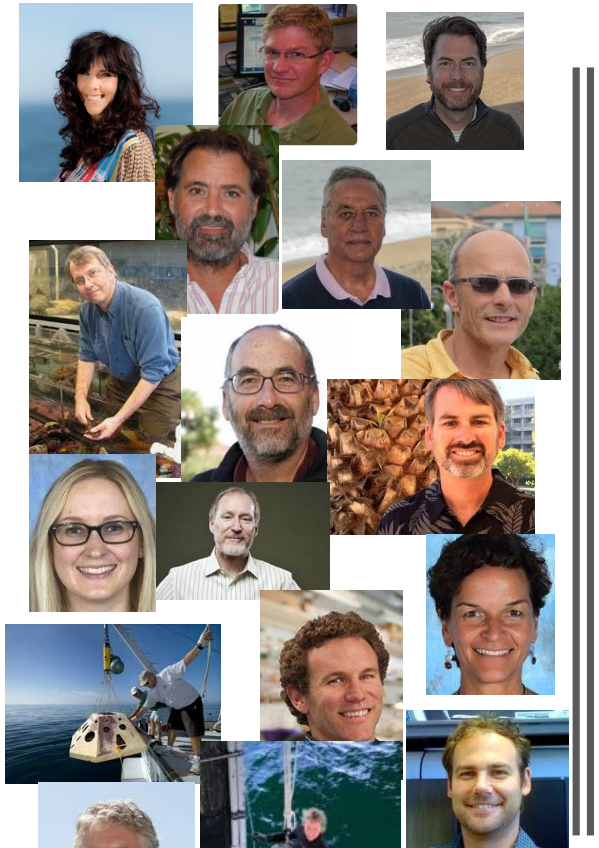
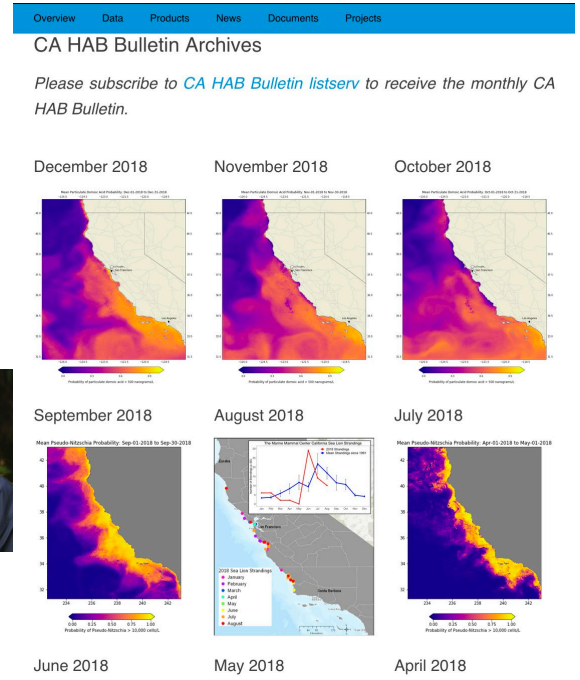
# IMPLEMENTATION OF AN AUTOMATED EARLY WARNING SYSTEM FOR HAB EVENTS IN CALIFORNIA

Clarissa Anderson, *Southern California Coastal Ocean Observing System (SCCOOS/SIO)*
Raphael Kudela, Brian Tissot, John Largier, Francisco Chavez, Henry Ruhl, Mark Brzezinski, David Siegel, Bob Miller, David Caron, Jayme Smith, Martha Sutula, George Robertson, Andrew Barton, Uwe Send, Melissa Carter, Andrew Allen

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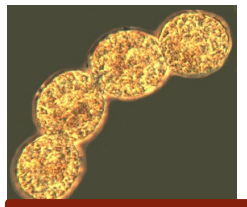
SOUTHERN CALIFORNIA COASTAL OCEAN OBSERVING SYSTEM

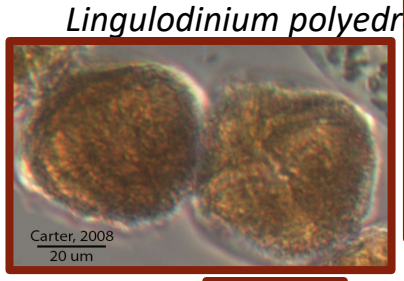
**Weekly measurements:**

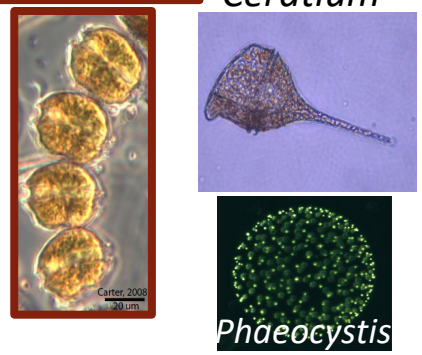
- Chl-a, Temp, Salinity, Nutrients
- HAB species (8-9 taxa)
- Domoic Acid + SPATT toxins
- Weekly alerts to HABMAP listserv
- Monthly QC'd data now served via ERDDAP
- Synthesis with models: CA HAB Bulletin

- **10 academic institutions**





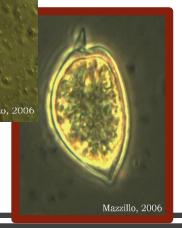















SOUTHERN CALIFORNIA COASTAL OCEAN OBSERVING SYSTEM

CENTRAL & NORTHERN CALIFORNIA OCEAN OBSERVING SYSTEM

# HARMFUL ALGAL BLOOM MONITORING & ALERT PROGRAM

*Cal-HABMAP was formally established in 2008 and is supported by SCCOOS & CeNCOOS*

SCCOOS
SOUTHERN CALIFORNIA
COASTAL OCEAN
OBSERVING SYSTEM

SIO/SCCOOS

Dale Robinson NOAA

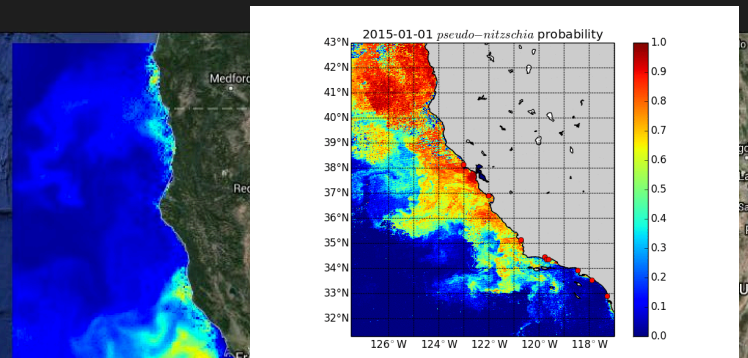
CeNCOOS Data Portal | Search for data | Catalog | Portal | 1 layers | Settings | BETA

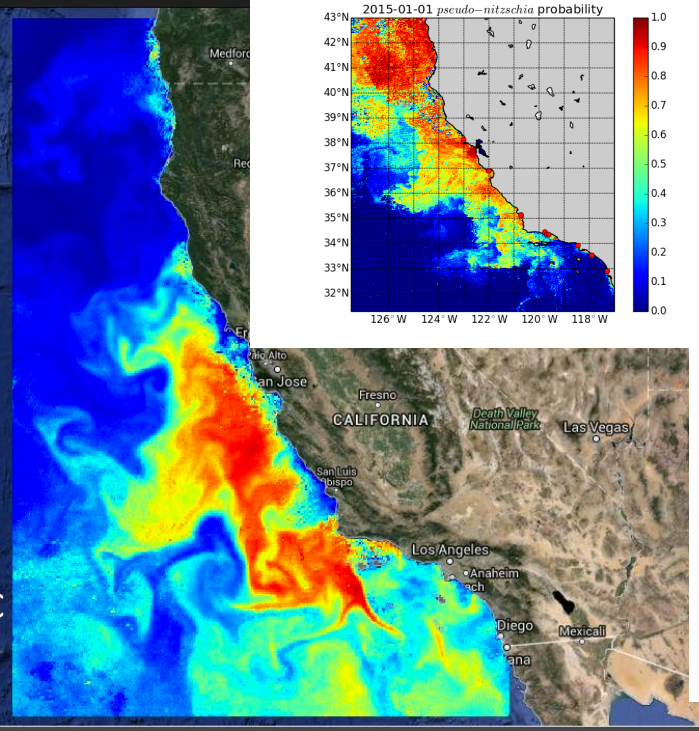
Uses operational 3-km CA ROMS + MODIS Ocean Color to create nowcasts + 3-day forecasts of DA probability

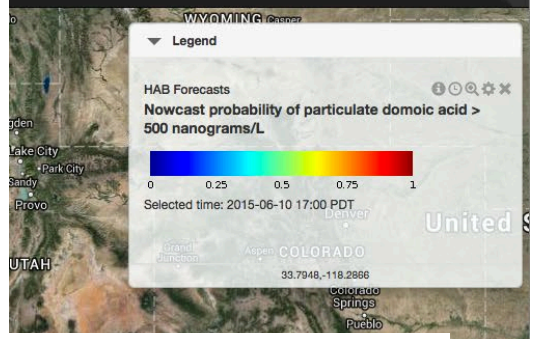
**transitioned to **operational** support at NOAA Coast Watch

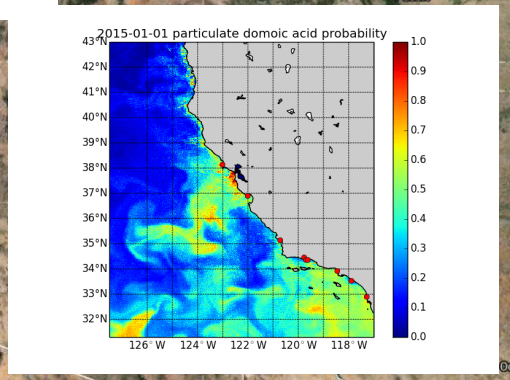
https://coastwatch.pfeg.noaa.gov/erddap/griddap/charmForecast3day.graph

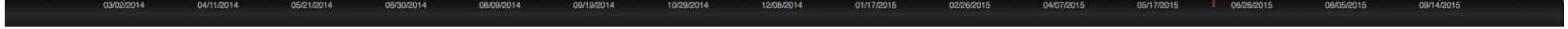
feedback



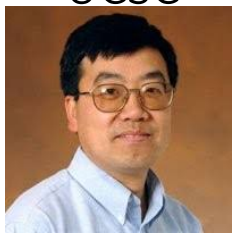




CeNCOOS
CENTRAL & NORTHERN
CALIFORNIA OCEAN
OBSERVING SYSTEM

Raphe Kudela
UCSC



Yi Chao -UCLA

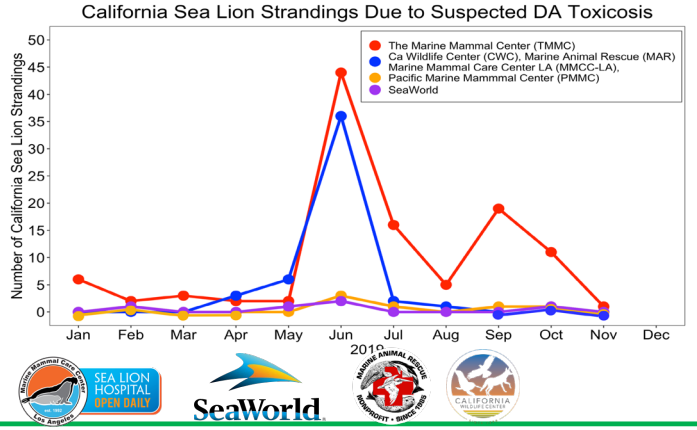
# California Harmful Algae Risk Mapping (C-HARM) System

*Operational model at NOAA Coast Watch that relies on the UCLA ROMS routine products*

- Extensive collaboration with all partners on creation of a monthly **CA HAB Bulletin** distributed via listserv and SCCOOS & HABMAP

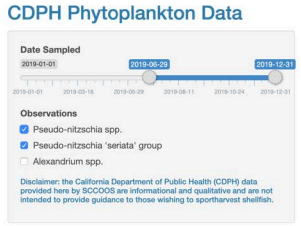
Anderson et al., *Harmful Algae* (2009), *GRL* (2011), *Harmful Algae* (2016)

## CA Marine Mammal Suspected DA Strandings

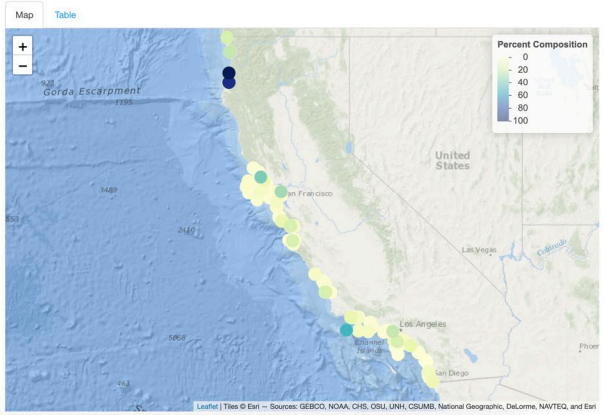




The Marine Mammal Center · PACIFIC MARINE MAMMAL CENTER · SEA LION HOSPITAL OPEN DAILY · SeaWorld

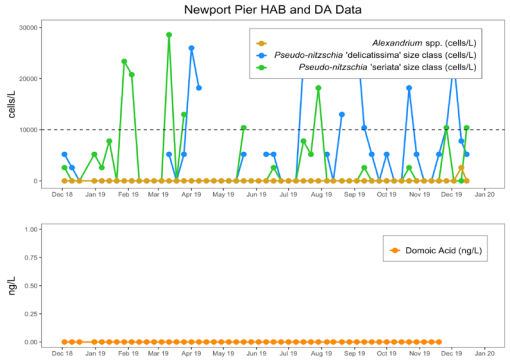
## California Department of Public Health (CDPH)



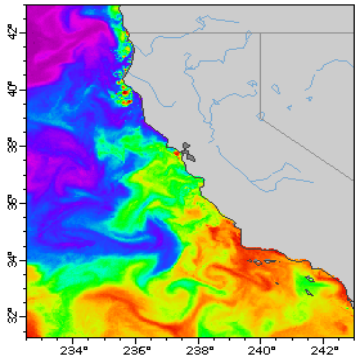

California Department of PublicHealth



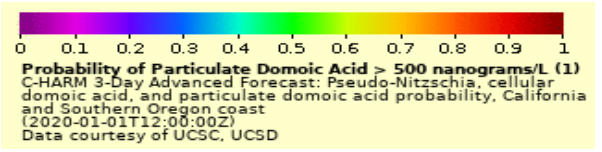

## HABMAP weekly sampling at 9 piers for HAB species & DA


## CA Harmful Algae Risk Mapping (C-HARM) System




Probability of particulate domoic acid Jan 1 -31, 2020




# California Harmful Algal Bloom Bulletin

*Provides a more complete picture of the regional variability in harmful algal blooms*

Monthly reports synthesize model output, near real-time observations, animal strandings, and public health alerts

SOUTHERN CALIFORNIA COASTAL OCEAN OBSERVING SYSTEM

# CA Ocean Protection Council Proposition 1 Round 3

OCEAN PROTECTION COUNCIL

**PROPOSITION 1 - ROUND 3**

Grant Program Funded by the Water Quality, Supply, and Infrastructure Improvement Act of 2014

**Grant Proposal Solicitation and Application Instructions**

*Applications due March 18, 2019*

PROP 1
GOVERNOR GAVIN NEWSOM
WATER BOND 2014
RELIABILITY | RESTORATION | RESILIENCE

# CA OPC Priority Issues for Prop 1

These are the OPC's current priority areas for grant support using Proposition 1 funding.

| Issue Areas | Priority Issue Area |
|---|---|
| **Marine Managed Areas** | ➢ MMAs: Projects that protect marine managed areas (MMAs)[3] - including the MPA Network - and help them to meet statutory goals[4].<br>➢ ASBSs: Projects that protect Areas of Special Biological Significance[5] (ASBSs) and help them to meet their statutory goals. |
| **Coastal and Ocean Water Quality Impacts** | ➢ Reduce pollution and contaminants, including nutrients, toxics, and contaminants of emerging concern from sources including stormwater, non-point source discharges, agricultural runoff, etc. Project is higher priority if discharges have historically and measurably impacted designated MMAs and/or ASBSs.<br>➢ Prevent land-based litter from reaching the ocean and becoming marine debris.<br>➢ Remove marine debris, including but not limited to derelict vessels and fishing gear, abandoned aquaculture materials, disused creosote pilings, and illegal artificial reefs, where liable owners or responsible parties cannot be identified.<br>➢ Remove microplastics and microfibers from sources including, but not limited to, wastewater effluent, agricultural runoff, and stormwater.<br>➢ Improve ability to detect and respond to Harmful Algal Blooms (HABs), including ability to assess conditions that may lead to toxin production or blooms of toxin-producing algae[6]:<br>o Improve understanding of offshore bloom dynamics and bloom timelines;<br>o Advance predictive modeling tools and better link models and model outputs to monitoring and management;<br>o Improve scientific understanding of the ecophysiology of marine HAB species (i.e., the study of the interrelationship between the normal physical function of HAB species and their environment), and improving understanding of how bio-toxins move through food webs; and<br>o Advancing research on the relationship between HABs and human health. |
| **Fisheries** | ➢ Fisheries infrastructure that protects or enhances marine and estuarine ecosystems.<br>➢ Restore habitat for marine, estuarine, and diadromous (anadromous and catadromous) fish. |
| **Climate Change** | ➢ **Sea-level Rise**: Promote risk reduction and resiliency of the built and natural environment in the face of sea-level rise, including innovative design elements and approaches such as living shorelines and nature-based infrastructure.<br>➢ **Sea-level Rise and Toxics**: Support projects that address needs of communities at risk of exposure to toxic or hazardous sites due to sea-level rise and flooding.<br>➢ **Ocean Acidification and Hypoxia**: Reduce impacts of these stressors to marine and estuarine ecosystems, natural resources and fisheries. |

# Scoring Criteria

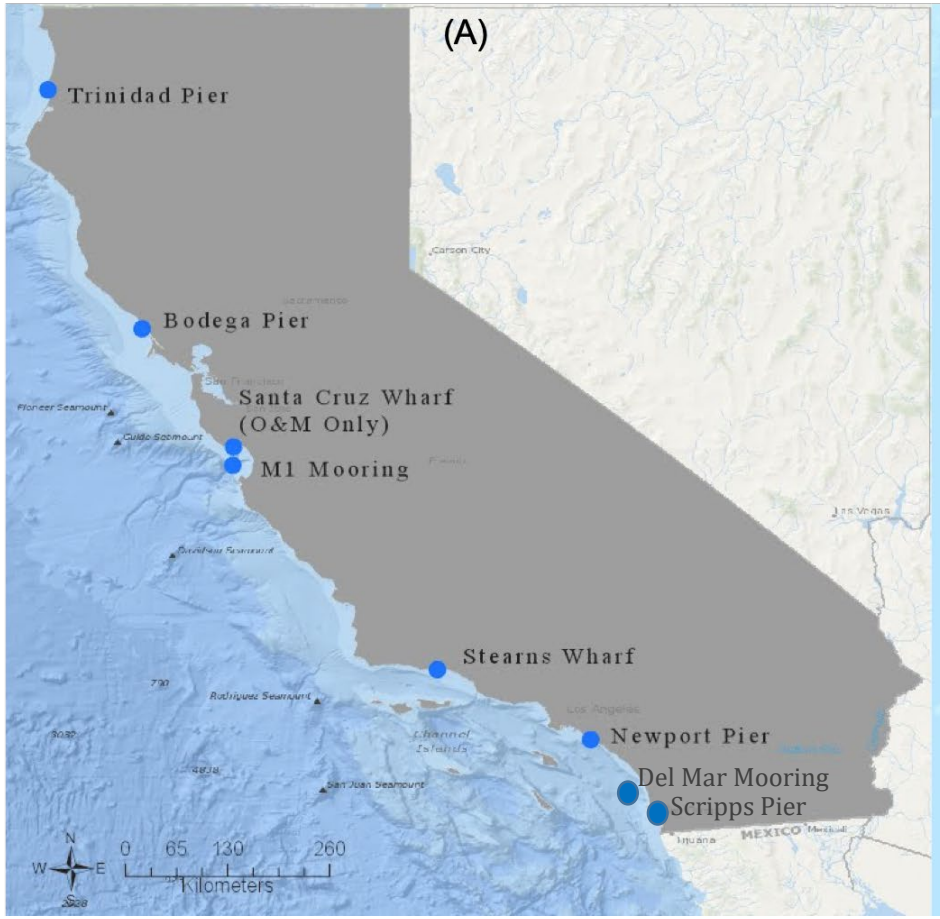
**3.6 Evaluation Criteria and Scoring for Proposals**

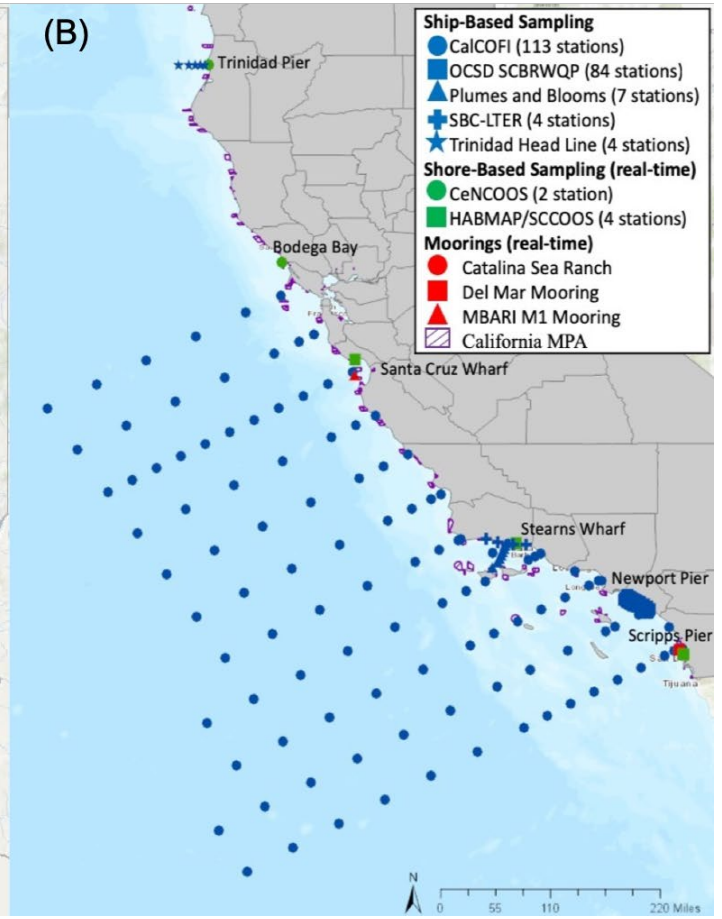
| SCORING CRITERIA FOR PROPOSALS | |
|---|---|
| **The extent to which the project proposal:** | **Points** |
| Includes complete, reasonable and well thought out proposal elements, including proposed scope of work (3 points), budget (3 points), and schedule (3 points). | 9 |
| Applicant demonstrates capacity to execute project, including<br>• Applicant has experience successfully implementing similar projects or demonstrates appropriate and necessary partnerships to complete the project. When applicable, the applicant shows that it can hire or contract with experienced scientific staff in an area of specialty that would improve the potential success of the underlying proposal. (4 points)<br>• Applicant has existing infrastructure or administrative capacity to develop, manage and implement the project successfully. (2 points) | 6 |
| Applicant clearly articulates how the project promotes and implements the goals and actions of the California Water Action Plan[15] (CWAP) | 10 |
| Provides **multiple benefits in OPC Key Priority Areas** described in Section 1.5. OPC seeks projects that remove or reduce multiple stressors from the ocean and near coastal environment. Proposals receive 5 points for the project's direct relevance to each of the four OPC Priority Issues (Marine Managed Areas; Coastal and Ocean Water Quality Impacts; Fisheries; and Climate Change) | 20 |
| Utilizes green infrastructure (2 points), natural systems (2 points), or systems that mimic natural systems (2 points). | 6 |
| Employs new, innovative, or proven technologies or practices to improve the manner in which the state manages ocean and coastal resources. Applicant demonstrates how the proposed technologies and practices are innovative in comparison to similar projects and the current practices and technologies. | 5 |
| Is consistent with best available science. Applicant demonstrates how relevant science used is up to date and appropriate for projects for the specific topic, as well as the feasibility of proposed work.<br>• Contains technical/scientific merit (5 points)<br>• Determining project effectiveness is very feasible (5 points)<br>• Project has a high likelihood to fulfill its stated goals and objectives (5 points) | 15 |
| Has a clear and reasonable method for measuring and reporting project effectiveness. (Section 4.5) | 10 |
| Has both local community support and greater than local interest.<br>• Project has local community support, as demonstrated by the submittal of correspondence demonstrating local support of the project (2 points)<br>• Project also has support from outside of the project area, as demonstrated by the submittal of correspondence from outside the project area. Prefer projects that demonstrate solutions that could be implemented regionally and/or statewide (2 points) | 4 |
| Project benefits disadvantaged communities as described in Section 2.6 | 10 |
| Project leverages private, federal or local funding sources: projects with at least 25% matching funds (1 point); more than 50% matching funds (2 points); or 100% matching funds (5 points).[16] | 5 |
| **Total possible points** | 100 |

# Unconventional Funding Opportunity

*CA Ocean Protection Council administers $30M in bond funds for coastal infrastructure*

Began proposal scoping at SIO in Spring 2018 in prep for Round 3

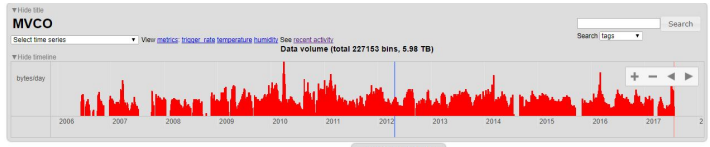


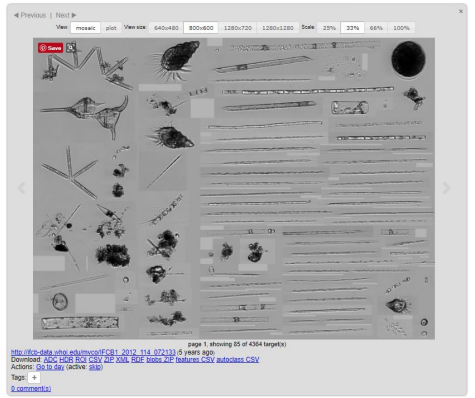




## Imaging FlowCytobot (IFCB) Network

10 IFCBs Total: 6 piers + 2 moorings

- 6 new IFCBs via OPC
- 1 new via ECOHAB (PI Allen)
- 3 extant (PI Kudela)




SOUTHERN CALIFORNIA COASTAL OCEAN OBSERVING SYSTEM

CENTRAL & NORTHERN CALIFORNIA OCEAN OBSERVING SYSTEM

# Proposed IFCB Network Design

*Highly leveraged with cost-share from 10 partner institutions across academia & industry*

OCEAN PROTECTION COUNCIL

About Program Areas Funding

Ocean Protection Council Meeting — November 13, 2019, Sacra

OCEAN PROTECTION COUNCIL

**OPC Meeting Agenda**
Wednesday, November 13, 2019 1:00 pm
Natural Resources Agency Auditorium
1416 9th Street, Sacramento, California 95814

**REVISED ON NOVEMBER 8, 2019**

Wade Crowfoot, Secretary for Natural Resources, Council Chair
Jared Blumenfeld, Secretary for Environmental Protection
Eleni Kounalakis, Lieutenant Governor, Chair of the State Lands Commission
Ben Allen, State Senator
Mark Stone, State Assemblymember
Michael Brown, Public Member
Jordan Diamond, Public Member

1. **Moment of Silence in Memory of Adrian Dahood-Fritz**
2. **Welcome, Introductions and Council Member Announcements**
   *Secretary Crowfoot, Council Chair*
3. **Introduction and Report from the Executive Director**
   *Mark Gold, Executive Director*
4. **Report from the Science Advisor**
   *Liz Whiteman, Executive Director, Ocean Science Trust*
5. **Discussion Item: Discussion of 2020-2025 Strategic Plan to Protect California's Coast and Ocean (Possible ac**
   *Mark Gold, Executive Director*
   - Exhibit A: Proposed Strategic Plan
6. **Action Item: Discussion and Possible Adoption of Investment Strategy to Minimize Whale and Sea Turtle Ent**
   *Jenn Eckerle, Deputy Director*
   - Exhibit A
7. **Action Item: Consideration of Authorization to Disburse Proposition 1 Funds – Revised on November 12, 2019**
   *Marina Cazorla, Program Manager*

Staff Recommendation
*Revised November 12, 2019*
November 13, 2019

## CONSIDERATION OF AUTHORIZATION TO DISBURSE FUNDS FOR PROPOSITION 1 PROJECTS

Marina Cazorla, Program Manager

**RECOMMENDED ACTION:** Staff recommends that the Ocean Protection Council (OPC) approve the disbursement of $2,~~6~~742,344 to various grantees as follows:

7a. $928,309 to The Nature Conservancy for the Resilient Ormond Beach Planning Project
7b. $529,000 to the Newport Bay Conservancy for the Big Canyon Coastal Habitat Restoration and Adaptation Project
7c. $1,~~1~~285,035 to the Regents of the University of California for the Automated Early Warning System for Harmful Algal Bloom (HAB) Events in California

**LOCATION:** Ventura County, Orange County, and Statewide; see Exhibits for more detailed project-specific locations and site maps.

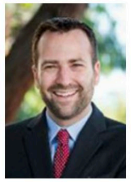
**STRATEGIC PLAN OBJECTIVE(S):** Climate Change; Sustainable Fisheries and Marine Ecosystems; Coastal and Ocean Impacts from Land-Based Sources

Rotates w/ CA Lt Gov.


Wade Crowfoot Secretary for Natural Resources, Council Chair


State Controller Betty T. Yee


Jared Blumenfeld Secretary for Environmental Protection


Ben Allen, State Senate


Mark Stone, State Assembly

Michael Brown Public Member


Jordan Diamond Public Member

*zorla@resources.ca.gov specifying item of*

- Members were asked to vote on a revised agenda that included funds for 6 IFCBS
- Public Comment Section – Stakeholders advocated for the network

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# CA Ocean Protection Council voted November 2019

- *Not the end of the line: Edits and new documents Nov 2019-June 2020*
- *Contract between UC San Diego and THE STATE approved 2 June 2020*

**PCMHAB 2020: Harmful Algal Bloom Community Technology Accelerator**

C. Anderson (SCCOOS), Rob Bochenek (Axiom), Heidi Sosik & Stace Beaulieu (WHOI), Raphe Kudela (UCSC), Henry Ruhl (CeNCOOS)

**Technical Advisory Committee:**

Barb Kirkpatrick, GCOOS
Jan Newton, NANOOS
Jake Kritzer/Tom Shyka, NERACOOS
Lisa Campbell, Texas A&M
Andrew Barton, SIO
Abigail Benson, USGS/OBIS
Mike Brosnahan, WHOI
Stephanie Moore, NWFSC
Holly Wyer, CA OPC

Task 1. Stand up Transition Advisory Committee (TAC) and convene scoping workshops in Years 1 and 2 (Leads: Anderson, Ruhl).

Task 2. Provide cyberinfrastructure for CA IFCB Network data feeds (Leads: Bochenek, Beaulieu)

Task 3. Plan for, ingest, and curate additional HAB data types and operational HAB forecast and nowcast biophysical modeling systems (Leads: Bochenek, Sosik. Beaulieu)

Task 4. Centralize, assess and optimize ML models and training data sets used by isolated groups across the community (Leads: Sosik, Bochenek, Beaulieu, Kudela)

Task 5. Develop a Transition Plan to support technology transfer (Lead: Anderson).

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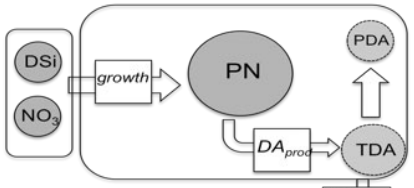
## Synergistic projects that will leverage the IFCB Network

*NOAA NCCOS will likely fund us to establish a national HAB Data Assembly Center that uses the CA IFCB Network as a prototype*

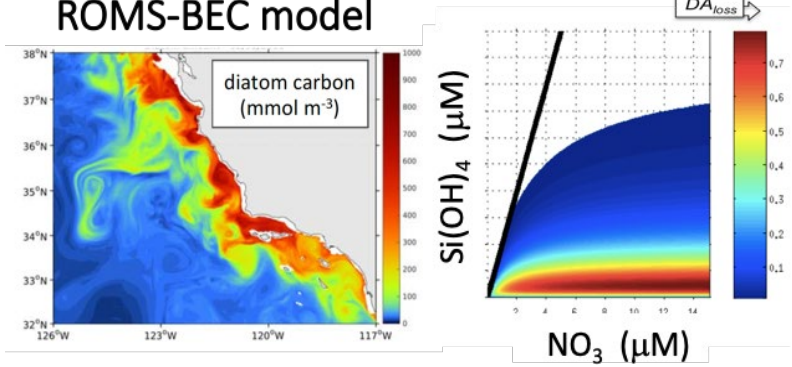
## NOAA ECOHAB 2018

Daniele Bianchi, Jim McWilliams,
C. Anderson, Raphe Kudela, Martha Sutula

**GOAL: Mechanistic modeling of DA production in a 3D coupled model**




ROMS-BEC model

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Ucla

SCCWRP
Established 1969

MBARI

SOUTHERN CALIFORNIA COASTAL OCEAN OBSERVING SYSTEM

## NOAA ECOHAB 2019

Andy Allen, Brad Moore (Monica Thukral), Chris Scholin, John Ryan, Jim Birch, Greg Doucette, Clarissa Anderson, Drew Lucas

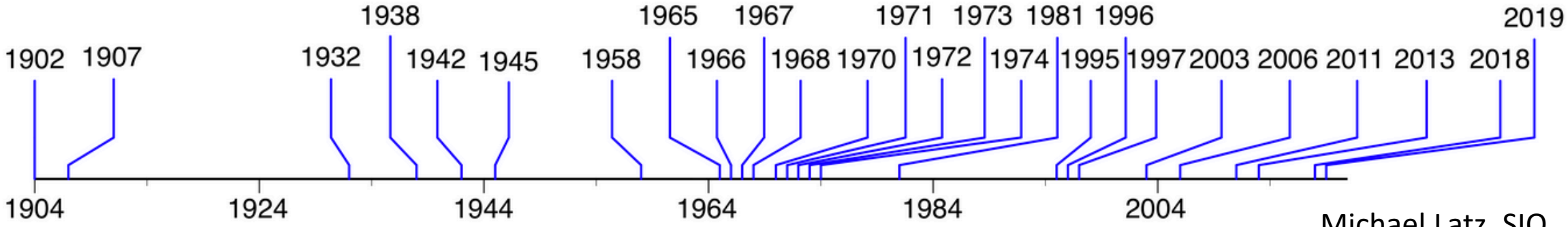
**GOAL: Link genes to ecosystems to identify mechanistic drivers of variability in HAB toxicity in the California Current**




IFCB deployed on CalCOFI cruises


## Synergistic projects that will leverage the IFCB Network

- Data from the IFCBs will be used to parameterize and validate models
- Offshore presence of *dab* genes will be compared to IFCB and HABMAP data


Michael Latz, SIO

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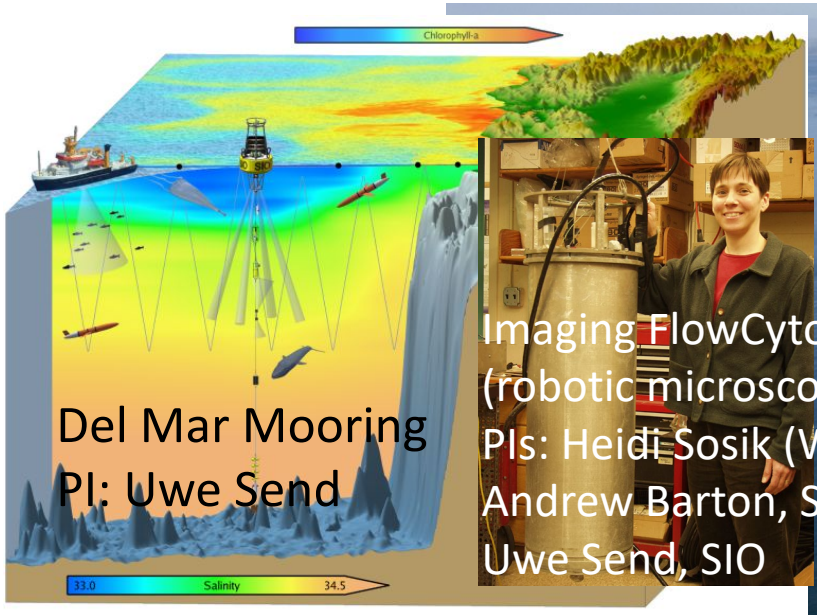
# Early Warning of HABs: Offshore Initiation of a Red Tide

*Bioluminescent "red tide" occurred from March – June 2020*




Del Mar Mooring
PI: Uwe Send

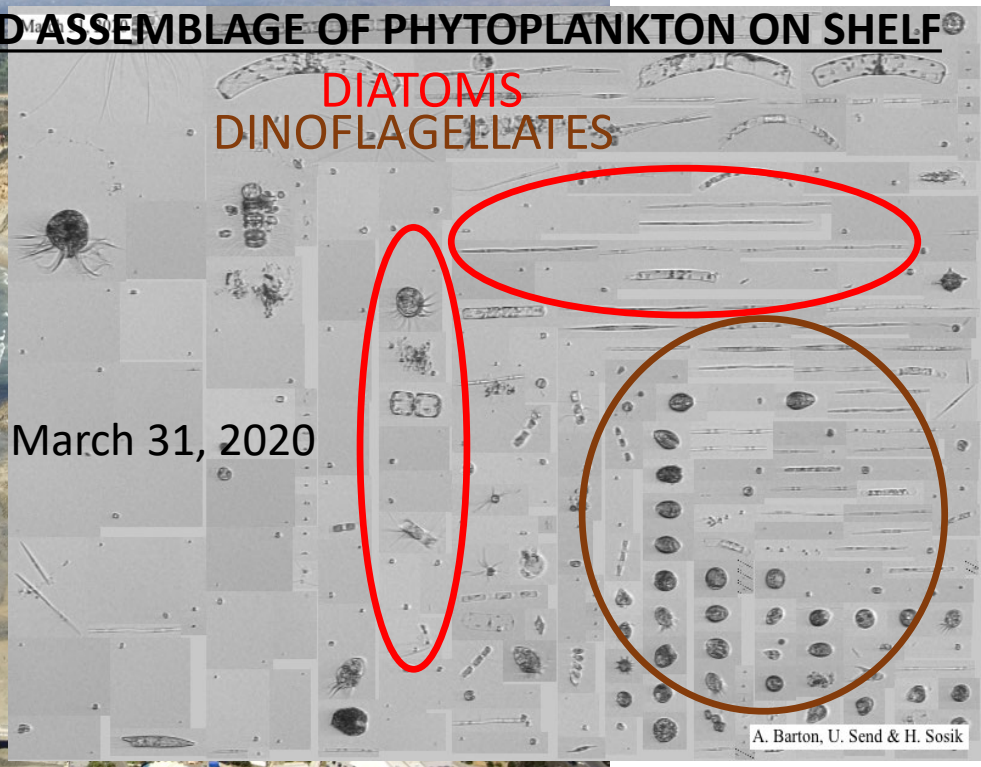


Imaging FlowCytobot
(robotic microscope)
PIs: Heidi Sosik (WHOI),
Andrew Barton, SIO
Uwe Send, SIO

**MIXED ASSEMBLAGE OF PHYTOPLANKTON ON SHELF**

DIATOMS
DINOFLAGELLATES

March 31, 2020

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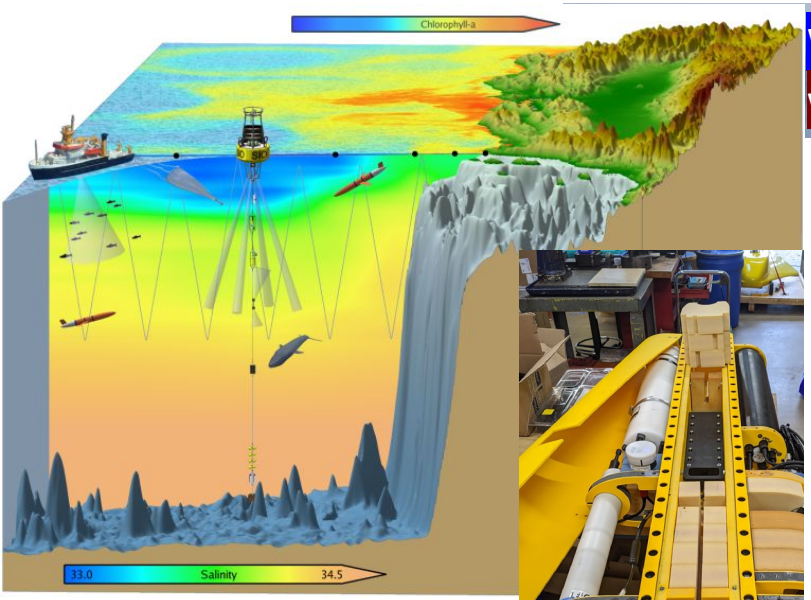
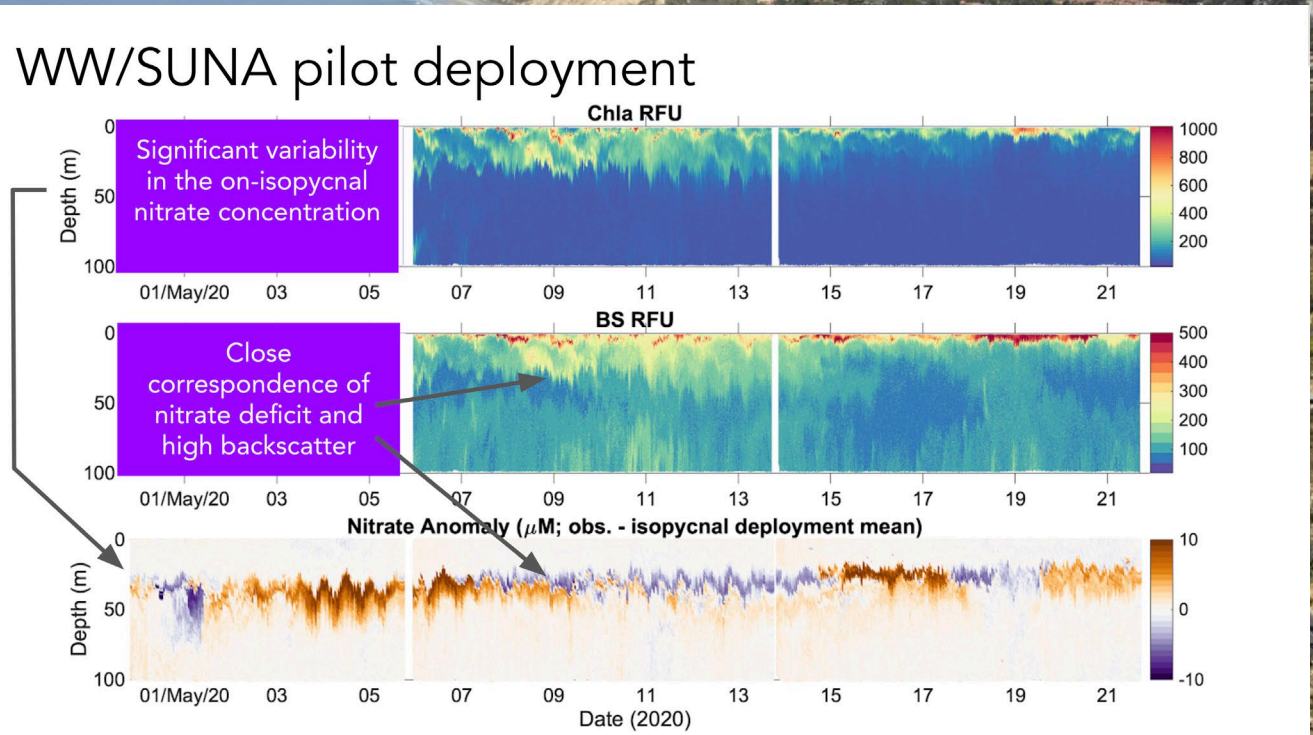
# Early Warning of HABs: Offshore Initiation of a Red Tide

*IFCB deployment on Del Mar mooring caught bloom initiation during COVID-19 shutdown*



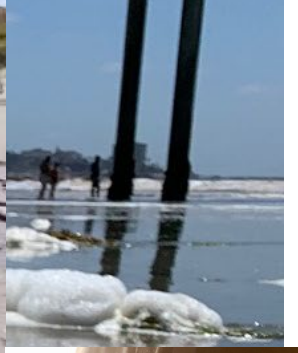

WireWalker
with a Nitrate Sensor

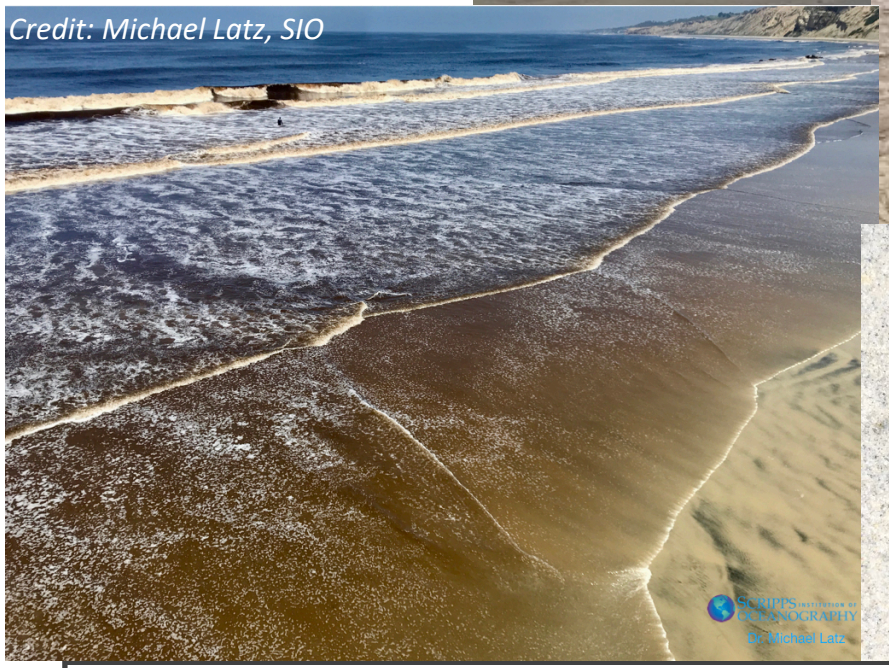



SOUTHERN CALIFORNIA COASTAL OCEAN OBSERVING SYSTEM

# Internal Tide-Driven Dynamics Captured with Autonomous Platforms

*Bloom initiation and maintenance resolved with remote sensors during COVID-19 shutdown*







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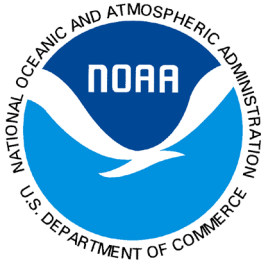
# *Lingulodinium polyedra* bloom turned noxious and deadly

- *Bloom decay captured by autonomous sensors and proved to be unprecedented for the region*
- *NCCOS Event Response funds will allow us to ascertain varying levels of YTX stress vs. OAH stress*













Thank you for inviting me to the FL HAB Task Force

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