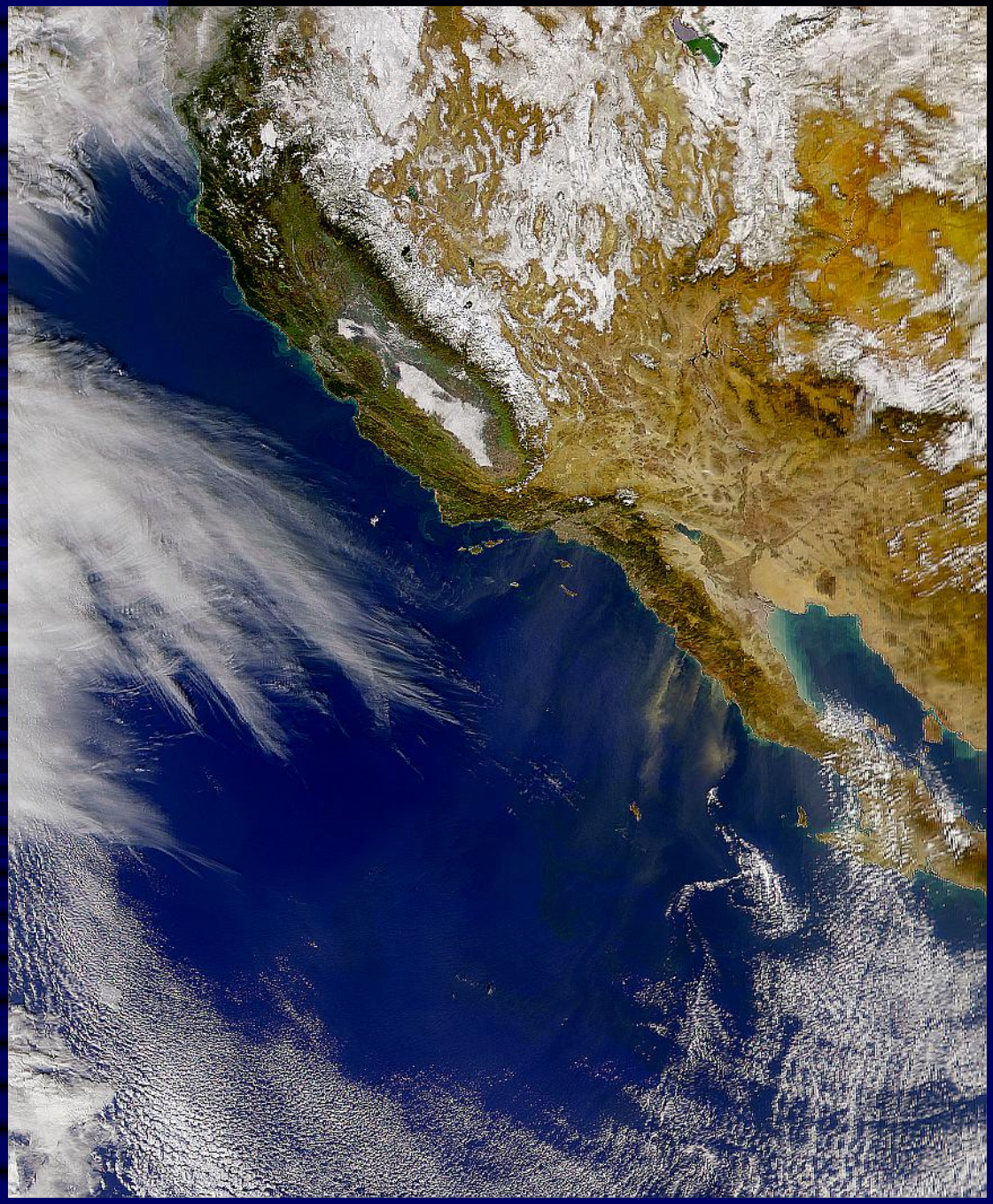


CALIFORNIA MARINE BIOTOXINS:

Overview of Statewide Monitoring Program

Marine Biotoxin Monitoring Program

California Department of Public Health
Environmental Management Branch

Gregg Langlois

Marine Biotoxin Background

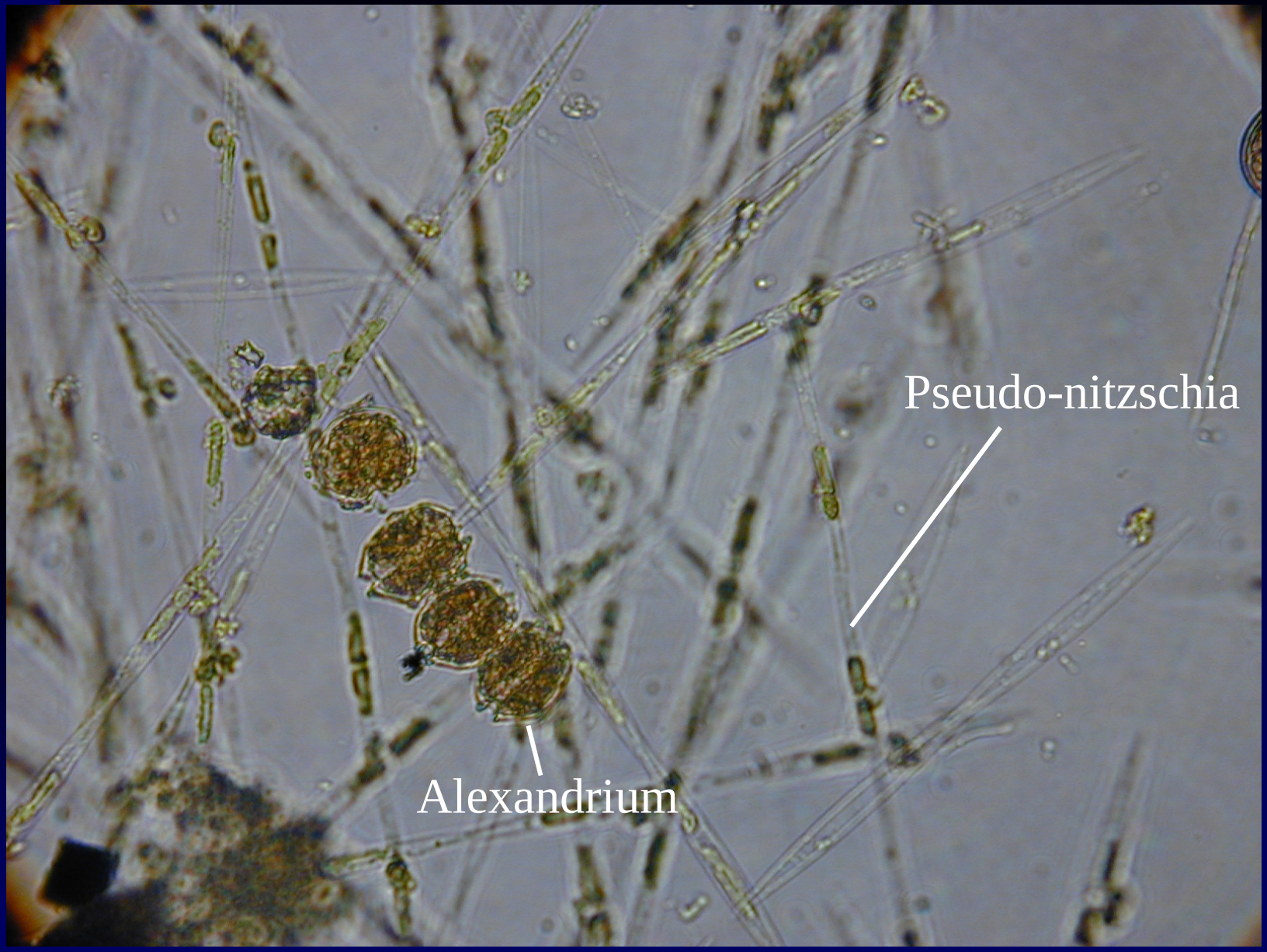
- Naturally occurring: All Climatic Regimes
  - nerve toxins: nuisance to deadly
  - produced by a few phytoplankton species
    - Dinoflagellates: PSP, NSP, DSP
    - Diatoms: ASP
- Bioconcentrated: food chain transport
- No antidotes (including garlic butter, EtOH)

Marine Biotoxin Background

- Regions with History of Outbreaks
- Regions with only Recent Outbreaks
  - Guatamala: 1987, 26 deaths (PSP; P. bahamense)
  - Phillipines: 1983, 21 deaths (PSP)
  - Canada: 1987, 4 deaths (ASP)
  - New Zealand: 1993, 180 cases (NSP, PSP)
- Global Increase in Frequency and Distribution

Marine Biotoxin Background

- Paralytic Shellfish Poisoning (PSP) Toxins
  - Dinoflagellate: *Alexandrium catenella*
  - Program (field, lab, management) built around this one toxin
- Amnesic Shellfish Poisoning (ASP) = Domoic Acid
  - Diatom: *Pseudo-nitzschia spp.*
  - Overnight challenge to existing program: field, lab, management

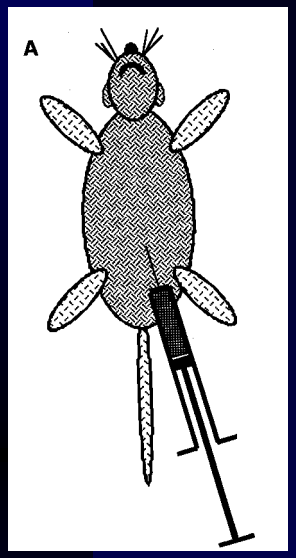

Pseudo-nitzschia
Alexandrium

PSP Health Effects

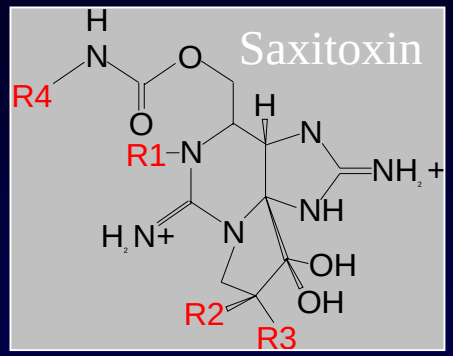
- Sodium Channel Blocker
- Alert Level: ≥ 80 ug/100 g tissue
- Mild Symptoms: 200 - 400 ug
  - (numbness of extremities, headache)
- Moderate/Severe: 500 - 2000 ug
  - (loss of coordination, difficulty breathing)
- Severe Symptoms: > 2000 ug
  - (paralysis, respiratory failure, death)

PSP Assay: Mouse Bioassay

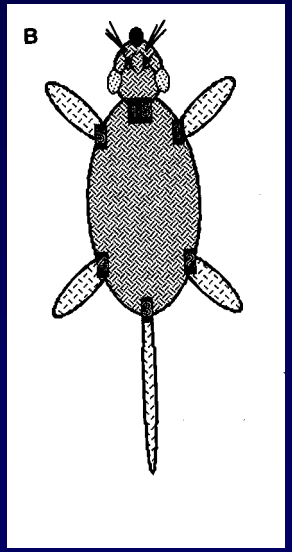
1927 – 1936:



PSP toxin assay begins using newly developed mouse bioassay.



- 2007:
  - Only approved method (FDA)
  - Low sensitivity (40 ug/100 g)
  - Labor intensive
  - Requires large quantities of materials
  - Limited to central lab concept

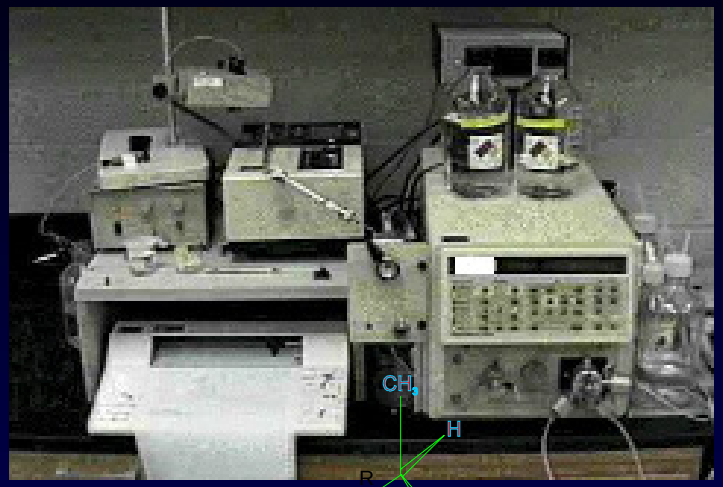


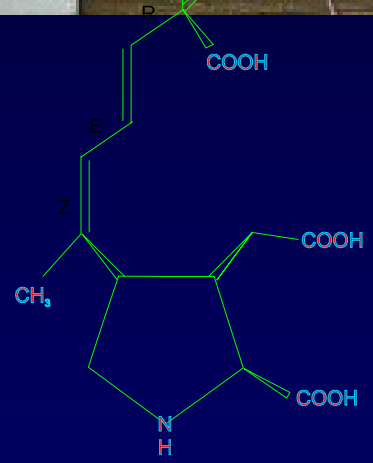
D.A. Health Effects

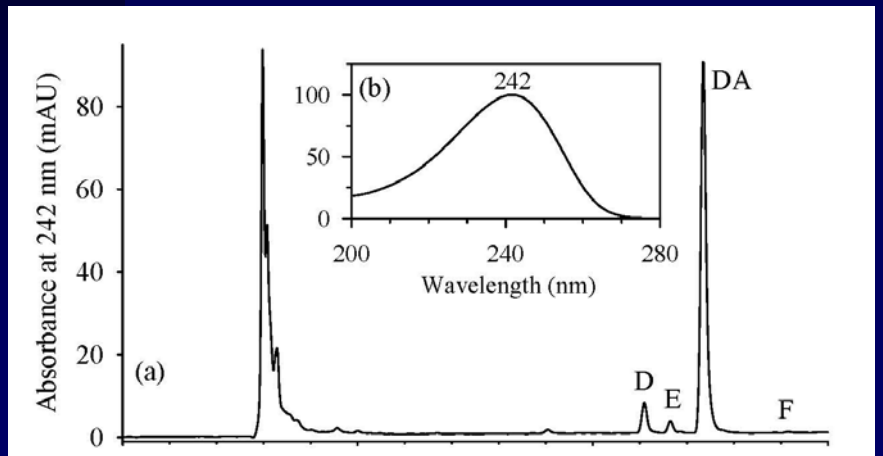
- Neuroexcitatory Amino Acid (glutamate receptors)
- Alert Level: 20 ug/g (ppm)
- Mild Symptoms: 27 - 75 ppm
  - (GI: cramps, diarrhea, vomiting)
- Moderate : 40 - 700 ug
  - (headache, disorientation)
- Severe Symptoms: > 450 ug
  - (loss of short-term memory, seizure, coma, death)

DA Analysis: HPLC

- High capital expense
- Simple methodology
  - Methanol extraction
  - Small sample size
  - Transferable to other labs
- Automated: rapid throughput
- Low detection limit (~ 1 ppm)





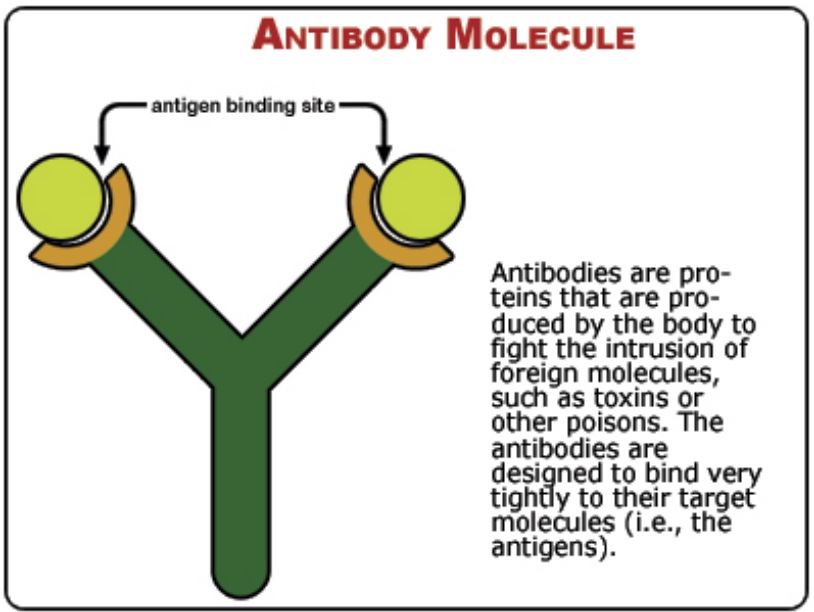


M. A. Quilliam. Chemical methods for domoic acid, the amnesic shellfish poisoning (ASP) toxin. In: G.M. Hallegraeff, D.M. Anderson & A.D. Cembella (Eds.), ***Manual on Harmful Marine Microalgae***, Monographs on Oceanographic Methodology, Vol. 11, Chapter 9. Intergovernmental Oceanographic Commission (UNESCO), Paris, 247-266 (2003).

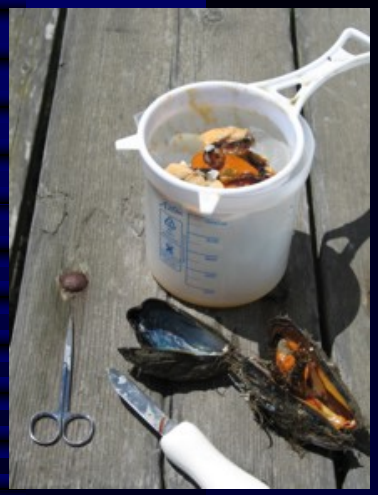
Alternative Analytical Methods

- Domoic Acid
  - Immunoassays (Biosense, NOAA, Jellett)
    - Jellett test is qualitative (presence/absence)

- PSP Toxins
  - Lawrence HPLC Method
  - Receptor Binding Assay
  - Immunoassay (Jellett)



Jellett Rapid Test: PSP



Shuck mussels

Mollusco-matic

Extract
(acidified IPA)

Filter

Wait 30 minutes

Add buffer to strip

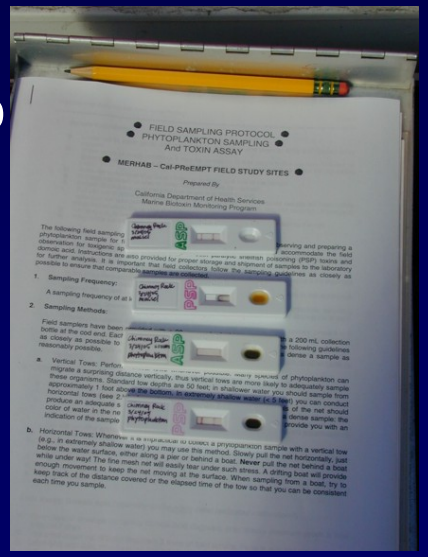
Add extract to buffer

1. Plankton Sampling

2. Plankton observations

3. Decision: run tests on plankton, shellfish?

4. Decision: ship samples to lab?



FIELD SAMPLING PROTOCOL
PHYTOPLANKTON SAMPLING
And TOXIN ASSAY

MERHAB – Cal-PReEMPT FIELD STUDY SITES

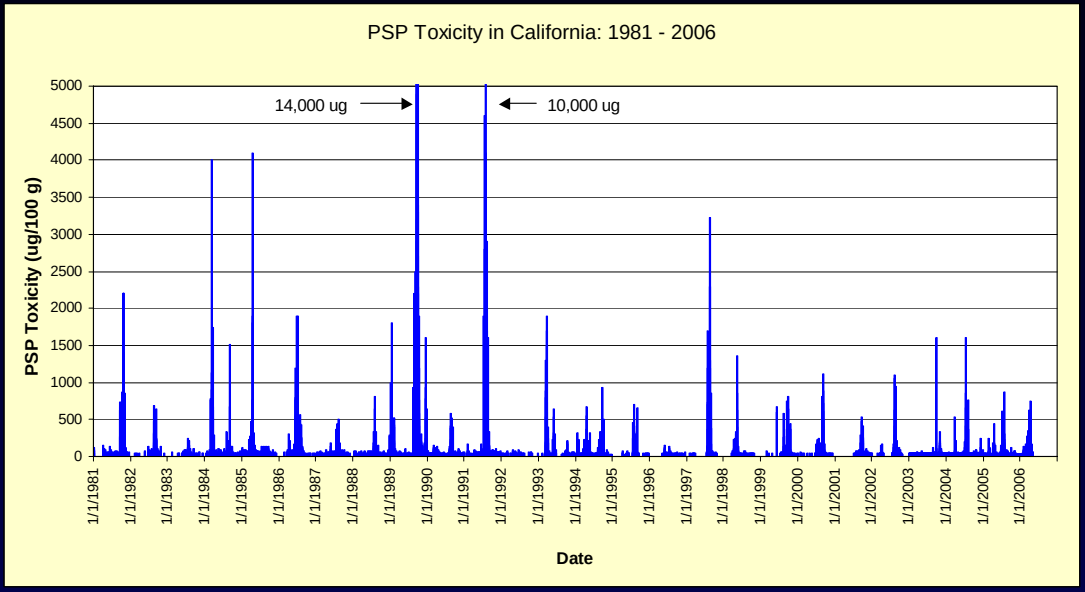
Prepared By

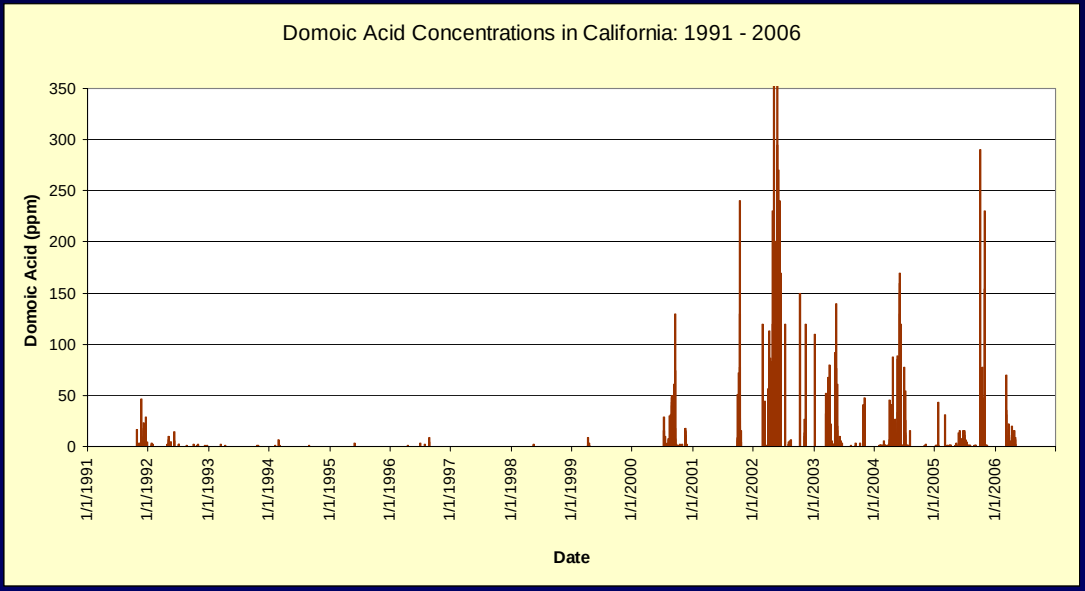
California Department of Health Services
Marine Biotoxin Monitoring Program

Monitoring Data

- Shellfish
  - Traditional Approach
  - Testing Food for Toxin
  - Tide, Weather Dependent
  - Low Frequency, High Cost
- Phytoplankton
  - Advanced warning
  - Relation to toxicity
  - Not limited by tide, weather
  - Immunoassay (Jellett)

Interannual Variability





Biological Cues:
Phytoplankton

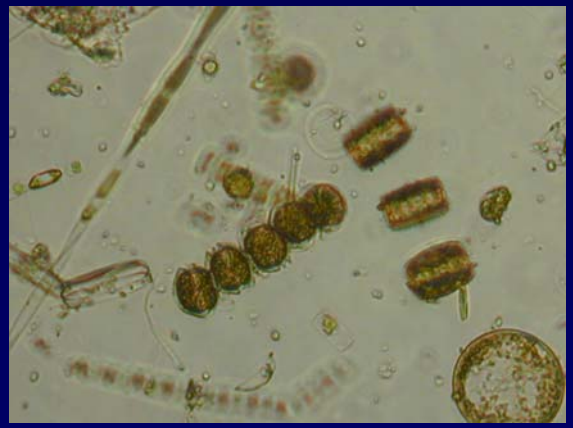
Photo courtesy of Kai Schumann

“RED TIDES”

- Vast majority are nontoxic
  - Anecdotal health effects
  - Wildlife impacts
  - Economic impacts
  - “Harmful Algal Blooms (HABs)”

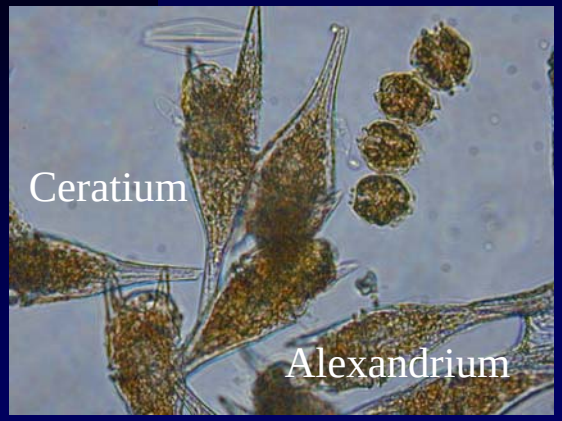
Photo courtesy of Tara Crow, Santa Monica Pier Aquarium

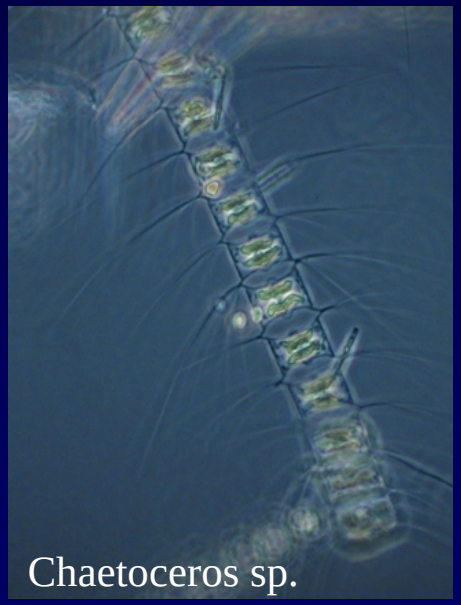
- Alexandrium rarely “blooms”



Phytoplankton Monitoring

- Easy to do in the field:
  - Plankton net, field microscope
  - Toxic species easily to ID
  - Rapid throughput
  - Low cost: Volunteer-based
  - Not weather/tide dependent





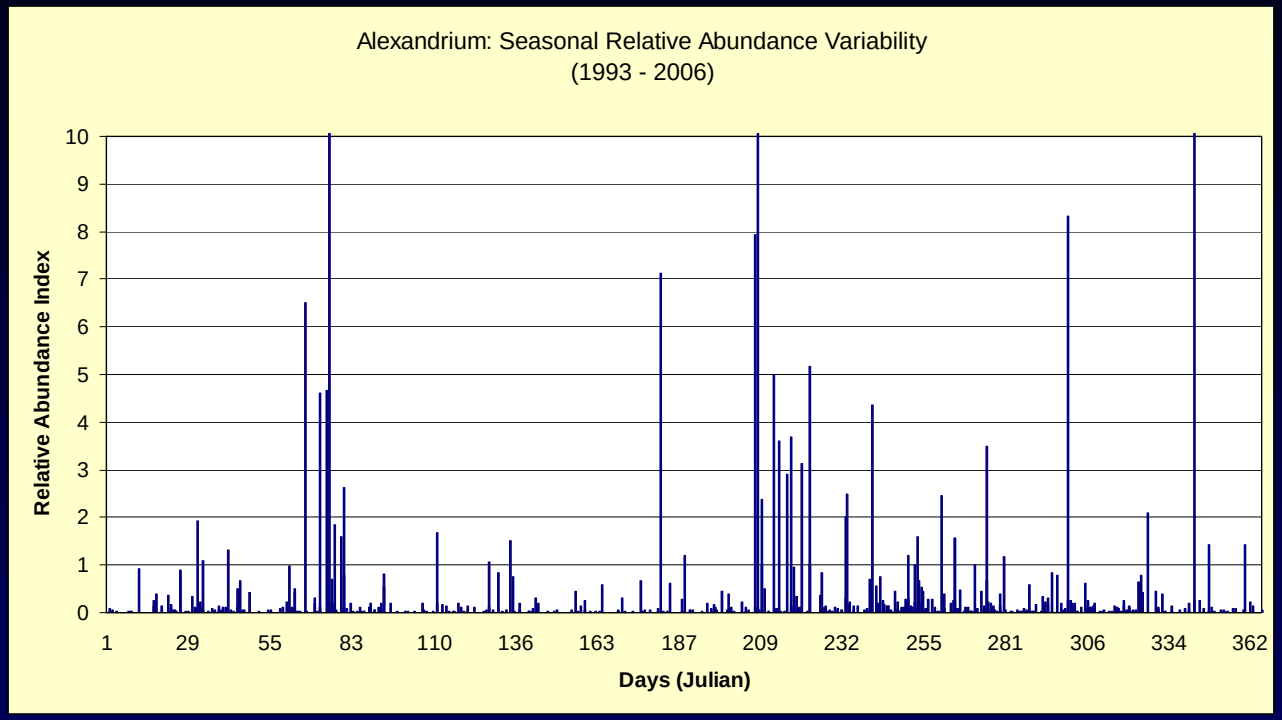
Phyto Data:

-Alexandrium:

-Not usually present

-Low #s = Toxicity

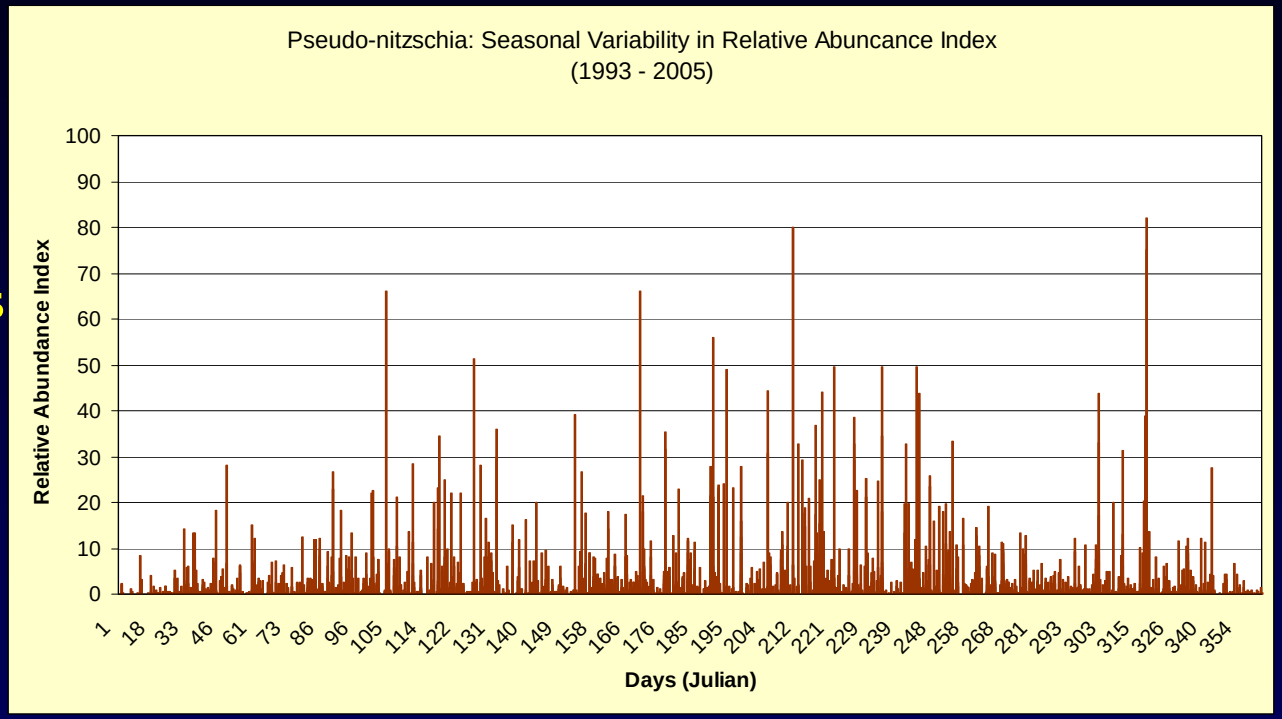
-Presence triggers response



Phyto Data:

-Pseudo-nitzschia:

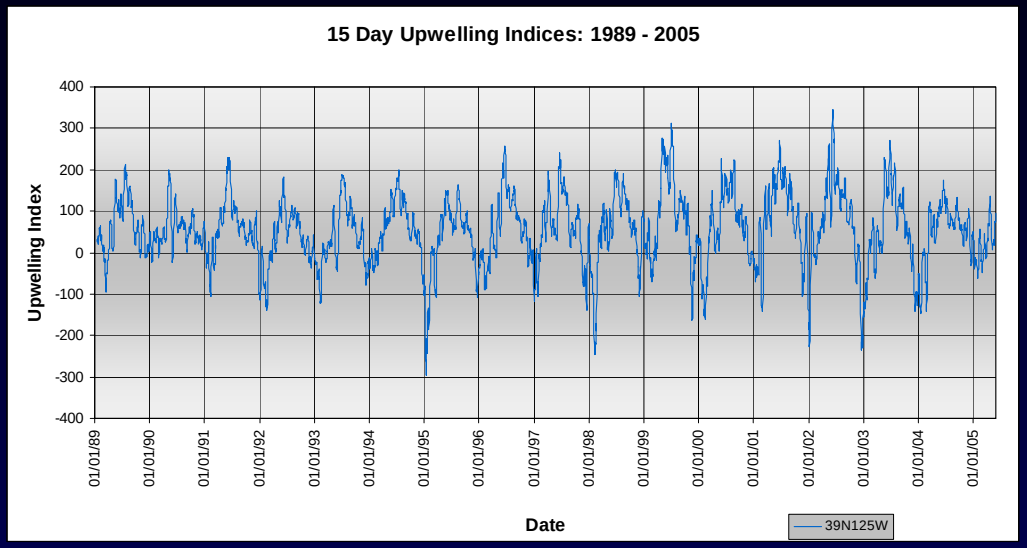
- -Often present
- -Track increases
- -Monospecific blooms
- -Increasing #s triggers response



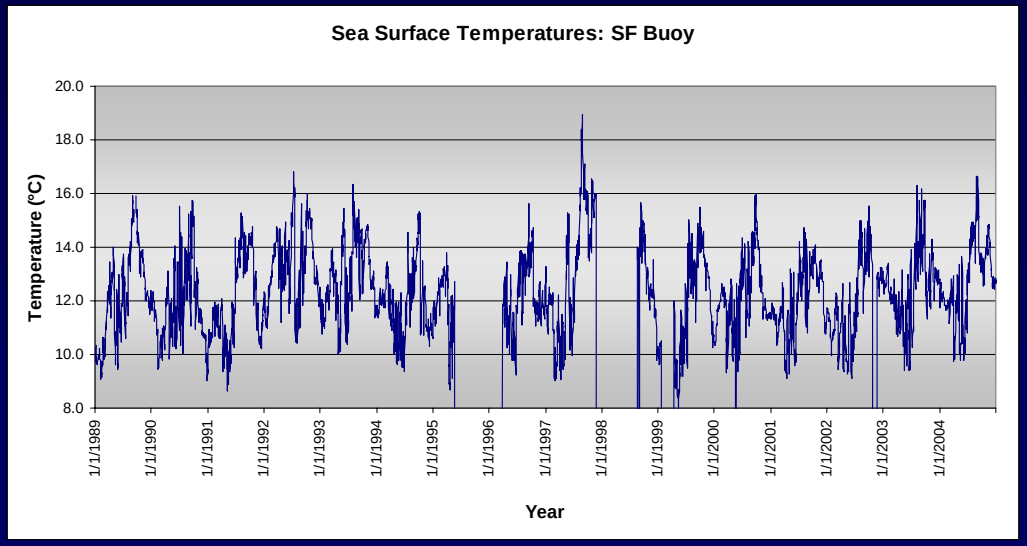
Environmental Cues:

Remote Sensing Data: Buoys

Environmental Cues



Upwelling Index



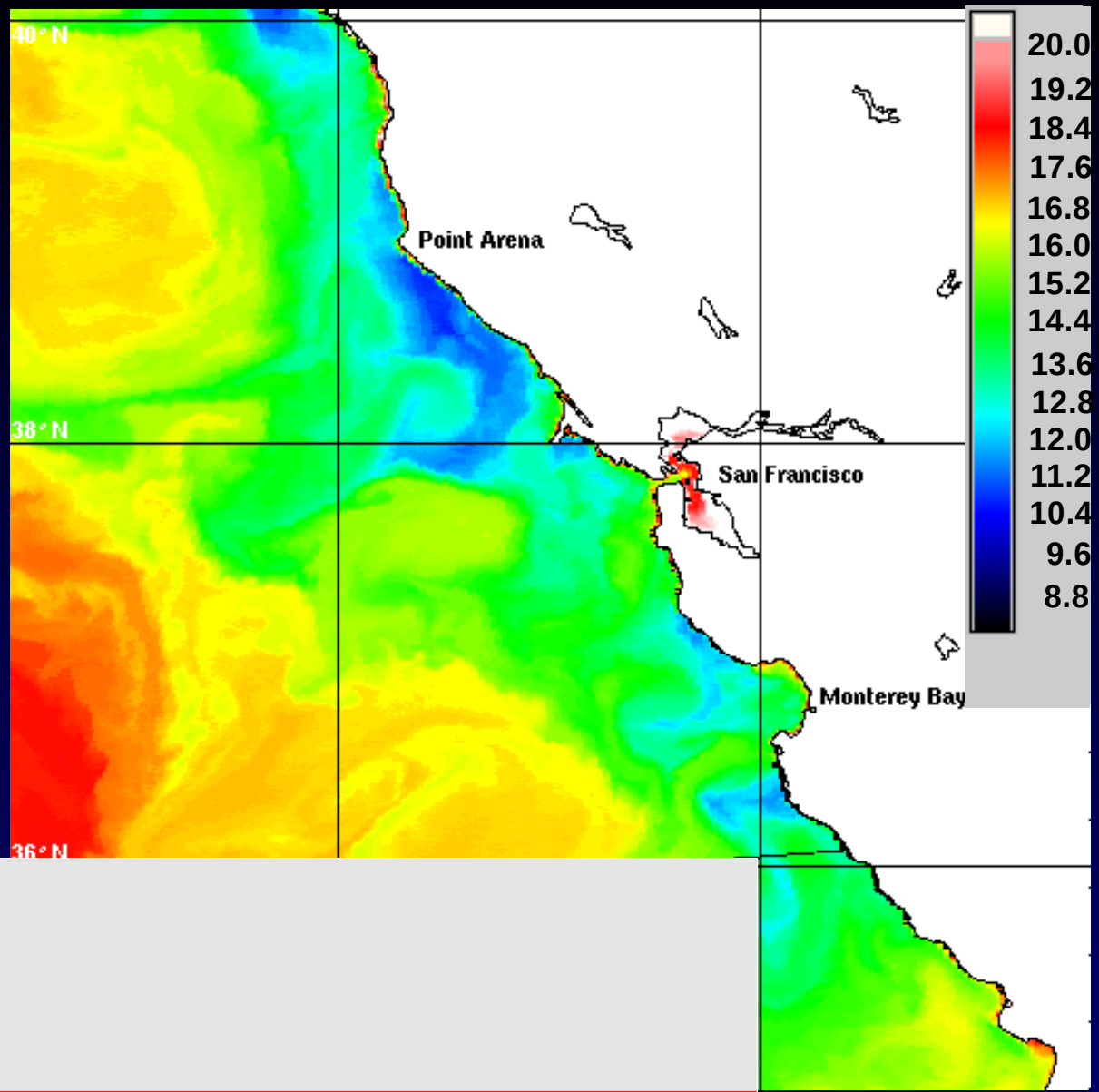
Sea Surface Temperature (SST)

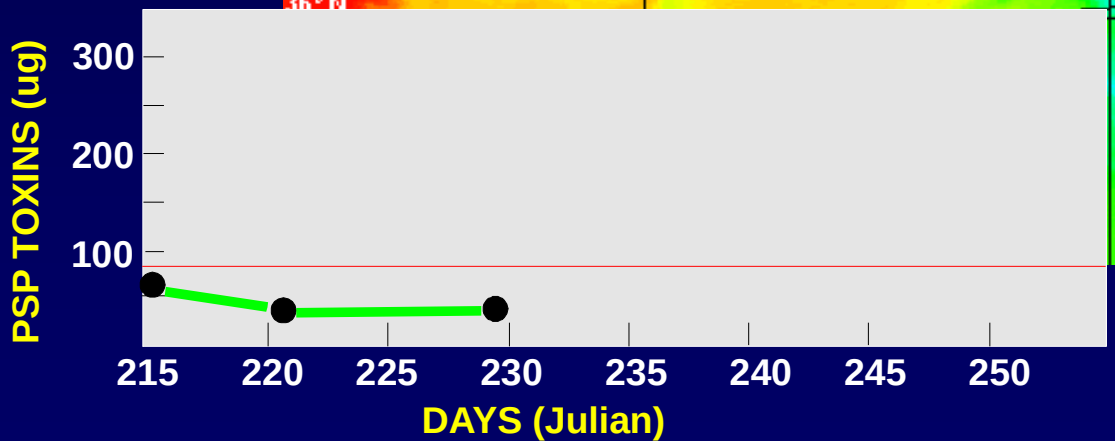
Environmental Cues:

Remote Sensing Data: Satellites

Sea Surface Temperatures via AVHRR: Advanced Very High Resolution Radiometry

August 15, 1994





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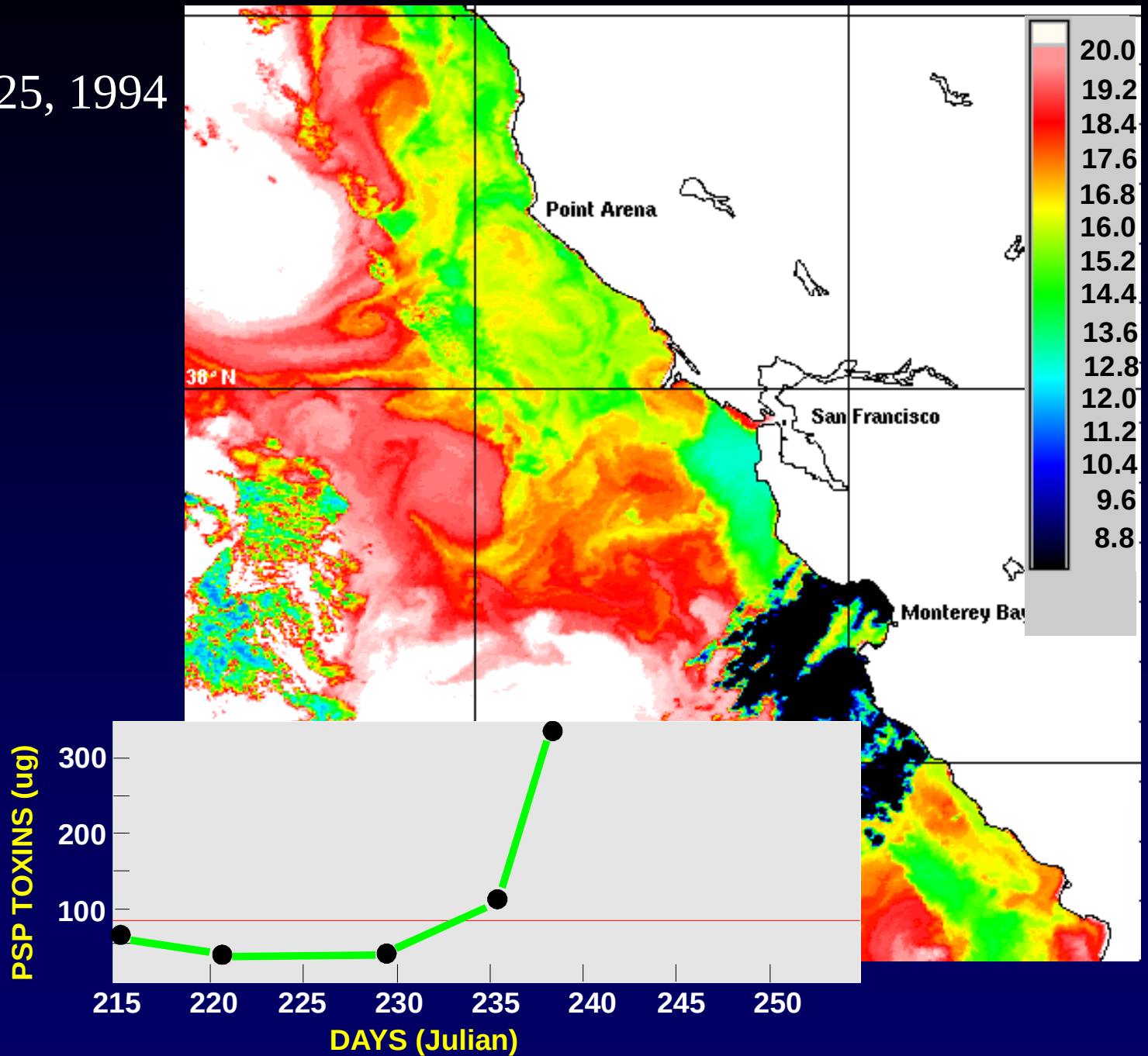
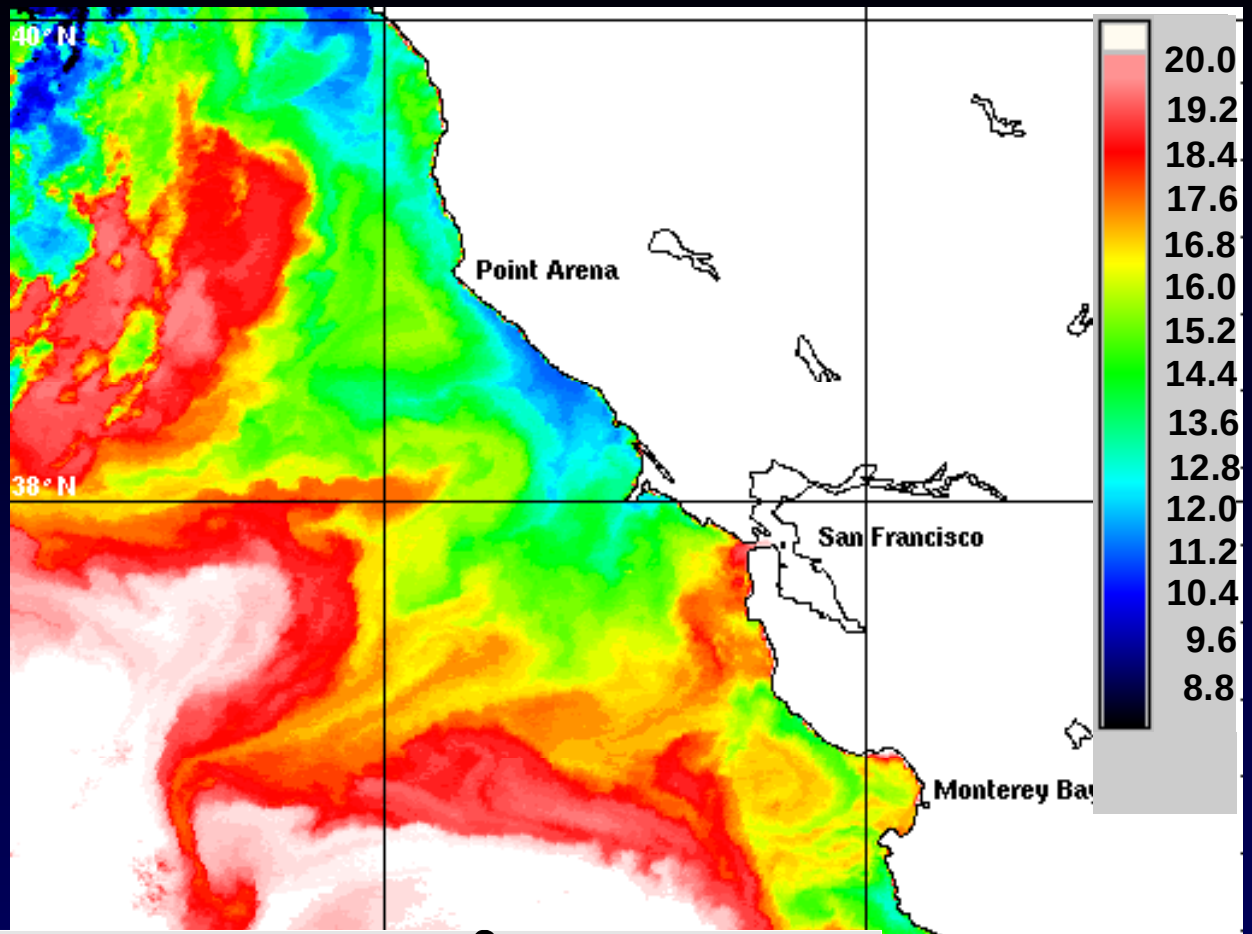
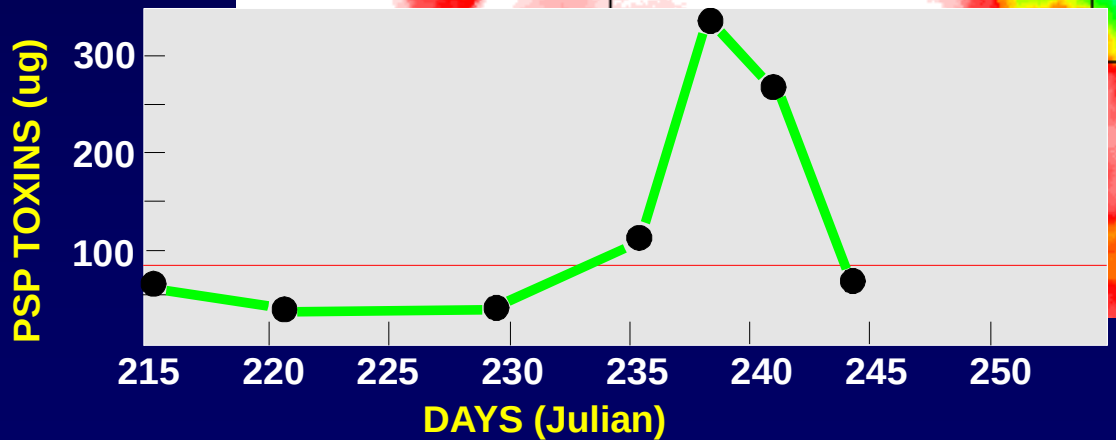


September 3, 1994





Environmental Cues:

Marine Mammal Strandings

Symptoms typical of Domoic Acid poisoning (seizures)

Integrated Monitoring: 2009

- Environmental Data:
  - Offshore Buoy SST
  - Imagery: AVHRR and SeaWifs
  - Marine mammal strandings
  - **Bloom transport tracking models**
- Phytoplankton Data
  - Field sampling, field/lab observations: toxic species
  - **Field test kits: cell toxicity**
  - **Gene probes: toxic species**
- Shellfish Toxicity Data
  - **Improved lab methods: automated, rapid, nonproprietary**
  - **Field screening for toxins (cull negatives; harvest info)**

Acknowledgements:

- Del Norte County Health Department
- U.C. Sea Grant Extension
- Coast Seafoods Company
- Humboldt Co. Environmental Health Dept.
- CDHS Volunteers
- Mendocino Co. Environmental Health Dept.
- CDHS Volunteer
- California Department of Fish and Game
- CDHS Volunteers
- Cordell Banks National Marine Sanctuary
- Bodega Marine Lab
- Johnson Oyster Company
- Drakes Bay Oyster Company
- Hog Island Oyster Company
- Marin Oyster Company
- Cove Mussel Company
- CDHS/UCSC Cal-PReEMPT
- The Marine Mammal Center (TMMC)
- San Francisco County Health Department
- Gulf of the Farallones Nat. Marine Santuary
- CDHS Volunteers
- San Mateo Co. Environmental Health Dept.
- TMMC/CDHS Volunteers
- Santa Cruz Co. Environmental Health Dept.
- U.C. Santa Cruz (UCSC)
- CDHS/UCSC Cal-PReEMPT
- TMMC/CDHS Volunteers
- Pacific Cetacean Group
- CDHS Volunteers
- Monterey Abalone Company
- TMMC/CDHS Volunteers
- Marine Pollution Studies Laboratory
- NOAA Coastal Discovery Center
- Williams Shellfish Company
- Tomales Bay Oyster Company (Morro Bay)
- Morro Bay National Estuary Program
- Morro Bay Natural History Museum
- California Department of Fish and Game
- Tenera Environmental
- TMMC/CDHS Volunteers
- CDHS/UCSC Cal-PReEMPT
- Vandenberg AFB
- Calif. Department of Parks and Recreation
- U.C. Santa Barbara
- Santa Barbara City College
- Santa Barbara Mariculture Company
- Ecomar, Inc.
- Santa Barbara Channel Keeper
- National Park Service
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- Ecomar, Inc.
- Orange CDHS Volunteers
- San Diego CDHS Volunteers
- Carlsbad Aquafarms Inc.
- Scripps Institute of Oceanography
- Avian Research Association
- U.S. Navy

Photo courtesy of Todd Warshaw