

FlowCytobot imaging and modelling of harmful algal blooms in the Gulf of Mexico

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NOAA/NCCOS Harmful Algal Bloom and Hypoxia Science Review
Feb 27, 2018



TEXAS A&M
UNIVERSITY

Harmful Algal Blooms (HABs)



K. brevis in Texas, S. Padre Island



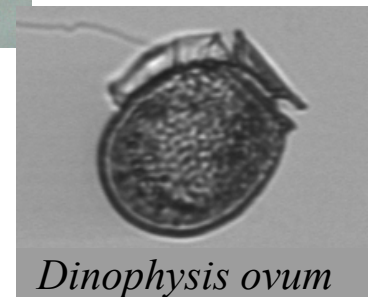
photo credit: D. Henrichs



- Early warning is the most effective mitigation for harmful algal blooms
- Requirements for an early warning system
 - ➔ Regular sampling
 - ➔ High frequency
 - ➔ High accuracy



Karenia brevis



Dinophysis ovum

Outline

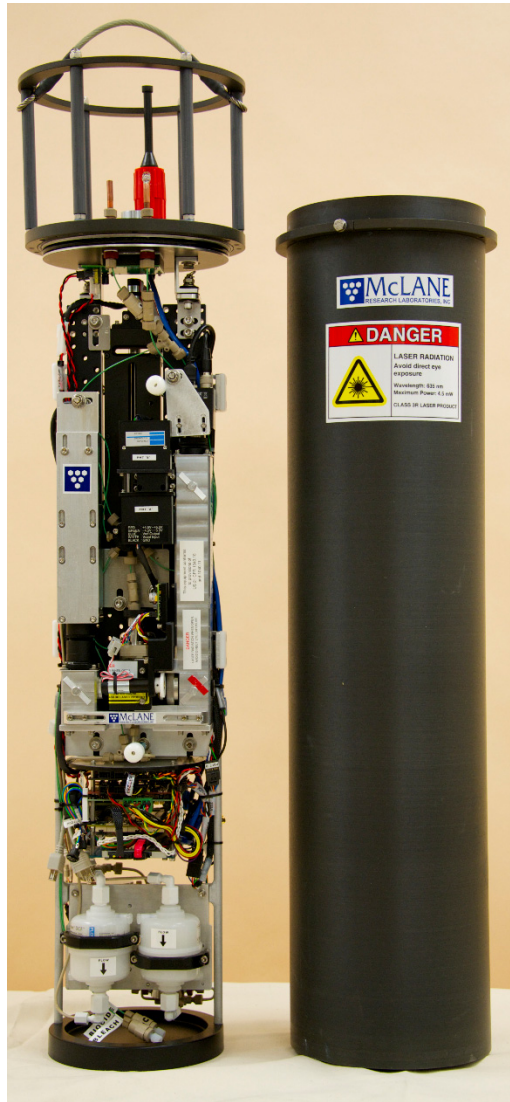


Continuous automated operation of the IFCB on the Texas coast has produced a >10-year phytoplankton time series and now an IFCB network

- high temporal resolution time series for successful early warning of HABs
- the importance of physical factors in controlling bloom dynamics

1. Imaging Flow Cytobot
2. HABs and early warning
3. Bloom initiation
4. Origin of bloom populations
5. Relevance of achievements

1. Imaging Flow Cytobot



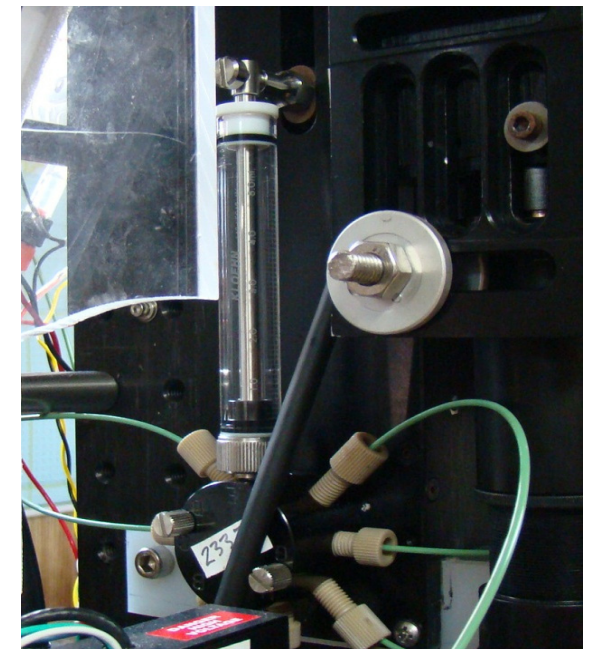
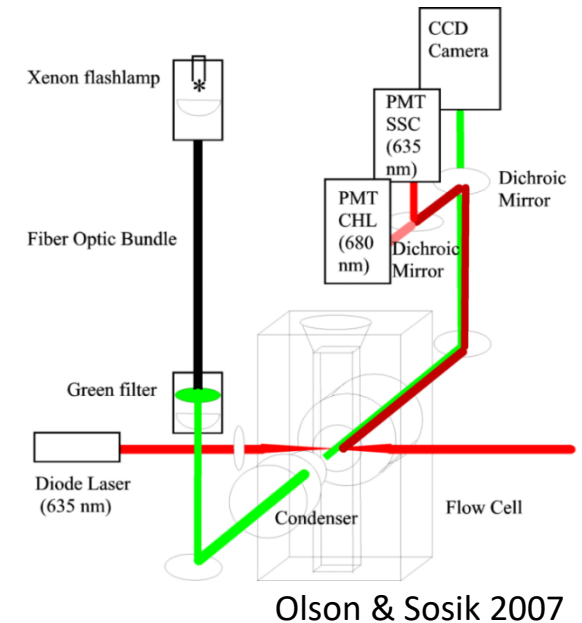
Operation:

- Combines flow cytometry and video technology
- 5-mL sample
- every ~20 min
- ~70 samples/day
- 24/7 operation

Data:

- Copied to Campbell Lab at TAMU
- Archived
- Image processing & automated classification
- Automated notification
- Manual inspection

<http://toast.tamu.edu/>



Campbell – NOAA/NCCOS HAB & Hypoxia Review

2. Harmful Algal Blooms: *Karenia brevis*

Novel approach for
early warning

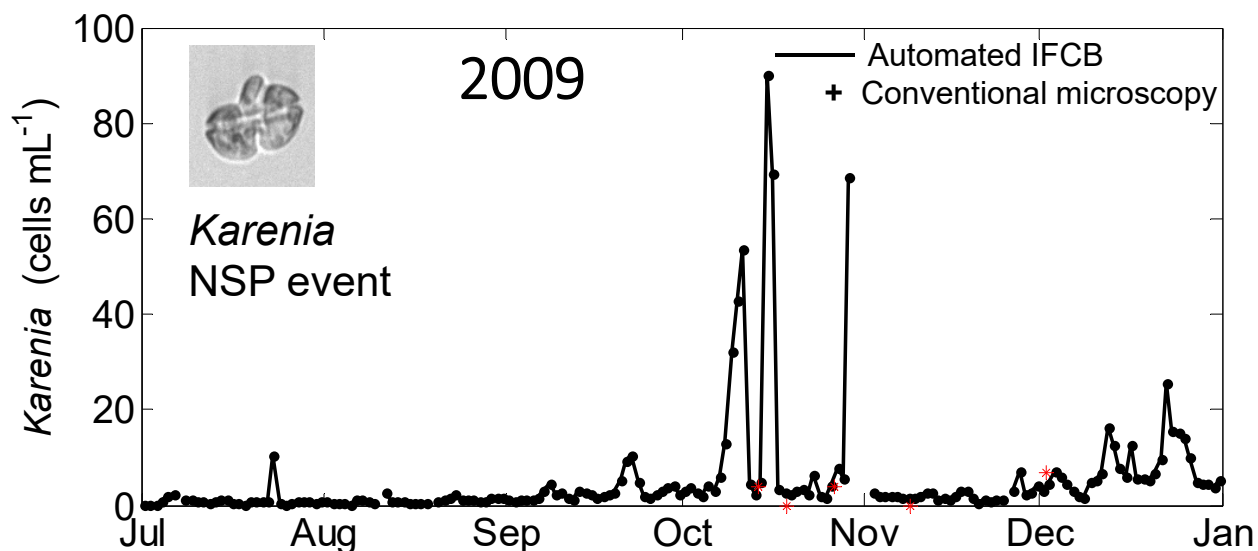
Daily resolution

→ Low level detection
>1 month before peak



Port Aransas area
fish kills Oct. 2009

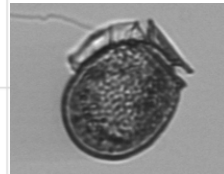
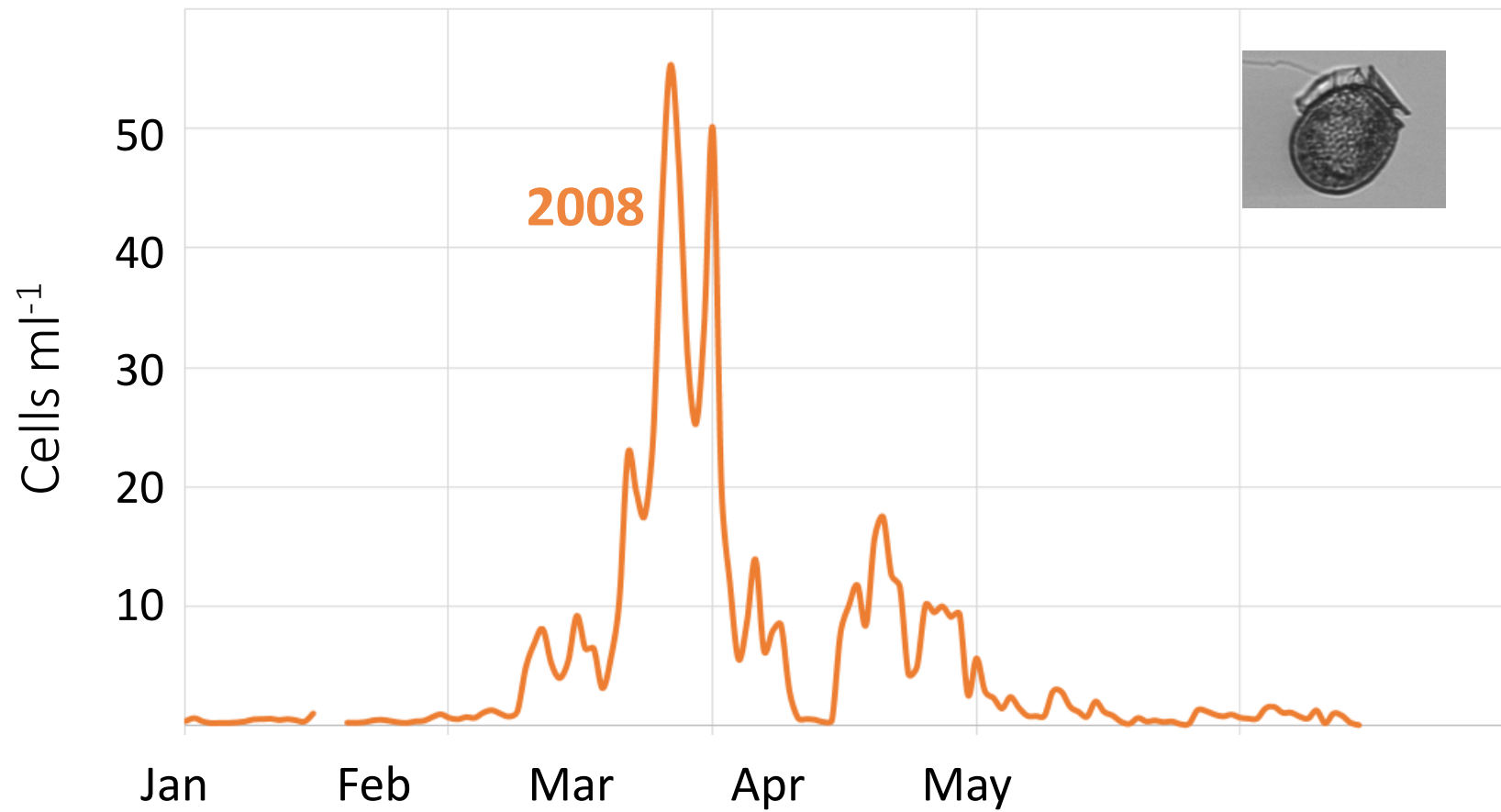
(Texas Parks and Wildlife Department;
<http://www.tpwd.state.tx.us>)



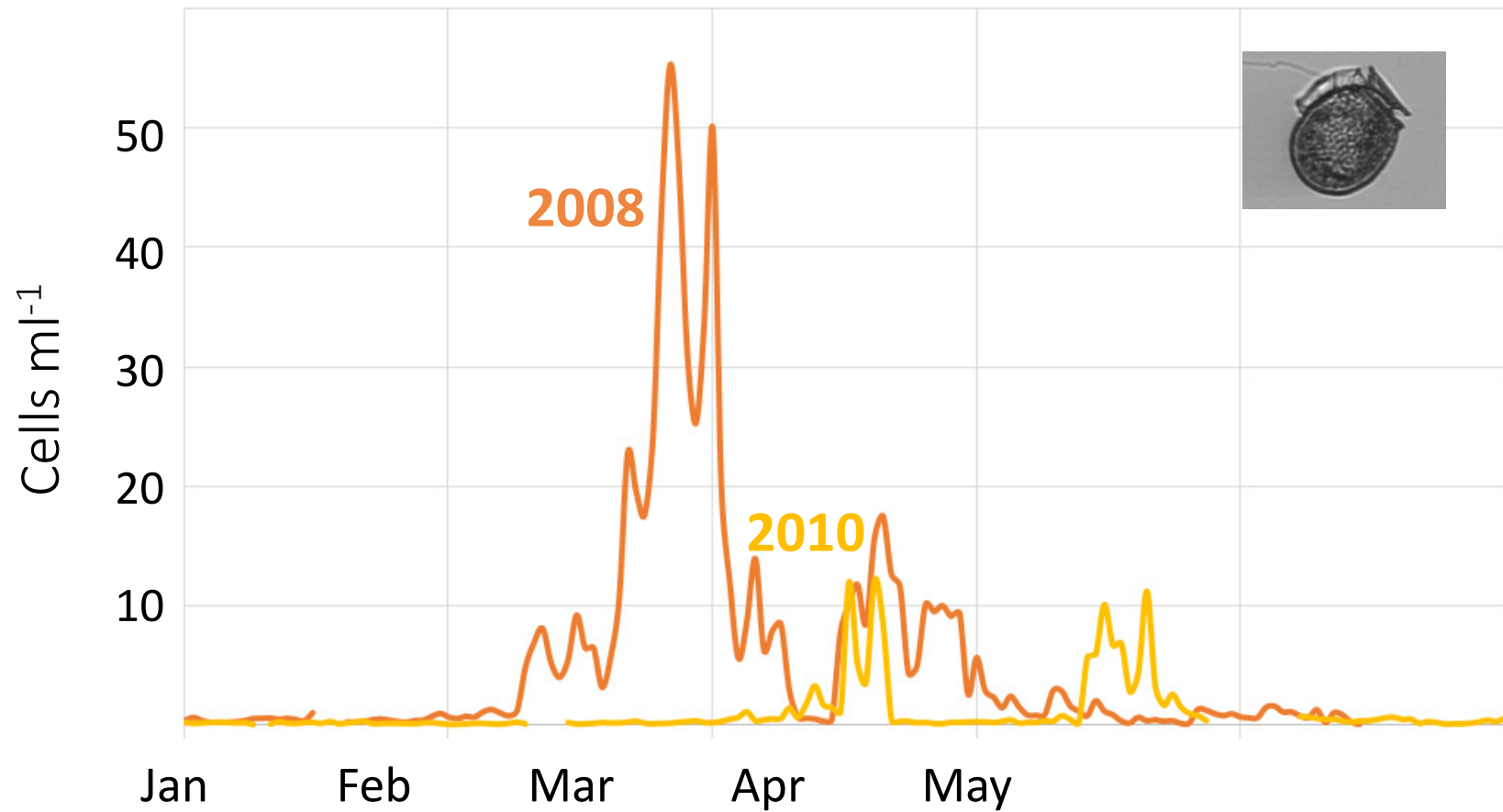
- ▶ Species-specific early warning
- ▶ Peaks in cell abundance were missed by standard monitoring
- ▶ Extreme patchiness

Campbell et al. 2010, 2013

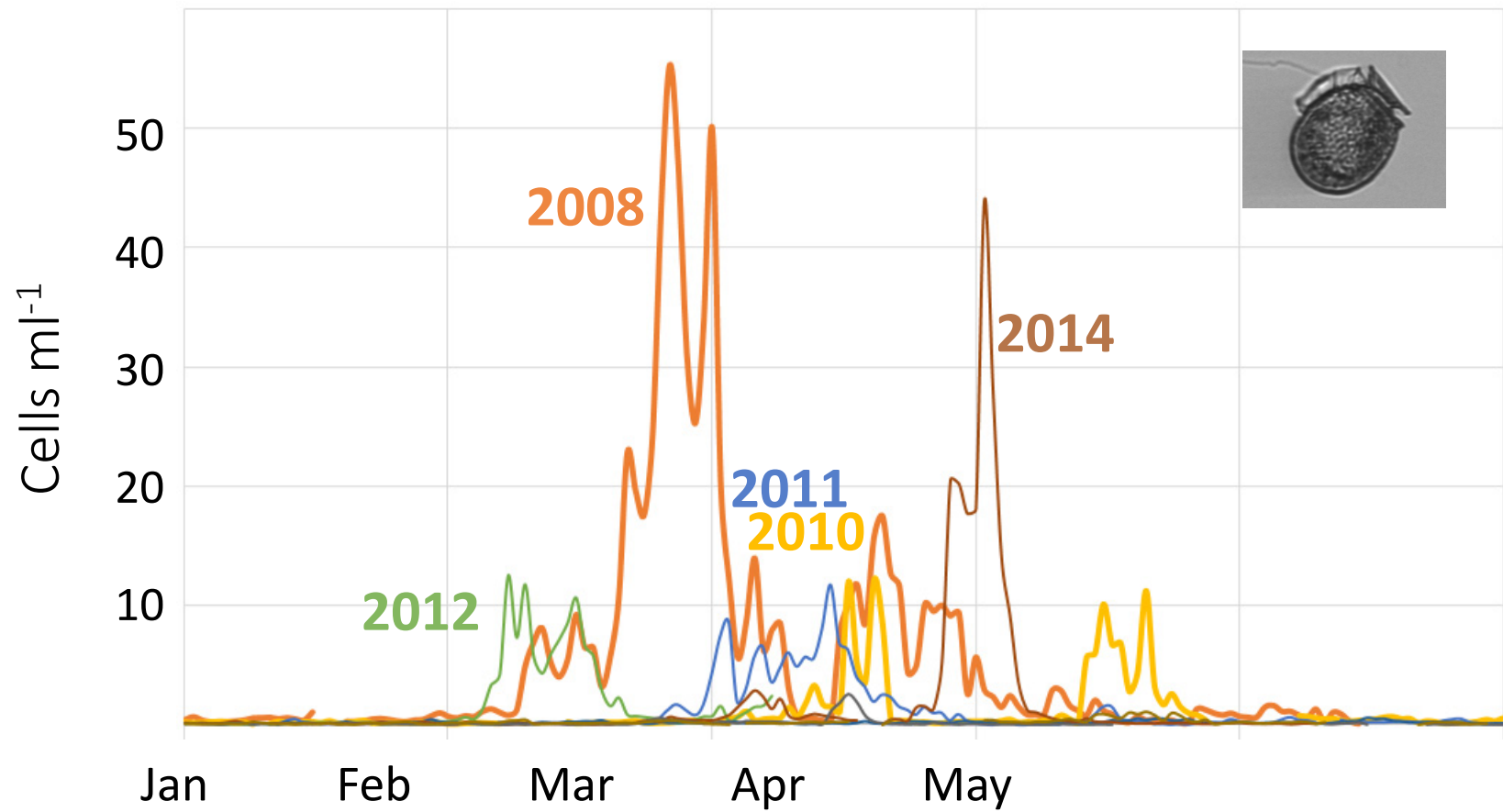
2. *Dinophysis*



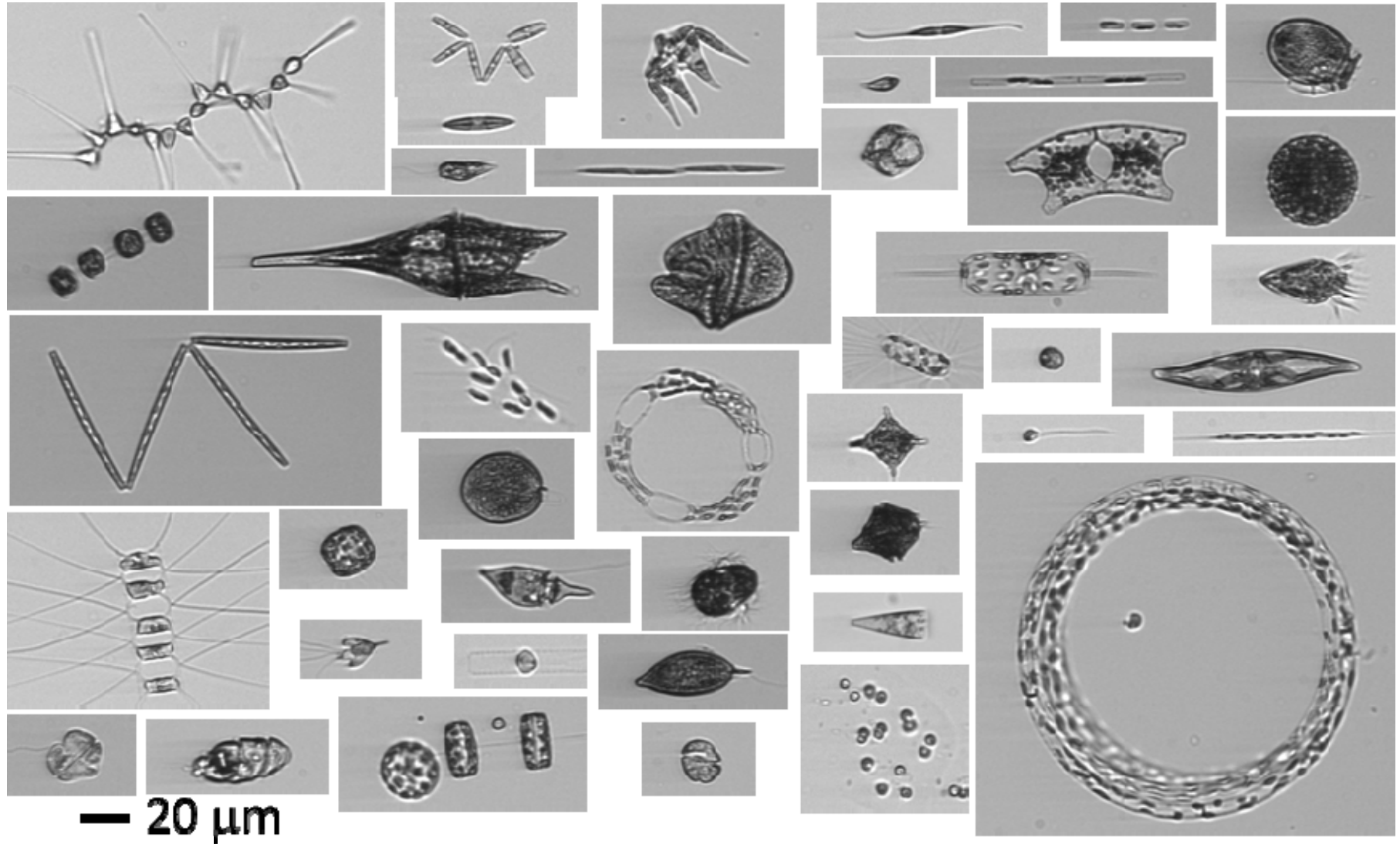
2. *Dinophysis*



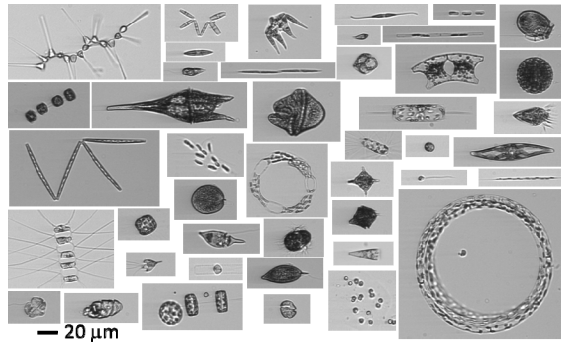
Phenology



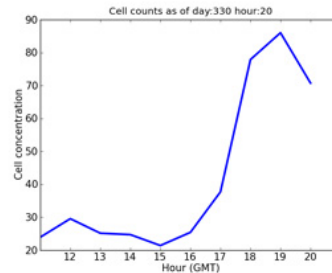
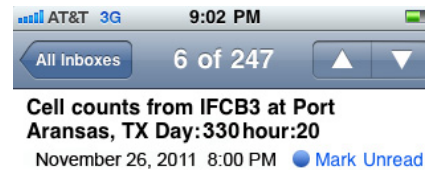
~ Billion images from > 10-yr time series
→ Automated classification is essential



2. Automated Classification & Messaging

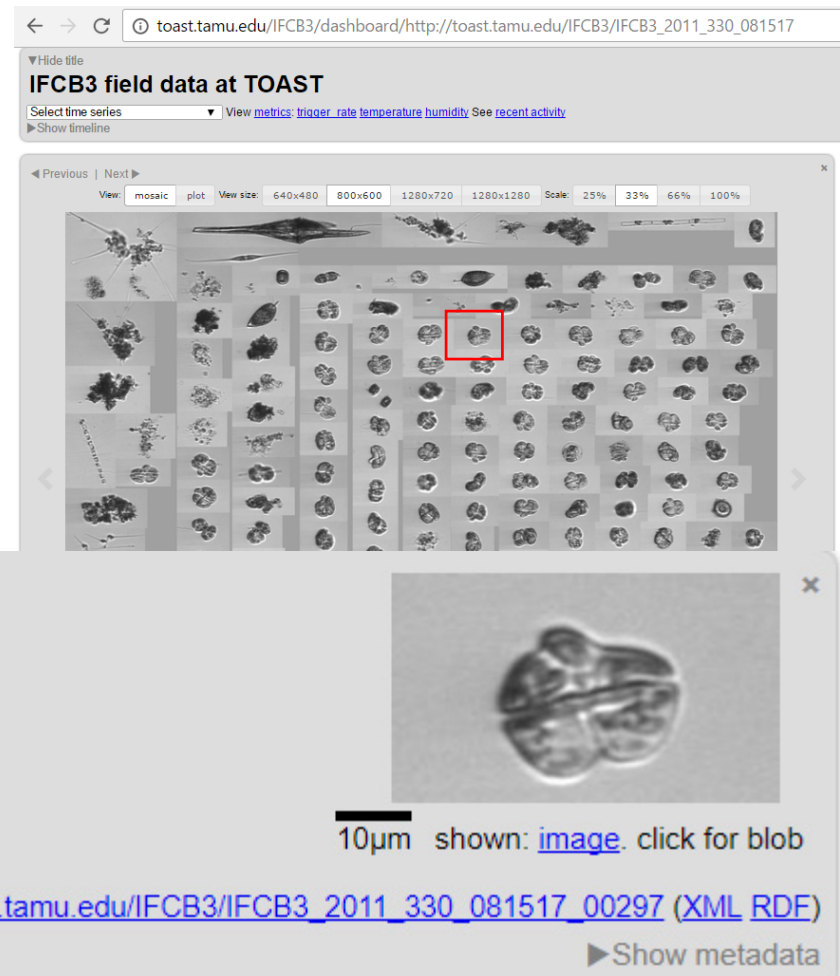


When >2 cells/mL:
Notifications sent via email to:
Campbell lab
Local state managers
TX State Dept. of Health Services



Automated cell counts of Karenia are listed below
Please note: these counts have not been manually verified

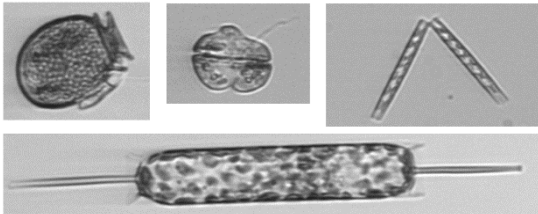
Cell counts have exceeded 2 cells
Day: 330 20:00:00 GMT
20: 70.74
19: 86.01
18: 77.88
17: 37.7
16: 25.42
15: 21.42
14: 24.73



- 8 successful early warnings
- No illnesses have been reported

<http://toast.tamu.edu/>

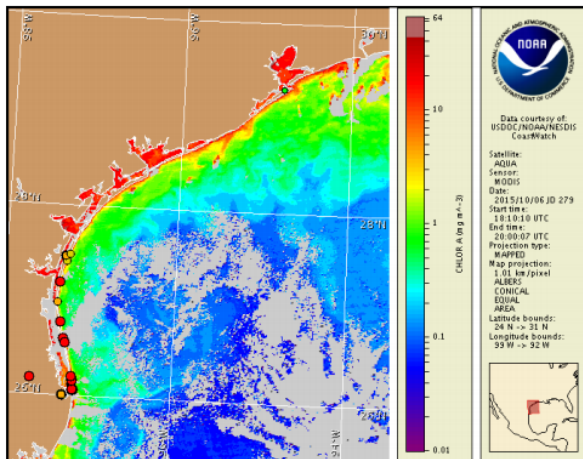
2. End-user customized emails (GCOOS)



IFCB Notification Form
Add threshold values for each species of interest



Gulf of Mexico Harmful Algal Bloom Bulletin
Region: Texas
Thursday, 08 October 2015
NOAA National Ocean Service
NOAA Satellite and Information Service
NOAA National Weather Service
Last bulletin: Monday, October 5, 2015



To: [jsmith](#) [Matthew Howard](#)
Cc:
Bcc:
Subject: Cell Counts from Surfside Beach, TX 2017-11-02T15:31:00Z
Message Size: 8 KB

Surfside Beach IFCB Notification: Tolerance Threshold(s) Exceeded 2017-11-02T15:31:00Z

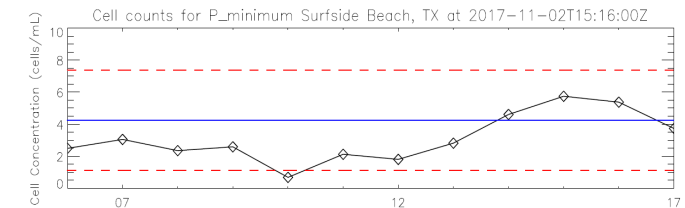
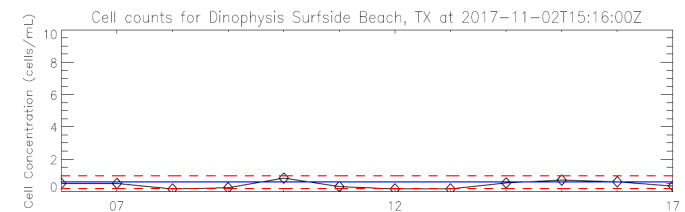
Latest Asterionellopsis concentration = 5.80 (cells/mL) <- Exceeded your low_threshold value of 2.00

Latest Chaetoceros concentration = 13.59 (cells/mL) <- Exceeded your low_threshold value of 2.00
Latest Chaetoceros concentration = 13.59 (cells/mL) <- Exceeded your high_threshold value of 5.00

Latest P_minimum concentration = 3.73 (cells/mL) <- Exceeded your low_threshold value of 2.00

Blue line is mean value for last 12 hours. Red lines are +/- one standard deviation.

To unsubscribe - send an email to mkhoward@tamu.edu



2 November 2017

HAB Bulletin

- IFCB data from Port Aransas is included in reports



3. Models: Bloom initiation model

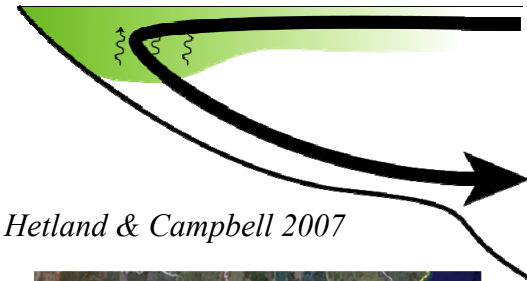
Hypothesis:

Downwelling created by convergence at the coast.

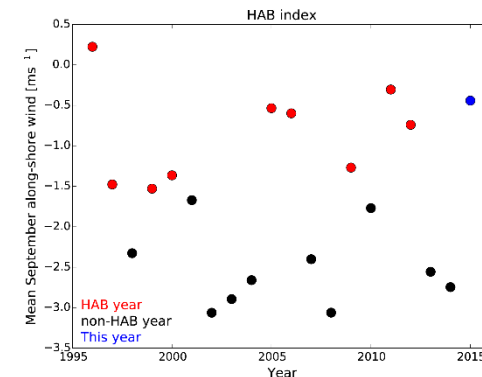
Plankton are concentrated between the downwelling circulation and swimming– no growth is required.

Concentration is proportional to the net amount of shoreward transport in the Ekman layer

Conceptual Model



Hetland & Campbell 2007



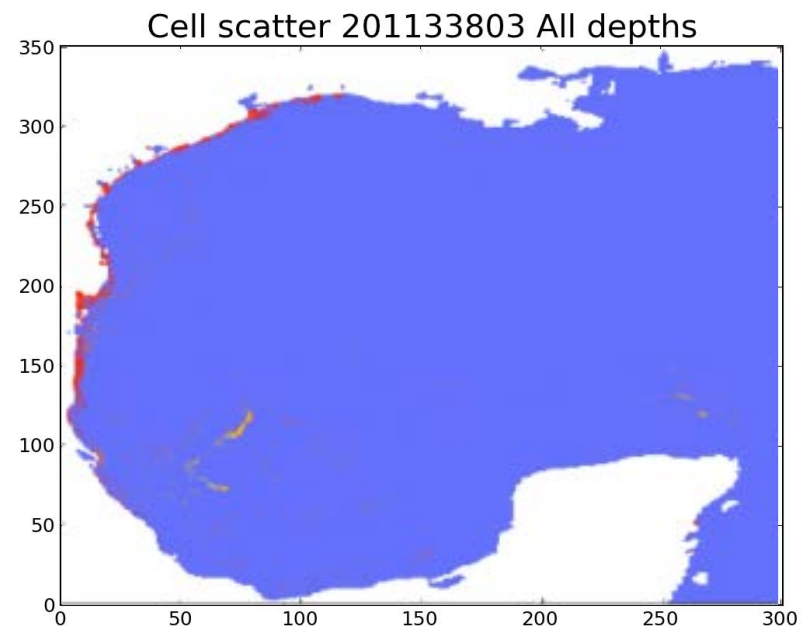
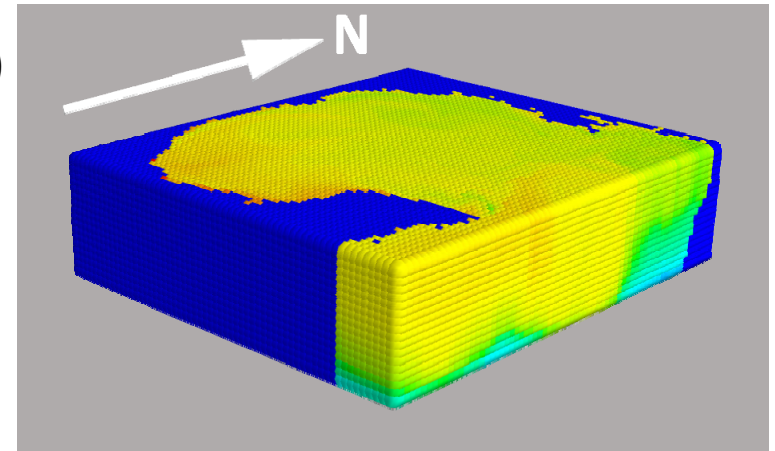
K. Thyng, unpublished; Thyng et al. 2013

Campbell – NOAA/NCCOS HAB & Hypoxia Review

4. Bloom origin: 2011 *Karenia*

Individual Based Model (IBM) (Henrichs et al. 2015)

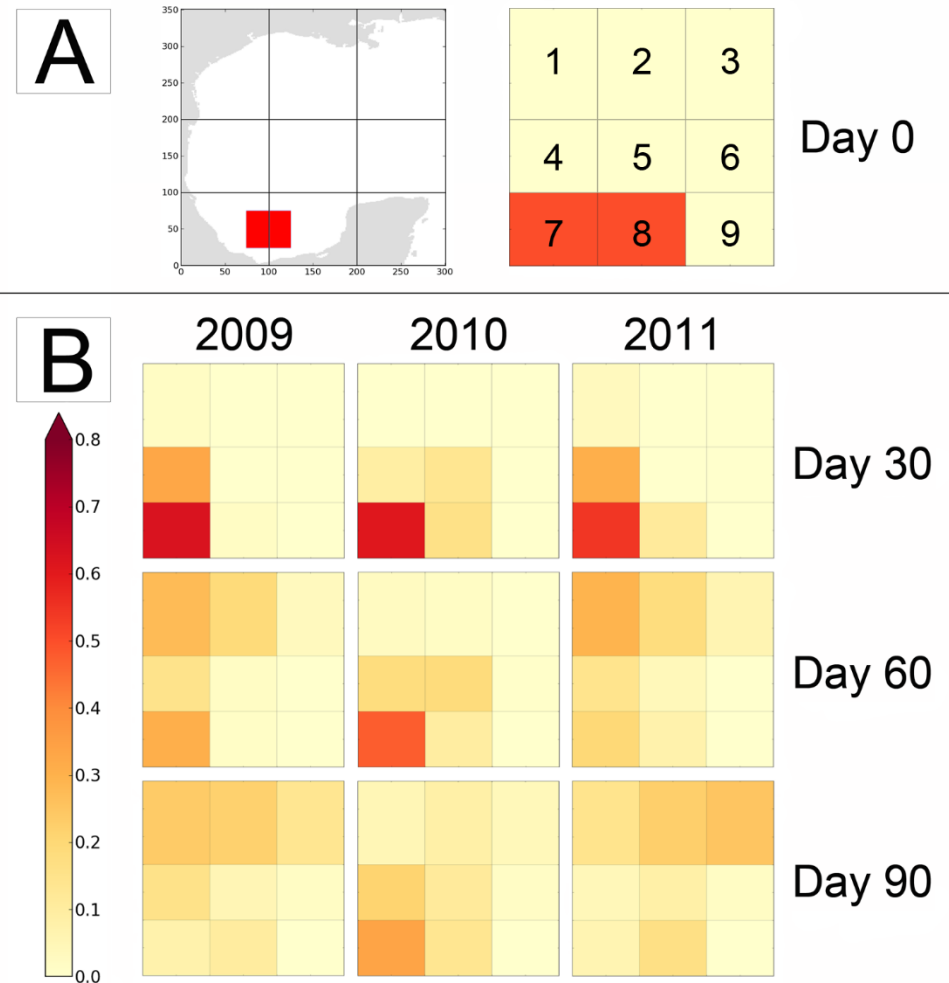
- Model behavior of individual cells
- Cells swim vertically
- Horizontal movement is controlled by currents
 - Gulf of Mexico HYCOM
 - Temperature
 - Salinity
- Run IBM in reverse
 - Input cells at IFCB location (Port Aransas)
 - Date/Time based on IFCB data



4. HAB Bloom origin

IBM– forward run in bloom vs. non-bloom years

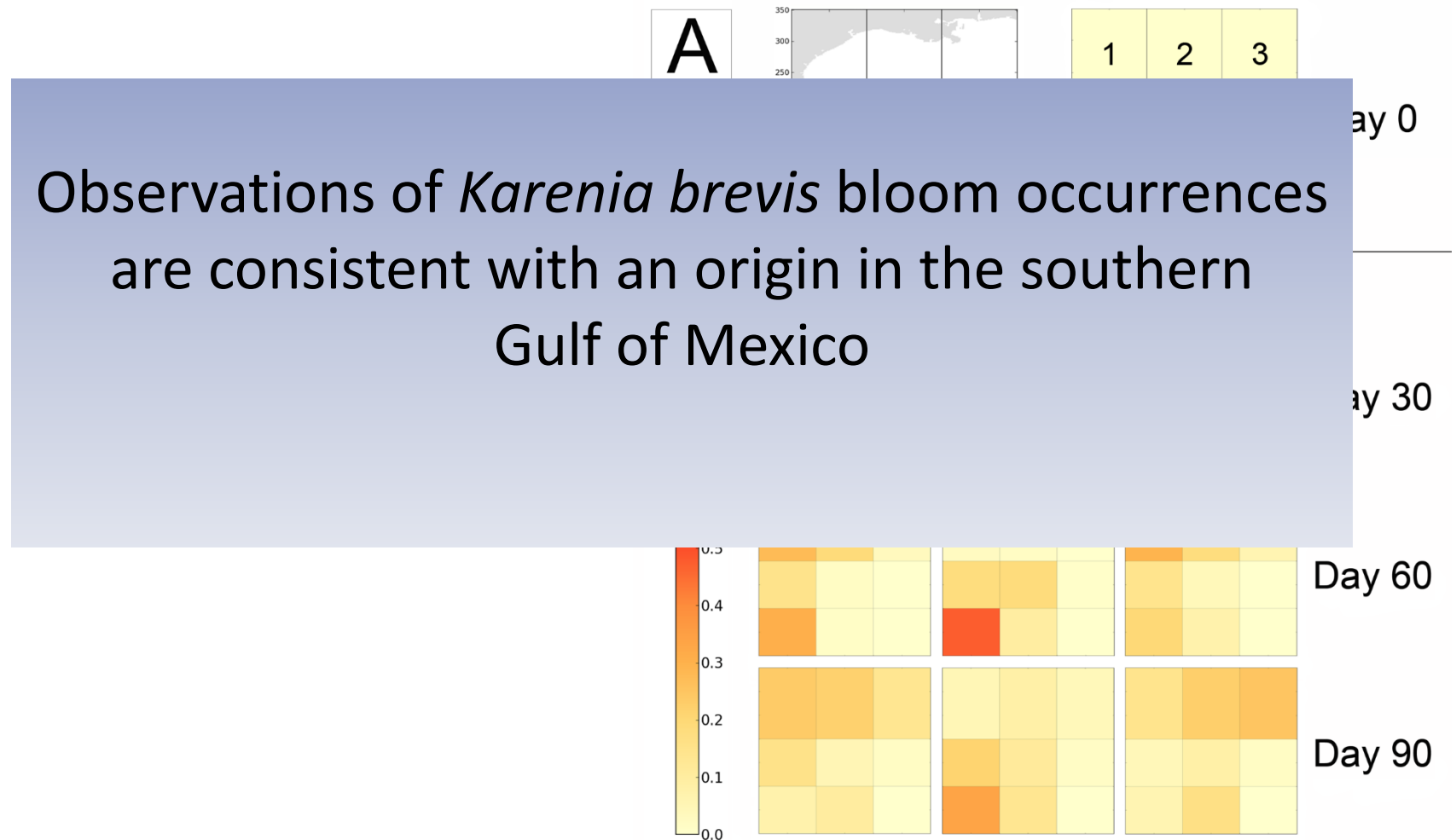
Input cells input in S.
Gulf of Mexico, model
run forward:
Bloom (2009 & 2011)
vs. non-bloom (2010)
years



Henrichs et al. 2015. Ecological Modelling

4. HAB Bloom origin

IBM– forward run in bloom vs. non-bloom years



Henrichs et al. 2015. Ecological Modelling

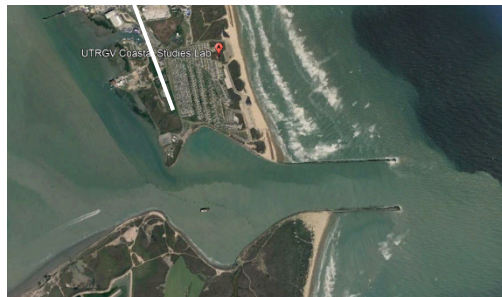
5. Specific Outcomes: Expanded network



May 2017- ongoing
Surfside Beach, TX



August 2007- 2017
Port Aransas, TX
--recovery plan



Summer 2018-
South Padre Island, TX
Chip Breier, UT-RGV

Conclusions

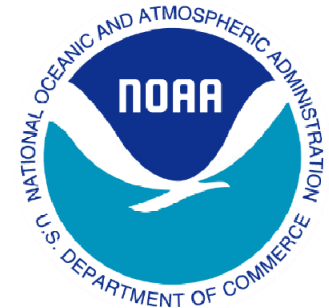
- ❖ High temporal resolution IFCB time series provides unique view of the phytoplankton community
 1. Early warning of HABs
 2. Models developed using IFCB data
 - Identify bloom initiation
 - Bloom origins
- ❖ Relevance of achievements:
 1. A network of IFCBs along the TX coast for early warning
 2. An information support system to enable end-users to utilize IFCB observations for HAB management decisions
 3. Improved automated image classification for HAB taxa; all code is publicly available
 4. Trained end-users
 5. Established partnerships between researchers and resource managers that promote access and sustainability toward operational use of IFCB technology.

Acknowledgements



Funding

- NOAA/ECOHAB/PCMHAB
- Texas Sea Grant
- GCOOS
- NSF



Modeling Blooms of *Alexandrium catanella* in the Gulf of Maine: From Climatology to Forecasting

ECOHAB: NOAA & NSF

MERHAB: NOAA

PCMHAB: NOAA

COHH: NSF & NIEHS

Anderson, McGillicuddy, Keafer (WHOI)

He (NCSU), Townsend, Pettigrew, Thomas (UMaine)

Turner, Pilskaln (UMass D), Bricelj (RU),

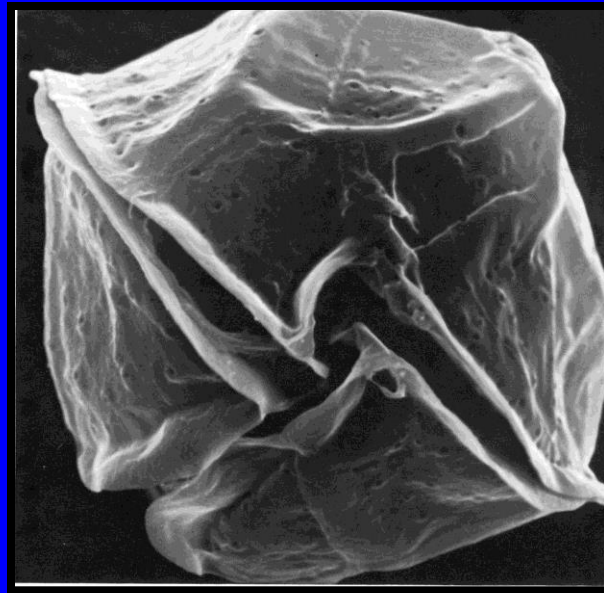
Manning, Mountain, P. Fratantoni (NMFS)

Haskell (NOS) Martin (DFO) Hall, DeGrasse, Deeds (FDA)

Hickey, Whittaker (DMF) Kanwit (DMR) Nash (DES)


Stumpf, Li (NOAA)

Alexandrium catanella



Dinoflagellate
~40 microns
Produces saxitoxins

Leads to Paralytic Shellfish Poisoning (PSP)



DANGER

Area Closed

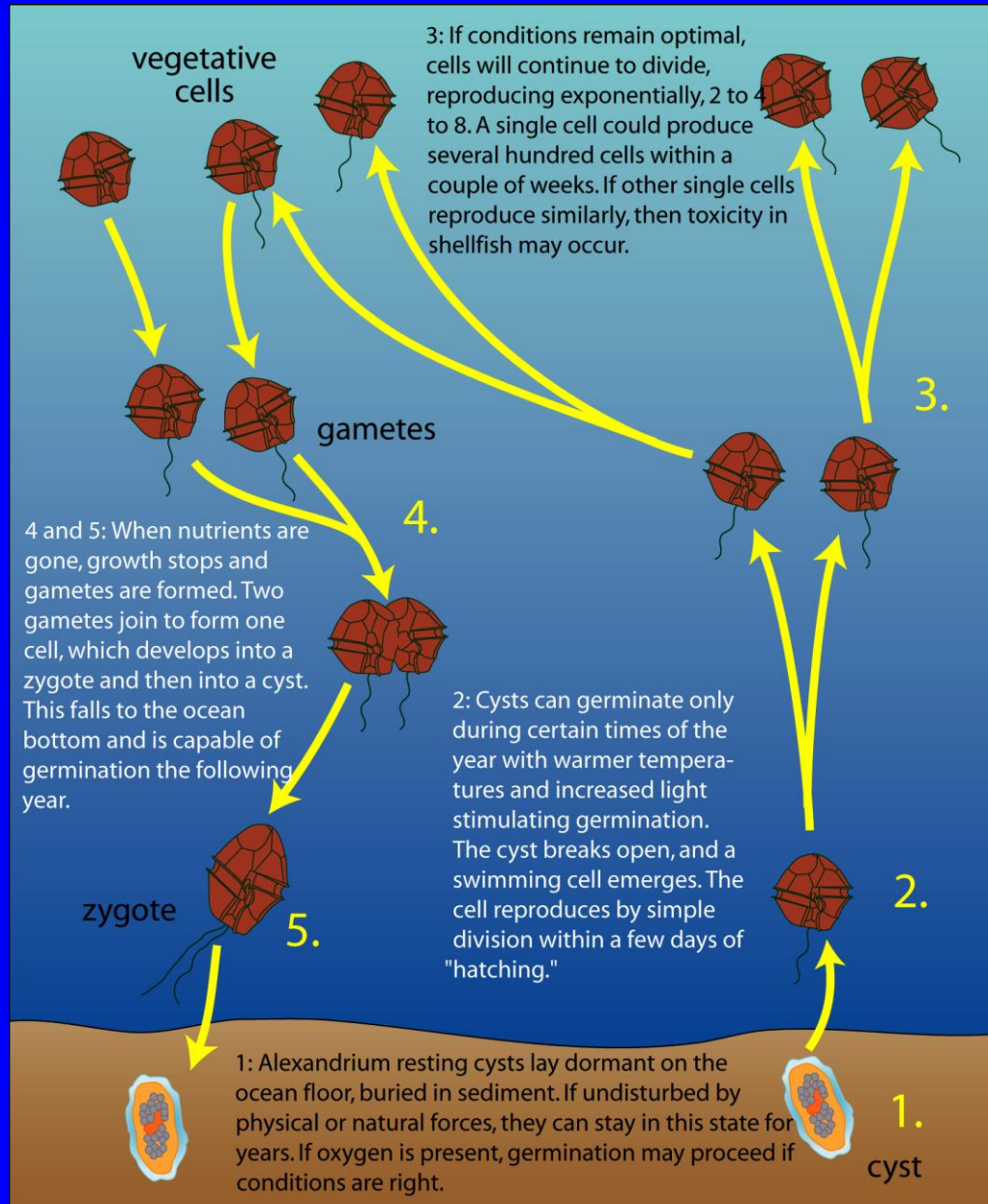
Shellfish (oysters, clams, mussels and other bivalve molluscs) in the area described below contain paralytic toxins and are not safe for use as food.

Secteur fermé

Les mollusques (huîtres, clams, moules et autres mollusques bivalves) provenant du secteur décrit ci-après contiennent des toxines paralysantes et sont donc impropres à la consommation.



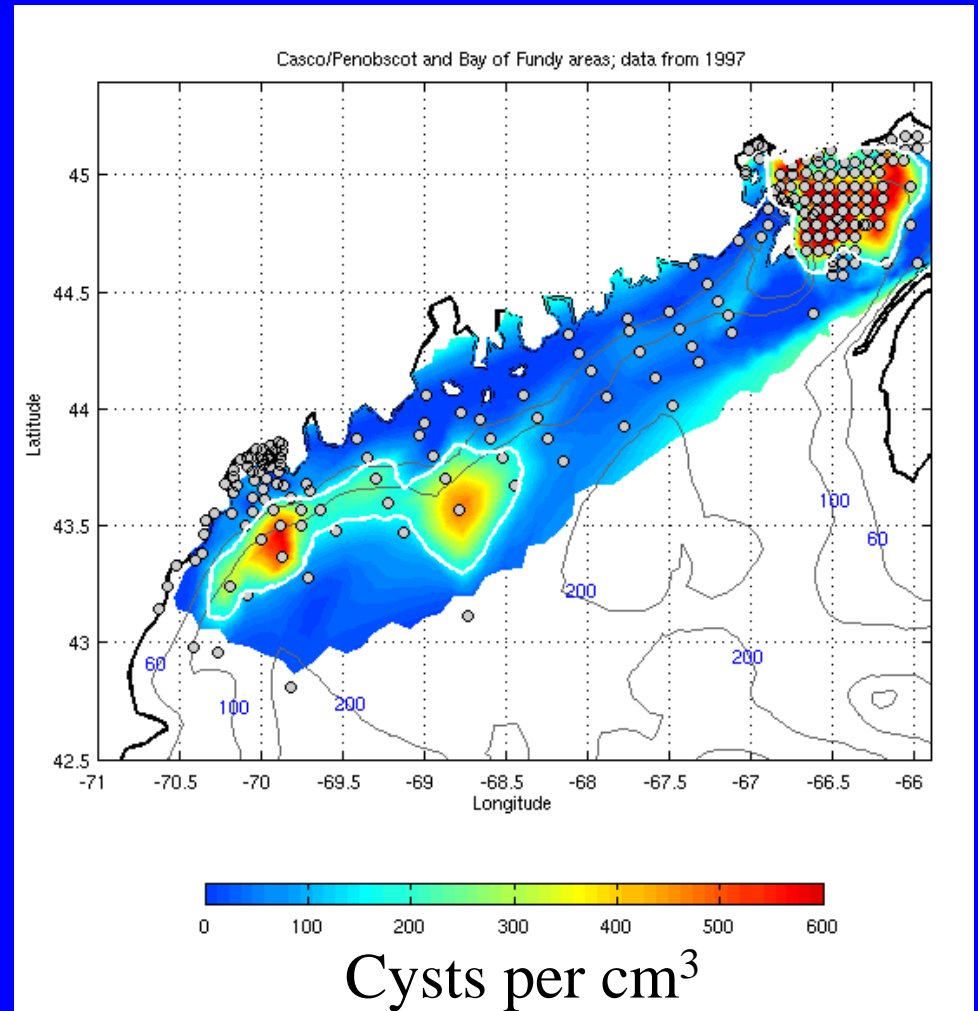
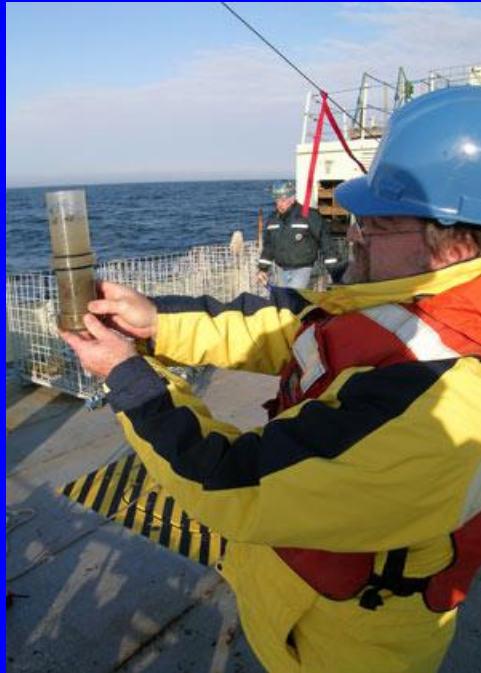
Life Cycle of *Alexandrium*



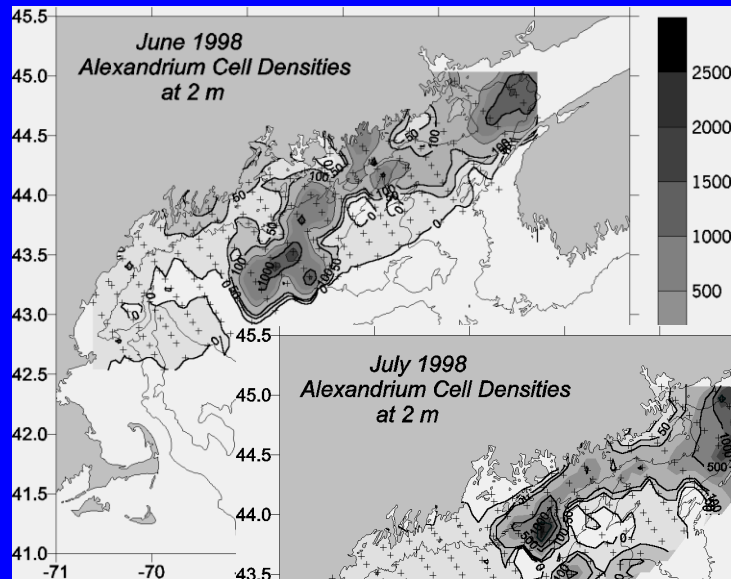
Chapter 1. ECOHAB-GOM 1997-2001

The mean seasonal cycle

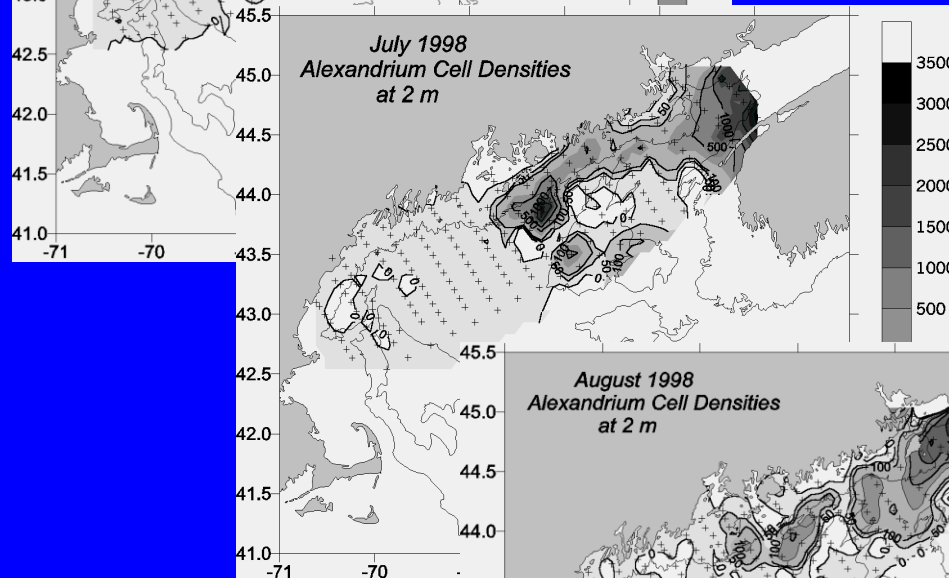
Benthic cyst distribution



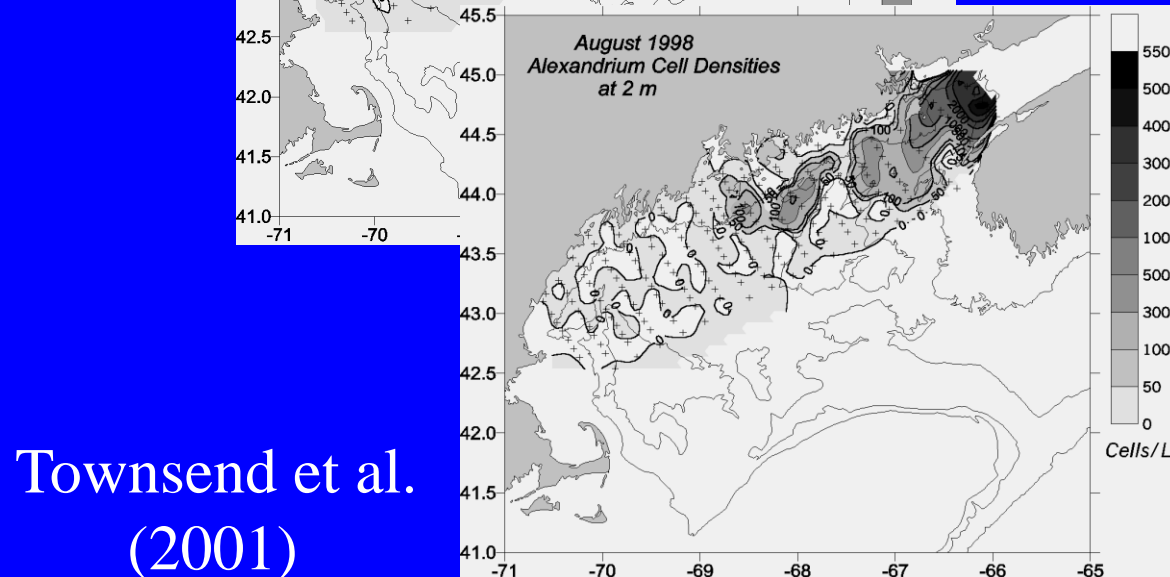
ECOHAB-GOM Observations



1) Gulf-wide
distribution



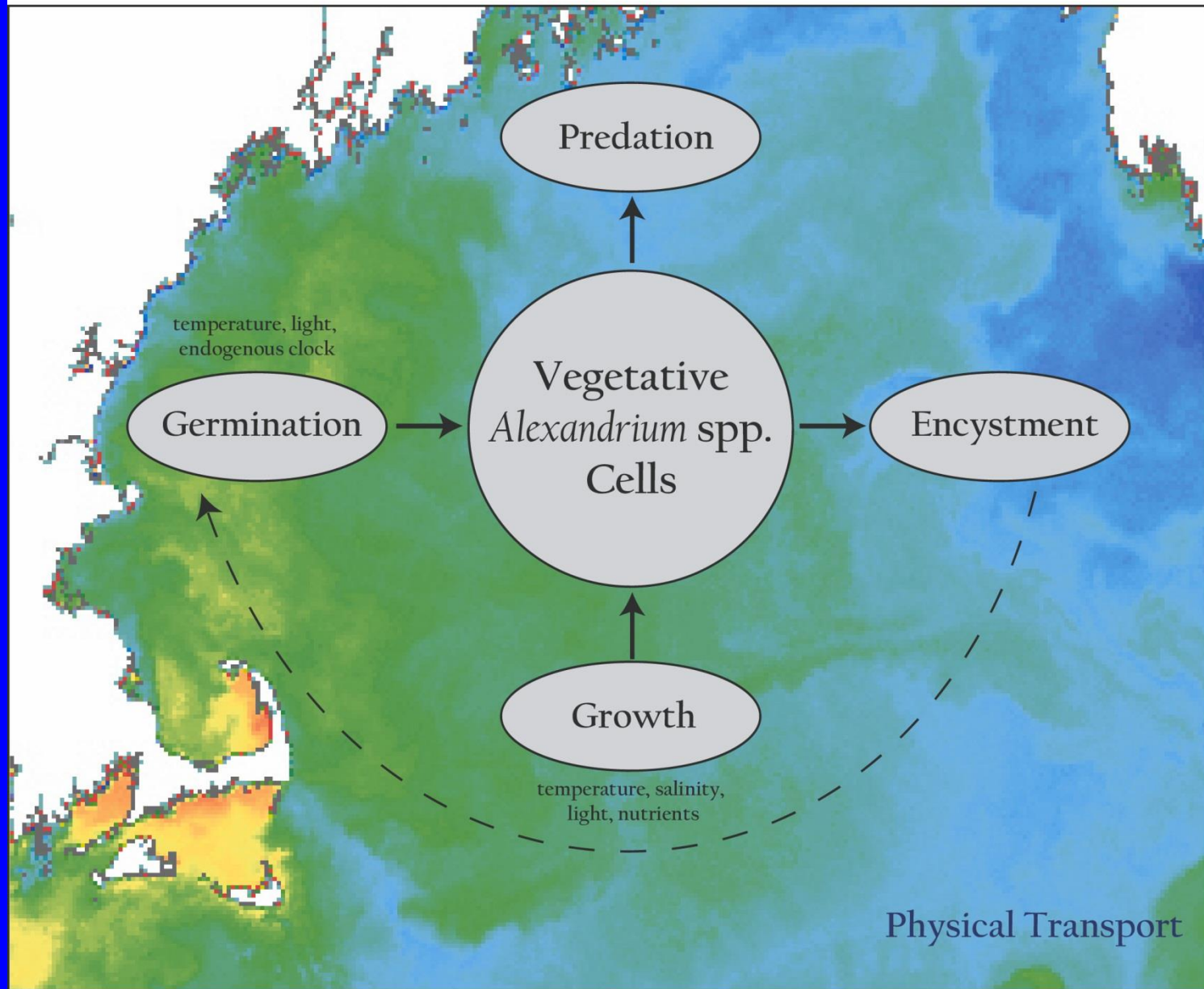
2) Association with coastal
current



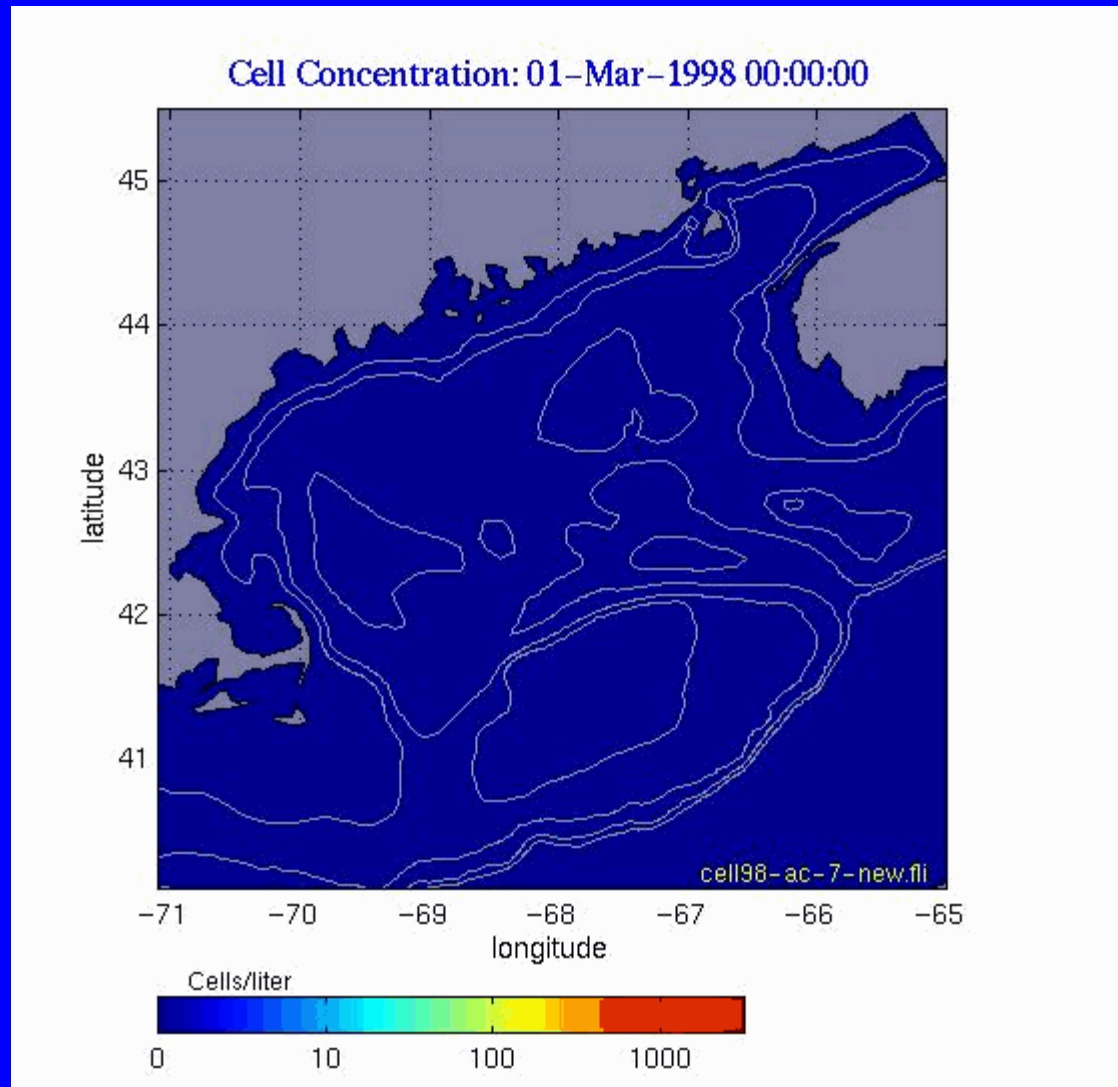
3) Center of mass
shifts west-to-east
as season progresses

Townsend et al.
(2001)

Population Dynamics of *Alexandrium* spp.



Germination, Growth, 'Mortality', Nut. Limit.



A conceptual model
for the large scale
seasonal variability
of *A. catanella* in the
Gulf of Maine

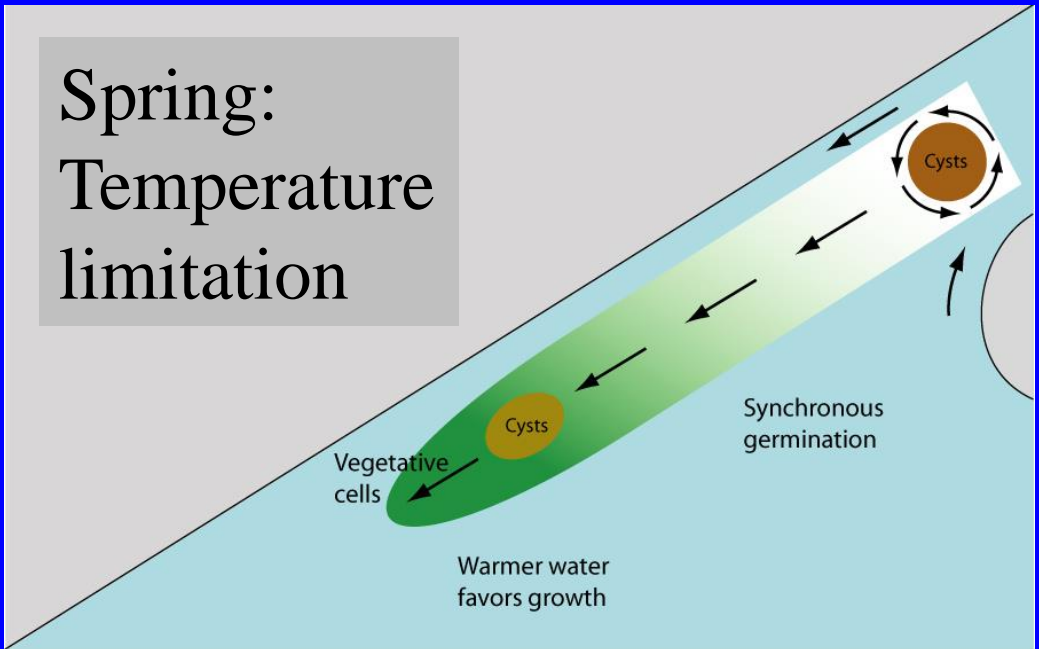
Spring:
Temperature
limitation

Vegetative
cells

Cysts

Warmer water
favors growth

Synchronous
germination



Summer:
Nutrient
limitation

Cysts

- Abundant nutrients
- Continued growth
- Retention in Bay of Fundy gyre
- Cyst deposition at end of growing season

- Nutrient limitation

- Cyst deposition



Chapter 2. MERHAB/COHH/GOMTOX 2005 bloom and a regime shift

The 2005 bloom

- Most widespread and intense bloom in at least 33 years, perhaps longer
- Record levels of toxicity in some locations; first-time ever records of toxicity in others
- Record high *A. catanella* cell concentrations (for this region)
- Large closure of federal (offshore) waters
- > \$50M loss to shellfish industry in MA alone
- Maine, MA - disaster declarations



Figure 2

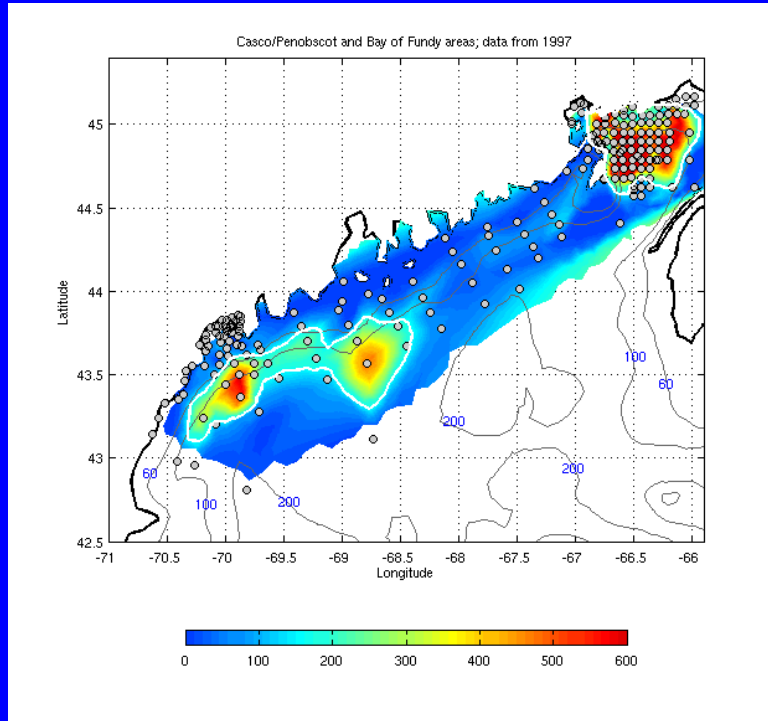
Anderson et al., 2005

Hypotheses

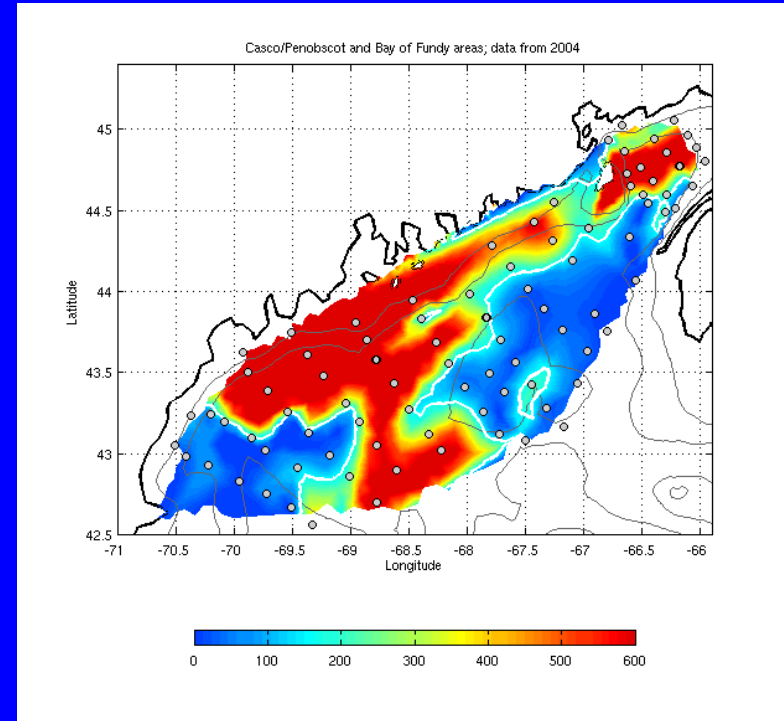
1. Source: High abundance of *A. catanella* cysts in western GOM sediments.
2. Transport: Northeast winds caused strong onshore advection of *A. catanella* populations
3. Anomalously high river runoff resulted in enhanced alongshore transport, and higher micro- and macro-nutrient concentrations.

Interannual variability in cyst population

1997



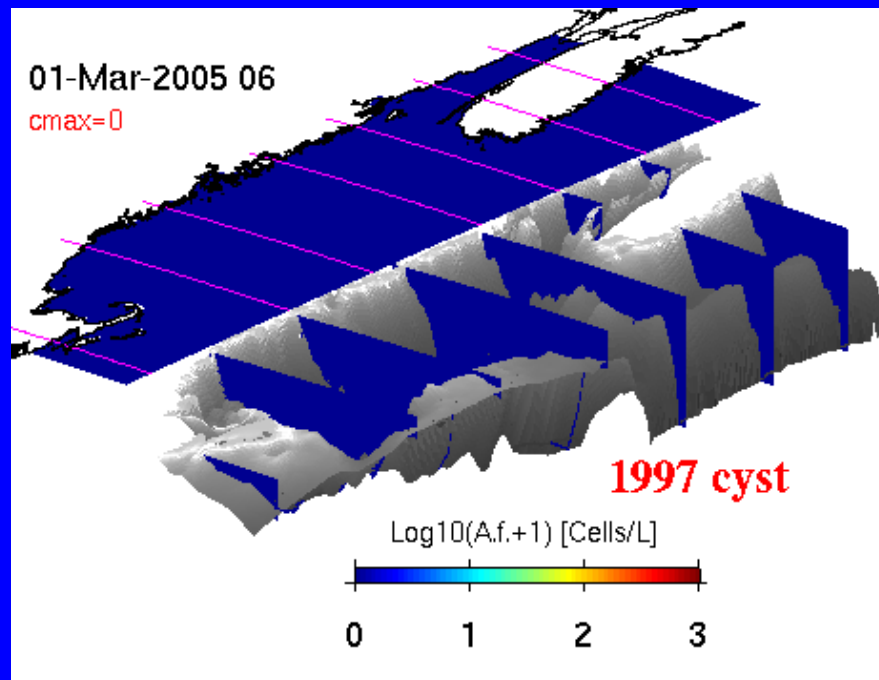
2004



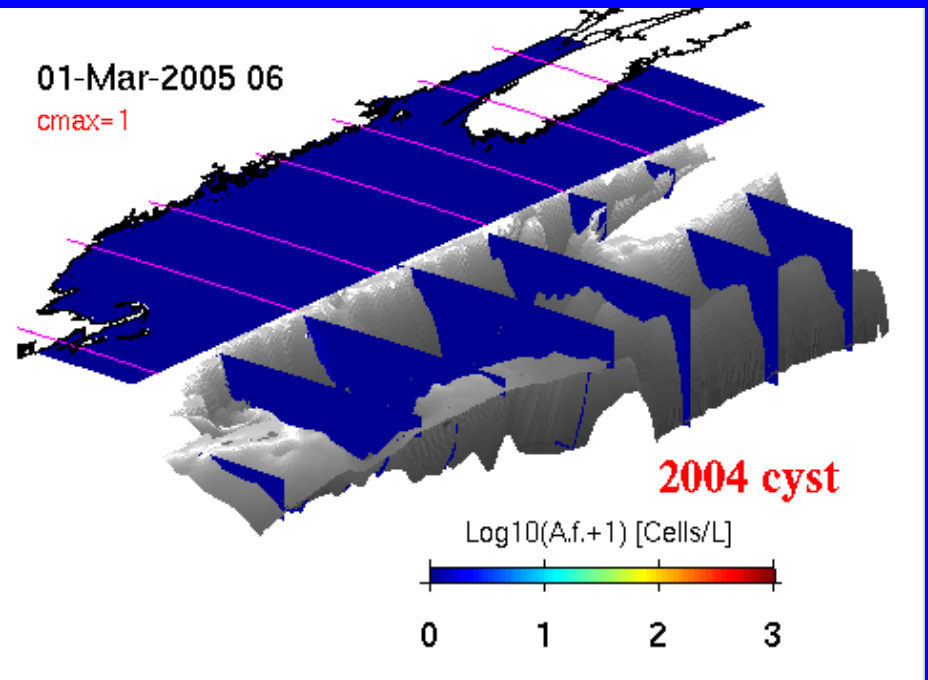
Bay of Fundy cyst bed stable over time

WGOM cyst bed: $2004 = 10 \times 1997$

2005 physics +
fall 1997 cyst map



2005 physics +
fall 2004 cyst map

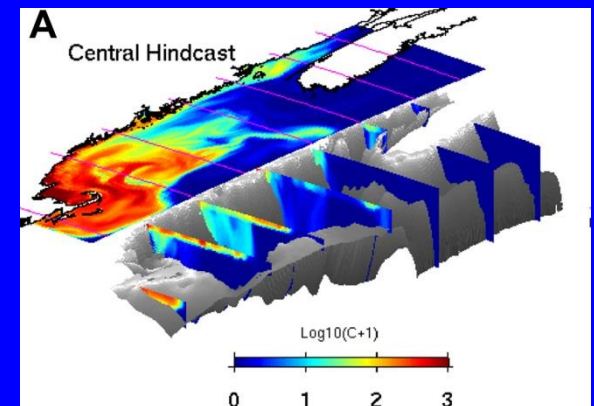
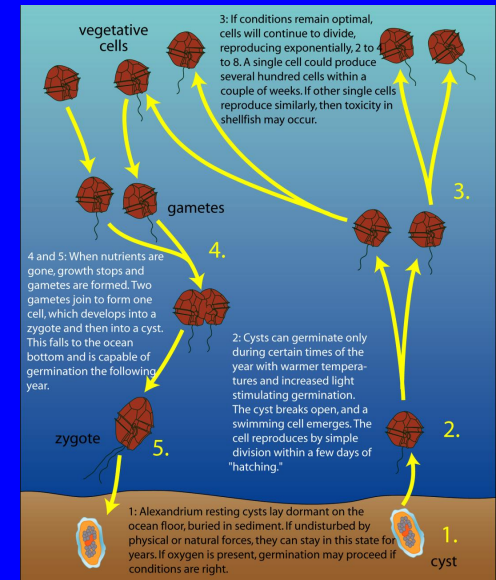


He et al., 2008ab

Theses

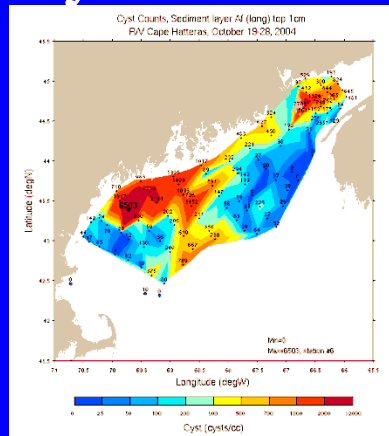
Cyst abundance is a first-order predictor of overall bloom severity.

Coupled hydrodynamic / population dynamics models forecast large scale seasonal characteristics of the bloom.

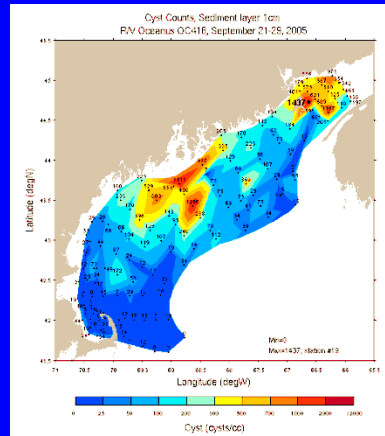


H_1 : Interannual variations in bloom severity result from fluctuations in cyst abundance

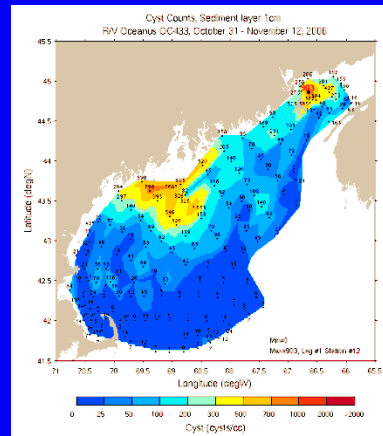
Cysts 2004



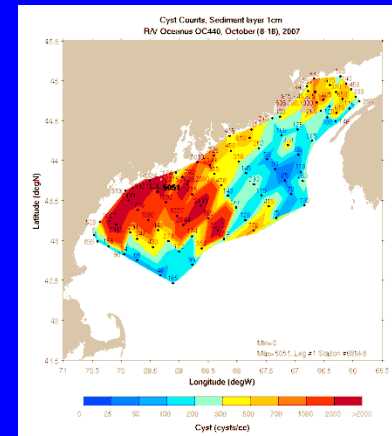
2005



2006



2007



Toxicity 2005



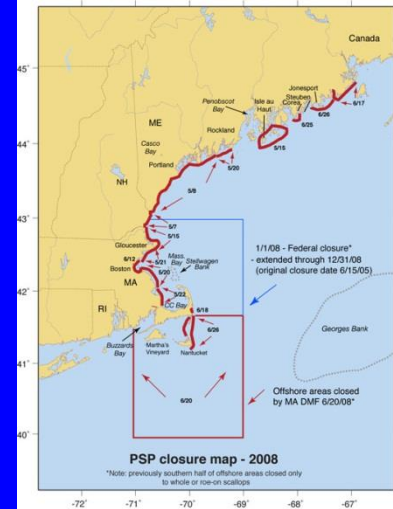
2006



2007

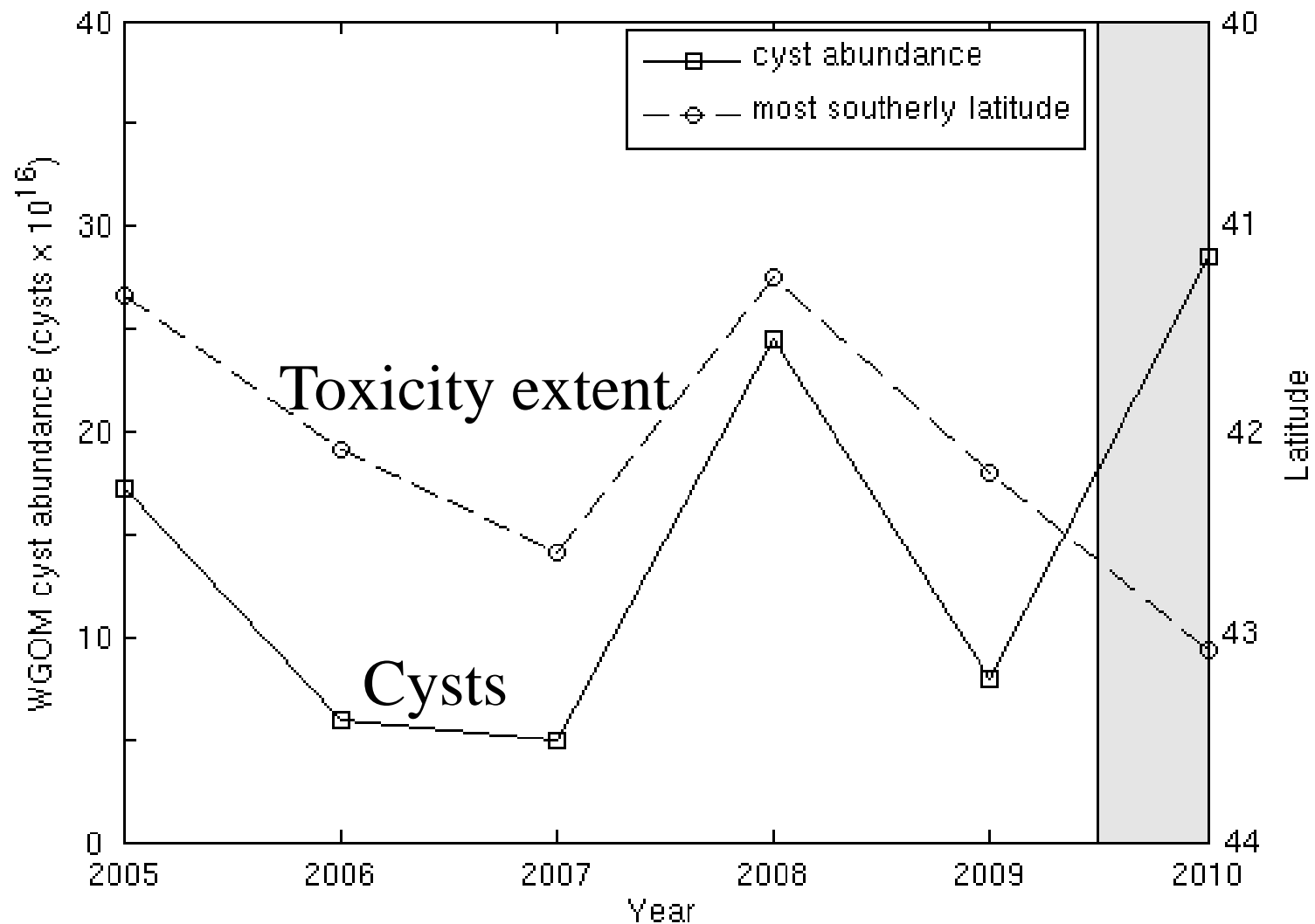


2008

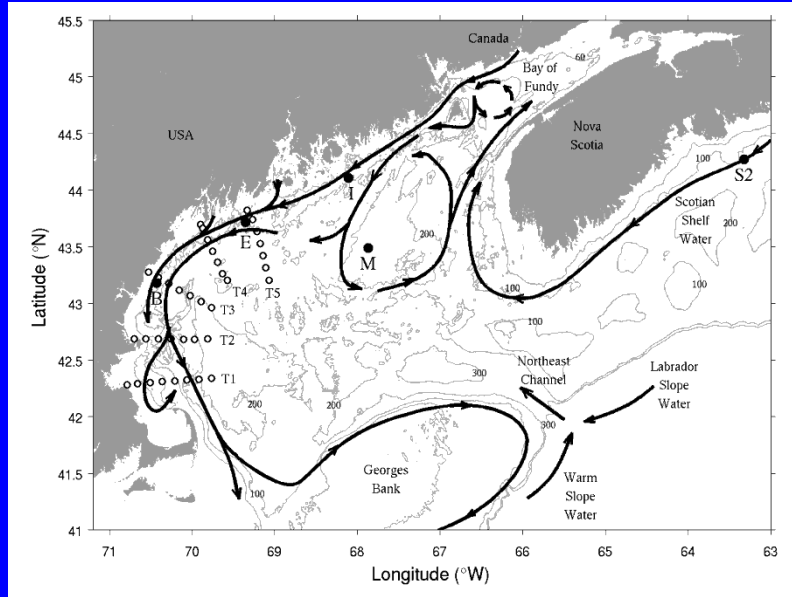


Cyst abundance and toxicity

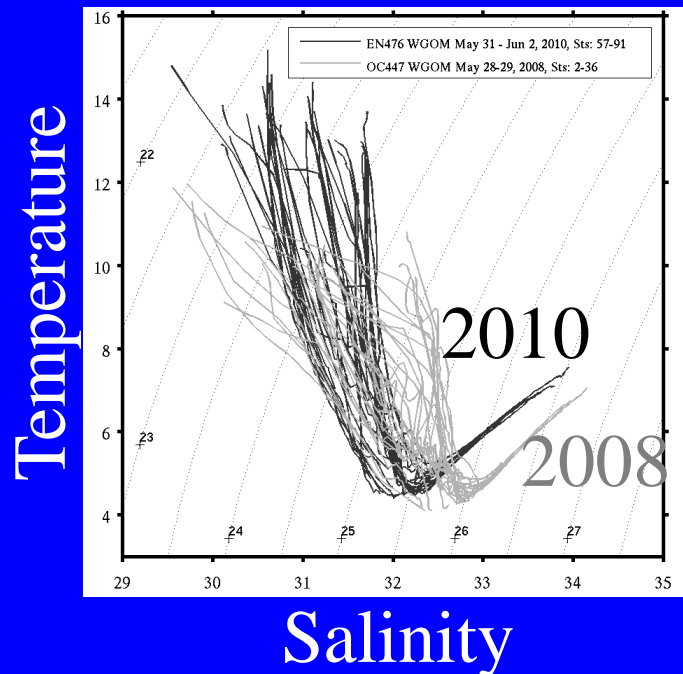
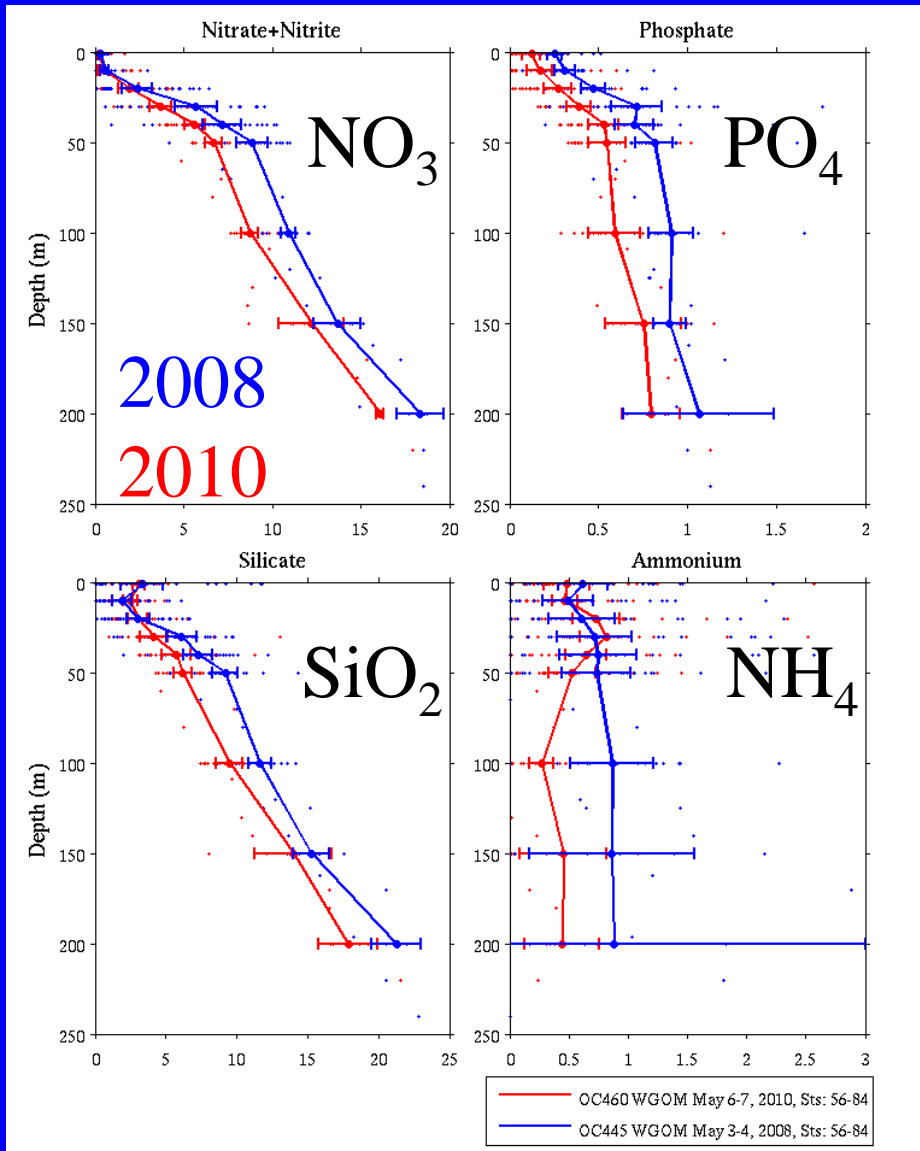
2005-2009: $r=-0.93$



Why did the 2010 bloom not materialize?

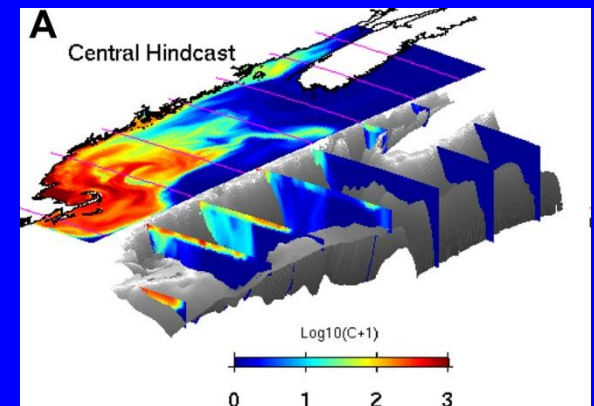
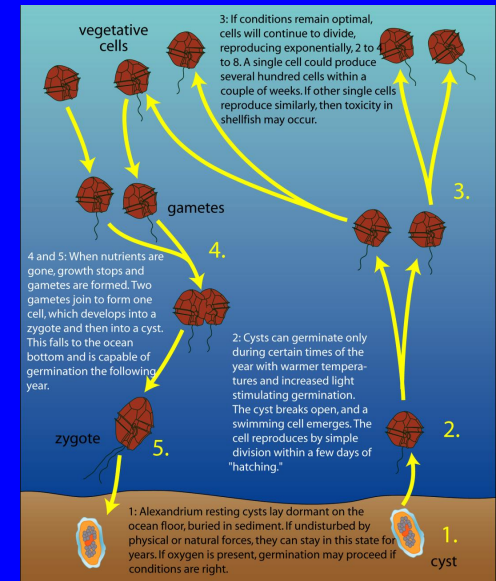


Nutrients: 2008 vs 2010



Thesis - revised

Cyst abundance is a first-order predictor of overall bloom ~~severity~~ *potential*; *whether or not that potential is realized depends on the growing conditions.*



Chapter 3. MERHAB/COHH/PCMHAB

Transition to operations and ESP detection

Ensemble Forecasting

Hydrodynamics

2015 seasonal forecast

2004

2005

2006

2007

2008

2009

2010

2011

2012

2013

2014

Scenario 1

Scenario 2

Scenario 3

Scenario 4

Scenario 5

Scenario 6

Scenario 7

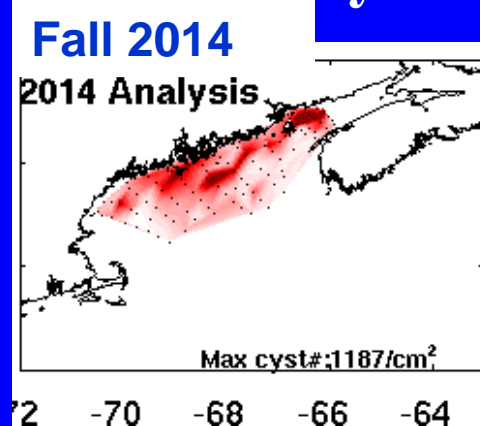
Scenario 8

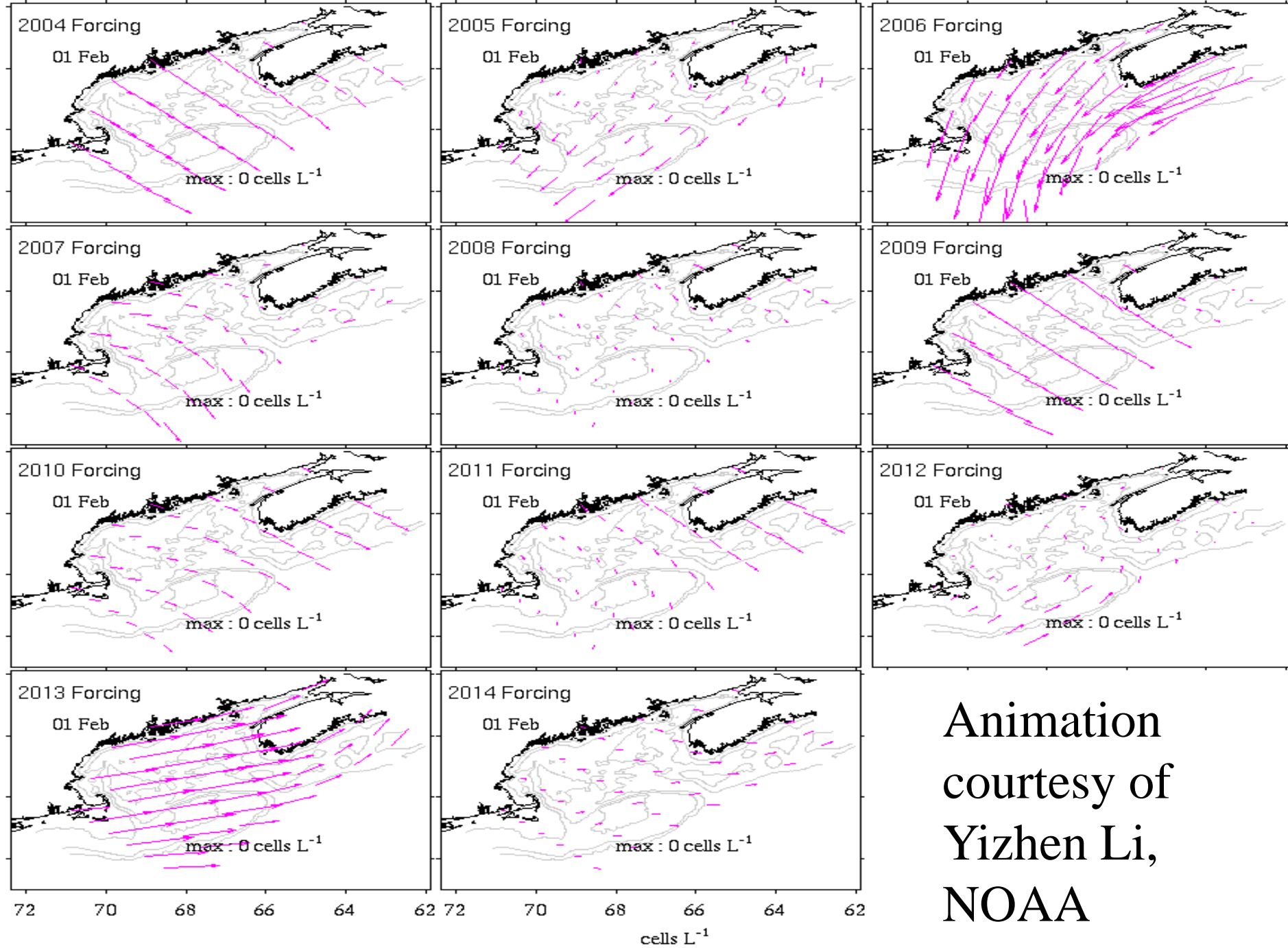
Scenario 9

Scenario 10

Scenario 11

Benthic Cyst





Animation
courtesy of
Yizhen Li,
NOAA

2017 Hindcast/Nowcast / Forecast

<https://products.coastalscience.noaa.gov/hab/gomforecast.aspx>

The National Centers for Coastal Ocean Science deliver ecosystem science solutions to sustain thriving coastal communities and economies.

Search NCCOS



NCCOS Harmful Algal Bloom Monitoring System

You are here: [Overview](#) / Gulf of Maine Nowcast

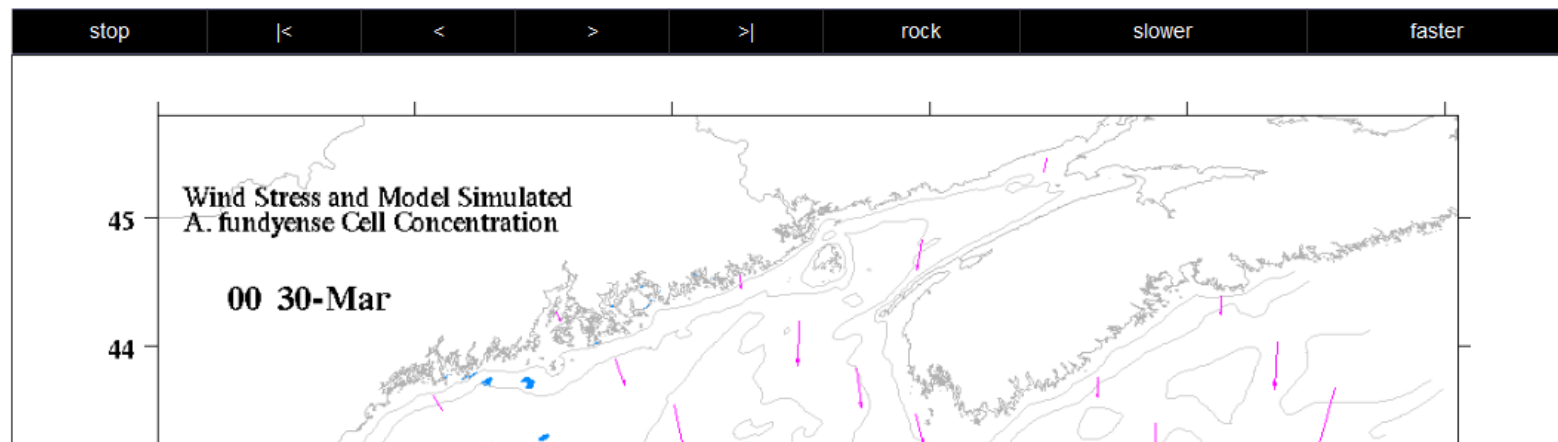
Experimental Gulf of Maine *Alexandrium fundyense* Nowcast/Forecast Simulation

Results here represent model solutions initiated from a cyst abundance map from November 2016, with germination, growth, and transport of *Alexandrium fundyense* cells driven by the factors listed below. This model is a demonstration, and may not represent actual conditions in the Gulf of Maine.

Modeled *A. fundyense* bloom

(You may need to refresh your browser or clear your browsing data to see the latest forecast.)

**An animation showing surface wind fields and modeled bloom conditions
from Mar-29 to Jul-08 12:00, 2017.**



Stakeholder Communication Network

«WOODS HOLE OCEANOGRAPHIC INSTITUTION

Northeast PSP

New England Harmful Algal Bloom / Red Tide Information

History

- Background
- Annual Forecasts
- Bloom Observations
- Cyst Maps
- Hydrometeorological Forecasts
- Status Report Archive
- Interannual Comparisons of Closure Areas
- Shellfish Monitoring
- Press Releases, Media Briefings
- Contact

History
New England Harmful Algal Bloom / Red Tide information


Donald M. Anderson

Purpose
This website is intended to provide background information as well as current observations and commentary on the status of Paralytic Shellfish Poisoning (PSP) outbreaks in the northeast United States. The content is provided for informational purposes only, and should not be used to guide recreational or commercial decisions regarding the harvesting of shellfish or other fisheries products within the region.

2016 Seasonal Forecast
Models predict a small bloom - the smallest observed over the last eleven years.

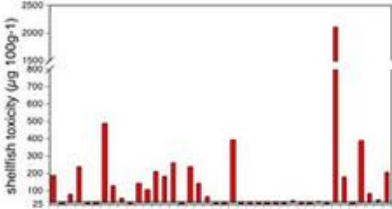
History of PSP in New England
Prior to 1972, PSP toxicity was historically restricted to the far eastern sections of Maine near the Canadian border, with the first documented PSP in Maine in 1958. In 1972, a massive, visible red tide of *Alexandrium fundyense* stretched from southern Maine through New Hampshire and into Massachusetts, causing toxicity in southern areas for

[Print](#) [PDF](#) [T](#) [T](#) [T](#)



[Enlarge image](#)

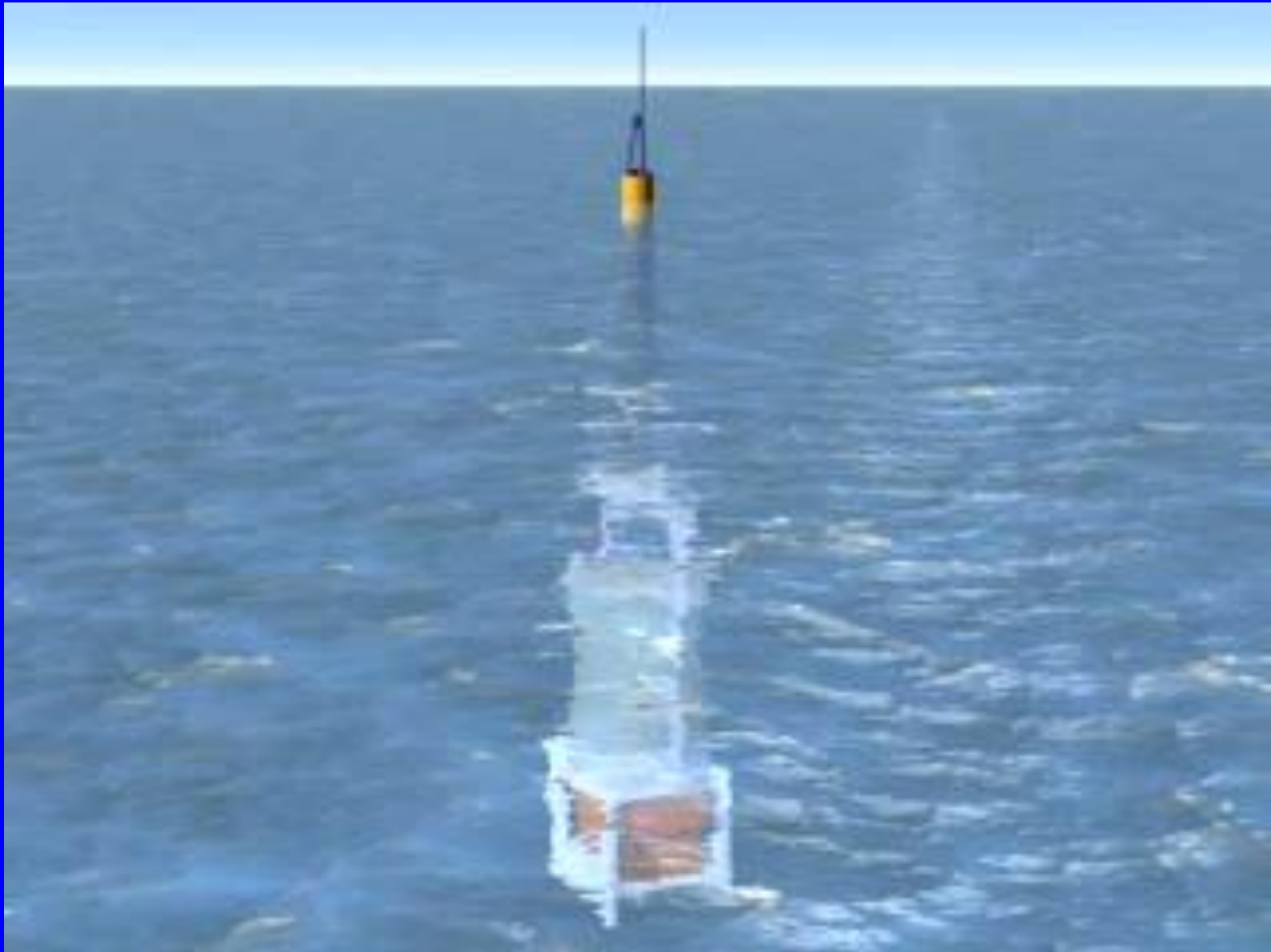
Deploying ESPdon in the WHOI deep well for testing prior to deployment in the Gulf of Maine. (Bruce Keafer, WHOI)



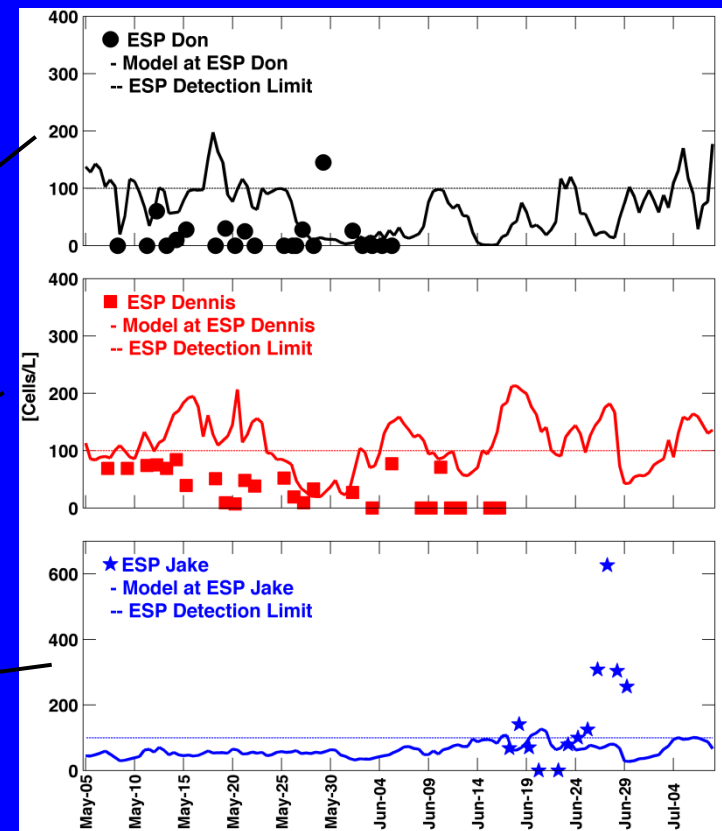
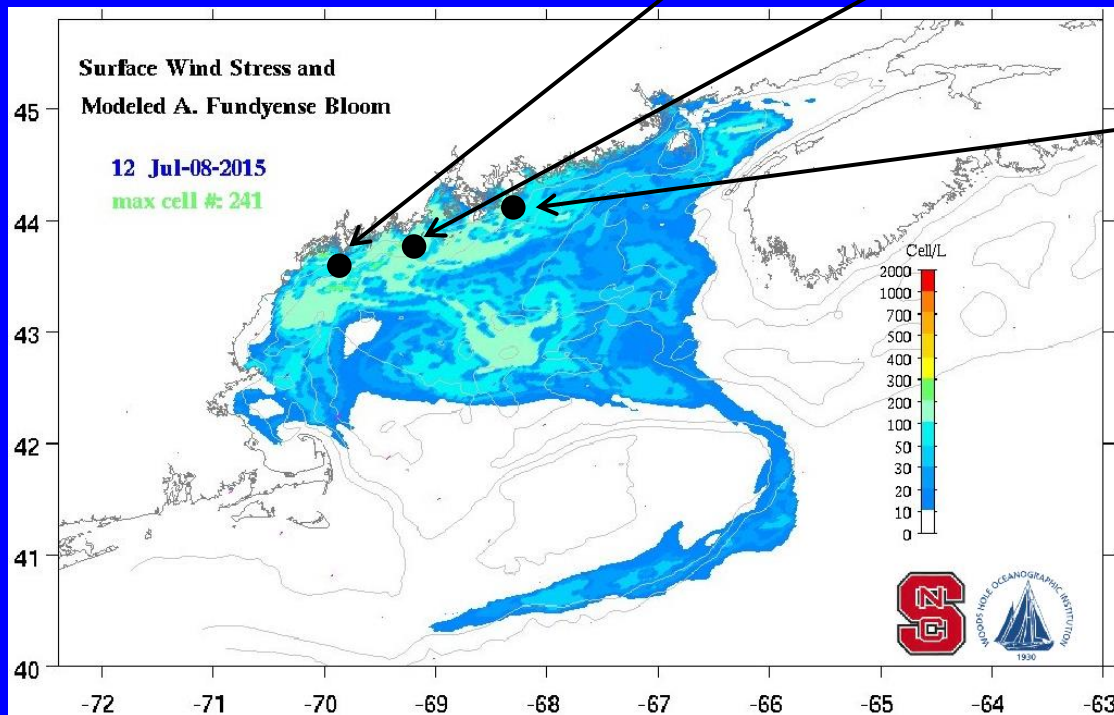
- Northeast PSP website (to be expanded and renamed Northeast HABs)
- Northeast PSP listserve has ~ 275 members (also to be renamed)
- Regional HAB conference calls with ~35 participants

Rhode Island Department of Environmental Management, RI Dept of Health, NH Dept of Env Services, Maine Dept of Mar Resources, Mashpee Wampanoag Tribe, Wampanoag Tribe of Gay Head (Aquinnah), Massachusetts Div Mar Fisheries, Town of Mashpee, MA, New York State Department of Environmental Conservation, CT Bureau of Aquaculture & Laboratory Services, FL Fish and Wildlife Res Inst, US FDA, NOAA, WHOI, UMass Dartmouth, URI, Bigelow Laboratory for Ocean Sciences

Environmental Sample Processor (C. Scholin)

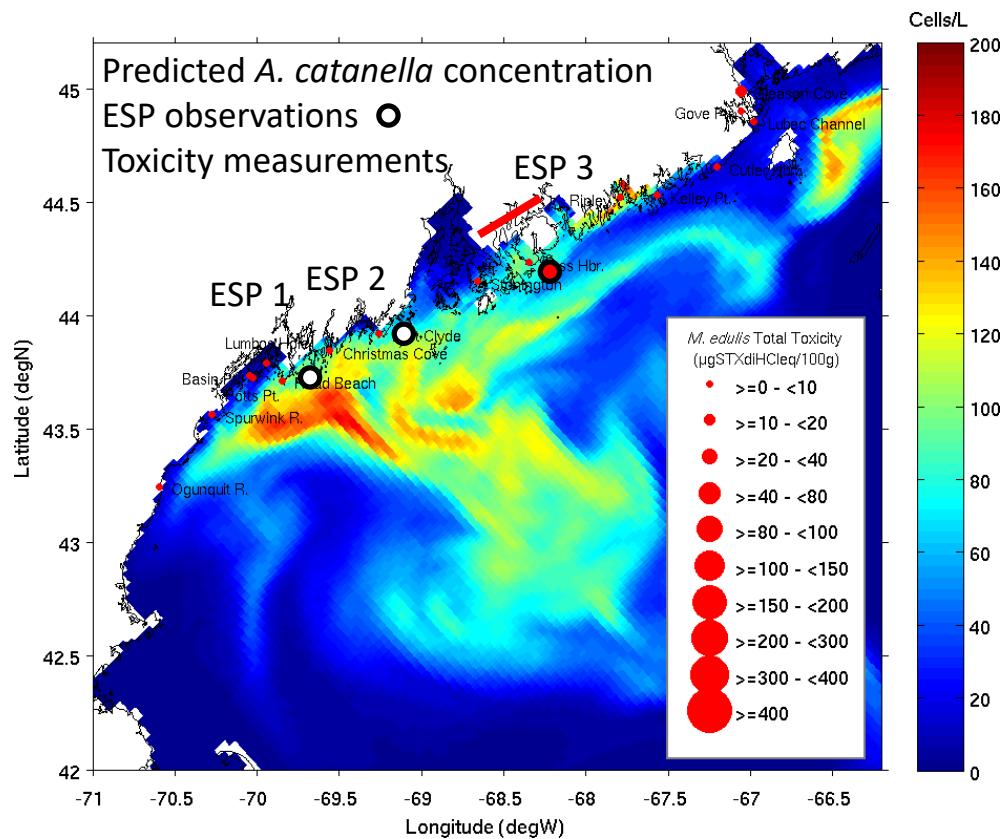


2015 Forecast and ESP Observations

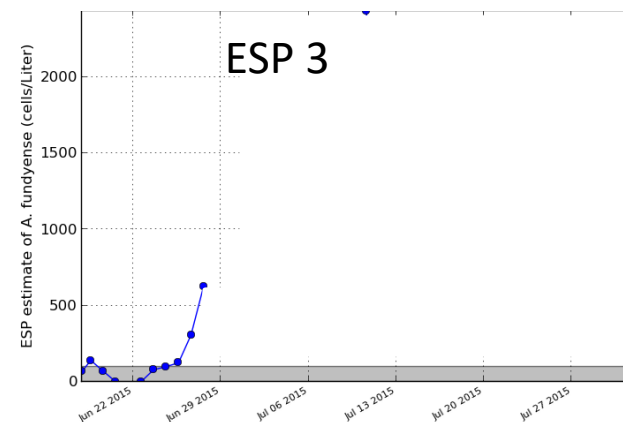
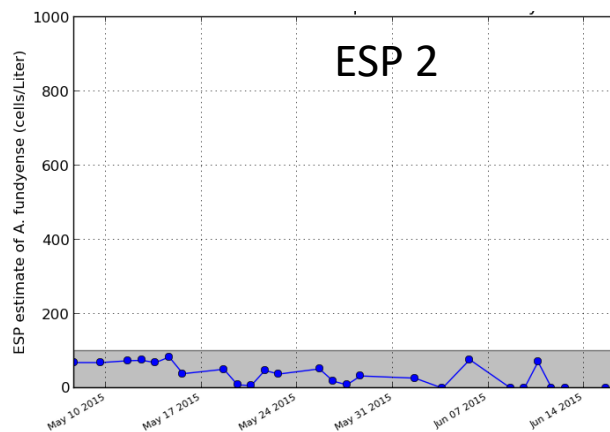
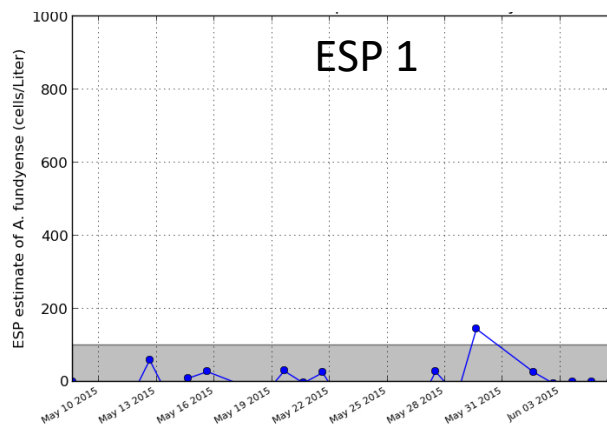
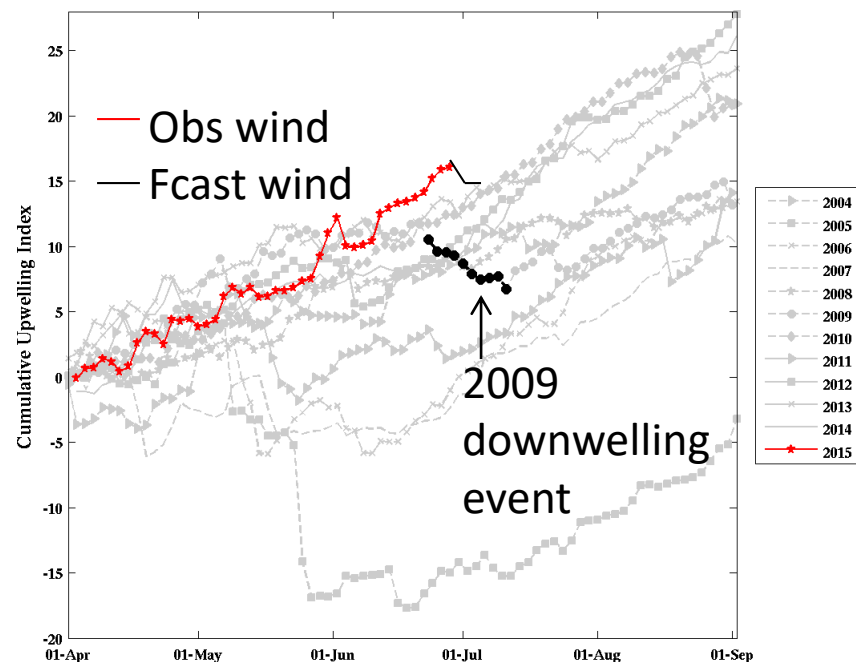


Stakeholder Dashboard

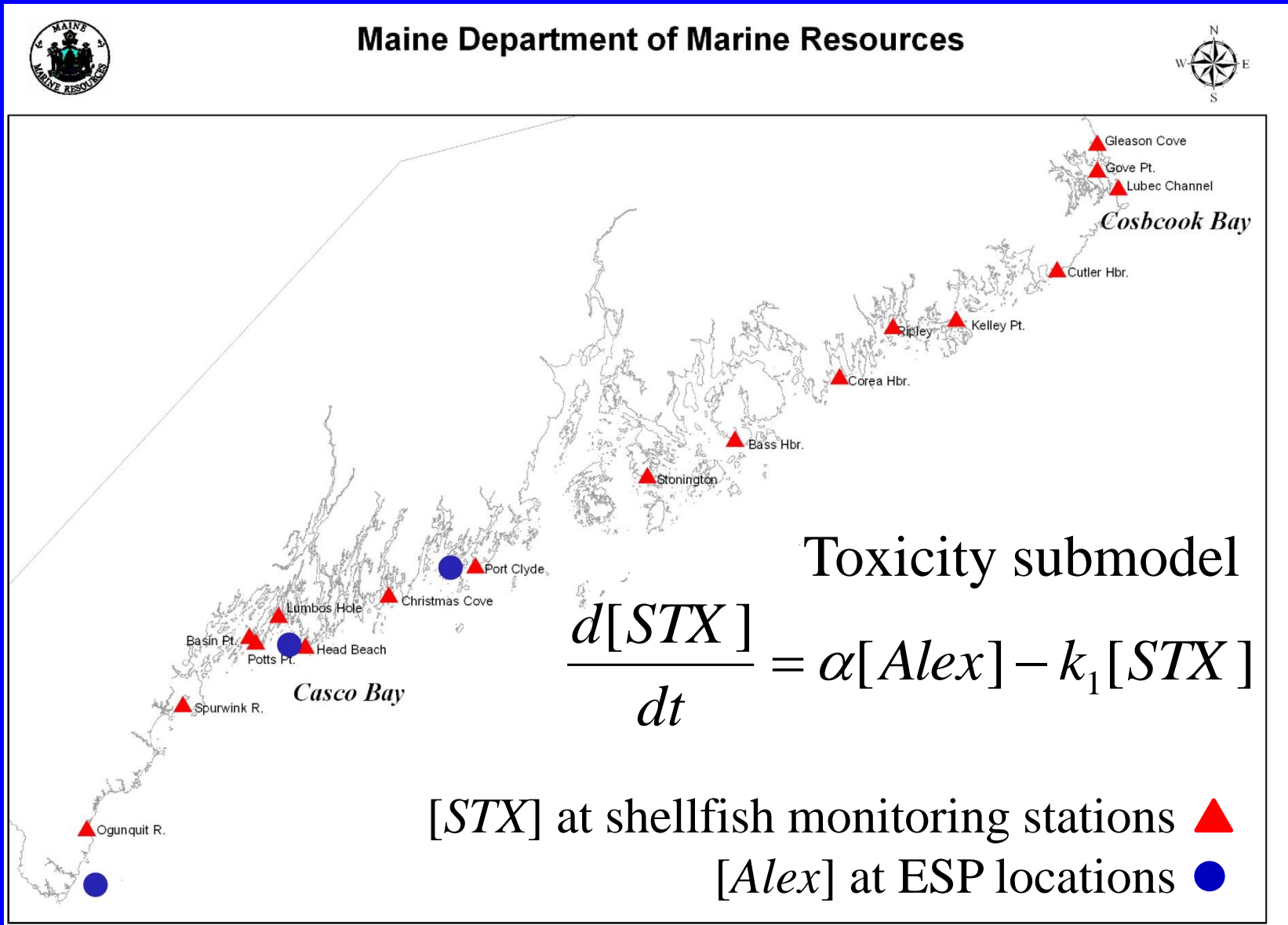
Date: June 29, 2015



Cumulative upwelling index – Buoy B

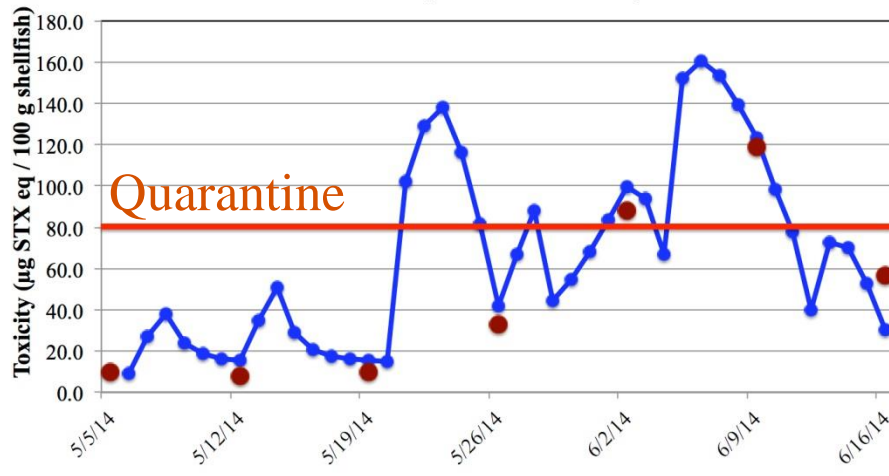


Estimating shellfish toxicity from ESP data



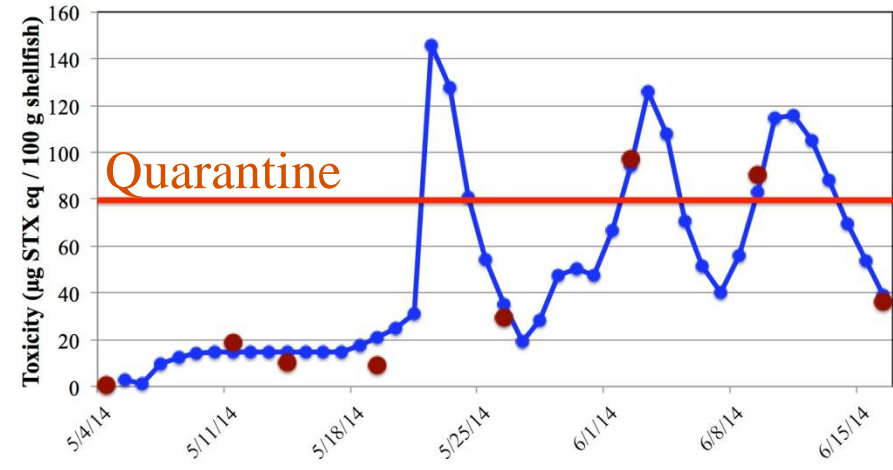
ESP-don - York River, ME toxicity

Modeled toxicity Observed toxicity



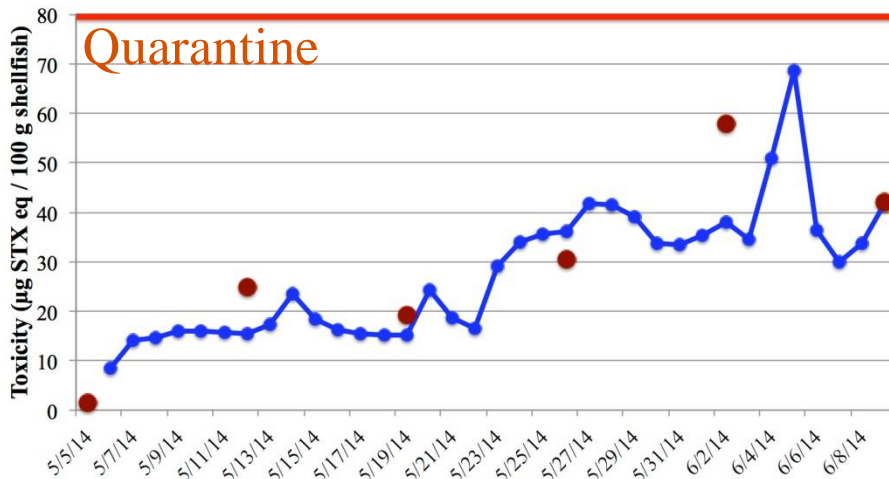
ESP-jake - Potts Point, ME toxicity

Modeled toxicity Observed toxicity



ESP-dennis - Christmas Cove, ME toxicity

Modeled toxicity Observed toxicity



Modeled toxicity vs.
measured toxicity in
shellfish (Maine
DMR) - 2014

Toward ecological forecasting in the ocean: a cautionary tale from the physical climate system

NATURE VOL. 321 26 JUNE 1986

ARTICLES

827

Experimental forecasts of El Niño

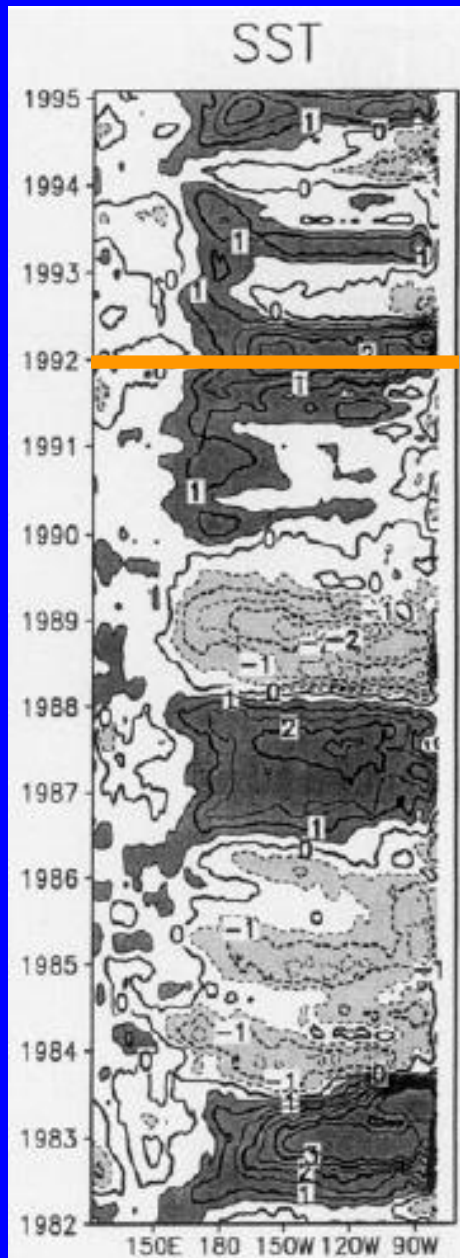
Mark A. Cane, Stephen E. Zebiak & Sean C. Dolan

Lamont-Doherty Geological Observatory of Columbia University, Palisades, New York 10964, USA

Experimental forecasts of El Niño events occurring since 1970, made with a deterministic model of the coupled ocean-atmosphere system, indicate that El Niño is generally predictable one or two years ahead. A forecast for 1986 is also presented.

Regime shifts can change the underlying dynamics

Ji et al. (1996) *Journal of Climate* **9**, 3105-3120.



W

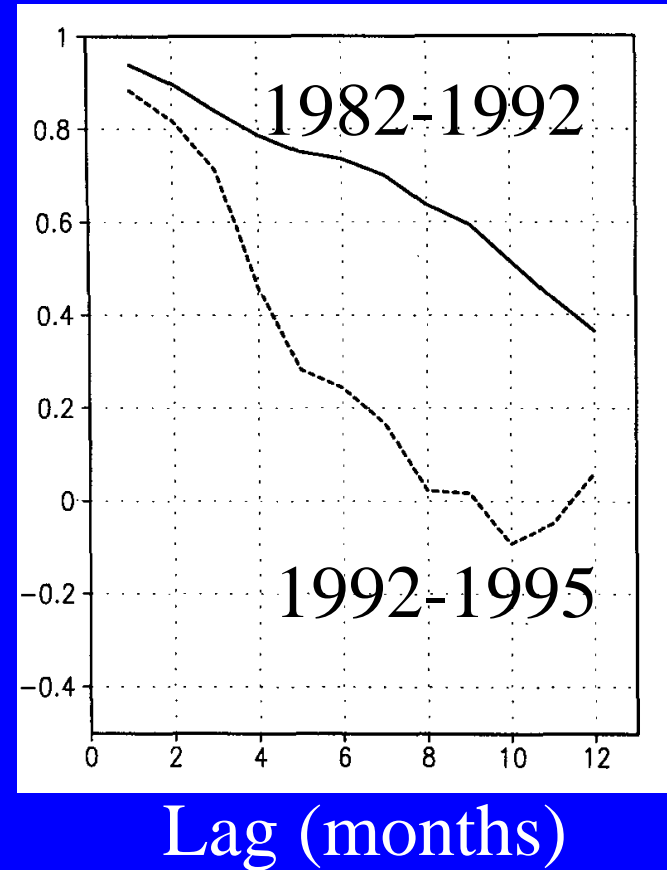
C

W

C

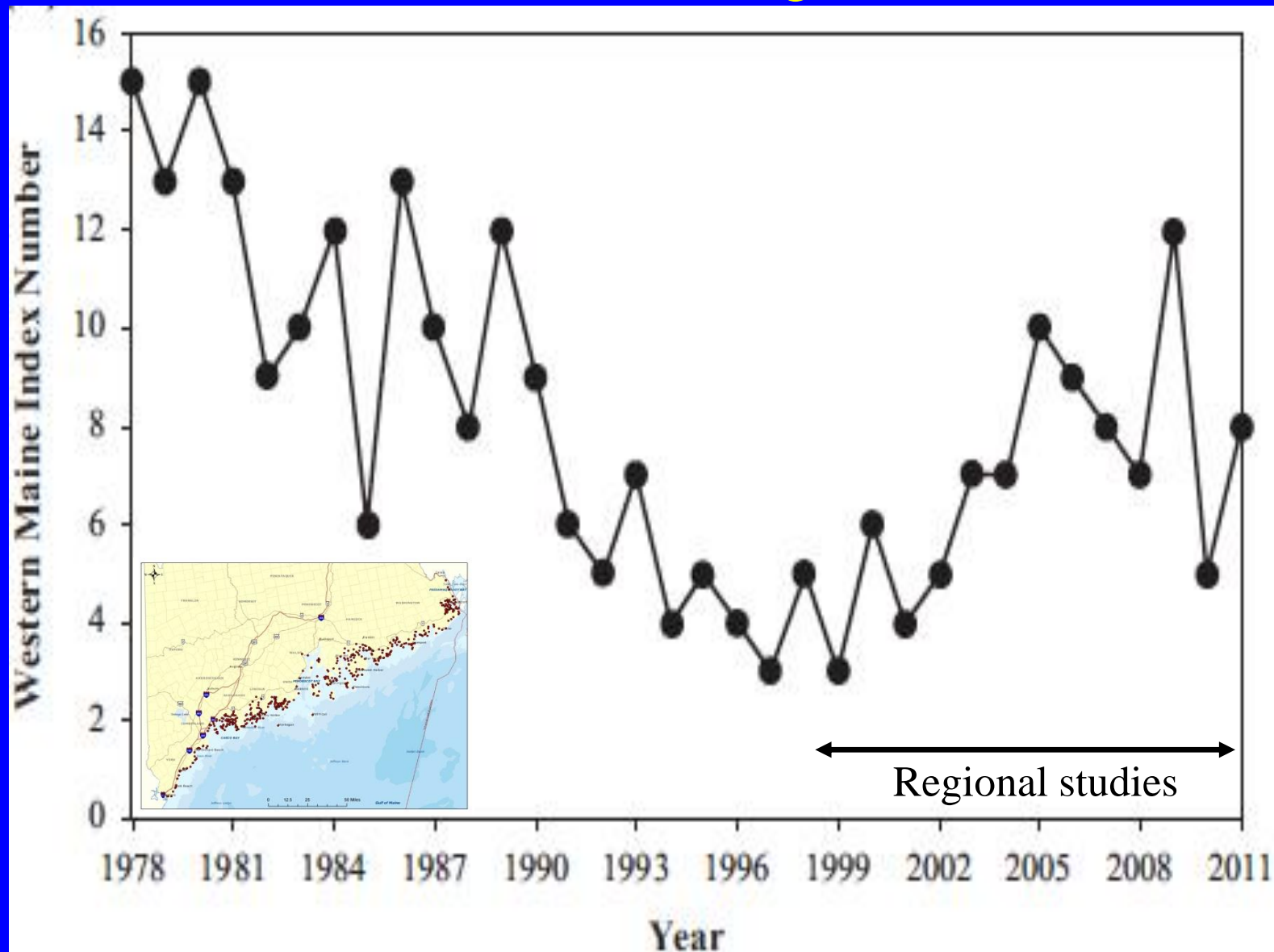
W

Correlation
(forecast, obs)



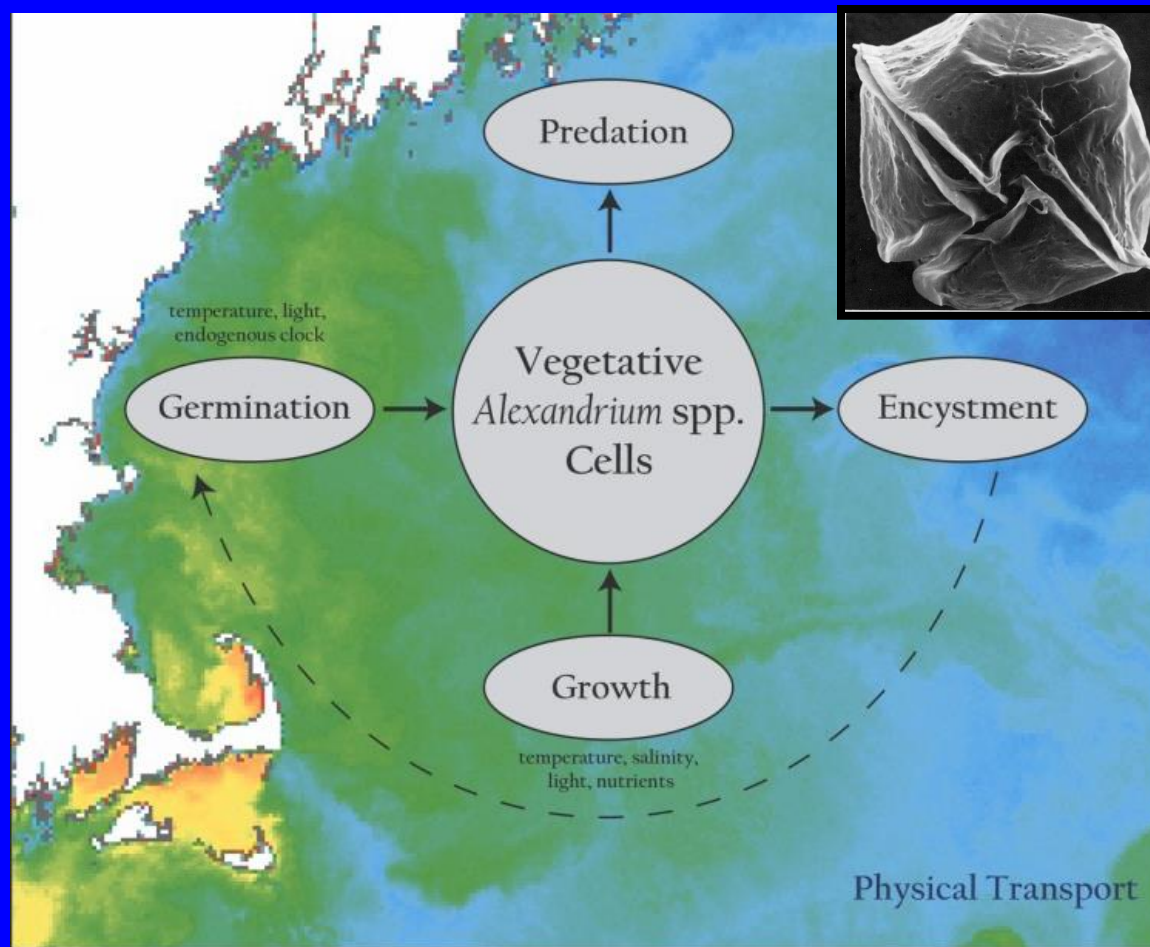
Chen et al. (1995) *Science* **269**, 1699-1702. An improved procedure for El Nino forecasting: implications for predictability.

Gulf of Maine HAB index from PSP monitoring stations



Looking forward

- Long-term observational networks are essential
- Data assimilation to keep models on track
- Process studies to understand changing dynamics



End

Using the Environmental Sample Processor to develop an early warning system for HAB toxins in western Lake Erie

Timothy Davis



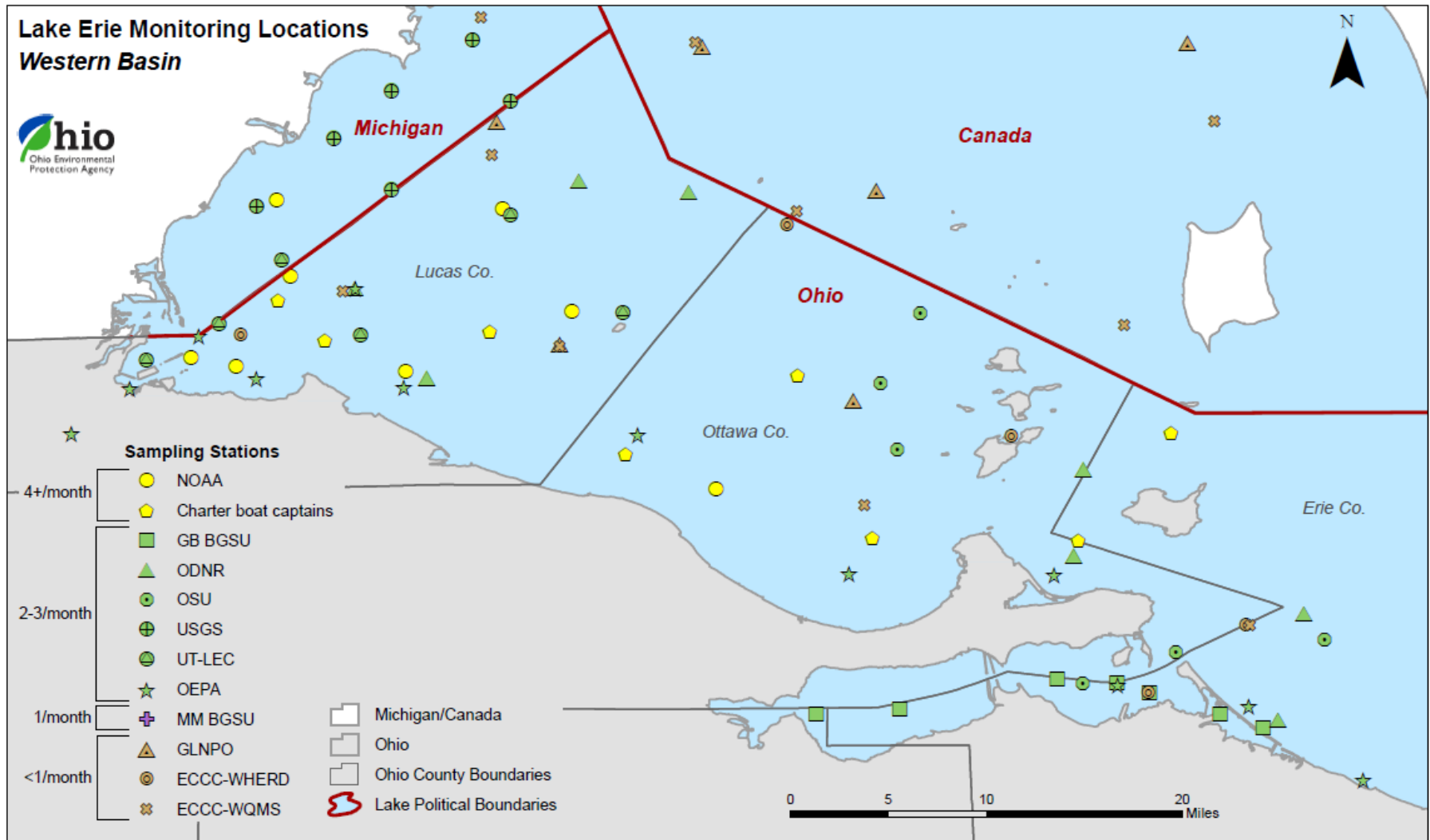
HARMFUL ALGAL BLOOMS AND HYPOXIA IN THE GREAT LAKES RESEARCH PLAN AND ACTION STRATEGY: AN INTERAGENCY REPORT

Monitoring and Surveillance

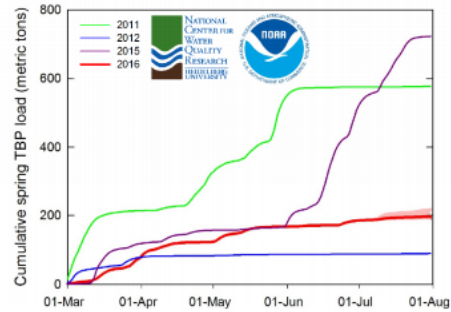
- Improve understanding of HABs, HAB toxins, and hypoxia distribution and drivers in the Great Lakes by:

- Expanding and coordinating in-lake HAB and hypoxia monitoring that includes frequency, location, toxicity, and seasonal coverage (Implement within 5 years). (NOAA, USGS, EPA);
- Determining the most effective monitoring design for successful detection of HABs, hypoxia, toxins, and drivers over the long-term, and in areas where this is already required for the GLWQA. Fill any need gaps with new efforts and coordination (Implement within 5 years). (NOAA, USGS, EPA);
- Coordinating monitoring within strategically selected small watersheds in the basin designed to detect and assess multi-scalar effects (link edge-of-field with small and larger watersheds) of conservation implementation. Monitoring should be designed to inform more effective action and adaptive management (Implement within 5 years). (USDA NRCs, ARS, NOAA, USGS, EPA).
- Continuing pilot testing of at least one ESP annually in Western Lake Erie, and expand to other parts of the Great Lakes, as possible and necessary (Implement within 5 years). (NOAA);
- Using hyperspectral and other remote sensing monitoring techniques to advance operational ecological forecasting of HAB events in coastal areas (Implement within 5 years). (NOAA, NASA); and
- Increasing the use of health surveillance data for making decisions, by reporting out on surveillance data, improving the ability to link existing health systems such as OHHABS and NORS with environmental monitoring data for analysis and data visualization, and expanding multidisciplinary collaboration on activities that directly impact health surveillance (e.g., detection of HABs and detection of HAB-associated illnesses) (Implement within 5 years). (CDC).

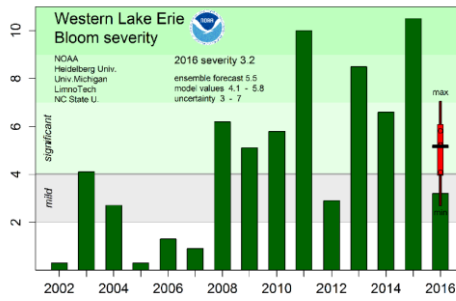
Partnerships between Federal, State, academic and citizen scientists help to monitor western Lake Erie



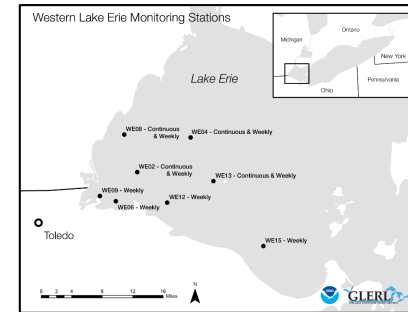
Bloom projection to data dissemination requires a multifaceted effort



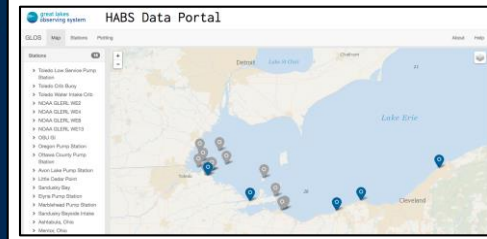
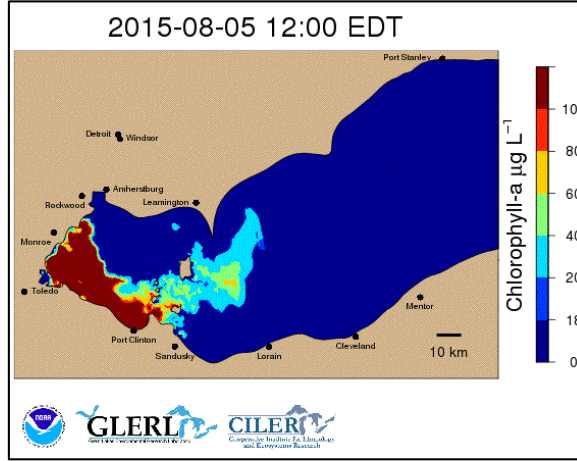
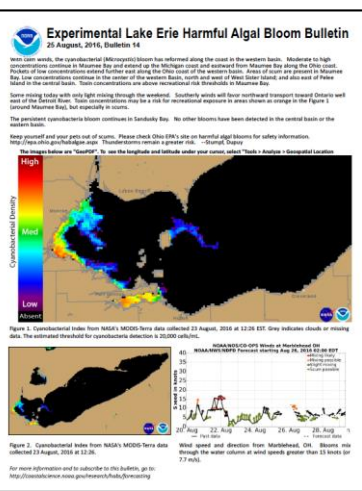
1) Project



2) Predict



3) Monitor

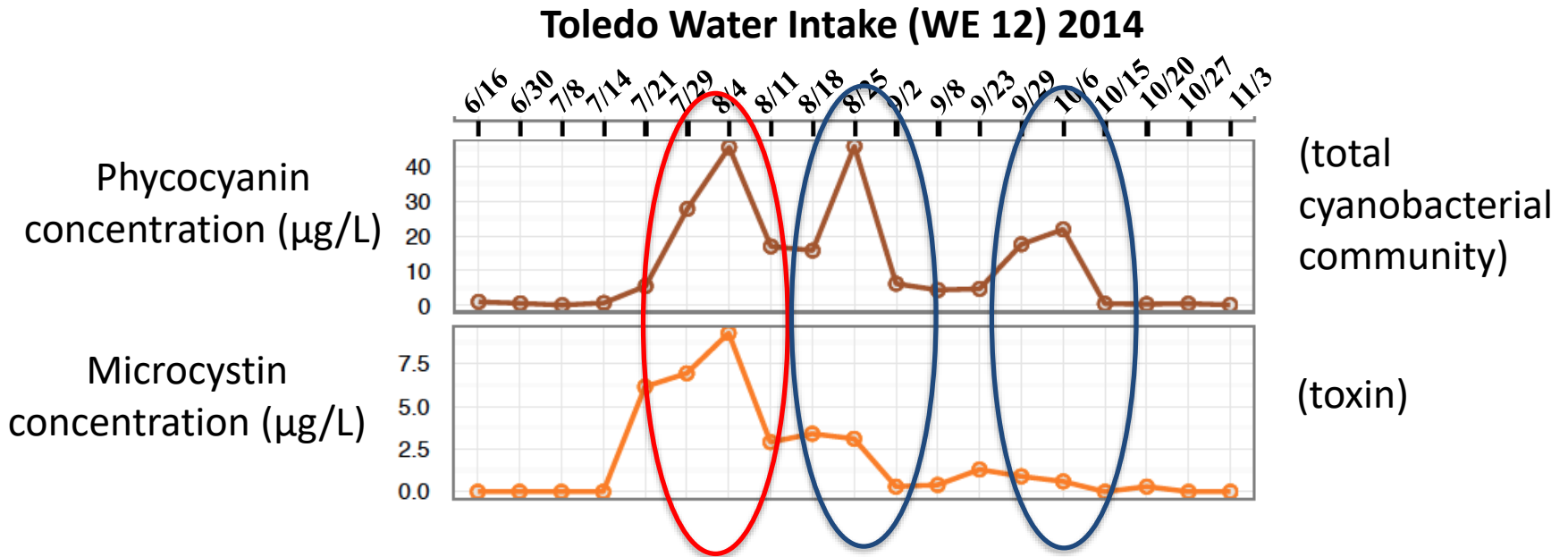


5) Disseminate Monitoring Data

4) Forecast

OVERVIEW

Bloom biomass does not predict toxin concentrations



The Washington Post

**When a
bold move
ends in the
basement**

A VA wheelchairer in Phoenix experiences an old federal tradition

"Beh, I am to go and I
papers, dancing?" she said. "I
to go upstairs and, you know, a
people."

The book itself was not too different from the country's average. It was a thick book, like a dictionary or the *Pleno*, a massive, 1,000-page volume. The printed edition was in the library. There was a small edition, a book of 100 pages, with a few pictures. It was a book of 100 pages, with a few pictures. It was a book of 100 pages, with a few pictures.

© 2000 Blackwell Science Ltd, *Journal of Internal Medicine* 247: 399–406

Kan. tea party stalwart tests a vulnerable GOP senator

PERREA, KALI.— One of the women standing at the "Carnegie Library" about a sitting on the edge of the fountain.



FOX 2 WATER BAN STILL IN EFFECT
6:55 77° FOR TOLEDO, PARTS OF MONROE COUNTY

OVERVIEW

THE CASE OF CAMERON TODD WILLIAMS

Fresh doubts over a Texas execution

New evidence revives concerns that a man was wrongly put to death in 2001



Full Informed:
Johnny Webb,
above, says he
used to sport
beards for the
country club
in Birmingham.
1/24/81

BY MARILYN FROST
The Marshall Project

COCONA, TEX. — For over 100 years, Coconawagon was a small, unincorporated community in Garza County. But in 1997, when the town's population was 100, the town was incorporated as the City of Coconawagon. The town's name is a combination of the words "Coconawagon" and "Wagon". The town's name is a combination of the words "Coconawagon" and "Wagon". The town's name is a combination of the words "Coconawagon" and "Wagon".

not in doubt: the interest of the Indians, Johnny E. With, even as a series of scientific reports have demonstrated the human origin of the Pittsburgh fossils. With, who has previously been accused and offered the same money, gave the first detailed account of how he had on the

whimsy stated in return for off-
by-the-German government, like
honest, in return for the
income for the country and to
large thousands of dollars.
except that a wealthy German
merchant, North American
and most like close that have
method diligently to increase
from after his recovery and
connection with the nation
Charles E. Brady Jr. to keep
sustained information for



© 2005 Blackwell Publishing Ltd *Journal of Internal Medicine* 258: 105–112

Toledo's drinking water crisis continues



Eden Rogers, 13, uses a stick to scoop algae off the shore line as she walks the beach at Maumee Bay State Park in Oregon, Ohio, with her sisters. The girls said they came to look at the toxic algae bloom along the shore of Lake Erie, which has led to more than 500,000 residents in the area without safe drinking water for a second day while local water facilities were being treated. The lake is one of the bulk of the area's drinking water. *AP Wire*

Israeli airstrike kills 10 in Gaza

U.N. CHIEF DEcriES 'A CRIMINAL ACT'

Muscle tube (not covered outside school's gates)

an American Tradition

***** DATA STOPPED *****

SAAR, GILA STRIP — An Israeli shoveler slips or swales back to ground whenever in Gaza, he has with the shovels continued to be used in an attempt to create a U.S. school's southern Gaza strip of land. The shovels are used to create some of the largest U.S. shovels of land since the war began.

Days. Brian Bushman, a spokesman for the Israeli Defense Forces, said the largest attack in the border city was three Palestinian militants posing as the widow's sons. "We identified a son-in-law target," Bushman said. "We definitely don't say sons or siblings."

Algae's lake effect reveals putrid, pea green disaster

Distribution centers offer free relief to community

THE UNIVERSITY OF CHICAGO



Officials won't give test results on 2nd day

Dr. Thomas H. Murray
1000 University Avenue
Berkeley, CA 94720

The main thing we wanted last year was to know what the owners of the house really thought about the place. We had to find out if they were really happy or if they were just saying so.

The new legislation has 3 sides to it. One side creates a provision under the law

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Journal compilation © 2006 Blackwell Publishing Ltd

FOR ASSISTANCE

Approximate, not allowing for
allowance for depreciation and
amortization to get to net book
value and therefore not
comparable to net book value

085 APR 2007

☐ Yes, I am a member of the following organization:
☐ Yes, I am a member of the following organization:
☐ Yes, I am a member of the following organization:
☐ Yes, I am a member of the following organization:

INDEX

Project: *Project: The Project*

[illegible]

Detroit
metrotimes Mon, Jan 20/2014 at 11:46pm -05:00

A toxic algal bloom caused a three-day ban on water usage for a half-million residents in St. Michigan and Toledo.

Experts say it's a "wake up call."

TAINTED BLOOM


by Ryan Tietton

WISC Matt Secrest's Personalization | **EAT** Tamiya Sato's Recipe | **ARTS** Pop culture on parade



Toledo water crisis Day 2

A do not drink/boil water advisory for Toledo and the surrounding area continued to grip more the near 500,000 residents affected by the crisis.

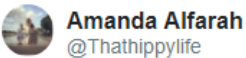
by  Toledo Blade 4 years ago 18,697 Views ▾



Thanks to Kroger for shipping 1.25 mil bottles of water to Toledo area stores & donating 4,800 1-gal jugs. [#emptyglasscity](#)

7:13 PM - Aug 2, 2014

♡ 69 💬 105 people are talking about this



Literally everything is closed in toledo besides the bars
[#EmptyGlassCity](#) [#toledowater](#) [#ToledoProblems](#)

12:57 AM - Aug 4, 2014

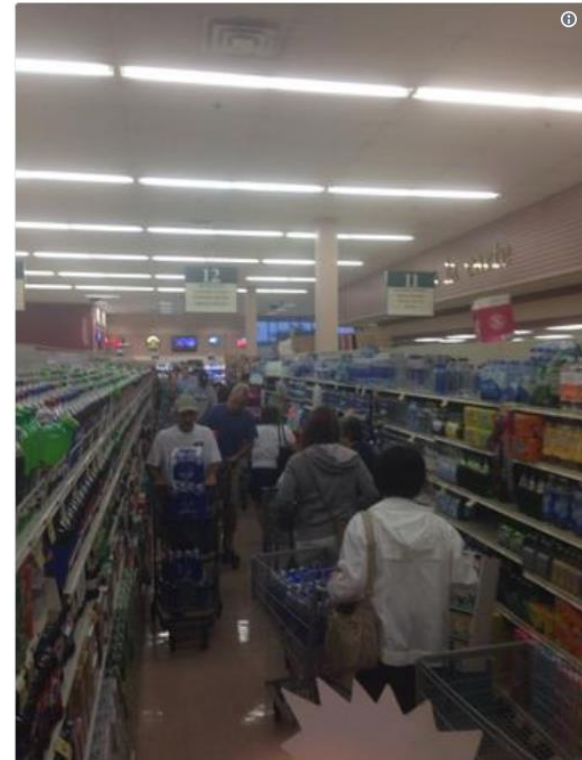
♡ 3 👤 See Amanda Alfarah's other Tweets



@EmptyGlassCity I really wish we could get a informal update about the water.Still hanging in there and trying to think positive.

1:13 AM - Aug 4, 2014

♡ 👤 See Danielle Marsh's other Tweets



Do not drink or boil" water warning for Toledo area. Groceries filled. bit.ly/1sf4X6k pic.twitter.com/h02i6DgU1Y | [#emptyglasscity](#)

OVERVIEW



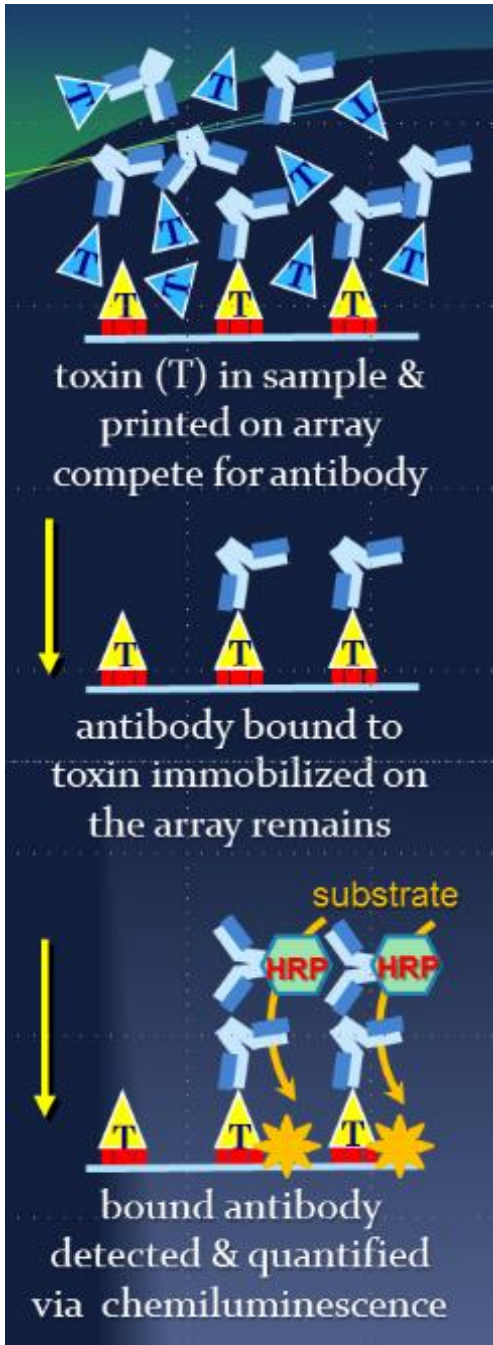
"We're committed to creating a new standard of care that will leave the Great Lakes better for the next generation."

- Post-Toledo, GLRI sought proposals to integrate new technologies to monitor HABs and toxins in western Lake Erie
- GLERL funded to bring ESP and hyperspectral technology to the Great Lakes
- Funded the purchase of all equipment necessary to deploy *ESPNiagara*
- Launched the cross-Line Office collaboration



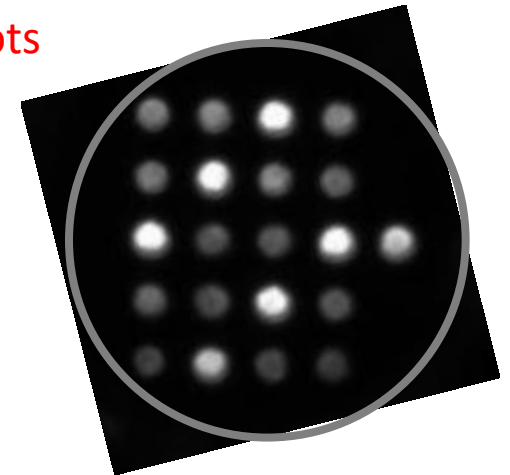
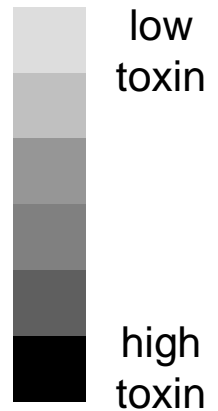
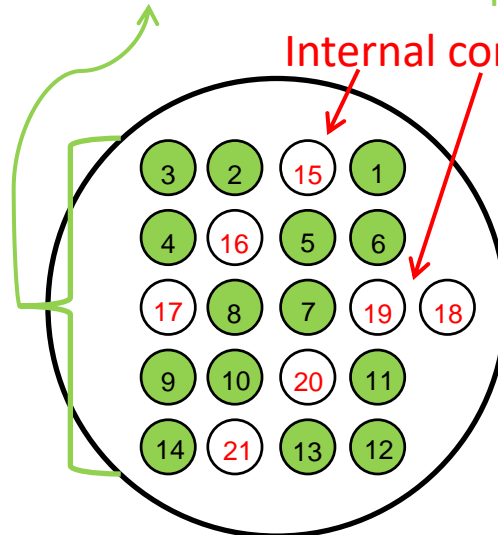
ESP microcystin extraction and assay development

- ESP extraction efficiency similar to Freeze/Thaw (EPA Method 546)
- ADDA specific
- Monoclonal, mouse antibody
- Detection and quantification by chemiluminescence
- Mouse IgG control spots serve as a QC check for assay chemistry and meter autoexposure images

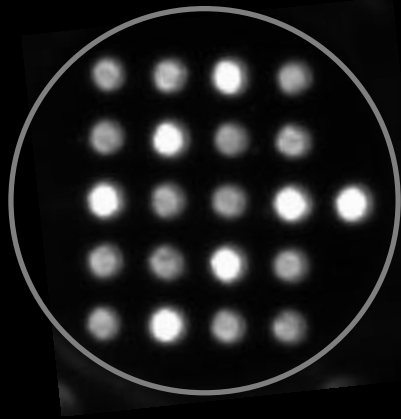


5 rows of MC LR-OVA spots

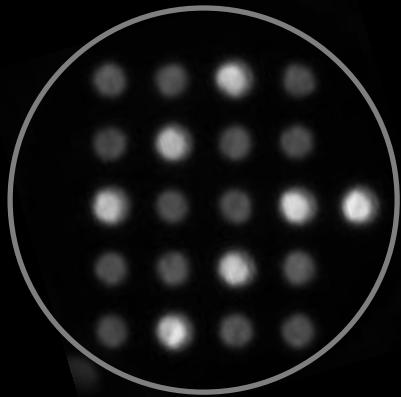
Internal control spots



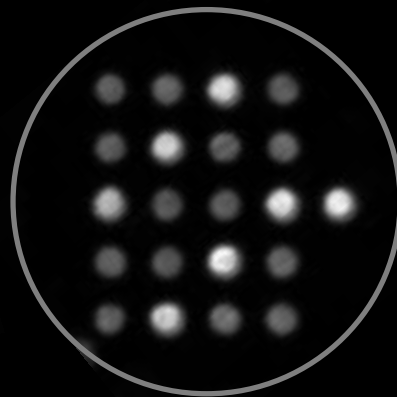
ESP detects microcystin at concentrations relevant to stakeholder needs



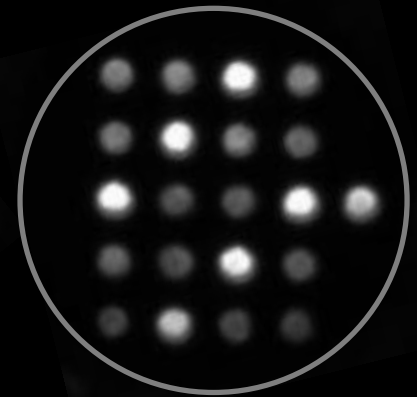
0.2 ng/mL



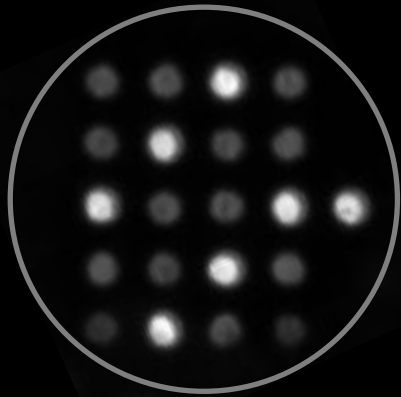
0.5 ng/mL



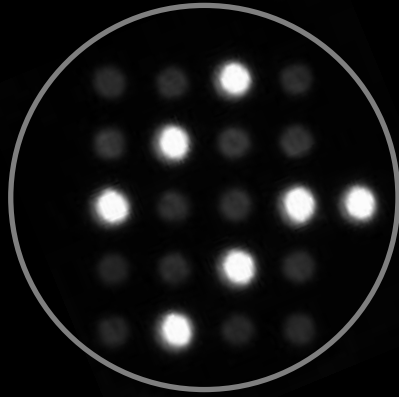
2.0 ng/mL



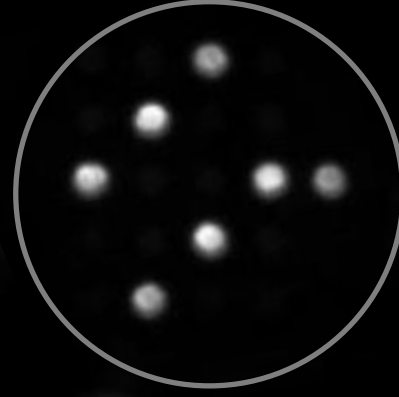
5.0 ng/mL



20.0 ng/mL



50.0 ng/mL

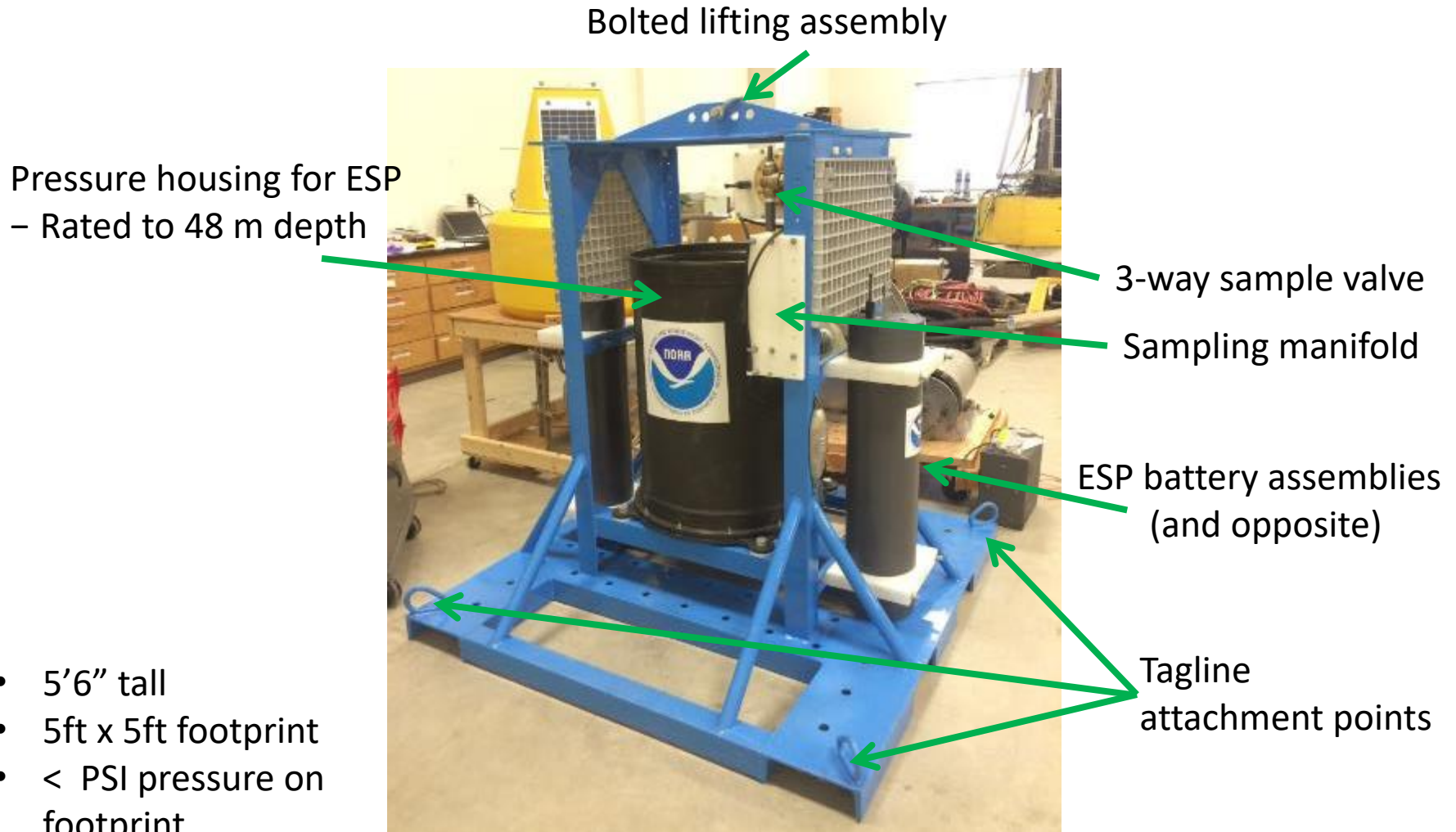


200.0 ng/mL



500.0 ng/mL

Lake Erie is shallow so new deployment design was needed



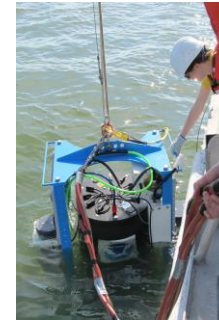
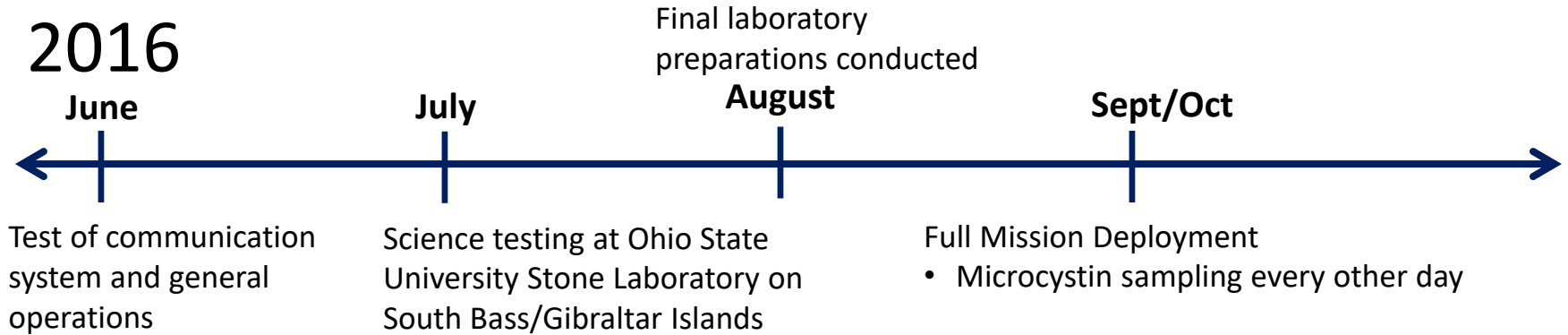
- 5'6" tall
- 5ft x 5ft footprint
- < PSI pressure on footprint
- Deck weight ~ 1200 lbs
- In-water weight ~ 750lbs

PERFORMANCE

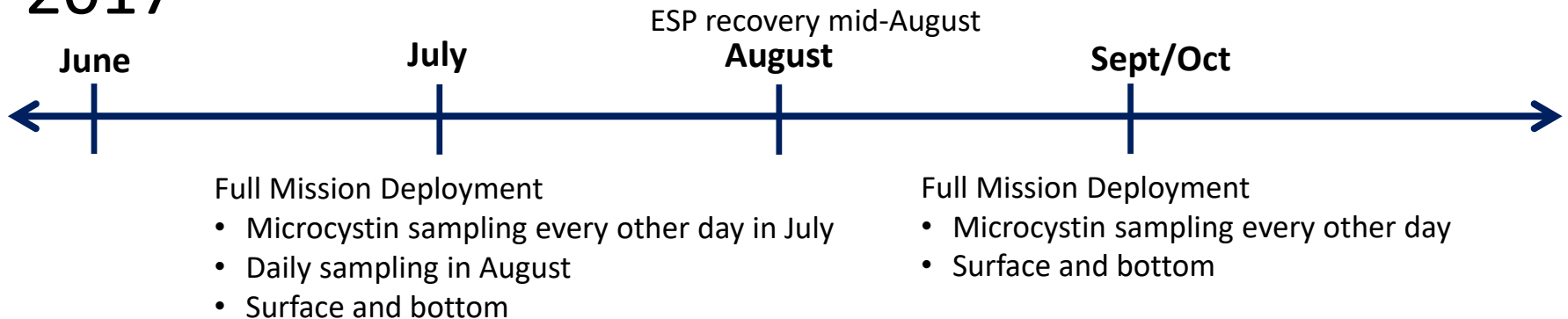


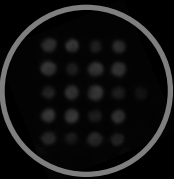
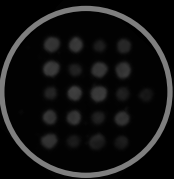
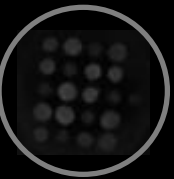
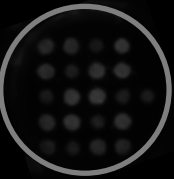
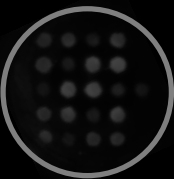
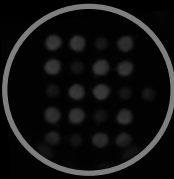
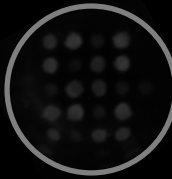

2016 and 2017 deployments of *ESPNiagara*

2016

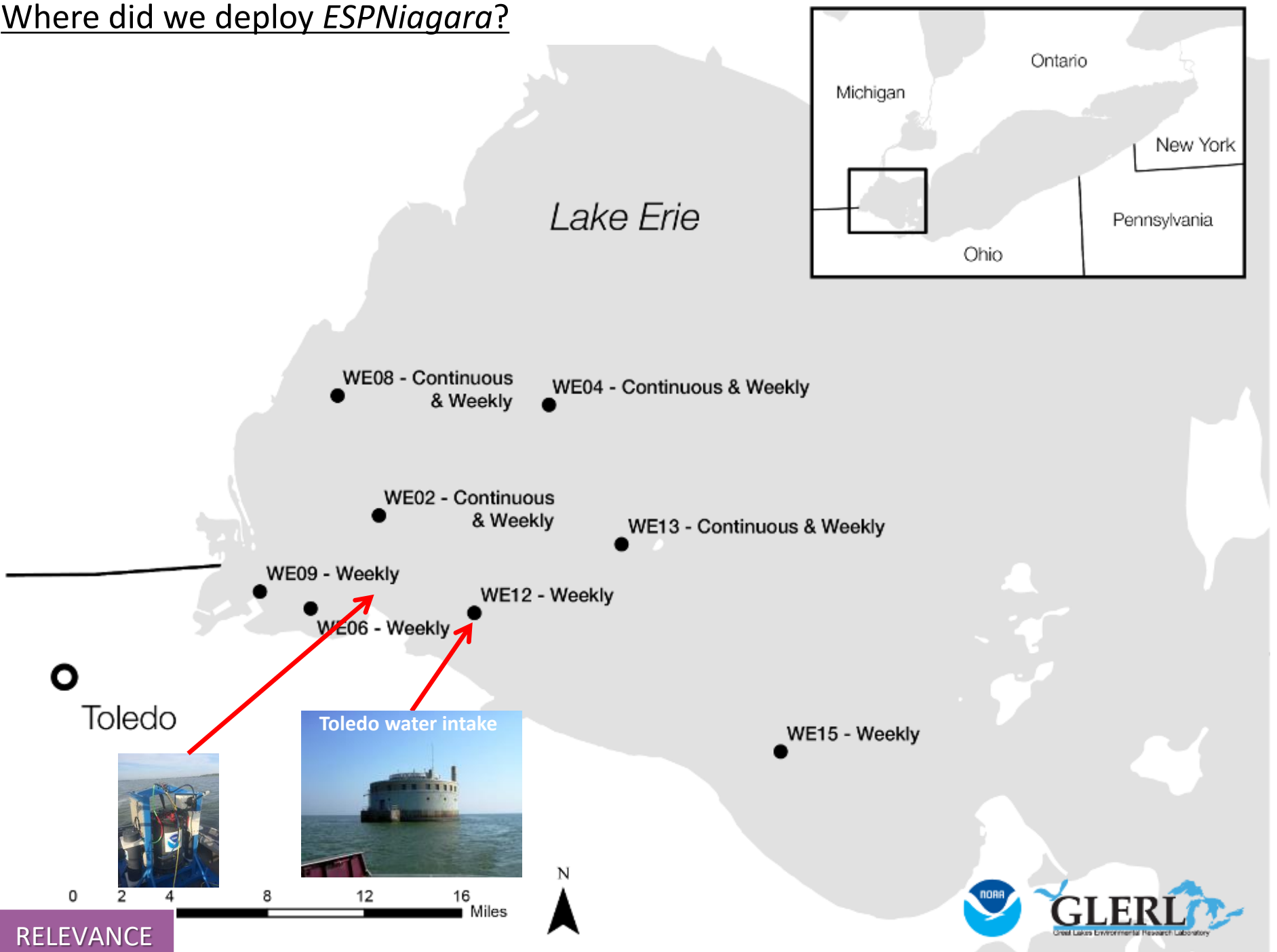


2017



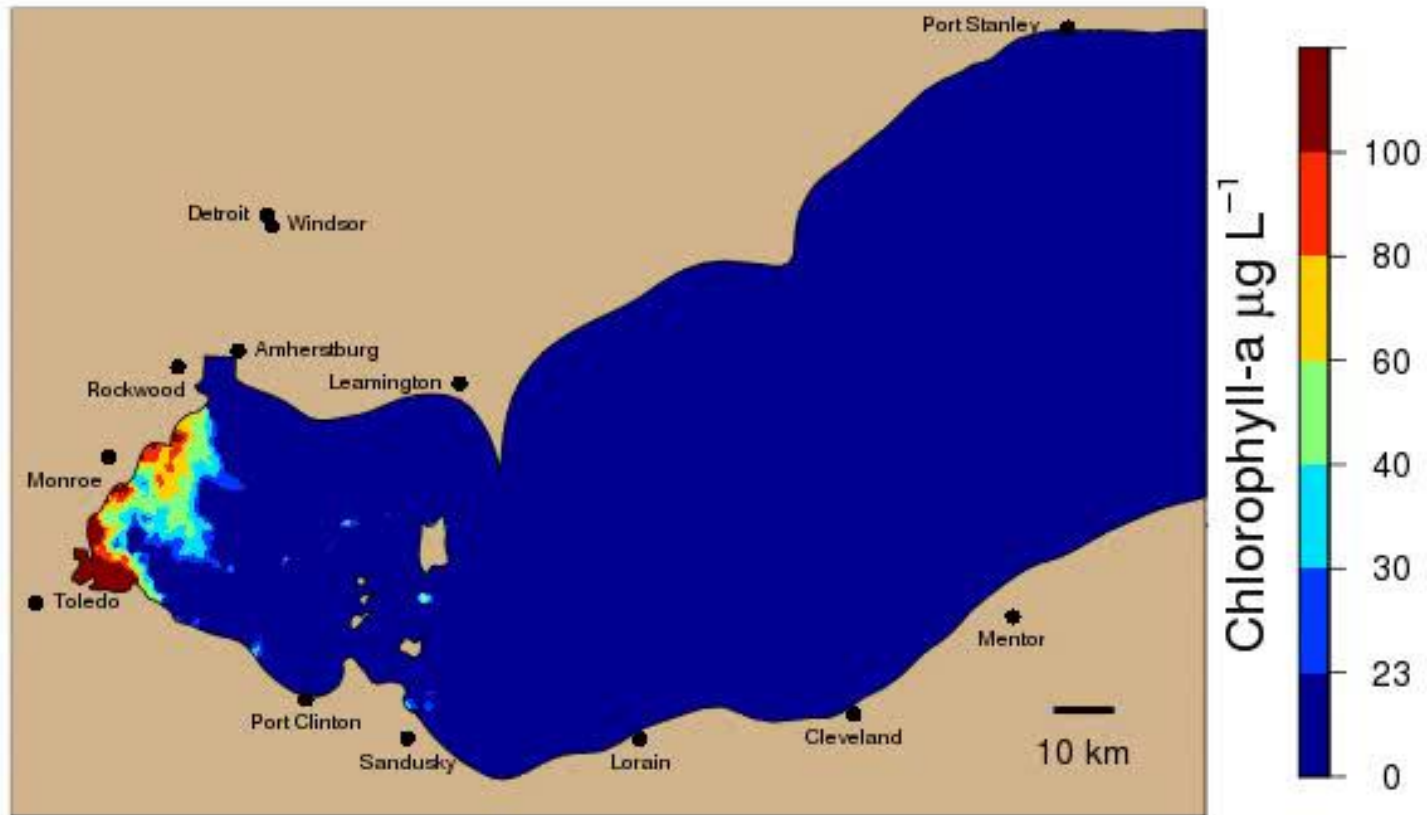
	Sept 14	Sept 15	Sept 16	Sept 17	Sept 18	Sept 19	Sept 20	Sept 21
Sample Depth	Bottom	Surface	Bottom	Surface	Bottom	Surface	Bottom	Surface
Sample Volume (mL)	100	100	100	100	100	100	200	200
LLOQ (ug/L)	0.19	0.19	0.19	0.19	0.19	0.19	0.09	0.09
ULOQ (ug/L)	1.54	1.54	1.54	1.54	1.54	1.54	0.77	0.77
Micro-cystin (ug/L), ESP	Below LLOD	Below LLOD	Below LLOD	Below LLOD	Below LLOD	Below LLOD	0.1	Below LLOD
								
Micro-cystin (ug/L), grab sample	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	Surface: 0.1 Bottom: BDL	NO DATA	NO DATA

Where did we deploy *ESP*Niagara?



Why did we deploy *ESP*Niagara where we did?

2016-08-18 13:00 EDT



Similar circulation pattern that caused the 2014 Toledo drinking water advisory

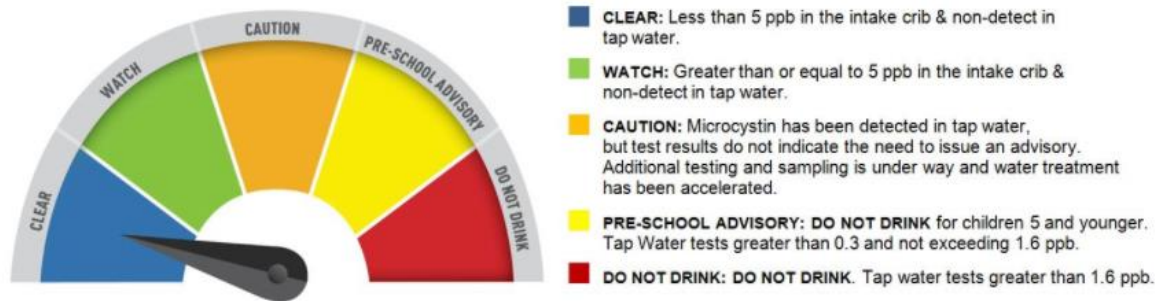
https://www.glerl.noaa.gov/res/HABs_and_Hypoxia/habTracker.html

Outcome: Near-real-time microcystin data will aid in minimizing risk of another drinking water crisis

Toledo Water Quality

Water Quality

Toledo tests raw and treated water regularly for the presence of toxins, including microcystin created by algae blooms. See scale below for the current status of drinking water quality according to Ohio EPA guidelines.



Last updated: 02/14/2018: HAB season is over for the year. City chemists continue to sample for microcystin daily, testing all samples and posting once a week on Wednesdays. When conditions warrant again next season, testing will be increased.

Our water is safe to drink.

We produce approximately 80 million gallons of safe drinking water daily for some 500,000 people. Hundreds of water quality tests are performed each day at the Collins Park Water Treatment Plant by certified chemists who are on duty around the clock to ensure our drinking water meets or exceeds all water quality standards.

- All toxin testing and bloom monitoring is critical
- Water managers want advanced warning of changes in bloom toxicity
- ESP, combined with other important NOAA HAB forecasting tools provides early warning of high toxicity biomass moving towards a water intake so managers can be proactive rather than reactive

Further collaboration and service

- OAR, NOS, MBARI collaborating to bring 3G ESP technology to Lake Erie in 2018
 - OAR Ocean Technology Development Grant
 - Doucette and Mikulski developing the MC array
- GLERL acquiring two additional ESPs in 2018
 - One through GLRI
 - NOAA IOOS OTT program



The background of the slide is an aerial photograph of a vast, green, textured landscape. The texture is irregular and organic, resembling a dense forest canopy or a large body of water covered in green algae. The colors range from a deep forest green to a lighter, almost yellowish-green, suggesting variations in vegetation or water depth. The overall effect is a sense of a large, natural, and somewhat mysterious environment.

Thank you for your attention!

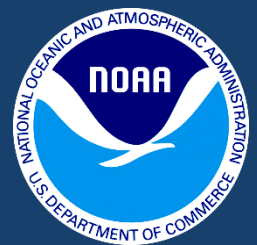
QUESTIONS?

NOAA – EPA

Citizen Science HAB Collaboration

Antonio Bravo

Office of Wetlands, Oceans & Watersheds



EPA Partnership with NOAA

- Complements the EPA National Communication Strategy on Nutrient Pollution
- Highlights Public Engagement through Citizen Science
- Creates Awareness of HABs and Water Quality
- Builds Local Capacity to Address Water Quality Issues
- Develops partnerships to Sustain Community progress



Nutrient pollution is one of the most widespread, costly, and challenging environmental problems in America.

Nutrient Pollution

National Communication Strategy



- Demonstrate the Problem
- Showcase Best Management Practices
- Engage Diverse Organizations
- Localize the Issue
- Highlight Community Benefits

Clean Water or Green Water?



Visit <https://www.epa.gov/nutrientpollution/harmful-algal-blooms>

If you see water that is:

discolored

foamy

scummy

has mats of algae

smells musty

Avoid contact or rinse
off immediately in
fresh water.

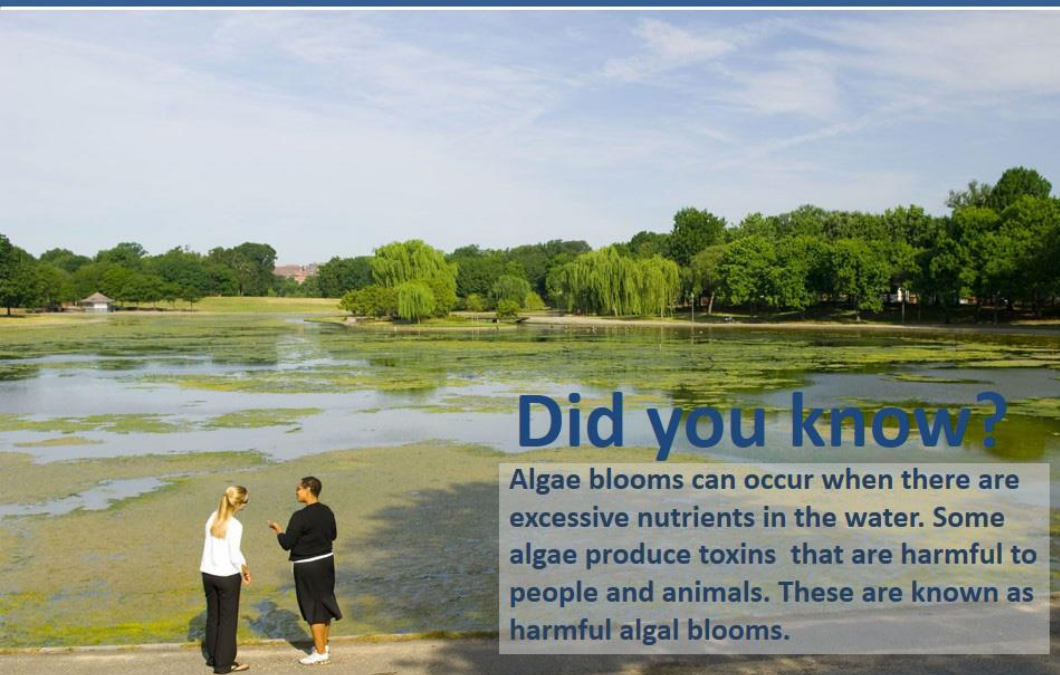
When in doubt,
stay out!





HAB Awareness Campaign

Clean Water or Green Water? 
Learn more at <https://www.epa.gov/nutrientpollution>



- Began in 2014
- Component of National Nutrient Pollution Communication Strategy
- **Environmental and human health impacts from HABs**

Public Engagement on HABs

- Work with Federal, State, NGO & Academic partners
- 4-part HAB expert webinar series
 - Average 700 participants
- HAB webpage
- Social media campaign, listservs
 - Nitrogen News, Water Headlines, Watershed News, etc.
- PSA's: Nutrient Pollution 101; When in Doubt, Stay Out; Protect Your Pooch from Harmful Algal Blooms
- Partnered with NEEF on 2014 Algal Bloom Photo Contest



Partnerships

EPA & The Humane Society partnered to alert pet owners of the dangers of HABs

- Public service announcements
 - 15, 30, & 60 second
- Social Media
 - Odin from Kansas Dept. of Health
 - HSUS has 200k+ Twitter followers and 1.7M+ Facebook likes



HSUS 
@HumaneSociety



Protect your dog from toxic algae! Get the facts from @EPAwater: www2.epa.gov/nutrientpollut...

 Reply  Retweet  Favorite  More

26
RETWEETS

5
FAVORITES



8:27 AM - 31 Jul 13

Protect Your Pooch

Clean Water or Green Water?

 **EPA**
United States Environmental Protection Agency

<http://www2.epa.gov/nutrientpollution/protect-your-pooch>

Don't Spoil the Fun!



Harmful algal blooms can make dogs very sick. If you think your dog has come in contact with a harmful algal bloom, rinse him or her immediately in fresh water.

Photo courtesy of Janet Neff

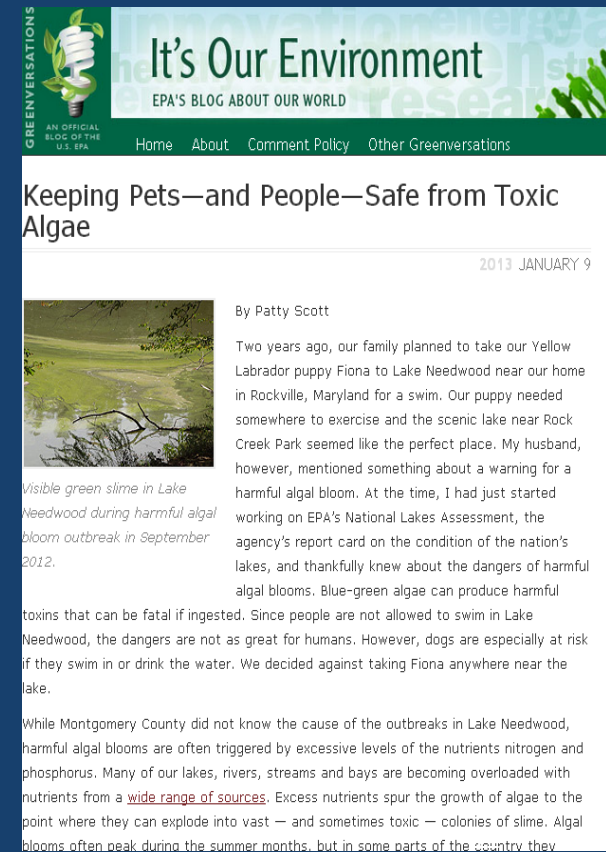
Key Partners:

- CDC
- Humane Society
- American kennel Club

Outreach to Dog Lovers

Pet Articles

- American Kennel Club
- Dog Fancy Magazine
- EPA blog



Multimedia Outreach

Videos:

- Nutrient Pollution 101
 - 34K+ views
- The Choice is Yours: Clean or Green Water?
 - 11K + views
- *Protect Your Pooch from Harmful Algal Blooms*
 - 8K+ views
- Requests received for broadcast-quality versions
 - Estimated audience of one outlet: 70K+



HAB Campaign Partnerships

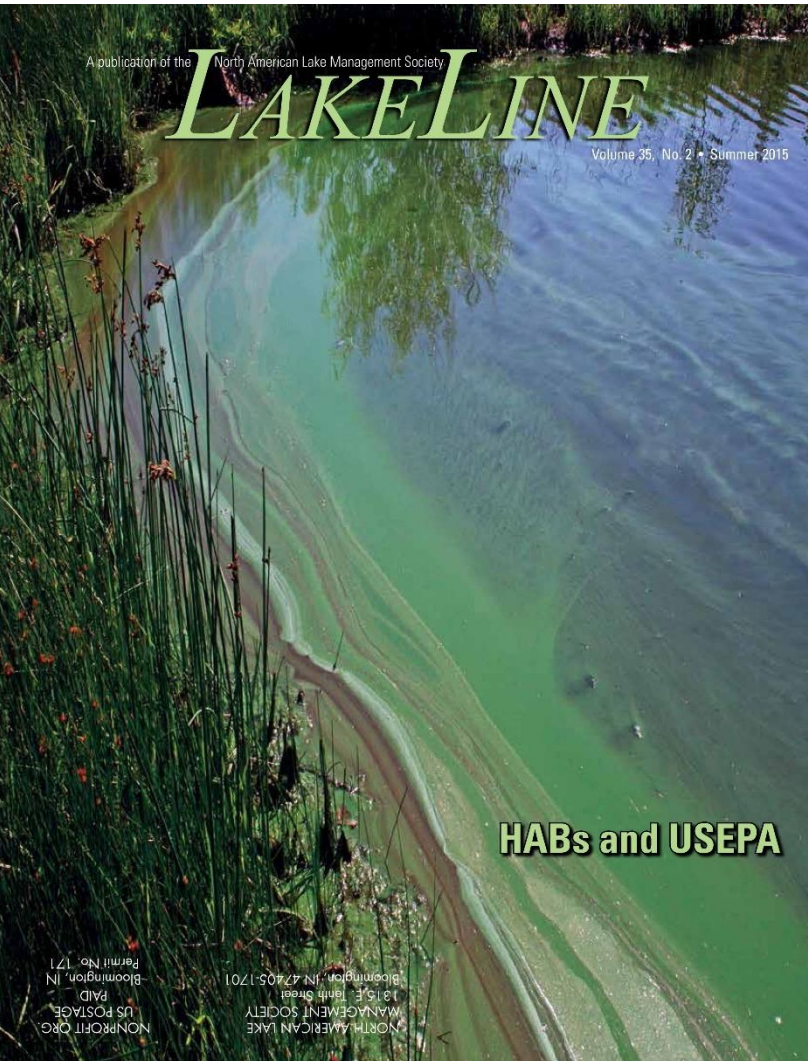
- North American Lake Management Society
- NOAA, CDC, USDA
- NGOs: Human Society, World Resources Institute, Nitrogen News, National Environmental Education Foundation
- States: Departments of Health and Environment (Montana, Maryland, Virginia)

Partnerships

NEEF-Earth Gauge

- 150 interesting tips about nutrient pollution for meteorologists to use on air & on-line
- Tips were distributed to 275+ outlets:
 - Broadcast meteorologists
 - Radio broadcasters
 - Journalists
 - National Weather Service meteorologists
- Reached 128 cities
- TV media markets reached 230 million+ viewers

North American Lake Management Society



- EPA partnered with North American Lake Management Society
- Dedicated Summer 2015 issue of LakeLine on HABs and EPA
- Featured EPA and NOAA articles
- Winning photo from NEEF national photo contest

EPA Partnership with NOAA

The PMN promises:

- Multiple Opportunities to complement EPA on Nutrient Pollution outreach
- Public Engagement through Citizen Science
- Creating Awareness of HABs and Water Quality
- Building Local Capacity to Address Water Quality Issues

Phytoplankton Monitoring Network

EPA and NOAA partner to support the Phytoplankton Monitoring Network (PMN)

Goals:

- Expand marine VPMN to freshwater
- Educate communities about WQ issues
- Build local capacity for addressing WQ issues



VPMN Volunteers

Lake Erie, September 2015



Citizen Science

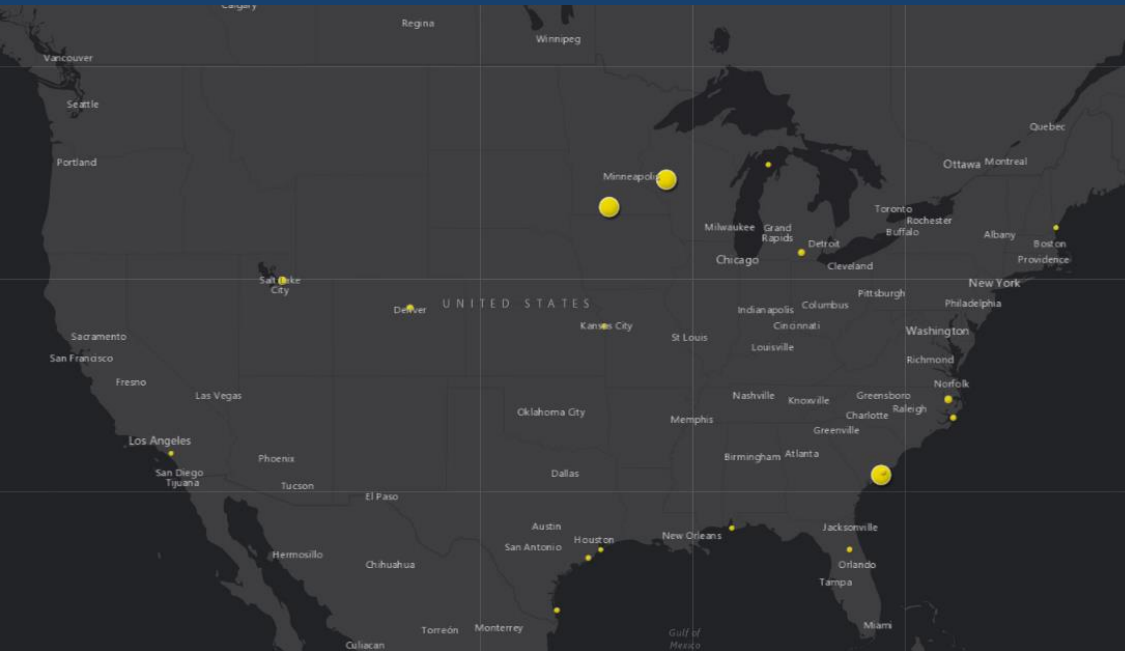


- The PHYTO app was developed to help PMN volunteers identify species of algae
- Helping to simplify science to encourage public participation

PMN Outreach Opportunities

- Communities on or around Lake Erie
- Esri Story Map to highlight PMN Sampling Sites
 - Michigan, Ohio, Utah and Montana
- Community Testimonials
 - Champions
 - Organizations
 - Innovative Approaches

The PMN Story



ESRI Story Map

- Tells the story of PMN
- Highlights volunteers
- Showcases innovation and citizen science

PMN Testimonials

- Biographical profiles of on-the-ground volunteers in communities
- Why they got involved,
- Perspective on WQ, citizen science, etc.
- Champions encouraging federal & citizen scientist collaborations
- Video featuring the life-cycle of a PMN sample

www.epa.gov/nutrientpollution



Environmental Topics

Laws & Regulations

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Nutrient Pollution

Learn the Basics of Nutrient Pollution

Nutrient pollution is one of America's most widespread, costly and challenging environmental problems.

[>Learn about the problem, its sources and its effects](#)

1 2 3 4



Sign up to get water resources in your inbox

Enter email address

sign up



- [The Problem](#)
- [Sources and Solutions](#)
- [The Effects](#)
- [Where it Occurs](#)



- [In Your Home](#)
- [In Your Yard](#)
- [In Your Community](#)
- [In Your Classroom](#)



- [What EPA is Doing to Reduce Nutrient Pollution](#)
- [State Progress Toward Developing Numeric Nutrient Criteria](#)
- [Tools to Assist States and Tribes](#)
- [Nutrient Data](#)
- [Reports, Research and Resources on Nutrient Pollution](#)

Southeast Alaska Tribal Ocean Research



Ensuring Sustainable Access to Traditional Resources

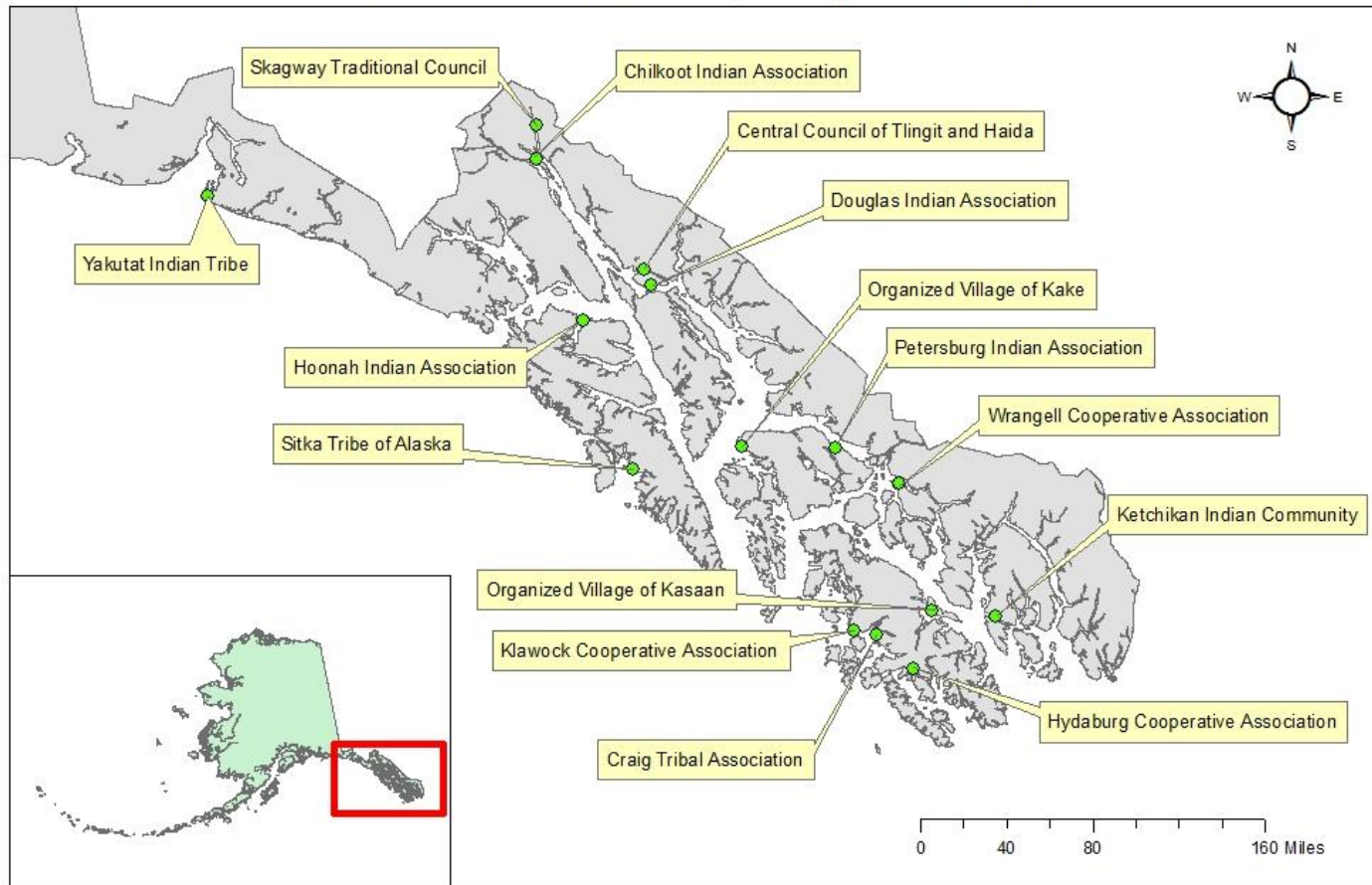
Chris Whitehead
Sitka Tribe of Alaska

NOAA Science Review February 27, 2018

Southeast Tribal Partners



Southeast Alaska Tribal Toxins (SEATT) Partner Locations



Regional Commitment

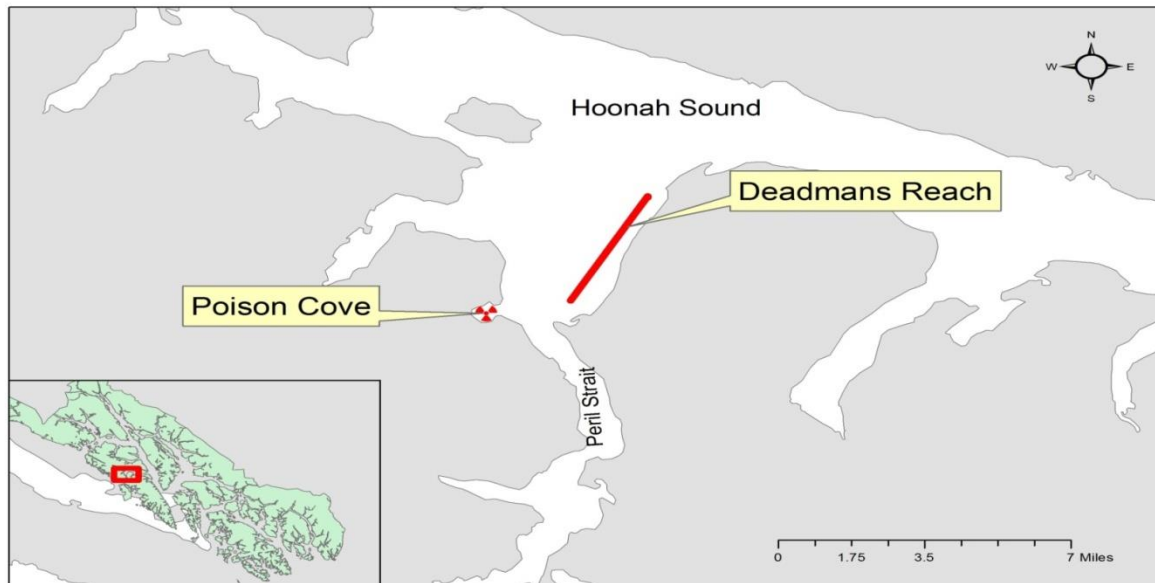


Relevance

Traditions and Culture



- Subsistence user groups play **toxin roulette** when harvesting bivalves in Alaska.



Relevance

Timeline



- Pre-SEATOR—Illness/deaths/limited harvest
- OCT 2013--Illness in Sitka
- NOV 2013—Planning meeting (Event Response funds)
- SEPT 2014--Tribal Collaboration formed
- NOV 2014—First workshop (PMN)
- OCT 2015—Sitka Lab funded
- FEB 2016—RBA Training (NCCOS Charleston)
- MAY 2016—Routine shellfish sampling
- DEC 2016—Expanding out of SE (AHAB)
- OCT 2017—ISSC, RBA for geoduck



Increased Capacity=Projects

- Southeast Alaska Regional Ocean Acidification Monitoring (SEAROAM)
- Integrated *Alexandrium* Cyst bed Mapping in Southeast Alaska (IACSEA): ECOHAB
- Undergraduate Teaching Internships
- Alaska Harmful Algal Bloom Network (AHAB)
- Intertidal Shellfish Population Estimates
- Heavy Metals and Mercury in Marine Mammals (HMMM)

TRIBAL CREDIBILITY





FUNDING

EPA IGAP -\$20-30K/Tribe/year (~\$250/yr)

EPA IGAP workshops/lab capacity-\$150K (STA)

BIA Climate Change Program-\$500K (STA)

ANA Environmental Regulatory Enhancement Program-\$580K (STA)

UAF BLaST program-\$64K



Other Partners



- NOAA –Northwest Fisheries Science Center and Charleston Marine Biotoxin Program NCCOS/PMN
- University of Alaska Fairbanks School of Fisheries and Ocean Science
- Southeast Alaska Regional Dive Fisheries Association (SARDFA)
- Washington State Department of Health Marine Biotoxin Program
- Alaska Department of Environmental Conservation (EHL)

Who Regulates for PSP and Toxins in Alaska?



- Alaska Department of Environmental Conservation follows FDA regulations for all commercially harvested shellfish in Alaska under the National Shellfish Sanitation Program
- $80\mu\text{g}$ toxins /100g shellfish tissue



Relevance

What About Subsistence Users?



- Alaska has no long-term recreational and subsistence monitoring program.

AND...

- Illness and deaths



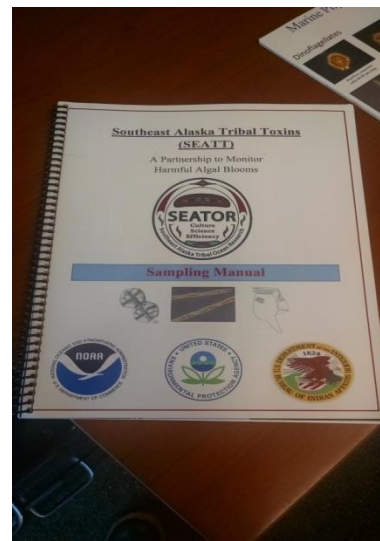
PMN Training

Equipment

- Digital Microscope with camera
- Refractometer and Thermometer
- Phytoplankton net
- Filtering apparatus
- Identification tools

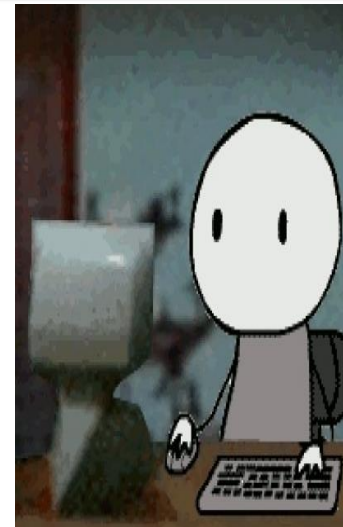
Training

- Workshops in Sitka
- Sampling Manual
- Videos
- Site Visits
- Technical training by PMN

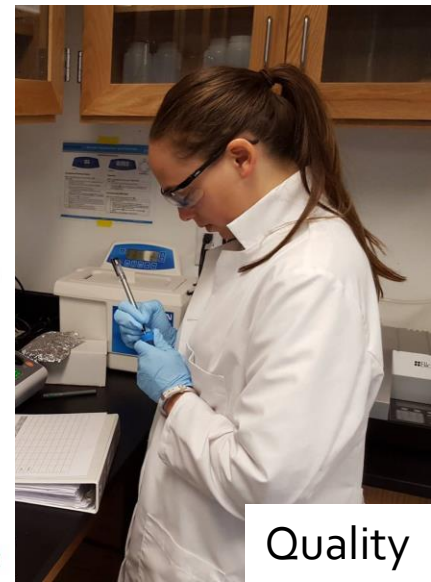




What does monitoring look like?



STAERL



Quality

Sitka Tribe of Alaska Environmental Research Lab (STAERL)

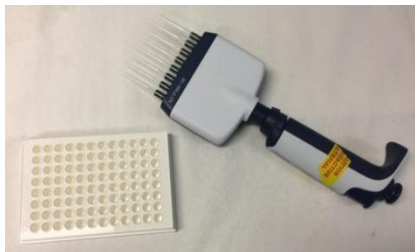


48 Hour turnaround on results

Tribes can establish subsistence management plans

Quality

RBA: Receptor Binding Assay



- NOAA Charleston Lab
- Lower detection limit (6.4 $\mu\text{g}/100\text{g}$)
- High throughput

Data and Shellfish Advisories



Southeast Alaska Tribal Ocean Research

Sitka Tribe of Alaska Environmental Research Laboratory

429 Katlian Street, Sitka Alaska (907) 966-9650

seator@sitkatriben-sn.gov



PSP Daily Report

6/10/2016

STAERL ID	Date Collected	Location	Sample Site	Species	PSP Result (µg/100g)	Sample Type	Collector
20160103	6/8/2016	Sitka	Starrigavan	Little Neck Clam	<10	whole	Sitka Tribe of Alaska
20160104	6/9/2016	Petersburg	Sandy Beach	Blue Mussel	<20	whole	Petersburg Indian Association
20160090	6/5/2016	Juneau	Amalga Harbor	Blue Mussel	414	whole	University of Alaska Fairbanks
20160096	6/6/2016	Juneau	Auke Rec	Butter Clam	146	whole	University of Alaska Fairbanks
20160098	6/5/2016	Juneau	Eagle Beach	Butter Clam	166	whole	University of Alaska Fairbanks
20160101	6/8/2016	Sitka	No Thorough Fare Bay	Rock Scallop	312	gut	Individual

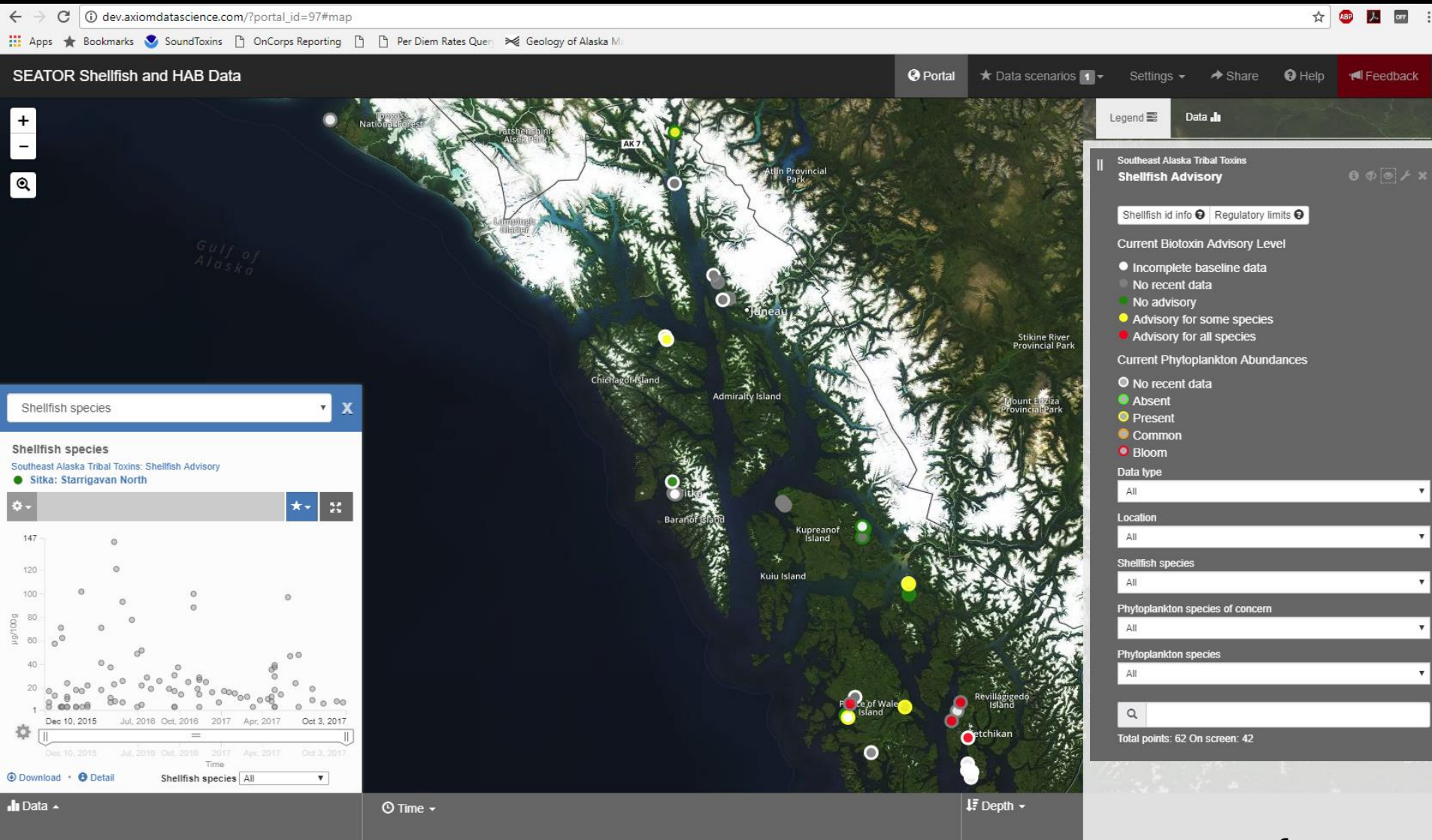
NTD: No Toxins Detected
FDA Action Level: 80 µg/100g

www.seator.org/data

Shellfish Marine Biotoxin Bulletin

Performance

All data accessible to researchers and shellfish harvesters



Performance

Outreach and Community



Toxic Shellfish 101

How plankton can ruin your dinner plans



Step 1: Phytoplankton "Bloom"

When conditions are just right, one species or genus of plankton can multiply especially rapidly. If the plankton is toxic, toxin levels can rapidly increase in populations. The exact factors that lead to blooms and to toxin production are not well-known.



Step 2: Shellfish Pick Up Toxins

Shellfish like clams, mussels, and oysters eat plankton that they filter out of the water. During a harmful bloom, a meal is almost entirely made of toxic plankton. Since a single shellfish can filter gallons of water a day, even low concentrations become highly concentrated. Most shellfish are unaffected by planktonic toxin feeding as usual throughout the bloom.

Step 3: Shellfish Are Eaten

There is no visual way to tell if shellfish are safe or not. The water can be clear, but the shellfish can be eaten or shelled, the time since the last bloom is recent or extensive, but it is impossible to say whether they were safe to harvest. As a result, shellfish are hospitalized every year in Alaska.

Getting sick could require a hospital stay or as few as one or two minutes or up to 48 hours depending on toxin type and the amount present.

Step 4: The Threat Dissipates

After as little as a few days or a few months, the bloom fades away and the water becomes safe again. Some species like blue tides are relatively quickly, but others, like butter clams, can take months to return to safe levels.

Harmful Alaskan Algal Species

Alexandrium spp.

- **TOXIC.** *Alexandrium* species can produce saxitoxins that accumulate in shellfish. These toxins cause Paralytic Shellfish Poisoning and cannot be neutralized by freezing or cooking.
- *Alexandrium* causes commercial shellfishery closures almost every year. Recreational shellfish harvesters are also sickened every year.
- *Alexandrium* has a cyst phase that allows cells to remain dormant for long periods of time (even years!). Cysts are also toxic and can contaminate shellfish.
- Some *Alexandrium* species can create a reddish tinge in the water, hence the name "red tide". Many blooms are not visible, however.
- Blooms of *Alexandrium* do not have consistent triggers, but they tend to be most common in mid-summer, after large rain events, or after a cyst bed has been disturbed.

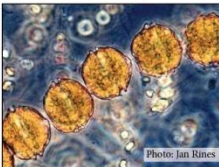


Photo: Jan Rites

Pseudo-nitzschia spp.

- **TOXIC.** *Pseudo-nitzschia* species can release domoic acid. Like saxitoxins, domoic acid accumulates in shellfish and cannot be neutralized by freezing or cooking. Domoic acid can lead to Amnesic Shellfish Poisoning.
- In July 2015, a *Pseudo-nitzschia* bloom stretched from southern California into Southeast Alaska. The southern portion of this bloom produced enough domoic acid to shut down shellfisheries along the coast and to sicken hundreds of sea lions.
- **Colorless!** Blooms of *Pseudo-nitzschia* are not visible without a microscope.
- *Pseudo-nitzschia* is one of the earliest harmful algal species to bloom in Southeast Alaska. In 2015, the bloom season stretched from May to September.

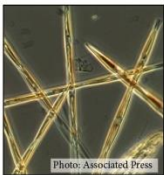


Photo: Associated Press

Dinophysis spp.

- **TOXIC, but non-fatal.** *Dinophysis* species can produce okadaic acid, which can accumulate in shellfish and cause severe gastrointestinal distress, or Diarrhetic Shellfish Poisoning. These toxins also cannot be neutralized by cooking or freezing.
- While okadaic acid exposure is not fatal, evidence from Europe suggests that it could promote tumor growth.
- *Dinophysis* blooms in warm conditions with stable salinity.

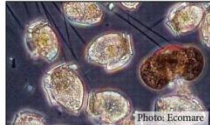


Photo: Ecomare

Heterosigma akashiwo

- **NOT TOXIC** to humans. *Heterosigma* can be toxic to fish, however, and has caused millions of dollars in damage to farmed fish in Puget Sound over the past few years. It has also been documented to kill wild salmon and crustaceans.
- *Heterosigma akashiwo*'s mechanism to fish and crustaceans is unknown. It could be producing an unstable neurotoxin, acting in concert with an unknown virus, or be producing radical oxides.
- Blooms are most likely when the water is warm and slightly brackish, as after a large summer rainstorm.

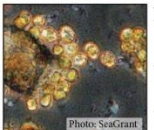


Photo: SeaGrant

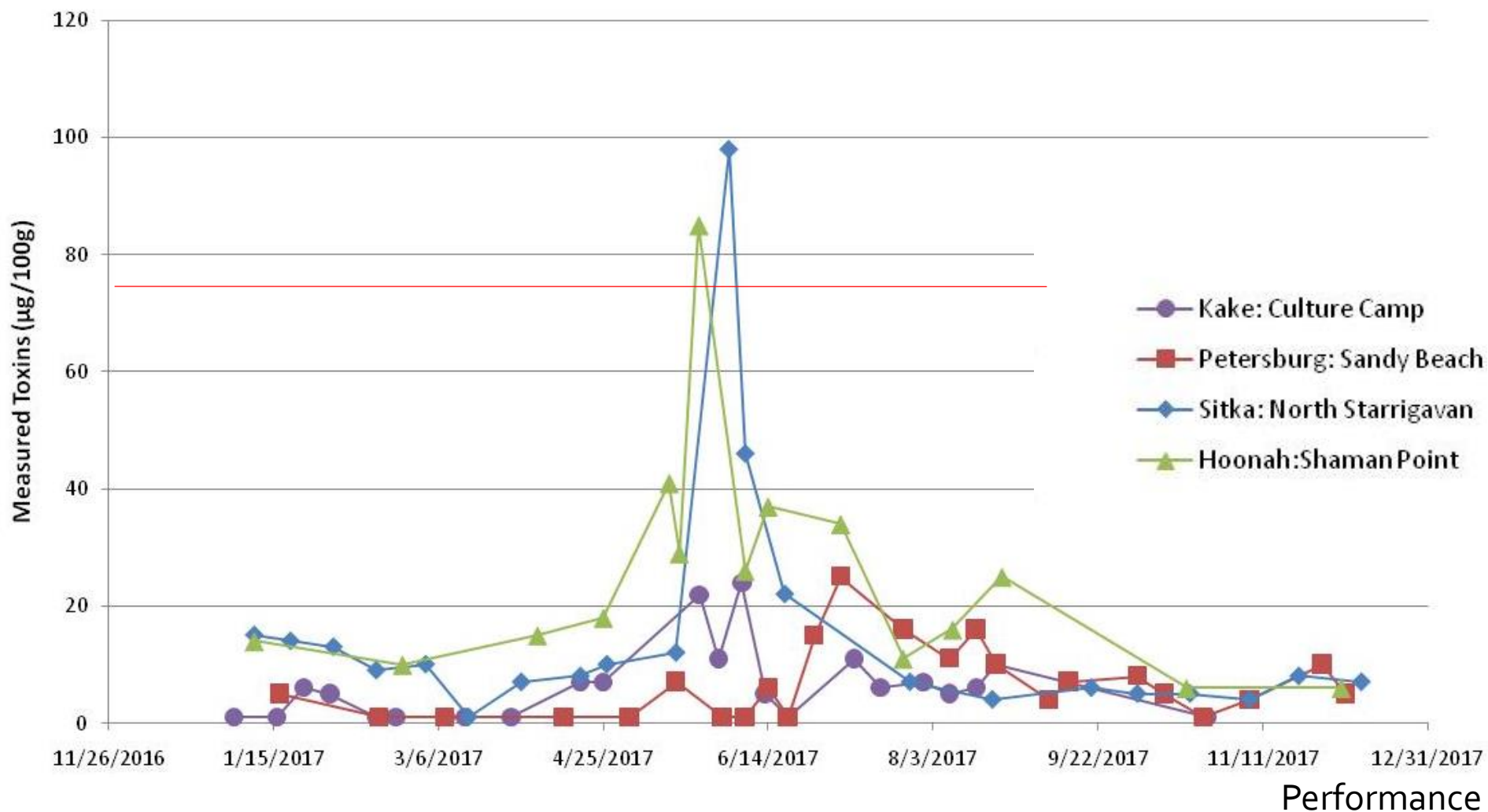
More questions? Find out more about harmful algal blooms, shellfish toxins, and available shellfish tests by contacting the Sitka Tribe's Environmental Lab. Phone: 907-747-7356. Email: seator@sitkatribenon.gov



SEATOR.ORG

Shellfish Data 2017

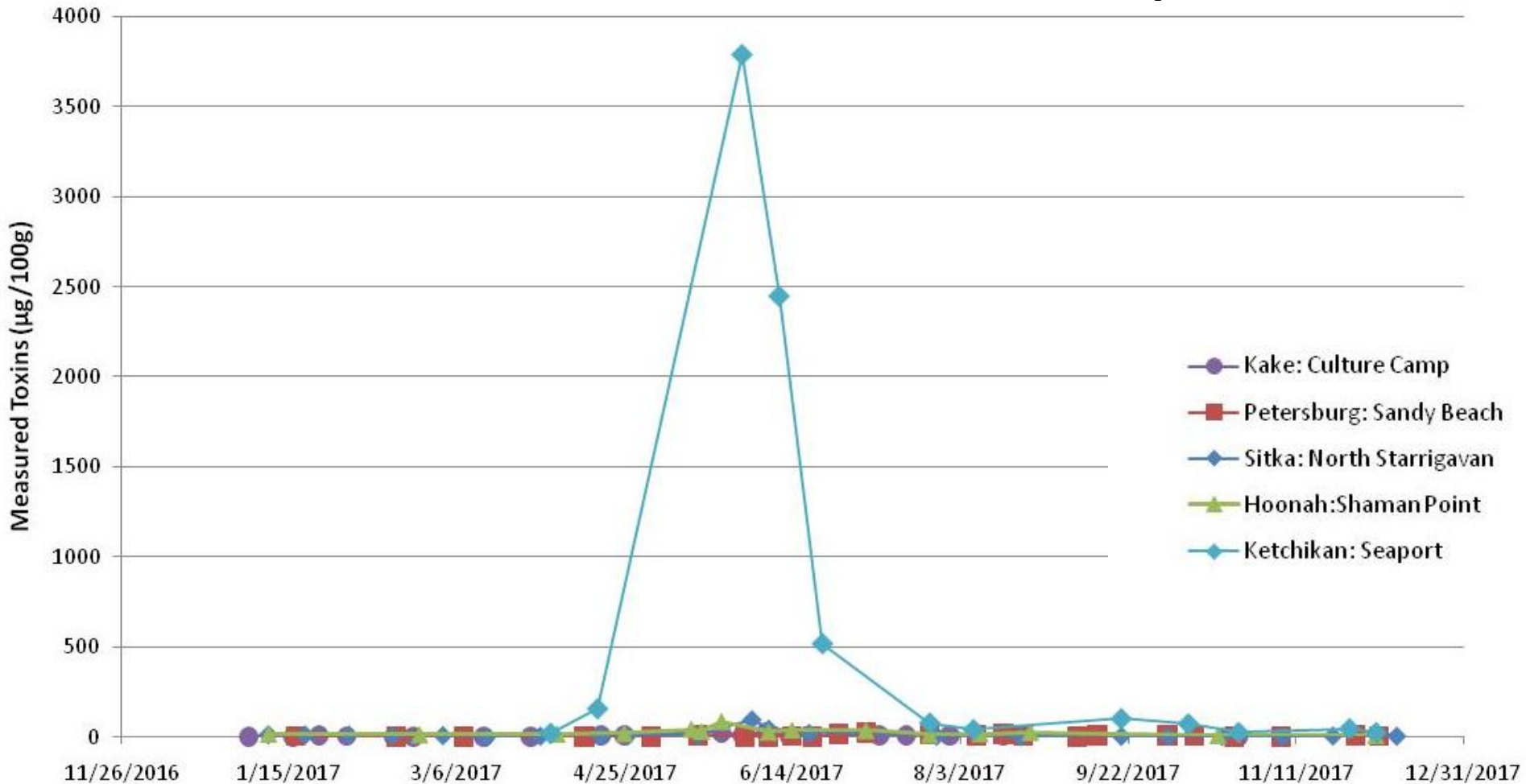
Blue Mussels Southeast Alaska 2017



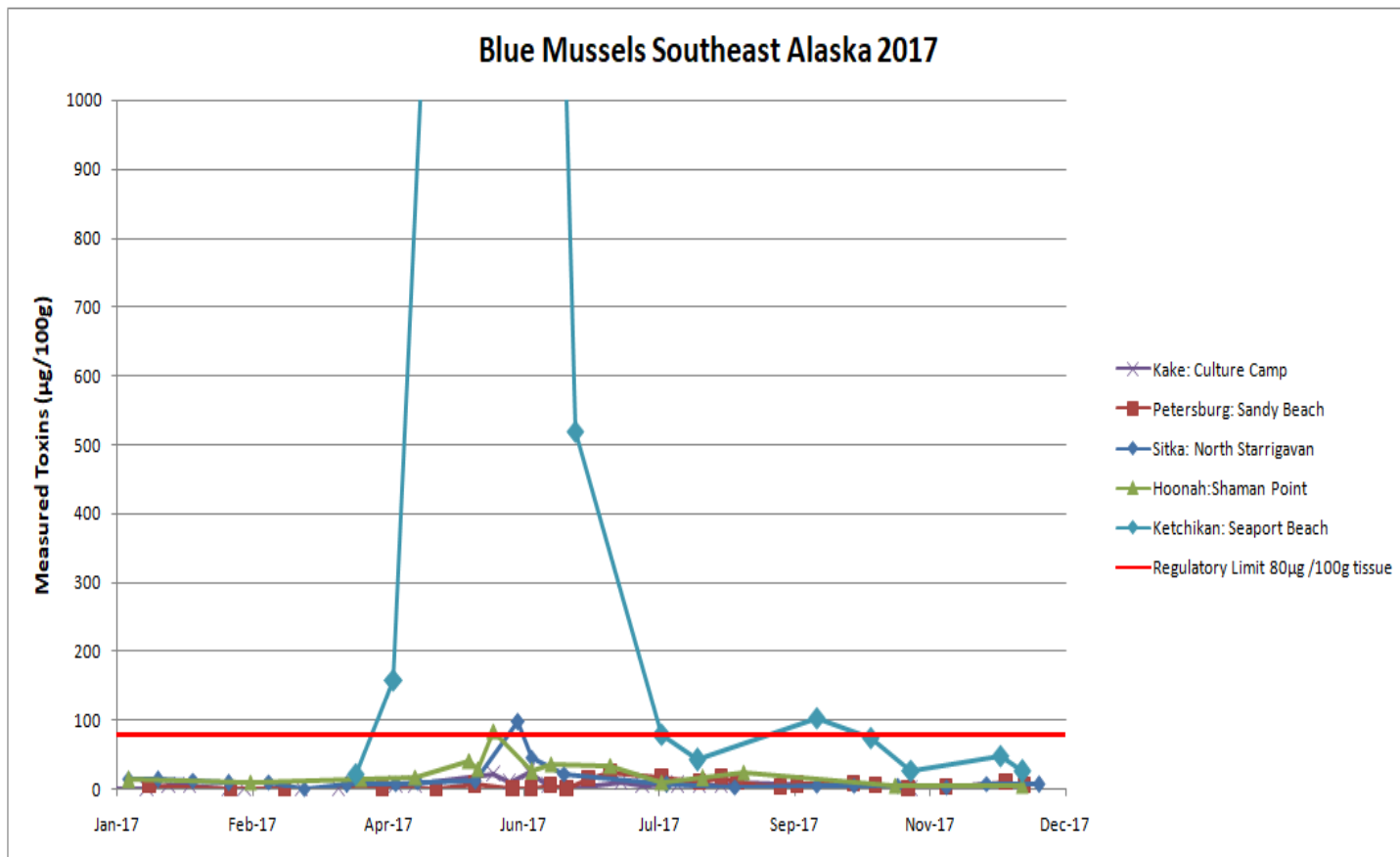
Shellfish Data 2017



Blue Mussels Southeast Alaska 2017



Protecting Human Health



No illness or deaths at any SEATOR
monitoring sites

Performance

Outcome



- Reduced risk
 - No illness or deaths at any monitor site
- Increased access to traditional resources
- Increased collaborations and relationships



Questions or Comments?



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