB Event response activities

HAB Events Stakeholders Outcomes Outputs

3/3/2016	CCEHBR	Maggie Broadwater	OPR	Determination of Brevetoxin in Gulf of Mexico Marine mammals (Northern Gulf of Mexico UME)	ART: Biotoxin extraction and detecti	Biotoxin determination in stranded marine mammals	OPR			Gulf of Mexico
3/17/2016	CCEHBR	Maggie Broadwater		Baseline domoic acid in Mid-Atlantic Bottlenose dolphins stranded 1998-2012	ART: Biotoxin extraction and detection	Biotoxin determination in stranded marine mammals	Virginia Aquarium S	Report 03/17/06	Data supplied for Pr	VA
3/28/2016	CCEHBR	Maggie Broadwater	OPR, Marine Mamn	Determination of DA in Vaquita stomach contents	ART: Biotoxin extraction and detecti	Biotoxin determination in stra	OPR, TMMC, Mexic	Report 5/27/16		Gulf of California
TBD	CCEHBR	Maggie Broadwater	OPR	2013 MidAtlantic Marine mammal UME	ART: Biotoxin extraction and detection	Biotoxin determination in stranded marine mammals	OPR, states			MidAtlantic; VA, NY, NC, MA
4/5/2016	CCEHBR	Maggie Broadwater	OPR	Determination of Brevetoxin in Gulf of Mexico Sea turtles	ART: Biotoxin extraction and detection	Biotoxin determination in stranded sea turtles	OPR			Gulf of Mexico
5/19/2016	CCEHBR	Maggie Broadwater	OR&R, OPR	Determination of Brevetoxin, DA & PSTs in bottlenose dolphins stranded during Texas City Y Oil spill	ART: Biotoxin extraction and detecti	Biotoxin determination in stra	OR&R, OPR, Texas			TX
5/25/2016	CCEHBR	Maggie Broadwater	PMN	PMN: Potential PST event	ART: Biotoxin extraction and detecti	Determination of PSTs in phytoplankton filter		Report 5/27/16		AK
6/22/2016	CCEHBR	Maggie Broadwater	PMN	PMN: Potential DA event	ART: Biotoxin extraction and detecti	Determination of DA in phytoplankton filter		Report 6/24/16		AK
6/29/2016	CCEHBR	Maggie Broadwater	OR&R, CA DPH, NC(	Request for HAB data to support Refugio OS NRDA	Outreach	Provide contacts for HAB mon	OR&R, CA	Communication 6/29/16		CA
7/31/2016	CSCOR	Quay Dortch	FL	Cyanobacterial bloom in FL (200 sq miles of Lake Okeechobee)	CSCOR HAB Event response funding	Tracking bloom, sampling & tc	Martin Co, FL; SUNY	Funding/support		FL
8/11/2016	CSCOR	Marc Suddleson/Quay Dor	VIMS	Active bloom of C. polykrikoides and A. monilatum	CSCOR HAB Event response funding	Examine HAB impacts	VIMS, VA	Funding/support	Assess oyster health	VA
8/12/2016	CCFHR	Wayne Litaker	KBL, CCEHBR	Provided data on increasing PSTs in AK shellfish	Outreach	Provided data on increasing P	KBRR, AK-DEC	Communication 8/1	Early warning	AK
8/30/2016	CCEHBR	Steve Morton/Maggie Bro	KBRR	Possible Dinophysis collected in Homer Harbor, AK	PMN / ART	PMN Confirmation of Dinoph	KBRR, AK State		Early warning	AK

2017 HAB Events | **2016 HAB Events** | 2015 HAB Events | 2014 HAB Events | 2013 HAB Events

Comments

You do not have permission to add comments.

Projects redefined with organizational change

Harmful Algal Bloom and Analytical Response Branch

Analytical Response Team

To provide rapid and accurate identification and quantification of marine algal toxins in suspected HABs, marine animal mortality events, and human poisonings.

Technology Transfer

To validate the performance of high throughput receptor binding assays for algal toxins and to transfer the receptor assay technology to constituents who are responsible for monitoring algal toxin levels in fishery resources.

Harmful Algal Bloom Monitoring & Reference Branch

Focal Area 5 of SIM Subpriority
HAB Forecasting and Detection

Analytical Methods and Reference

Analytical methods and reference materials which leverage existing NCCOS expertise will be advanced in concert with other federal agencies participating in the HABHRCA IWG to support the development of standardized methods and training for testing laboratories and validation of their use to assure accurate and reproducible measurements nationwide.

NCCOS HAB Implementation Plan: Focal Area 5: Analytical methods and reference materials which leverage existing NCCOS expertise, are advanced in concert with other federal agencies participating in the HABHRCA IWG to support the development of standardized methods, training for testing laboratories and validation of their use to assure accurate and reproducible measurements nationwide

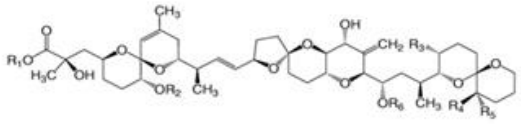
What		When due	Why	How
Assure harmonized standard methods and reference materials Publish guidance for seafood safety managers	HABHRCA Interagency working group (IWG) subgroup on Analytical Methods and Reference Materials, Information (POC: John Ramsdell)	Annually	HABHRCA Act of 2014 requires NOAA under sec. 603A(f) to: (1) increase the availability to appropriate public and private entities of analytical facilities and technologies, operational forecasts, and reference and research materials; and (2) work cooperatively and avoid duplication of effort with other offices, centers, and programs within the National Oceanic and Atmospheric Administration, other agencies on the Task Force, and States, tribes, and nongovernmental organizations	CCEHBR, CCFHR, HQ staff time and multiple federal agencies
	ISSC Laboratory Methods Review Committee and Biotoxin Committee (POC: Maggie Broadwater and Quay Dorch)	Annually	NOAA and FDA are lead agencies in ISSC	CSCOR and CCEHBR staff time, FDA
	NOAA and IAEA collaboration on validation performance and regulatory application of receptor assays (POC: John Ramsdell)	Annu		
	Integrated Consortium of Laboratory Networks Working Group on Methods (POC: John Ramsdell)	Annu		
	Handbook on the correct application of molecular assays for toxic Alexandrium species for use in assessing paralytic shellfish poisoning (POC: Wayne Litaker)	FY17		
	Set standards to observation data through a national network of HAB observations	FY18	potential connection to forecasts	IOOS staff time; other
Analytical Method Development	Transfer LC-MS/MS method for lipophilic shellfish toxin (DSP/AZA) analysis to Washington state managers (POC: Marc Suddleson)	FY18 Q4	HABHRCA Act of 2014, sec. 603A(f); ISSC need for reference methods for controls for DSP and AZP toxins	CSCOR, CCEHBR, contract staff, NMFS, WDOH
	LC-MS/MS method for P-CTX (POC: John Ramsdell)	FY18	Request technology transfer from CDC	CCEHBR staff time, contract staff, CDC
	PCMHAB FFO on ISSC methodology (POC: Quay Dortch)	FY18-20	NOAA and FDA are lead agencies in ISSC	CSCOR, TBD
Reference Material Calibration	Calibration of radiolabeled saxitoxin standard (POC: Maggie Broadwater)	FY17	HABHRCA Act of 2014, sec. 603A(f)	CCEHBR staff time and FDA
	Calibration of NIST Reference Material® 8642 FDA Saxitoxin Dihydrochloride Solution, (POC: Maggie Broadwater)	FY19	HABHRCA Act of 2014, sec. 603A(f)	CCEHBR staff time, FDA and NIST
Promote User Laboratories	Sitka Tribe of Alaska Environmental Research Laboratory, Finalized system/deployed routinely (POC: Tod Leighfield)	FY18	HABHRCA Act of 2014, sec. 603A(f)	CCEHBR staff time, CDC, Sitka Environmental Research Laboratory
	West Coast Laboratory Network, Demonstration in operational test environment (POC: Tod Leighfield)	FY18	HABHRCA Act of 2014, sec. 603A(f)	CCEHBR staff time, State of AK, WA, OR and CA
	Community Based PSP Testing for Subsistence and Recreational Shellfish Harvesting In Southwestern Alaska. Proof of concept (POC: Wayne Litaker)	FY17-FY19	HABHRCA Act of 2014, sec. 603A(f)	NPRB funded project
	IAEA Regional Laboratories, Demonstration in relevant test environment (POC: Tod Leighfield)	Annually	NOAA-IAEA Agreement	CCEHBR staff time, IAEA and IAEA member states

Analytical Method Development: Detection of lipophilic toxins associated with DSP using LC-MS/MS

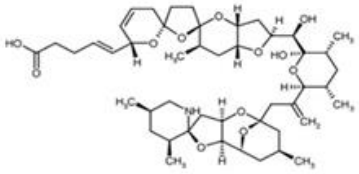
Continued Improvement and Validation of the DSP suite of of lipophilic toxins

DSP / Lipophilic toxins

(i) Okadaic acid and dinophysistoxins (DTXs) (>10 analogues and esters) [86,87]

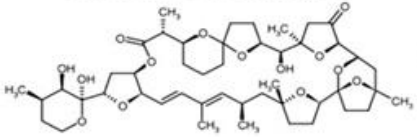


(ii) Azaspiracid (~20 analogues) [88,89]



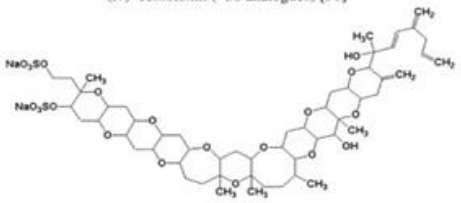
Azaspiracid-1

(iii) Pectenotoxin (~13 analogues) [90]



Pectenotoxin-2

(iv) Yessotoxin (~36 analogues) [91]



Russian White Sea study: OA, DTX1, PTX, YTX detection (Vershinin, Leighfield, Quilliam)

Performance testing for OA, DTX1-2, AZA1-3, PTX2, YTX and 45-OH-YTX (Gerssen, Doucette, Wang)

International validation: Quantitative determination of lipophilic toxins in shellfish using LC-MS/MS (Doucette, Wang)

Morocco shellfish toxin analysis: DSP toxins > 10X regulatory limit (Morton, Wang)

2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018

Toxin-producing *Dinophysis* in Maine coastal waters (Van Dolah, Morton, Leighfield, Haynes)

Marine mammal exposure to OA in Gulf of Mexico (Fire, Wang)

MERHAB NY DSP/PSP sample analysis (Gobler, Morton, Wang)

Matrix-specific method development for *Deepwater Horizon* NRDA

MERHAB Pacific NW method comparison (Trainer, Borchert, Doucette, Wang)

Method validation: LC-MS/MS of lipophilic toxins in shellfish

RIKILT WAGENINGEN UR

Quantitative determination of marine lipophilic toxins in shellfish using LC-MS/MS

International validation study - final report

Why we care.

- Shellfish containing lipophilic toxins can cause DSP
- Need for a harmonized analytical method for DSP-related toxins
- No accepted regulatory methods to control DSP hazards in shellfish

What we did.

- Evaluated method performance characteristics for determination of marine lipophilic toxins by LC-MS/MS using alkaline mobile phase -- Mussels, oysters, & cockles were tested for OA, DTX1, DTX2, AZA1, AZA2, AZA3, PTX2, YTX, and 45-OH-YTX
- NCCOS Charleston Marine Biotoxins Program met/exceded data requirements (linearity, slope of calibration curve, sensitivity, error in ion ratios of MRM channels, error in retention time shifts)

Benefits - what's the difference?

- Quantitative determination of lipophilic toxins in shellfish for official control purposes
- Alternative to mouse/rat bioassay

What followed?

- EU Harmonised SOP for Determination of Lipophilic Marine Biotoxins in Molluscs by LC-MS/MS (2015)
- ISSC acceptance of LC-MS/MS Method for Monitoring DSP Toxins (FDA CFSAN 2017)

Recovery of lipophilic toxins from irregular matrices: dolphin urine & tissues

Why we care.

- Deepwater Horizon Natural Resource Damage Assessment called for evaluation of exposure to marine toxins in dolphins potentially affected by oil spill and related activities
- OR&R requested method validation detection of HAB toxins

What we did.

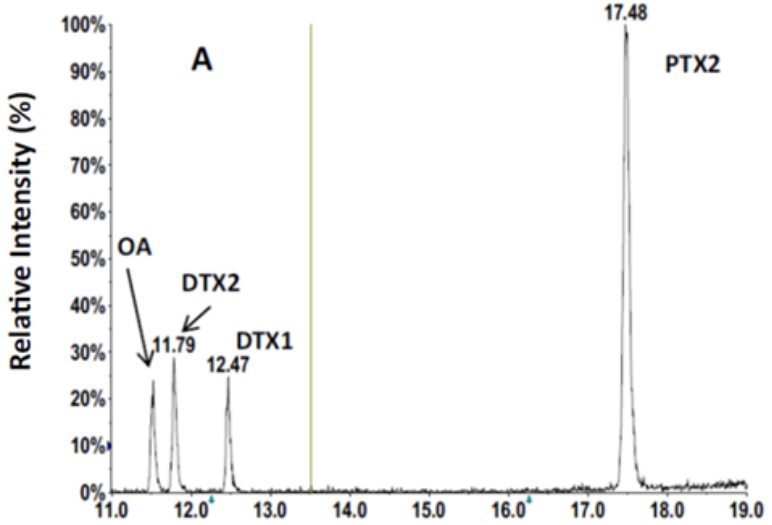
- Developed and validated a method for quantitative determination of lipophilic toxins (OA, DTX, PTX) in bottlenose dolphins (SPE-LC-MS/MS)
- Toxin recoveries ranged 80 - 130% (RSD < 15% using an optimized method; LOD ≤ 0.7 ppb in urine, ≤ 2.8 ppb in tissues
- Evaluation of clean-up (SPE), LC separation, and MS detection
- Mobile phase aging, column temperature significantly affect analytical results

Benefits - what's the difference?

- Assure toxin recovery from irregular matrices (dolphin urine, tissues)
- Evaluate low levels of toxin exposure

What followed?

- Damage assessment data withstood scrutiny - responsible party liable for costs of assessment and implementation of restoration
- Method used to assess lipophilic toxin exposure in other at-risk populations



An example of data from our analytical method for DSP lipophilic suite of toxins

Date: 14 February 2017
Documented by: Maggie Broadwater, PhD

A. Suspected Event and Sample Details

Forty-one shellfish samples were submitted to the NCCOS HAB Monitoring and Reference Branch. Samples were assigned NOS ID numbers (SLM350 – SLM390) upon receipt in preparation for toxin extraction and analysis. Samples were extracted and a comprehensive list of diarrhetic shellfish toxins, including okadaic acid (OA), dinophysistoxins (DTX1 and DTX2), azaspiracids (AZA1, AZA2, AZA3), pectenotoxin-2 (PTX2), and yessotoxins (YTX, Homo-YTX, 45OH-YTX, 45OH-Homo- YTX) were determined. A complete sample list is provided in the data summary below (section D).

B. Findings

At least one toxin congener was detected in all 41 shellfish samples, and 39 samples exceeded the EU regulatory limit for at least one toxin group reported. Thirty-seven samples exceeded the EU regulatory limit for OA group toxins (160 ng OA equivalents per gram shellfish meat); positive values for total OA equivalents ranged from 14 – 12,255 ng per gram (median 767 ng per gram). Ten samples exceeded the EU regulatory limit for total YTX (3750 ng YTX equivalents per gram shellfish meat) and positive values for total YTX-eq ranged from 44 – 53,121 ng per gram (median 498 ng per gram). No samples exceeded the EU regulatory limit for total AZA (160 ng per gram shellfish meat); positive values for total AZA ranged from 1 – 144 ng per gram (median 8 ng per gram).

D. Data Summary

Table 1. Toxin concentrations in shellfish samples (ng toxin per gram shellfish);

NOS ID	Sample ID	Date collected	OA	DTX2	DTX1	Total OA*	Total DTX2*	Total DTX1*	AZA1	AZA2	AZA3	PTX2	YTX	Homo-YTX	45OH-YTX	45OH-Homo-YTX
SLM350	A1	09/20/10	1331	ND	ND	2089	ND	ND	ND	5	ND	ND	653	ND	146	ND
SLM351	A2	10/25/10	797	51	ND	1070	71	ND								30
SLM352	A3	10/18/10	373	ND	ND	683	ND	ND								15
SLM353	A4	10/25/10	501	ND	ND	775	ND	ND								19
SLM354	A5	09/20/10	364	ND	ND	760	ND	ND								ND
SLM355	A6	10/17/10	407	ND	ND	1178	ND	ND								46
SLM356	A7	10/25/10	296	ND	ND	467	ND	ND								16
SLM357	A8	09/07/10	132	21	ND	359	31	ND								ND
SLM358	A9	10/26/10	725	50	ND	1295	66	ND								ND
SLM359	A10	10/10/11	834	ND	ND	1661	ND	ND								91
SLM360	A11	10/17/11	382	ND	ND	728	ND	ND								58
SLM361	A12	10/26/11	429	ND	ND	998	ND	ND								72
SLM362	A13	10/31/11	394	ND	ND	627	ND	ND								127
SLM363	A14	10/10/11	1180	ND	ND	1726	ND	ND								87
SLM364	A15	10/17/11	498	ND	ND	753	ND	ND								96
SLM365	A16	10/26/11	439	ND	ND	852	ND	ND	ND	24	ND	ND	112	63	63	56
SLM366	A17	12/05/11	10	ND	ND	14	ND	ND	ND	9	ND	ND	39	18	17	7
SLM367	A18	12/06/11	ND	ND	ND	ND	ND	ND	ND	4	ND	ND	ND	ND	ND	ND
SLM368	A19	06/24/13	1031	ND	ND	1619	ND	ND	ND	2	ND	ND	9	26	4	11
SLM369	A20	07/02/13	4621	ND	ND	6488	ND	ND	ND	1	ND	ND	108	613	27	217
SLM370	A21	07/10/13	1705	ND	ND	2827	ND	4	ND	1	ND	ND	72	401	19	154
SLM371	A22	07/15/13	5057	ND	ND	6422	ND	4	ND	2	ND	ND	116	747	41	380
SLM372	A23	10/30/13	110	ND	ND	180	ND	ND	ND	8	ND	ND	186	1960	219	2763
SLM373	A24	11/22/13	95	ND	ND	186	ND	ND	ND	8	ND	ND	144	747	122	796
SLM374	A25	07/15/13	6450	ND	ND	12255	ND	ND	ND	2	ND	ND	99	867	48	570
SLM375	A26	07/15/13	2353	ND	ND	2874	ND	ND	ND	1	ND	ND	108	535	37	211
SLM376	A27	07/16/13	2453	ND	ND	5515	ND	ND	ND	2	ND	ND	11	113	4	47
SLM377	A28	11/24/14	115	11	ND	234	12	ND	ND	21	ND	1	66	92	55	106
SLM378	A29	11/24/14	342	13	ND	683	11	ND	ND	28	ND	1	58	224	52	266
SLM379	A30	11/24/14	214	7	ND	434	10	ND	ND	22	ND	ND	55	192	44	218
SLM380	A31	08/01/15	59	ND	ND	179	ND	ND	ND	5	ND	ND	188	1142	122	624
SLM381	A32	08/02/15	275	ND	ND	791	ND	ND	ND	144	ND	ND	35	226	17	149
SLM382	A33	09/01/15	366	23	ND	708	21	ND	ND	15	ND	ND	1939	35,296	1384	29,004
SLM383	A34	10/01/15	264	11	ND	528	11	ND	ND	9	ND	1	1242	18,610	937	14,589
SLM384	A35	10/01/15	21	ND	ND	48	ND	ND	ND	4	ND	1	245	5809	152	3405
SLM385	A36	07/01/15	112	ND	ND	384	ND	ND	ND	29	ND	ND	372	3562	236	3151
SLM386	A37	11/01/15	86	ND	ND	192	ND	ND	ND	4	ND	2	132	3014	81	1617
SLM387	A38	07/01/15	708	ND	ND	3215	ND	ND	ND	17	ND	ND	26	102	9	49
SLM388	A39	06/27/16	1861	ND	ND	2237	ND	ND	ND	2	ND	0	46	112	14	51
SLM389	A40	06/27/16	988	ND	ND	1283	ND	ND	ND	2	ND	1	41	130	15	67
SLM390	A41	06/28/16	42	ND	ND	59	ND	ND	ND	1	ND	ND	33	34	34	23

DSP-associated toxins detected at levels > 75X action limit (160 ng per g shellfish)

ND = not detected (<dl). OA = okadaic acid; DTX1/2 = dinophysis toxins; AZA1/2/3 = azaspiracids; PTX2 = pectenotoxin-2; YTX = yessotoxin. Values in bold indicate the sample exceeds the EU regulatory limit for the toxin group (OA, AZA or YTX).* Total OA, DTX2 and DTX1 were determined following hydrolysis of sample extracts and include the 7-hydroxy-acylated derivatives of these toxins (collectively termed DTX3).

Lipophilic toxins in the Pacific Northwest: Comparison of analytical methods

Why do we care?

- State agencies requested interlaboratory comparison of DSP toxin analysis and assessment of risk in WA shellfish
- Limited information on toxicity in algal species associated with DSP present in WA waters

What did we do?

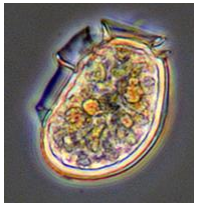
- Address matrix issues (matching vs. removal)
- Spike-recovery studies for quality control and determination of matrix-specific correction factors for quantitation
- Mussel homogenates analyzed by LC-MS/MS (WA DOH, NMFS NWFSC, and NCCOS Charleston)
- Compare alkaline and acidic toxin detection methods

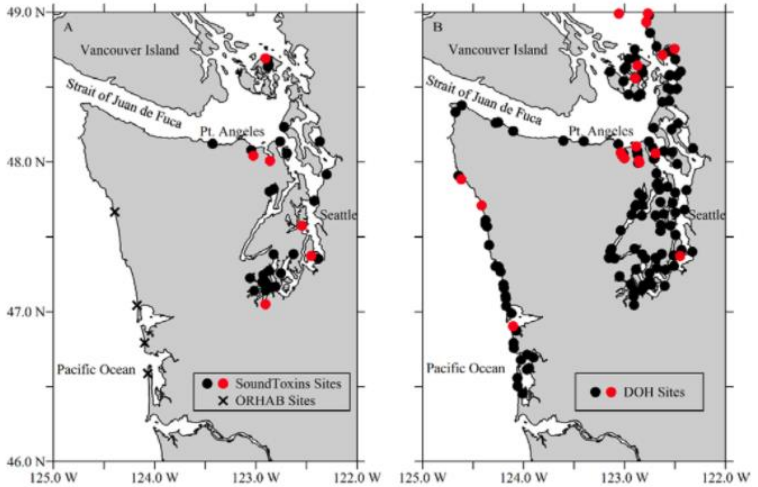
Benefits - what's the difference?

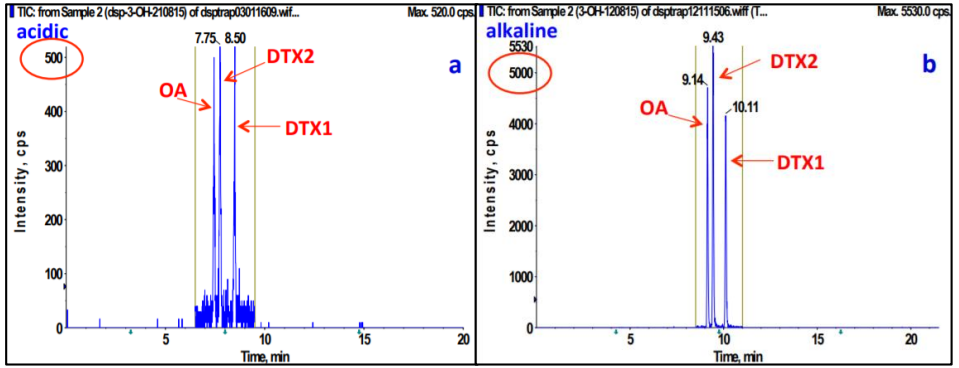
- Assist state managers in establishing harmonized protocols for quantifying lipophilic toxins as part of routine state monitoring

What's next?

- Address FDA & EU regulatory standards for shellfish toxins
- Facilitate export of WA-grown shellfish to EU







Addressing program evaluation criteria

Quality

We develop, validate, and support analytical methods to address specific questions related to HAB toxins and their effects.

We generate quality data that are assured to be accurate using established methods.

We communicate results using formal reports reviewed by a team of interdisciplinary experts.

We assist in developing standardized protocols for the collection and analysis of environmental and animal samples for HAB toxin detection in scientific studies and hazard response assessments subject to scrutiny.

Performance

Our data are managed effectively and efficiently through a toxin analysis management team to achieve specific results.

We work with collaborators and partners within and beyond NCCOS and NOAA to develop and validate methods to advance a coordinated strategy for HAB science.

Our efforts are planned and tracked using the NCCOS HAB implementation plan.

We maintain capabilities and flexibility for event-driven consultation and analytical support to assure accurate science-based decision making during HAB events.

Relevance

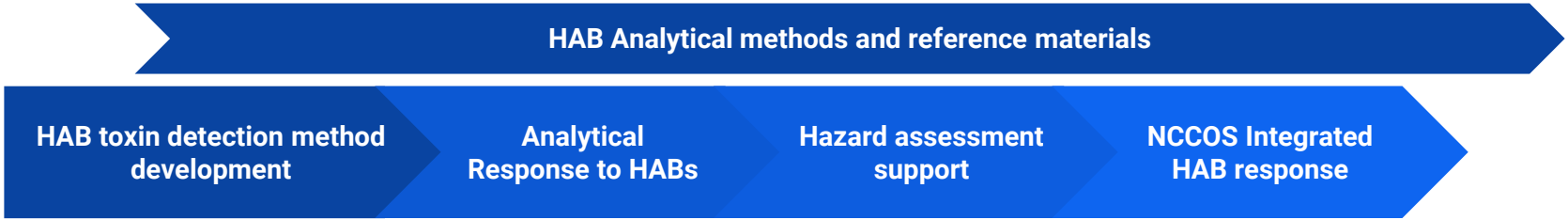
HAB toxin detection methods developed and/or validated at the NCCOS Charleston laboratory have been successfully applied to serve management needs.

We provide actionable information to meet the needs of customers and stakeholders.

We work together with NCCOS HAB Forecasting and Competitive Research routinely, and in response to episodic HAB events.

NCCOS HAB analytical methods and related research have led to notable improvements in management and response to HABs and other hazards.

Progression of HAB response capabilities



1987 Dolphin UME--Lack of robust and specific methods for measuring marine toxins

1992 National Plan

Effort to develop series of toxin class-specific methods

Reference methods
Regulatory application

Application of methods to determine event association with HABs

1993-2012 Support for mortality/morbidity events

ART-TAMT experience and routine for quality management

MBP and ART baseline data (lab/field exposure studies, response data) to support hazard assessment needs

Existing framework that demonstrates successful method application and quality performance metrics

Detection, forecasting, and competitive research provide a holistic response effort across NCCOS

Focus Area 5: Analytical methods and reference materials

Unfolding the Future: work in concert with other agencies leveraging vital assets to enable a network of HAB laboratories to serve the broad coastal community

HABHRCA Interagency Subgroup on CRMs

INTEGRATED CONSORTIUM OF LABORATORY NETWORKS — ICLN

DLN	LRN	NAHLN	NPDN	FERN	ERLN	Vet-LIRN
DoD Laboratory Network	Laboratory Response Network	National Animal Health Laboratory Network	National Plant Diagnostic Network	Food Emergency Response Network	Environmental Response Laboratory Network	Veterinary Laboratory Investigation & Response Network
DoD	CDC	USDA	USDA	USDA/FDA	EPA	FDA

NIST National Institute of Standards and Technology U.S. Department of Commerce

CDC Centers for Disease Control and Prevention

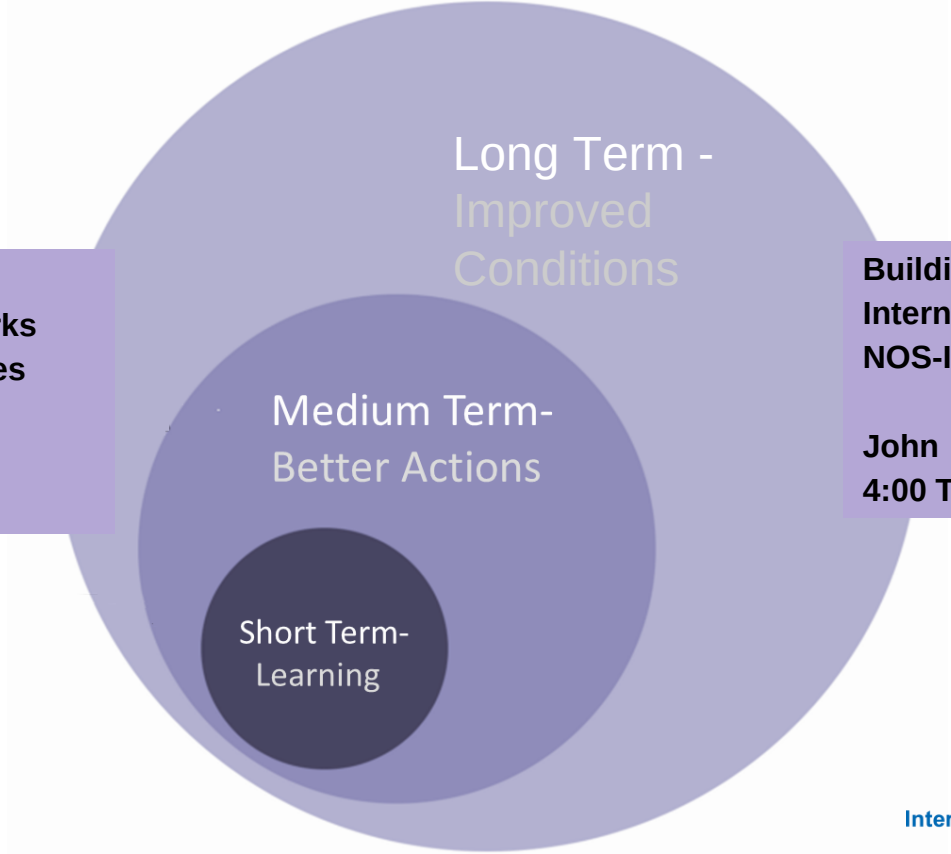
Portal
Standard Operating Procedures
Combined Registry
Data Exchange Utility

Outcomes from NCCOS Detection Technologies and Reference Materials

Enable communities to apply new technologies and practices to mitigate the threat of harmful algal blooms

Building Capacity –
Tribal laboratory networks and response capabilities

Chris Whitehead
3:45 PM Today



Building Capacity –
International laboratories and NOS-IAEA Agreement

John Ramsdell
4:00 Today

SEATOR
Culture
Science
Community
Southeast Alaska Tribal Ocean Research

IAEA
International Atomic Energy Agency
Atoms for Peace

The NOAA and IAEA collaboration on Harmful Algal Blooms

Under the collaboration framework ,

- The IAEA and NOAA work together to support IAEA Member States in the development and implementation of joint strategies and programmes concerning human health, seafood safety and the environmental impacts of HABs.

- The focus is on developing capacities for HABs monitoring, toxin testing and technology transfer applicable to HABs investigations with special attention is paid to the Receptor Binding Assay (RBA) methods for toxin in shellfish, which cause paralysis (PSP) and ciguatera.

Origin of the International Atomic Energy Agency

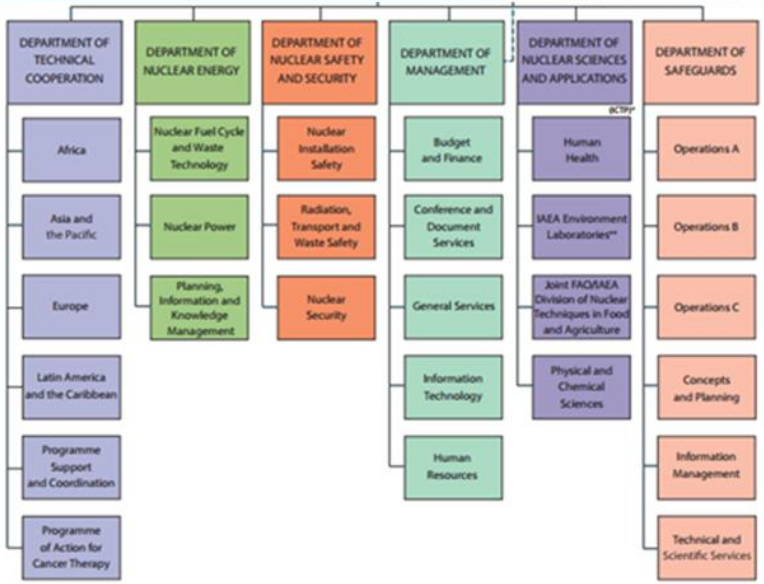
US President Eisenhower addresses the United Nations General Assembly delivering his "Atoms for Peace" speech, 8 December 1953, New York.

An "international atomic energy agency" to promote the peaceful uses of nuclear energy "for the benefit of all mankind."

Head of the Department of Technical Cooperation

Dazhu Yang

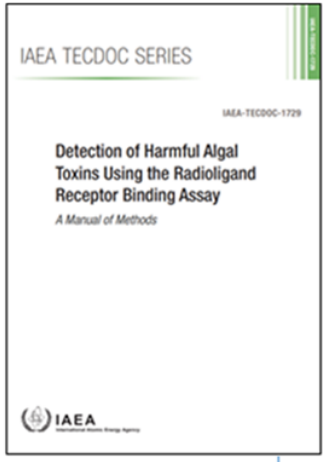
Head of the Department of Technical Cooperation



The Department of Technical Cooperation is responsible for formulating and delivering the IAEA's development mandate. The Agency's technical cooperation with Member States aims to promote tangible socioeconomic impacts, supporting the use of nuclear science and technology to address major sustainable development priorities at the national, regional and interregional levels

Following a request made by the Philippines during the IAEA General Conference to identify possible measures to address the impacts of HABs, the IAEA initiated related Technical Cooperation projects to assist Member States in strengthening their capacities for prevention, management and mitigation of health and socioeconomic impacts of HABs.

The IAEA and the National Oceanic and Atmospheric Administration (NOAA) iniated concerted actions to develop and to validate a radioligand based method, the receptor binding assay (RBA).



IAEA-NOAA Practical Agreement → Renewal

1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018

Signed in two originals in English

U.S. Department of Commerce	International Atomic Energy Agency (IAEA)
National Oceanic and Atmospheric Administration (NOAA)	
National Ocean Service	
David M. Kennedy	Ana María Cetto
Acting Assistant Administrator	Deputy Director General
National Ocean Service	Department of Technical Cooperation
11/10/10	29.11.2010, Vienna
Date and Place	Date and Place
Silver Spring, Maryland USA	

Practical Arrangements
between
the International Atomic Energy Agency (IAEA)
and
the National Oceanic and Atmospheric Administration (NOAA)

These Practical Arrangements are made between the International Atomic Energy Agency (hereinafter referred to as the "IAEA") and the National Oceanic and Atmospheric Administration (hereinafter referred to as "NOAA").

The programmatic authorities for NOAA to enter into these Practical Arrangements are:

Section 310 of the Coastal Zone Management Act (CZMA), 16 U.S.C. 1456c, under which the Secretary is authorized to provide technical assistance in coastal zone management to further international cooperative efforts. The Oceans and Human Health Act, 33 U.S.C. 3301 *et seq.* under which the Secretary is authorized to conduct integrated oceans and human health research on, among other things, harmful algal blooms and hypoxia and participate in international research efforts.

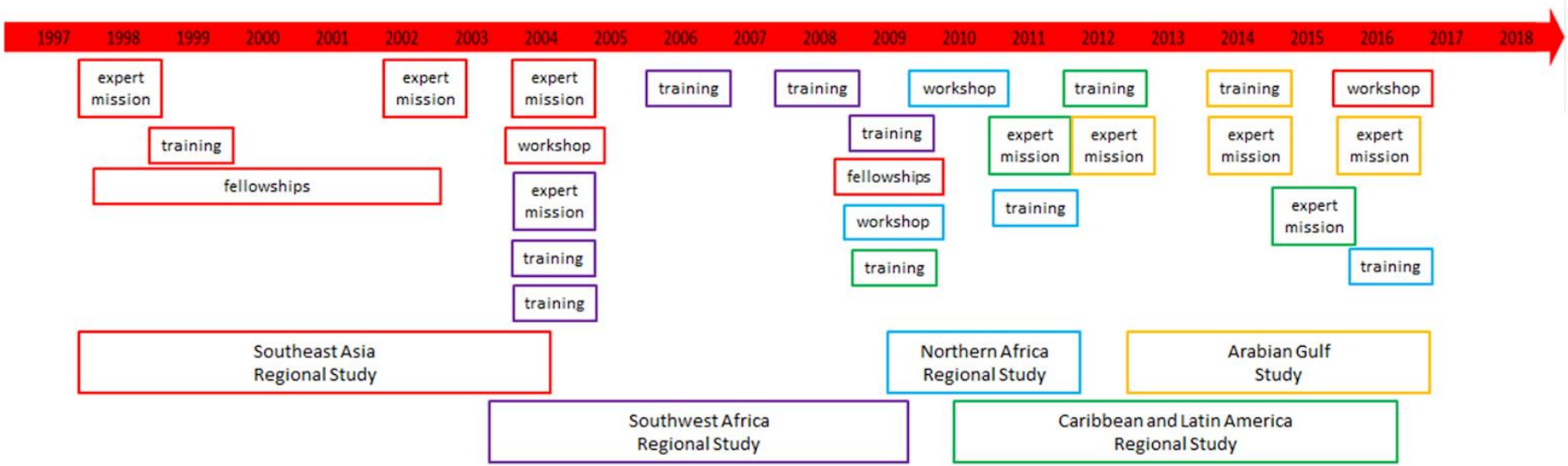
1. These Practical Arrangements provide a framework for the IAEA and NOAA to collaborate with IAEA Member States receiving technical assistance dealing with Harmful Algal Blooms (HABs) and their serious global impacts on human health, economies and ecosystem services. The working relationship between NOAA and IAEA may include the following:

- Collaboration in the development and implementation of joint strategies and programmes concerning human health, seafood safety and environmental impacts of HABs in IAEA Member States;
- Technical guidance from NOAA to the IAEA and its Member States directed to the development of capacity for HABs monitoring and toxin testing;
- Collaborative work for technology transfer applicable to HABs investigations and specifically to Receptor Binding Assay (RBA) methods for toxin detection;
- Joint facilitation of interlaboratory comparisons for the validation of RBA methods in IAEA Member States;
- Joint efforts to ensure sustained availability and evaluate the suitability of the radiolabeled tracers and other custom reagents (e.g. enzymes, membrane preparation) used for RBA methods;
- Exchange of data of mutual interest and relevance; and
- Cooperative dissemination of information and results using the RBA technology.

FOR the IAEA:	FOR the [Partner]:
International Atomic Energy Agency	U.S. Department of Commerce
(IAEA)	National Oceanic and Atmospheric Administration (NOAA)
	National Ocean Service
(Signature)	(Signature)
Dazhu Yang	W. Russell Callender, Ph.D.
Deputy Director General	Acting Assistant Administrator
Department of Technical Cooperation	National Ocean Service
(Name and Title)	(Name and Title)
Vienna, 2015-12-15	Silver Spring, MD 9/14/15
(Place and Date)	(Place and Date)

Activities (outputs) conducted between NOAA and IAEA

Expert Missions assist Member States to achieve self-reliance in IAEA coordinated projects. NOAA staff provide advice to counterparts in the field, lecture at training courses, and contribute to meeting/workshops.
Fellowships are awarded as part of an IAEA technical cooperation project in order to meet the needs of a Member State. They provide opportunities for training the necessary personnel to undertake the development of nuclear technology applications for peaceful purposes in their own countries.
Regional training courses/workshops support national training courses/workshops in cooperation with its Member States. Training courses are offered on peaceful uses and application of nuclear technologies, such as with the receptor binding assay for shellfish toxins



Assessment of Quality, Performance and Relevance

NOAA has worked with the IAEA Technical Cooperation Programme to apply nuclear technology to measure toxins such as saxitoxin and to transfer this capability to developing Member States in Africa, Asia, Latin America and the Arabian Gulf.

QUALITY:

A direct product of our joint action is the IAEA Technical Document entitled Detection of Harmful Algal Toxins Using the Radioligand Receptor Binding Assay: A Manual of Methods (IAEA-TECDOC-1729). Issued in 2013, this manual serves as a standard method for developing countries that wish to use the RBA method to monitor and respond to HAB events.

PERFORMANCE:

Technical training by NOAA experts continues to expand knowledge to Member States. Last year, the IAEA TC Programme supported two week-long training courses, one at the Kenya Marine Fisheries and Research Institute and another at the Center for Research in Environmental Pollution in Costa Rica training managers in 20 Member states on Africa and Latin America.

RELEVANCE:

Implementation of the RBA into monitoring programs support sustainable domestic and international markets. The Technical Cooperation Programme workshop at NOAA Charleston for Asia and Pacific region Member states this past July demonstrated the value of testing and use of regulatory monitoring programs for domestic and international markets with guidance from policy makers and regulators.

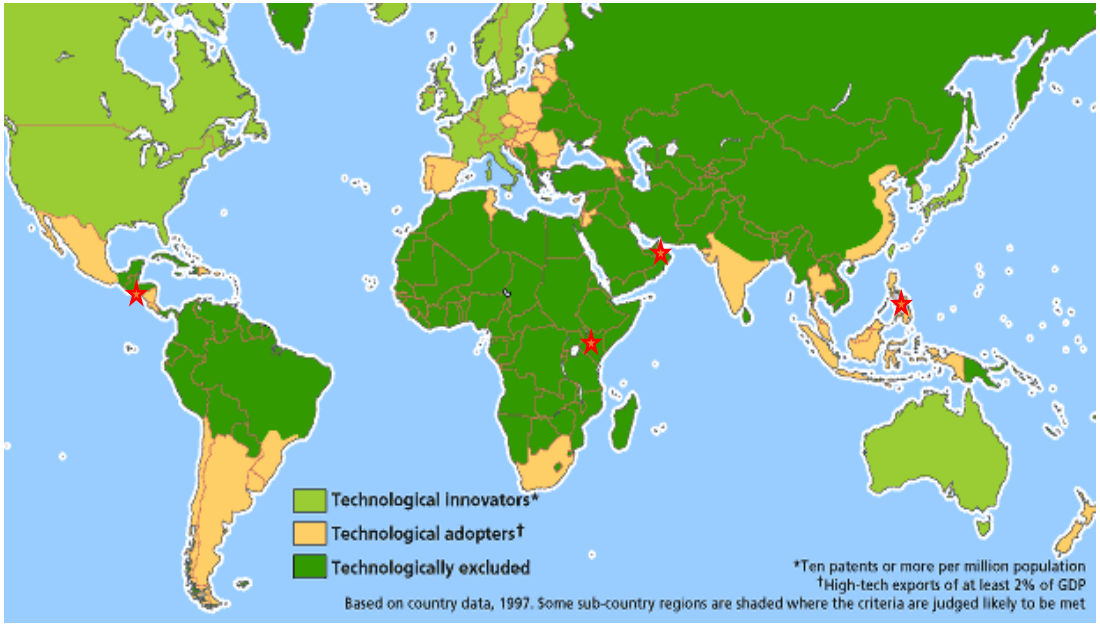
Jane Gerardo Abaya, Section Head of the Division for Asia and the Pacific of the Department of Technical Cooperation and POC for IAEA for the NOAA-IAEA Agreement.

Today’s world is divided by technology

Technological innovators: 15% of the earth's population, provides nearly all of the world's technology innovations

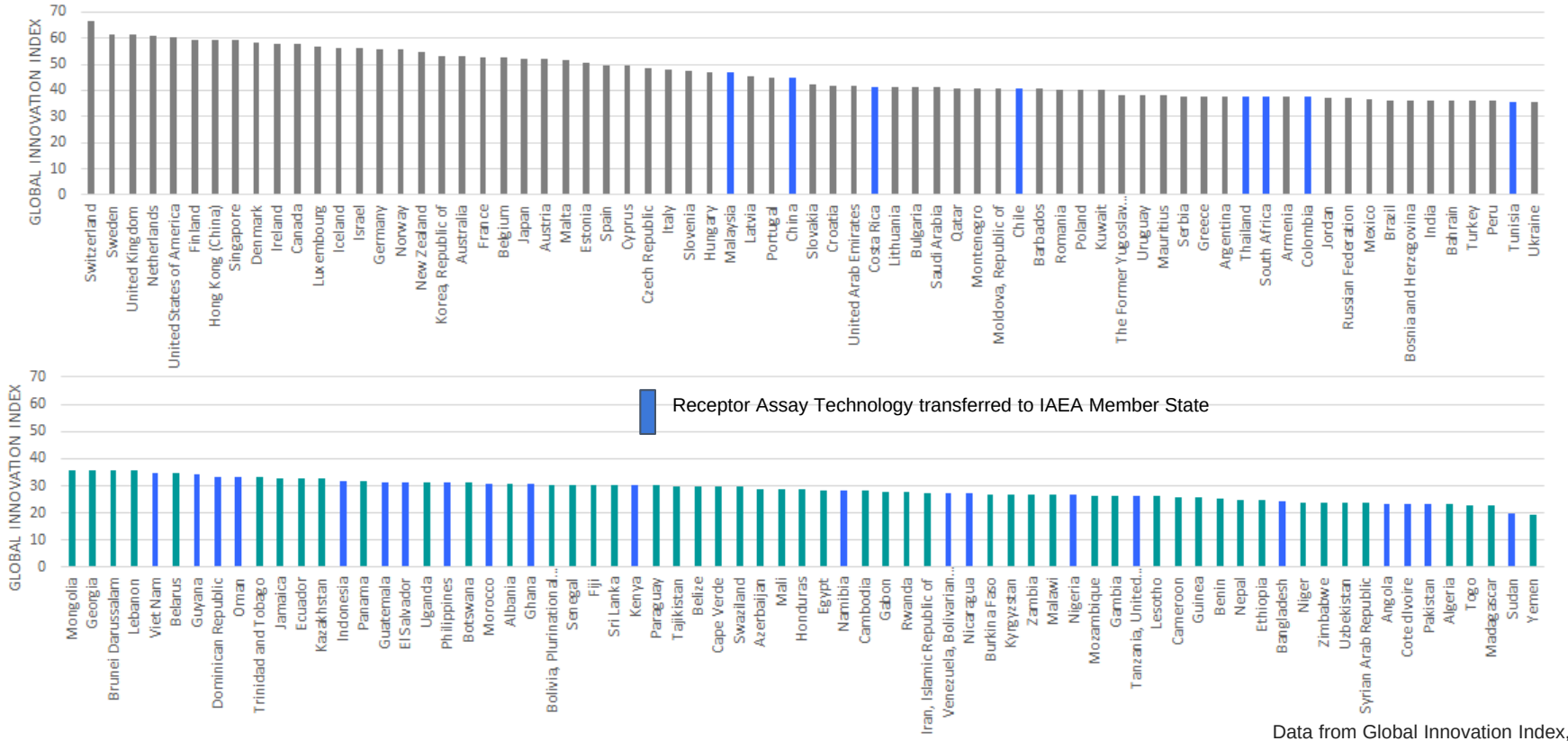
Technological adapters: Half of the world's population, is able to adopt these technologies in production and consumption.

Technological excluded: The remaining part, covering around a third of the world's population, is technologically disconnected, neither innovating at home nor adopting foreign technologies



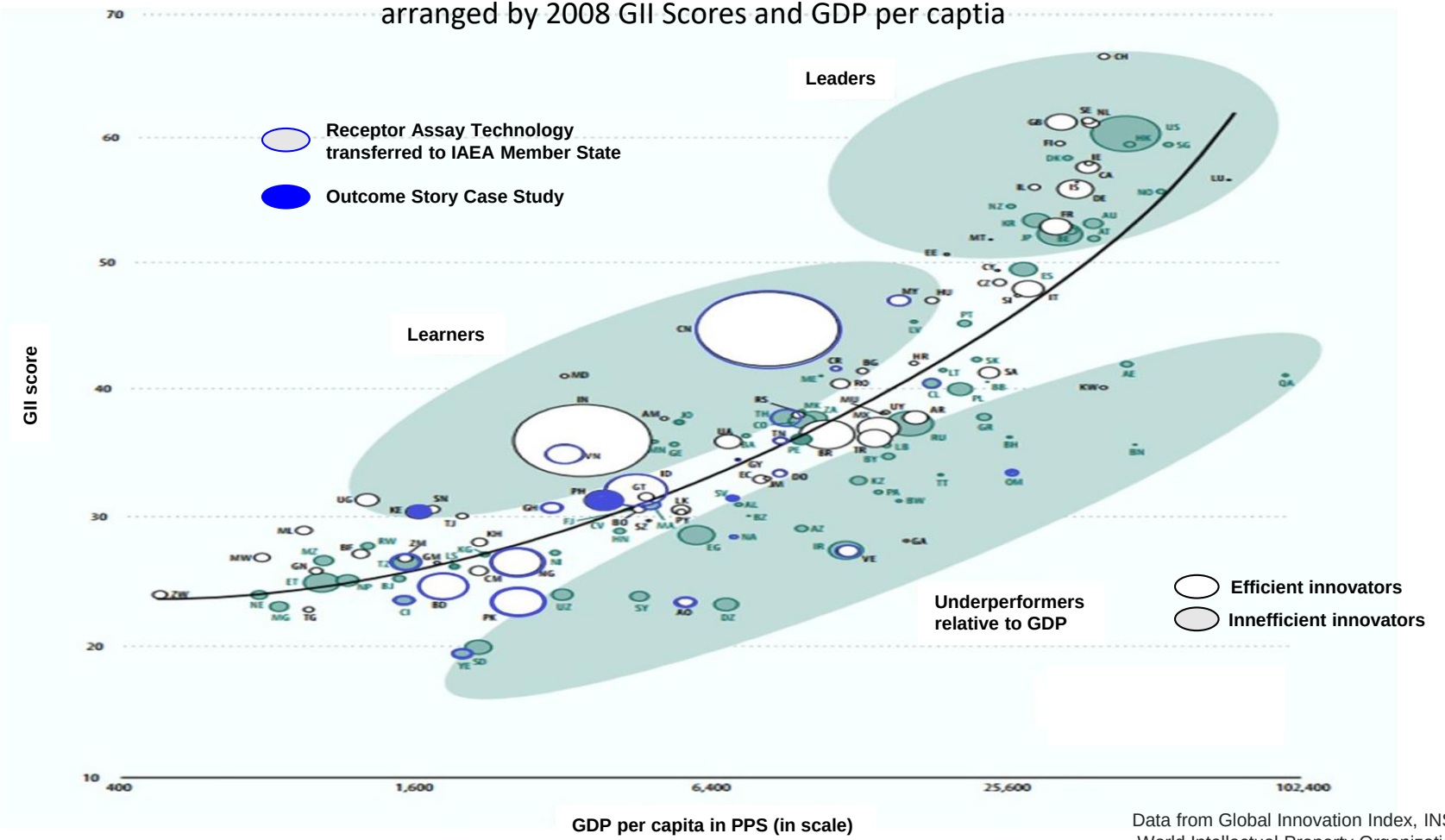
Transfer of Receptor Assay Technology to IAEA Member States

The Global Innovation Index provides detailed metrics about the innovation performance of 127 countries and economies around the world. the GII is a 'unique tool for refining innovation policies . . . for providing an accurate picture on the role of science, technology and innovation in sustainable development'



Data from Global Innovation Index, INSEAD; World Intellectual Property Organization

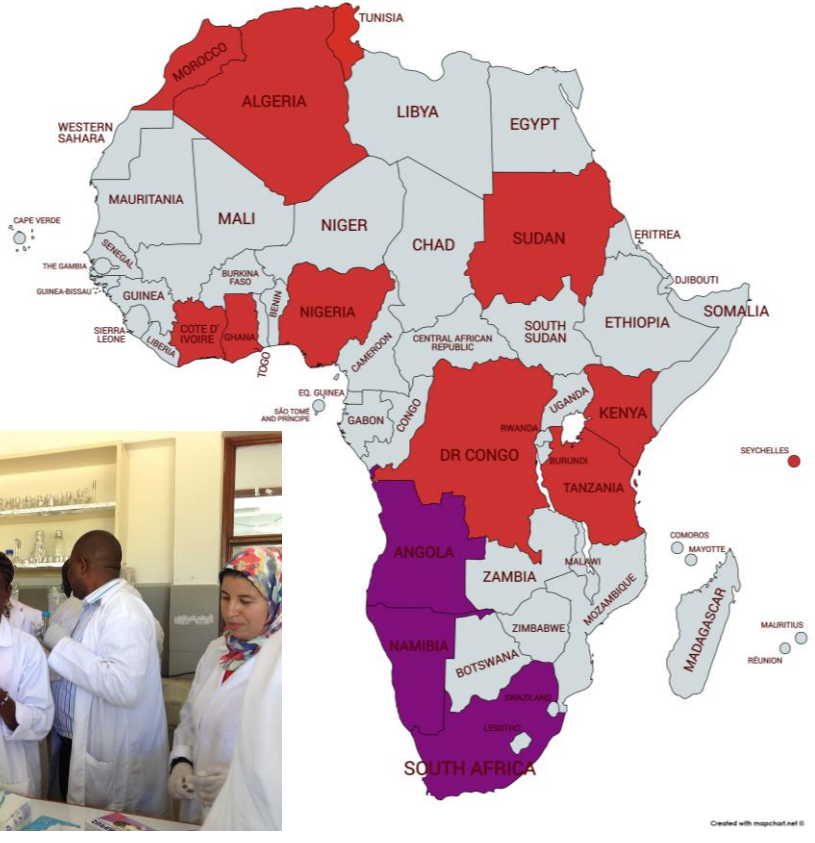
Transfer of Receptor Assay Technology to World Economies arranged by 2008 GII Scores and GDP per captia



Data from Global Innovation Index, INSEAD; World Intellectual Property Organization

OUTCOME STORY- KENYA

Direct Benefit: Regional Training to Technology Excluded Economies



In December of 2016 the IAEA TC Programme supported a week-long training course at the Kenya Marine Fisheries and Research Institute in Monbasa, Kenya.

The training conducted by NOAA Technical Expert Tina Mikulski expanded PSP RBA from SW Africa (2004) to 11 additional Northern and Central African Member States

OUTCOME STORY- EL SALVADOR

Leveraged Opportunity: Institutional Operation for Technology Excluded Economy

Fisherman

Scientists

Conservationist

"In the last ten years we have had a red tide event almost once every year and so, with the cooperation of NOAA and IAEA, we are giving a timely response to the authorities and to the general public in order for the authorities to have a fundamental understanding in order to make a correct (rightful) decisions and possibly we are collaborating in order to protect human health."

"In 2013 about 200 turtles were found stranded in our coastline. Through the RBA we could determine the reason of the turtle mortalities was intoxication due to high concentrations of saxitoxin. These results were obtained in a short period of time and at the same time these results were verified at NOAA and the IAEA laboratory in Monaco."

Accreditation of RBA at LABTOX-UES will allow for increased surveillance of marine toxins to inform resource managers about the threat of HAB associated toxins to protected species and to increase the protection of public health while possibly expanding the economy through the exportation of shellfish.

OUTCOME STORY _ OMAN

Leveraged Opportunity: Institutional Operation for Technology Adaptor Economy

Oman Ministry of
Agriculture and Fisheries

Oman Achievements:

- Developed testing capacity and algal surveillance program
- Conduct response for fish kills

OUTCOME STORY-PHILIPPINES

Leveraged Opportunity: Institutional Operation/Global Promotion by Technology Adaptor Economy

As both capital and human capacities have been built to conduct the receptor binding assay worldwide in our cooperation with the IAEA, other institutions (such as the Philippine Nuclear Institute) are now acting as resource institutions and are taking on a greater role within the IAEA framework in providing services such as expertise, providing training via fellowships and conducting analytical services.

Learning

OUTCOMES

Better Actions

Improved Conditions

1. Direct benefits
These are **benefits** that will occur simply by virtue of the technology transfer taking place.

2. Leverage opportunities
These are the **additional benefits** that can be developed around the technology transfer itself.

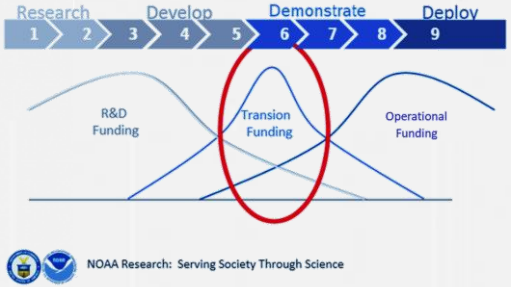
3. Legacy opportunities
These are **the lasting or long-term benefits** that can be accrued beyond the technology transfer.

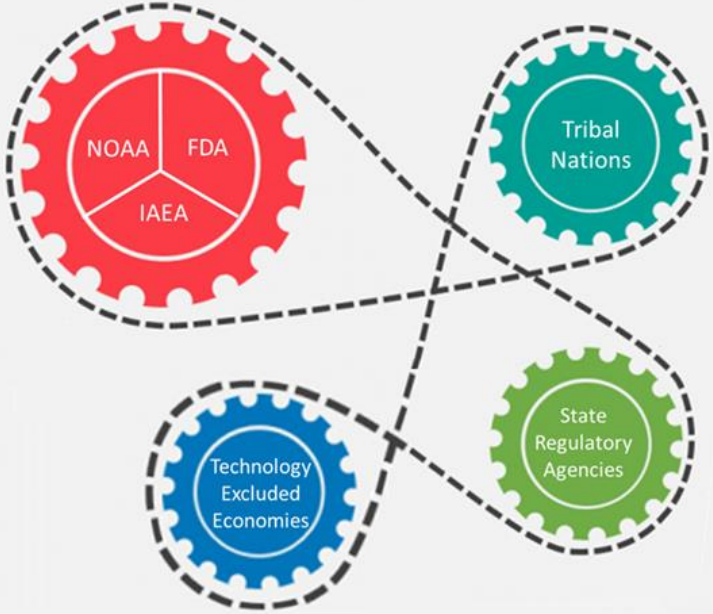
Building Capacity in Alignment with HABHRCA, NOAA and NCCOS

HABHRCA Act of 2014 requires NOAA under sec. 603A(f) to: Increase the availability to appropriate public and private entities of (A) analytical facilities and technologies, (B) operational forecasts, and (C) reference and research materials;

Work cooperatively and avoid duplication of effort with other offices, centers, and programs within the National Oceanic and Atmospheric Administration, other agencies on the Task Force, and States, tribes, and nongovernmental organizations to coordinate HAB and hypoxia activities and research.

NAO 216-115A Section 3.02-
Transitioning research and development: Continually improving NOAA's products …by developing the most promising research… to the point they can be transitioned into operations, applications, commercialization or other use (R2X).





Science serves to sustain

NCCOS NATIONAL CENTERS FOR COASTAL OCEAN SCIENCE

thriving coastal communities and economies

HAB FOCUS AREA 5: Analytical methods and reference materials which leverage existing NCCOS expertise, will be advanced in concert with other federal agencies participating in the HABHRCA IWG to support the development of standardized methods and training for testing laboratories and validation of their use to assure accurate and reproducible measurements nationwide