



Nutrients in the Bay

The next five years of NMS science

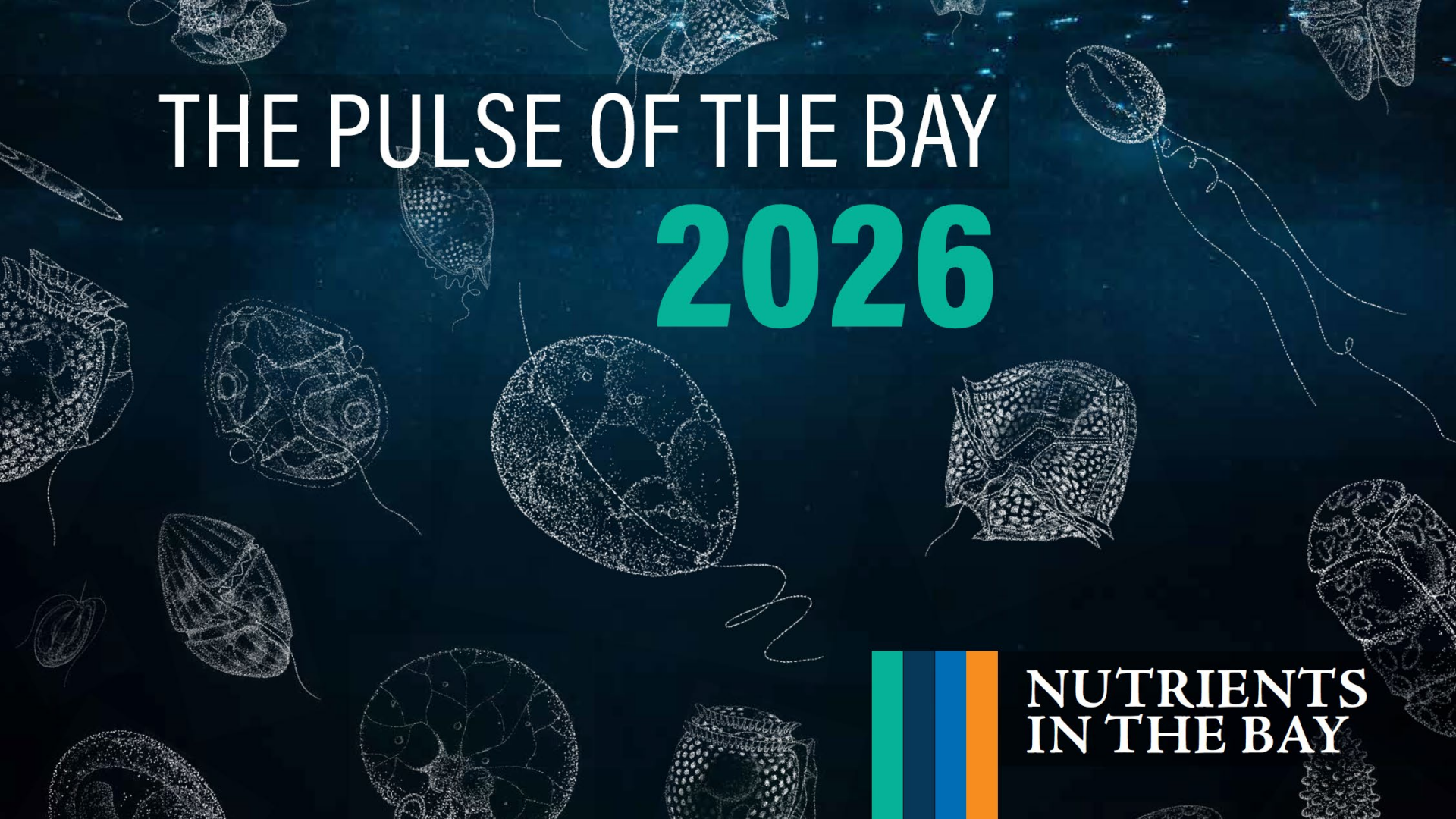
SFEI

SAN FRANCISCO
ESTUARY INSTITUTE

Ian Wren

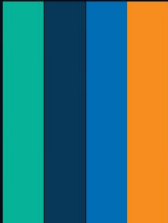
Program Manager, Nutrient Management Strategy

October 21, 2026



THE PULSE OF THE BAY

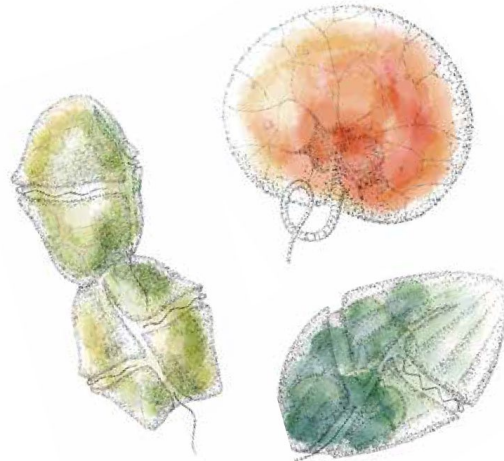
2026



**NUTRIENTS
IN THE BAY**

Responding to a changing Bay

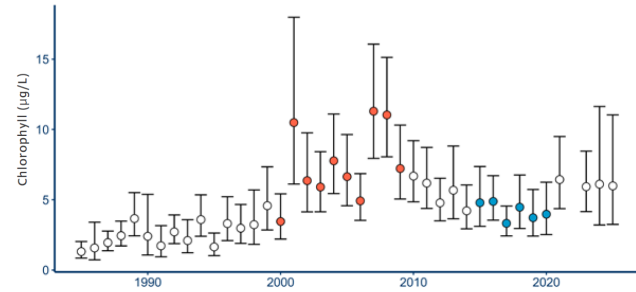
- USGS sampling of the Bay since 1969, one of the longest records in North America
- Nitrogen loads among the highest of any estuary, yet blooms stayed in check for decades
- Murky water, strong tides, and filter-feeding clams contributing factors



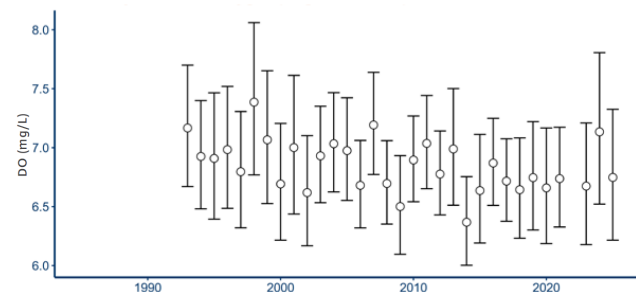
Warning signs in the data

- Algae growth roughly doubled, 1990s to 2010s
- Regulators acted on warnings from Jim Cloern (USGS) and others
- NMS founded in 2012 with ~15 Steering Committee members

South Bay Chlorophyll (August-October)



South Bay Dissolved Oxygen (August-October)



2022: the wake - up call

- *Heterosigma akashiwo* , mid - July to August 31
- At least 691 sturgeon, thousands of other fish
- Oxygen near zero in South Bay after the collapse
- Triggered a shift in management and science priorities

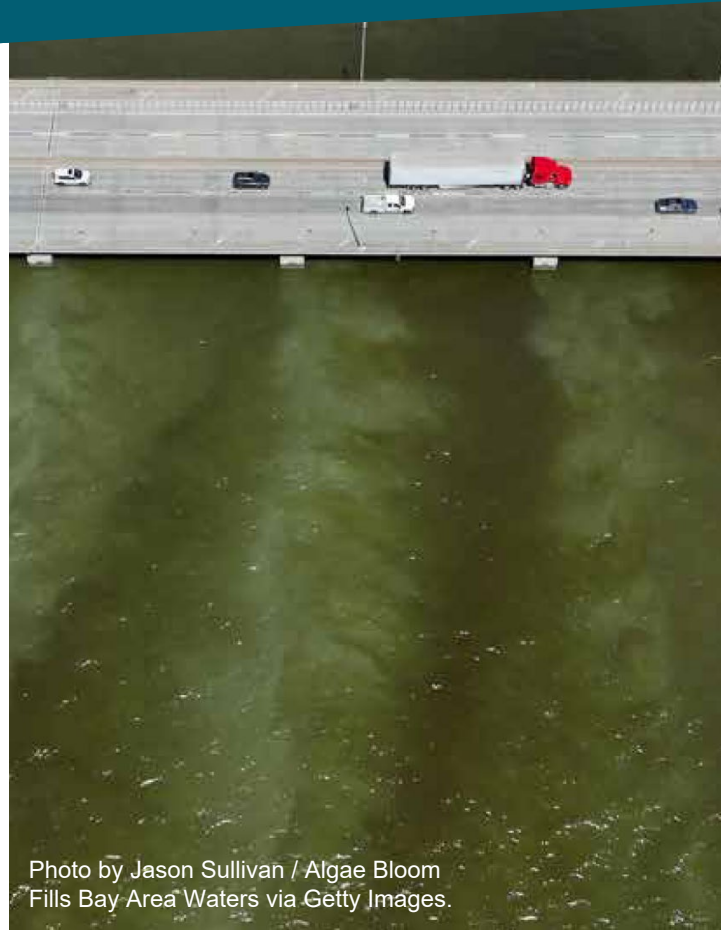


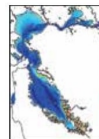
Photo by Jason Sullivan / Algae Bloom
Fills Bay Area Waters via Getty Images.

How the bloom unfolded

- Nearly all nitrogen in South Bay consumed to fuel growth
- Swimming on weak daytime tides enabled rapid growth
- Mass fish mortality indicates direct toxicity from *H. akashiwo*
- Recent molecular work points to marine viruses for sudden bloom collapse

1 Bloom initiation Late July to early August

H. akashiwo began rapid growth near Alameda.



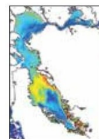
2 Expansion and sustained growth August 3–9

The bloom expanded into the open Bay west of Alameda, where it achieved sufficiently rapid growth to sustain and increase its biomass.



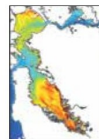
3 Stalled spread August 11–17

After its initial rapid growth, growth appeared to slow over the next week, with the bulk of the bloom confined to the northern third of South Bay.



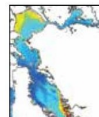
4 Rapid expansion August 18–27

Instead of petering out, the bloom rapidly expanded into the remainder of South Bay, and biomass levels increased roughly tenfold in the newly occupied areas.



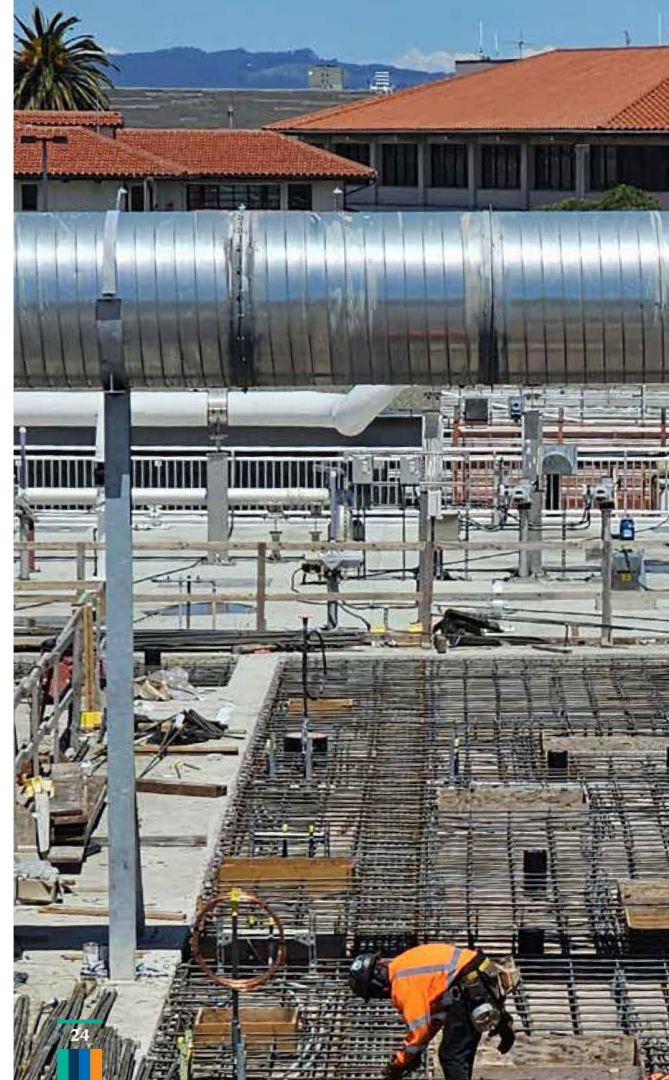
5 Abrupt collapse August 29–31

After dominating the system for nearly a month, the bloom died off over the course of just three days.

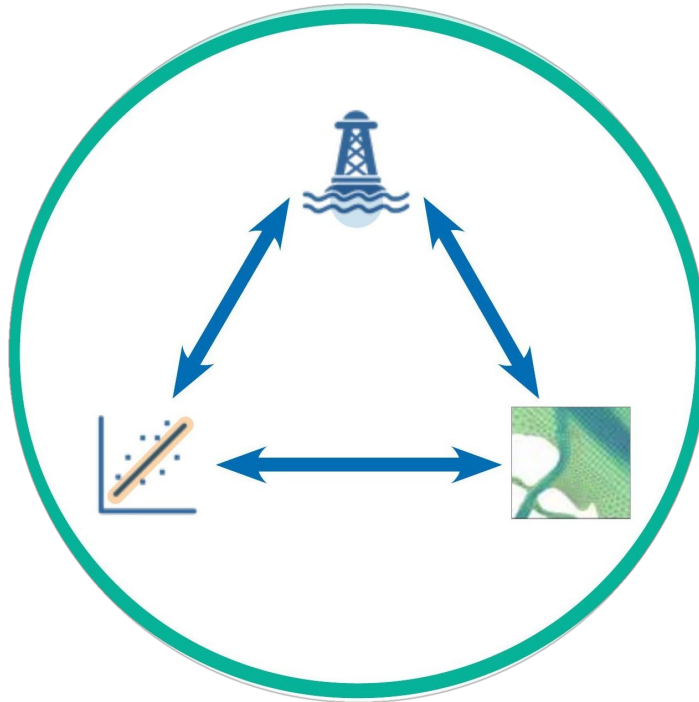


The region is acting

- Major upgrades
- Demonstration projects
- Water quality trading
- Nature-based solutions
- Wastewater recycling

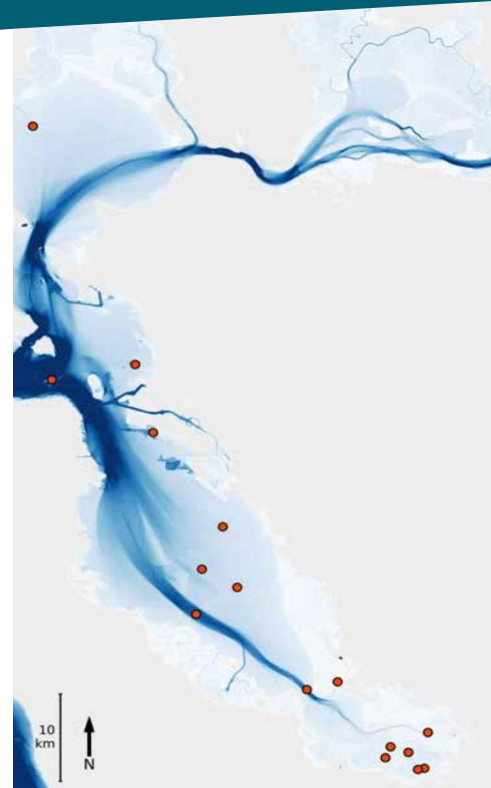


An integrated program



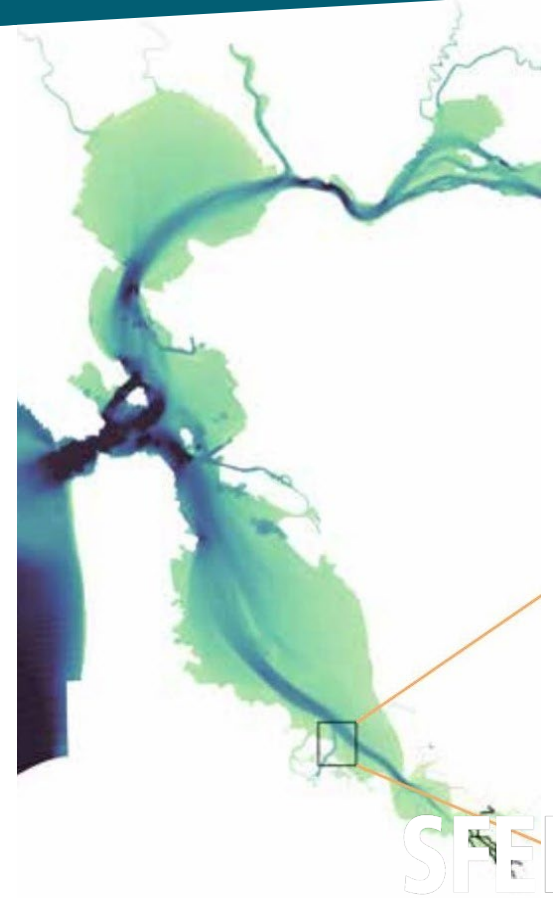
Observing the whole Bay

- USGS channel cruises
- 16 moored sensors, 5 streaming in real time
- Shoal mapping in South, San Pablo, and Suisun Bays
- Satellite chlorophyll and turbidity



Modeling the Bay

- Hydrodynamics for 2013–2023
- Reproduces seasonal nutrient and algae cycles
- External Model Advisory Group, 2023 and 2026
- Next: forecasting, uncertainty, HABs, Bay–Delta



What comes next

- How blooms start and end: viruses, grazers, strains
- How *Heterosigma* kills fish
- Forecasting blooms with expert-guided models
- Gaps: ocean boundary, depth, North Bay, Delta
- Watching the Bay respond as loads fall



Remembering Jim Cloern and Mike Connor

Jim Cloern , 1948–2025

- Led the USGS Bay program from 1976
- Showed why a nutrient - rich Bay resisted blooms: turbidity, tides, grazers
- His warnings led the Water Board to establish the NMS in 2012

Mike Connor, 1951 –2025

- SFEI Executive Director 2002 – 2008; EBDA General Manager 2008 –2018
- Took Jim's warnings seriously when few others did
- Set in motion the treatment plant investments now underway

Remembering Jim Cloern and Mike Connor



Thank you

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