Review requirements for research and development in NOAA

Jawed Hameedi

NCCOS HAB and Hypoxia Portfolio Review

Silver Spring, MD

26-28 February 2018

Key steps in managing NOAA's research and development portfolio: planning, execution/monitoring, evaluation, and reporting (Procedural Handbook, NAO 216-115A, draft 2017)

R&D Evaluations in NOAA (modified from Procedural Handbook, NAO 216-115A, draft 2017)

Evaluation	What to evaluate	Purpose	Who conducts evaluation	Criteria	Relative to which plan	How often?
Periodic	LO/Goal – FY program execution	Assess state of program execution relative to plans	NEC/NEP	Budget, performance, outcomes	IP or AOP	Yearly or more often
Program / Laboratory / Science Center	Entities conducting or funding R&D	Evaluate program (or an aspect of the program) design, effectiveness, and outcomes	Independent Review Panel	Quality, Relevance and Performance	Program plan, objectives, and intended outcomes	Every five years
R&D Progress-to-Plan	NOAA R&D enterprise	Evaluate priorities and targets in R&D portfolio	NOAA Research Council	Quality, Relevance. Performance, and balance	NOAA R&D Plan	Every two years
Portfolio	NOAA R&D enterprise	Evaluate portfolio relative to agency strategic plans and inform subsequent strategies	NOAA Research Council	Relevance, Performance, and balance	NOAA R&D Plan, agency strategic plans	Every four years
ad hoc	Variable	Address specific topics or science themes	NOAA Research Council	Variable	Variable	As needed

External, peer-review of a program is intended to:

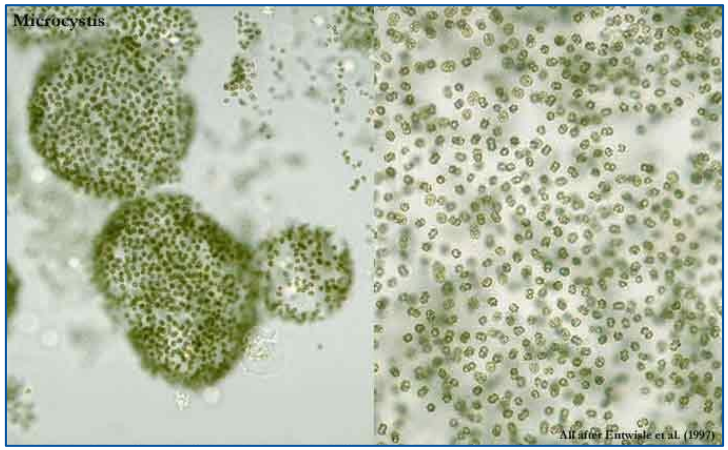
- Provide feedback on both program design and execution
- Ensure consistent standards of excellence in its research and development (R&D) portfolio
- Encourage innovation and collaborative approaches to meet the program goals and objectives
- Evaluate for stakeholders the outcomes of NOAA research, development and transition
- Highlight direction for future R&D activities

Core Evaluation Criteria (NAO 216-115A, and briefly described in the document “Guidance and Charge to Reviewers”)

- Quality
- Relevance
- Performance

Epilog

- The term "NOAA R&D Portfolio" includes the full range of R&D activities undertaken by NOAA and for NOAA.
- Portfolio: A set of investments that yield benefits, have costs and associated risks. Through management of a portfolio, NOAA can explicitly assess the tradeoffs among competing investment opportunities in terms of their benefits, costs, and risks (NAO 216-111).
- ***Your evaluation and recommendations will be a critical factor as we look for new priorities and tradeoffs!***

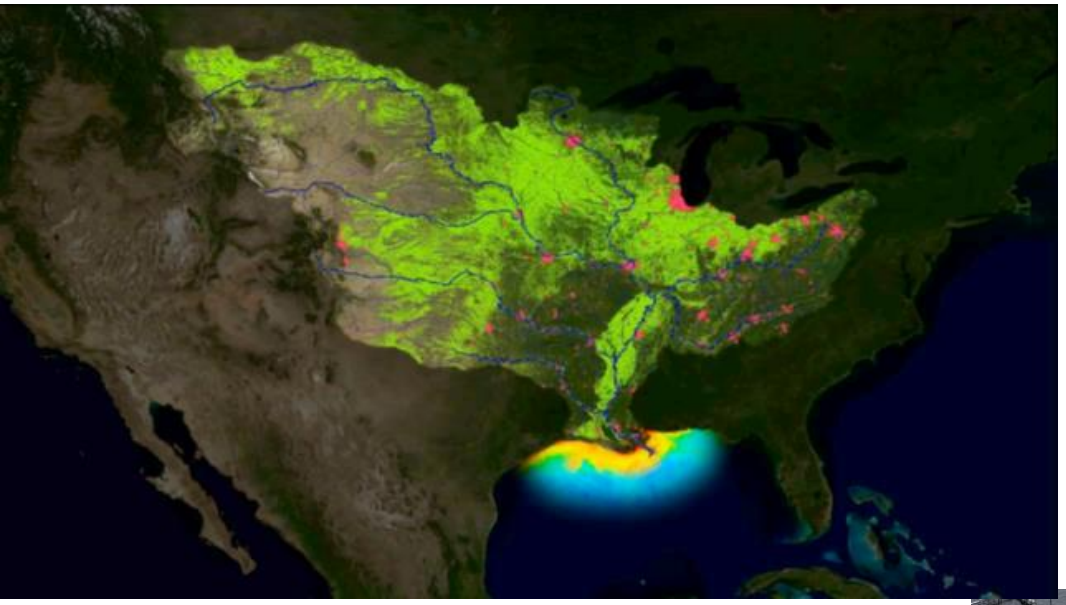


Overview of NCCOS HAB and Hypoxia Portfolio

Steve Thur, Ph.D.

Director

NOAA National Centers for Coastal Ocean Science



Presentation outline

- NCCOS mission and strategic direction
- HABHRCA overview
- Ecoforecasting
- Charge to reviewers

Photo credits: NOAA, Treasure Coast Palm newspaper, Toledo Blade, Toledo Blade

VISION

Science serving coastal communities

MISSION

The National Centers for Coastal Ocean Science delivers ecosystem science solutions

~ for stewardship of the Nation's ocean and coastal resources

~ in direct support of NOS priorities, offices, and customers

~ to sustain thriving coastal communities and economies

"Advancing Coastal Science", NCCOS strategic document

Congress of the United States
Washington, DC 20515

January 17, 2017

President-Elect Donald Trump
Trump Tower
725 Fifth Avenue
New York, NY 10022

Dear President-Elect Trump,

We respectfully request that you allocate robust funding in the Fiscal Year 2018 budget request for programs that address an increasing problem around the country: harmful algal blooms (HABs). These naturally occurring phenomena are increasing in regularity, severity, and toxicity across the country, but unfortunately our understanding of when and where and with what intensity they will occur remains inadequate. We strongly support investments in science and research to increase our capacity to accurately forecast HABs and to improve our understanding of their impacts on human health. The benefits of being able to accurately forecast HABs include protecting economic

HABs occur in all 50
Americans. Some re
with the so-called alg
summer of 2015, shu
communities tens of
Lee, and Palm Beach
blooms, which led ov
would vacation elsew
days for over 400,000
detected in the munic

While federal agenci
of their occurrences a
the Environmental Pr
Oceanic and Atmospl
lakes nationwide, 39
nationally representat
revealed that toxins v
results are alarming,
the detection method
discover the various t

To make tangible pro
human health and ou
response in this year'

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HABHRCA

115TH CONGRESS
1ST SESSION

S. 1057

AN ACT

To amend the Harmful Algal Bloom and Hypoxia Research and Control Act of 1998 to address harmful algal blooms, and for other purposes.

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

SECTION 1. SHORT TITLE.

This Act may be cited as the "Harmful Algal Bloom and Hypoxia Research and Control Amendments Act of 2017".

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

Except as otherwise expressly provided, wherever in this Act an amendment or repeal is expressed in terms of an amendment to, or repeal of, a section or other provision, the reference shall be considered to be made to a section or other provision of the Harmful Algal Bloom and Hypoxia Research and Control Act of 1998 (33 U.S.C. 4001 et seq.).

SEC. 3. INTER-AGENCY TASK FORCE.

Section 603(a) (33 U.S.C. 4001(a)) is amended—

(1) in paragraph (12), by striking "and" at the end;

(2) by redesignating paragraph (13) as paragraph (14); and

(3) by inserting after paragraph (12) the following:

"(13) the Army Corps of Engineers; and".

SEC. 4. SCIENTIFIC ASSESSMENTS OF FRESHWATER HARMFUL ALGAL BLOOMS.

Section 603 (33 U.S.C. 4001) is amended—

(1) by striking subsection (f);

(2) by redesignating subsections (g), (h), (i), and (j) as subsections (f), (g), (h), and (i), respectively; and

(3) by amending subsection (g) to read as follows:

"(g) SCIENTIFIC ASSESSMENTS OF MARINE AND FRESHWATER HARMFUL ALGAL BLOOMS.—Not less than once every 5 years the Task Force shall complete and submit to Congress a scientific assessment of harmful algal blooms in United States coastal waters and freshwater systems. Each assessment shall examine both marine and freshwater harmful algal blooms, including those in the Great Lakes and upper reaches of estuaries, those in freshwater lakes and rivers, and those that originate in freshwater lakes or rivers and migrate to coastal waters.".

SEC. 5. NATIONAL HARMFUL ALGAL BLOOM AND HYPOXIA PROGRAM.

(a) PROGRAM DUTIES.—Section 603A(e) (33 U.S.C. 4002(e)) is amended—

(1) in paragraph (1), by inserting ", including to local and regional stakeholders through the establishment and maintenance of a publicly accessible Internet website that provides information as to Program activities completed under this section" after "Program";

Miles of Algae Covering Lake Erie

By JUGAL K. PATEL and YULIYA PARSHINA-KOTTAS OCT. 3, 2017

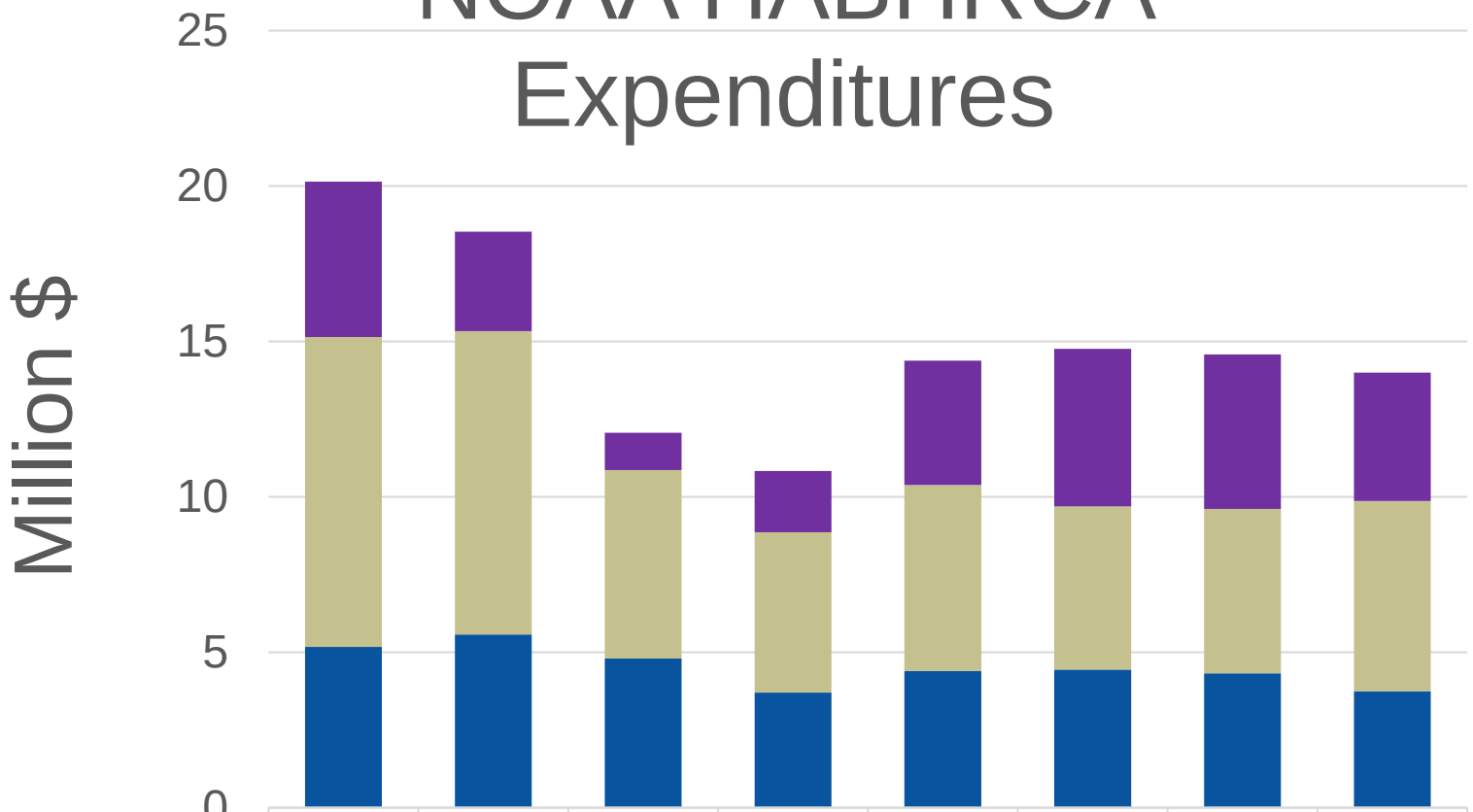
A potentially harmful algae bloom covered more than 700 square miles in the western basin of Lake Erie last week, turning the lake bright green and alarming residents and local officials.

Scientists say that algae blooms have been a growing problem for Lake Erie since the 2000s, mostly because of the extensive use of fertilizer on the region's farmland.

The algae blooms contain cyanobacteria, which, under certain conditions, can produce toxins that contaminate drinking water and cause harm to the local ecosystem.

During last week's bloom, the amount of toxins in the algae remained low at the intake points where towns draw water

NOAA HABHRCA Expenditures



	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
Other NOAA	5.00	3.20	1.20	1.97	4.00	5.07	4.97	4.13
NCCOS External	9.97	9.76	6.06	5.16	5.98	5.25	5.29	6.12
NCCOS Internal	5.17	5.57	4.80	3.70	4.40	4.44	4.32	3.75

Pacific Northwest

HAB risk key:

JISAO | School of Oceanography, University of Washington | ORHAB Partnership

The statements, findings, conclusions, and recommendations do not necessarily reflect the views of NOAA or the Department of Commerce.

Lake Erie Harmful Algal Bloom Bulletin

21 September, 2017, Bulletin 21

The *Microcystis* cyanobacteria bloom continues in the western basin from Maumee Bay east into the central basin, and extending north towards the Ontario coast. Observed winds since Monday (9/18-21) caused an increase in surface concentrations. Scums were visible extending from Maumee Bay northeast to the Ontario coast. Measured toxin concentrations are below recreational thresholds throughout most of the bloom extent, but concentrations can exceed the threshold within Maumee Bay and west of the Islands where the bloom is most dense (appearing green from a boat).

Forecast winds (2-7 kn) today through Sunday (9/21-24) may increase the potential for scum formation and northerly transport of remaining *Microcystis* concentrations. The water temperature is approaching or below 68˚F (20˚C) throughout the western basin, limiting the growth of *Microcystis* concentrations.

Please check Ohio EPA's site on harmful algal blooms for safety information: http://epa.ohio.gov/habalgae.aspx. Keep your pets and yourself out of the water in areas where scum is forming. NOAA's GLERL provide https://www.glerl.noaa.gov/res/HABs_and_Hypoxia. The persistent cyanobacte

The images below are "GeoPDF". To see the longitude and latitude under your

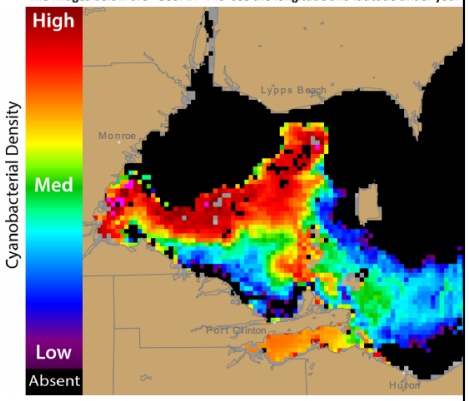


Figure 1. Cyanobacterial Index from NASA MODIS-Terra & Aqua data collected 2 missing data. The estimated threshold for cyanobacteria detection is 20,000 cells/

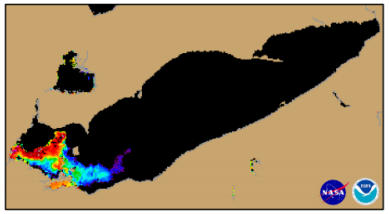
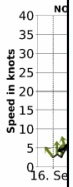


Figure 2. Cyanobacterial Index from NASA MODIS-Terra & Aqua data collected 20 September, 2017 at 12:20.



Wind spee the water c

NOAA COMMUNICATIONS

UNITED STATES DEPARTMENT OF COMMERCE

NOAA awards $1.7 million for harmful algal bloom research to protect public health from toxins in shellfish

Multi-year awards to focus on bloom prevention in seven states

Contact
Keeley Belva, Keeley.Belva@noaa.gov, 301-713-3066
Kathleen Goggin, kathleen.goggin@noaa.gov, 301-713-3066

September 19, 2017

NOAA has announced nine research grants will go to organizations around the country seeking to better understand and measure the toxicity of harmful algal blooms, known as HABs.

In the first year, $1.68 million will fund research for projects in Alaska, California, Florida, Maine, Maryland, Ohio and Virginia. The grants are administered by NOAA's National Centers for Coastal Ocean Science.

NOAA funding enhances state and regional monitoring with advanced harmful algae detection capabilities, including shellfish toxin tests. (Credit: Washington State Department of Ecology Marine Monitoring Unit)

Charge to reviewers: Review consideration criteria

Quality
Relevance
Performance

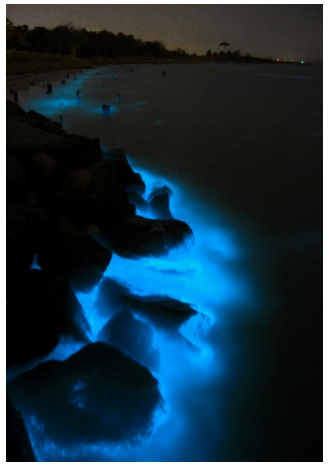
Charge to reviewers, cont.

Steven.Thur@noaa.gov

Ecology and Oceanography of Harmful Algal Blooms (ECOHAB)

Quay Dortch

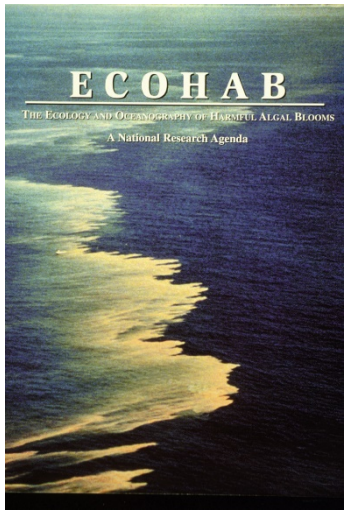
Program Manager



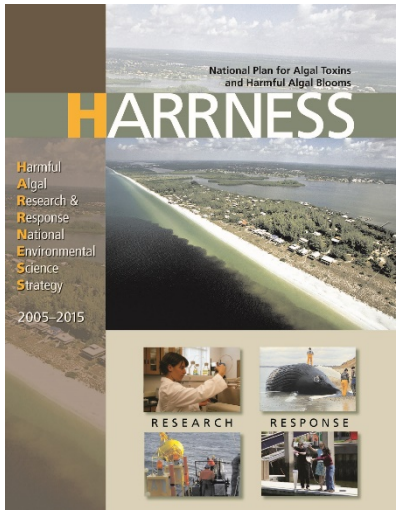
COMPETITIVE RESEARCH PROGRAM
NATIONAL CENTERS FOR COASTAL OCEAN SCIENCE

ECOHAB History

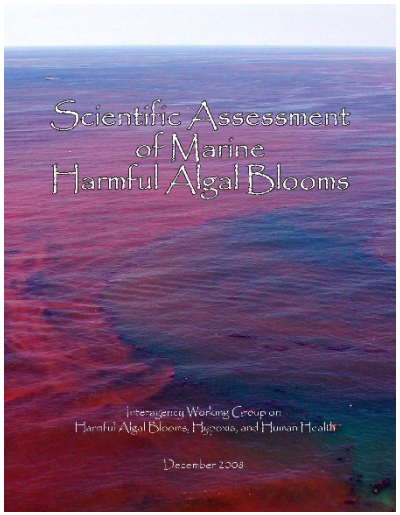
- **Community & HABHRCA Plans & Reports**



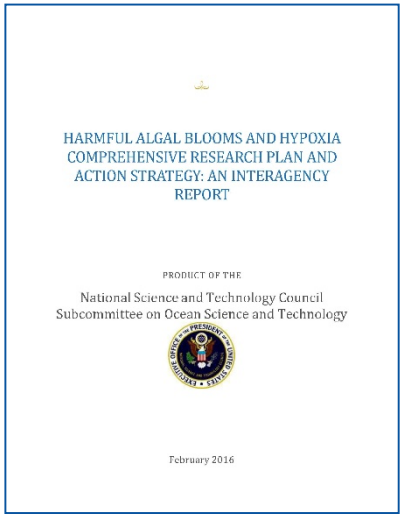
1995



2005



2008

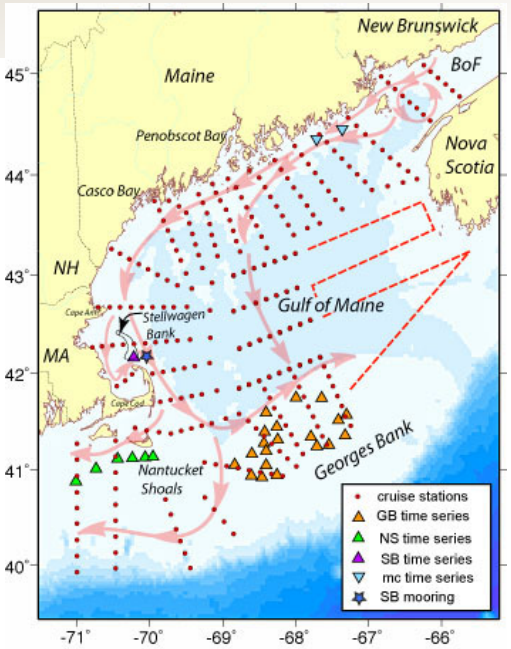


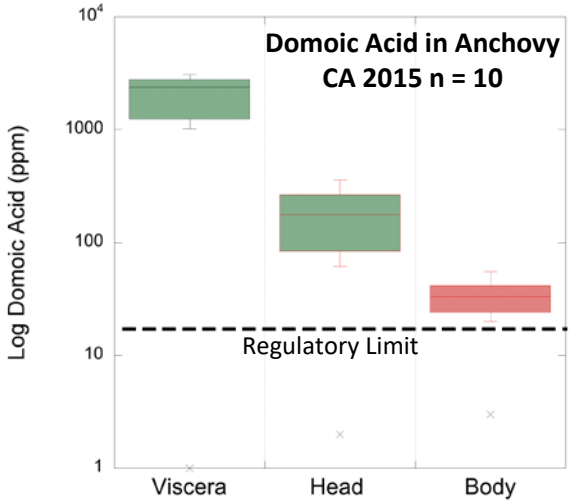
2016

- **1997 First competition**
- **1998, 2004, 2014 Authorized by HABHRCA**
- **2009 Federal Register Notice FRN describing program & regional rotation**

ECOHAB Goals

- **Understanding HABs & their toxins in relation to the surrounding environment**
- **Understanding trophic transfer and impacts of toxins on higher trophic levels**





ECOHAB Goals

- **Understanding HABs & their toxins in relation to the surrounding environment**
- **Understanding trophic transfer & impacts of toxins on higher trophic levels**

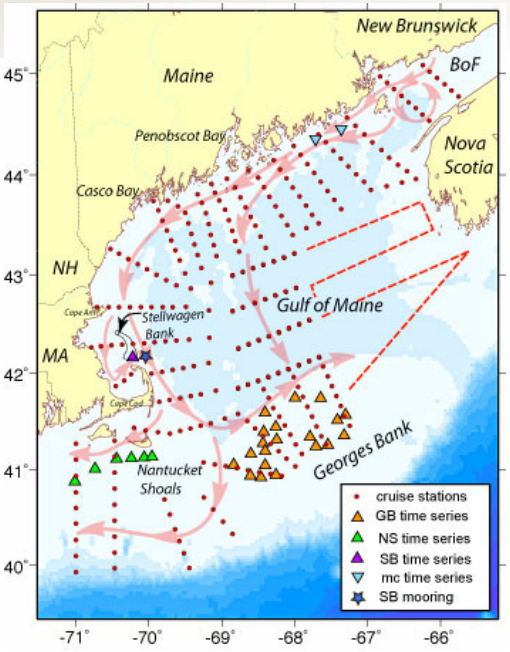
with the intent of developing new information & tools,

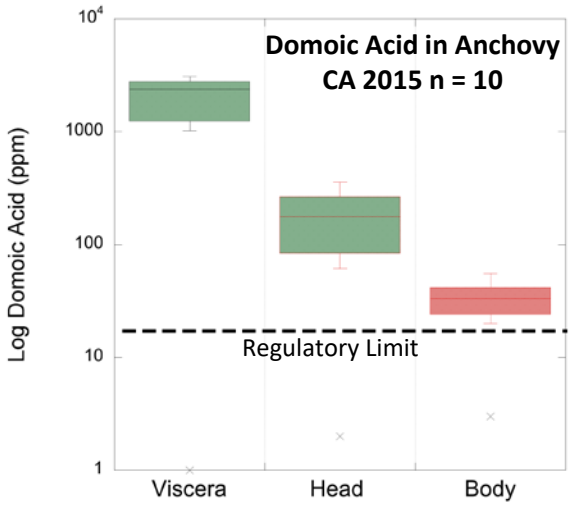
predictive models & forecasts,

& prevention strategies

<u>to aid managers</u>

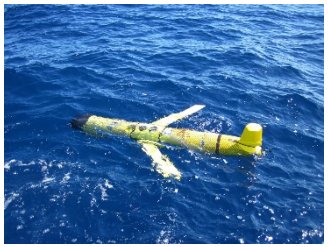
<u>in coastal environments</u>





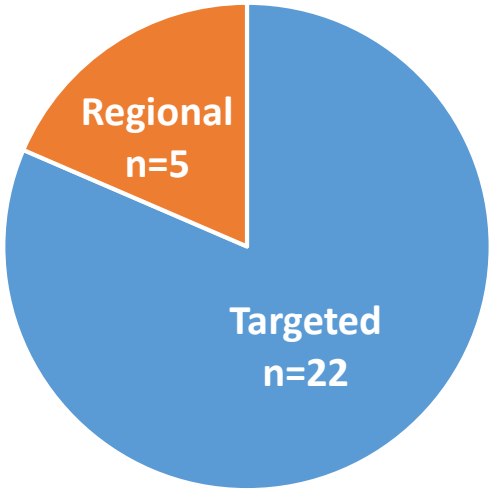
ECOHAB Topics (from 2017 FFO)

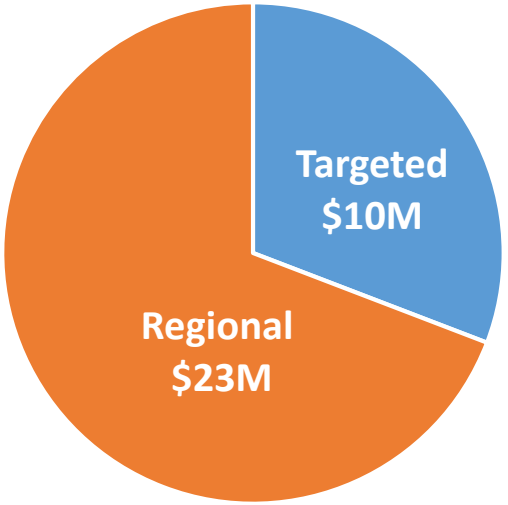
- **Factors controlling growth & toxicity, focusing on genetics, physiology, & toxin production**
- **Community ecology & ecosystem dynamics, including top-down & bottom-up control**
- **Biosynthetic pathways & metabolism of toxins**
- **Trophic transfer of toxins within food webs & impacts of toxins on individual organisms & food webs**
- **Effects of environmental changes, such as eutrophication, ocean acidification &/or climate change**



Types of Projects 2012-2017

- **Regional**
  - 3-5 yrs ~$5M field project
  - Large multi-disciplinary, team of investigators
  - Ecosystem approach
  - Develop predictive models
  - Share information and research products with end-users or include end-users
- **Targeted**
  - 3 yr ~$0.75M lab or field project
  - Individual investigators or small interdisciplinary efforts
  - Answer fundamental ecological & oceanographic questions related to HAB events



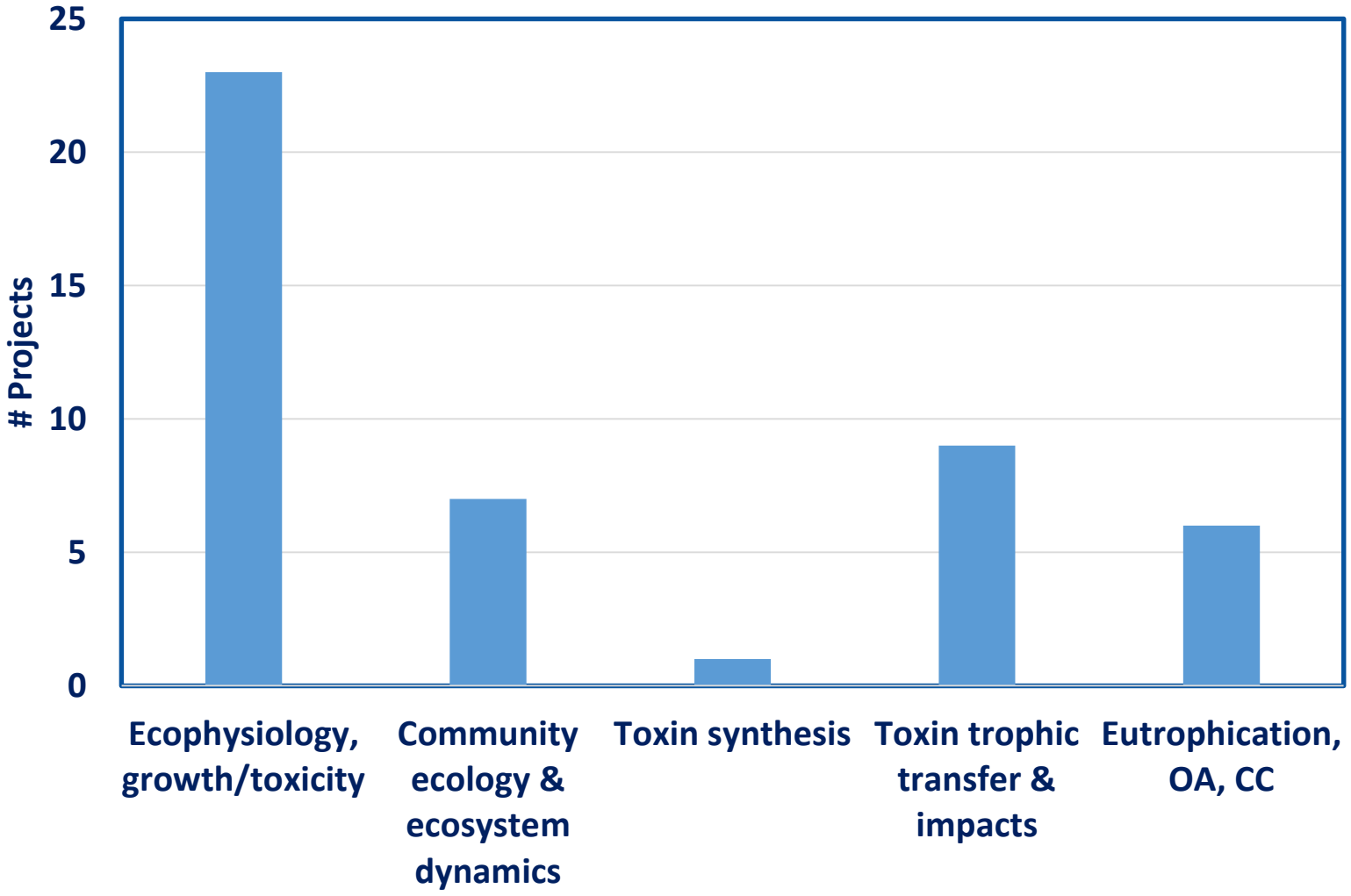


ECOHAB Time Line Competitions

Year	Focus	LOI*		# Proposals		# Funded Projects		% Success
		T*	R*	T*	R*	T*	R*	
2006	National	na	na	57	6	5.5 NOAA 3.5 EPA	2 NOAA	17%
2008	National	na	na	79	2	6 NOAA 2 NASA	0.5 NOAA 0.5 NSF	11%
2010	Regional: West Coast, AK, Great Lakes	18	2	24	2	3	0/1	15%
2011	Regional: GOMEX, Carib/Pac Is	46	3	31	2	2	1	9%
2012	Regional: East Coast	44	0	40	0	0	0	0%
2015	Regional: East Coast	39	3	32	2	4	0	12%
2017	National	na	na	38	na	7	na	18%

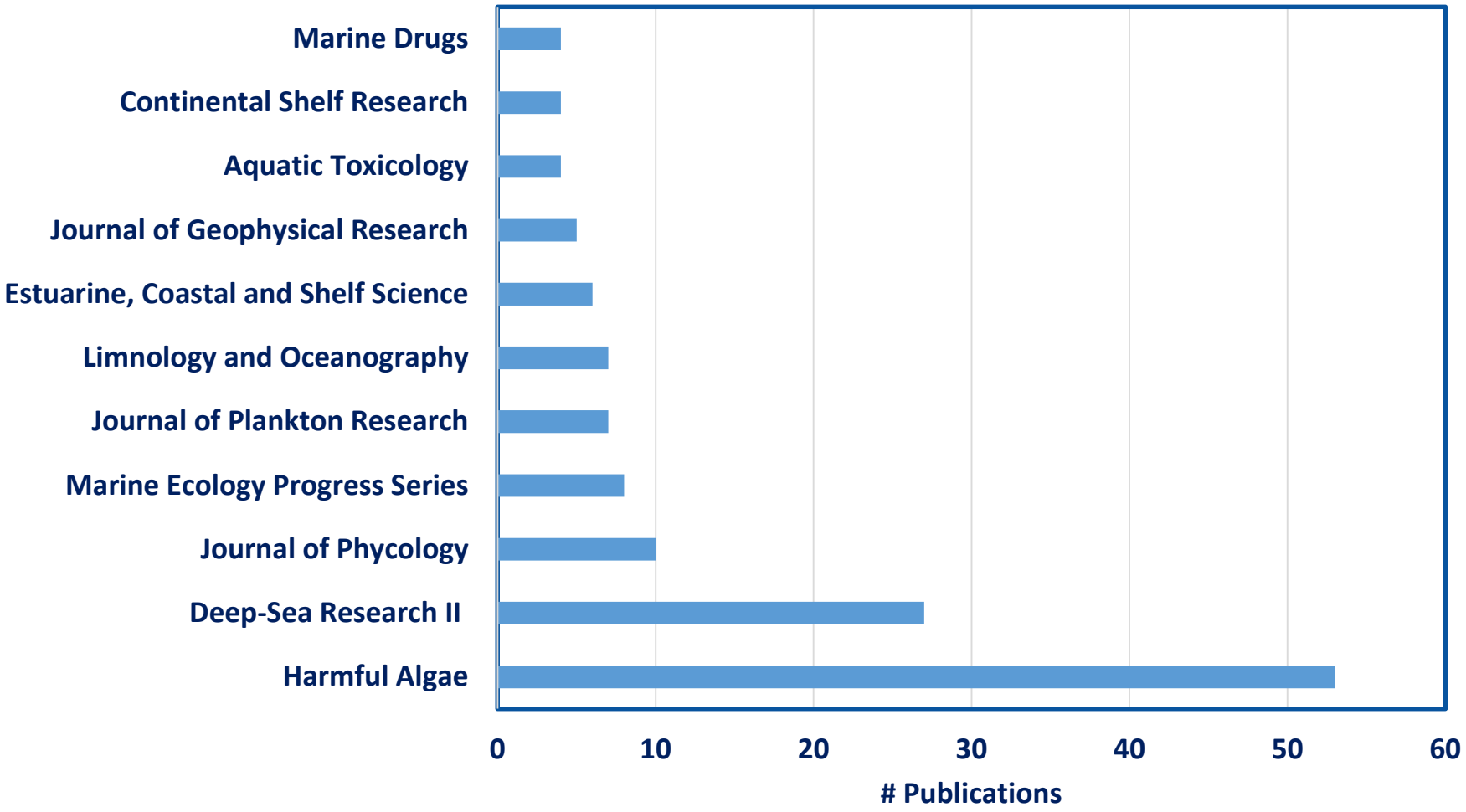
*LOI=Letter of Intent T=Targeted
R=Regional

Projects Funded: 27 projects $33M



ECOHAB Publications 2012-2017

Peer Reviewed Journal = 185 Other = 36



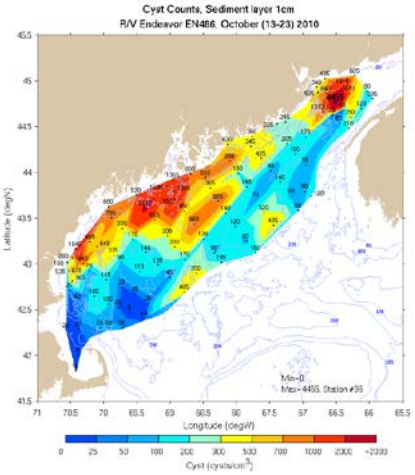
ECOHAB Publications

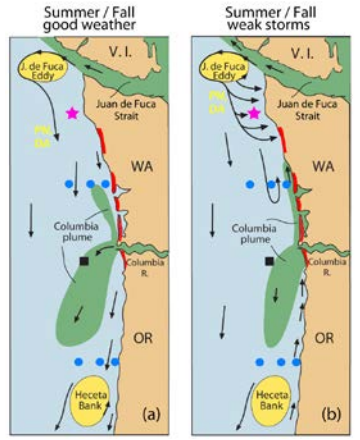
3 special journal issues from regional projects

- **2014 Harmful Algae in the Gulf of Maine: Oceanography, Population Dynamics, and Toxin Transfer in the Food Web**
  - Deep Sea Research II
  - DM Anderson, DJ McGillicuddy, SL DeGrasse, KG Sellner, VM Bricelj, JT Turner, DW Townsend, JL Kleindinst
- **2014 Nutrient dynamics of *Karenia brevis* red tide blooms in the eastern Gulf of Mexico**
  - Harmful Algae
  - JM O'Neil, CA Heil
- **2016 Tracking the fate of anthropogenic inputs and effects on coastal ecosystem dynamics during a wastewater diversion on the Southern California Bight coastal shelf**
  - Estuarine Coastal Shelf Science
  - MDA Howard, RM Kudela, K McLaughlin

ECOHAB Progress
Understanding HAB Growth & Toxicity

- **Forecasts: Various purposes & stages of research to transition to operations**
  - *Alexandrium* Gulf of Maine
  - *Pseudo-nitzschia* California
  - *Pseudo-nitzschia* Washington Coast
  - *Alexandrium* Puget Sound (climate)
  - *Karenia* Texas
  - *Karenia* Florida
  - *Procentrum* & *Karlodinium* Chesapeake Bay
  - *Microcystis* toxins Lake Erie
  - *Gambierdiscus* Greater Caribbean

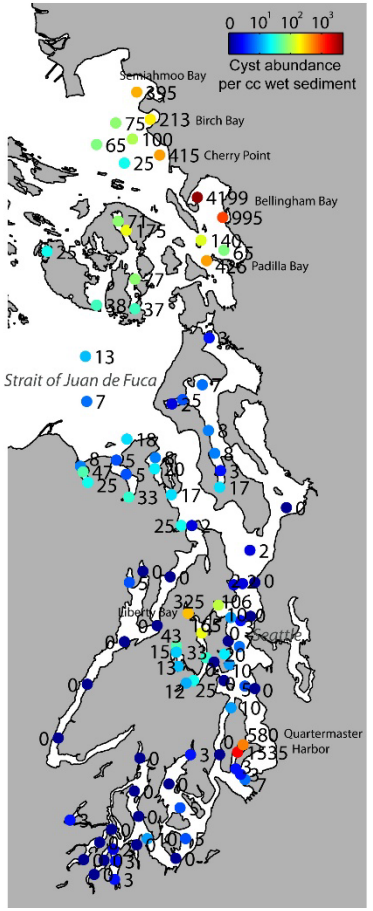




ECOHAB Progress
Understanding HAB Growth & Toxicity 2

- **Developed ecogenomic approach for assessing causes of Long Island Brown Tide**
- **Located *Alexandrium* cyst beds in Puget Sound to track spread of blooms in partnership with shellfish industry**
- ***Gambierdiscus* super-bugs ID'd & conditions promoting growth established**
- **Environmental conditions leading to *Heterosigma* growth and fish-killing toxicity determined**
- **Determined nitrogen growth kinetics in *Alexandrium* for use in models**

2011 Winter Puget Sound
Alexandrium Cyst Map



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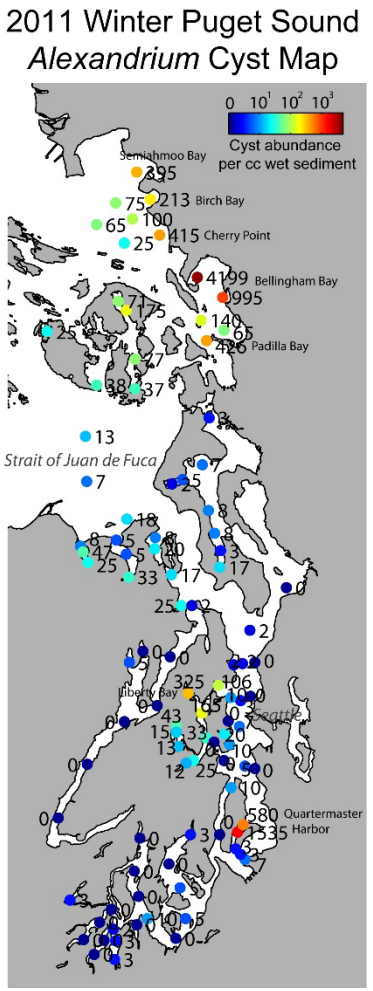
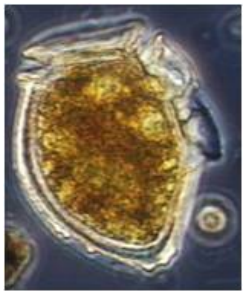
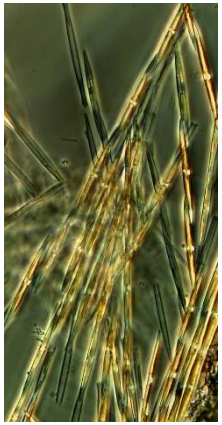
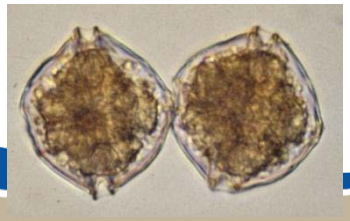


ECOHAB Progress
Understanding HAB Growth & Toxicity 3

- Gulf of Maine *PN* data provided warning of emerging issue before management response needed
- Many sources for nutrients causing *Karenia* blooms on W. FL shelf—surface runoff not primary cause
- Opened up Georges Bank to shellfish harvesting; approach a model for other situations
- Enabled immediate response to 2015 West coast *PN* bloom
- N/Si ratios determine *PN* toxicity—needs to be included in models
- Tested link between programmed cell death and cyst formation in *Alexandrium*







ECOHAB Progress
Understanding HAB Growth & Toxicity 3

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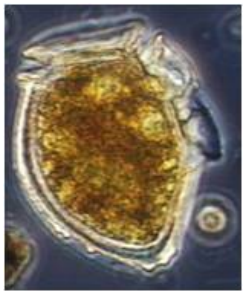
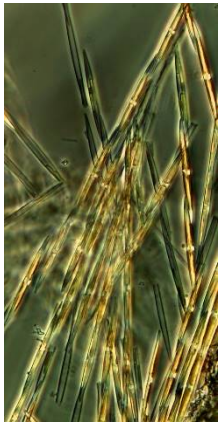
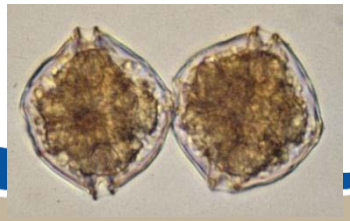
- N/Si ratios determine *PN* toxicity—needs to be included in models
- Tested link between programmed cell death and cyst formation in *Alexandrium*







ECOHAB Progress—Toxins and Impacts on Higher Trophic Levels

- Brevetoxin impacts on turtles & treatment
- Goniodomin A impact and accumulation in oysters, crabs, finfish
- Paralytic Shellfish Toxin (PST) accumulation in zooplankton and shellfish in Gulf of Maine & Georges Bank
- Mechanism of PST accumulation in geoducks
- Ciguatoxin accumulation & biotransformation in finfish
- Effect of climate change on HAB toxicity & nutritional quality and impact on micro- & mesozooplankton grazers
- Identify gene expression patterns in LIBT that indicate defense against predation
- Antibody to DA in fish and marine mammals that indicates low level exposure

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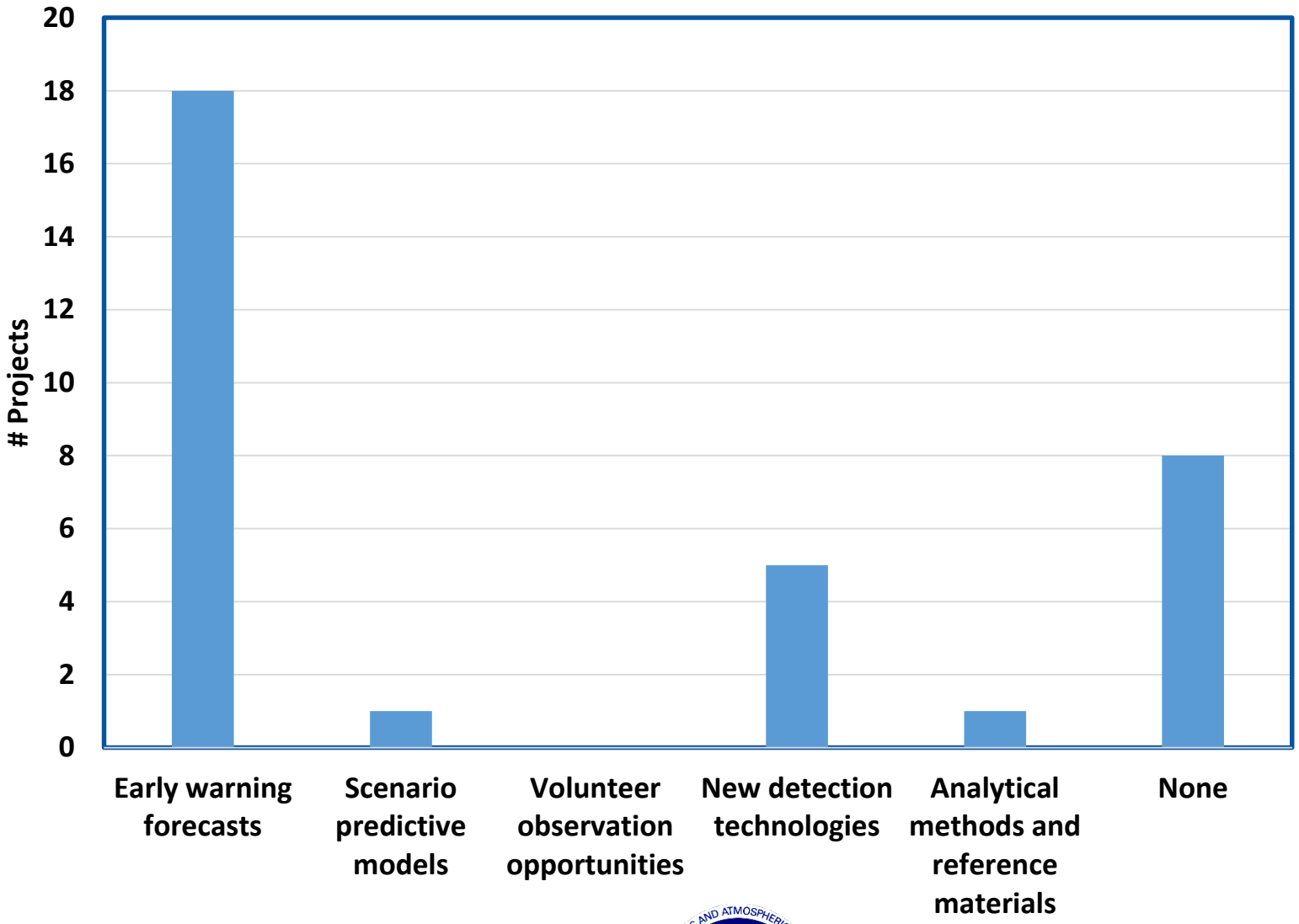
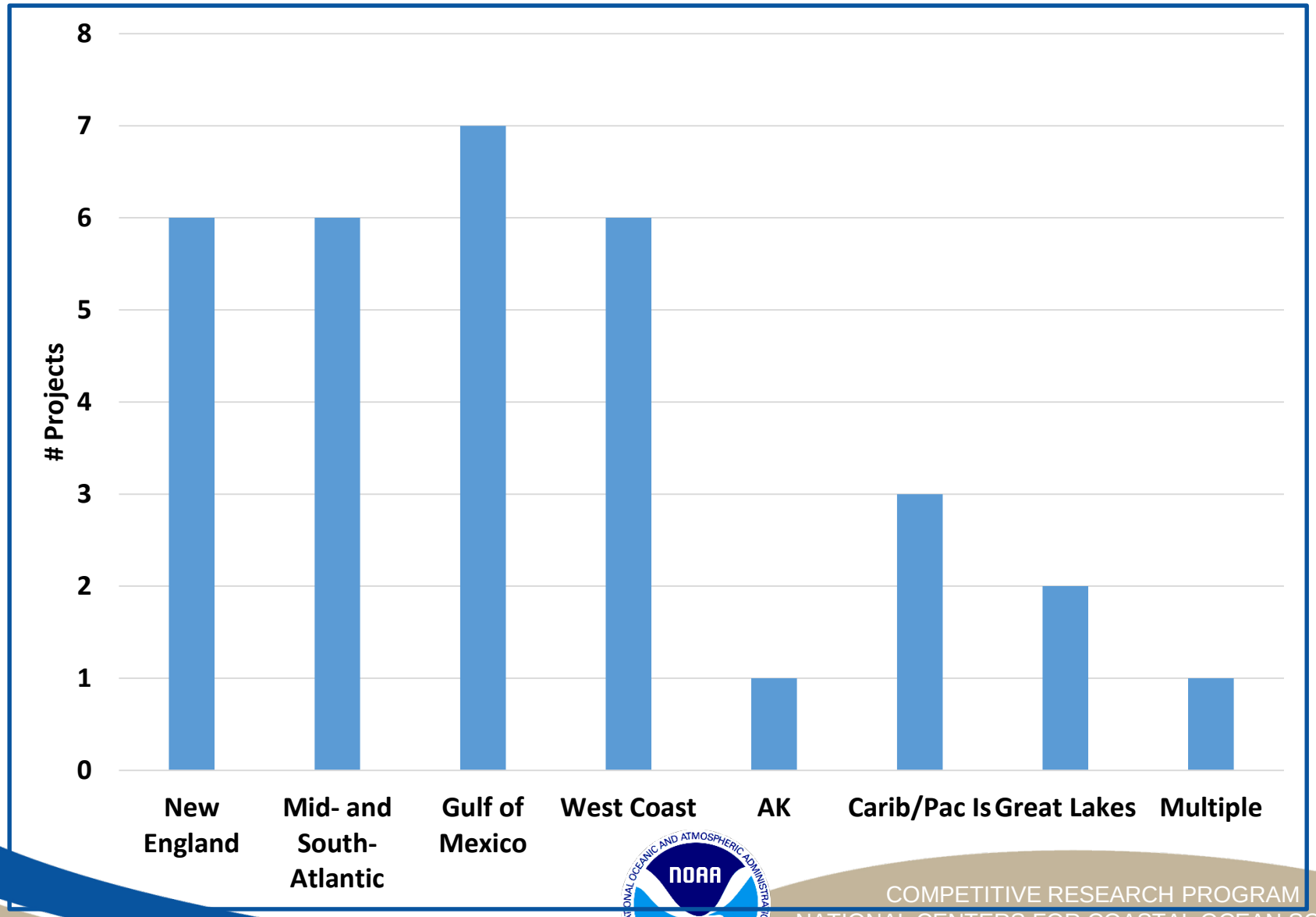
ECOHAB Future Plans

- **Why keep program in existence since 1997**
  - Complexity of HABs
  - New tools—models, molecular methods, sensors, platforms
  - Emerging/expanding HABs and changing environment
- **Next competition—depends on funding 2021**
- **Need for regional projects**
  - No other program/agency does large-scale ecosystem research--only way to develop predictive models & understand impacts
  - Challenge
    - ~$5M over 5 yrs
    - Ship time a major cost
- **Needs to be a broad call—applied but not proscriptive**

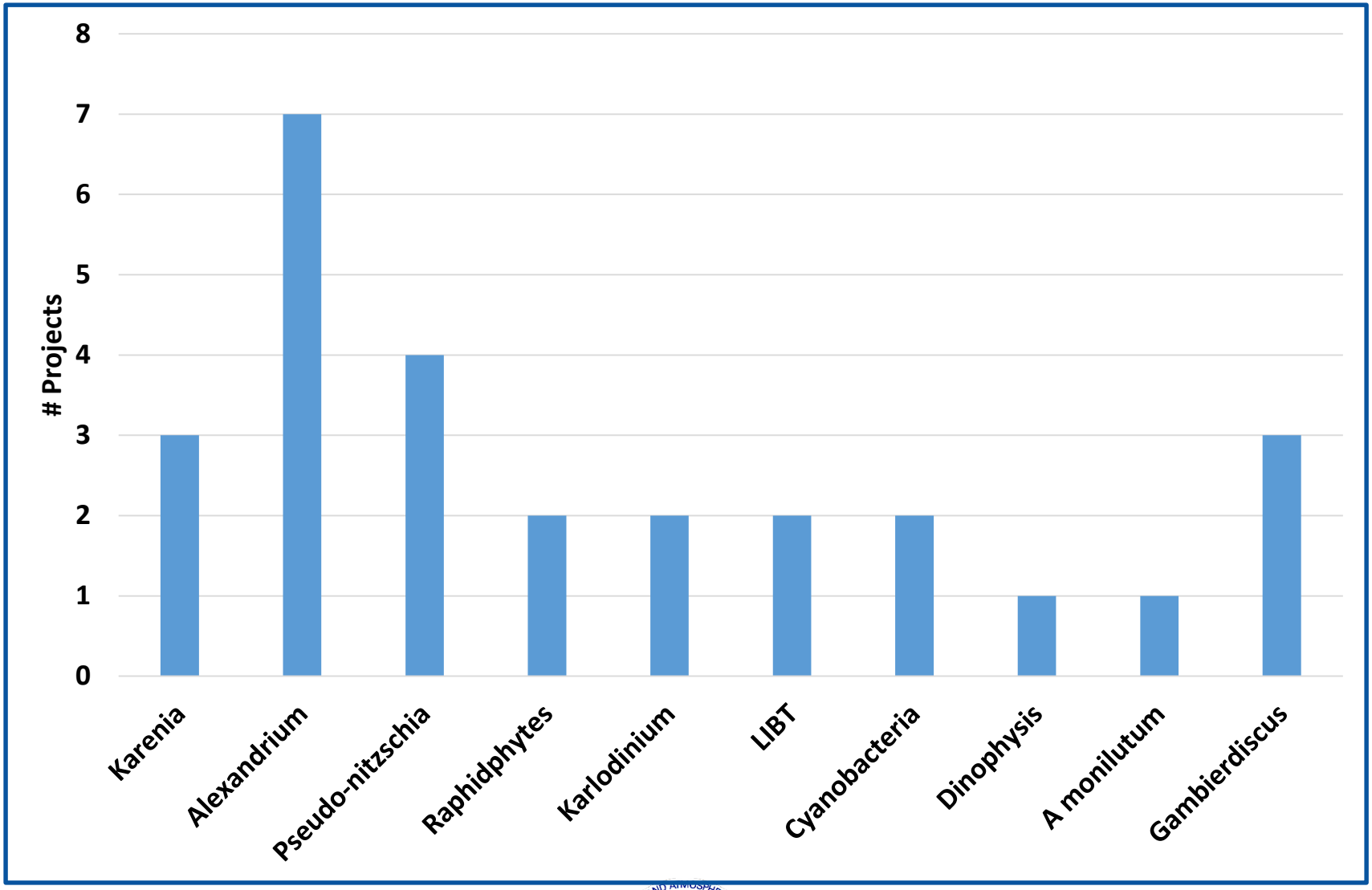
Projects by NCCOS Priorities



Projects by Region



Projects by HAB Group



Prevention, Control, and Mitigation of Harmful Algal Blooms (PCMHAB)

Quay Dortch

Program Manager

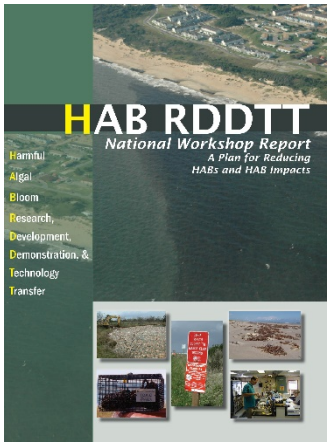
COMPETITIVE RESEARCH PROGRAM
NATIONAL CENTERS FOR COASTAL OCEAN SCIENCE

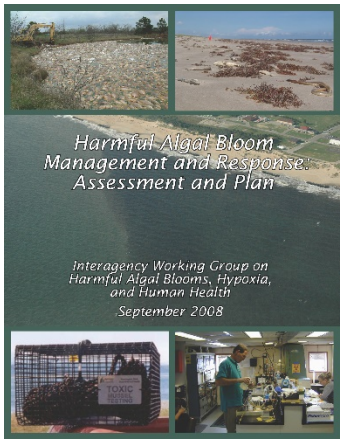
PCMHAB History

- **HABHRCA authorized**

  "the National Ocean Service of the NOAA to carry out a peer-reviewed research project on management measures that can be taken to prevent, reduce, control, and mitigate HABs" 1998

- **2008 Community Report & HABHRCA Report to Congress**





- **2009 FRN describing program & regional rotation**
- **2010 First competition**

PCMHAB Goals

- **Develop and make widely available new socially and environmentally acceptable strategies and methods for PCM of HABs and their impacts;**
- **Assess the social and economic costs of HAB events and the costs and benefits of PCM**

PCMHAB Topics

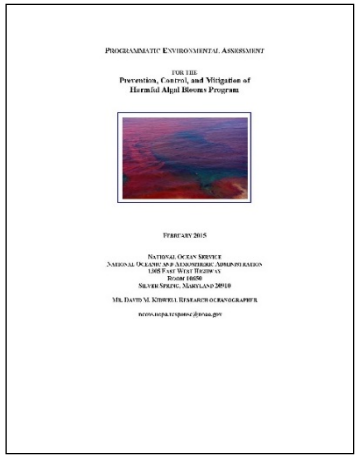
- **Prevent HABs**
  - Use/modify existing models to identify strategies to prevent HABs
  - Minimize/prevent introductions of invasive HAB species, their cysts, & organisms that facilitate the success of HAB species
- **Control HABs and their impacts**
  - Eliminate/reduce HAB organisms or toxins through ***biological***, chemical, or physical treatment
- **Mitigate HABs & their impacts by developing or improving methods**
  - HAB cell & toxin detection
  - Relocate or modify aquaculture & wild-capture resources
  - Harvesting bans & closures
  - Fishing & processing practices
  - Education & outreach
  - Enhancing community capacity to respond to social & economic impacts
  - Intervening to reduce wildlife mortality

PCMHAB Topics Socioeconomic

- **Enhance HAB response and ensure socially responsible development and effective implementation of PCM**
  - **Measure social & economic costs of HABs & their impacts & costs & benefits of HAB PCM**
  - **Improve communication strategies & approaches for facilitating changes in human behavior/attitudes**
  - **Improve coordination of researchers & stakeholders in implementing PCM research**

Other Requirements

- **Three phases**
  - **Development phase--advance & evaluate unproven but promising technologies & strategies**
  - **Demonstration phase--test, validate & evaluate new technologies in the field**
  - **Technology/Information Transfer phase—transition technologies and strategies to end-user application**
- **Must have Transition Advisory Committee (TAC)**
- **National Environmental Policy Act (NEPA)**
  - **"socially and environmentally acceptable methods"**
  - **Programmatic Environmental Analysis--defines acceptable methods**


PROGRAMMATIC ENVIRONMENTAL ASSESSMENT

FOR THE

Prevention, Control, and Mitigation of Harmful Algal Blooms Program

FEBRUARY 2015

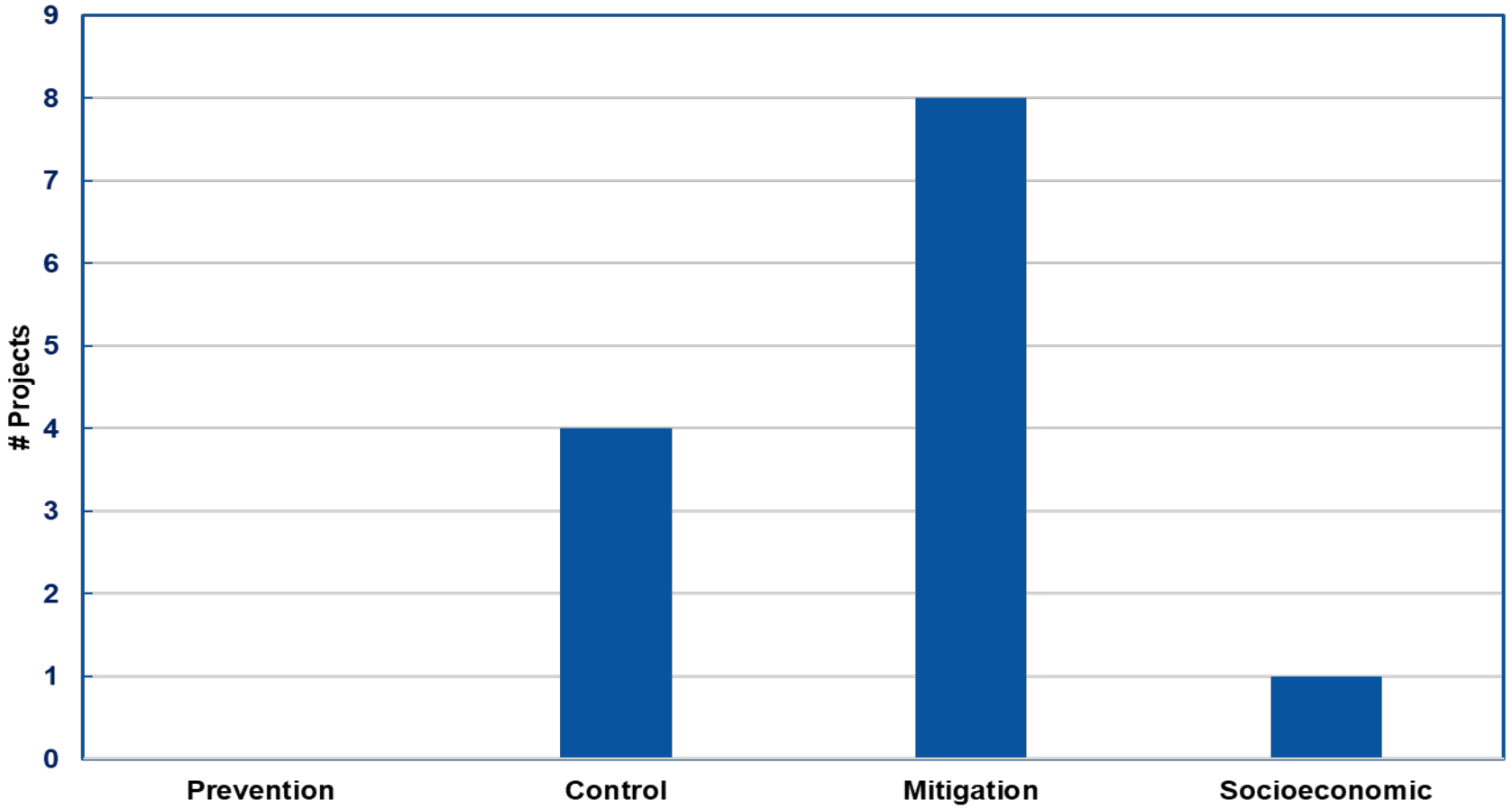
NATIONAL OCEAN SERVICE

PCMHAB Time Line

Year	Focus	# LOI*	# Proposals	# Funded	Success Rate
2010	Regional: East Coast	15	16	3/4	25%
2011	Regional: West Coast, AK, Great Lakes	11	10	3	33%
2012	Regional: GOMEX, Carib/Pac Islands	17	11	0	0%
2015	Regional: GOMEX, Carib/Pac Islands	17	12	5	42%
2017	National: ISSC Methods Shellfish Toxin Analysis	15	4	2	50%

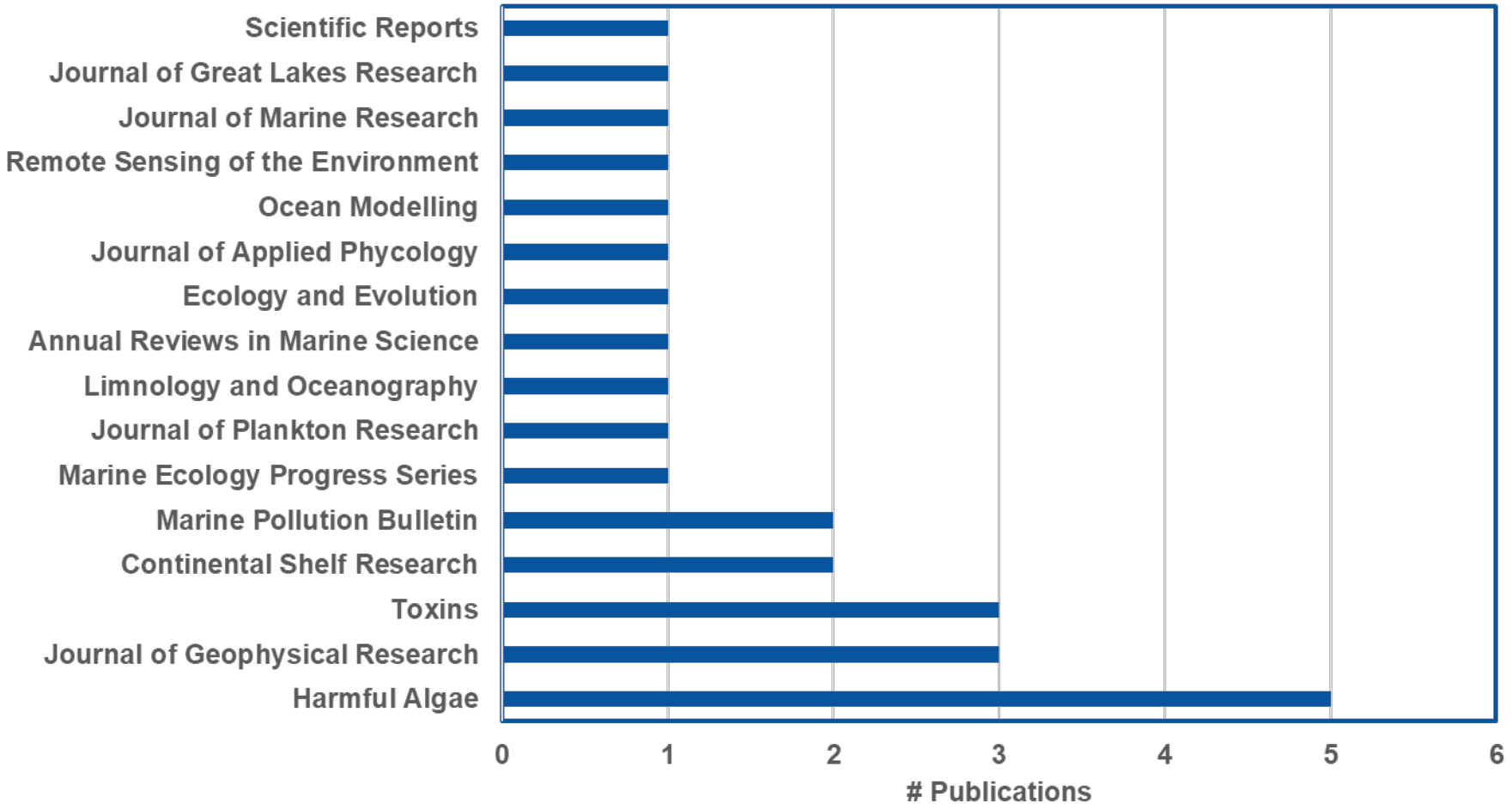
*LOI=Letter of Intent

PCMHAB Projects Funded
12 projects $7,862,831



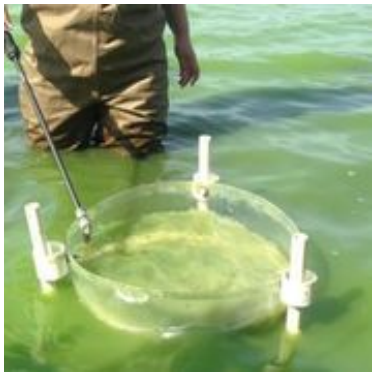
PCMHAB Publications

Peer-Reviewed Journal = 26 Other = 14



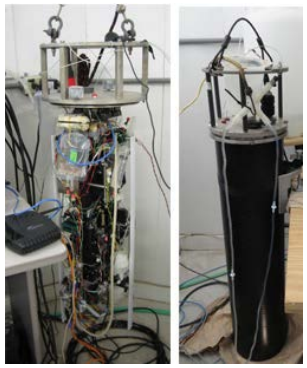
PCM HAB Progress Control

- Cyanobacteria
  - Clay flocculation
  - Barley straw
  - Hydrological modification
- *Alexandrium* cyst sediment burial
- "Dinocidal" compound(s) produced by natural bacteria—2 projects



PCM HAB Progress Mitigation

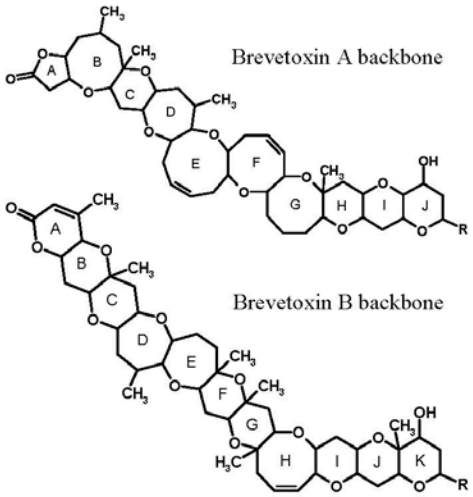
- **Transition HAB forecasts**
  - Gulf of Maine *Alexandrium*—other talks
  - West Florida shelf *Karenia* seasonal

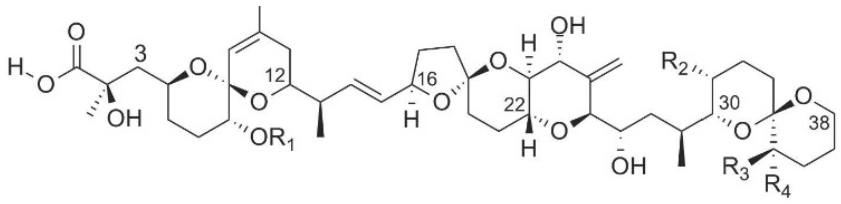


- **Method Development & Transition**
  - Hand-held sensor for *Karenia brevis* cells (Grouper Chek)
  - Microcystin biofilters for water treatment plants
  - Engineering upgrades Environmental Sample Processor (ESP)
  - Imaging Flow Cytobot (IFCB) Network

PCM HAB Progress Mitigation 2

- **Method Development & Transition** (continued)
  - New approved regulatory methods for toxins in shellfish & training for new users
    - ELISA for brevetoxin—approved 3 shellfish species
    - Comparison 3 methods for DSP-toxins

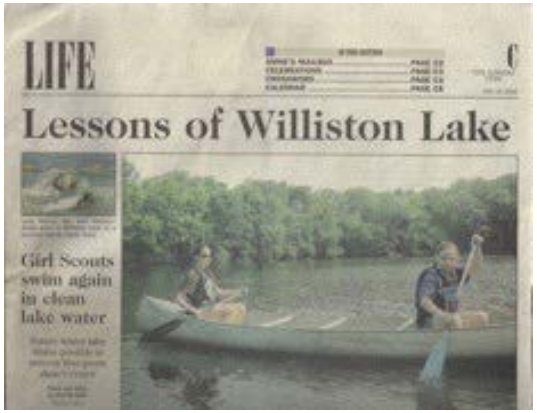




OA: R_1=H R_2=CH_3 R_3=H R_4=H
DTX-1: R_1=H R_2=CH_3 R_3=CH_3 R_4=H
DTX-2: R_1=H R_2=H R_3=H R_4=CH_3
DTX-3: R_1=Acyl R_2=CH_3 R_3=CH_3 R_4=H

PCM HAB Progress Socioeconomic

- **Used a socio-ecological systems framework to investigate stakeholder response to HAB management to compare**
  - Top-down management in Mattowan Creek watershed
  - Community-driven management approach Lewiston Lake


LIFE

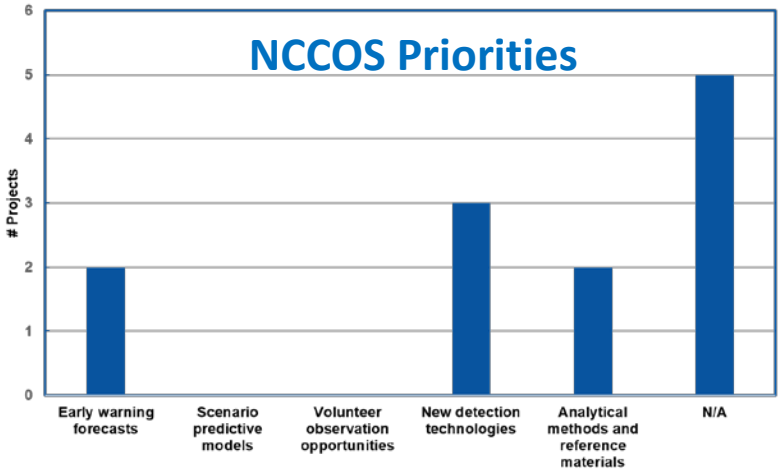
Lessons of Williston Lake

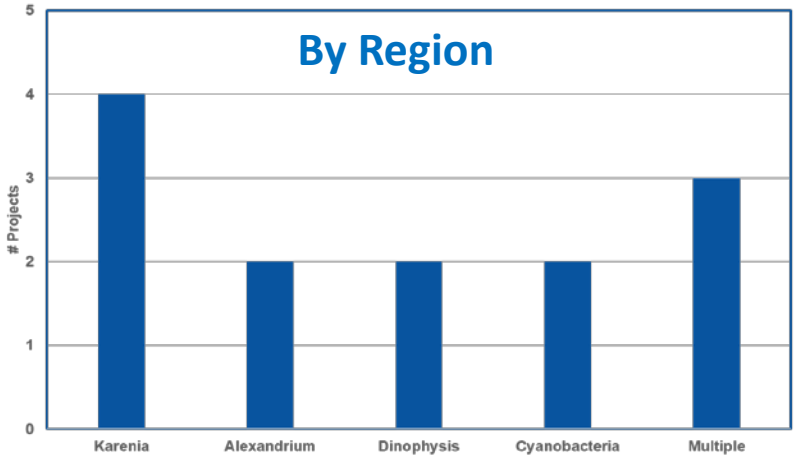
Girl Scouts swim again in clean lake water

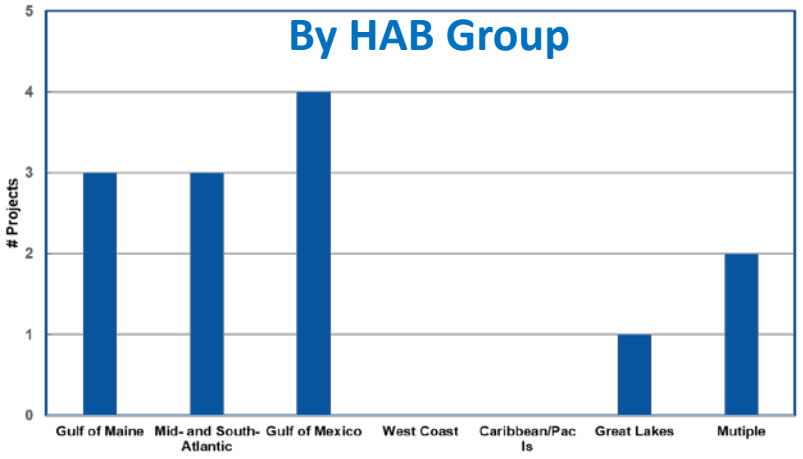
PCMHAB Future Plans

- **Next competition—depends on funding**
  - **2020 Economic Impacts HABs**
  - **2021**
    - **Compare efficacy of control methods**
    - **Address ISSC Needs for biotoxin methods**
- **How to address shortage of good quality socioeconomic proposals**
  - **Workshop**
    - **Discuss appropriate methods**
    - **Develop priorities**
    - **Introduce social scientists & economists to HAB issues**
  - **Hold separate call for proposals**

PCMHAB Projects







Monitoring and Event Response for Harmful Algal Blooms (MERHAB)





NCCOS HAB & Hypoxia Review

February 2018

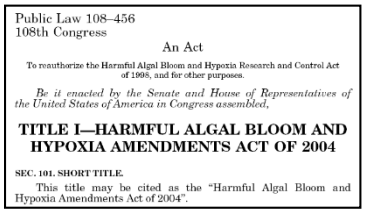
Marc Suddleson

MERHAB Program Manager

MERHAB History

- Harmful Algal Bloom Hypoxia Research and Control Act (1998, 2004, 2014)
- Community and Agency Reports
- Early NCCOS projects enhanced HAB monitoring in Chesapeake Bay (Maryland), St. John's River (Florida), and the Olympic Peninsula (Washington).
- NCCOS developed national MERHAB competitive program to tackle other impacted regions with first MERHAB FFO in FY2002.
- MERHAB FFOSs - 2002*, 2004*, 2005*, 2007*, 2010, 2011, 2012, 2014, 2015

* national competitions. All others part of regional HAB program rotation.


Public Law 108–456
108th Congress

An Act

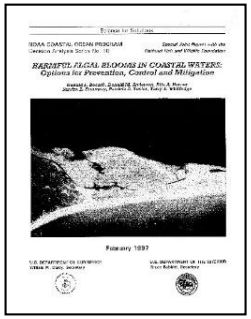
To reauthorize the Harmful Algal Bloom and Hypoxia Research and Control Act of 1998, and for other purposes.

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

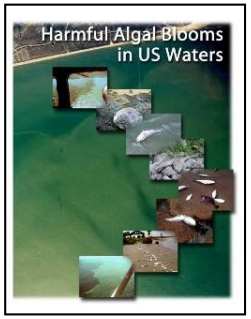
TITLE I—HARMFUL ALGAL BLOOM AND HYPOXIA AMENDMENTS ACT OF 2004

SEC. 101. SHORT TITLE.

This title may be cited as the "Harmful Algal Bloom and Hypoxia Amendments Act of 2004".


HARMFUL ALGAL BLOOMS IN COASTAL WATERS: Options for Prevention, Control and Mitigation

February 1997



"Research on how to make monitoring programs more efficient while providing better coverage in time and space is sorely needed."

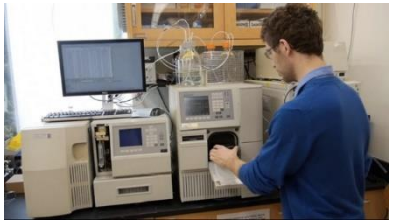
CENR. 2000. National Assessment of Harmful Algal Blooms in US Waters. National Science and Technology Council Committee on Environment and Natural Resources, Washington, DC.

MERHAB Program Goals

Build HAB monitoring and response capacity within local, state, and tribes, and private sector through:

- Adoption of faster, less expensive and more reliable detection for HAB cells and toxins and conditions influencing HABs;
- Demonstrate operational monitoring capabilities for early warning and forecasting capability;
- Enhance response capabilities to ensure trained and equipped personnel are able to mobilize quickly, conduct appropriate sampling and testing, and communicate effectively during HAB events.

Olympic Region HAB (ORHAB) program training.



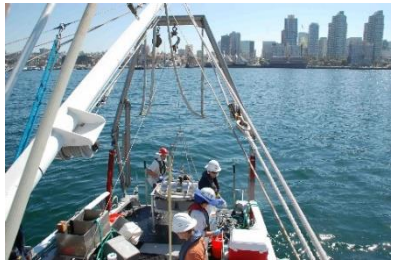
MERHAB Lower Great Lakes CyanoHAB lab at SUNY ESF

FWC and Mote Florida Red Tide Monitoring Program

MERHAB Innovation – Management Relevance

- Managers Part of the PI team.
- Managers as Reviewers (mail and panel).
- Projects as “testbeds” or “pilots”
- Plan and execute transition from grant to operational funding
- Target broad array of monitoring programs for HAB impacted coastal resources.

  (e.g. reg. observing associations, water quality, wild\farmed fisheries)



MERHAB Competition Time Line

Year	Focus	# LOI*	# Proposals	# Funded	Success Rate
2005	National	n/a	18	8	44%
2007	National	n/a	10	3	30%
2010	Regional: GOMEX, Carib/Pac Islands	20	12	1	8%
2011	Regional: East Coast (North, Mid, & South Atl.)	16	9	3	33%
2012	Regional: West Coast, AK, Great Lakes	24	17	0	0%
2015	Regional: West Coast, AK, Great Lakes	27	14	4^	29%

*LOI=Letter of Intent

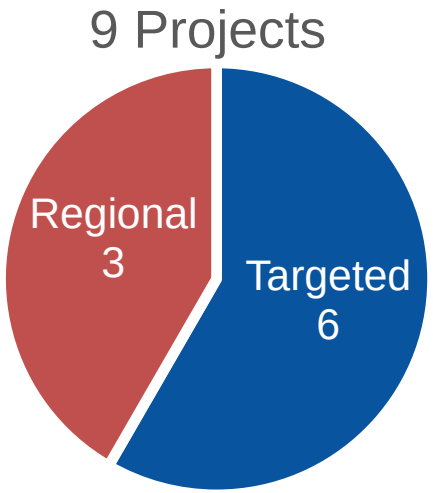
^1 project held until 2016

MERHAB Project Types & Totals

2012–2017

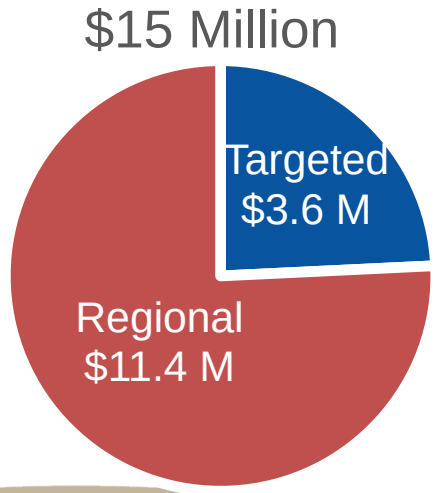
Regional

- 3-5 yrs, ~$400-500/year,
- Large multi-disciplinary, investigators including managers,
- Test and demonstrate enhanced monitoring
- Create and execute plan to sustain enhanced monitoring after MERHAB ends



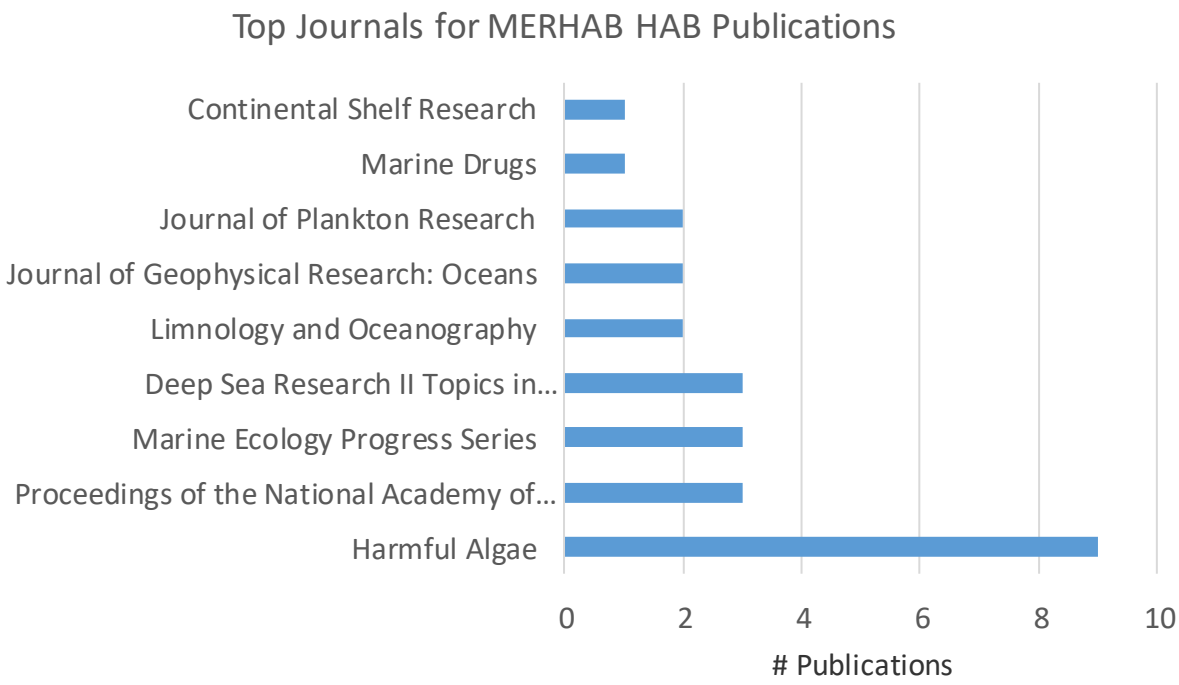
Targeted

- 3 yrs, ~$200/year lab or field project
- Single PI or small interdisciplinary team
- Field-test promising HAB technologies with management applications
- Create plan to demonstrate enhanced monitoring.



MERHAB Peer-Review Publications 2012-2017

Year	Pubs
2012	12
2013	5
2014	10
2015	10
2016	3
2017	11
Total	**51**



MERHAB 2012–2017: Project Accomplishments

Enhanced Regional HAB Monitoring for Early Warning and Forecasting

- *Pseudo-nitzschia* (and *Alexandrium)* – West Coast
  - S. California (Add HABs to: BIGHT Water Quality program; SCCOOS; and CalHABMAP);
  - Oregon (Add HABs to state shellfish program (MOCHA); linking HABs & climate);
  - Washington Coast (ORHAB and PNW HAB monitoring\forecasting system).
- *Alexandrium (and Pseudo-nitzschia)* – Gulf of Maine
  - Gulf of Maine 1st multi-ESP deployments for species and toxin (PSP) detection.
  - U.Maine \ DMR rapid, field-deployable HAB species detection
- Guidance on molecular species detection and quantification, comparing SHA and qPCR.

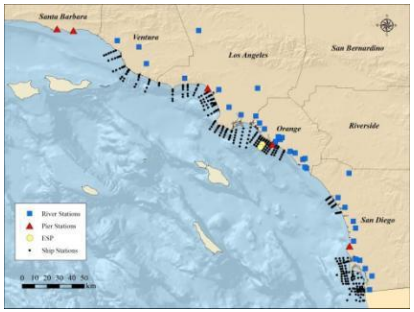
Keeping Pace with Expanded \ Emerging HABs

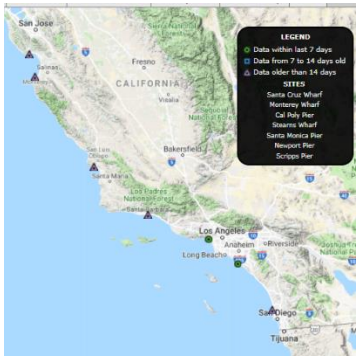
- *Dinophysis* Washington, Puget Sound -Washington
- Cyanobacteria and toxins in estuaries – California
- *Alexandrium and Dinophysis – Long Island Sound and NY Atlantic coast*

Enhanced national HAB "infrastructure"

- Sustainable, national HAB Identification training program at Bigelow Lab
- Cyanotoxin rapid response lab at SUNY ESF supports NOAA and Partners

MERHAB Enhanced Monitoring in California





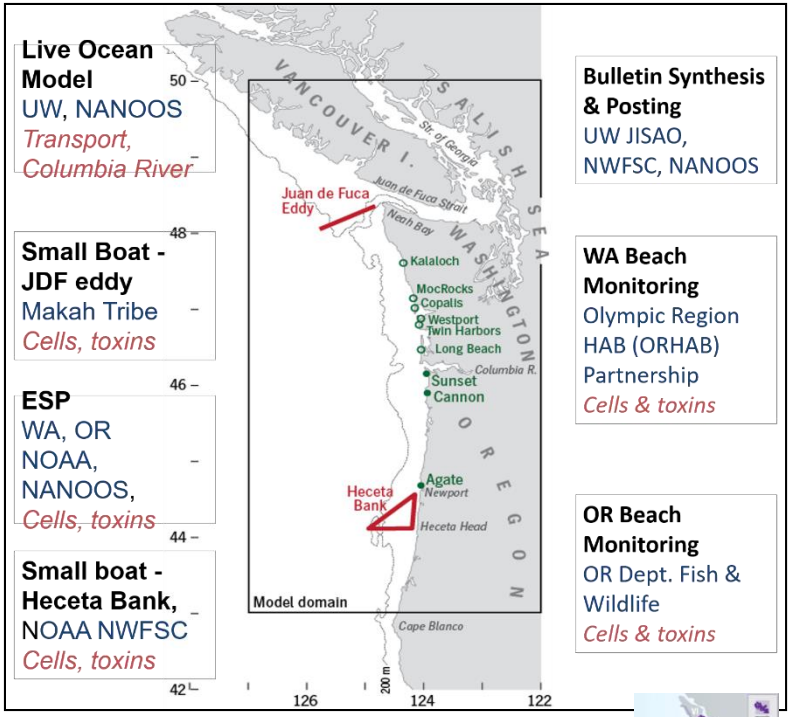
Monitoring & Alert
CalHAB Program
Implementing a s
system for Califc

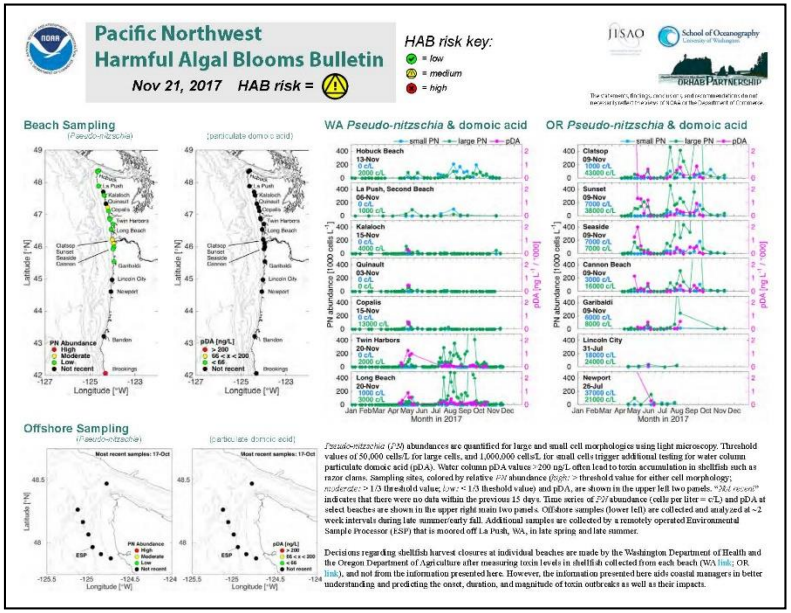
Pier-based sampling adopted by SCCOOS

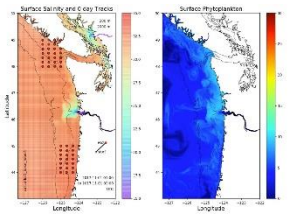
Added HABs focus to SCCWRP's BIGHT Water Quality program

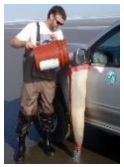
Project Title: *Rapid Analysis of Pseudo-nitzschia and Domoic Acid, Locating Events in Near- Real Time*

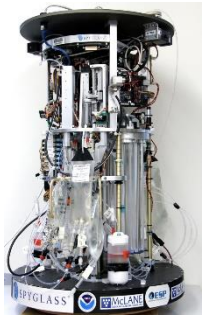
MERHAB in PNW – HAB monitoring\forecasting











Project Title: An Early Warning System for Pseudo-nitzschia Blooms on PNW Outer-Coast Beaches

MERHAB – Addressing Emerging HAB Threats

CyanoHAB Toxins in Many U.S. Estuaries
Emerging Issue

How widespread?

Is it a human health threat?

No guidance for toxins in shellfish!

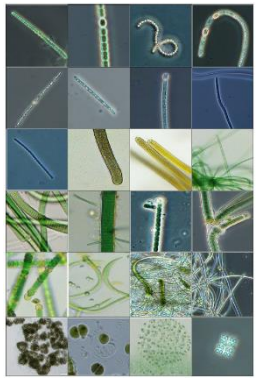
California Sea Otter - CyanoHAB Sentinel

MERHAB Supported Response

- Assess magnitude of problem in California estuaries
- Fund state, tribes, feds (USGS and EPA) partnership*
- Adapt new monitoring tools (SPATT)

*Key MERHAB and SCWRP partners: CENCOOS, SCCOOS, CA Sea Grant, & Tijuana River NERR

SPATT toxin sampler.

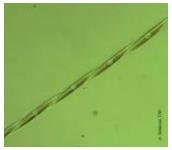


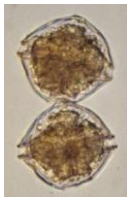
Cyanobacteria genera found in CA estuaries
Tatters et al. (2017) *Toxins* **2017**, *9*(3), 95.

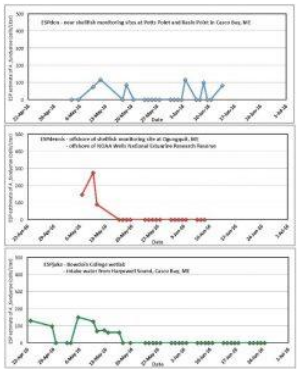
Project Title: *Improving Tools for Monitoring Multiple HAB Toxins at the Land-Sea Interface in Coastal California*

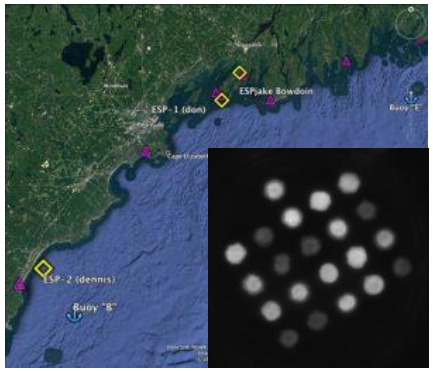
MERHAB in Gulf of Maine - “Launching” ESPs

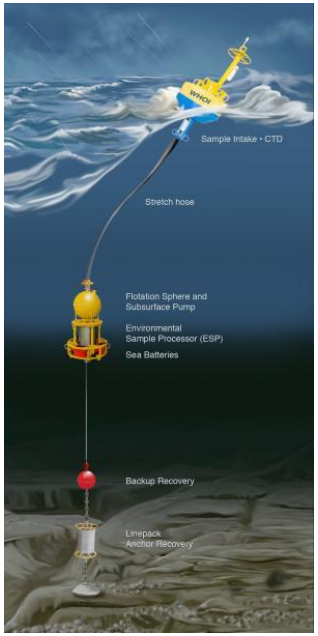
- Demonstrated successful multi-year deployments of Environmental Sample Processor (ESPs) at multiple locations. Ending with 3 ESPs from April to July 2016.
- Real-time detection of *Alexandrium* and *Pseudo-nitzschia* spp.
- Facilitated the 1st successful ESP in situ autonomous detection of PSP toxin by NCCOS.
- Verify NOAA seasonal GOM HAB Forecast and support weekly state bloom updates.











Incorporation of ESP technology into Gulf of Maine HAB monitoring and management

MERHAB Future Plans

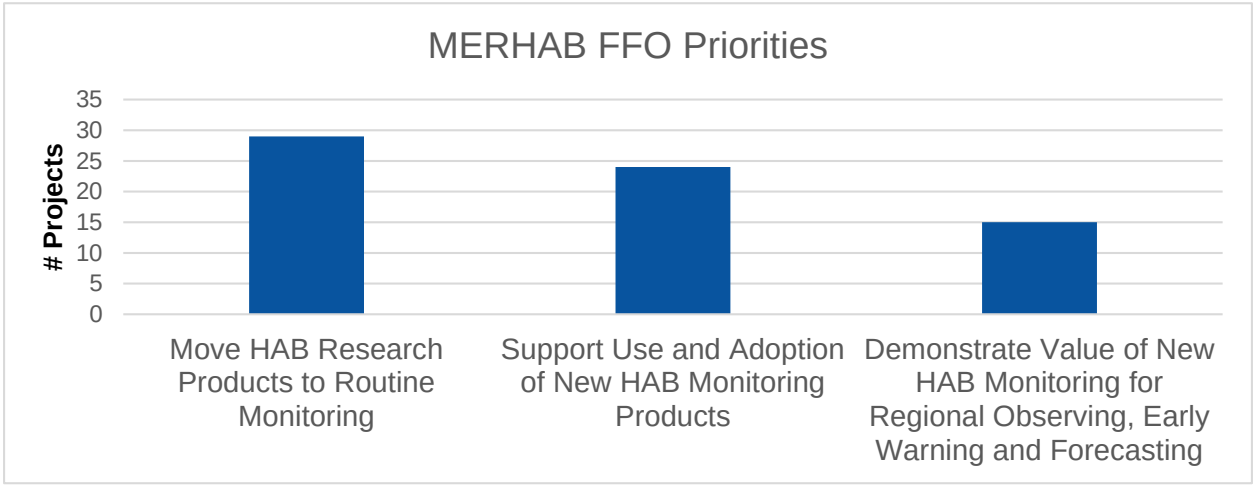
- Next competition—depends on funding
  - FY 2019
- Need for regional projects
  - Builds critical capacity for HAB monitoring and response
  - Provides data needed to demonstrate effective predictive capabilities
  - Valuable state, federal, academic partnerships
- Expand MERHAB to demonstrate benefits of NOAA HAB programs to other HAB impacted sectors (e.g. aquaculture).

MERHAB Projects 2012–2017 Background

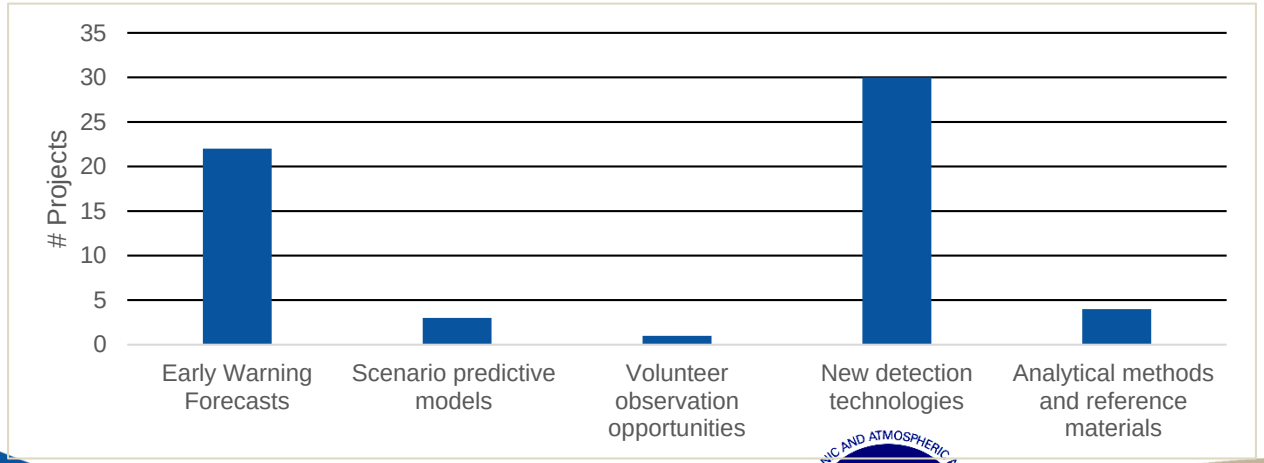
Recipients	Lead PI	Reg/ Target	Title & Link to NCCOS Project Page	Total ($ K)
USC, UCLA, UCSC, SCCWRP	Caron	R	RAPIDALERT: Rapid Analysis of Pseudo-nitzschia & Domoic Acid, Locating Events in near-Real Time	$2,480
OSU, UO, ODFW	White, A.	R	Integrated HAB monitoring and event response for coastal Oregon	$2,301
College of Charleston, SCDNR, UD	Greenfield	T	Comparative analysis of quantitative detection methods for enumeration of HAB species: Applications for resource management	$673
WHOI, UMaine, MBARI	Anderson	R	GOM-ESP: Incorporation of Environmental Sample Processor technology into Gulf of Maine HAB monitoring and management	$5,308
SUNY Stony brook, NCCOS, NYDEC	Gobler	T	Monitoring, forecasting, and enhanced response to PSP And DSP events in New York coastal waters	$523
U. Maine	Connell	T	HAB detection instrument validation and transition to State monitoring program	$574
Bigelow	Lomas	T	Training course on the identification of harmful algae in United States marine waters	$331
NWFSC, NCCOS, Jamestown S'Klallam, WA Sea Grant	Trainer	T	Clear and present danger: Monitoring and management of lipophilic shellfish toxins in Washington State	$701
SCCWRP, USC, UCSC, USGS	Howard	T	Improvement of monitoring tools and development of toxin strategy at the land-sea interface in Coastal California.	$842
UW JISAO, NWFSC, ODFW	McCabe	T	An early warning system for Pseudo-nitzschia HAB's on Pacific Northwest outer-coast beaches	$1,297

MERHAB Projects 2012–2017 Background

MERHAB Projects by FFO Priorities

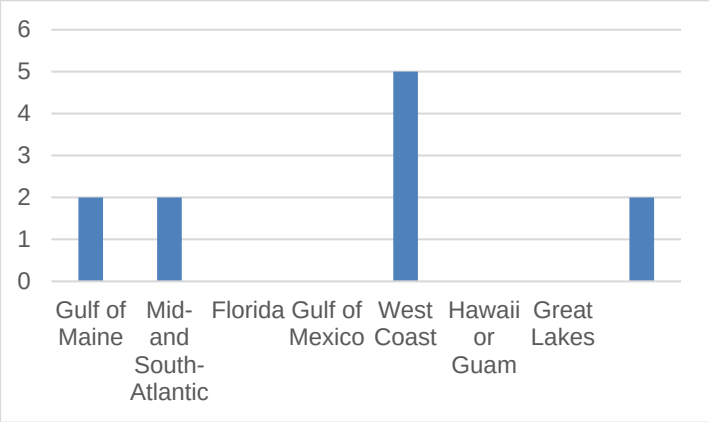


MERHAB Projects by NCCOS Priorities

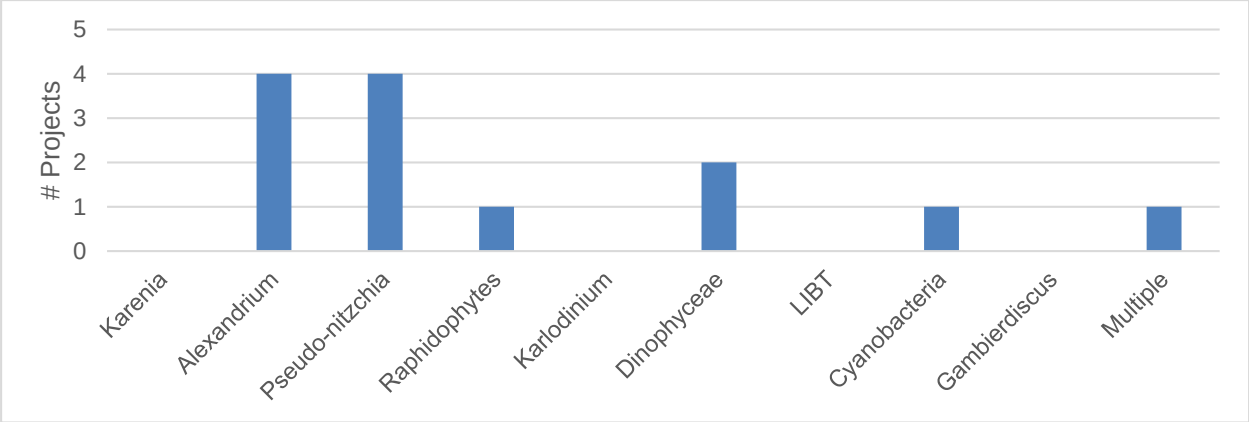


MERHAB Projects 2012–2017 Background

MERHAB Projects by Region



MERHAB Projects by Species, Genus or HAB Group



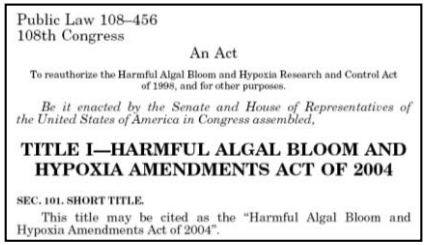
HAB Event Response Program

NCCOS HAB & Hypoxia Review
February 2018

Marc Suddleson
Co-manager, HAB Event Response Program

HAB Event Response (ER) History

- Harmful Algal Bloom Hypoxia Research and Control Act (1998, 2004, 2014)
- Community and Agency Reports (e.g. Clean Water Action Plan, RDDTT)
- Pre-2003 - *Pfiesteria*-related human health concerns (Ches. Bay), sea lion seizures and deaths (California) and humpback whales (Gulf of Maine) prompt calls for coordinated federal, state and university response and **rapid assistance**.
- 2003 - NCCOS CRP establishes current national HAB Event Response program partnering with U.S. National HAB at Woods Hole Oceanographic Institution.


Public Law 108–456
108th Congress

An Act

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

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

TITLE I—HARMFUL ALGAL BLOOM AND HYPOXIA AMENDMENTS ACT OF 2004

SEC. 101. SHORT TITLE.

This title may be cited as the "Harmful Algal Bloom and Hypoxia Amendments Act of 2004".

HAB ER Program – Small $ \ Big Impact

HAB ER Projects 2012-2017

- Funded: 23 projects totaling $170,743
- Project Cost Range: $22,000 (Max) to $238 (Min).
- Average Cost per event ~ $7,500
- Can cover ~ 4 events each year
- Publications = 24 (not primary purpose of program)

Goal: Immediate assistance for planning response and advancing the understanding of HABs

- Can tap in-kind NCCOS resources
- Often rapidly mobilizes expertise in grant-funded external state and academic labs
- Quick reimbursement for costs to mount response

HAB ER Program – Priorities

3 Types of Responses are Prioritized:

- Unusual or unique species, toxin, or harmful effects that threatens health and/or economies
- Sudden, unexplained animal mortalities with a suspected HAB cause
- Timely data on major HAB events needed to inform management decisions and mitigate impacts

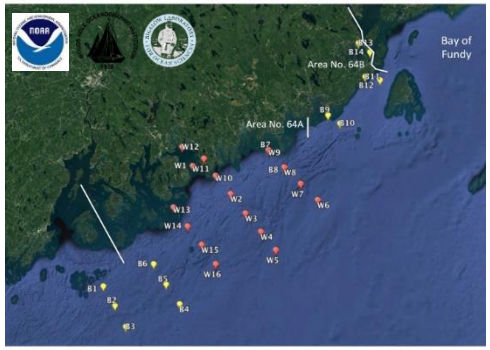
HAB ER Priority: Unusual or Unique HAB Events

1st Texas Brown tide bloom in Florida in 2012

ID *Aureoumbra lagunensis*, developed a genetic probe for rapid and accurate detection, assessed temporal and spatial scale of bloom, and determined bloom effects on filter feeding bivalves (hard clams). *$8,840*.

1st Domoic Acid Closure in New England in 2016

2016 Response supported ship-based surveys of extent and toxicity of a *Pseudo-nitzschia australis* bloom in Gulf of Maine. The team ID'd species and shared results with impacted states. *$22,000*.



HAB ER Priority: Marine Animal Mortalities

Improving treatment of Manatees exposed to brevetoxin

Mote and Lowry Park Zoo. A persistent red tide in 2013 led to a record number of Manatee deaths. Response supported blood collection and analysis from wild manatees exposed to brevetoxin. Results showed brevetoxin exposure has potential to suppress immune response and likely increases susceptibility to other stressors and support the development of new treatment and recovery. *$5,016*.

Terrapin die-off during *Alexandrium* bloom Long Island, NY

Supported NYDEC and partners role of PSP toxins in deaths of hundreds of diamondback terrapins on Western Long Island during an active toxic *Alexandrium* bloom 2015. Measured PSP-toxins in tissues taken from dead terrapins. Published evidence that toxin in shellfish likely caused or contributed to mortality. *$3,750*.

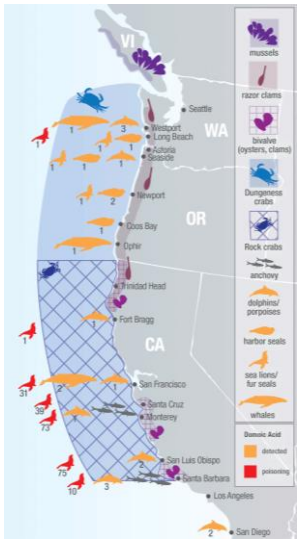
HAB ER Priority: Major Management or Resource Impacts

Cyanotoxins in Toledo water supply source

Supported NOAA GLERL, SUNY ESF and partners efforts to help Ohio EPA and water utilities during the 2014 Toledo drinking water crisis. Results assured accuracy of microcystin tests kits, and analyzed suite of toxins (anatoxin, cylindrospermopsin, and BMAA) in plankton samples near drinking water intakes to determine if other toxins of concern were present. *$6,030*.

2015 West Coast-wide domoic acid bloom

Supported a NOAA Fisheries, ORHAB, ODFW and Olympic Coast Nat. Marine Sanctuary rapid response to a major coast-wide domoic acid outbreak. Purchased domoic acid test kits for ORHAB (states & tribes) and use on coastal cruises. Covered shiptime enabling Washington HAB hotspot sampling. *$9,294**



HAB ER Projects – Accomplishments Summary

2012-2017

- Mapped bloom extent, severity, and toxicity & environmental conditions, address causes: **10 events**
- Assisted states and other management entities with immediate assistance with toxin monitoring: **8 events**
- Assessed impact of blooms on higher trophic levels: **6 events**
- ID organism: **3 events**
- Developed/improved method of detection: **3 events**
- Held outreach event/developed outreach materials: **3 events**
- Determined cause of mortality/stranding events: **2 events**
- Held training workshop: **1 event**
- Applied control method: **1 event**

Pros and Cons of Current HAB ER Program

Pros

- Rapid – Decision and funds released in days.
- High visibility for funding agency and responders
- Worked for 15 years

Cons

- Tiny amounts of funding
- Multiple or large events deplete national fund quickly
- Doesn't cover response and mitigation to long-lived blooms

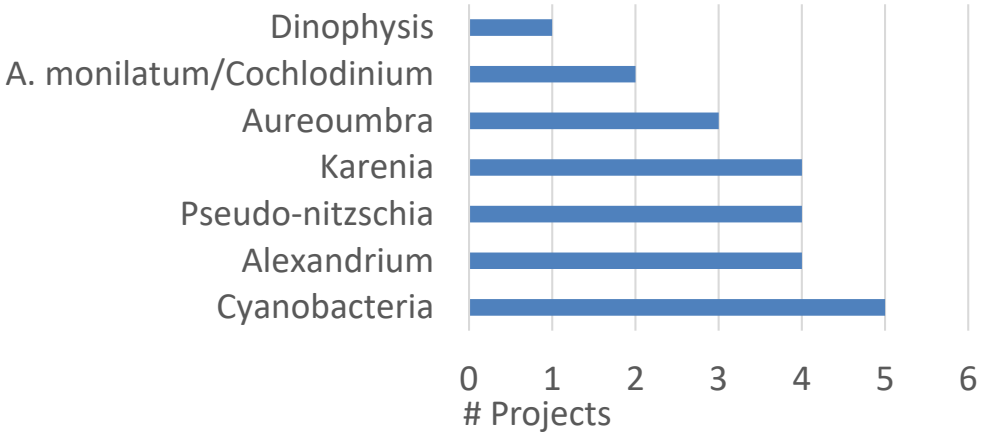
Possible HAB ER Future Direction

New HABHRCA Reauthorization S 1057

- **Assess** and **mitigate** detrimental environmental, economic, subsistence use, and public health effects for "**Events of National Significance**"
- Determined by NOAA or EPA Administrator (governors can request)
  - Criteria
    - HAB toxicity or hypoxia severity
    - Potential to spread
    - Economic impact
    - Relative size in relation to past 5 events (if recurrent)
    - More than one municipality or state
    - Cross international boundary
- New Fund for Responses to Events of National Significance
  - States or Local Governments Eligible
  - Federal funds cannot exceed 50%
  - Potential for accepting donations of funds, services, facilities, materials, or equipment.

HAB ER Program Additional Background

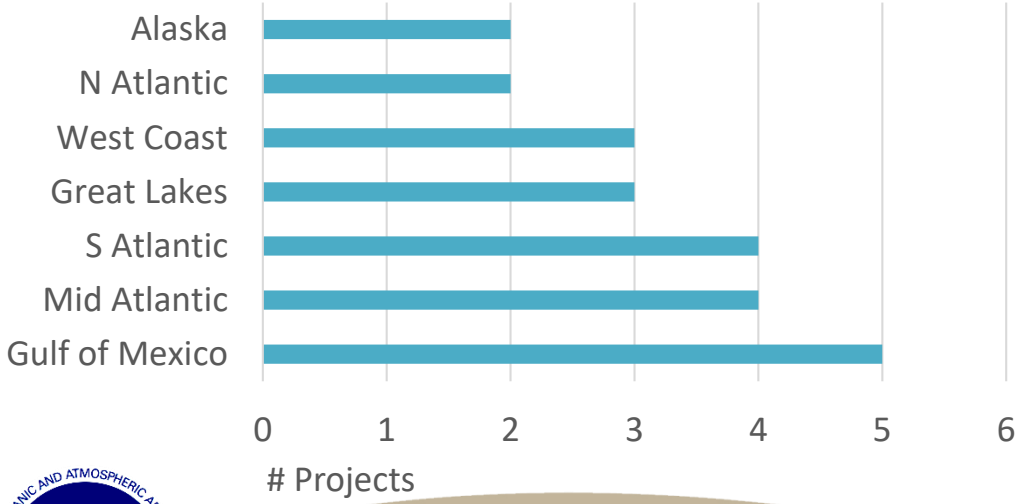
Event Response Projects by Species, Genus or HAB Group



2012-2017

Event Response Projects by Region

2012-2017



Competitive Research Program Overview

Alan Lewitus
NOAA National Ocean Service
National Centers for Coastal Ocean Science

NCCOS HAB and Hypoxia Portfolio Review

26 February 2018, Silver Spring, MD

NCCOS Competitive Research Program

Coastal Ocean Program (1992)

↓

Center for Sponsored Coastal Ocean Science (1999)

↓

Competitive Research Program (2017)

NCCOS CRP provides the critical information and predictive capabilities required to manage the nation's coastal resources in an ecosystem context.

These issues typically require multi-disciplinary research teams and a significant long-term commitment of resources because of their complexity and the effort required to reach a new level of understanding sufficient to support NOS priorities and drive future coastal management decisions.

CRP Operating Principles

- National and regional-scale programs
- Priorities from stakeholders, NOAA, Congress
- Research administered through long-term program planning and strategic partnerships
- Rigorous competitive peer-review process
- Strong mechanisms and oversight to assure management relevance and transition to application

- Focus Areas include HABs, Hypoxia, Ecological Effects of SLR, OA, Coral Reef Ecosystems, Multiple Stressors, Ecological Forecasting, Ecosystem-Based Management, Socioeconomics, Nature-Based Infrastructure

CRP Three-Phase Research Enterprise

Research Prioritization - to identify most critical research needs for CRP portfolio of national and regional based programs

Program Oversight/Research Execution - to ensure proper use of funds for achieving progress towards stated objectives

Transition to Application - to ensure that research results & tools are used by stakeholders to achieve societal benefits

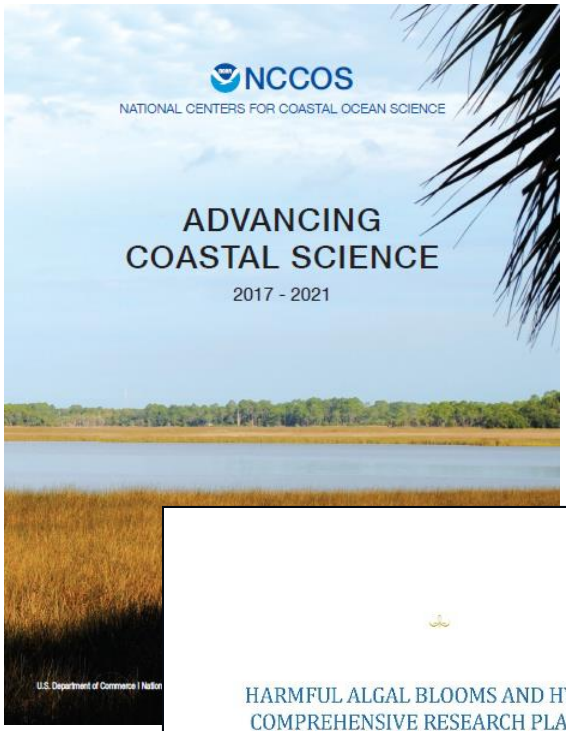
Setting Priorities

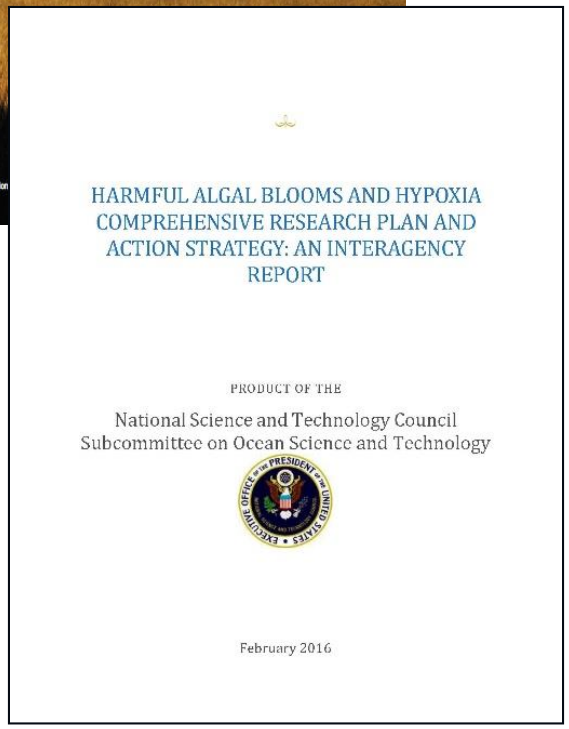
Research Prioritization

- **Strong user/stakeholder engagement**
- **Tied to NOAA/NOS/NCCOS priorities and Congressional direction**

Drivers:

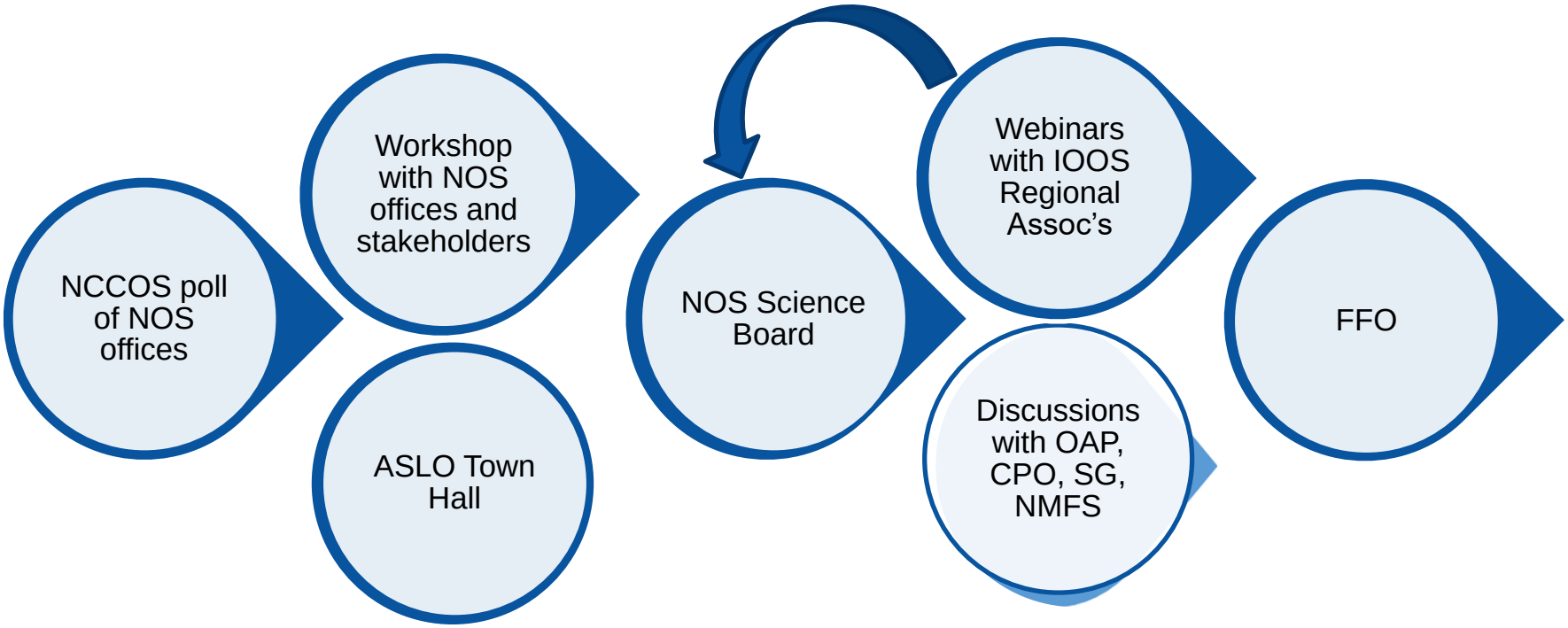
- **Congress (HABHRCA)**
- **Strategic Plans (NOAA, NOS, NCCOS)**
  - **Ecological Forecast Roadmap**
  - **Sentinel Site Program**
  - **Habitat Blueprint**
- **Reports, Plans and Workshops (HAB Nat Plan, Hypoxia and NRC reports)**
- **Internal Planning (Research Prioritization)**
- **Users, Users, Users**





Research Prioritization

Process to inform development of Coastal Thresholds FFO



Ensuring Progress towards Stated Objectives

Program Oversight/Research Execution

- FFO with mandatory elements to ensure application of research
  - Formation of Management Transition to Application Groups with annual meetings
  - Manager co-PIs, Application PI
  - Transition to Management Plan
- Open competition – ensure best science
- Robust peer review process
- Cooperative agreements
- Milestone, output, budget, progress tracking
- Site visits with PIs and managers

Ensure Research Results and Tools are Used

- **Transition to Application**

  - **Ensure that research results and tools are used by stakeholders to achieve management outcomes:**
    - **Changes in management knowledge**
    - **Changes in management behavior**
    - **Societal benefits**

  - **Strong Outreach/partner engagement**
    - **Research Coordination and Stakeholder Workshops**
    - **Synthesis Documents**
    - **Regional Coordination Networks**
    - **Management Coordination/Guidance Committees**

  - **Program Managers work to transition results/tools well after grant ends**

Harmful Algal Bloom and Hypoxia Research and Control Act (HABHRCA)

Directs NCCOS (on behalf of DOC) to lead federal research on HABs and hypoxia including:

- **coordination with other federal agencies**
- **research prioritization with end users**
- **synthesis and programmatic reports**

Scientists testifying before the Subcommittee on Energy and Environment Committee on Science, Space and Technology, U.S. House of Representatives; NOAA's Robert Magnien on left.

Competitive Programs Authorized by HABHRCA

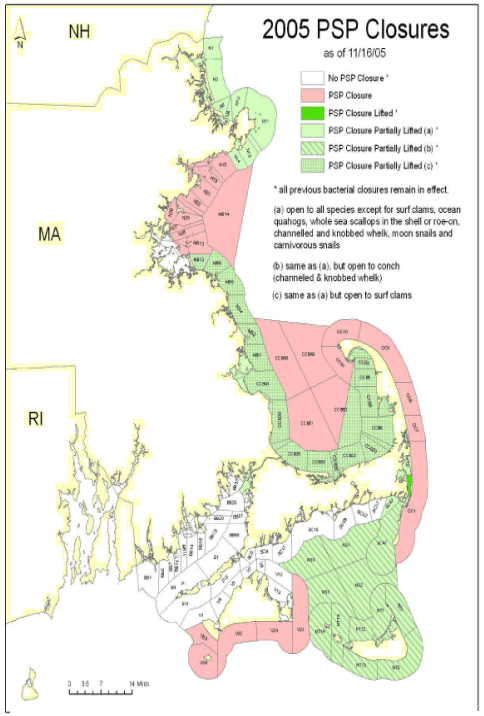
HABs:

- **Ecology & Oceanography of HABs (ECOHAB)**
  - **determine causes & impacts**
- **Monitoring & Event Response of HABs (MERHAB)**
  - **build national capacity to improve monitoring & response**
- **Prevention, Control & Mitigation of HABs (PCMHAB)**
  - **develop PCM methods, and transition them to end-user operations;**
  - **assess socioeconomic impacts**
- **HAB Event Response – Rapid help to minimize HAB impacts**

Develop Forecast Models

Monitoring for Early Warning

Transition Forecast System to Operations



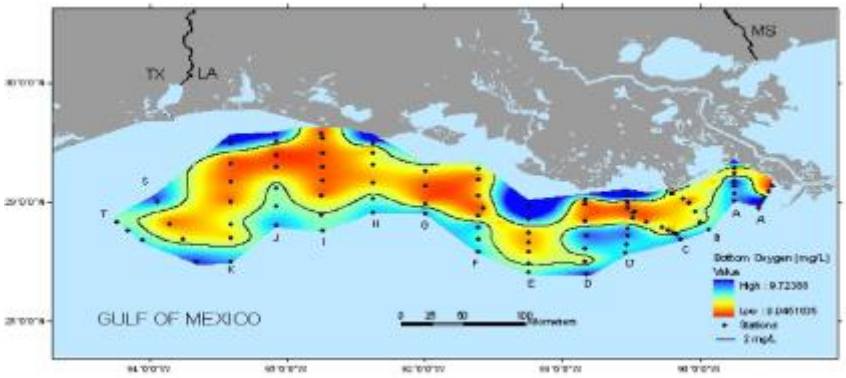
New England red tide in 2005 resulted in a NOAA-declared fisheries failure and an economic loss of ~$23 million to the region

Competitive Programs Authorized by HABHRCA

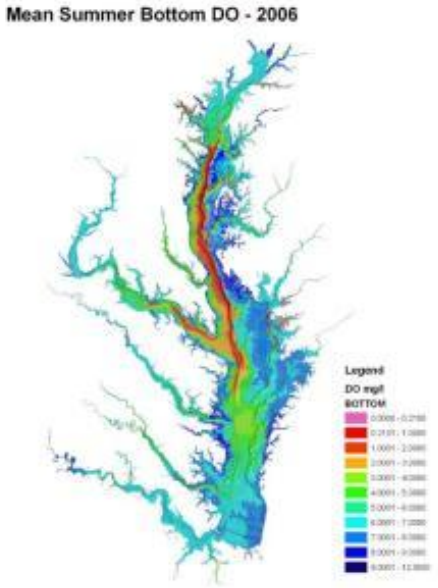
<u>Hypoxia</u>:

- **Northern Gulf of Mexico Ecosystems and Hypoxia Assessment Program (NGOMEX)**
  - **Improve understanding of the causes and impacts of hypoxia in northern Gulf of Mexico, and advance management capability to mitigate hypoxia impacts**

- **Coastal Hypoxia Research Program (CHRP)**
  - **Advance management of hypoxia in the rest of U.S.**



Hypoxia in northern Gulf of Mexico



Hypoxia in Chesapeake Bay

HABHRCA - U.S. National Offices

- **U.S. National Office for Harmful Algal Blooms (housed at WHOI) - provides coordination and technical support to enhance the response to and management of HABs**
  - **Informational web pages**
  - **Current Events facebook page**
  - **Support for National HAB Committee**
  - **Administers CRP Event Response Program**
  - **Support for national and international HAB meetings**

- **U.S. National Office for Hypoxia (housed at NGI) - provides coordination and technical support to enhance the response to and management of hypoxia**
  - **Technical Assistance to support scientific and research efforts**
  - **Observations & Monitoring in hypoxic regions of the Gulf of Mexico**
  - **Coordination of hypoxia research and management in the Gulf of Mexico**

NCCOS Intramural/Extramural Collaboration

- Coordination in NCCOS strategic planning
- NCCOS priority drivers of FFO research focus areas
- NCCOS review of FFO prospectuses
- Research Transition
  - e.g. extramural development of HAB forecast models foundational for intramural transition to operations
- Research Integration
  - e.g. ongoing extramural projects contributing to development, transition, or improvement of HAB forecasts targeted by NCCOS HAB Forecast Branch
  - NCCOS scientist collaboration on extramural projects

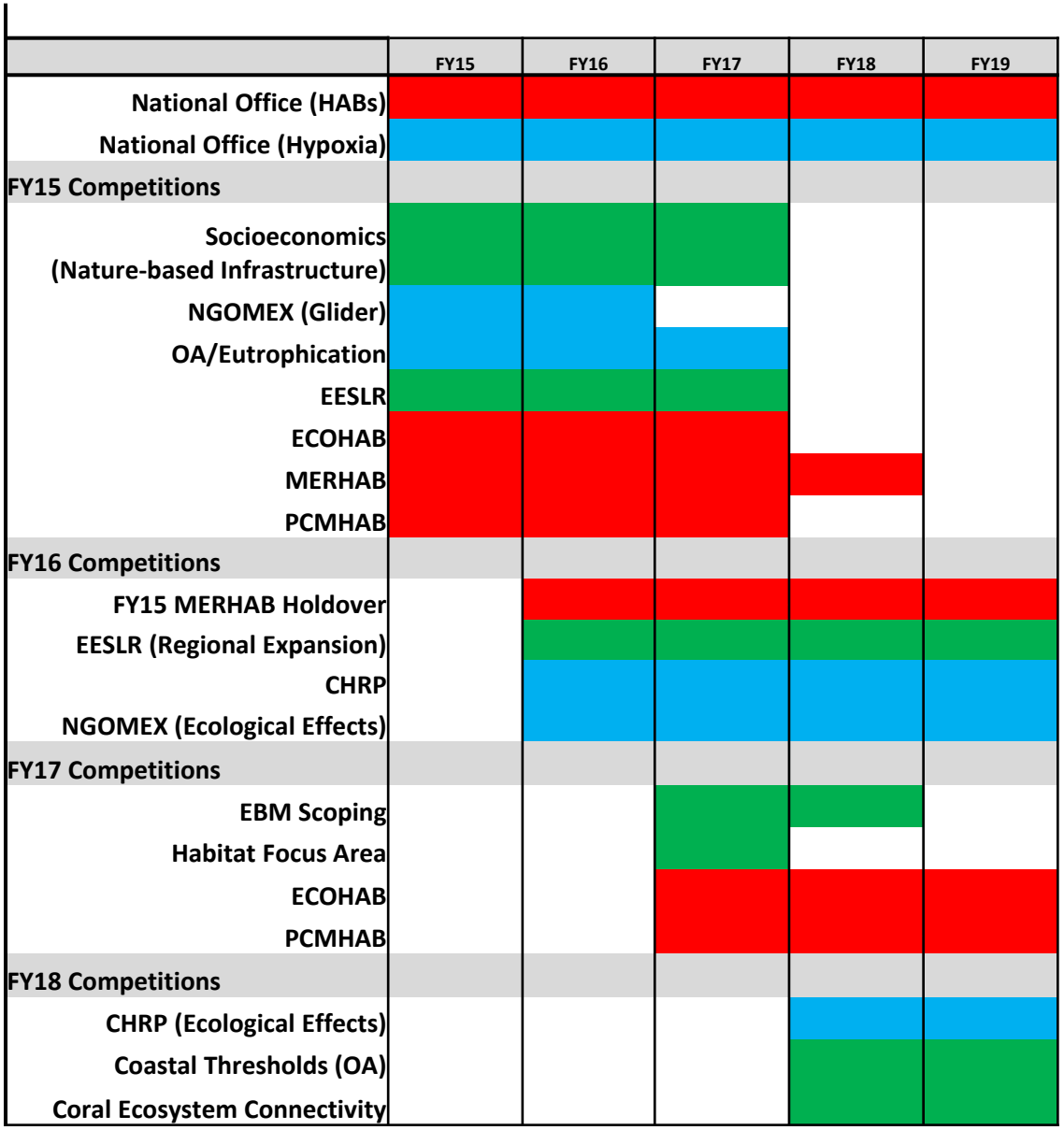
The End

Program Portfolio from FY12 to Present

Focus Area	Program
Harmful Algal Blooms	ECOHAB, MERHAB, PCMHAB
Hypoxia	NGOMEX, CHRP
Ocean Acidification	OA
Ecological Effects of Sea Level Rise	EESLR
Regional Ecosystem Research	*REPP – Integrated Ecosystem Research
	REPP – Concept/Tool Development
	REPP – Invasive Species
	Multistress
	Coral Reef Ecosystem Studies
Ecological Forecasting	ECOFOR
Ecosystem Based Management	EBM
Socioeconomics of Natural Infrastructure	Socioeconomics

*Regional Ecosystem Prediction Program

CRP Portfolio (FY15 to FY18)



Note: No new starts in FY12 to FY14 due to budget sequestration

Color Codes:
Red = HABs
Blue = Hypoxia
Green = Other

Timeline of CRP RFPs by Program

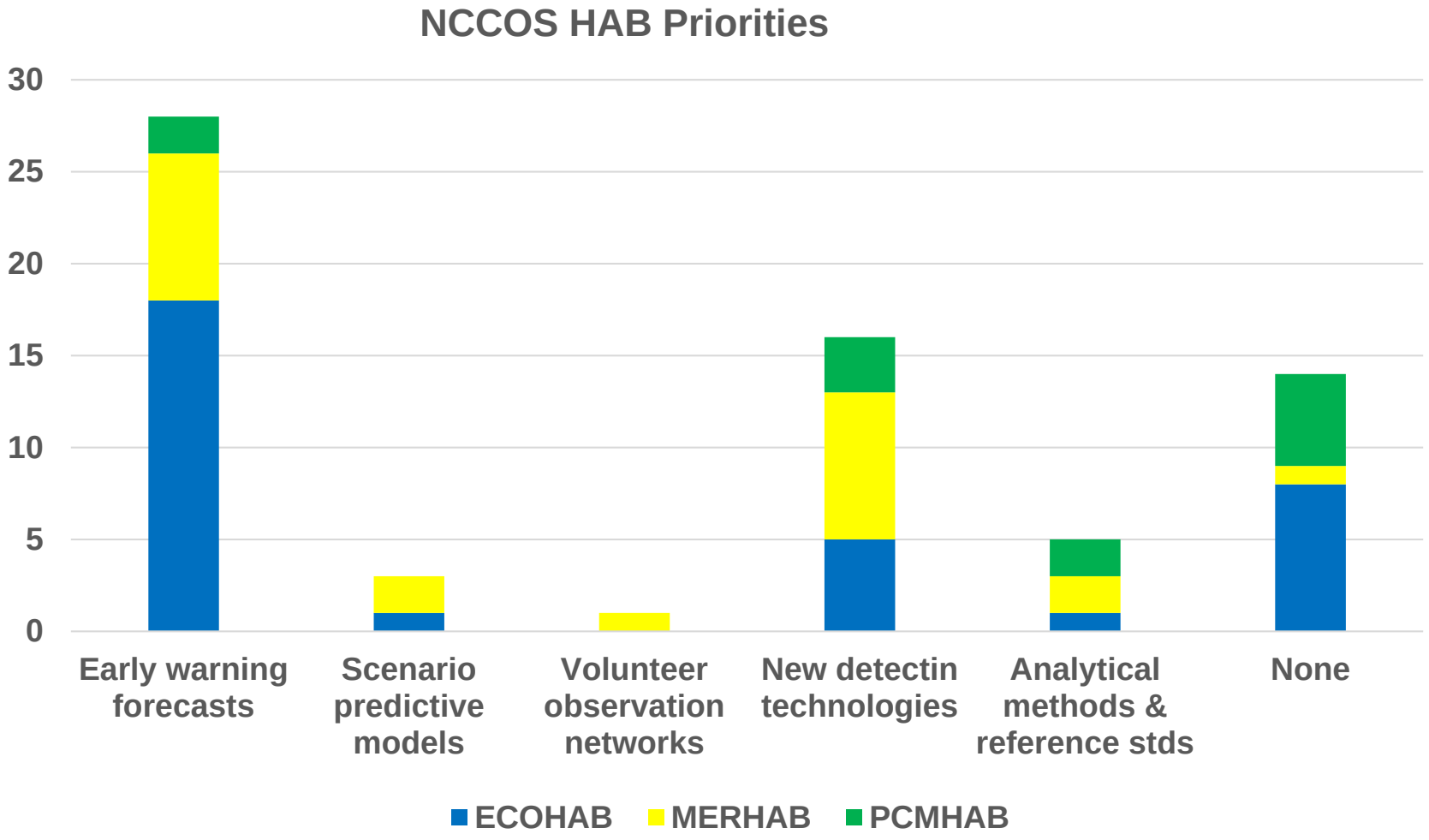
Year	ECOHAB	MERHAB	PCMHAB	NGOMEX	CHRP
2006	National	None	NP	Regional	None
2007	None	National	NP	None	National
2008	National	None	NP	None	None
2009	None	None	NP	Regional	None
2010	Regional	Regional	Regional	None	National
2011	Regional	Regional	Regional	None	None
2012*	Regional*	Regional*	Regional*	None	None
2013	None	None	None	None	None
2014	None	None	None	None	None
2015	Regional	Regional	Regional	Regional	National
2016	None	National	None	Regional	None
2017	National	None	All--Limited	None	None
2018	None	None	None	None	National

*Cancelled; FY12 Competitions held but no projects funded
NP = no program

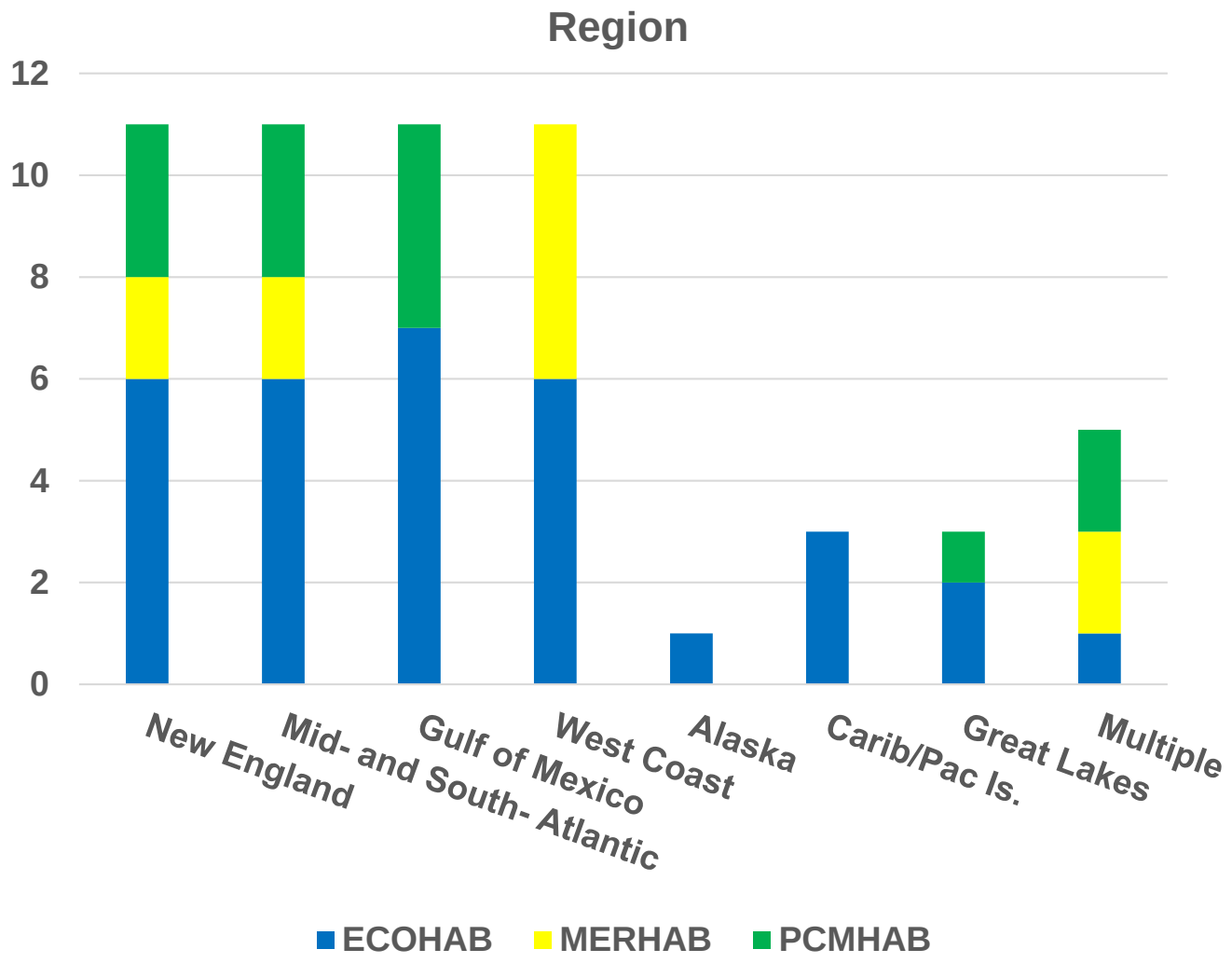
Regional Rotation of HAB Programs

Geographic Regions	2010	2011	2012/2015
Gulf of Mexico Caribbean Pacific Islands	MERHAB	ECOHAB	PCM HAB
West Coast Alaska Great Lakes	ECOHAB	PCM HAB	MERHAB
South Atlantic Mid-Atlantic Gulf of Maine	PCM HAB	MERHAB	ECOHAB

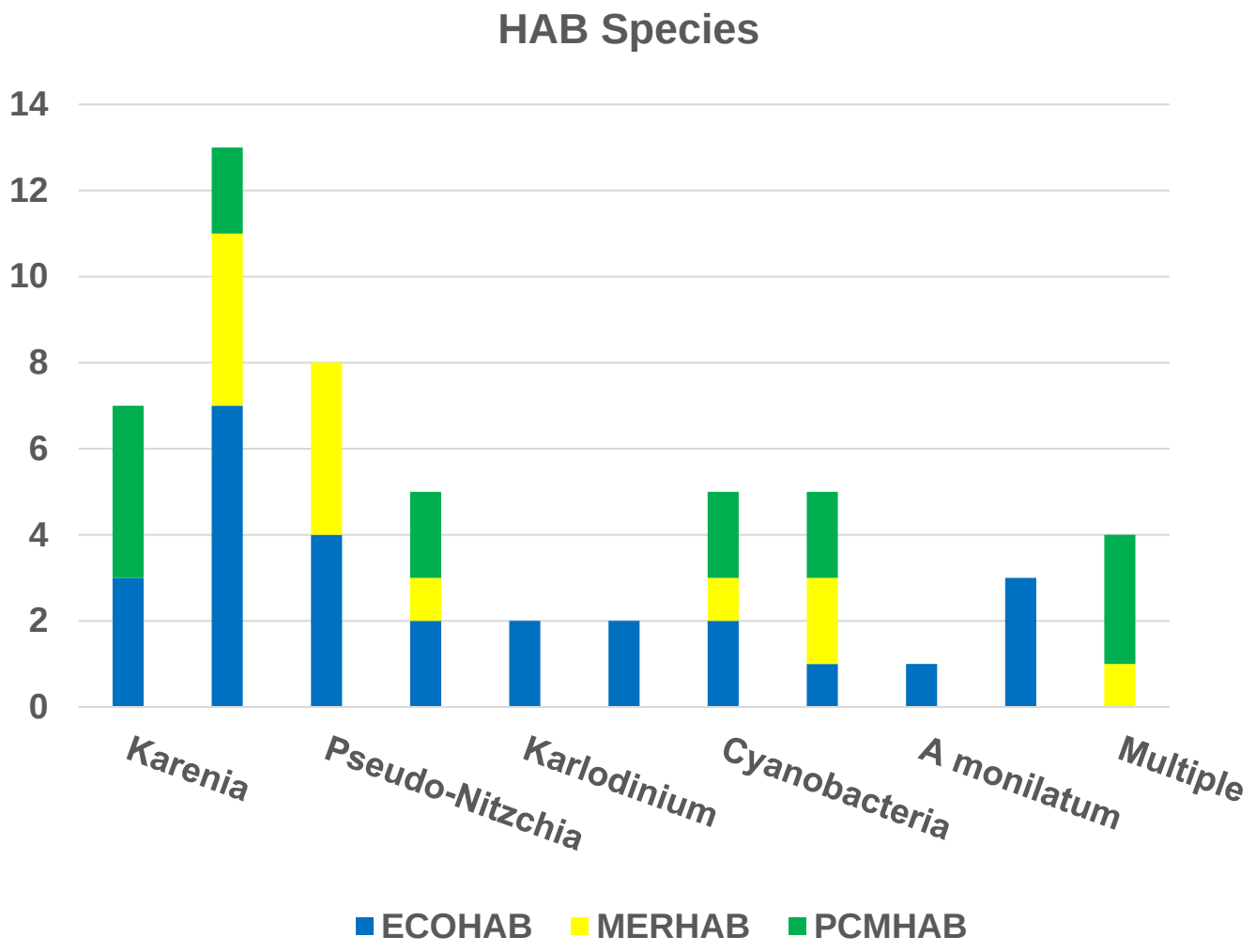
CRP HAB # Projects by NCCOS Priority



CRP HAB # Projects by Region



CRP HAB # Projects by Species



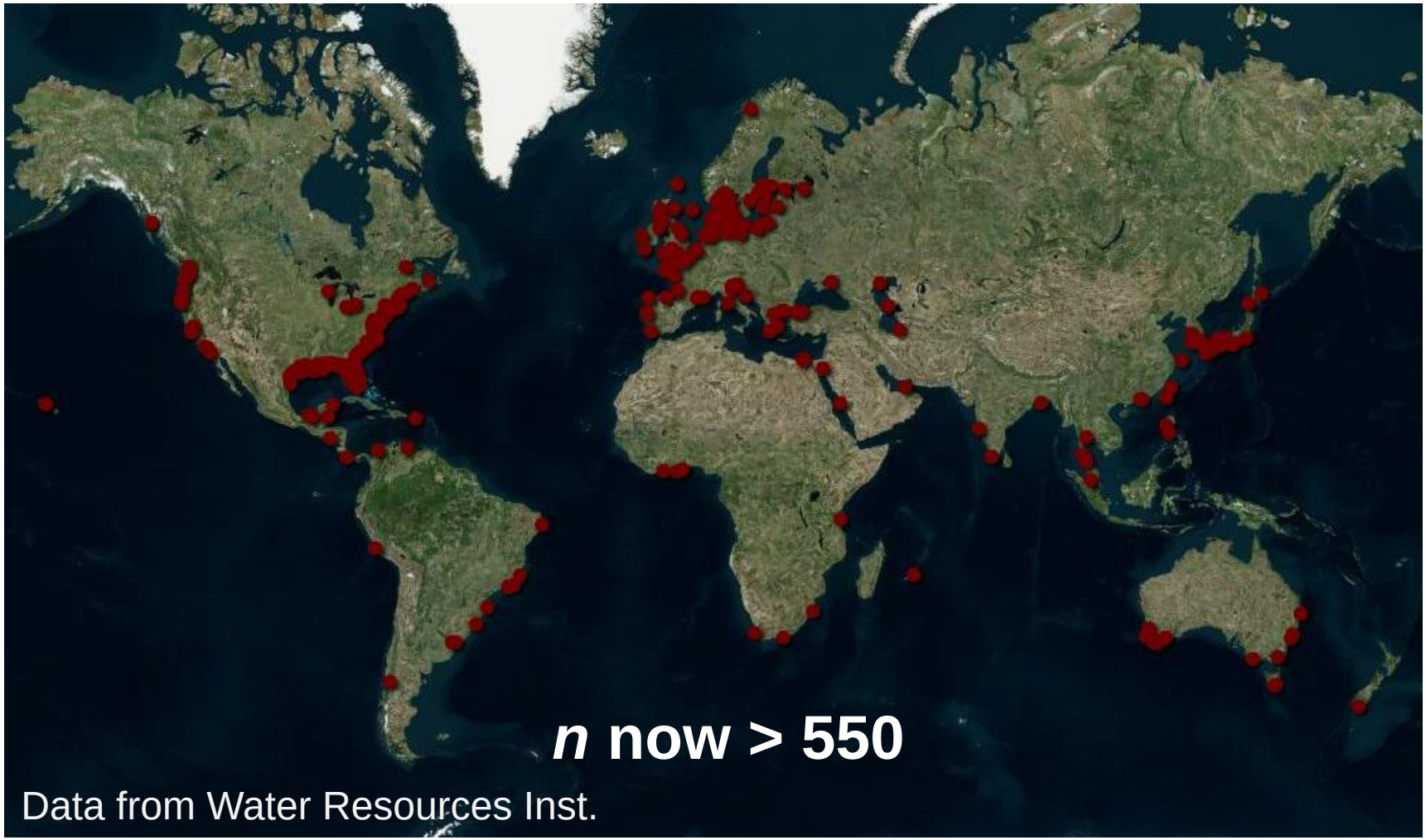
Introduction to NCCOS Hypoxia Research

Alan Lewitus
NOAA National Ocean Service
National Centers for Coastal Ocean Science

NCCOS HAB and Hypoxia Portfolio Review

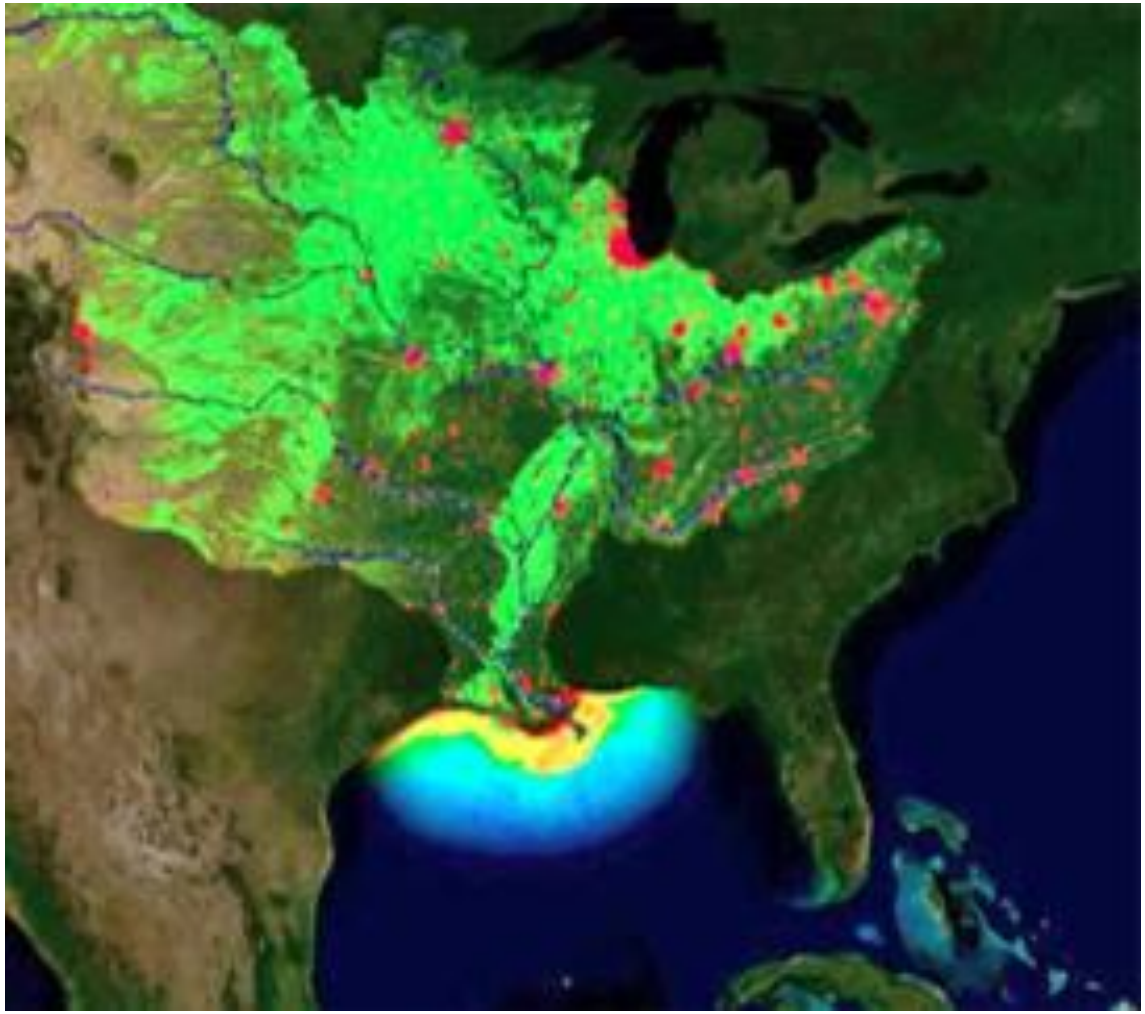
26 February 2018, Silver Spring, MD

Hypoxia – Global Expansion



Also: Breitburg et al. 2018. Declining oxygen in the global ocean and coastal waters. Science (05 Jan 2018): Vol. 359, Issue 6371, eaam7240. DOI: 10.1126/science.aam7240

Northern Gulf of Mexico Ecosystems and Hypoxia Assessment Program (NGOMEX)



Nutrient Enhanced Coastal Ocean Productivity in the Northern Gulf of Mexico (NECOP) Program

- **1990-1996: first major field effort of newly created Coastal Ocean Program**

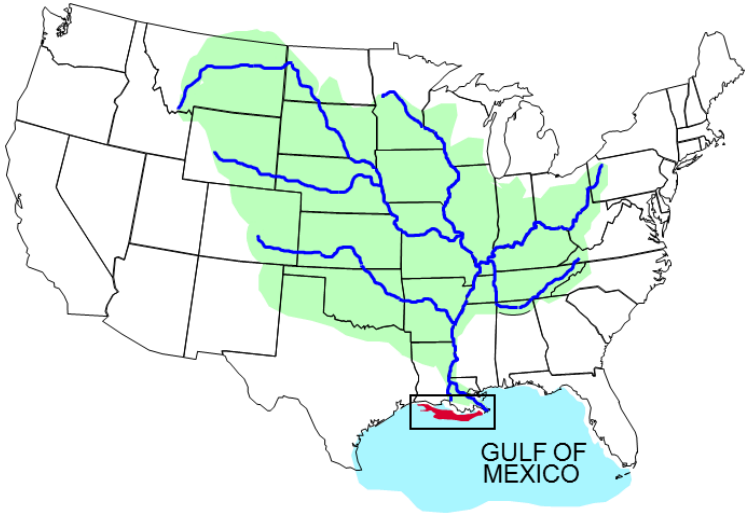
- **Revealed dead zone as a serious and growing environmental threat - triggered and informed Congressional development of HABHRCA legislation:**

  - **Authorized the NGOMEX Program to characterize the dynamics of the hypoxic zone and determine its causes and effects**
  - **establishment of monitoring program (supported by NECOP supplement in 1997-1999, NGOMEX from 2000 to 2014, NCCOS Base from 2015 to present)**
  - **formation of the interagency Mississippi River/Gulf of Mexico Watershed Nutrient Task Force (aka Hypoxia Task Force), established in the fall of 1997**
  - **mandate for an Action Plan (issued by the Task Force in 2001)**

NGOMEX Goals

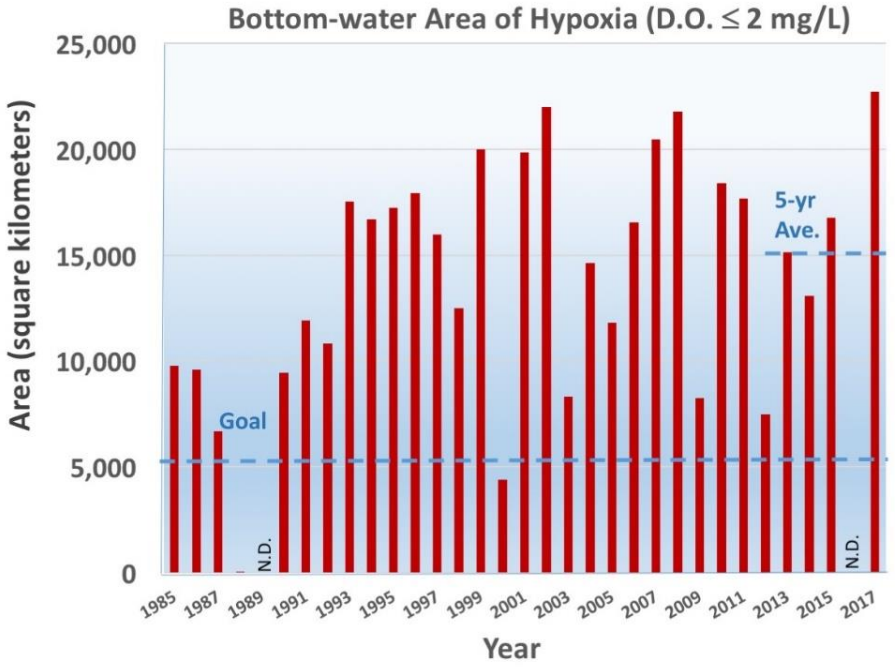
- **Develop a fundamental understanding of the northern Gulf of Mexico ecosystem with a focus on the causes/effects of the hypoxic zone and the prediction of its future extent and impacts; and**

- **Identify and fill critical research gaps used in the interagency adaptive management program that connects monitoring, data analysis, and model predictions with management actions to restore and protect the Louisiana continental shelf ecosystem.**



NGOMEX Objectives

- **Characterize the magnitude and extent of the hypoxic zone;**
- **Develop quantitative models to predict the extent of the hypoxic zone given varying levels of nutrient inputs, physical forcing, and other factors that control hypoxia;**
- **Develop quantitative models to determine the impacts of the hypoxic zone on ecologically and economically important living resources.**



NGOMEX - Management Needs Addressed

- **Hypoxia Task Force:**

  - Mid-summer ship survey measurement of dead zone areal extent, the metric for assessing progress of watershed nutrient reduction actions in mitigating hypoxia;

  - Scenario forecast models (regression-based, 3D time variable) that give the HTF guidance on nutrient reductions strategies and effective targets;

  - 3D time variable models that give temporal and spatial details of the influence of environmental drivers of hypoxia

NGOMEX - Management Needs Addressed (continued)

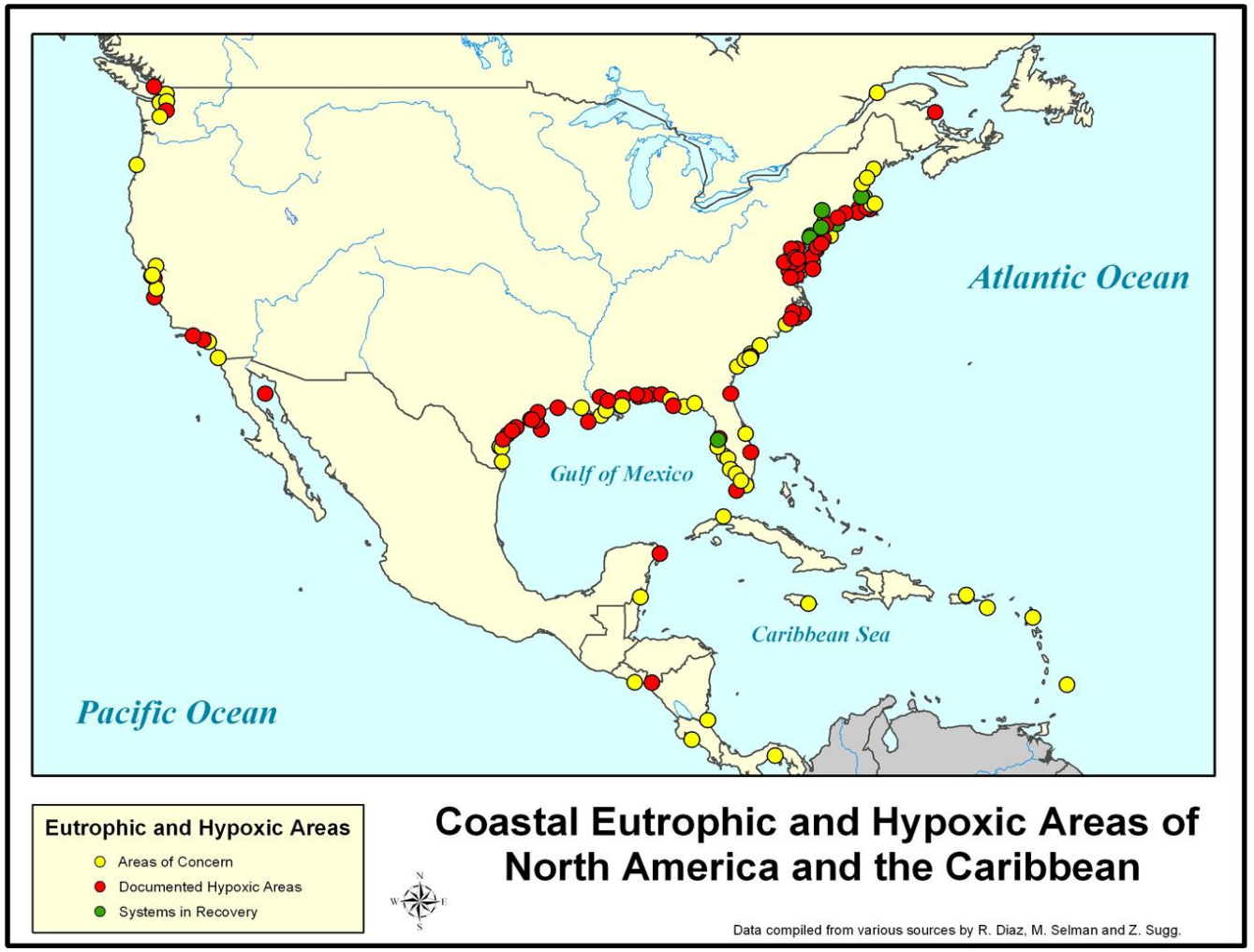
- **Resource Managers:**

  - ecological models to understand the effects of hypoxia on populations and habitats of fisheries for refining stock assessment and supporting ecosystem-based fisheries management

- **Water Quality, Resource, and Restoration Managers:**

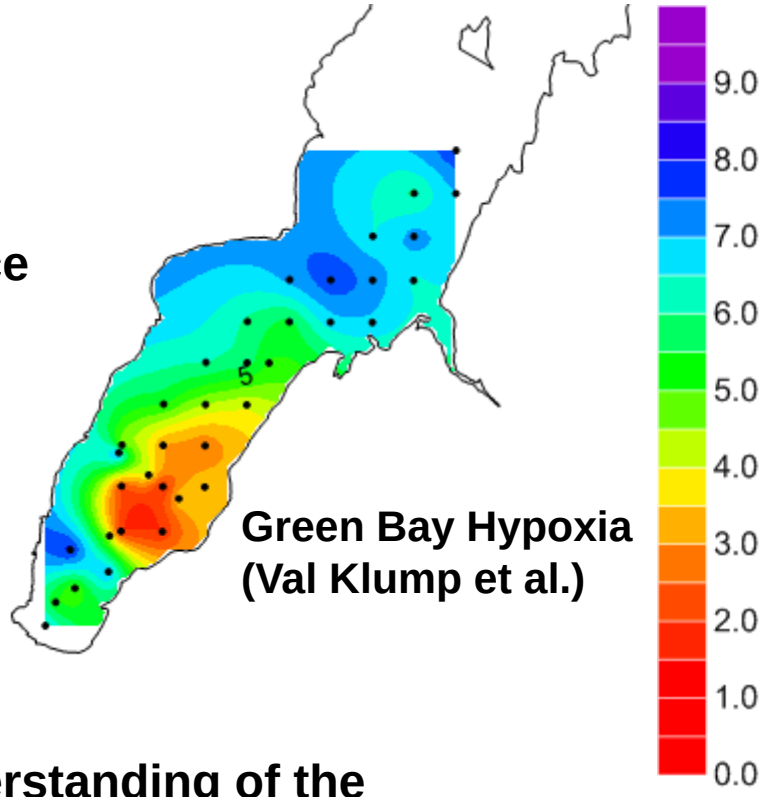
  - hydro/biogeochem/ecological coupled scenario forecast models to predict future effects of hypoxia and interactive factors (e.g. climate change, restoration activities such as freshwater diversions)

Coastal Hypoxia Research Program (CHRP)



CHRP Goals

- **Improve the capability of coastal managers to effectively prevent or reduce the ecological and socioeconomic impacts of hypoxia.**



Green Bay Hypoxia (Val Klump et al.)

Accomplished by:

- development of fundamental understanding of the causes and effects of hypoxia specific to a region;

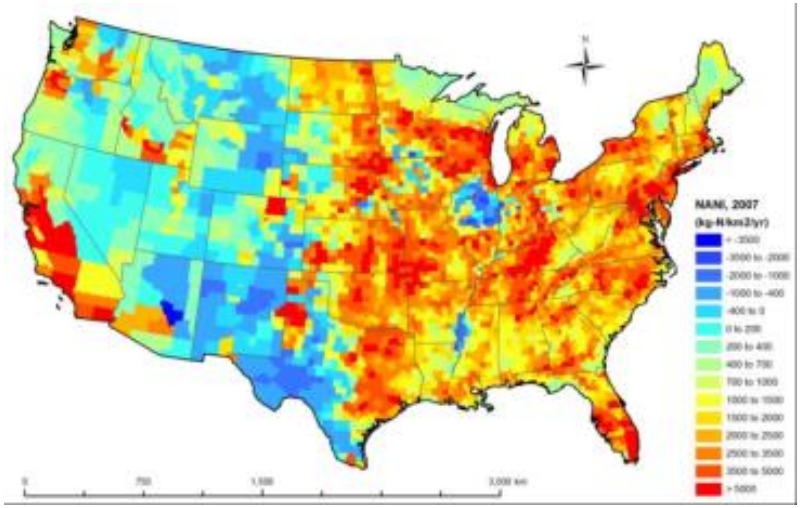
- making available forecasting tools to evaluate the effectiveness of alternative management strategies from an ecosystem level context.

CHRP Objectives

- **Quantify in a holistic manner the effects of specific natural and anthropogenic factors on the spatial and temporal extent of hypoxia;**

- **Quantify the ecological and socioeconomic impacts of hypoxia;**

- **Develop predictive models to assess the parameters of hypoxia under a range of environmental scenarios and alternative management strategies.**

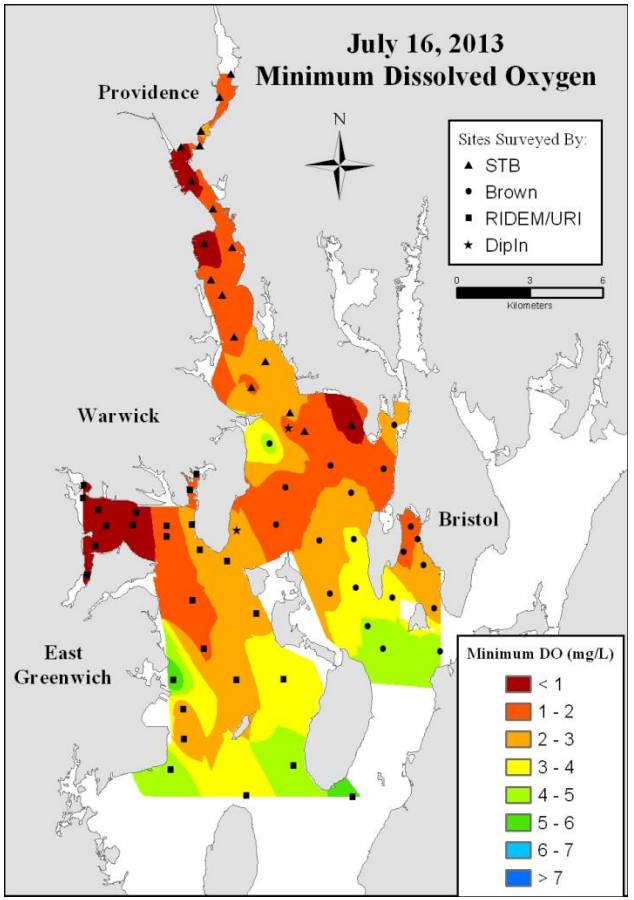


County-scale Net Anthropogenic Nitrogen Input in 2007, following Hong et al. (2011); Source: Don Scavia, (U. Mich)

CHRP – Management Needs Addressed

- **Provide scenario forecasting guidance on the effectiveness of hypoxia mitigation strategies - e.g. Narragansett Bay, Chesapeake Bay, Lake Erie, Green Bay, Delaware Inland Bays**

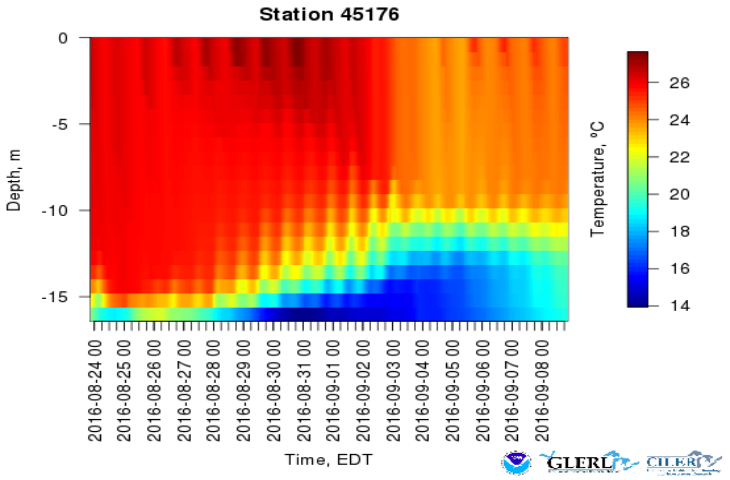
- **Nowcasts and short-term hypoxia forecasts used to inform decision-making by fishermen and coastal managers**



Source: Warren Prell (Brown U)

CHRP – Management Needs Addressed

- **Real-time nowcast/forecast (5-10 d) to provide public water systems with advance warning of hypoxia**



Model forecast of an upwelling event in 2016 that brought hypoxic water to drinking water plant intakes along the south shore of Lake Erie. Source: Craig Stow, GLERL.

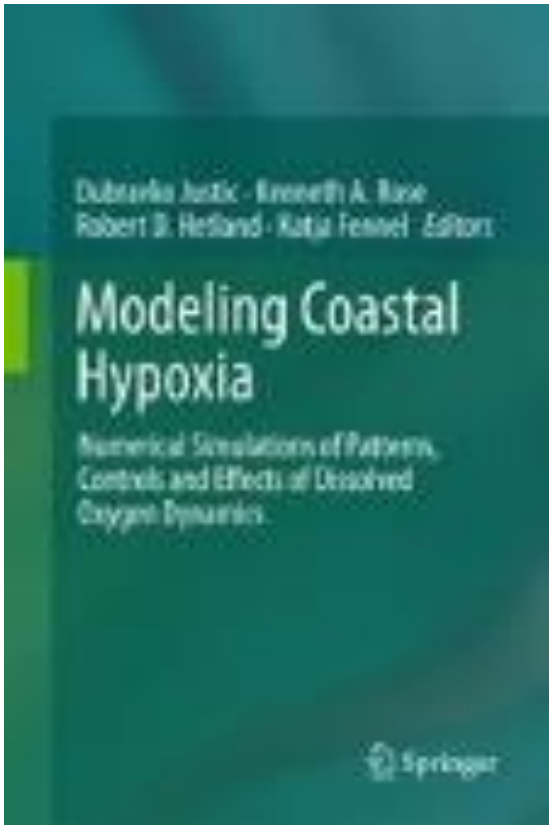
- **Determine effects of hypoxia on living resources, habitats, fisheries, and economies.**

Publications

- **NGOMEX: 124 since 2012**
- **CHRP: 97 since 2012**

- **Modeling Coastal Hypoxia: Numerical Simulations of Patterns, Controls and Effects of Dissolved Oxygen Dynamics. Justic, D., K.A. Rose, R.D. Hetland, and K. Fennel (eds.). 2017. 433 p.ISBN 978-3-319-54569-1**

[Twelve of 15 chapters feature research by 31 NCCOS sponsored scientists under NGOMEX or CHRP].



The End

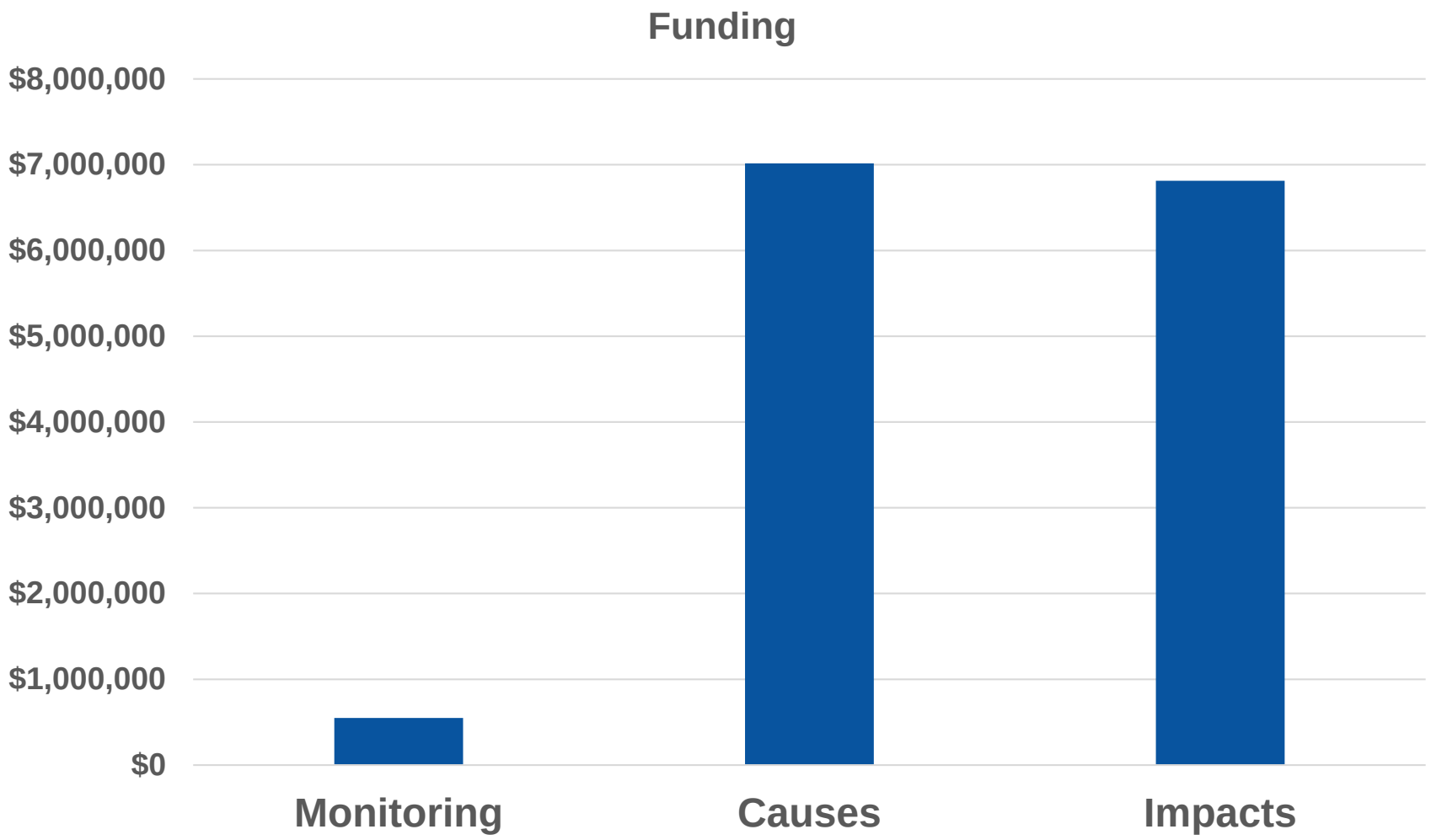
- **Next up –**

Nancy Rabalais (LSU/LUMCON) and Alan Lewitus (NCCOS). ***Hypoxia modeling, nutrient reduction targets, and stakeholder engagement***

NGOMEX Time Line of Competitions

Year	# Proposals	# Funded	Success Rate
2006	20	6	30%
2009	12	5	42%
2015 (Glider)	1	1	100%
2016 (Ecological Effects)	9	3	33%

2012-2018 NGOMEX Funding by Objective



CHRP Time Line of Competitions

Year	# Proposals	# Funded	Success Rate
2005	29	6	21%
2007	25	1	4%
2010	25	3	12%
2016	11	2	18%
2018	19	tbd	

2012-2018 CHRP Funding by Region