BAY AREA CLEAN WATER ASSOCIATION · ANNUAL MEETING 2026

Nutrient Management Strategy

An overview and current trajectory

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SFEI

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TODAY

Where we're going in the next fifteen minutes

01 What is the NMS?

02 BACWA's role — the funding partnership behind the science

03 2022: the turning point

04 The 2024 Permit and the NMS

05 Where we're going next

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sfei.org/programs/cw/nutrients

PROGRAM

What is the Nutrient Management Strategy?

A collaborative science program, established in 2014, that gives the region a rigorous basis for managing nutrient impacts in San Francisco Bay.

- Housed at SFEI; co-managed with the SF Bay Regional Water Quality Control Board
- **15-member Steering Committee** — dischargers, regulators, environmental groups, scientists
- **Mission:** develop the scientific basis for managing nutrient impacts in the Bay
- **Funded** primarily through the SF Bay Nutrient Watershed Permit, plus EPA and NOAA grants

R/V Turning Tide, USGS · NMS field operations

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PARTNERSHIP

BACWA: foundational partner from day one

2014 – 2019 · FIRST PERMIT CYCLE

$880K

Total BACWA contribution that funded the founding NMS science program.

2019 – TODAY · 2ND & 3RD CYCLES

$2.2M/ yr

Annual investment through the SF Bay Nutrient Watershed Permit, supplemented by EPA and NOAA grants.

+ $550K/ yr via the Regional Monitoring Program — supports ship-based and moored sensor work.

Without BACWA, there is no monitoring program, no model, and no scientific basis for the 2024 Permit.

Since the 2022 Bloom, federal funding has increased the program to ~$6 million per year

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Why nutrients matter in San Francisco Bay

- Largest estuary on the Pacific Coast — **1,600 km²** , watershed of 8 million people
- Among the most nutrient-enriched estuaries on Earth — **90th percentile globally for nitrogen**
- Historically resilient — high turbidity, strong tidal mixing, and filter-feeding clams kept algae in check
- That resilience is **weakening**

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Standing on the shoulders of giants

USGS began monitoring SF Bay water quality in 1969 — one of the longest continuous estuarine datasets in the world.

- Carried forward for decades by the late **Dr. Jim Cloern** , whose conceptual frameworks still anchor how we understand the Bay.
- Every trend we discuss today rests on that record.

USGS field operations

PHASE 1 · 2014 – 2022

The first eight years: building the foundation

FOUNDATIONAL SCIENCE — CHARACTERIZING CHRONIC CONDITIONS

- Moored sensor network grew from **2 stations (2013) to 12 (2019)**
- Built the **SF Bay Biogeochemical Model**
- Established molecular HAB detection
- Central Bay primary production grew **2–3× since the early 1990s** — the first sign resilience was weakening

Peterson cruise · 2019 · SFEI

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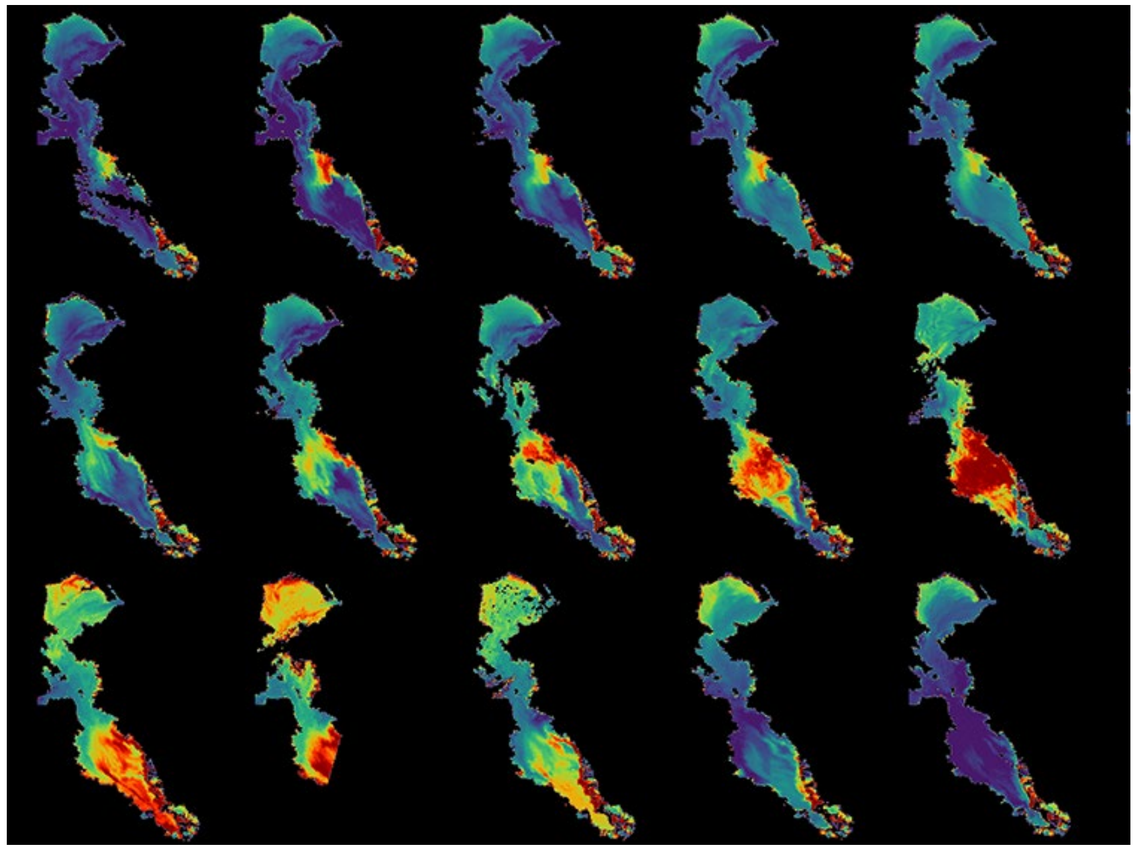
August 2022: the turning point

Heterosigma akashiwo bloomed across the lower Bay from July through September 2022.

- Peak chlorophyll-a: >**500 µg/L on August 23**
- Cell densities exceeding **1 million per liter**
- Bloom consumed **~1.6 million pounds of nitrogen** — more than was available at the start
- Largest HAB event in the Bay's recorded history



Bay-wide satellite chlorophyll-a, July–September 2022 · RE-SFB algorithm, UCSC / SFEI

947

sturgeon documented dead Bay-wide — the largest fish mortality event in the Bay's recorded history

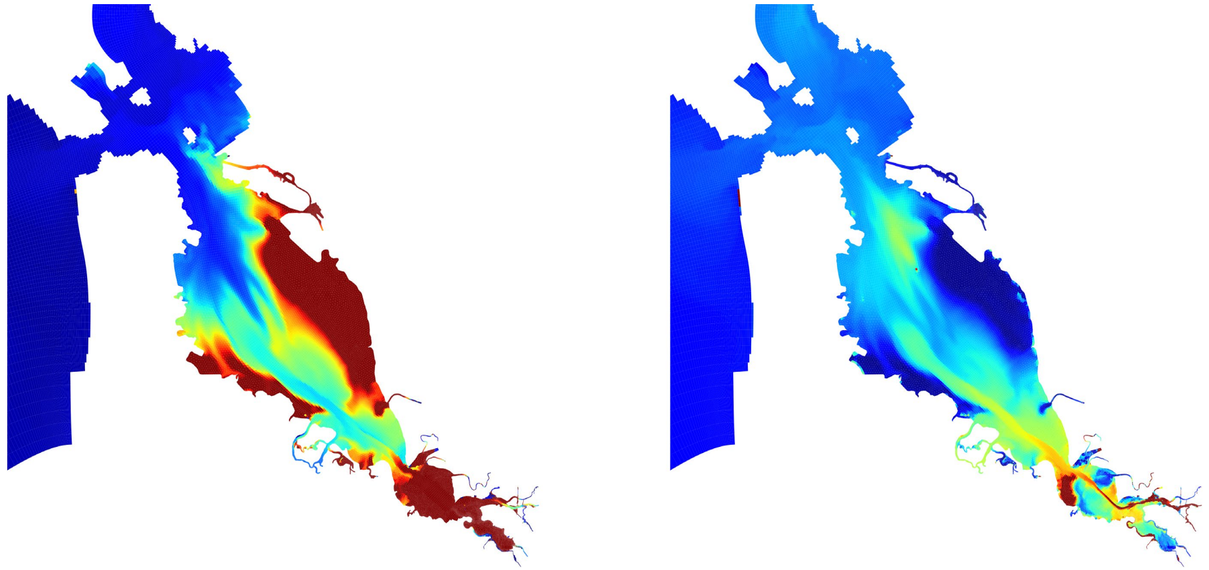
White sturgeon population dropped from roughly **30,000 to under 6,500** legal-size fish.

Most died *before* oxygen depleted. The toxicity mechanism remains unresolved.

The 2024 Nutrient Watershed Permit

Third Nutrient Watershed Permit (2024 – 2029) — adopted July 2024

- 40% reduction in dry-season nitrogen loads required
- The biogeochemical model provided the technical basis for the 40% number
- Compliance schedule extends through the permit cycle and beyond



Modeled chlorophyll-a, and dissolved inorganic nitrogen, Spring 2018 · SF Bay Biogeochemical Model

What this means for treatment plants

- POTWs contribute ~90% of dry-season loads in Central and South Bays
- The 40% reduction falls primarily on the agencies in this sub-region
- Substantial capital investment ahead — but the science behind the number is the strongest it could be

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DIRECTION

A pivot in NMS focus

2022 reoriented the program — from documenting *chronic change* to predicting *acute events*.

- **2014-2022** (chronic conditions) → **2024 -> ?** (future scenarios + acute events)
- Monitoring scope expanded substantially after the 2024 Permit
- Modeling now central to permit-relevant decisions
- Analysis of the 2022 bloom prepares us for the *next* one

Moored sensor buoy · SFEI

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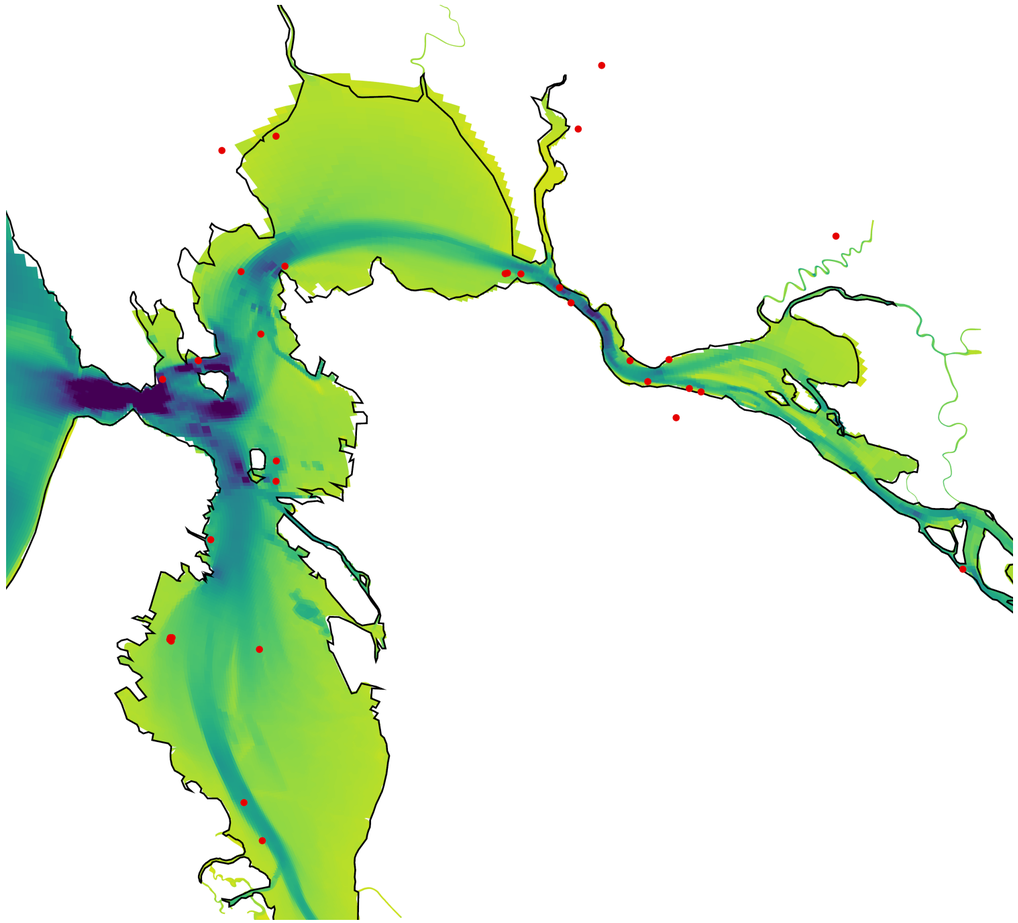
Modeling steps into a bigger role

- **SF Bay Biogeochemical Model** — coupled hydrodynamic and biogeochemical, ten years in development.
- Set the 40% target; now used to test scenarios environmental and management scenarios
- Future use: load-response curves, regional reduction prioritization, climate scenarios



Bay bathymetry and wastewater point sources used in the model

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REPORTS

Recent deliverables

OVERVIEW REPORT

Science to Inform Management

Plain-language summary, ~30 pages, for non-specialists.

STATE OF THE SCIENCE

12-year synthesis

Deep technical synthesis of NMS monitoring and modeling.

SCIENCE PLAN

2025 – 2030 roadmap

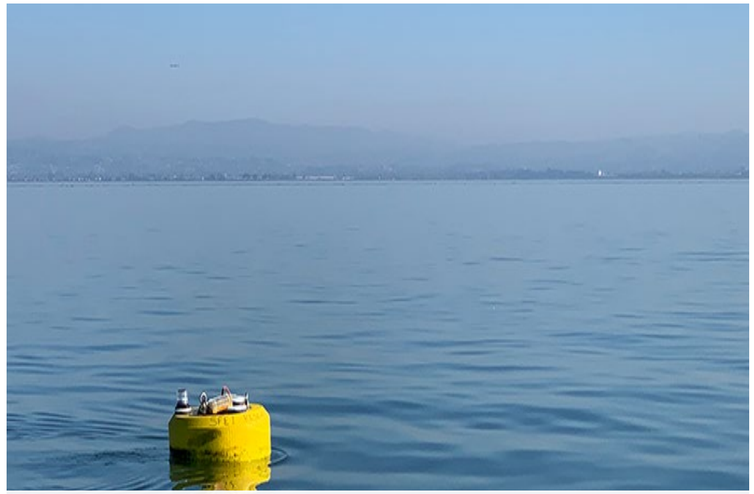
Where the program is going through the next permit cycle.

Approved May 2025

ALL AVAILABLE AT sfei.org/programs/cw/nutrients

INFRASTRUCTURE

One of the most comprehensive monitoring programs in North America



Moored sensor stations

Ship-based monitoring

Field maintenance

- **15 moored sensor stations** — 15-minute data on chl-a, DO, salinity, temperature, turbidity, pH
- **38 ship-based stations** — monthly to bimonthly nutrient and phytoplankton transects
- **7 high-speed shoal-mapping cruises** per year
- **RE-SFB satellite algorithm** — near-real-time Bay-wide bloom maps
- **$3M NOAA MERHAB grant** (2023) — expanded HAB monitoring + public dashboard

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2025 – 2030

Science priorities for the next five years

1. **Is the 40% reduction protective?**
   Model refinement and load-response evaluation — ahead of the next permit.

2. **What caused the 2022 bloom?**
   And why didn't 2023 spread the same way? HAB mechanism and trigger research.

3. **Status and trends of key indicators**
   Sustained baseline tracking — how we'll know whether the permit is working.

4. **Nature-based solutions**
   Wetlands, eelgrass, and salt pond management — co-benefits at the margins.

Together, these build the technical foundation for the **2029 Permit reissuance**.

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The path forward informs decisions

Science → permit → action → adaptive feedback.

- Continued partnership: BACWA, the Water Board, scientists, and the public
- Every part of the loop has to stay funded and engaged for it to work
- The next five years will inform continual improvements

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Thank you.

The NMS exists because BACWA showed up — and kept showing up — for over a decade.

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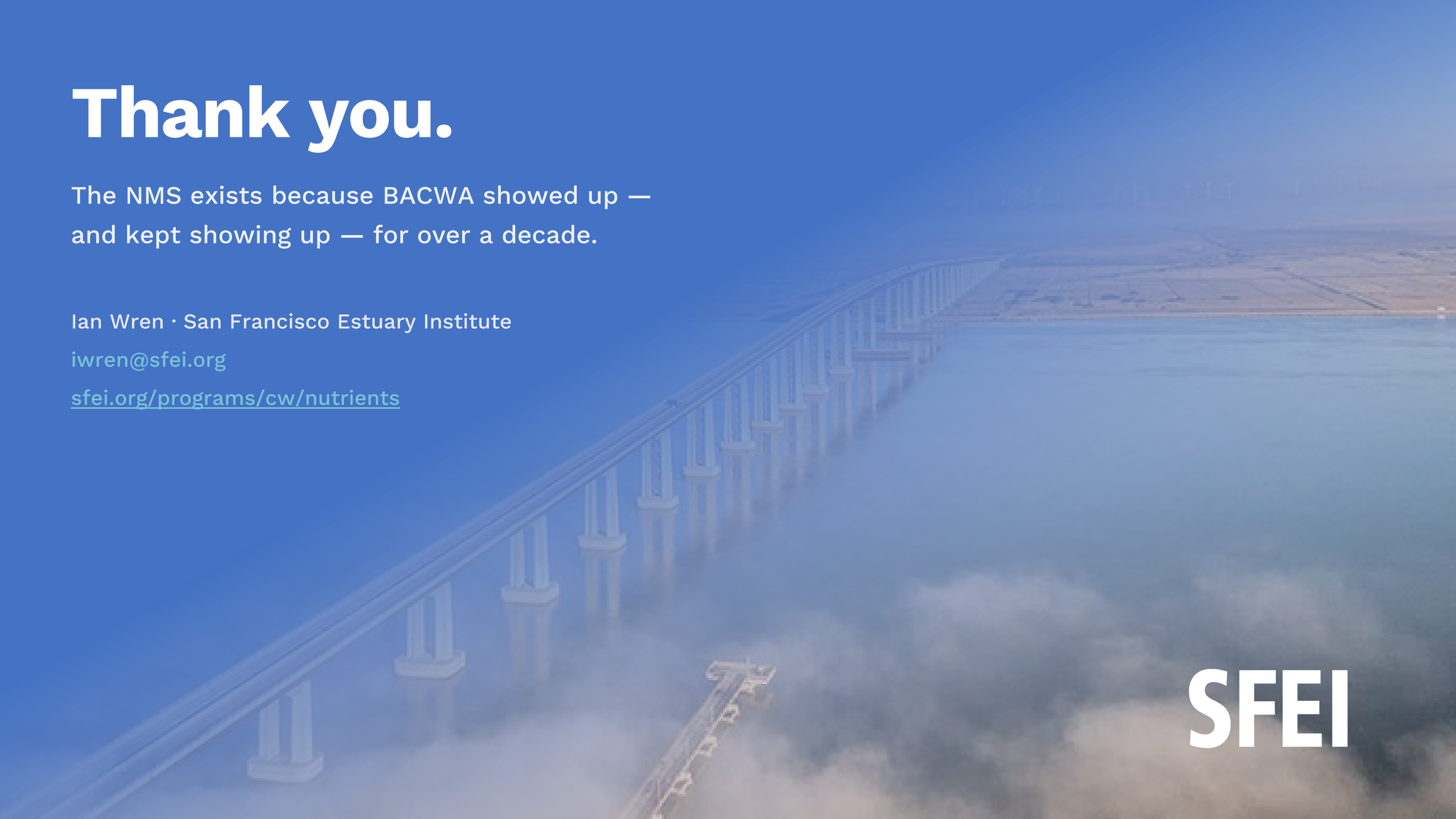

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