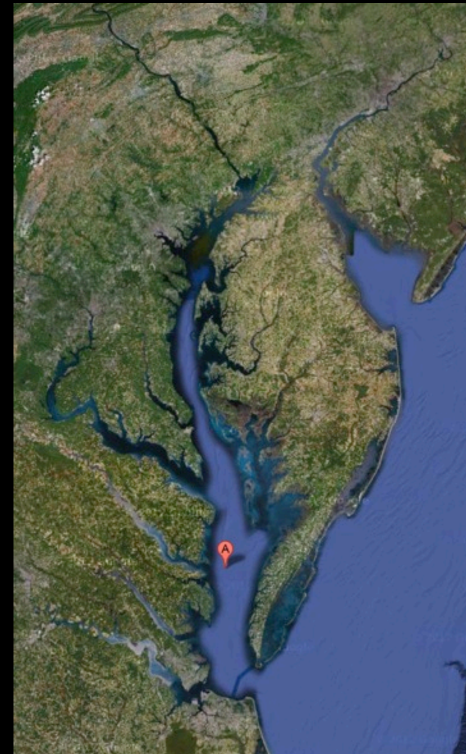
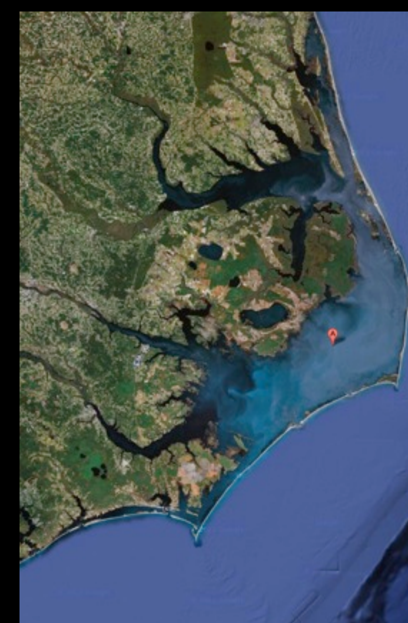
Lessons From Sustained Observations in Estuaries

Jim Cloern, USGS, Menlo Park CA

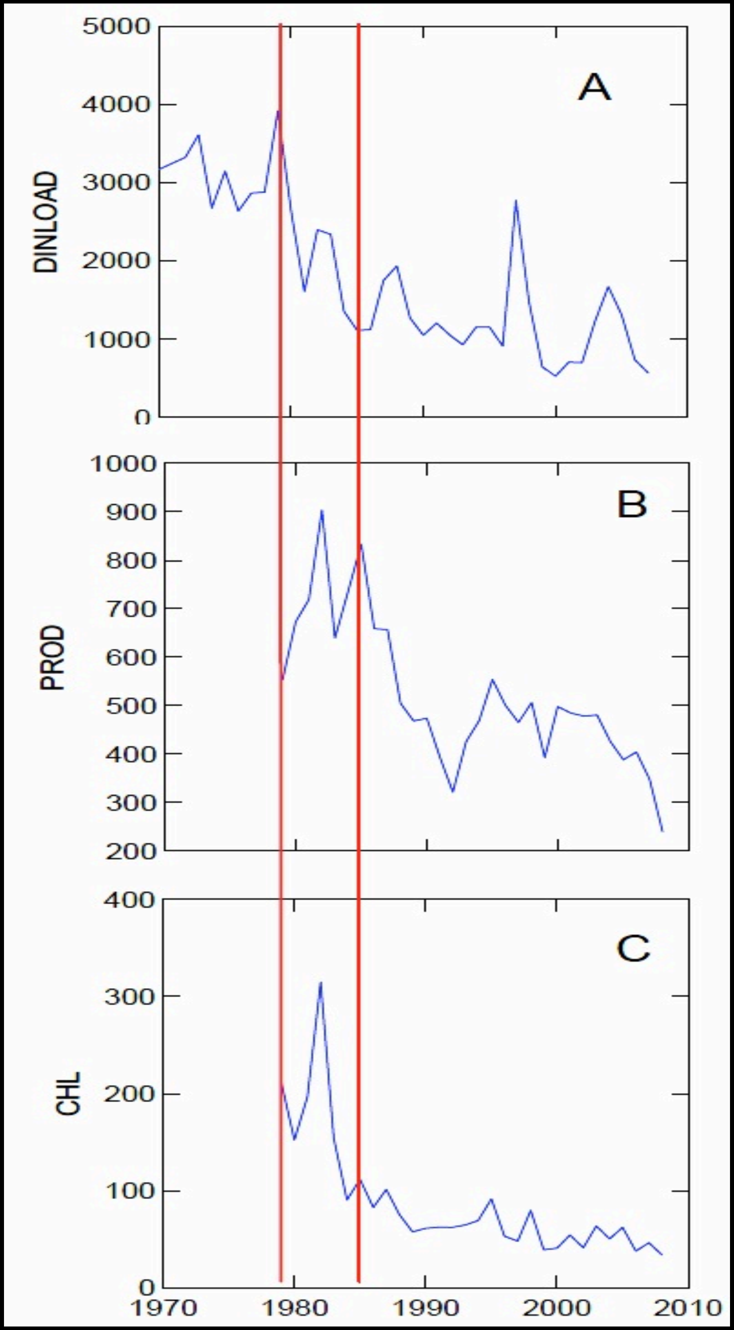




USGS
science for a changing world

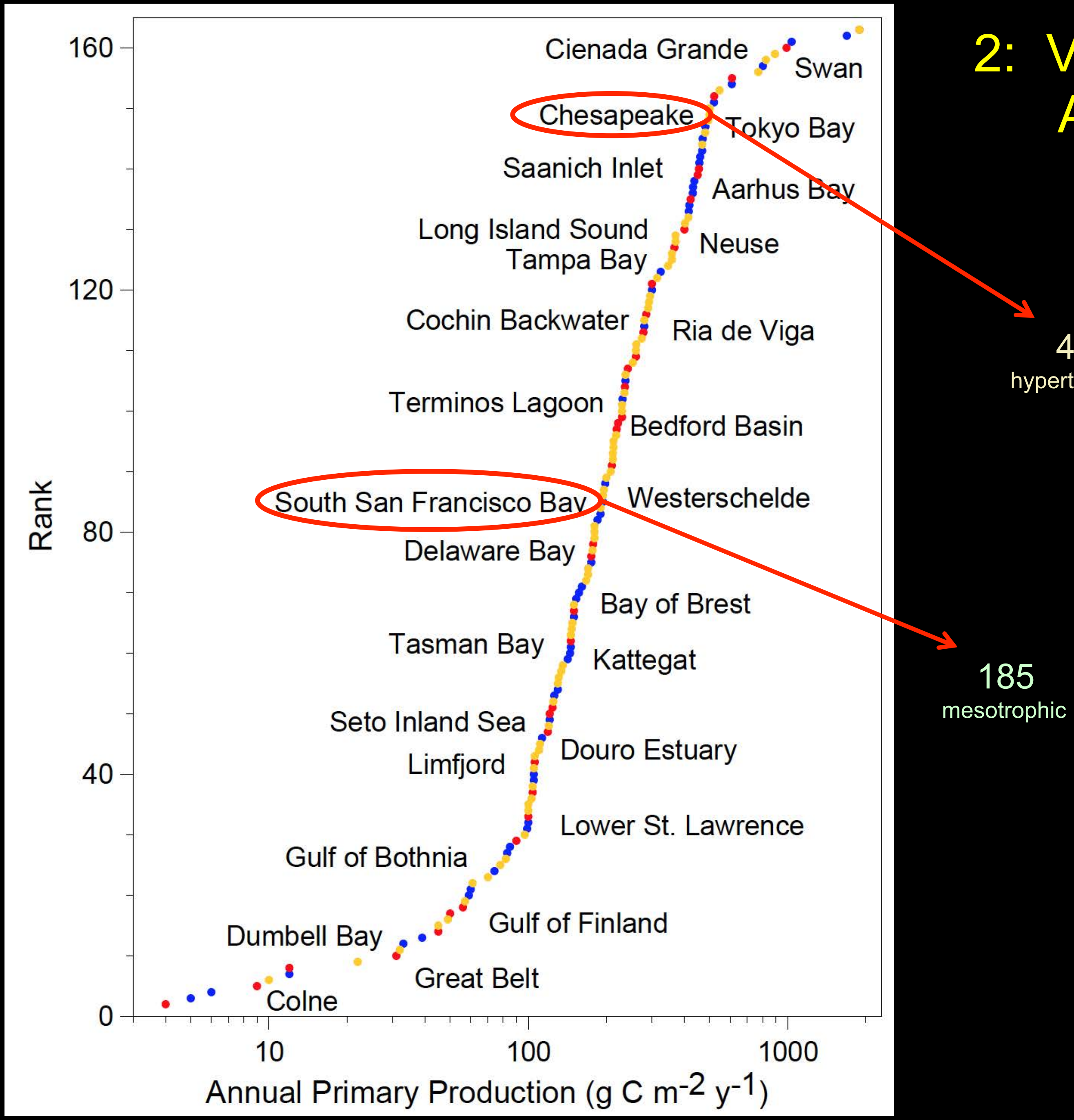
1: Responses to Nutrient Reductions

Tampa Bay

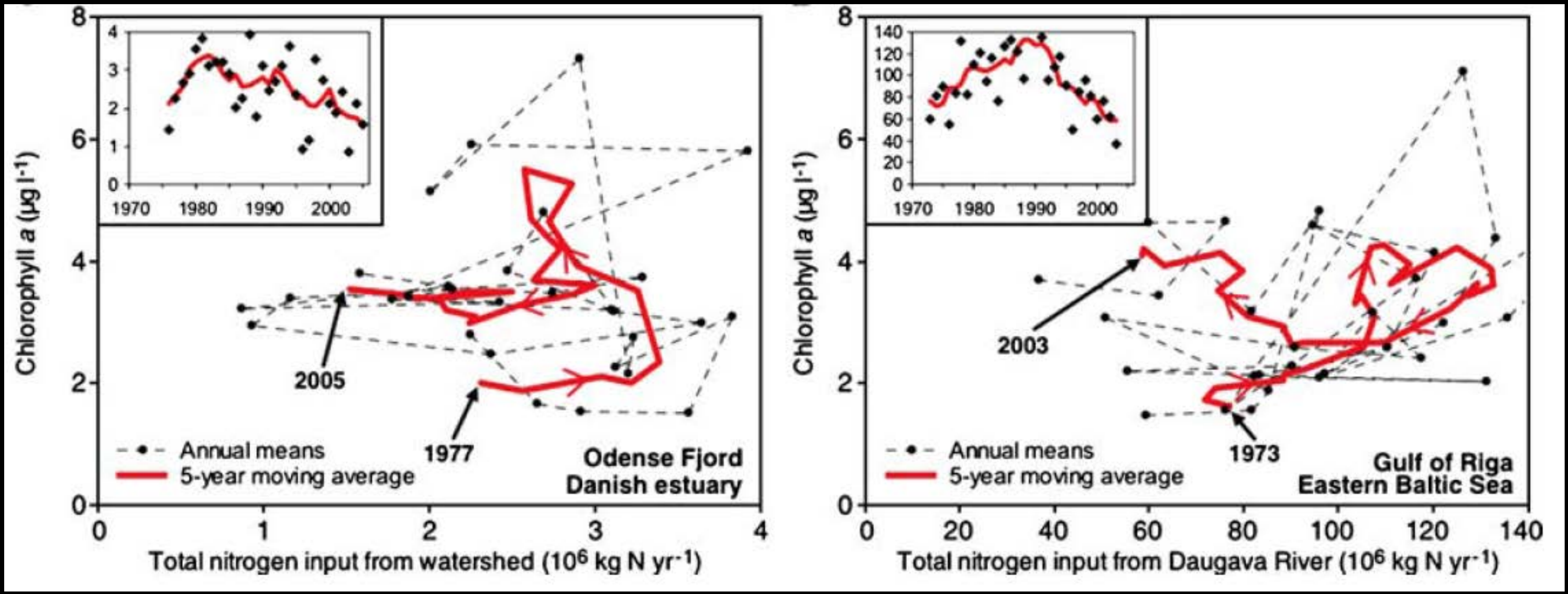


Johansson 2010

2: Variable Sensitivity Across Estuaries

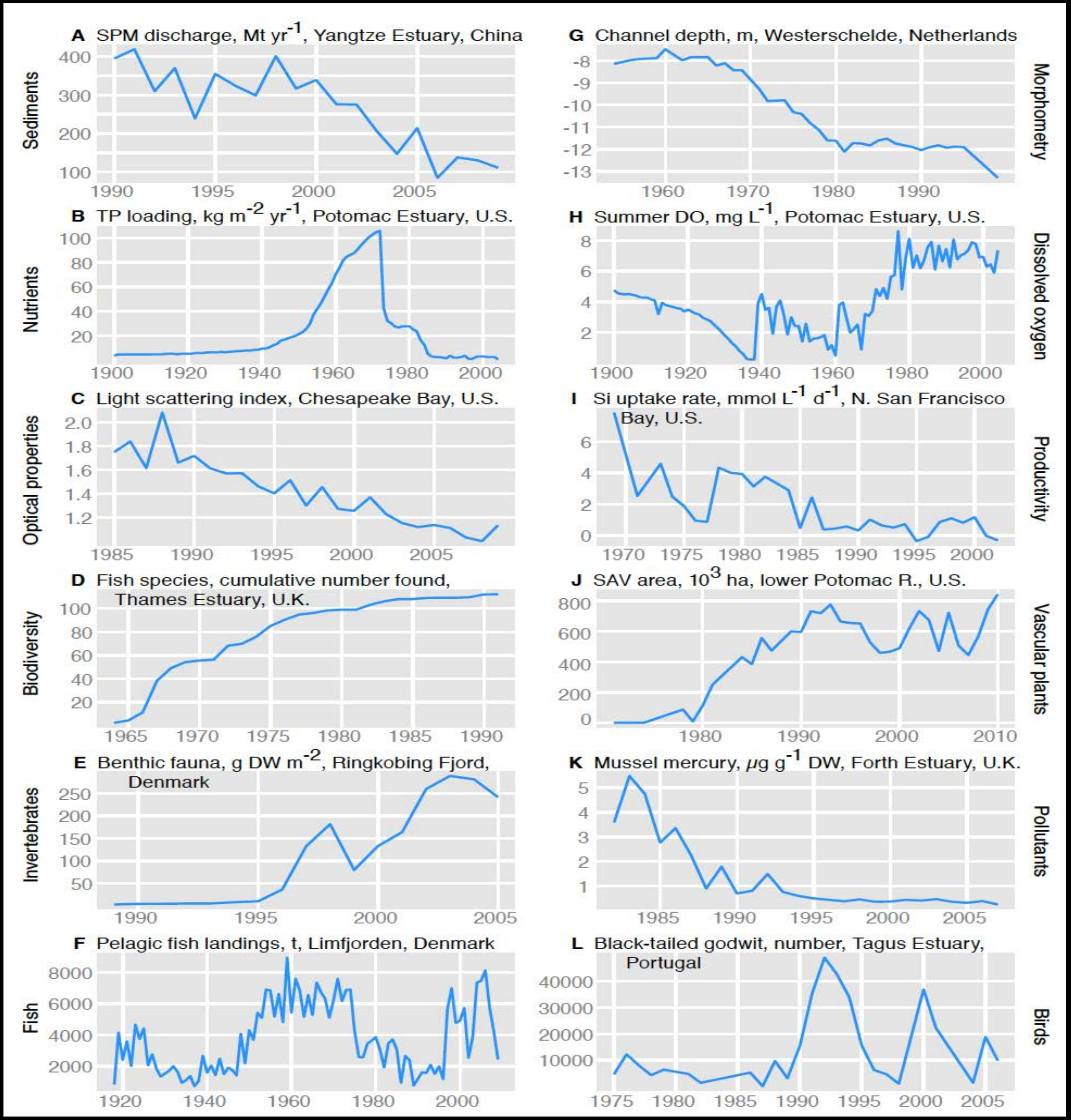


3: Disappointing/Unexpected Responses to Nutrient Reductions

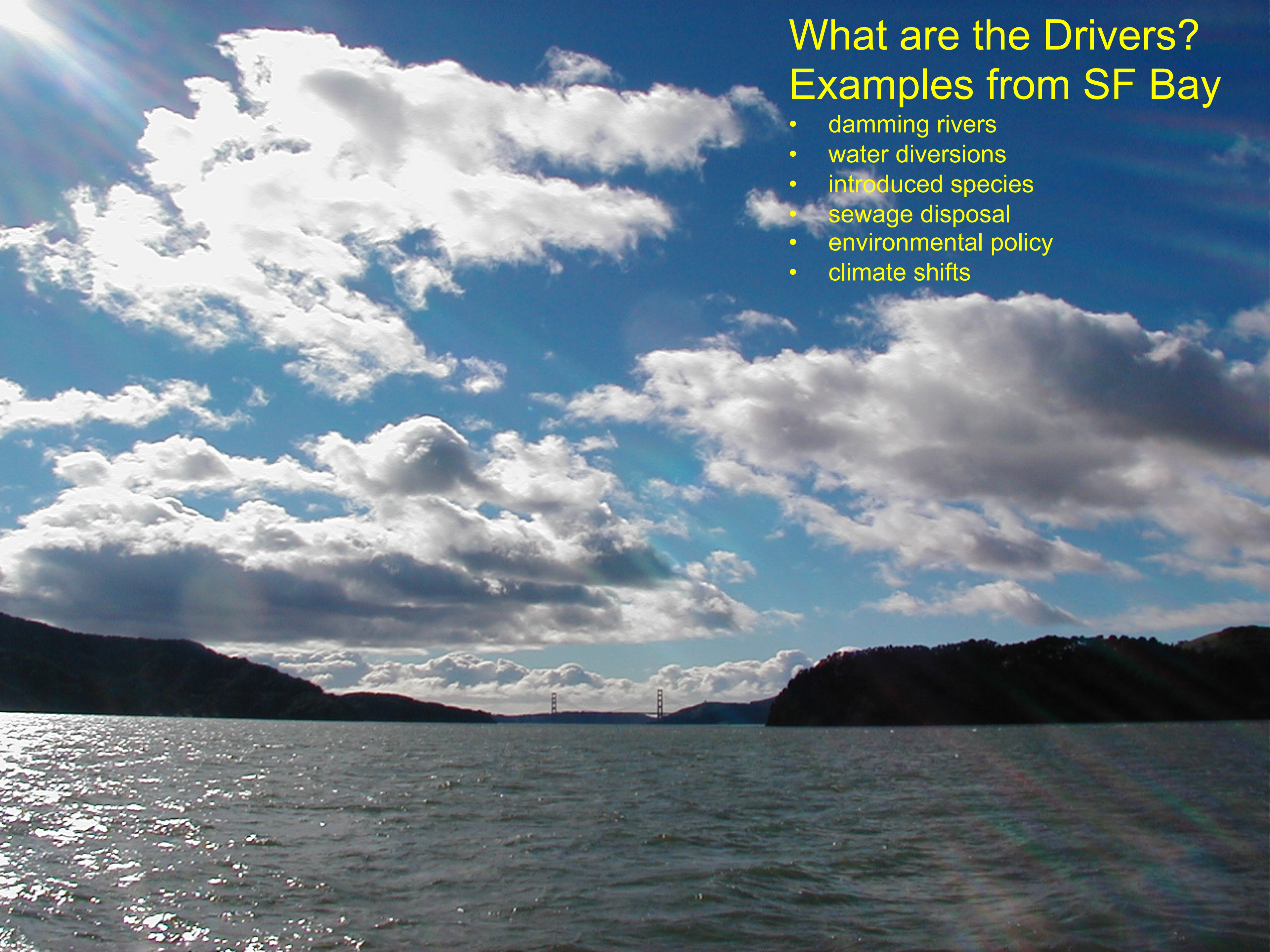


Duarte et al. 2009

4: Things Change



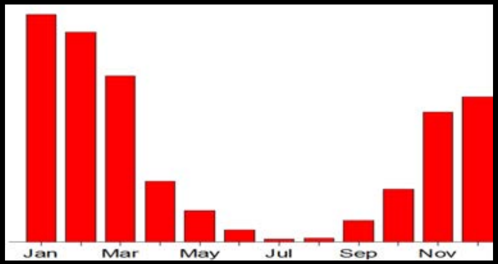
Cloern & Jassby 2012

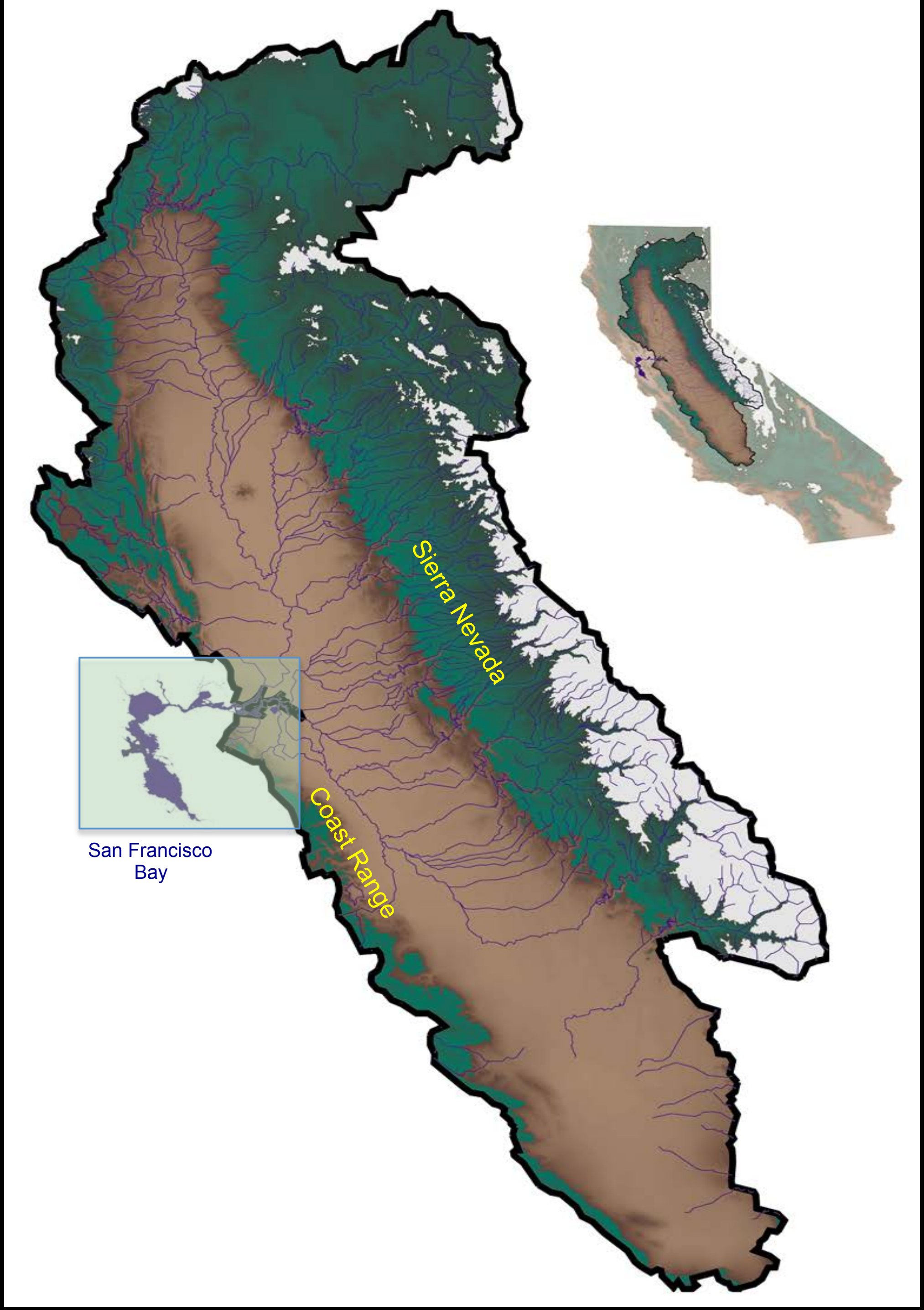


What are the Drivers? Examples from SF Bay

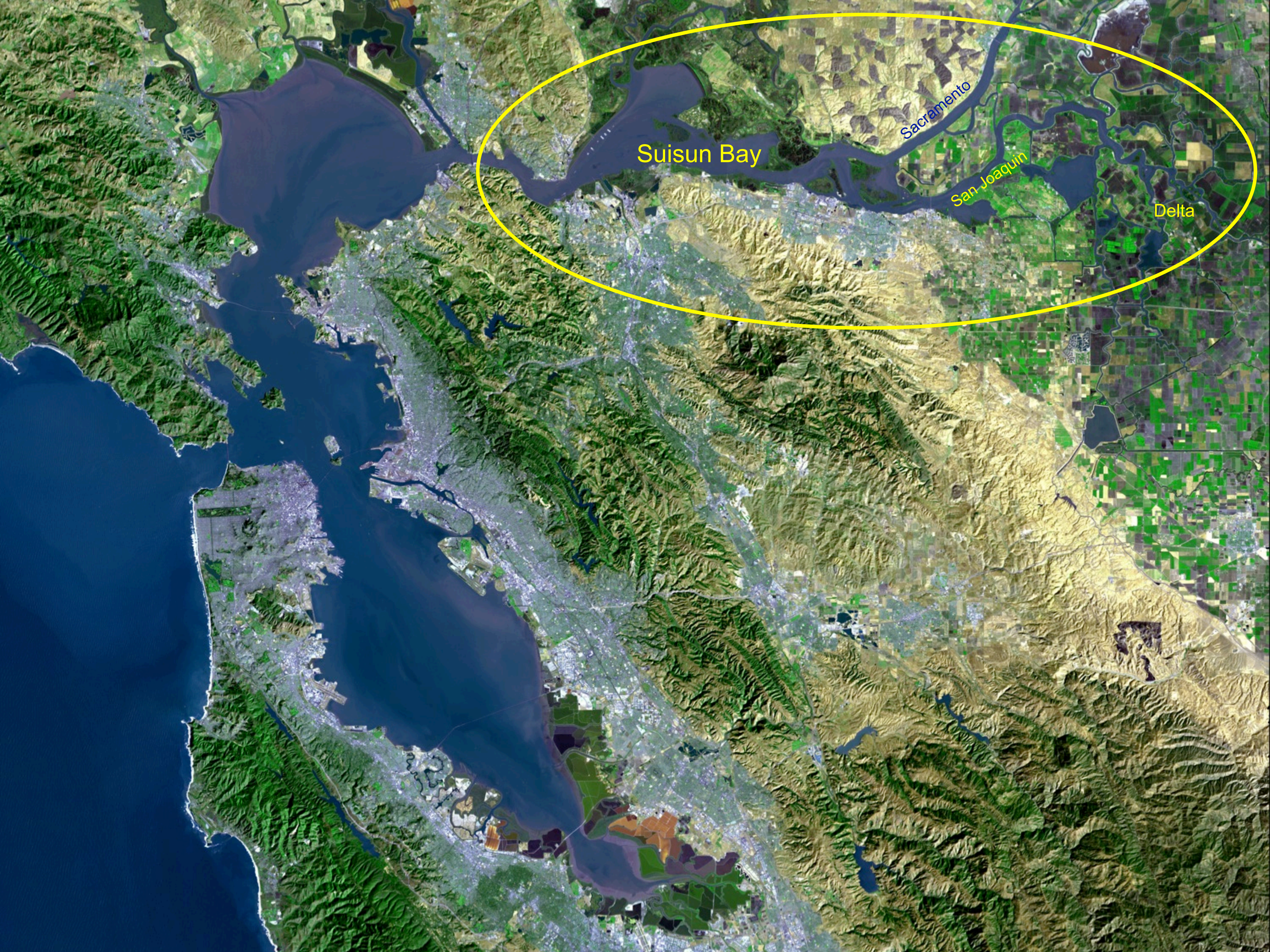
- damming rivers
- water diversions
- introduced species
- sewage disposal
- environmental policy
- climate shifts

San Francisco Bay is an Estuary

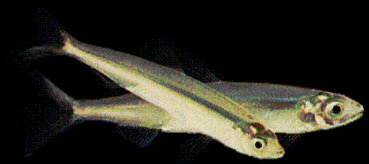


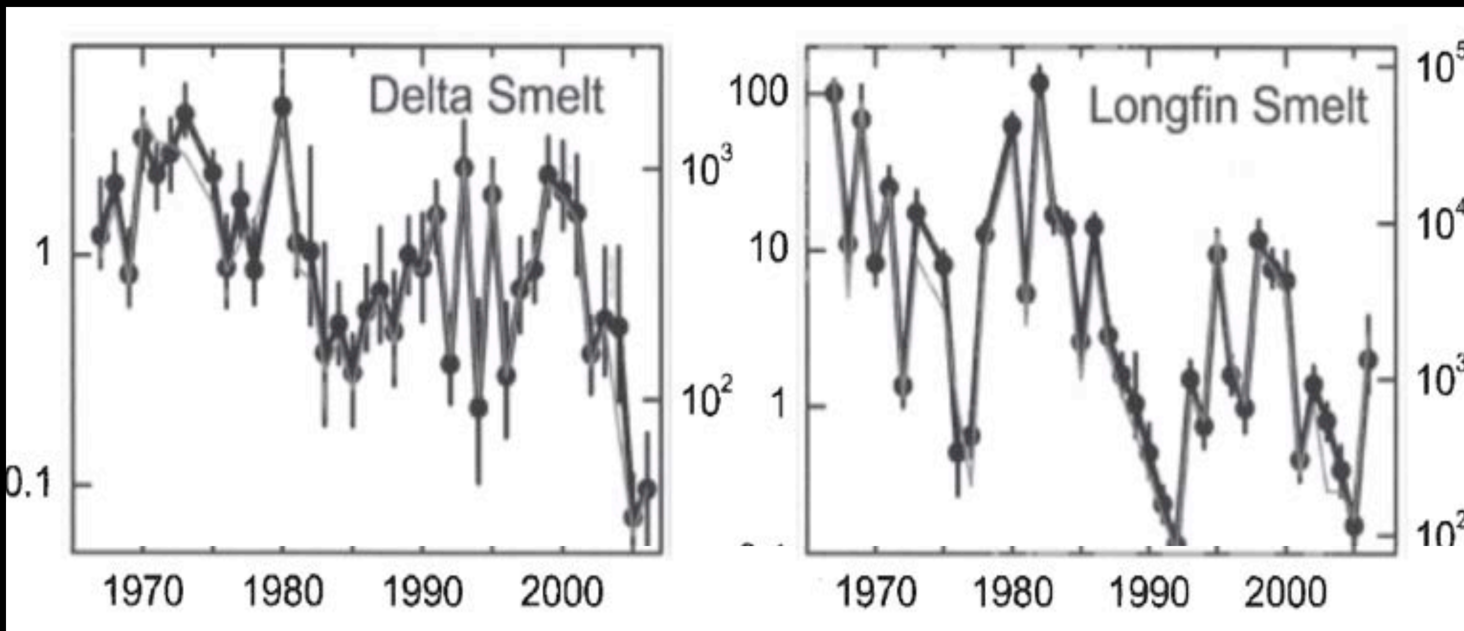



San Pablo
Suisun Bay
Sacramento
San Joaquin
Delta
Golden Gate
San Francisco
Pacific Ocean
South Bay

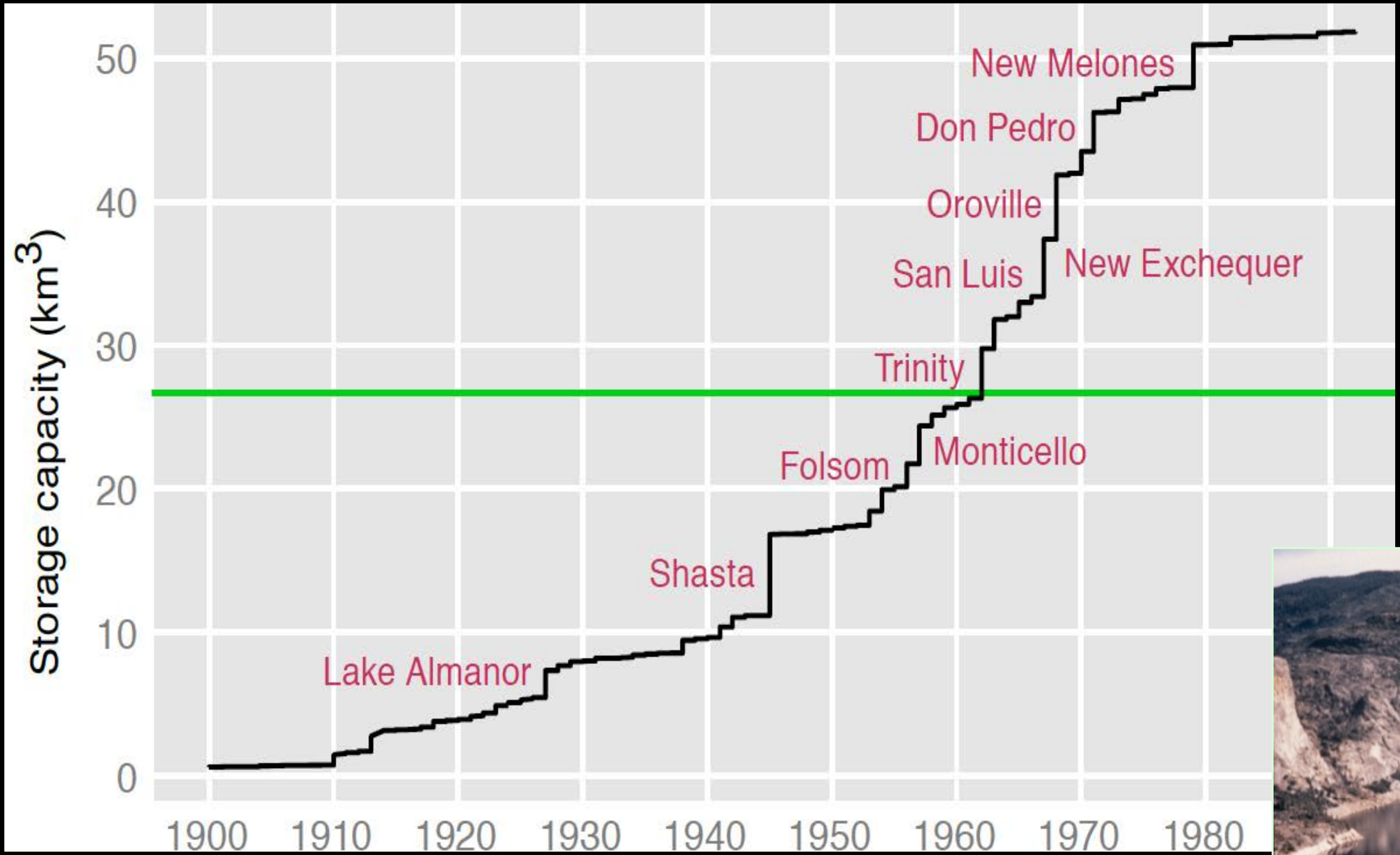

Suisun Bay
Sacramento
San Joaquin
Delta

Priority Management Issue: Endangered Native Fishes

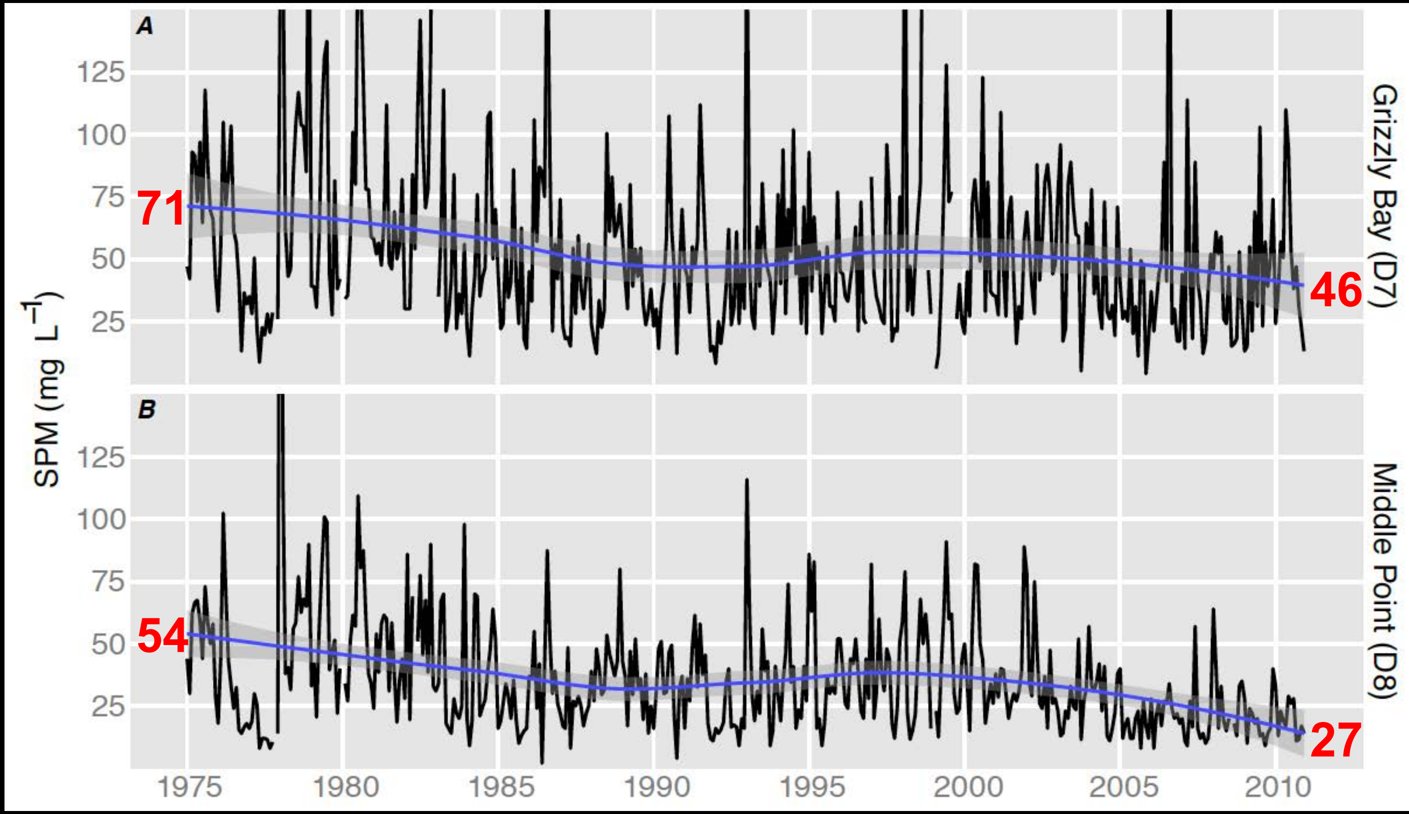




DRIVER #1: damming rivers

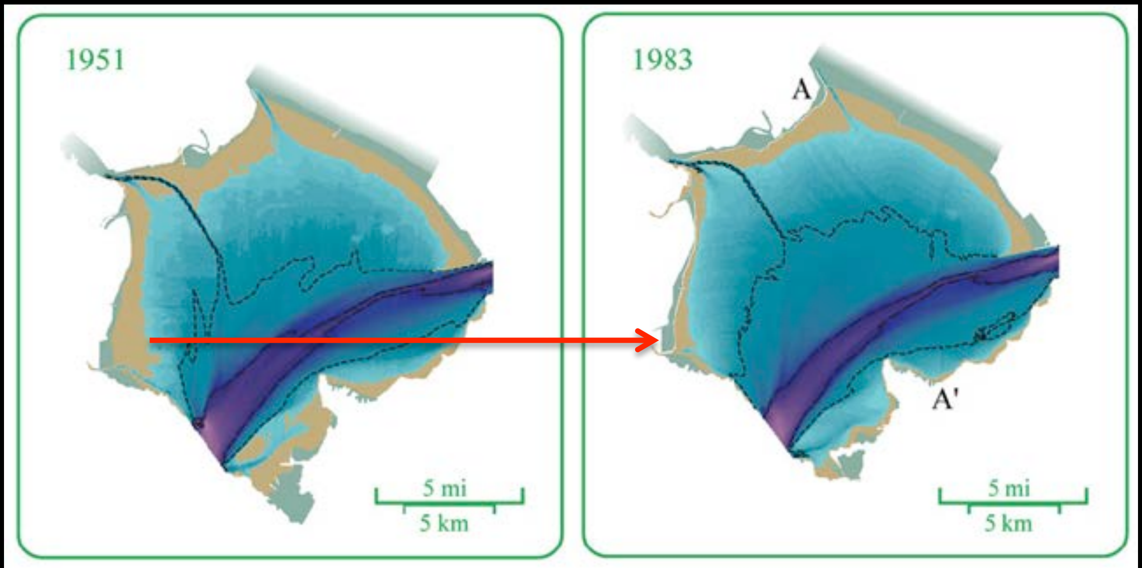


RESPONSE: reduced sediment supply and sediment concentrations



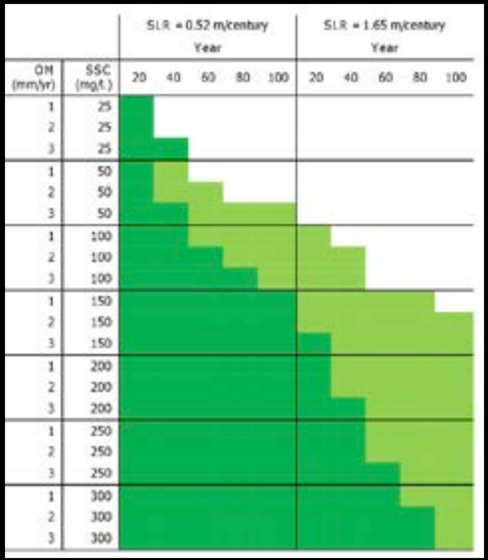
IMPLICATIONS:

increasing transparency



loss of mudflats

sustainability of tidal marshes ?

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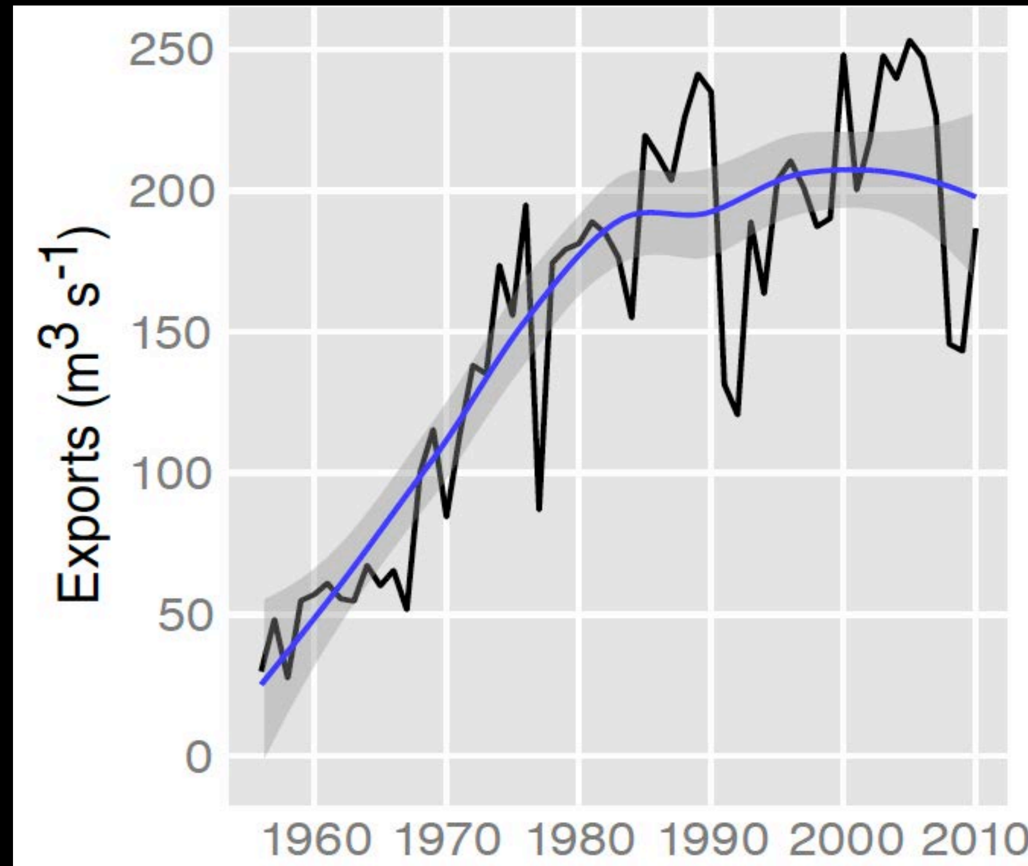
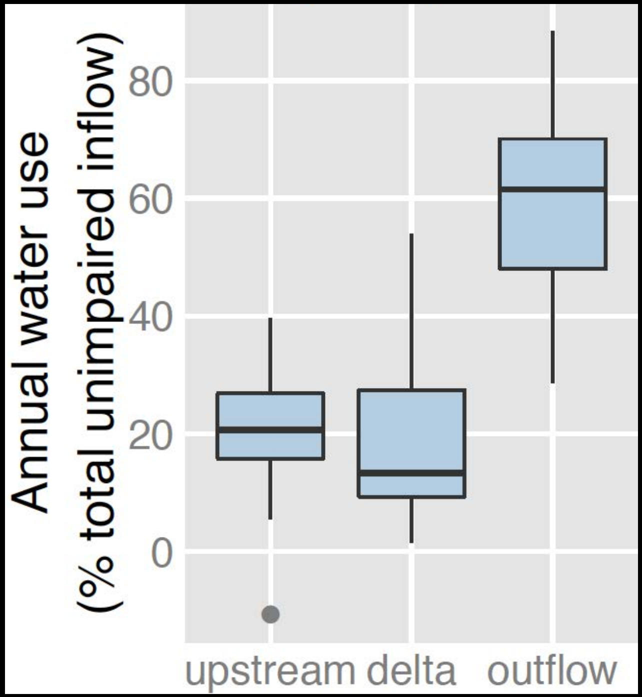
Evaluating Tidal Marsh Sustainability in the Face of Sea-Level Rise: A Hybrid Modeling Approach Applied to San Francisco Bay

Diana Stralberg, Matthew Brennan, John C. Callaway, Julian K. Wood, Lisa M. Schile, Dennis Jongsomjit, Maggi Kelly, V. Thomas Parker, Stephen Crooks

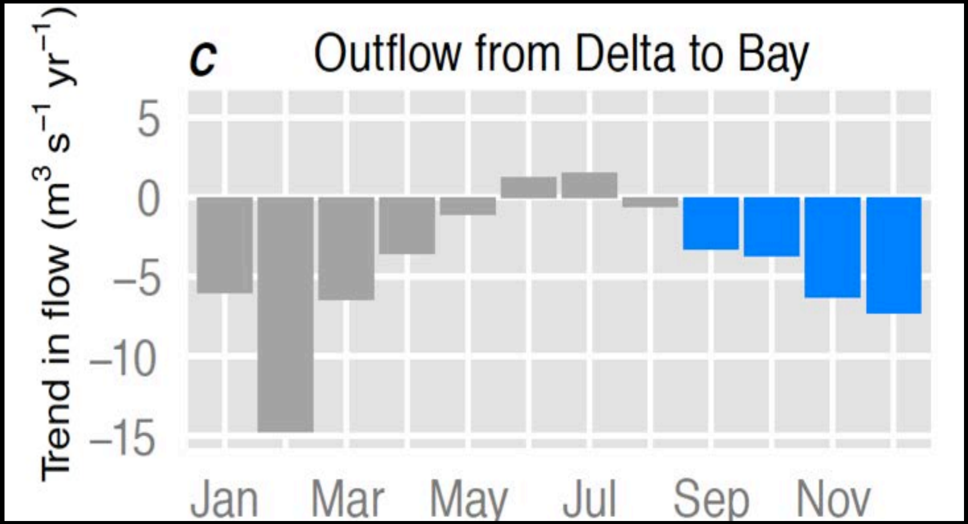
DRIVER #2: water consumption and diversions



RESPONSE:



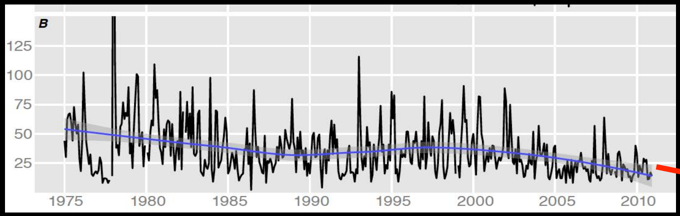
39% reduction in freshwater inflow

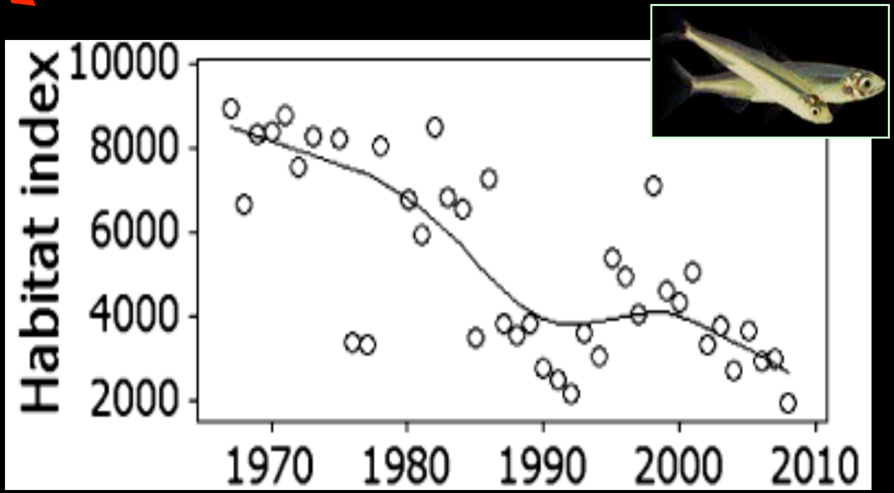


altered hydrograph

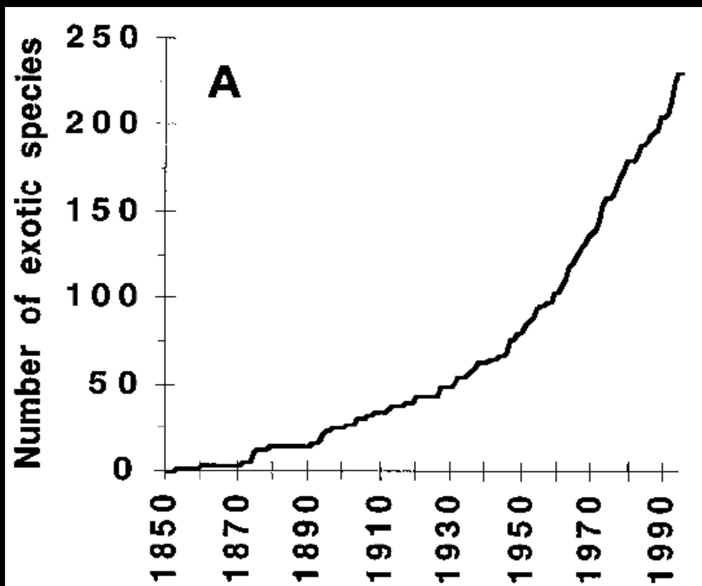
IMPLICATIONS:

New Flow Standard





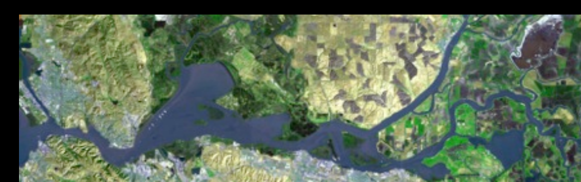
DRIVER #3: introduced species



Accelerating Invasion Rate in a Highly Invaded Estuary

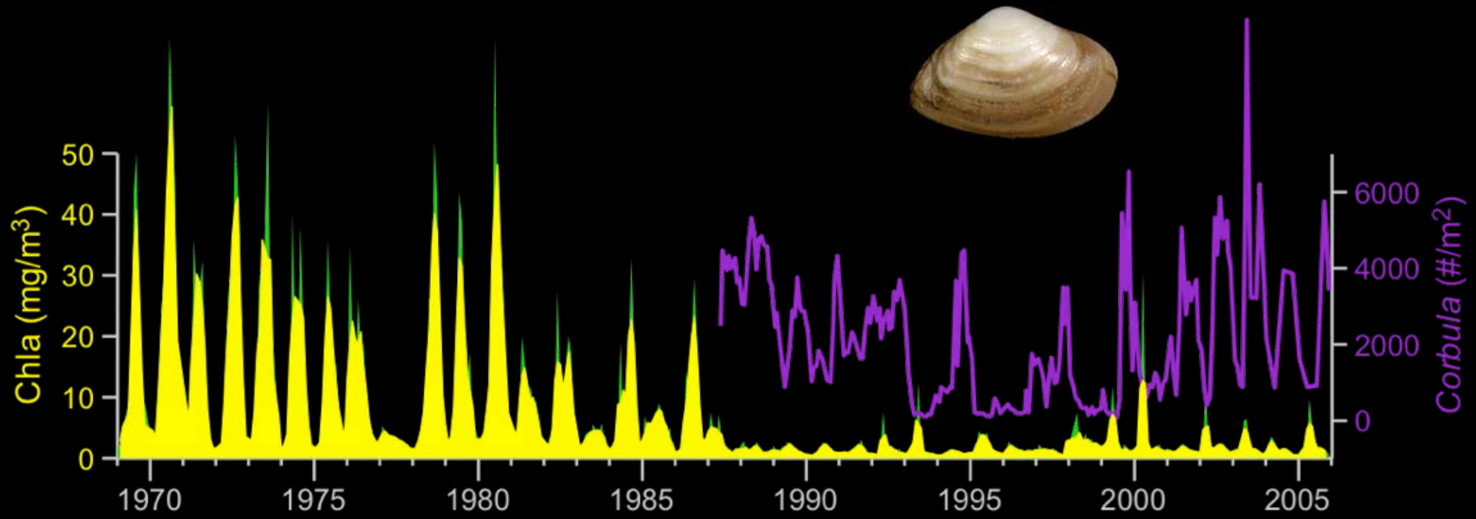
Andrew N. Cohen* and James T. Carlton

"San Francisco Bay and Delta ecosystem may be the most invaded estuary in the world"



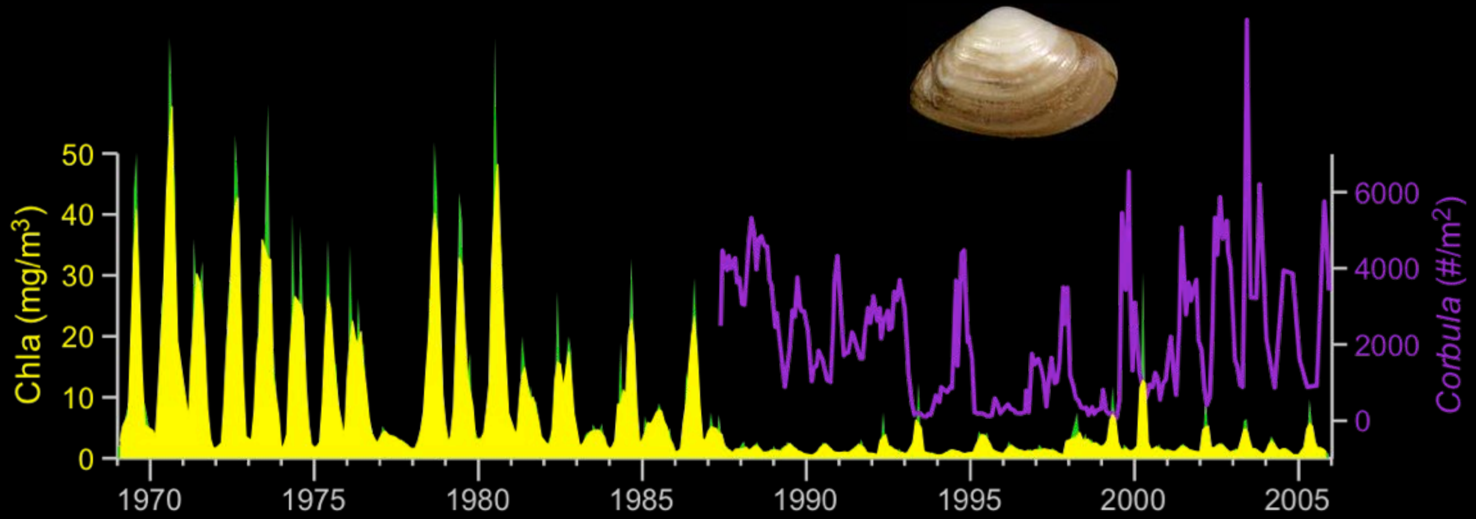
Corbula amurensis

RESPONSE:

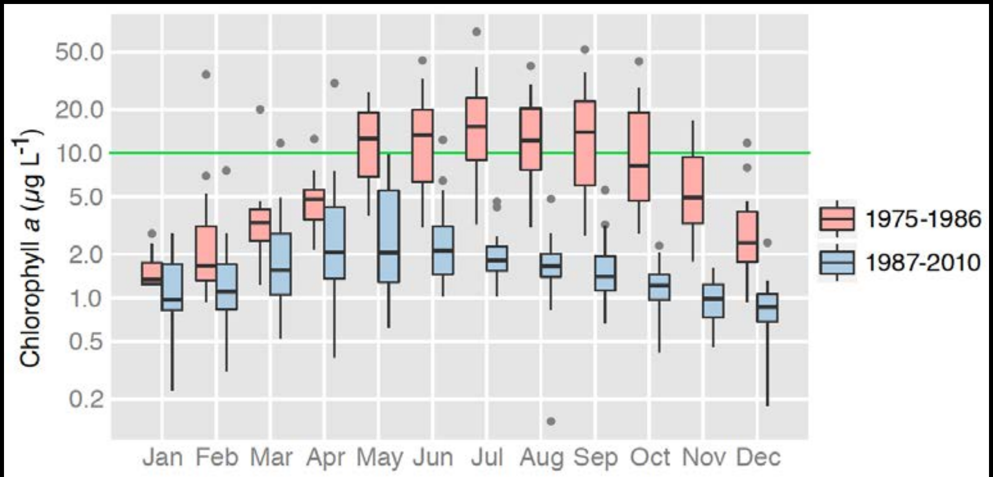


5-fold reduction of phytoplankton biomass and production

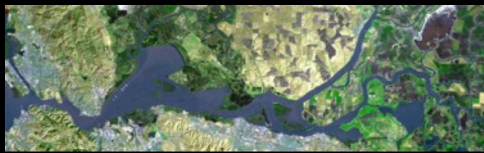
RESPONSE:

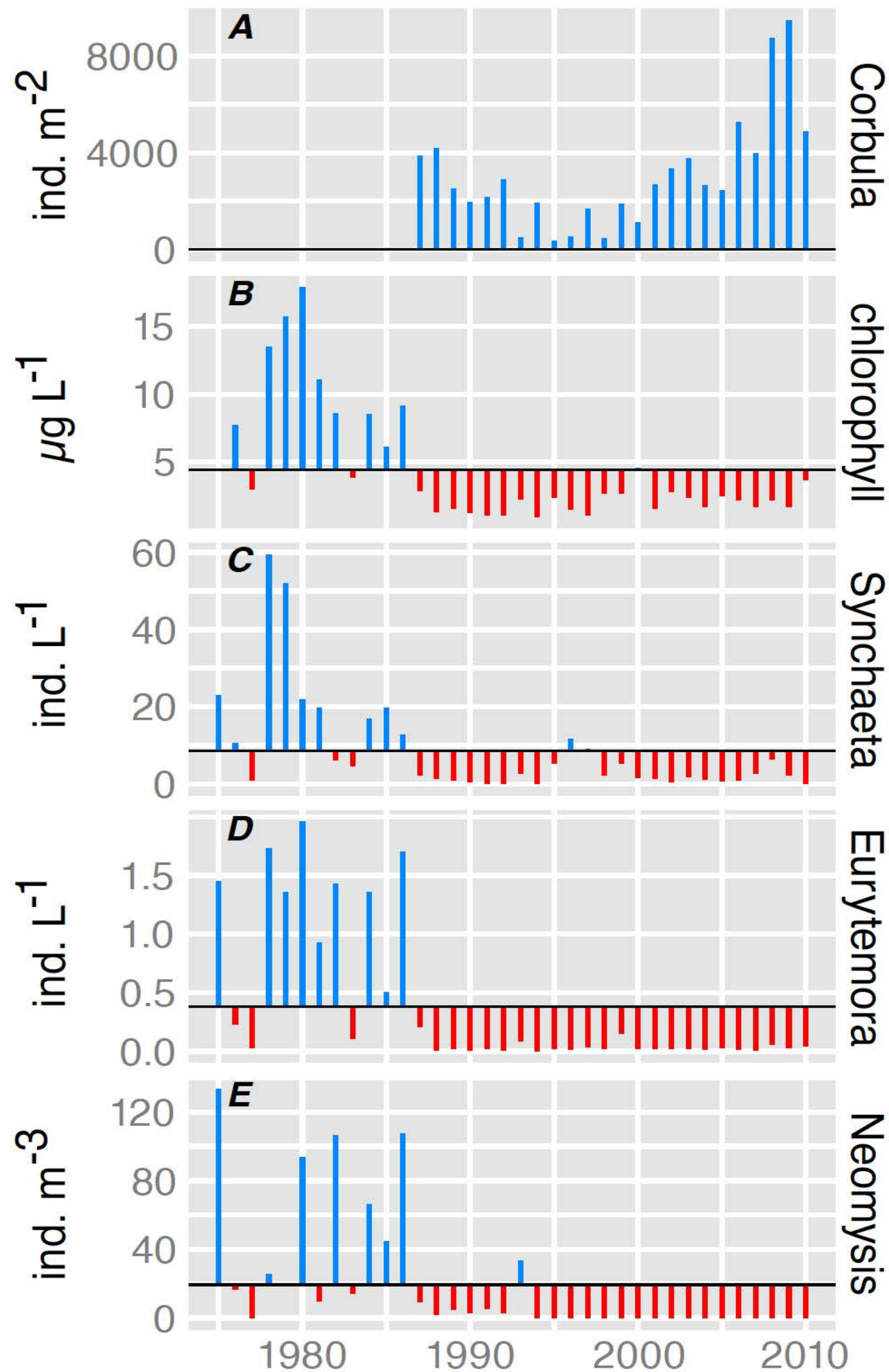


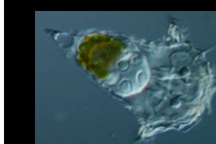
5-fold reduction of phytoplankton biomass and production



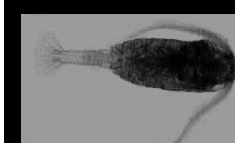
food limitation of consumers



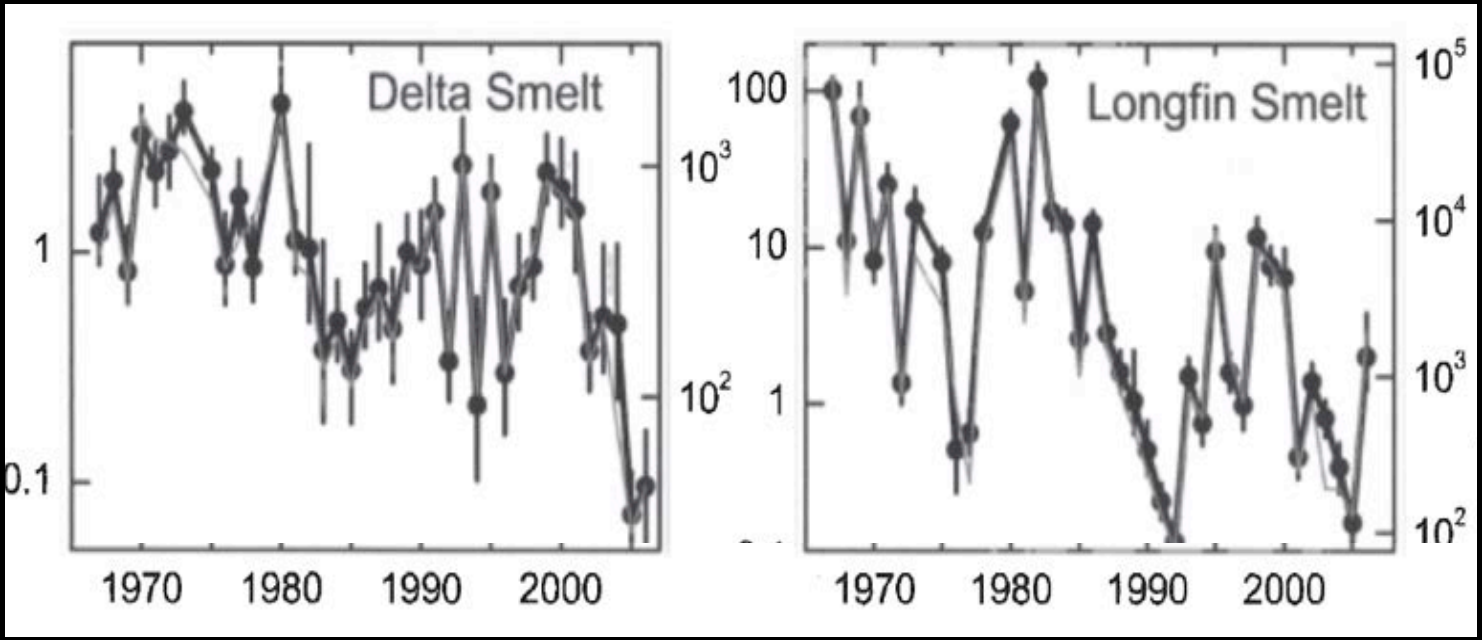




loss of zooplankton



IMPLICATIONS:



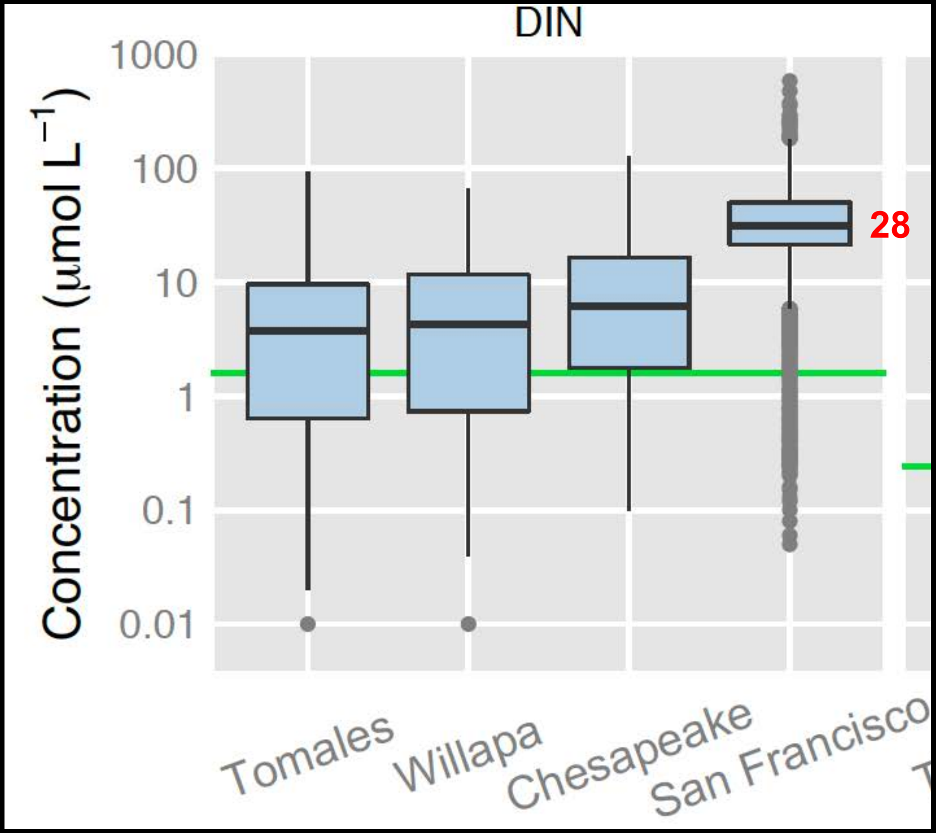
Pacific Ocean
South Bay

DRIVER #4: sewage disposal

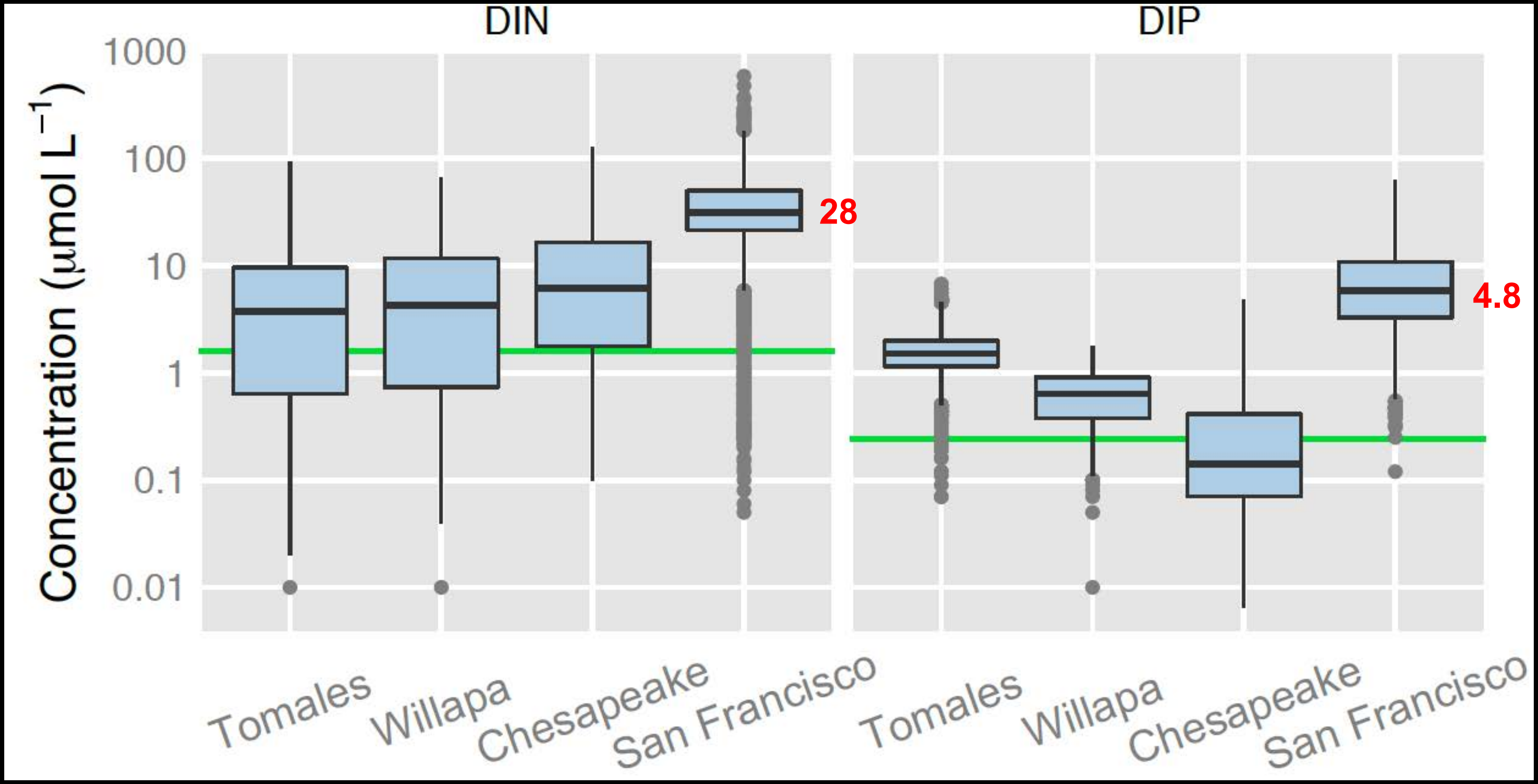
4 M people
375 Mgal/day

11,000 tons/yr DIN
1,900 tons/yr DIP

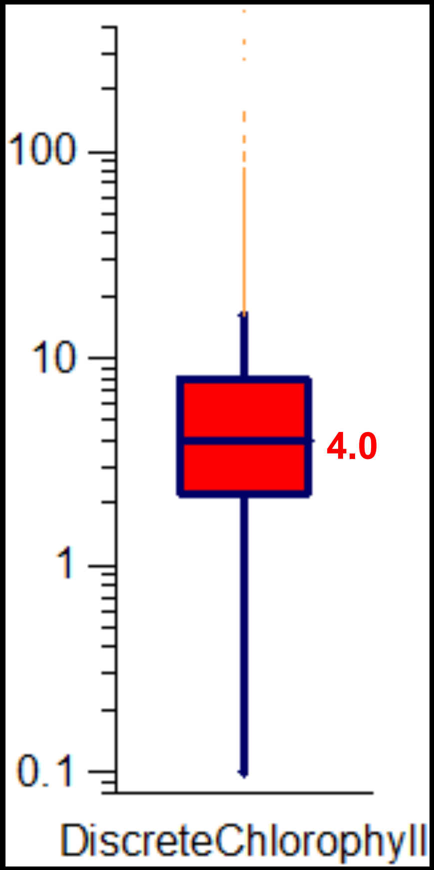
RESPONSE: high N and P concentrations



RESPONSE: high N and P concentrations



IMPLICATIONS: *potential* for very high phytoplankton biomass



But South SF Bay has low phytoplankton biomass, partly because of strong grazing by bivalves

DRIVER #5: environmental policy

Clean Water Act

Full title	Federal Water Pollution Control Amendments of 1972
Acronym	CWA / Clean Water Act
Enacted by the	92nd United States Congress
Effective	October 18, 1972
Citations	
Public Law	P.L. 92-500
Stat.	86 Stat. 816 (1972)
Codification	
Act(s) amended	Federal Water Pollution Control Act
Title(s) amended	33 (Navigable Waters)
U.S.C. sections created	33 U.S.C. § 1251 *et seq.*

Legislative history

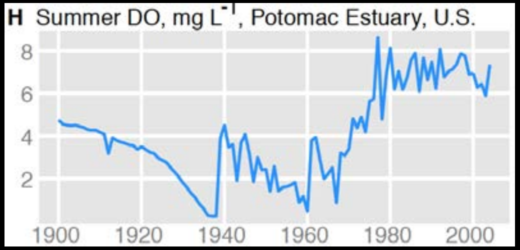
- **Introduced in the Senate as** S. 2770 **by** Edmund Muskie **on** October 28, 1971
- **Committee consideration by:** Senate Public Works Committee
- **Passed the Senate on** November 2, 1971 ()
- **Passed the House on** March 29, 1972 ()
- **Reported by the joint conference committee on** October 4, 1972; **agreed to by the House on** October 4, 1972 () **and by the Senate on** October 4, 1972 ()
- **Vetoed by President** Richard Nixon **on** October 17, 1972
- **Overridden by the Senate on** October 18, 1972 ()
- **Overridden by the House and became law on** October 18, 1972 ()

mandated secondary treatment to remove BOD and NH_4

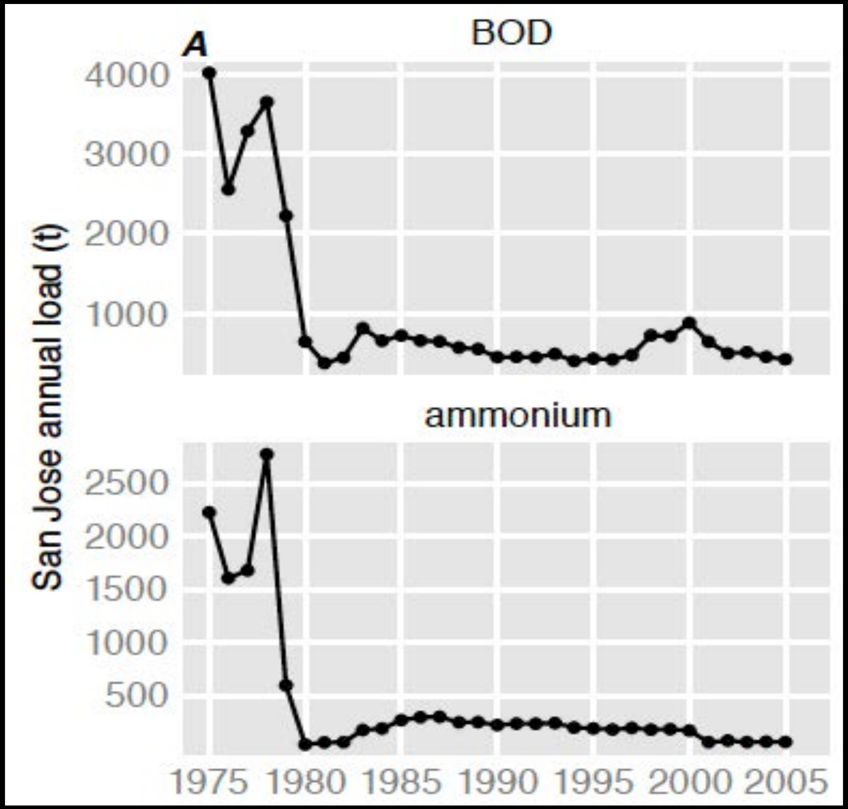
"to restore and maintain the chemical, physical and biological integrity of the nation's waters"

and attain

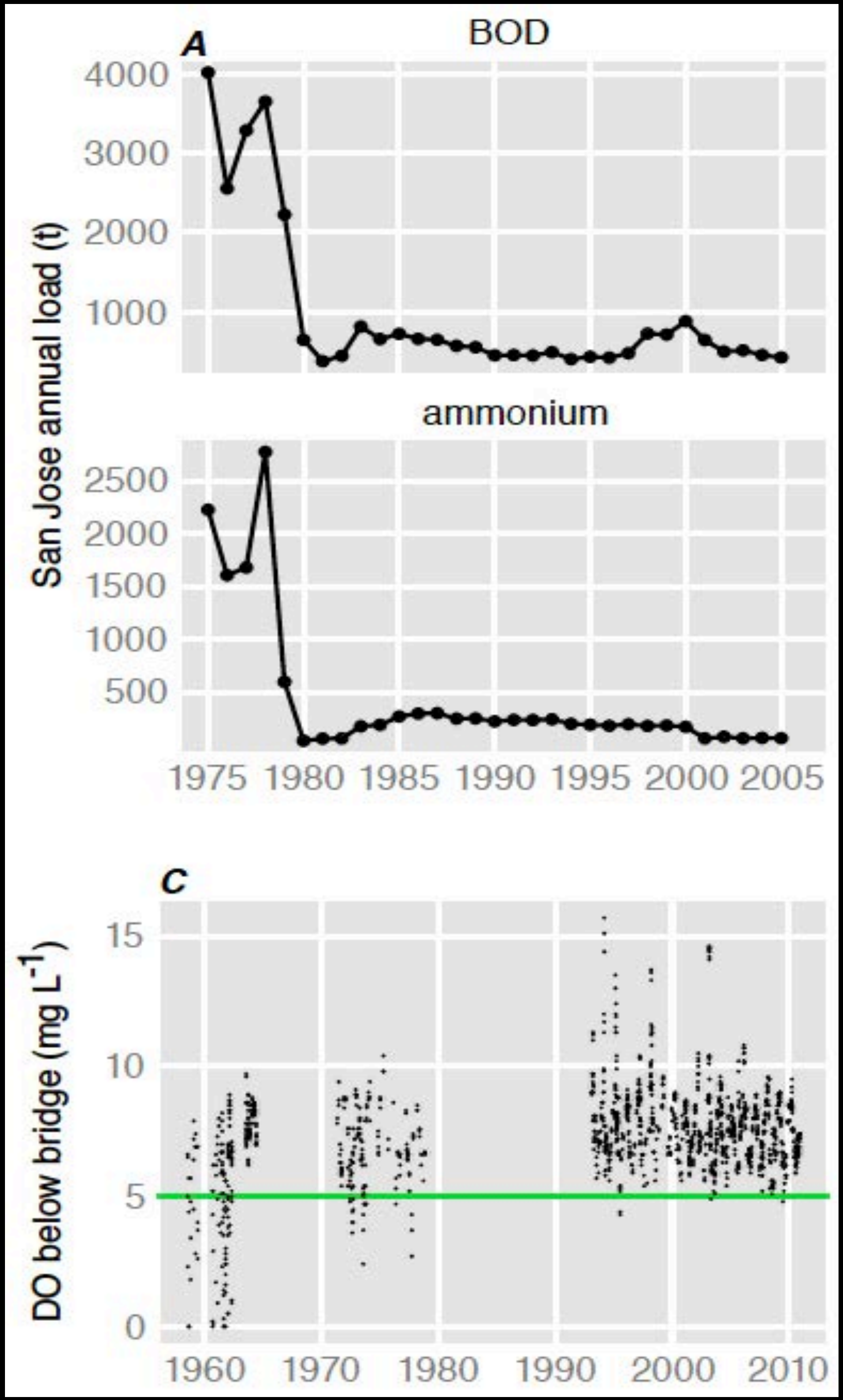
"fishable and swimmable waters"



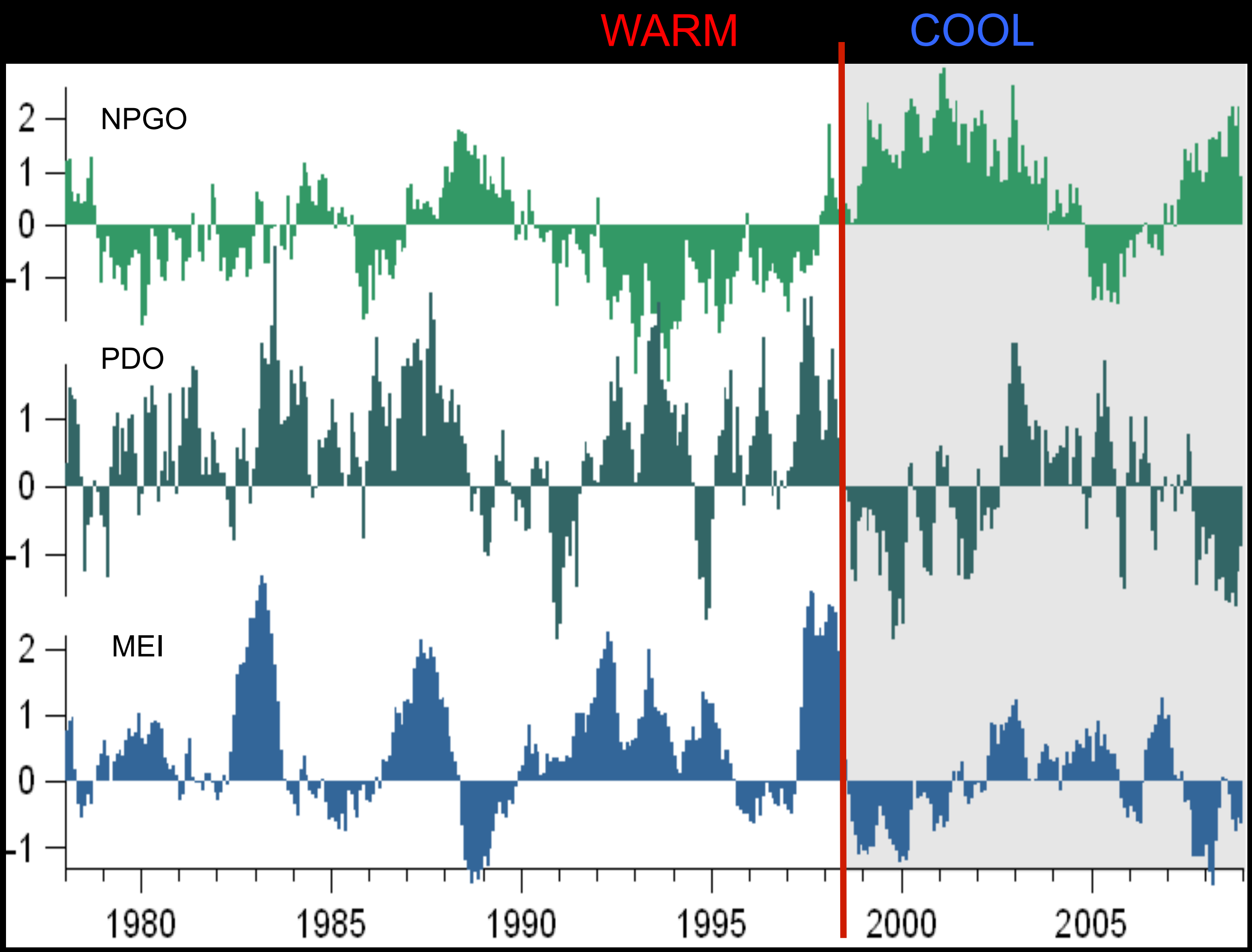
advanced tertiary
treatment 1980

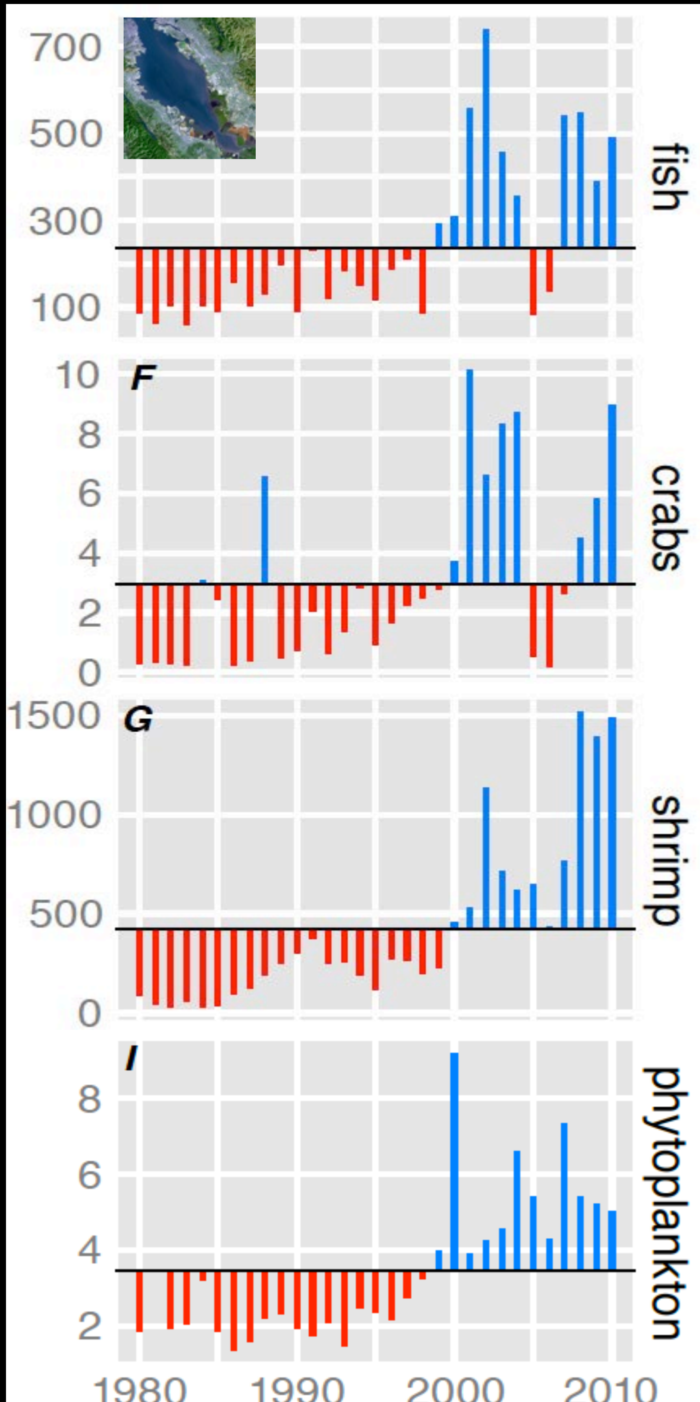


RESPONSE: elimination of summer hypoxia



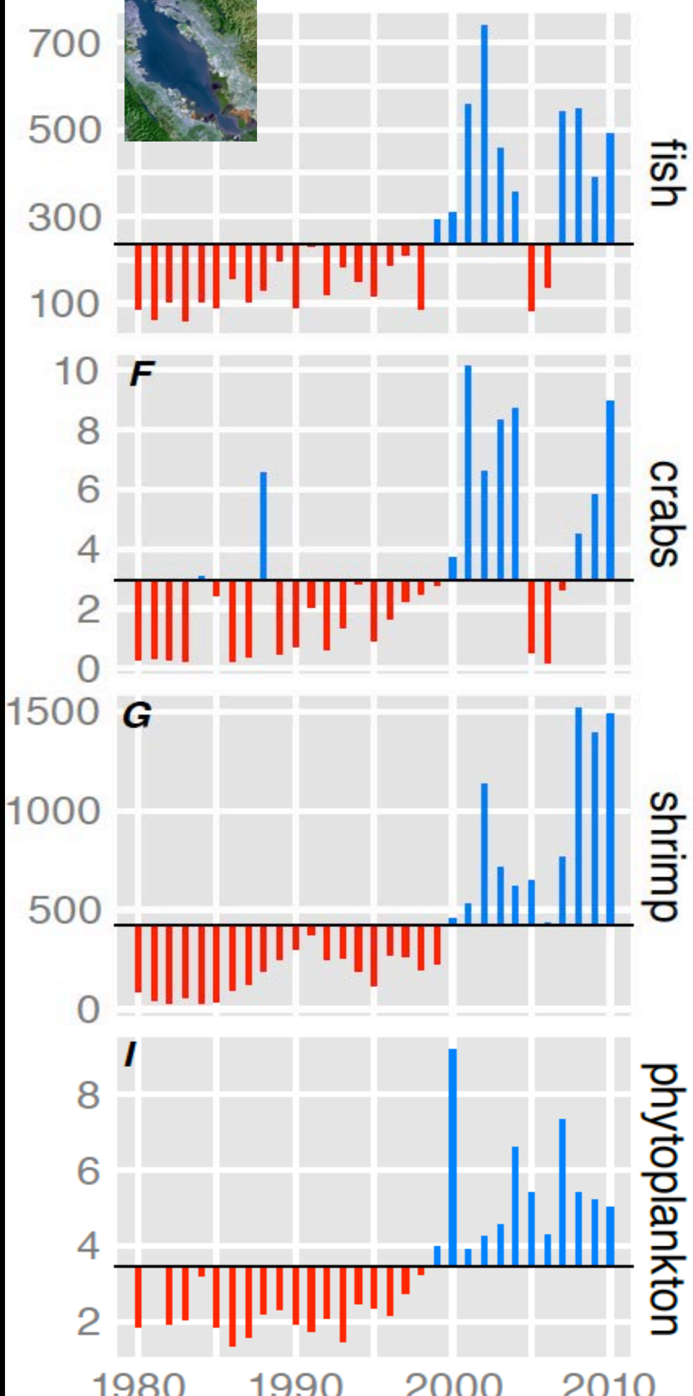
DRIVER #6: climate shifts

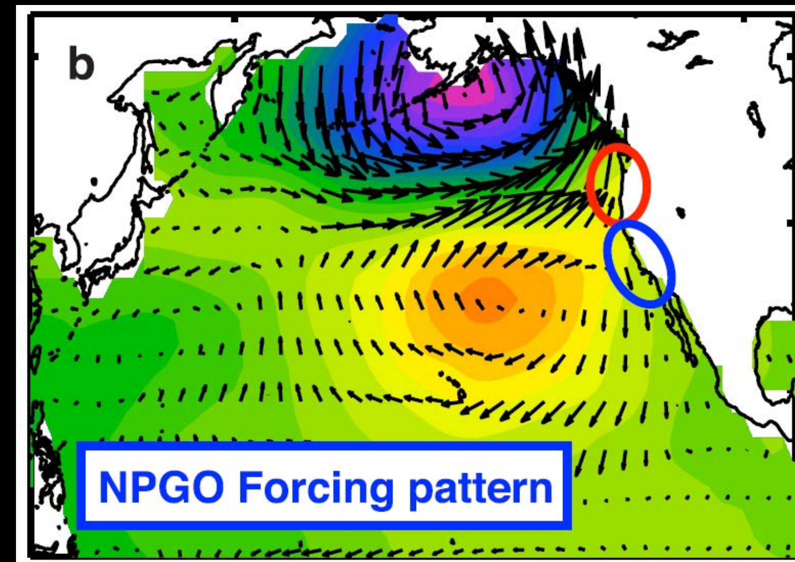




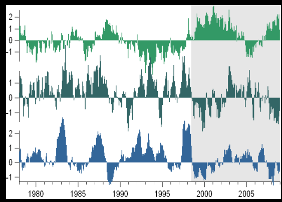
RESPONSE: record-high abundances of (juvenile) flatfish, crabs, shrimp

increasing phytoplankton biomass

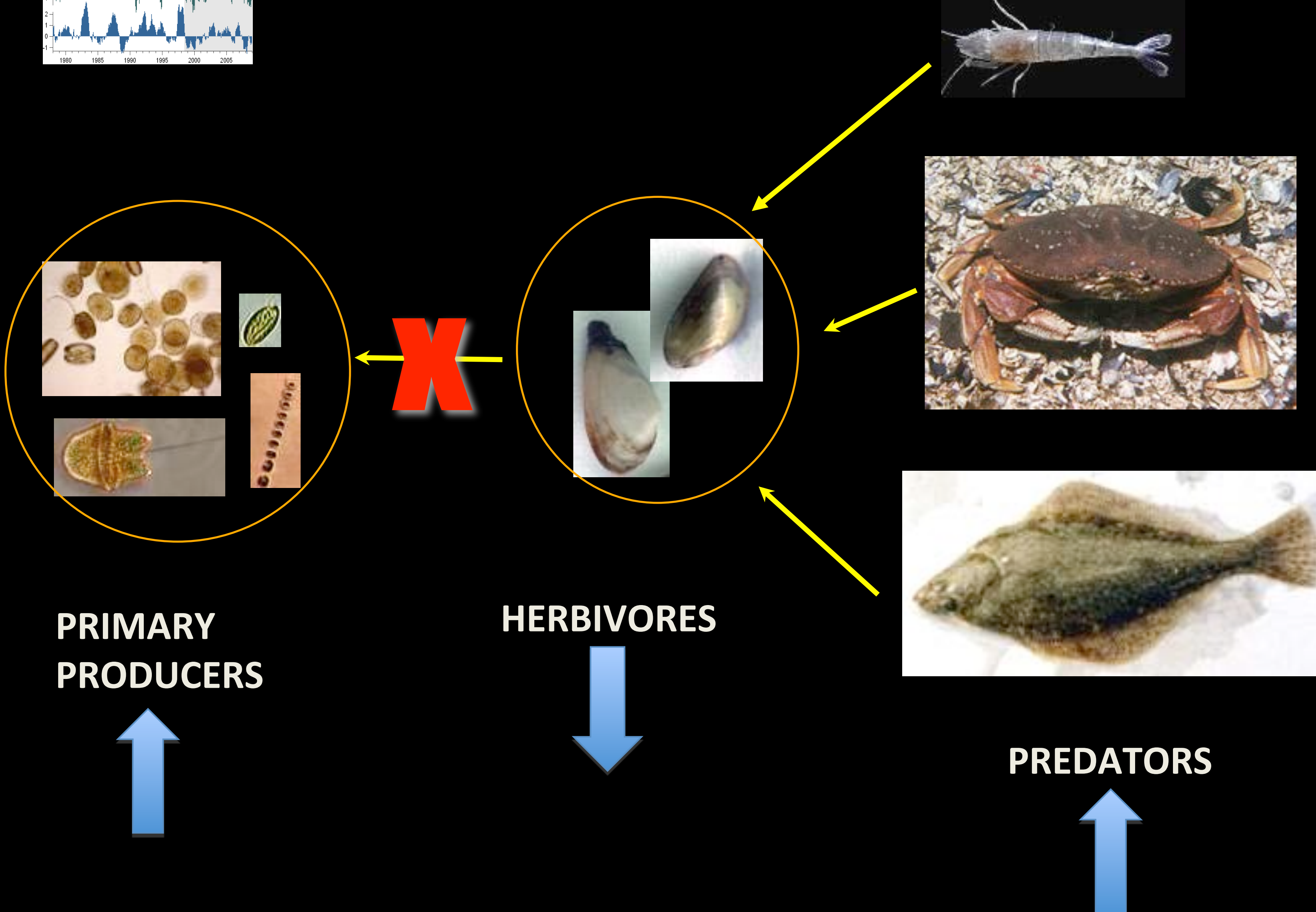




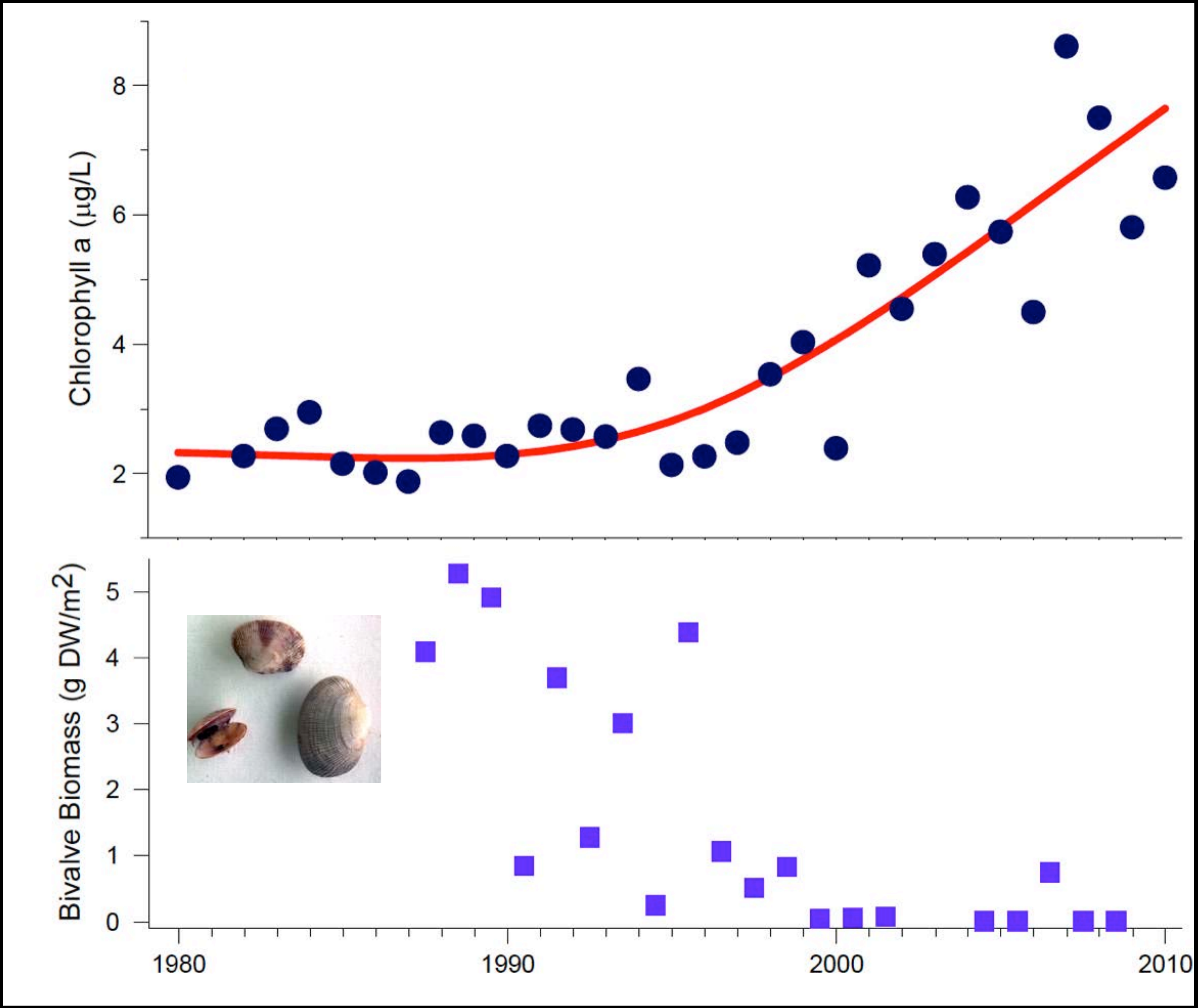
because of intensified coastal upwelling and productivity



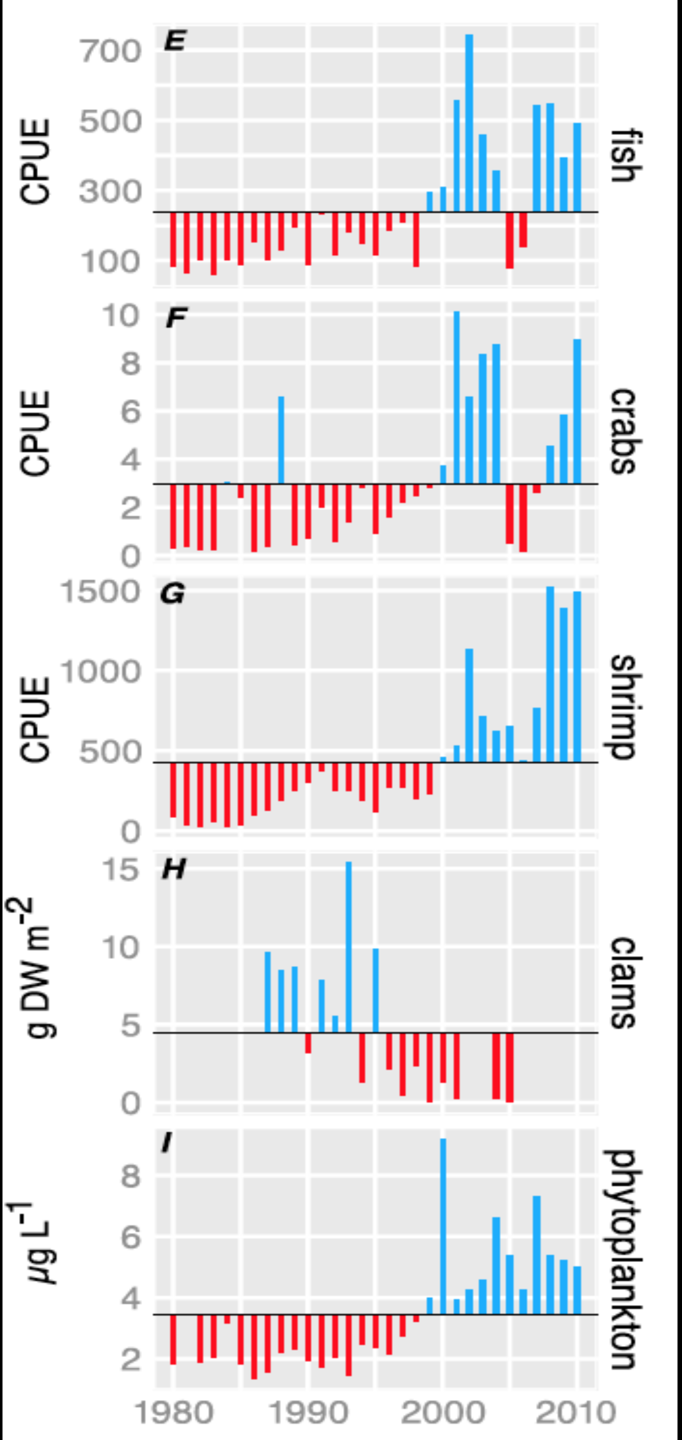
Climate-driven trophic cascade



IMPLICATION: nutrients have become a policy issue



5: Nutrient Management in an Ecosystem Context



6: The Unique Value of Sustained Observations

Chesapeake Bay Program

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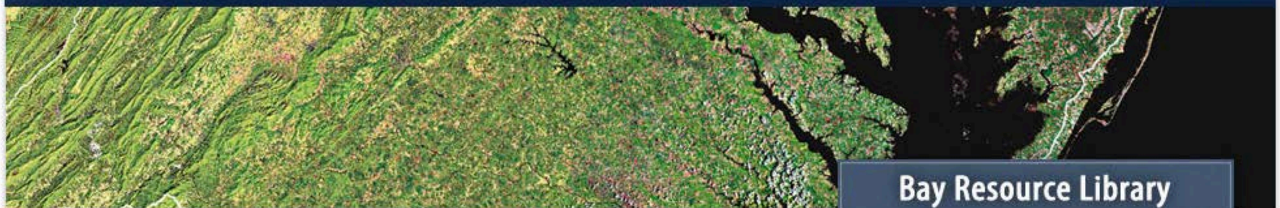

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Data Hub

This interface provides access to several types of data related to the Chesapeake Bay. Bay Program databases can be queried based upon user-defined inputs such as geographic region and date range. Each query results in a downloadable, tab- or comma-delimited text file that can be imported to any program (e.g., SAS, Excel, Access) for further analysis. Comments regarding the interface are encouraged. Questions in reference to the data should be addressed to the contact provided on subsequent pages.

To insure data accuracy, the Bay Program maintains a Quality Assurance Program that monitors and tracks several environmental data sets that look at pollutants, water quality, land use, algae, fish, crabs and submerged aquatic vegetation.

Data Programs | Data Downloads | Data Tools

Data Programs

Modeling: Environmental models are essential for simulating ecosystems that are either too large or too complex to isolate for experiments in the real world. These simulations, called scenarios, allow scientists to predict positive or negative changes within our ecosystem due to management actions such as improved sewage treatment, controlling urban sprawl, or reduced fertilizer or manure application on agricultural lands.

Monitoring: Monitoring the Chesapeake Bay and its tributaries allows Bay Program partners to detect changes that take place; improves our understanding of the natural environment; and reveals trends over time that can provide valuable information to policy makers. The Chesapeake Bay Monitoring Program, which began in 1984, is a Bay-wide cooperative effort involving Maryland, Pennsylvania, Virginia, the District of Columbia, several federal agencies, 10 institutions and over 30 scientists.