Monitoring Harmful Algal Blooms with the Power of Citizen Scientist: The NOAA Phytoplankton Monitoring Network

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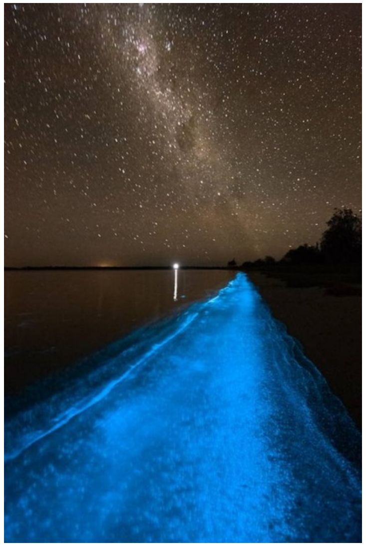
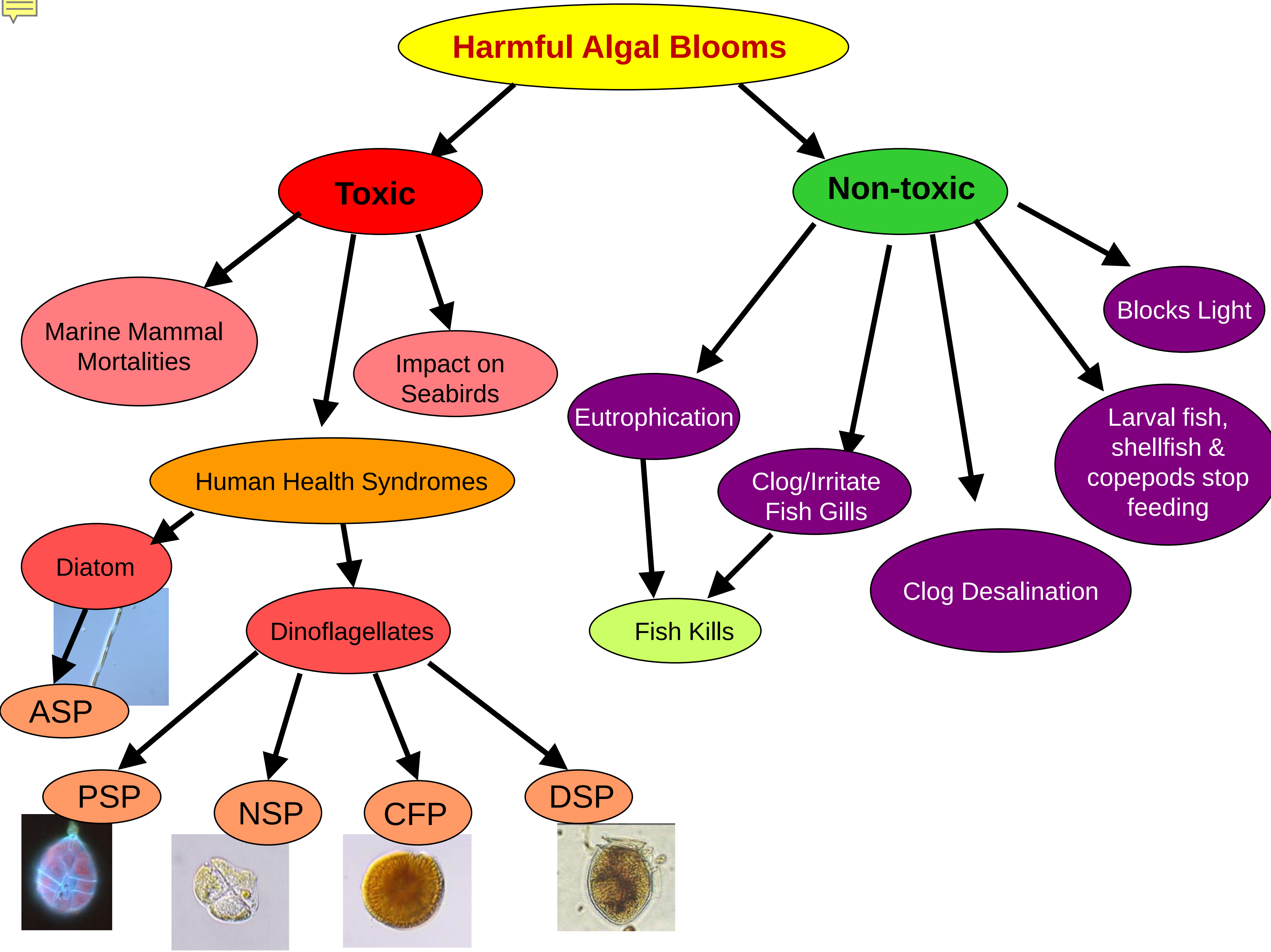
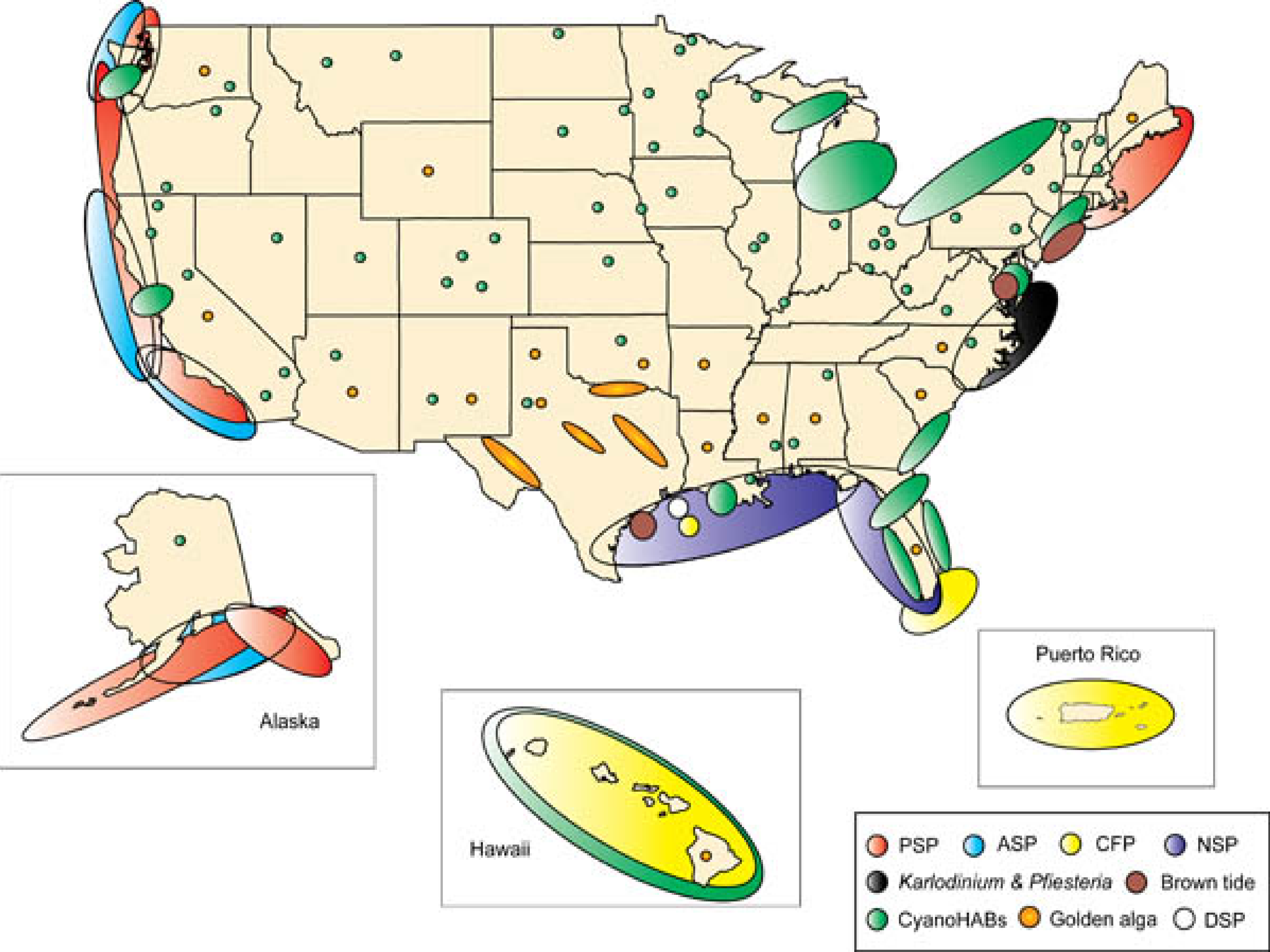
National Center for Coastal Ocean Science
HAB Monitoring and Reference Branch

Harmful Algal Blooms




Harmful Algal Blooms
Toxic
Non-toxic
Marine Mammal Mortalities
Impact on Seabirds
Human Health Syndromes
Diatom
ASP
Dinoflagellates
PSP
NSP
CFP
DSP
Eutrophication
Clog/Irritate Fish Gills
Fish Kills
Clog Desalination
Larval fish, shellfish & copepods stop feeding
Blocks Light


Alaska
Hawaii
Puerto Rico
PSP
ASP
CFP
NSP
Karlodinium & Pfiesteria
Brown tide
CyanoHABs
Golden alga
DSP

Internal HAB Portfolo

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

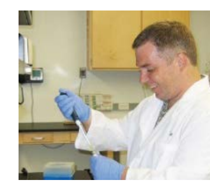
Harmful Algal Bloom Monitoring and Reference

Branch Chief: John Ramsdell

- Sensor Development - Greg Doucette
  - Environmental Sample Processor (ESP) toxin detection & Hand-held sensor development
- Phytoplankton Monitoring Network - Steve Morton
  - Taxonomy of Harmful Phytoplankton; Monitoring and early warning of marine and freshwater HABs
- Analytical methods and reference materials - Maggie Broadwater
  - National Response to HAB events / Development of new analytical methods
- Validation and Technology Transfer of Toxin Detection Methods - Tod Leighfield
  - Validation of toxin methods / Transfer of detection methods and laboratory development
- Mitigation and Control of Harmful Algae - Peter Moeller
  - Ozone Nanobubbles to control HABs and mitigate their effects



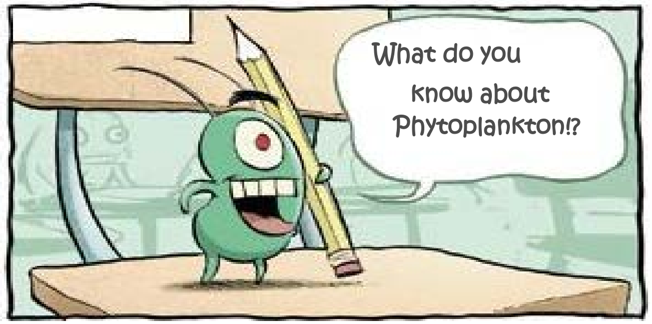




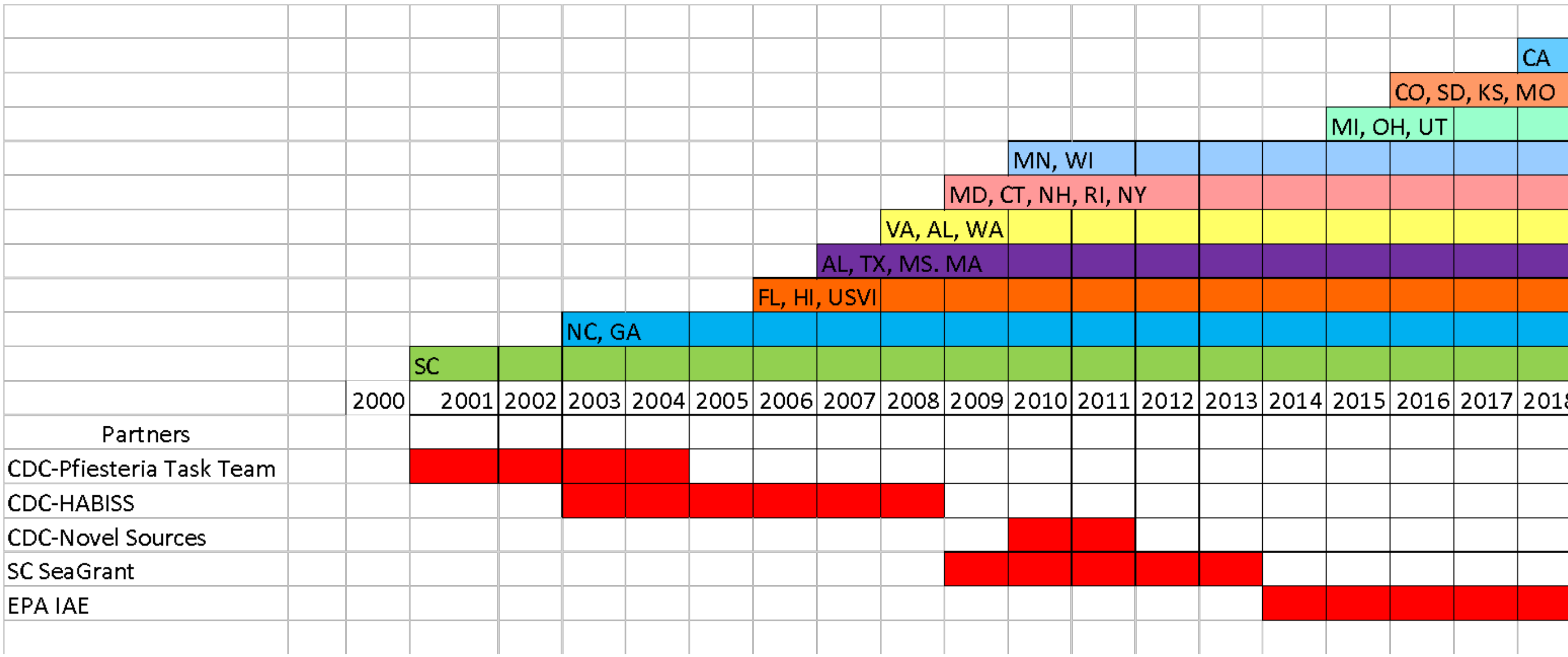

Phytoplankton Monitoring Network

PMN Mission ~

"To educate the public on harmful algal blooms (HABs) while expanding the knowledge of phytoplankton that exist in coastal waters."



PMN Development Timeline



Volunteer Equipment

Volunteers are loaned all sampling equipment

- Refractometer
- 20 um 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

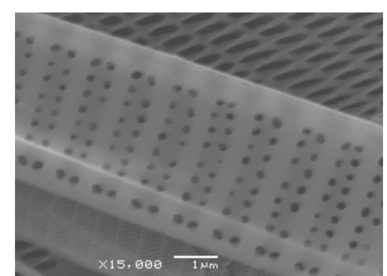
*The PMN Manual has data sheets, phytoplankton ID sheets, and HAB information specific to your local coastal waters.

Photo credit: Elizabeth Zerai

EPA-NOAA Partnership

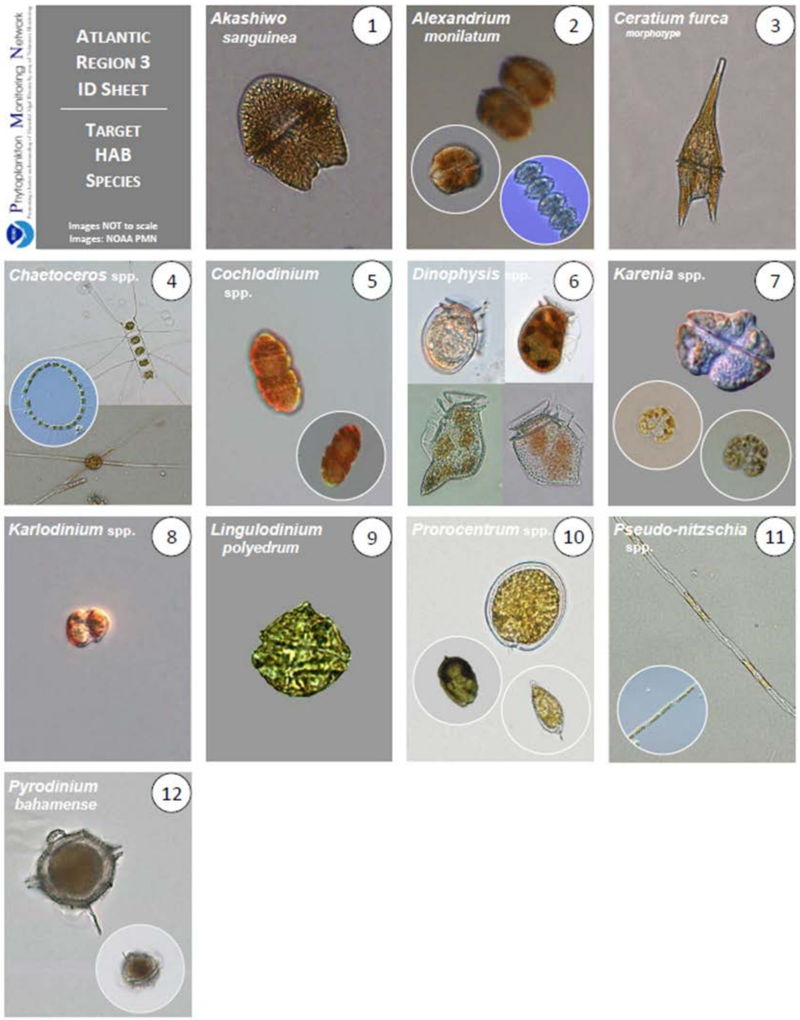
- Expand PMN to freshwater ecosystems
- Looking for 5 species of potentially toxin producing Cyanobacteria

When a Bloom is reported




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

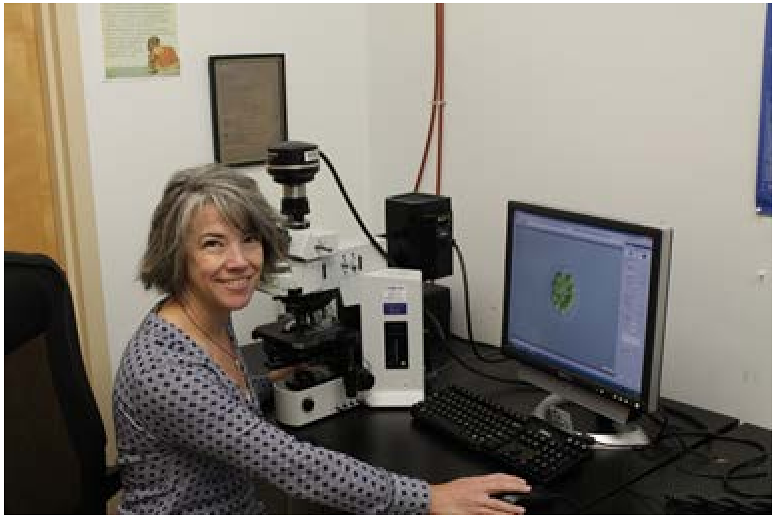
Training

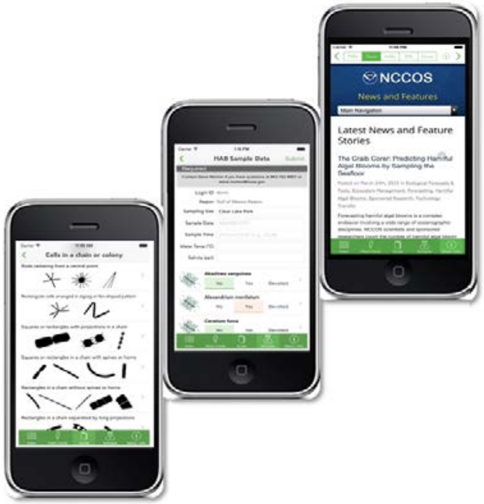


- Usually done remotely
- Background of algae
- What puts the H in HAB?
- Sampling protocols
- How to ID Target species

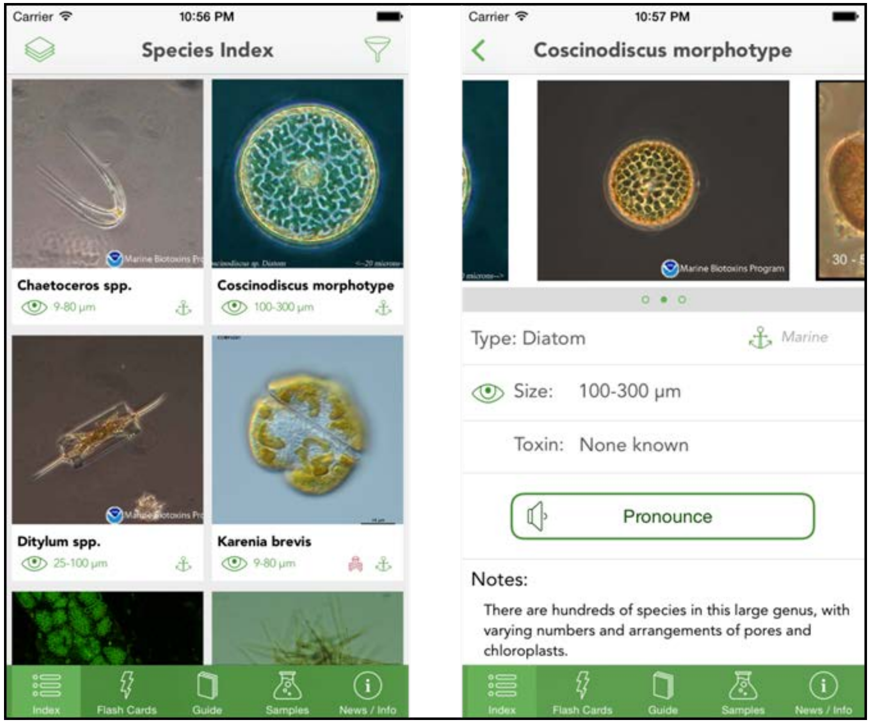
Use of Technology

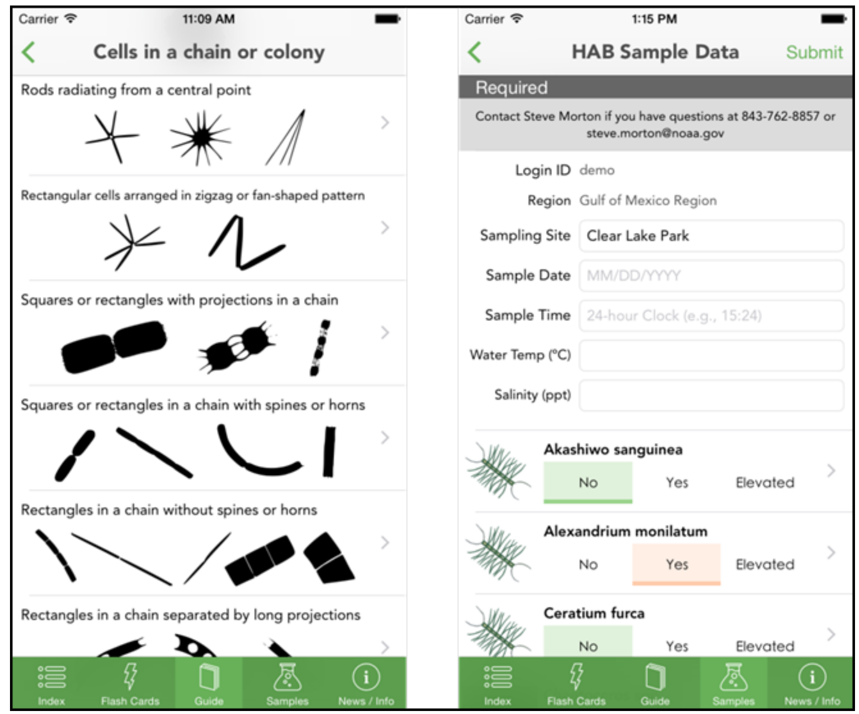
Rigour: combination of staff experience & use of tools delivers quality results: Interfacing users with technology





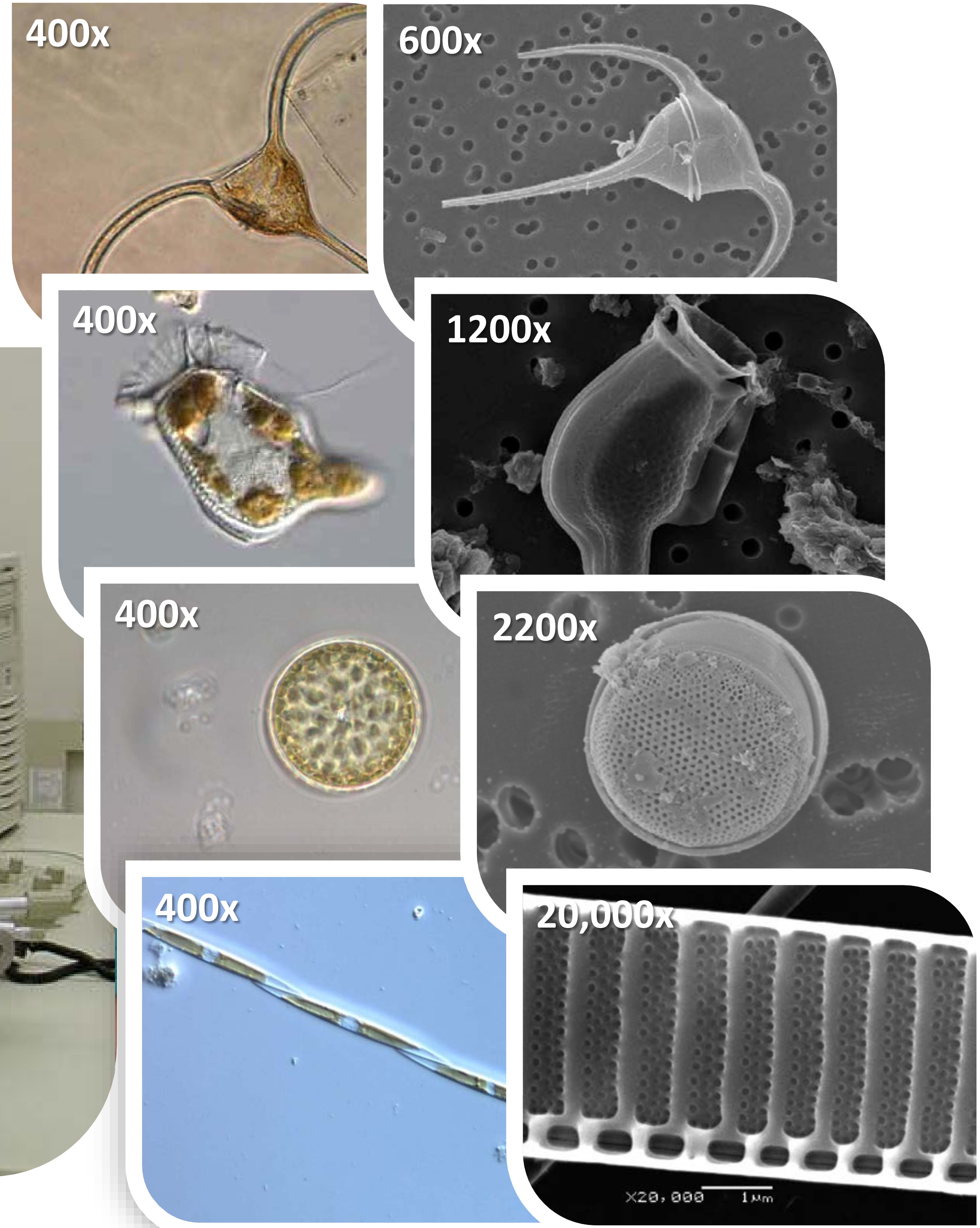
Yes, we have an app for that!





https://www.youtube.com/watch?v=ItzxoB06De0&feature=youtu.be

Phytoplankton Monitoring Network



PHYTOPLANKTON MONITORING NETWORK

NATIONAL CENTERS FOR COASTAL OCEAN SCIENCE

Science Serving Coastal Communities

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

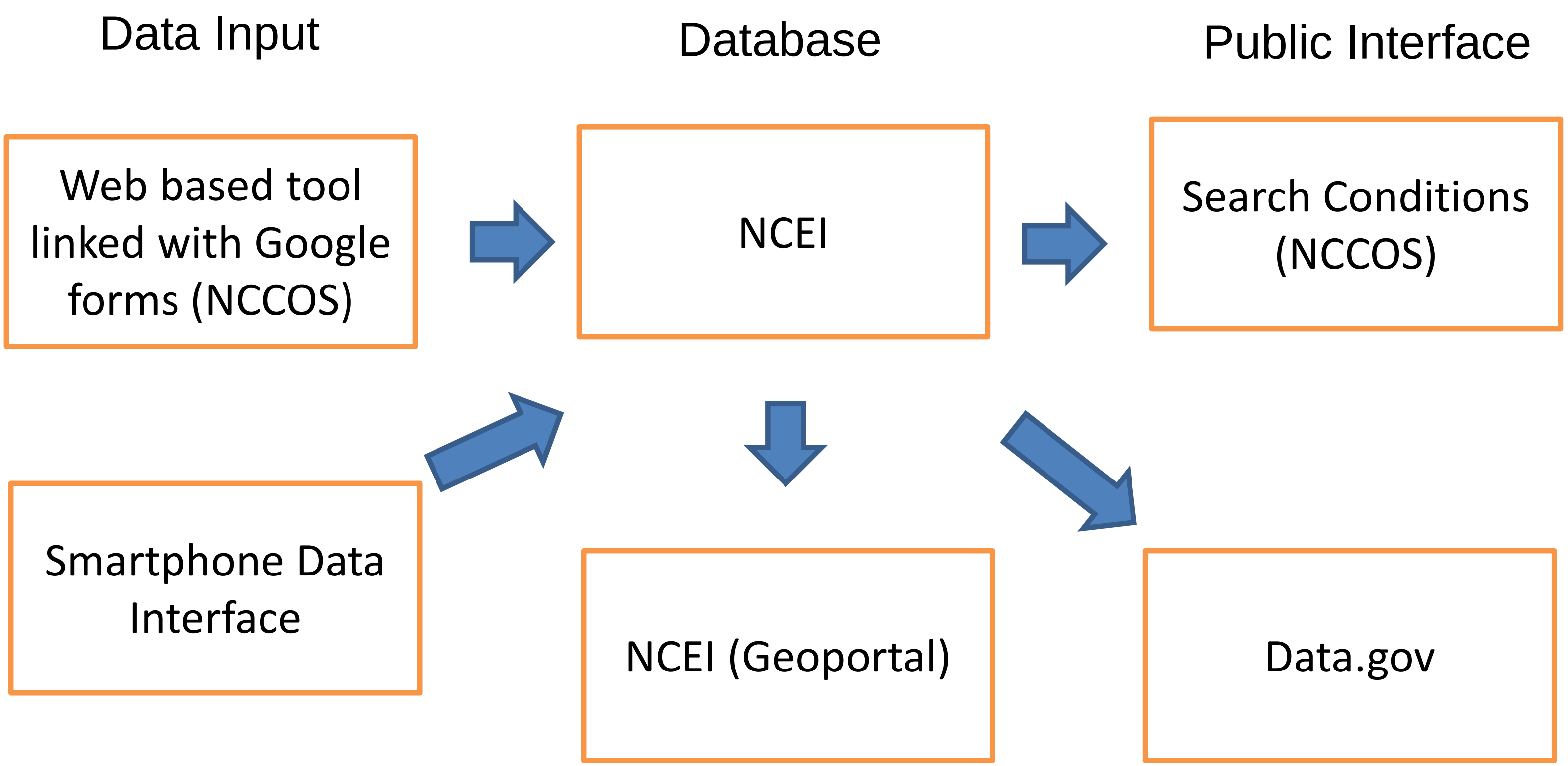
Train citizen scientists to:

- *Collect samples on weekly or bi-weekly basis*
- *Identify potential harmful algal species*

NOAA scientists can then:

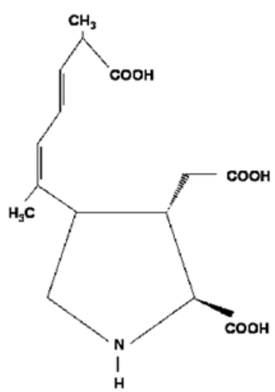
- *analyze water samples for HAB toxins*
- *Together can identify temporal and geographic HAB trends*

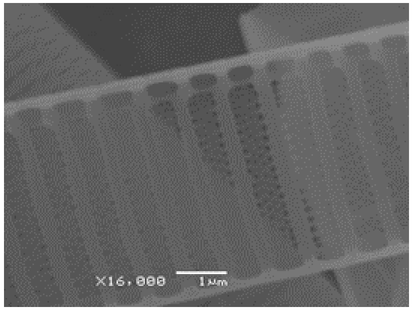
Data Flow


Data Input
Database
Public Interface
Web based tool linked with Google forms (NCCOS)
NCEI
Search Conditions (NCCOS)
Smartphone Data Interface
NCEI (Geoportal)
Data.gov

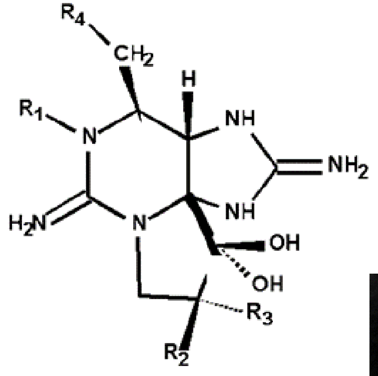
Case Studies

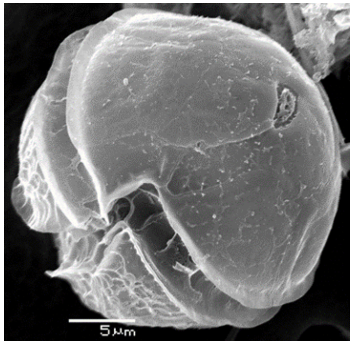
- *Pseudo-nitzshia* in Southeast
  - Diatom that produces the toxin, Domoic acid





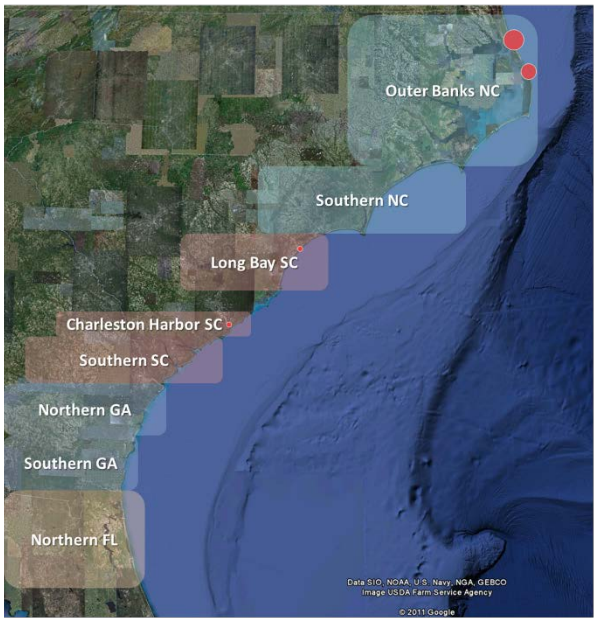
- *Alexandrium* in Alaska
  - Dinoflagellate that produces the toxin, Saxitoxin

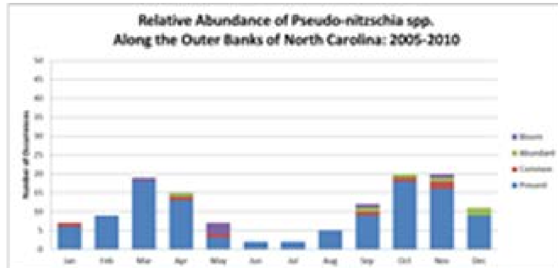


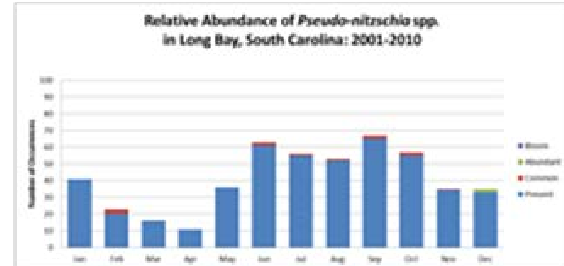


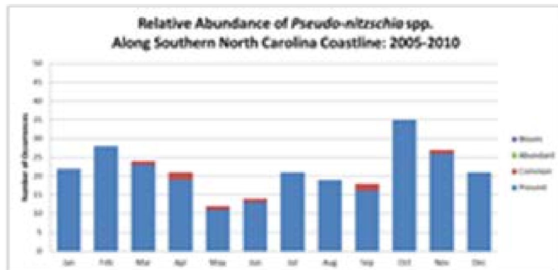
Pseudo-nitzschia in the Southeast—The First Flight High School Phytofinders

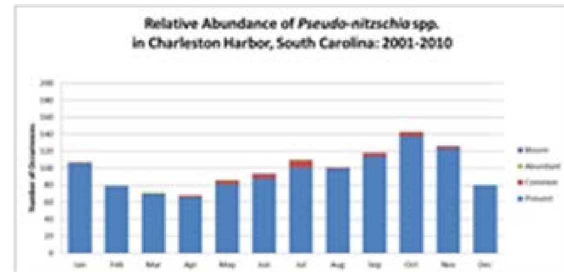
- Prior to 2006, no confirmed toxin blooms of *Pseudo-nitzschia* from the SE USA were known
- November 2006, first bloom was observed

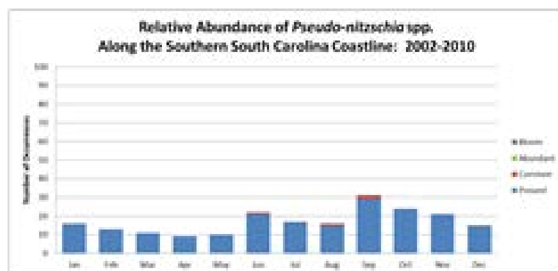

Outer Banks NC
Southern NC
Long Bay SC
Charleston Harbor SC
Southern SC
Northern GA
Southern GA
Northern FL
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Image USDA Farm Service Agency
© 2011 Google

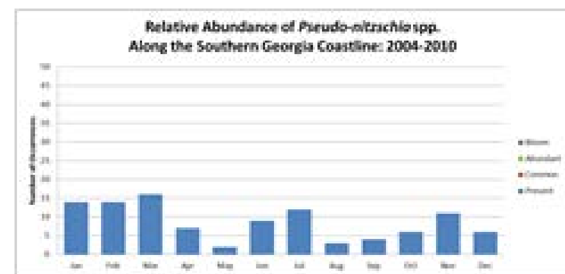

Relative Abundance of Pseudo-nitzschia spp.
Along the Outer Banks of North Carolina: 2005-2010

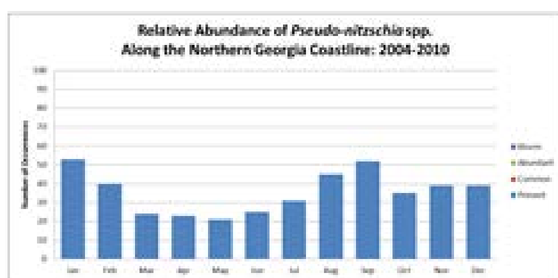

Relative Abundance of Pseudo-nitzschia spp.
in Long Bay, South Carolina: 2001-2010

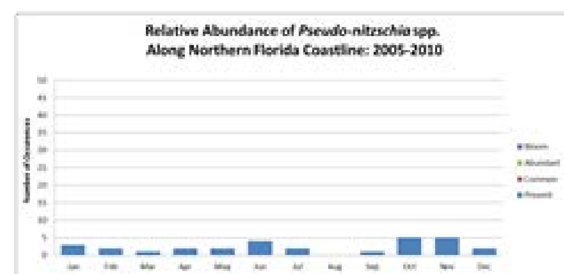

Relative Abundance of Pseudo-nitzschia spp.
Along Southern North Carolina Coastline: 2005-2010

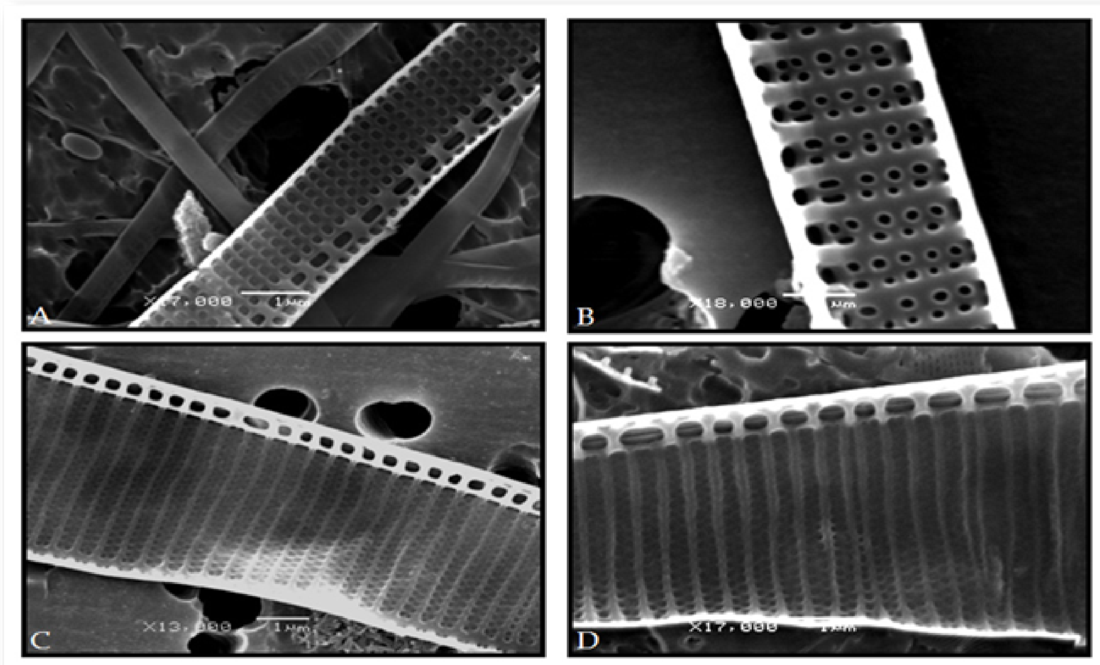

Relative Abundance of Pseudo-nitzschia spp.
in Charleston Harbor, South Carolina: 2001-2010


Relative Abundance of Pseudo-nitzschia spp.
Along the Southern South Carolina Coastline: 2002-2010


Relative Abundance of Pseudo-nitzschia spp.
Along the Southern Georgia Coastline: 2004-2010


Relative Abundance of Pseudo-nitzschia spp.
Along the Northern Georgia Coastline: 2004-2010


Relative Abundance of Pseudo-nitzschia spp.
Along Northern Florida Coastline: 2005-2010



NOAA PMN has evaluated many samples from the southeastern US coastline, and has identified four different species that can be found in this region.

A) *Pseudo-nitzschia pseudodelicatissima*, taken from June 7, 2010 Charleston Harbor Bloom

B) *Pseudo-nitzschia pungens*, taken from March 7, 2010 Oregon Inlet Bloom Sample

C) *Pseudo-nitzschia multiseries*, taken from March 7, 2010 Oregon Inlet Bloom Sample

D) *Pseudo-nitzschia seriata,* taken from sample submitted from NOAA R/V Pisces while sampling off the Charleston Harbor.

Date	Sites	Species	Concentrations	Toxin in Water	Toxin in Shellfish
November 29, 2001	Springmaid Pier	*P. pseudodelicatissima*	N. A.	N. A.	N. A.
May 4, 2005	FRF Pier (Duck, NC)	*P. pseudodelicatissima*	N. A.	N. D.	N. D.
May 5, 2005	Oregon Inlet	*P. pseudodelicatissima*	N. A.	N. D.	N. D.
May 11, 2005	FRF Pier (Duck, NC)	*P. pseudodelicatissima*	N. A.	N. D.	N. D.
November 1, 2006	FRF Pier (Duck, NC)	*P. multiseries* *P. pungens* *P. pseudodelicatissima*	3,500 cells/mL	trace	N. A.
November 1, 2006	Oregon Inlet	*P. multiseries* *P. pungens* *P. pseudodelicatissima*	7,000 cells/mL	0.9 ng/L	9.6 ng/g
September 5, 2007	FRF Pier (Duck, NC)	*P. pungens*	N. A.	11.8 ng/L	62 ng/g
March 7, 2010	Oregon Inlet	*P. multiseries* *P. pungens*	2,000 cells/mL	45 ng/L	trace
June 7, 2010	Charleston Harbor	*P. multiseries* *P. pungens* *P. pseudodelicatissima*	N. A.	N. A.	N. A.

N. A. = Not Available   N. D. = Not Detected   trace = below detection limit of LC/MS

Harmful Algae 17 (2012) 6–13

Contents lists available at SciVerse ScienceDirect

Harmful Algae

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

Spatial and temporal trends of the toxic diatom *Pseudo-nitzschia* in the Southeastern Atlantic United States

Andrew J. Shuler [a], Jeffrey Paternoster [a], Matthew Brim [a], Kimberly Nowocin [a], Templeton Tisdale [b], Kathleen Neller [c], Julie A. Cahill [a,d], Tod A. Leighfield [a], Spencer Fire [a], Zhihong Wang [a], Steve Morton [a,*]

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[b] South Carolina State University, 300 College Street NE, Orangeburg SC 29117 USA
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Keywords:
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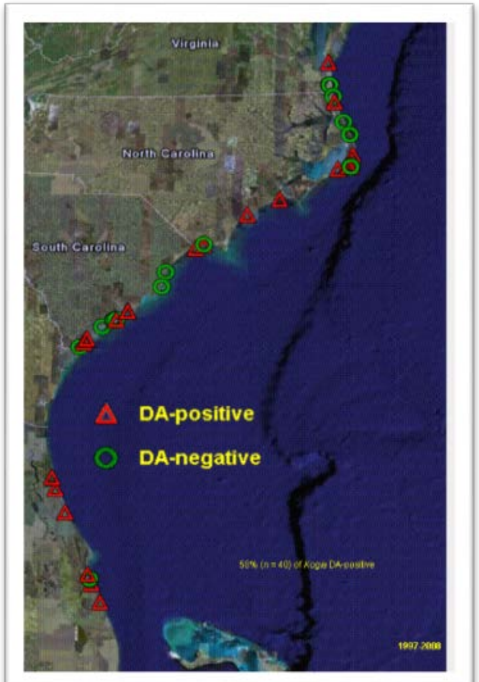
Southeast
Volunteer monitoring

ABSTRACT

Data collected by NOAA Phytoplankton Monitoring Network volunteers, from the beginning of the program (2001) through 2010, was used to assess the spatial and temporal trends of *Pseudo-nitzschia* spp. from North Carolina through northern Florida along the southeastern US coastline. *Pseudo-nitzschia* spp. was present from North Carolina to Florida, and was most common in North and South Carolina. Across the majority of the Atlantic southeast US, the highest rates of occurrence were observed in late summer, early fall, with most areas experiencing the lowest rate of occurrence in the spring. The Outer Banks of North Carolina, however, experienced a peak of occurrence in late winter to early spring in addition to a late summer, early fall peak. *Pseudo-nitzschia* was found in temperatures ranging from less than 5 °C to 35 °C and salinities from 5 to 37. Six unique bloom events were documented during this period of nine years, three of which contained detectable levels of domoic acid. The majority of these bloom events and all of the toxic events occurred in the Outer Banks of North Carolina. Given the extent and intensity of coverage afforded by the NOAA PMN, this program provides the optimal approach to not only assess past trends but to monitor environmental changes and emerging trends in the dynamics of this toxigenic species. Understanding the dynamics of this species allows resource managers to better predict the threats associated with domoic acid.

Kogia Mortality events



41 Samples from 1997-2008 tested for DA, 57% of the samples were DA positive

Harmful Algae 8 (2009) 658–664

Contents lists available at ScienceDirect

Harmful Algae

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

Domoic acid exposure in pygmy and dwarf sperm whales (*Kogia* spp.) from southeastern and mid-Atlantic U.S. waters☆

Spencer E. Fire[a,*], Zhihong Wang[a], Tod A. Leighfield[a], Steve L. Morton[a], Wayne E. McFee[a], William A. McLellan[b], R. Wayne Litaker[c], Patricia A. Tester[c], Aleta A. Hohn[c], Gretchen Lovewell[c], Craig Harms[d], David S. Rotstein[e], Susan G. Barco[f], Alex Costidis[g], Barbara Sheppard[g], Gregory D. Bossart[h], Megan Stolen[i], Wendy Noke Durden[i], Frances M. Van Dolah[a]

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[h] Marine Mammal Research and Conservation Program, Harbor Branch Oceanographic Institution, 5600 U.S. 1 North, Fort Pierce, FL 34946, USA

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Kogia
Phycotoxin
Pygmy sperm whale

ABSTRACT

The neurotoxin domoic acid (DA) was detected in urine and fecal samples recovered from pygmy sperm whales (*Kogia breviceps*) and dwarf sperm whales (*Kogia sima*) stranding along the U.S. Atlantic coast from 1997 to 2008. Of the 41 animals analyzed from Virginia, North Carolina, South Carolina and Florida, 24 (59%) tested positive for DA at concentrations of 0.4–1.8 ng/mL in urine and 12–13,566 ng/g in feces as determined by liquid chromatography–tandem mass spectrometry (LC–MS/MS). Feces appeared to be the best indicator of DA exposure in *Kogia* spp., with 87% of all fecal samples analyzed testing positive for this toxin. Additional stranded animals ($n = 40$) representing 11 other cetacean species were recovered from the same region between 2006 and 2008 and analyzed by LC–MS/MS, however DA was not detected in any of these individuals. DA is produced naturally by diatoms in the genus *Pseudo-nitzschia*. Although blooms of DA-producing *Pseudo-nitzschia* have been associated with repeated large-scale marine mammal mortalities on the west coast of the U.S., there is no documented history of similar blooms on the southeast U.S. coast, and there were no observed *Pseudo-nitzschia* blooms in the region associated with any of these strandings. The feeding habits of *Kogia* spp. are poorly documented; thus, the vector(s) for DA exposure to these deep-diving species remains to be identified. Toxin accumulation in these pelagic whale species may be an indication of cryptic harmful algal bloom activity in offshore areas not currently being monitored. This study highlights the need for a better understanding of the role of toxigenic algae in marine mammal morbidity and mortality globally.

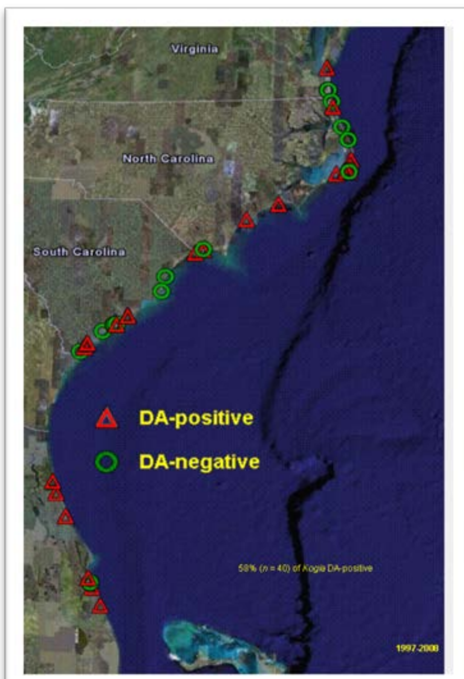
National Centers for Coastal Ocean Science

Science Serving Coastal Communities

Phytoplankton Monitoring Network

Phytoplankton Monitoring Network

Identifies First Recorded Bloom of a Toxic Pseudo-nitzschia species in North Carolina Waters

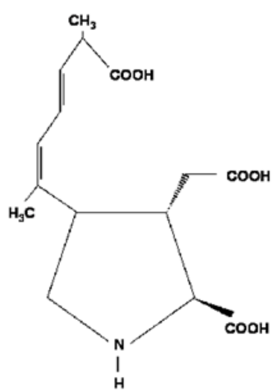


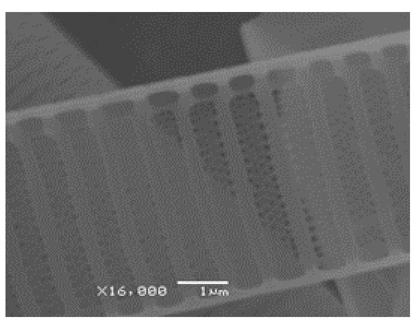
Provides Window to Research & Response

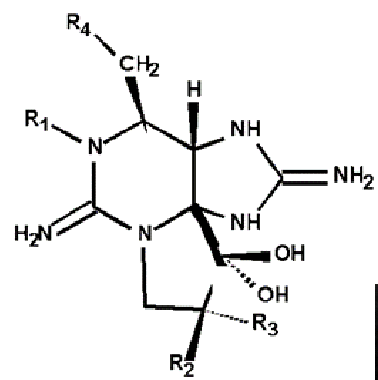
First time Identification of Domoic Acid in Marine Mammals in Southeastern U.S Waters

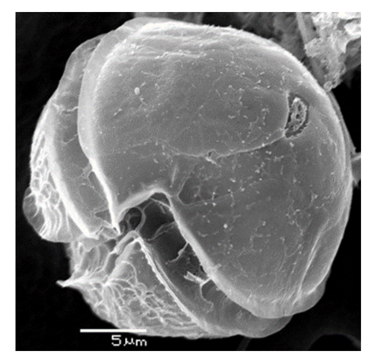
Case Studies

- *Pseudo-nitzshia* in Southeast
  - Diatom that produces the toxin, Domoic acid
- *Alexandrium* in Alaska
  - Dinoflagellate that produces the toxin, Saxitoxin



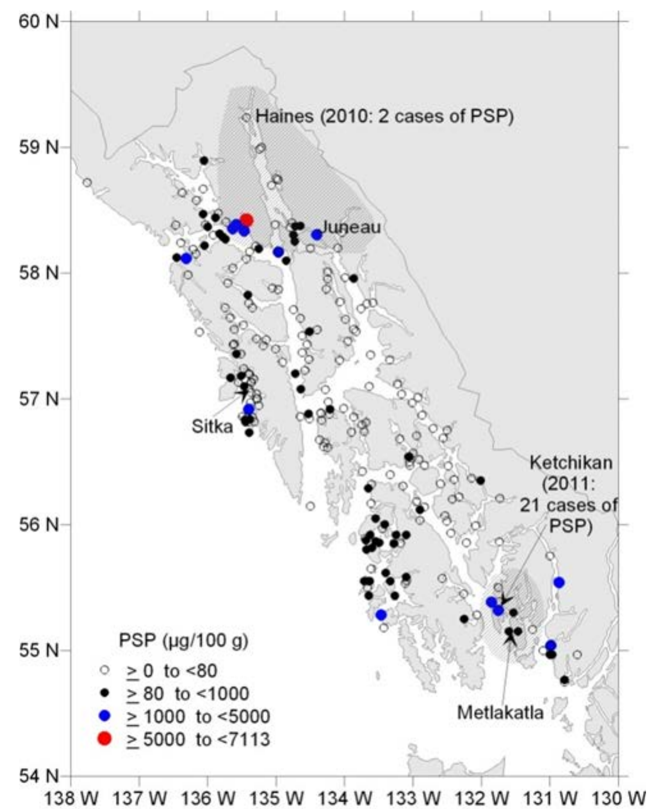






Alexandrium in Alaska—Southeast Alaska Tribal Ocean Research

- Subsistence user groups play toxin roulette when harvesting bivalves in Alaska.
- Coastal Alaskan Native populations are 12 times more likely to be affected by PSP than the Caucasian community because of the greater use of subsistence foods.

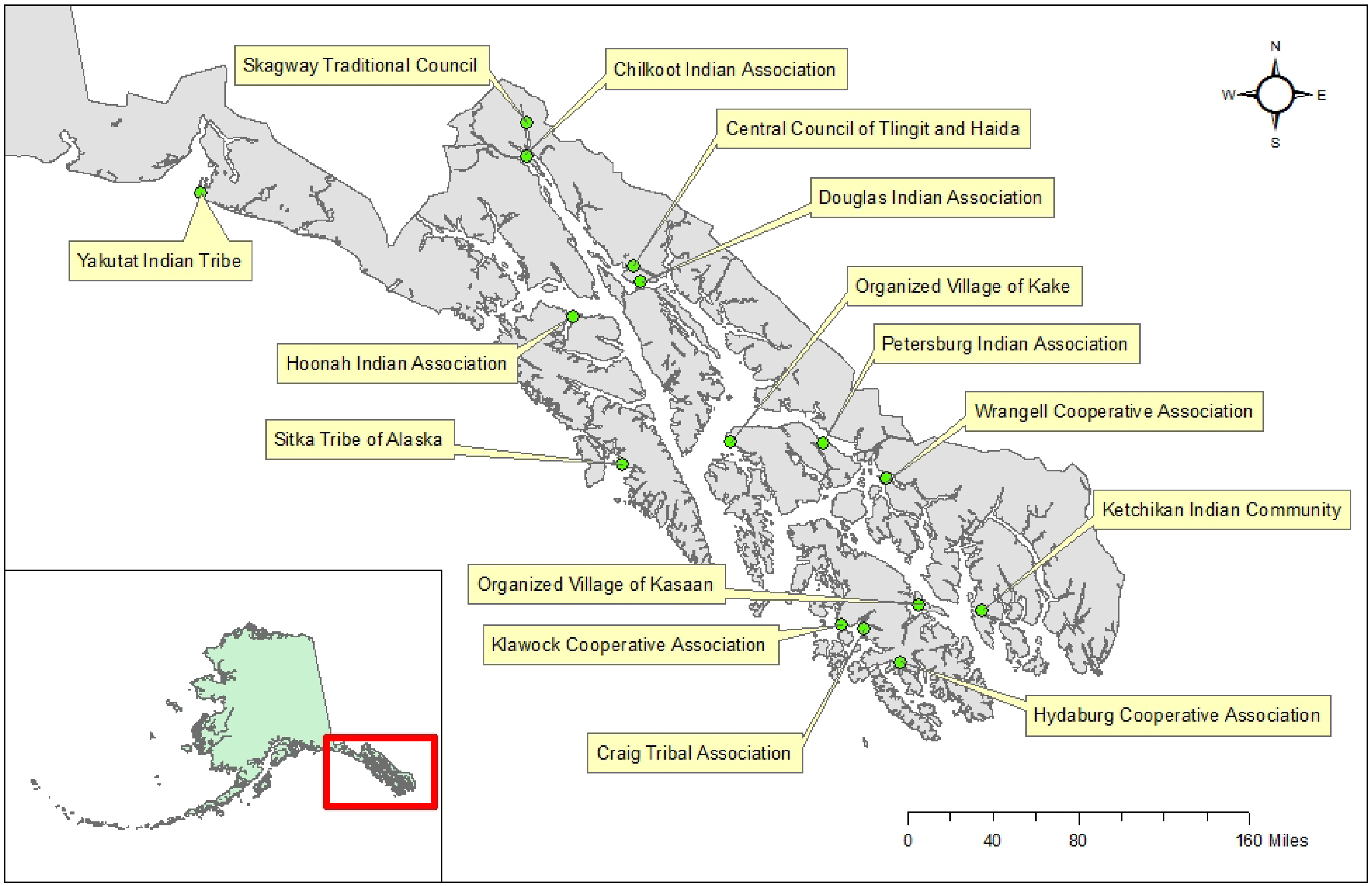


Partnership overview

- Arose from a common concern about subsistence resources
  - e.g. Butter clam (*Saxidomus gigantea*)
- No assistance from AK state agencies
- Sitka Tribe (STA) reached out to other SE tribes
- Created SEATOR in Sept 2013
- Build tribal capacity for monitoring toxic algal blooms

Southeast Tribal Partners

Southeast Alaska Tribal Toxins (SEATT) Partner Locations



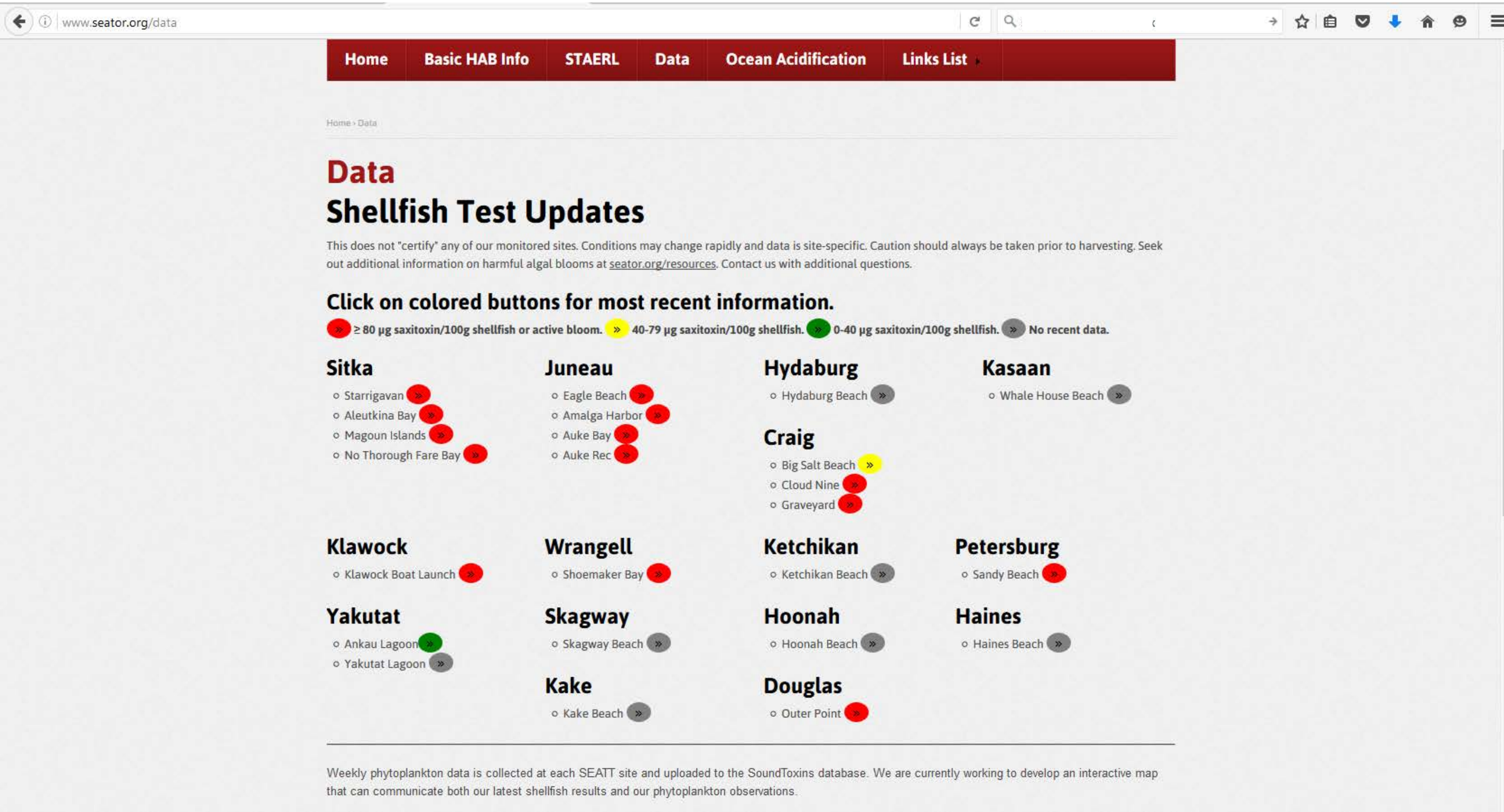
What Does Monitoring Look Like?

SEATOR
Culture
Science
Efficiency
Southeast Alaska Tribal Ocean Research

STA Toxin Analysis Lab

- Conduct regulatory sampling for SEATT partners
  - STX by RBA
  - DA by ELISA
- Ability for Tribes to establish their own subsistence shellfish management plans based on sampling data
- Possibility to incorporate other needs that Tribes may have (e.g. ocean acidification)

Data Accessibility



www.seator.org/data

Home | Basic HAB Info | STAERL | Data | Ocean Acidification | Links List

Home › Data

Data

Shellfish Test Updates

This does not "certify" any of our monitored sites. Conditions may change rapidly and data is site-specific. Caution should always be taken prior to harvesting. Seek out additional information on harmful algal blooms at seator.org/resources. Contact us with additional questions.

Click on colored buttons for most recent information.

» ≥ 80 µg saxitoxin/100g shellfish or active bloom. » 40-79 µg saxitoxin/100g shellfish. » 0-40 µg saxitoxin/100g shellfish. » No recent data.

Sitka
- Starrigavan »
- Aleutkina Bay »
- Magoun Islands »
- No Thorough Fare Bay »

Juneau
- Eagle Beach »
- Amalga Harbor »
- Auke Bay »
- Auke Rec »

Hydaburg
- Hydaburg Beach »

Craig
- Big Salt Beach »
- Cloud Nine »
- Graveyard »

Kasaan
- Whale House Beach »

Klawock
- Klawock Boat Launch »

Wrangell
- Shoemaker Bay »

Ketchikan
- Ketchikan Beach »

Petersburg
- Sandy Beach »

Yakutat
- Ankau Lagoon »
- Yakutat Lagoon »

Skagway
- Skagway Beach »

Hoonah
- Hoonah Beach »

Haines
- Haines Beach »

Kake
- Kake Beach »

Douglas
- Outer Point »

Weekly phytoplankton data is collected at each SEATT site and uploaded to the SoundToxins database. We are currently working to develop an interactive map that can communicate both our latest shellfish results and our phytoplankton observations.

Communication

PUBLIC SERVICE ANNOUNCEMENT

Recent **blue mussel** and **cockle** samples collected on **4/9/19** from Seaport Beach in **Ketchikan** have **elevated and increasing** amounts of paralytic shellfish toxins above the FDA regulatory limit of 80µg/100g. **Butter clam** samples collected on **4/9/19** from Seaport Beach in **Ketchikan** have **highly elevated** amounts of paralytic shellfish toxins above the FDA regulatory limit of 80µg/100g. These samples indicate an active bloom in the Ketchikan area, and harvesting shellfish is not recommended at this time.

Ongoing shellfish advisories are currently in place in several areas across Southeast Alaska. Updates are available on the Southeast Alaska Tribal Ocean Research website (SEATOR.org).

Samples are analyzed by The Sitka Tribe of Alaska Environmental Research Lab (STAERL). Contact SEATOR with additional questions at (907)-966-9650 or seator@sitkatribe-nsn.gov.

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

During summer 2017, lethal PSP toxin concentrations were observed. Alerts posted to the tribal communities participating in the SEATOR program contributed to lack of deaths or illness. In the first 18 months of operation, greater than 100 positive samples have been identified.

How you can get involved

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https://coastalscience.noaa.gov/research/stressor-impacts-mitigation/pmn/

Special Thanks