Are we in a new era of marine mammal mortality events associated with harmful algal blooms in California?

Clarissa Anderson, PhD
Director, SCCOOS + CIMEAS

Marine Mammal Commission 2025 Annual Meeting, *September 11*

SOUTHERN CALIFORNIA COASTAL OCEAN OBSERVING SYSTEM

SCRIPPS INSTITUTION OF OCEANOGRAPHY
UC San Diego

IOOS Integrated Ocean Observing System

Clarissa Anderson, Ph.D.
Director

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Deputy Director

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IoT Data Scientist
Data Product and Web App Development

Danielle Muller
Program Coordinator
Administrative Assistant, Outreach, & Blue Economy

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Integrated Ecosystem Data Products and Service Delivery

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Board Chair, PI
UCSB Professor

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Executive Chair, PI
SIO Professor

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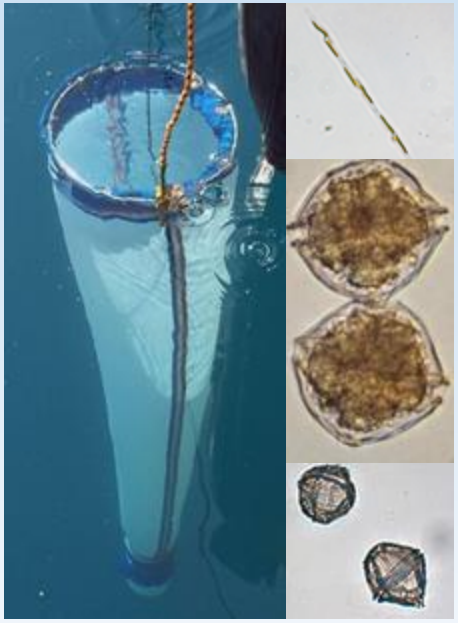
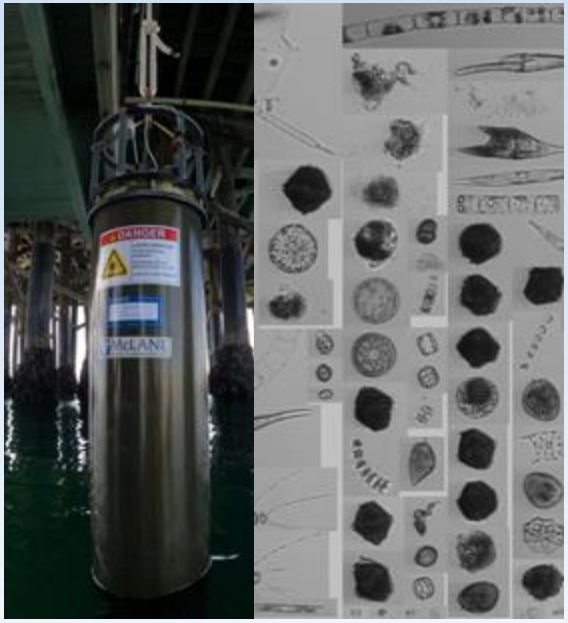
Research Scientist,
SCCOOS/IOD
HAB Early Warning System

SOUTHERN CALIFORNIA COASTAL OCEAN OBSERVING SYSTEM

Program Office & Leadership



CA HAB Monitoring Alert Program (CalHABMAP) - Weekly net tows & water samples since 2008



CA Imaging FlowCytobot Network (CA IFCB Network) - Real-time automated *in situ* microscopic imaging

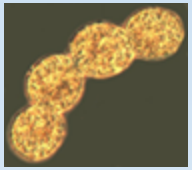
Harmful Algal Bloom Monitoring & Implementation of an Early Warning System

Operate, sustain, and expand HAB monitoring in support of a National HAB Observing Network.
PI: Anderson/Carter (SIO), Caron (USC), Brzezinski (UCSB), Pasulka (Cal Poly SLO)

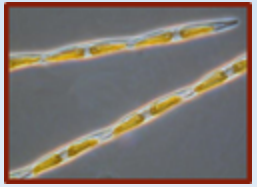
Weekly measurements:

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

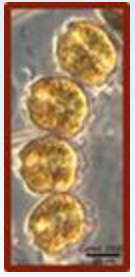
10 Institutions



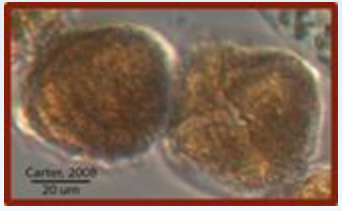
Pseudo-nitzschia



Alexandrium

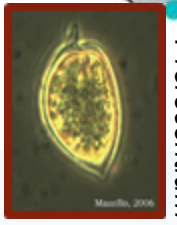


Lingulodinium polyedra

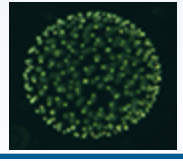


Akashiwo

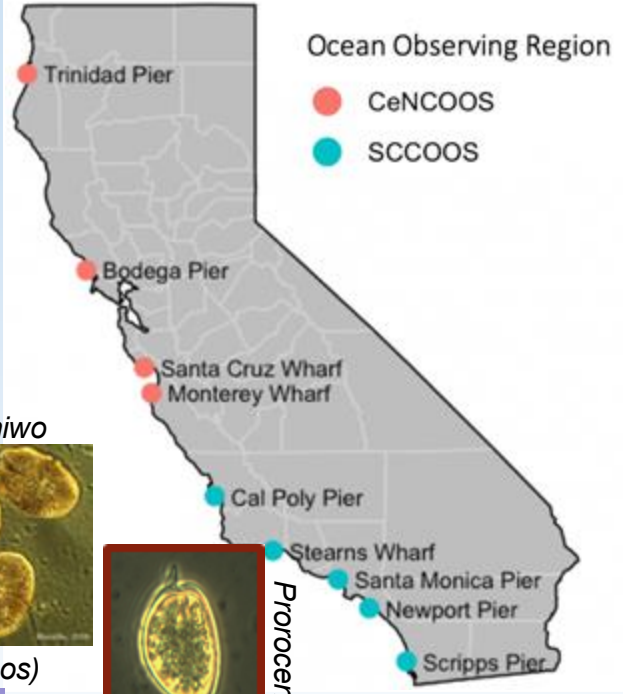
Prorocentrum



Phaeocystis



Ceratium (Tripos)



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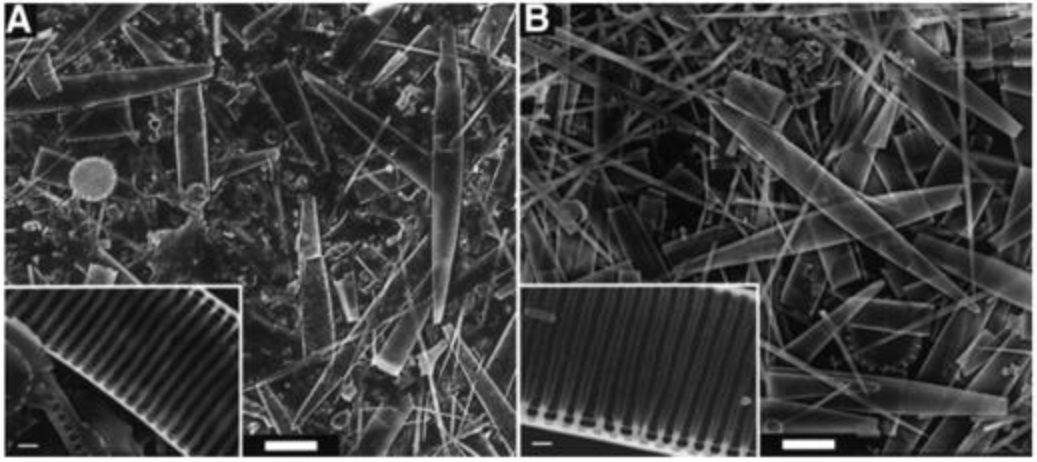
HAB Monitoring & Alert Program + SPATT dissolved toxins

SCCOOS PI: Anderson (UCSD), Caron (USC), Shipe (UCLA), Brzezinski (UCSB), Walter/Pasulka (Cal Poly)



Gut contents of anchovy collected during Spring 1998 bloom in Monterey Bay (Lefebvre et al. 1999 *Nature*)

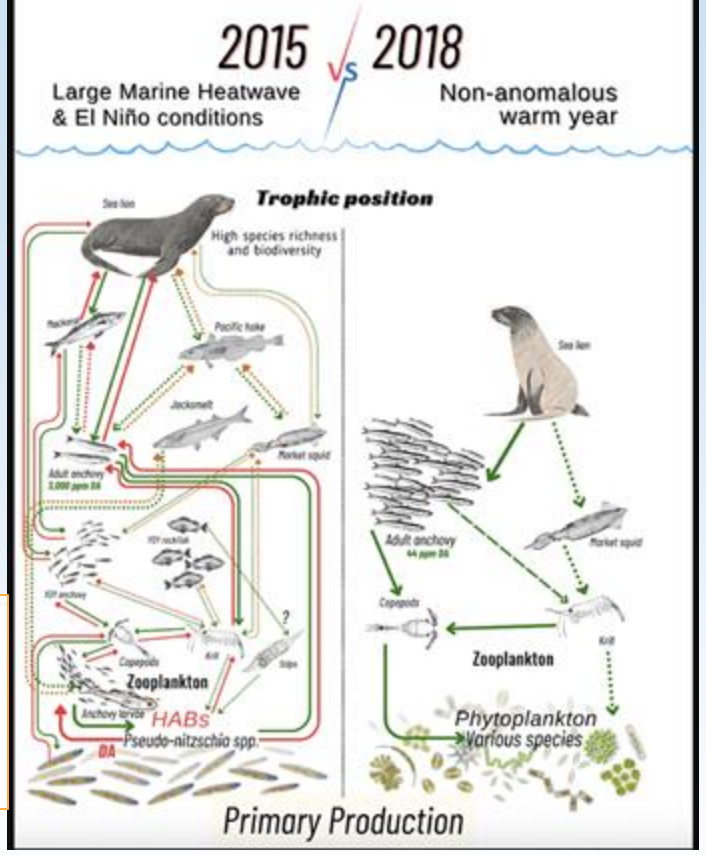
Detection of Domoic Acid in Northern Anchovies and California Sea Lions Associated with an Unusual Mortality Event†

Kathi A. Lefebvre,[1] Christine L. Powell,[2] Mark Busman,[2] Gregory J. Doucette,[2] Peter D. R. Moeller,[2] Joel B. Silver,[1] Peter E. Miller,[3] Margaret P. Hughes,[4] Sara Singaram,[4] Mary W. Silver[4] and Ronald S. Tjeerdema[5]
[1]Biology Department, University of California at Santa Cruz (UCSC), CA, USA
[2]Marine Biotoxins Program, NOAA/National Ocean Service, Charleston, SC, USA
[3]Monterey Bay Aquarium Research Institute, Moss Landing, CA, USA
[4]Institute of Marine Science, UCSC, Santa Cruz, CA, USA
[5]Department of Environmental Toxicology, University of California at Davis, CA, USA

Perturbations in a pelagic food web during the NE pacific large marine heatwave and persistent harmful diatom blooms

Rocio I. Ruiz-Cooley [a b], Clarissa Anderson [c], Raphael Kudela [d], Robin Dunkin [e], John Field [f]

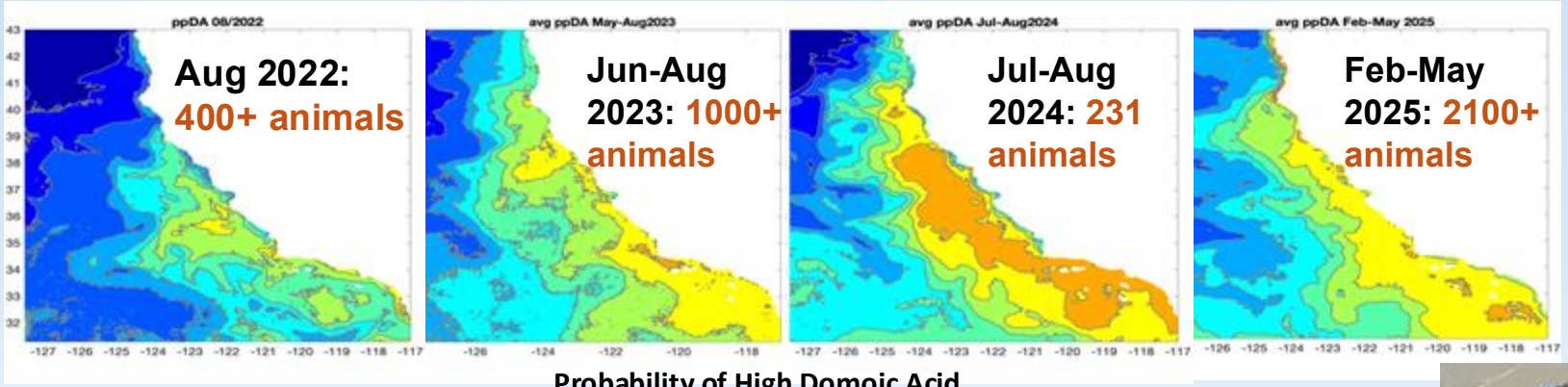
Ruiz-Cooley et al. 2024 *Harmful Algae*



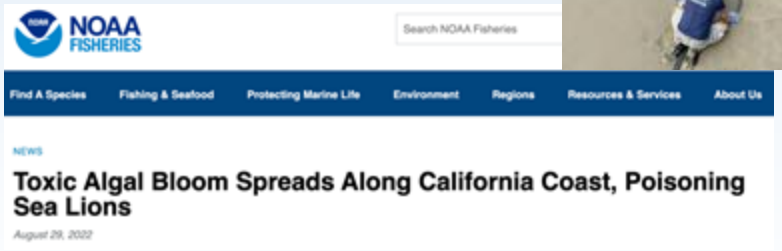
Bottom-up transfer of DA leading to mortality events

Anchovy are an ideal vector for DA into marine food webs (others = zooplankton/sardine/squid)

California Harmful Algae Risk Mapping System (C-HARM) – NOAA NESDIS West Coast Node of CoastWatch



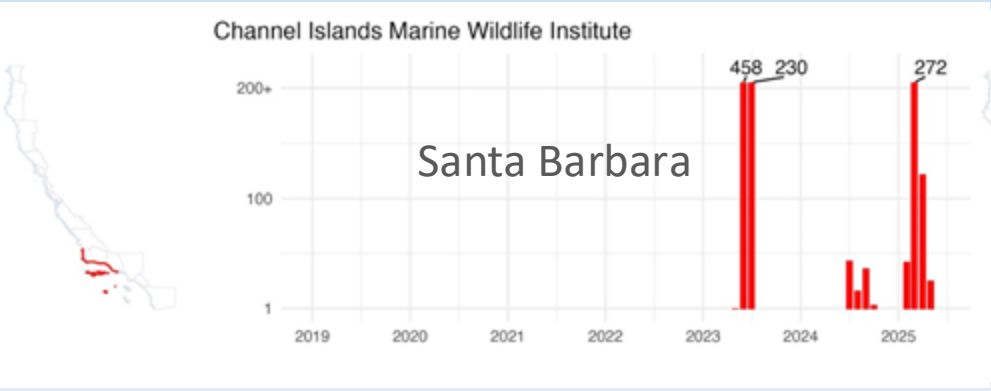
See CA HAB Bulletins for details:
https://sccoos.org/california-hab-bulletin/

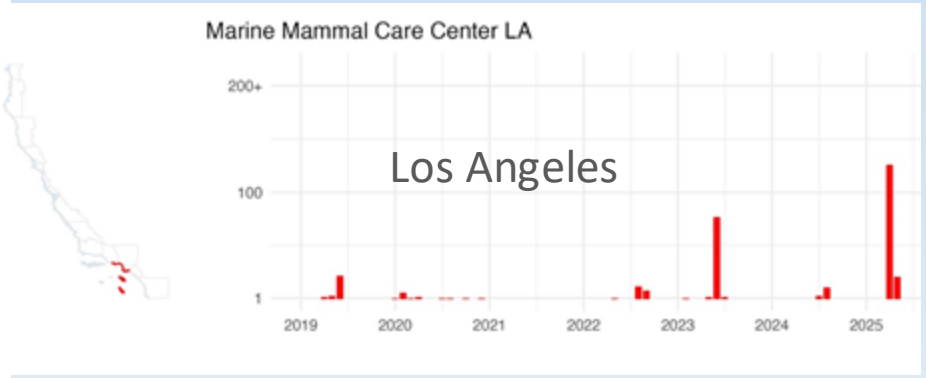


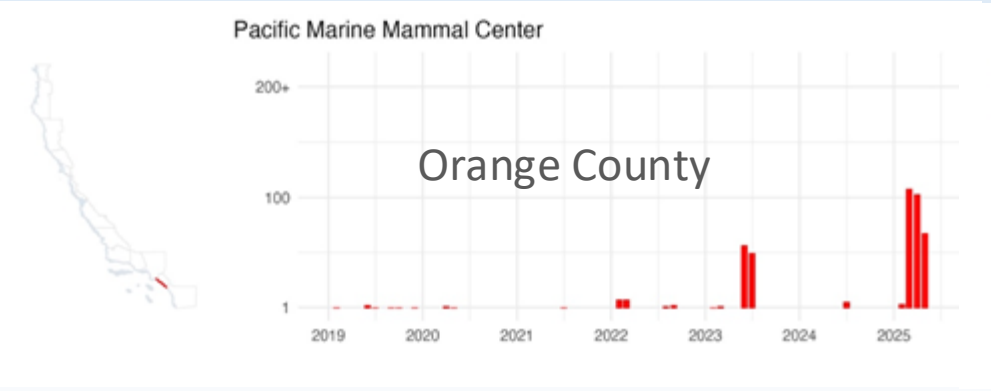
The Marine Mammal Center · Marine & Wildlife · Marine Animal Rescue · California Wildlife Center · Marine Mammal Care Center · Pacific Marine Mammal Center · SeaWorld San Diego

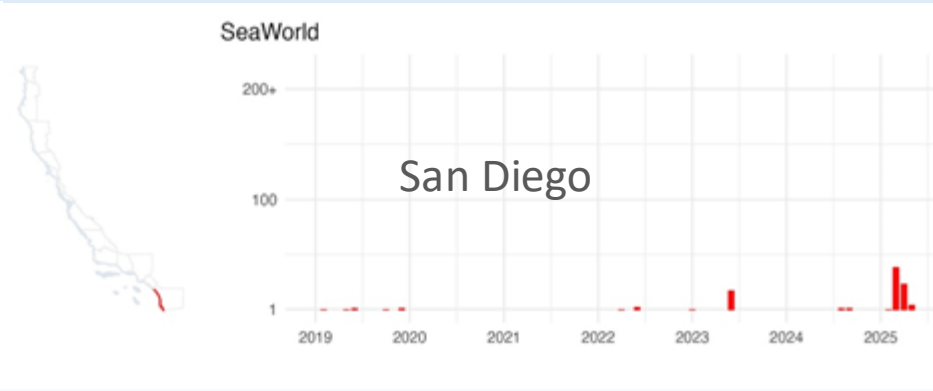
Beginning in 2022, a streak of DA events has been focused in Central and Southern CA

C-HARM is only synoptic view we have during bloom evolution; tracks strandings fairly well over a bloom period







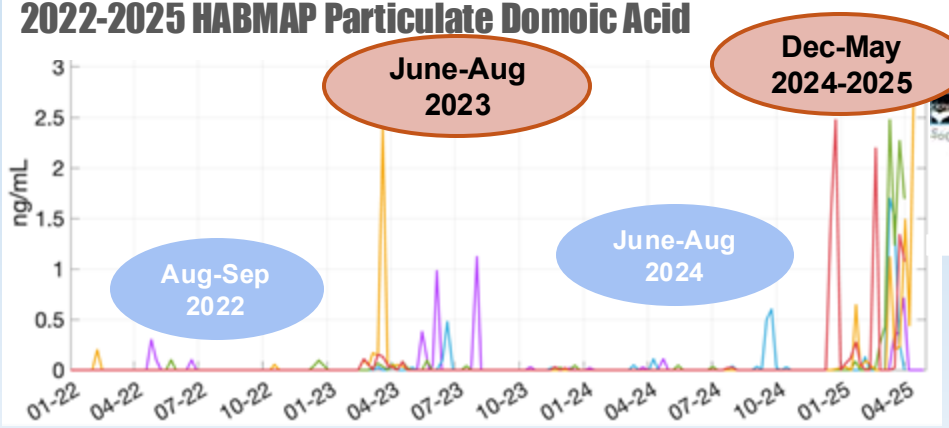


Collating monthly reports from the Marine Mammal Stranding Network

2,100+ suspected DA intoxication cases between Feb-May 2025

Abnormal number of violent encounters with humans due to erratic behavior

2022-2025 HABMAP Particulate Domoic Acid



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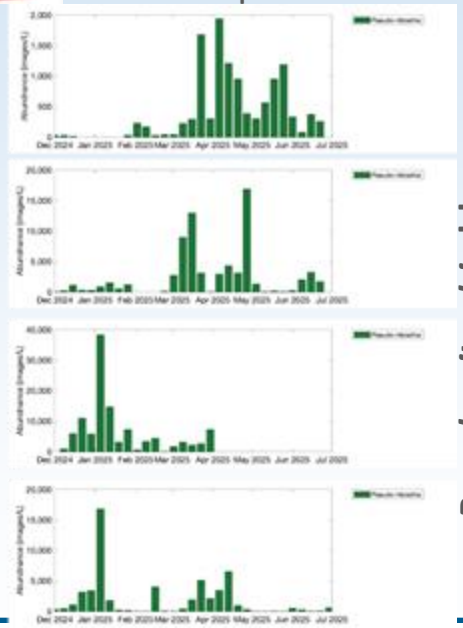
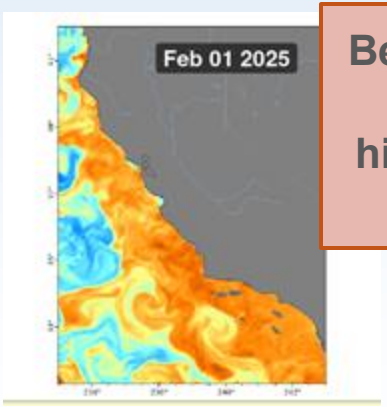
IFCBs captured
La Niña pattern of bloom



Pseudo-nitzschia bloom developed South to North

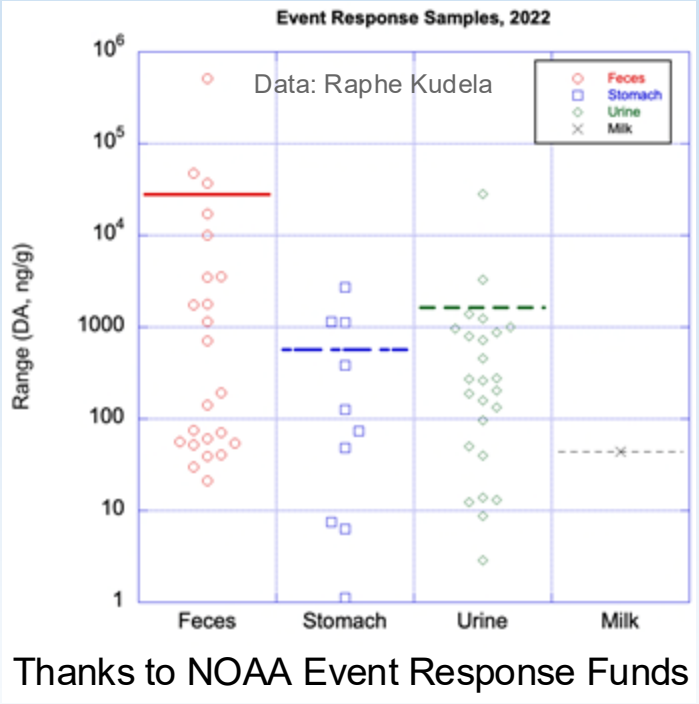


Beginning in Dec. 2025, nearshore monitoring detected *sustained* high levels of domoic acid across southern CA

See the 2025 CA HAB Bulletins for details:
https://sccoos.org/california-hab-bulletin/

HAB Early Warning System – very useful in 2023 and 2025

California Sea Lions as sentinels in 2022 and 2024



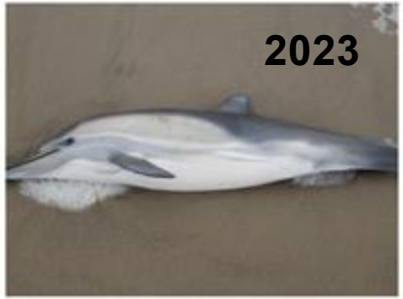
Thanks to NOAA Event Response Funds

NCCOS IOOS Integrated Ocean Observing System OCEAN PROTECTION COUNCIL

Marine Mammal Tissue from 3 Rescue Centers 2022

- N = 45 animals
- 59 samples processed across 4 possible matrices
- Highest *known* recorded animal DA ~ 507,608 ng/g in feces of **California Sea Lion** CIMWI-SB-22-124-CU-001 from Channel Islands Marine Wildlife Institute (CIMWI)

Highest *known* recorded DA in dolphins 296,538 ng/g in feces collected from a dolphin in Ventura on June 19, 2023



Data: Michelle Berman-Kowelewski and Kathi Lefebvre

SOUTHERN CALIFORNIA COASTAL OCEAN OBSERVING SYSTEM

CENTRAL & NORTHERN CALIFORNIA OCEAN OBSERVING SYSTEM

Highest DA measured in animals in 2022 and 2023 (other years TBD)

Mammal tissue A levels keep breaking records, more dolphins + cetaceans seem to be stranding, and STX identified in 2025 in some animals!

Data Sharing

Public Health Warnings

HAB Monitoring Outreach

SCCOOS helps coordinate HAB event response

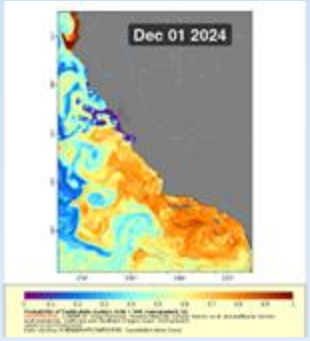
Rapid dissemination of public health advisories (DA + STX this year!), stranding maps, monitoring data

California HAB Bulletin
March-April 2025

Summary written by Dr. Clarissa Anderson and Dr. Kasia Kenitz, May 5th

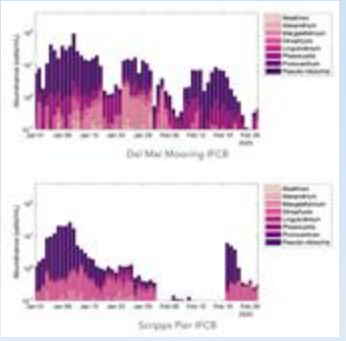
SUMMARY: The ecological impacts observed during this period have surpassed those of the past four years, with toxins affecting CA sea lions and other pinnipeds, dolphins, sea birds, larger cetaceans, and producing shellfish advisories from Santa Barbara to San Diego. Very high levels of DA detected in sardine tissue prompted state agencies to recommend recreational fishery restrictions in Southern California. The biological toll of this multifaceted toxic event has been staggering, with more than 1,670 reported to date, far exceeding those reported in any of the toxic events over the past four years. Over 1250 of which were in Los Angeles, Ventura, and Santa Barbara counties. The origin of this bloom appears to be linked to the longest, nearshore cold water episode since the La Niña year of 2011, which began as early as December 2024 in Baja and at Scripps Pier and sustained it through February to April. The cold water brought elevated nutrient levels – silicic acid and nitrate – setting the stage for a major bloom of toxic *Pseudo-nitzschia*. This was followed by the emergence of several other HAB taxa, most notably an extensive toxic *Alexandrium* bloom that caused the first known prolonged saxitoxin advisories in shellfish for southern California areas such as San Diego. Blooms of *Akashiwo* and *Margalefidinium* also crept in at shore stations with no known impacts.

C-HARM



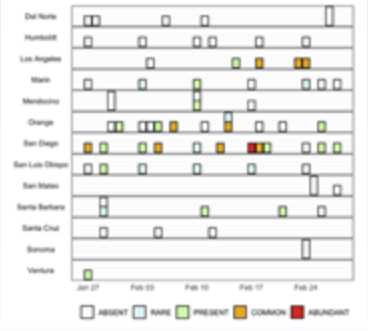
HABMAP

IFCB Network

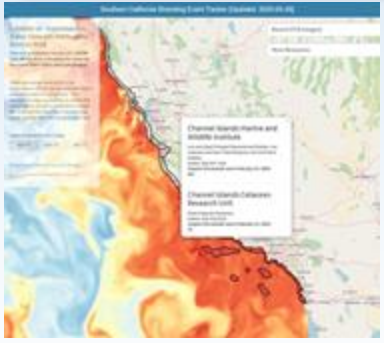


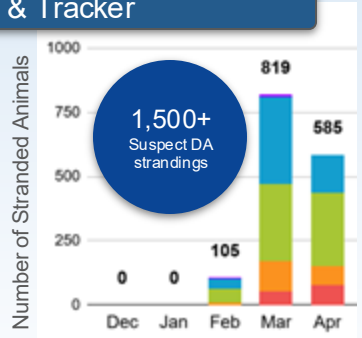
CDPH

Pseudo-nitzschia seriata



Stranding Data & Tracker

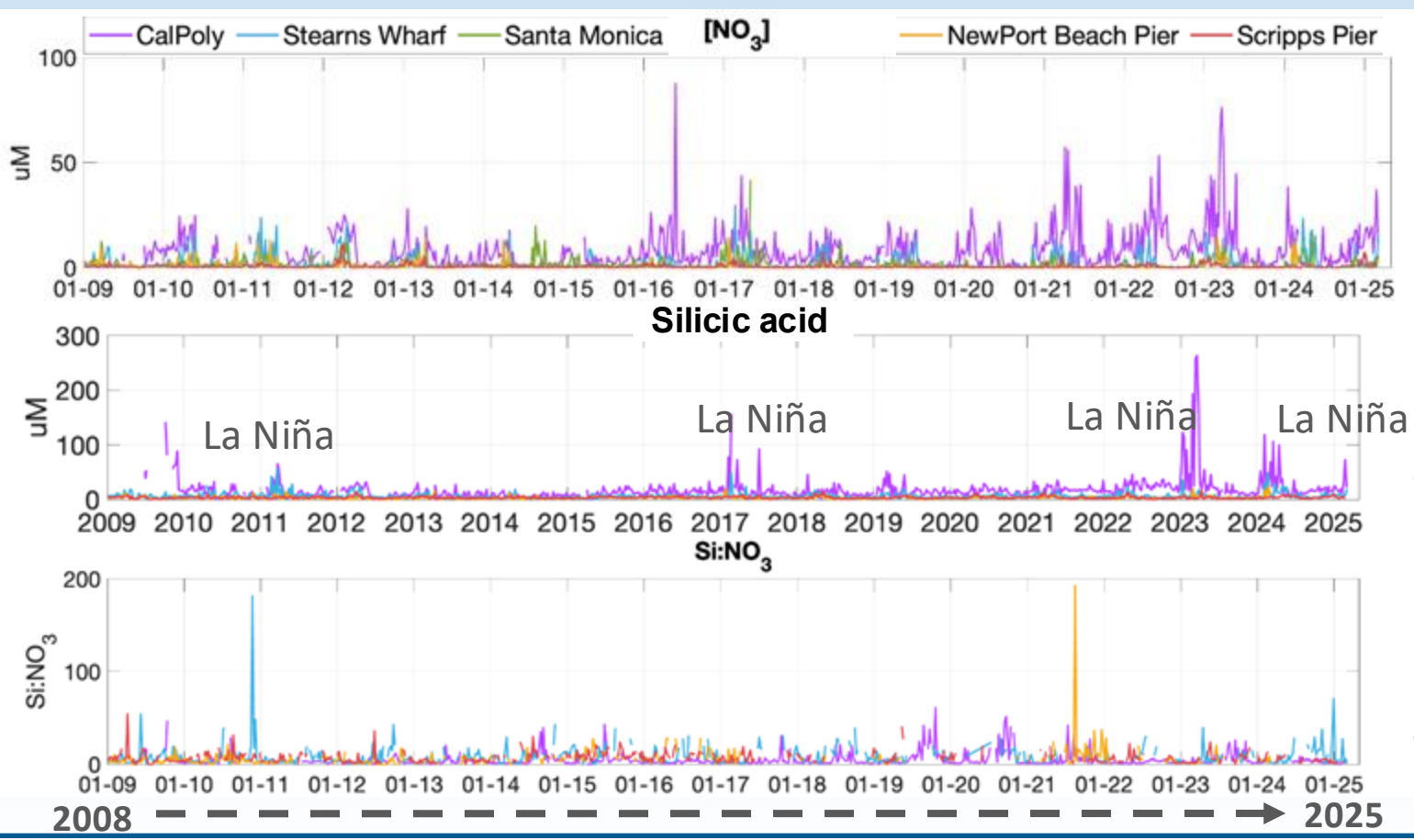




Data: SeaWorld, NOAA Fisheries, PMMC, MMCC-LA, CWC, OARRA, CIMWI, CICRU, TMMC

SCCOOS Publishes Bimonthly CA HAB Bulletin

Retrospective synthesis of observations, predictions, advisories, and mammal strandings — sccoos.org/california-hab-bulletin



Nitrate max in May 2016 at Cal Poly Pier (SLO) - no precip that month; El Nino conditions likely present in CCS

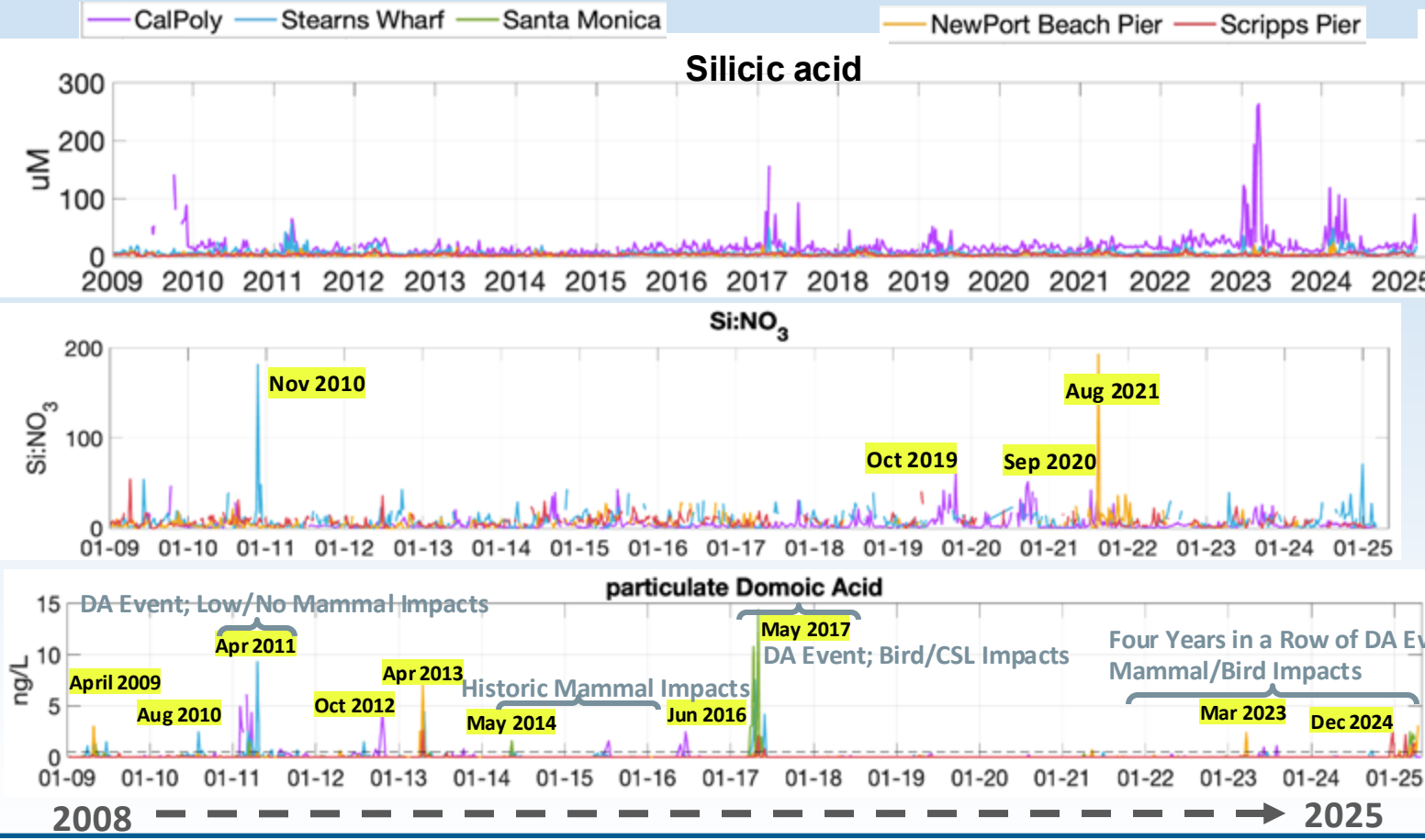
Si peaks are evident in the La Niña of 2010-2011, 2017-2018, 2020-2023, and 2025

2017 DA Event – nutrients high at all SoCal stations

Si:N signal dwarfed by a few sites: Cal Poly Pier, Stearns Wharf, and Newport Beach Pier

Drivers of Domoic Acid Events

Macronutrient Levels from HABMAP sites: 2008-2025



Runoff and Ash Deposition during the 2025 bloom may have driven local enhancement of nitrate and possibly phosphorous to stimulate additional PN and/or DA Production

Drivers of Domoic Acid Events

Silicic Acid and/or Si:NO3 may be better predictors than nitrate for DA events

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- SCCOOS is working with marine mammal rescue and research orgs to better share event-based bloom and animal stranding data and predictions
- Recent events appear anomalous in terms of frequency, magnitude, duration of tissue DA levels, aberrant animal behavior, and new toxins like STX
- Long-term SCCOOS databases useful for understanding DA event and food web impact variability

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SCIENCE FOR A HEALTHY CALIFORNIA

California Department of PublicHealth

CALIFORNIA WILDLIFE CENTER

The Marine Mammal Center

OARRA

MARINE MAMMAL CARE CENTER

PACIFIC MARINE MAMMAL CENTER

SeaWorld SAN DIEGO

Channel Islands Marine & Wildlife INSTITUTE

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Thank you to our partners and collaborators!