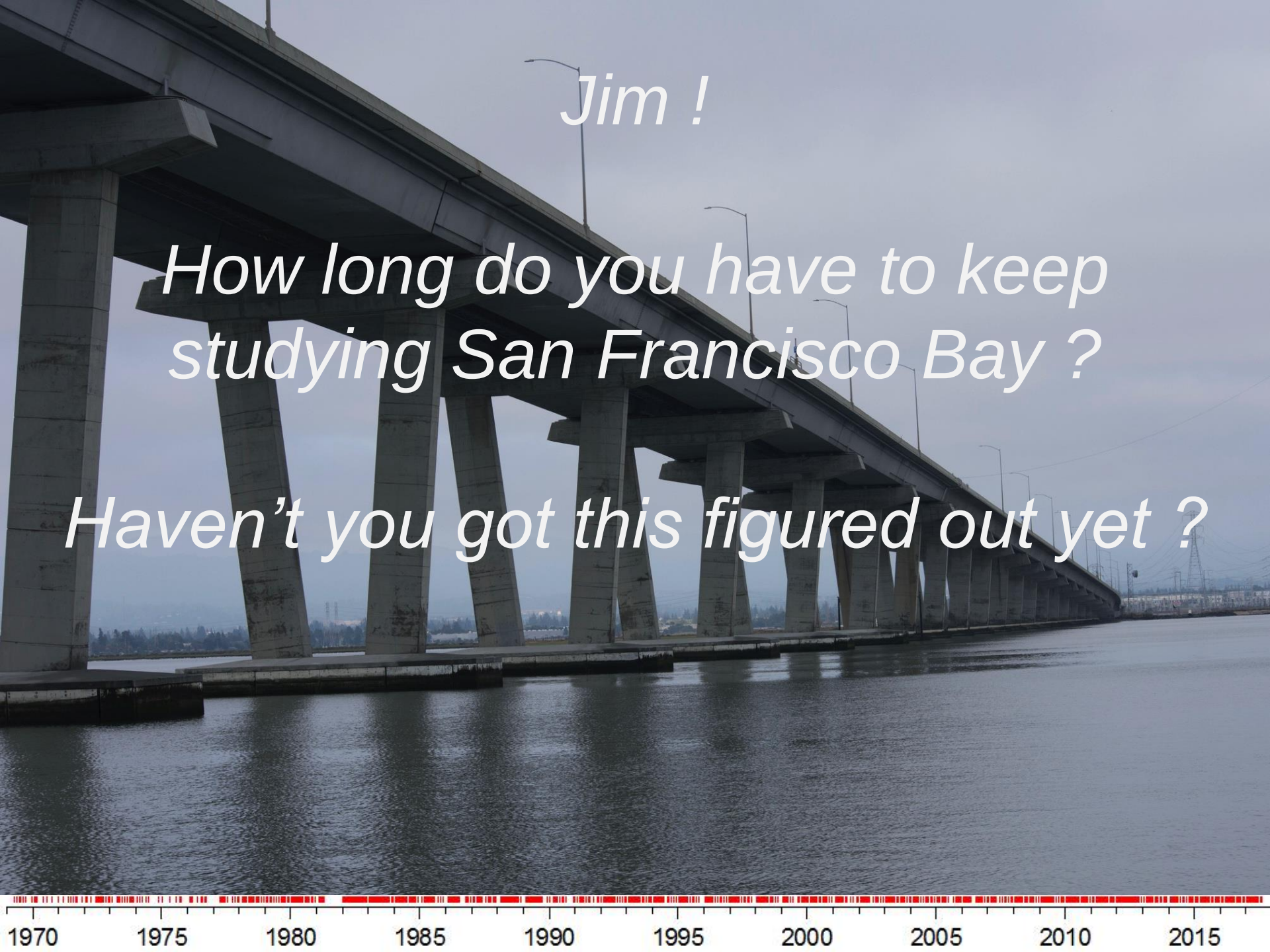
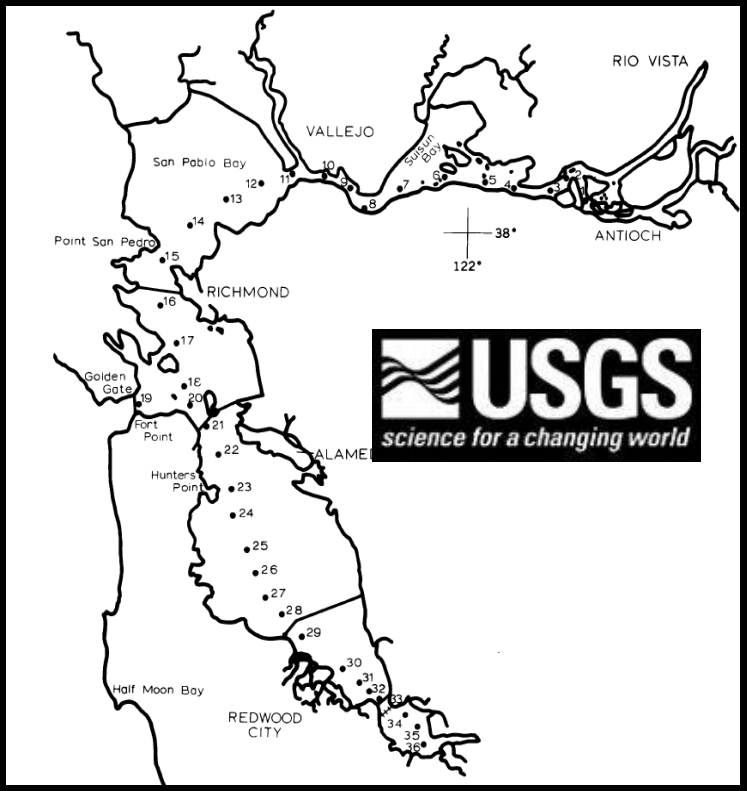

Jim !
How long do you have to keep studying San Francisco Bay ?
Haven’t you got this figured out yet ?
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015

John Conomos
1968

Dave Peterson
1967

Fred Nichols
1969/70

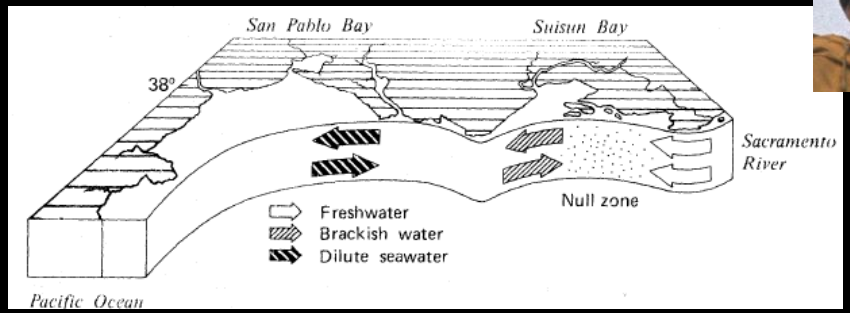


April 10, 1969

An Era of Discovery Begins

1970 1975 1980 1985 1990 1995 2000 2005 2010 2015

Estuarine Circulation & Turbidity Maximum



Benthic Infauna

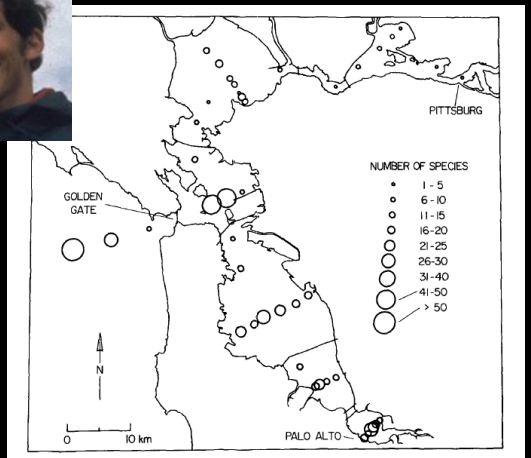
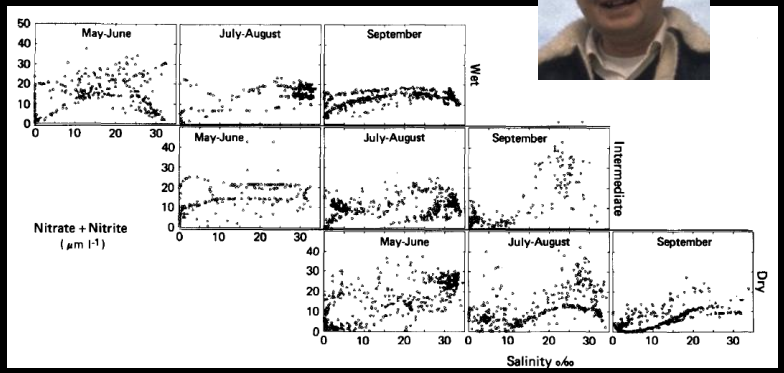
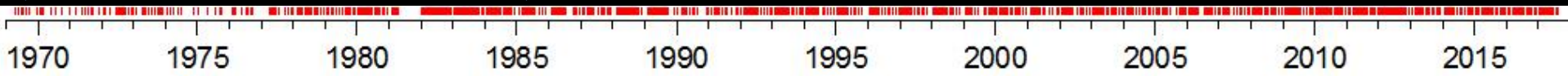


Fig. 2. Total number of benthic macrofauna species collected during February and August 1973 in replicate 0.1-m² samples and retained on 1.0-mm sieve.

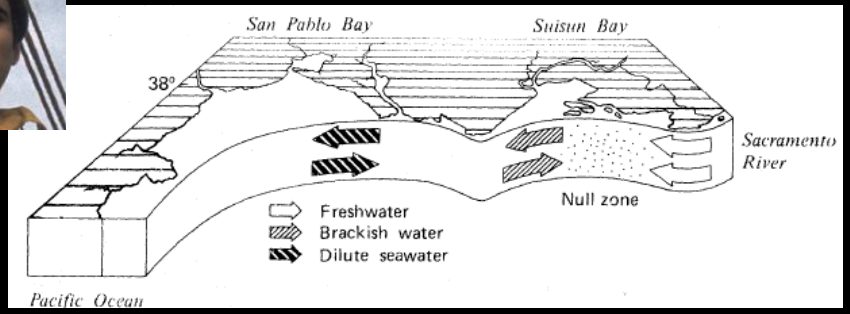
Nutrient Concentrations, Seasonal-Spatial Patterns



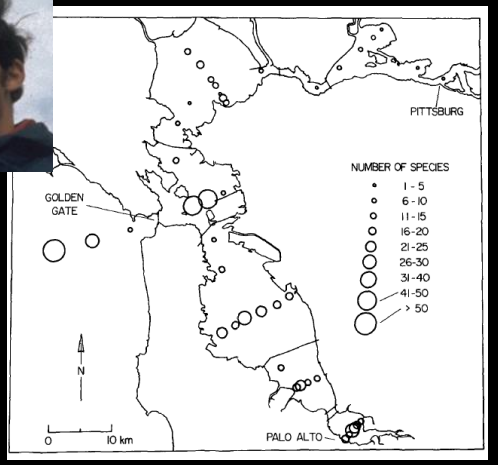
Era of Discovery



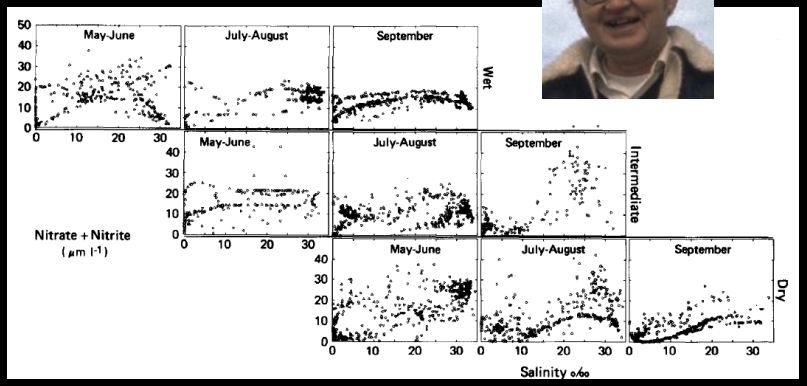
Estuarine Circulation & Turbidity Maximum



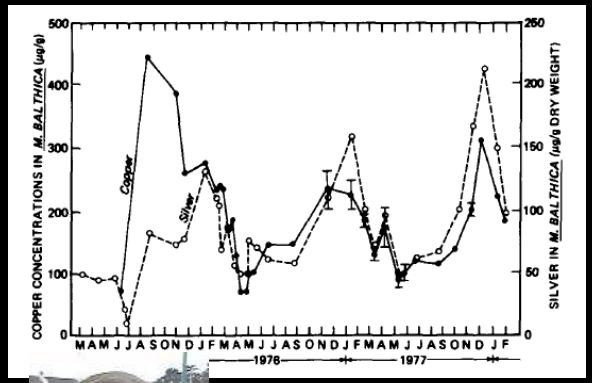
Benthic Infauna



Nutrient Concentrations, Seasonal-Spatial Patterns

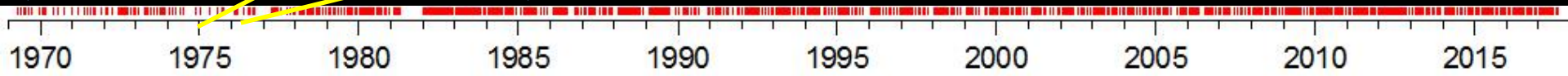


Metals

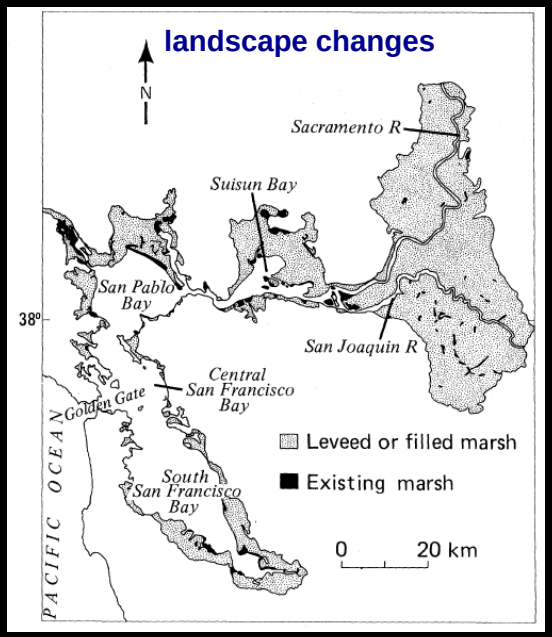


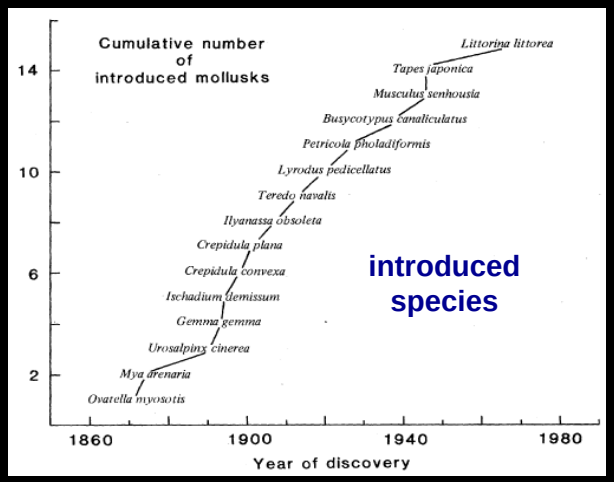
Plankton & Modeling

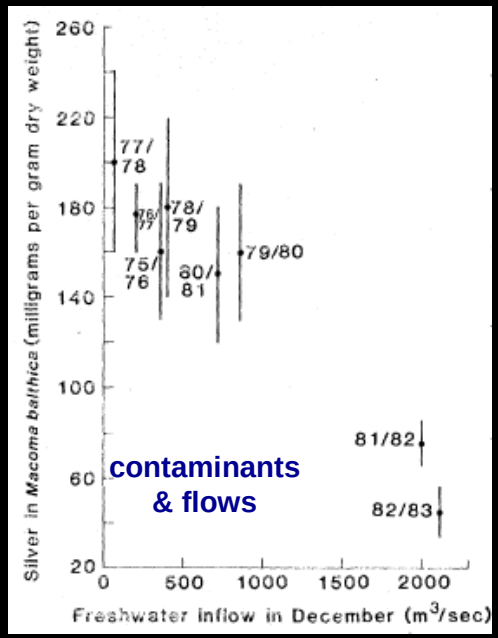
Era of Discovery

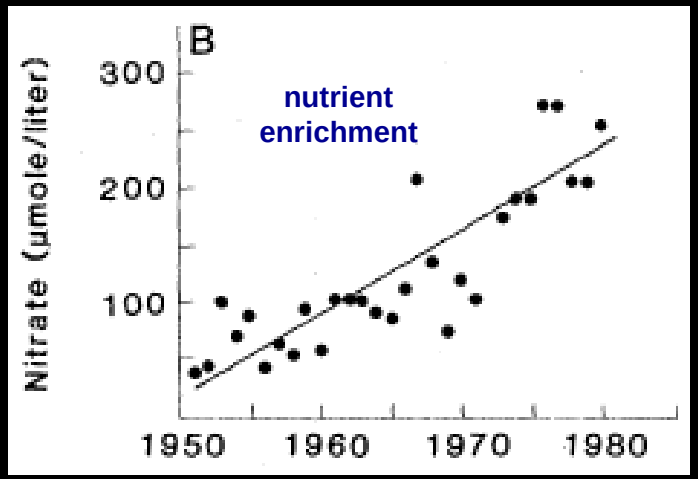


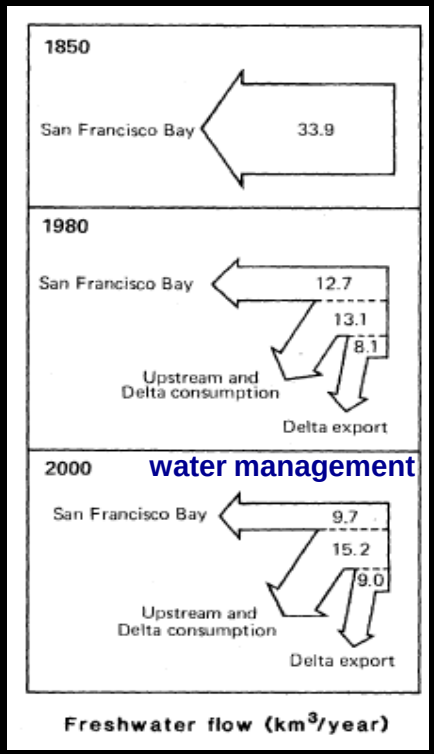
1986: End of an Era

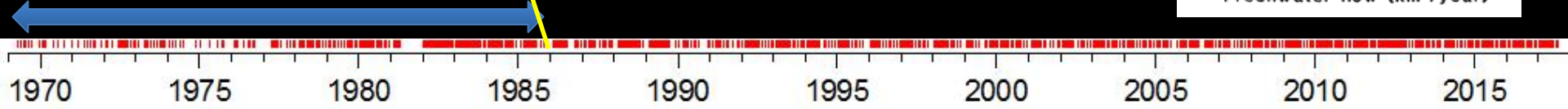




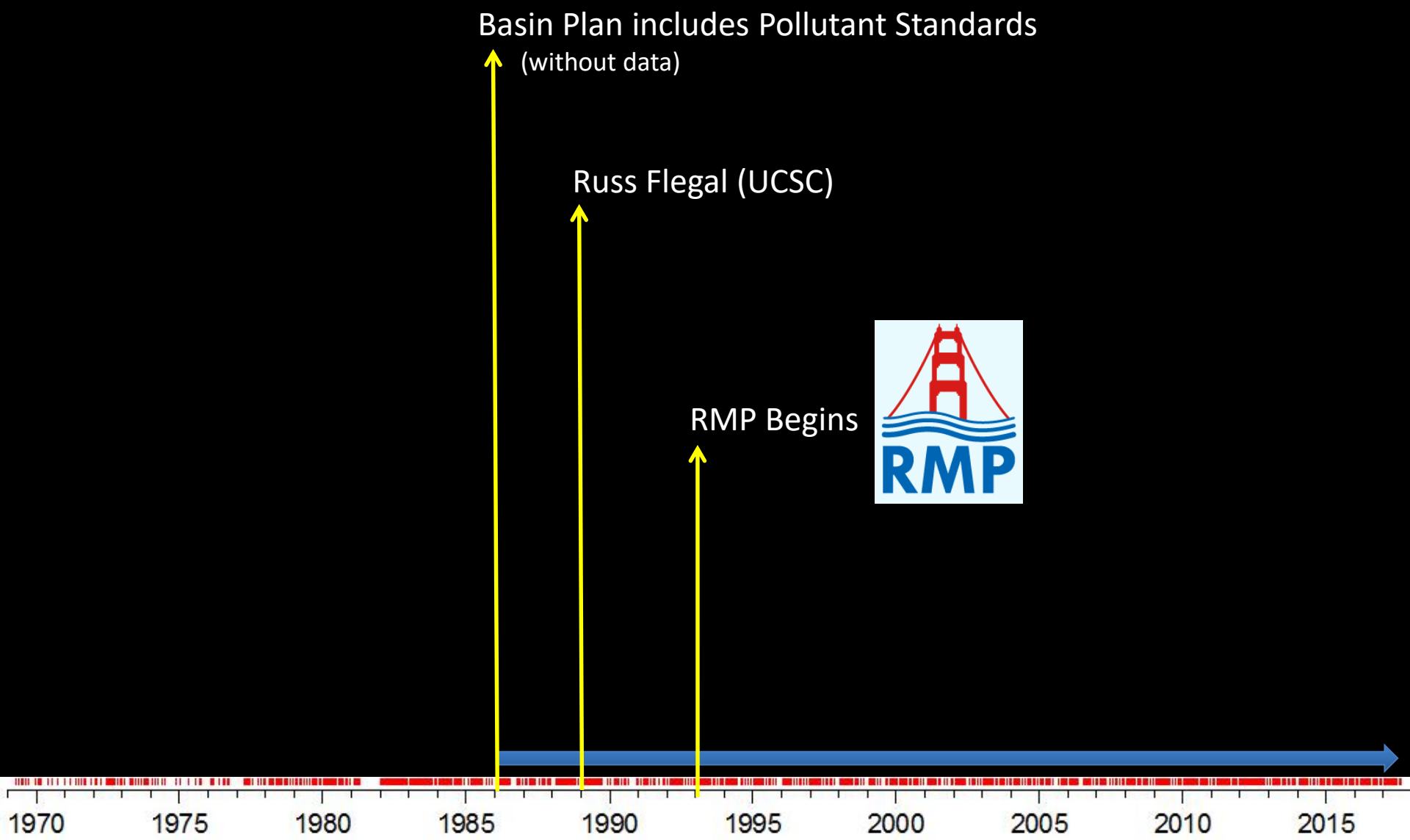




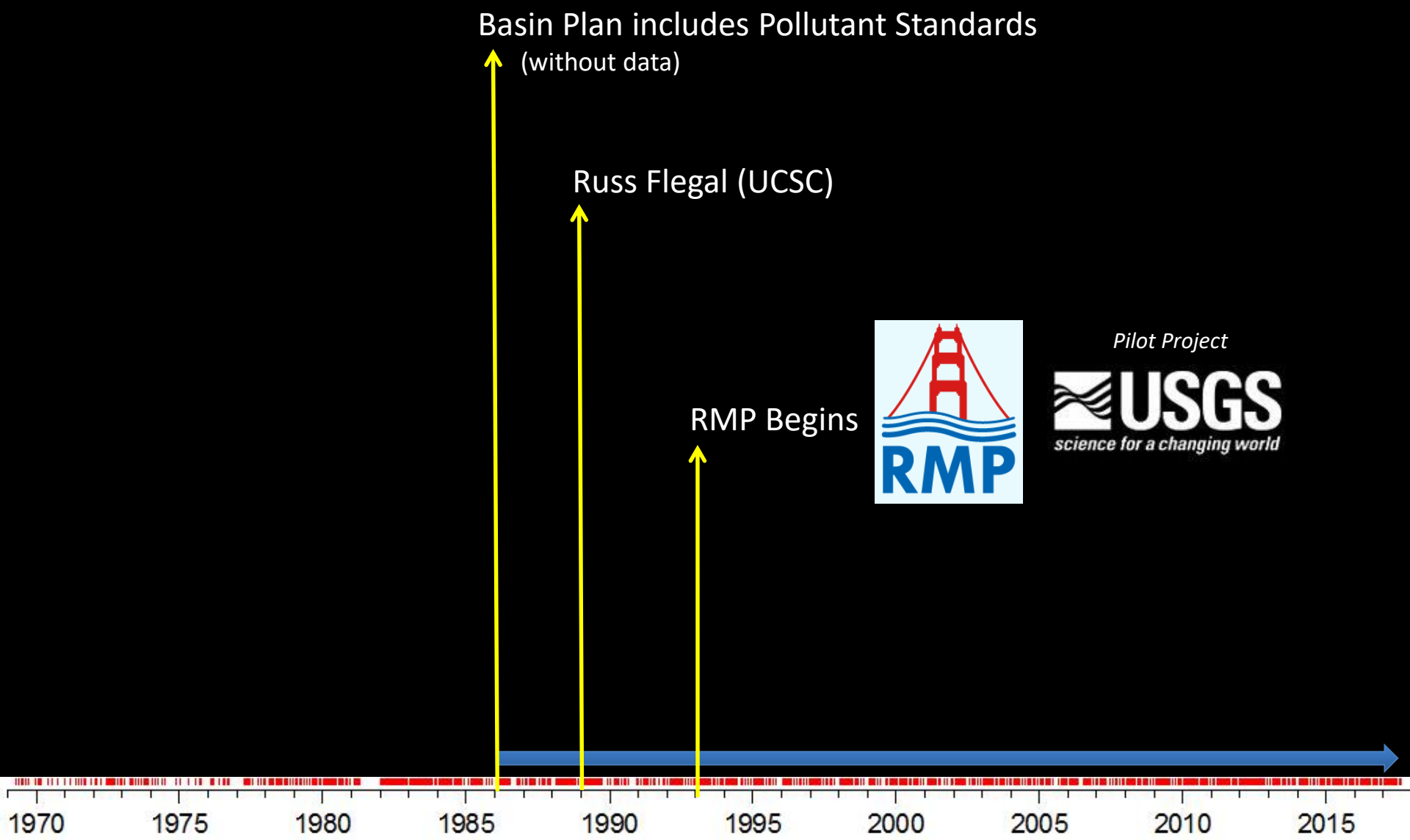


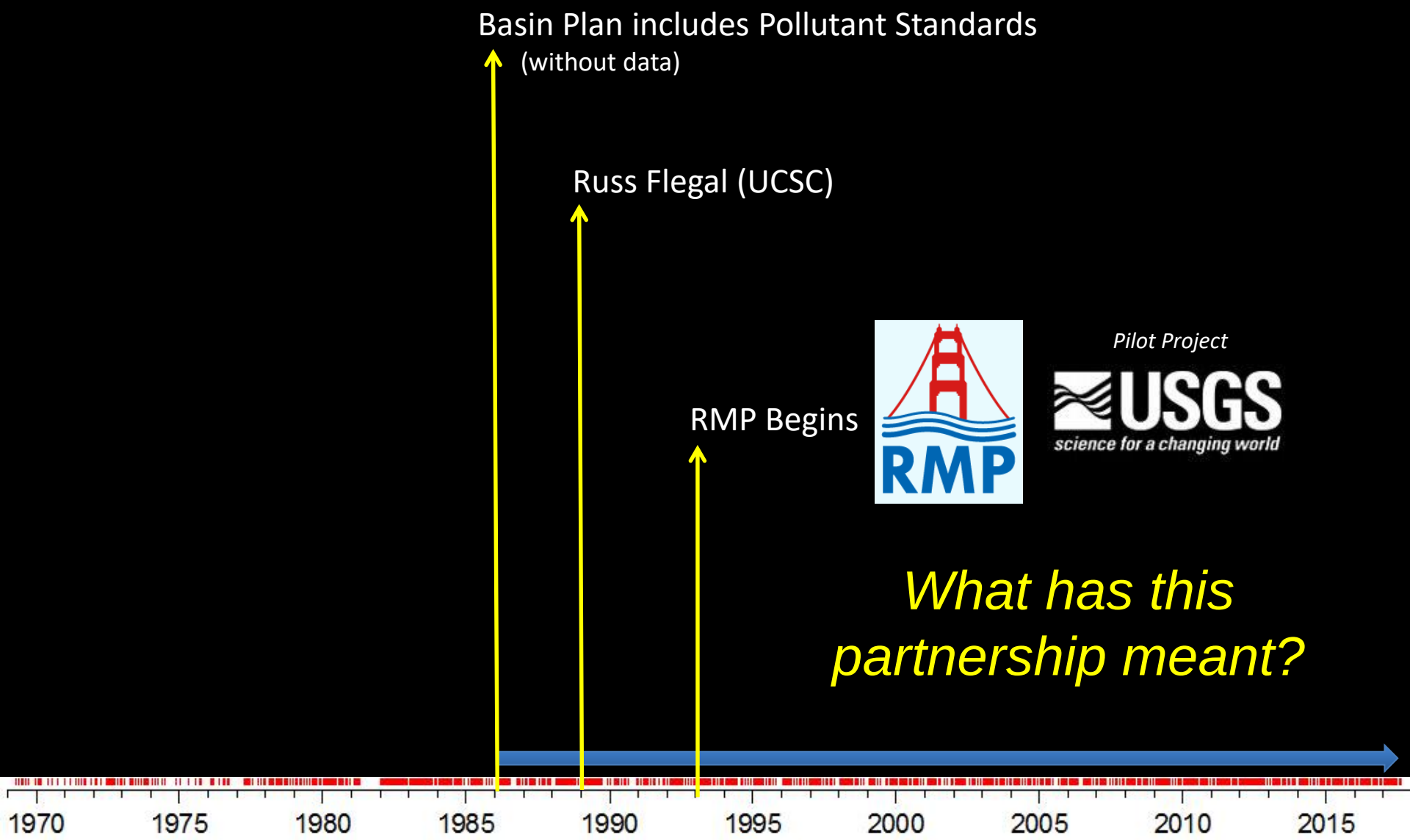


1986: Beginning of a new Era



1986: Beginning of a new Era




Basin Plan includes Pollutant Standards
(without data)
Russ Flegal (UCSC)
RMP Begins
RMP
Pilot Project
USGS
science for a changing world
What has this partnership meant?
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015

#1 We are engaged

RMP
Regional Monitoring Program for Trace Substances
1995 Annual Report

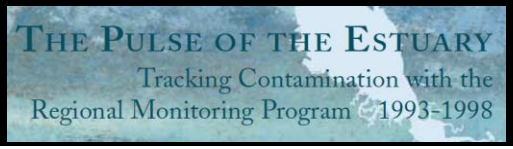
Toxic Phytoplankton in San Francisco Bay

Kristine M. Rodgers and David L. Garrison,
University of California, Institute of Marine Sciences, Santa Cruz, CA
and James E. Cloern, United States Geological Survey, Menlo Park, CA

RMP
Regional Monitoring Program for Trace Substances
1996 Annual Report

Water Quality Variability in San Francisco Bay, Some General Lessons from 1996 Sampling

James E. Cloern, Brian E. Cole, Jody L. Edmunds, and Jelriza I. Baylosis
United States Geological Survey, Menlo Park, CA



Patterns of Water-Quality Variability in San Francisco Bay During the First Six Years of the RMP, 1993-1998

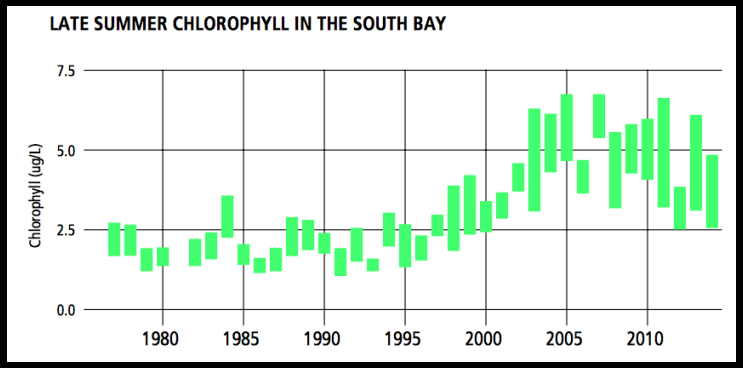
Lessons from Monitoring Water Quality in San Francisco Bay

James E. Cloern (jecloern@usgs.gov), Tara S. Schraga, Cary B. Lopez, and Rochelle Labiosa — U.S. Geological Survey, Menlo Park, CA

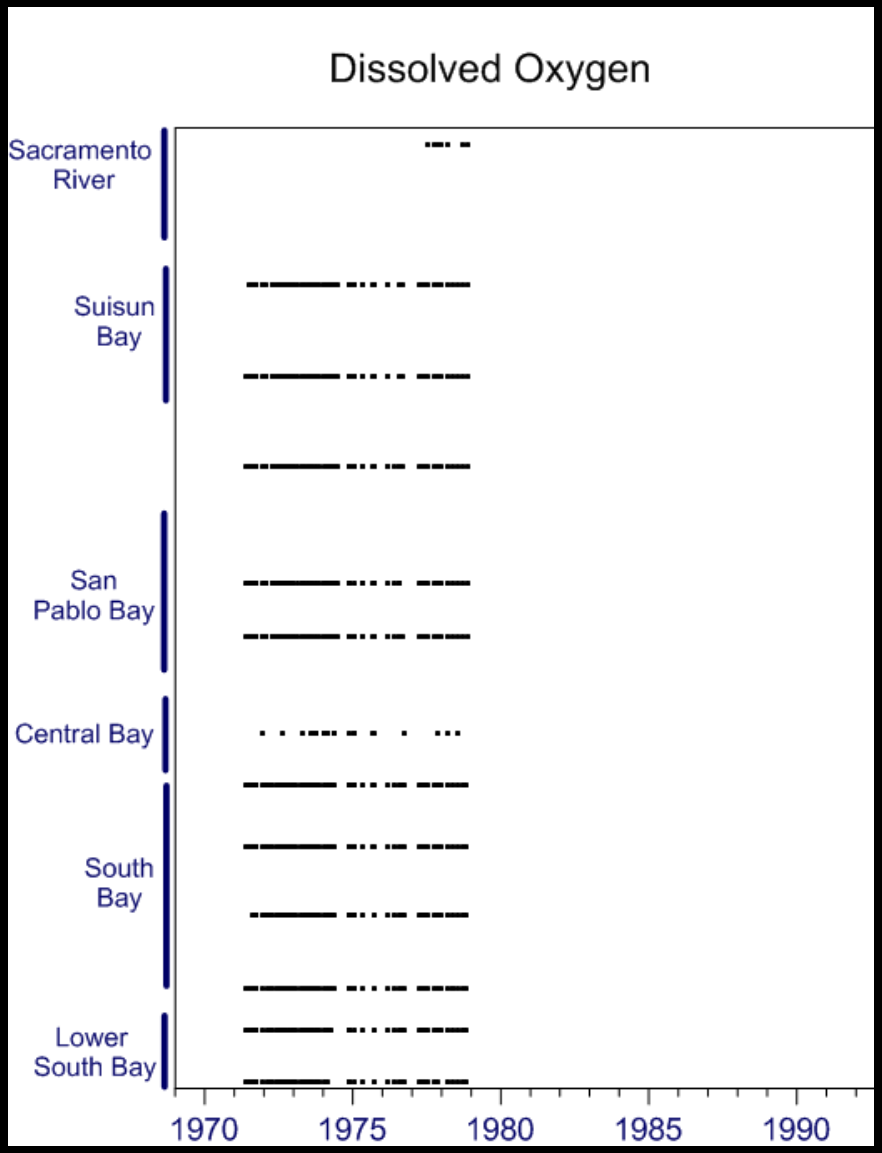
What is Causing the Phytoplankton Increase in San Francisco Bay?

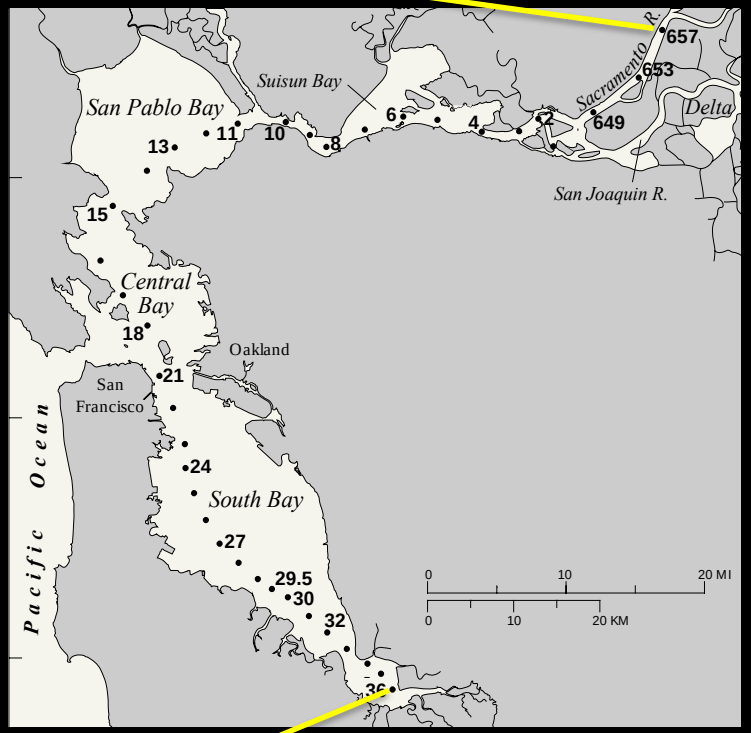
James E. Cloern[1] (jecloern@usgs.gov), Alan D. Jassby[2], Tara S. Schraga[1] and Kate L. Dallas[1]

THE PULSE OF THE BAY
The State of Bay Water Quality: 2015 and 2065

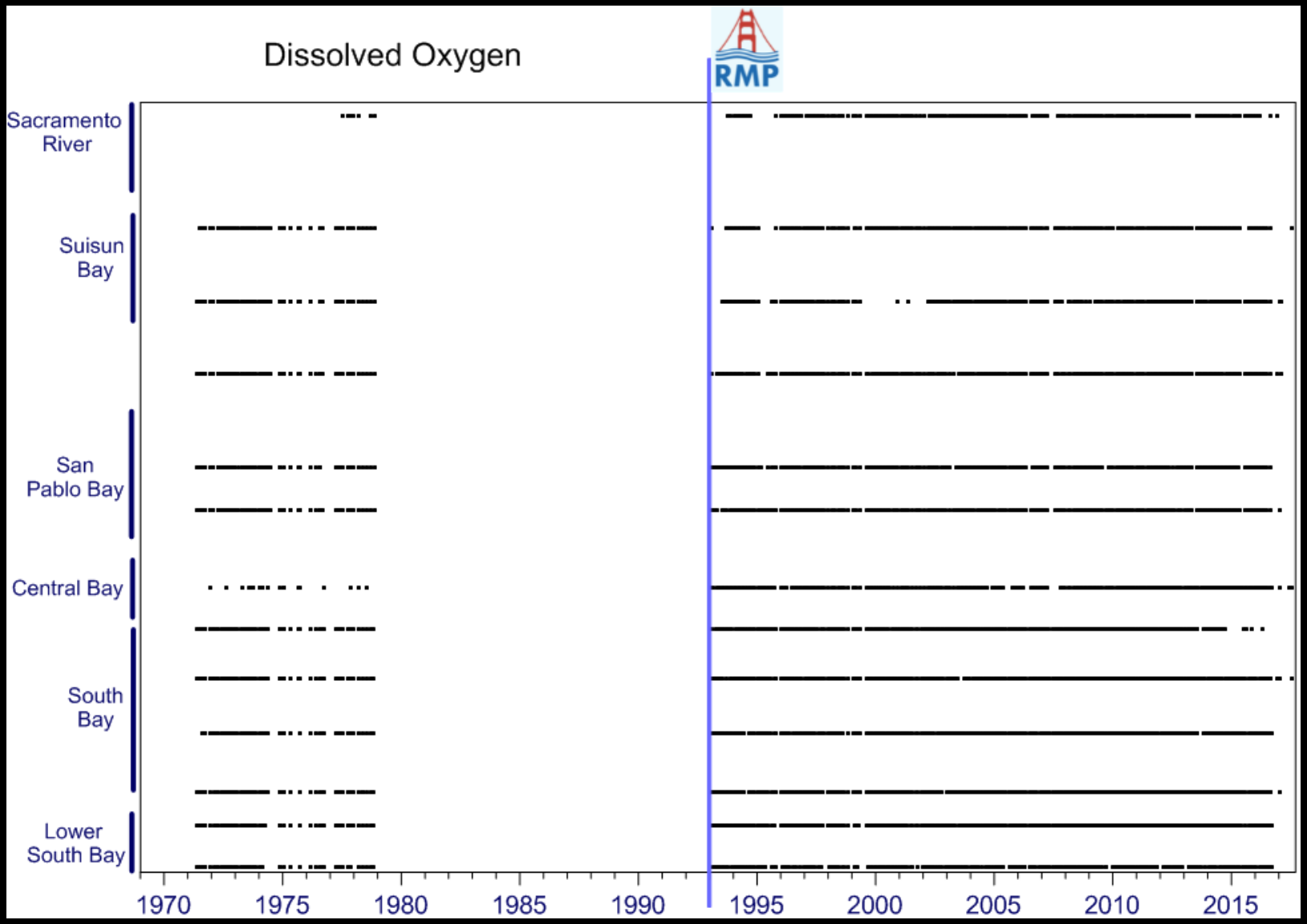


#2 Continuity of Measurements



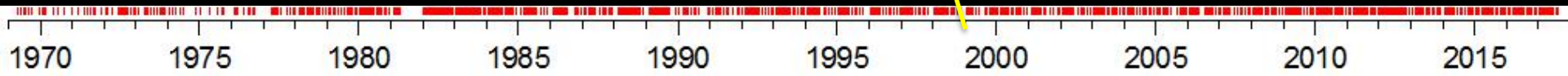


#2 Continuity of Measurements



Data Online


USGS
science for a changing world
Water Quality of San Francisco Bay
Home | Overview | Data Visualization | Data Query | *NEW* Cite Data | ACCESS | Project Team
Since 1968, the USGS has sustained a research program to understand how coastal ecosystems function and how those functions are altered by human disturbances.
One component of this program is directed towards following and understanding changes in the
WATER QUALITY OF SAN FRANCISCO BAY
Project Overview
Long-term Data Visualization
Query Data 1969-present
X-Y Scatter Plots
Latest Cruise Data July 31, 2017


1970
1975
1980
1985
1990
1995
2000
2005
2010
2015

Who Accesses the Data?

88 countries

.ad (Andorra)
.ae (United Arab Emirates)
.al (Albania)
.ao (Angola)
.ar (Argentina)
.as (American Samoa)
.at (Austria)
.au (Australia)
.bd (Bangladesh)
.be (Belgium)
.bn (Brunei Darussalam)
.br (Brazil)
.by (Belarus)
.ca (Canada)
.ch (Switzerland)
.ci (Ivory Coast)
.cl (Chile)
.cn (China)
.co (Colombia)
.cy (Cyprus)
.cz (Czech Republic)
.de (Germany)
.dk (Denmark)
.do (Dominican Republic)
.ee (Estonia)
.ec (Ecuador)
.eg (Egypt)
.es (Spain)
.fi (Finland)
.fr (France)
.gh (Ghana)
.gr (Greece)
.hk (Hong Kong)
.hr (Croatia)
.hu (Hungary)
.id (Indonesia)
.ie (Ireland)
.il (Israel)
.in (India)
.io (British Indian Ocean Territory)
.ir (Iran)
.it (Italy)
.jo (Jordan)
.jp (Japan)
.ke (Kenya)
.kr (South Korea)
.lt (Lithuania)
.lu (Luxembourg)
.lv (Latvia)
.md (Moldova)
.mg (Madagascar)
.mv (Maldives)
.mx (Mexico)
.my (Malaysia)
.nc (New Caledonia)
.ni (Nicaragua)
.nl (Netherlands)
.no (Norway)
.np (Nepal)
.nz (New Zealand)
.pe (Peru)
.pf (French Polynesia)
.ph (Philippines)
.pk (Pakistan)
.pl (Poland)
.pt (Portugal)
.pw (Palau)
.qa (Qatar)
.ro (Romania)
.ru (Russia)
.sa (Saudi Arabia)
.se (Sweden)
.sg (Singapore)
.si (Slovenia)
.sk (Slovakia)
.tc (Turks and Caicos Islands)
.th (Thailand)
.tr (Turkey)
.tv (Tuvalu)
.tw (Taiwan)
.tz (Tanzania)
.ua (Ukraine)
.uk (United Kingdom)
.us (United States)
.uy (Uruguay)
.vn (Vietnam)
.za (South Africa)
.zw (Zimbabwe)

How are the data used?

.ad (Andorra)
.ae (United Arab Emirates)
.al (Albania)
.ao (Angola)
.ar (Argentina)
.as (American Samoa)
.at (Austria)
.au (Australia)
.bd (Bangladesh)
.be (Belgium)
.bn (Brunei Darussalam)
.br (Brazil)
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.ca (Canada)
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.ci (Ivory Coast)
.cl (Chile)
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.si (Slovenia)
.sk (Slovakia)
.tc (Turks and Caicos Islands)
.th (Thailand)
.tr (Turkey)
.tv (Tuvalu)
.tw (Taiwan)
.tz (Tanzania)
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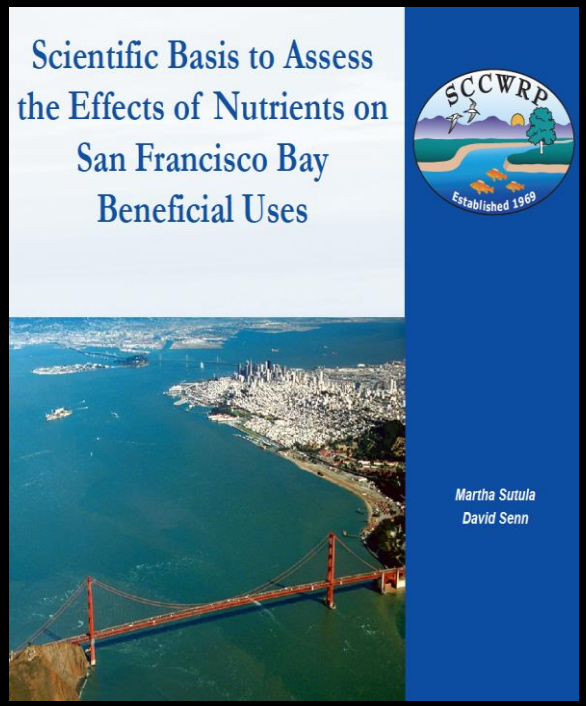
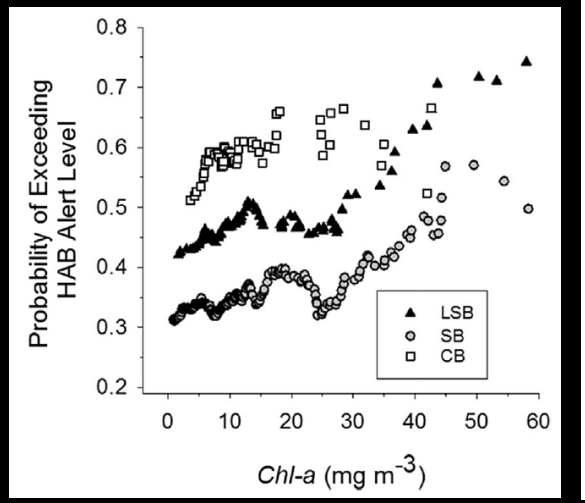
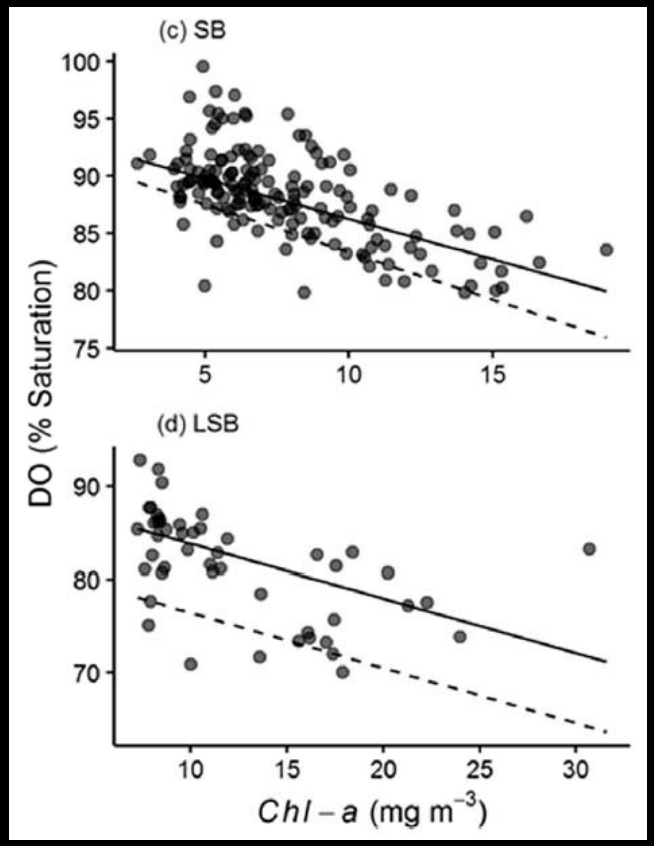
.us (United States)
.uy (Uruguay)
.vn (Vietnam)
.za (South Africa)
.zw (Zimbabwe)

Data used in assessments







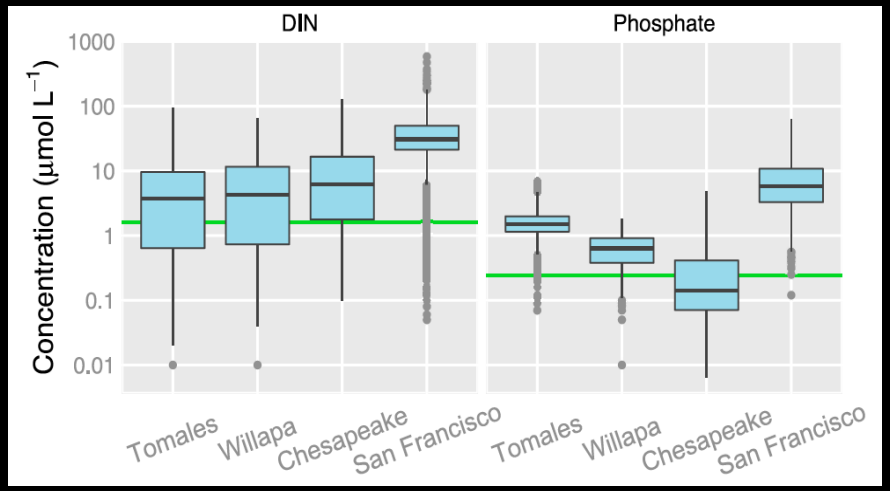
Contents lists available at ScienceDirect
Estuarine, Coastal and Shelf Science
journal homepage: www.elsevier.com/locate/ecss

Novel analyses of long-term data provide a scientific basis for chlorophyll-a thresholds in San Francisco Bay

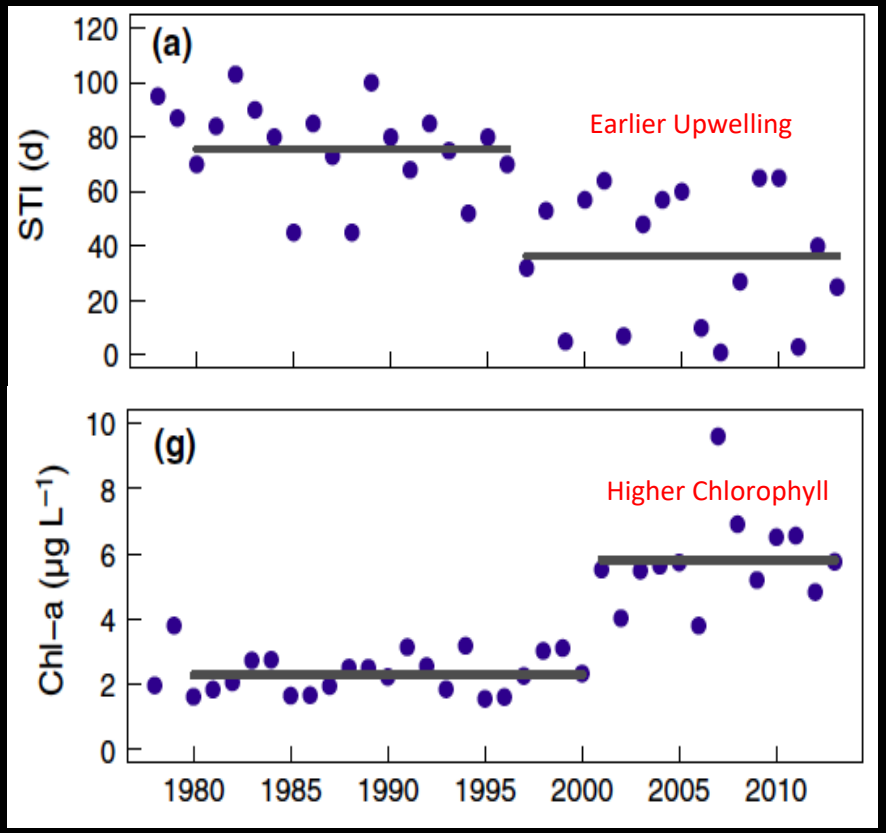
Martha Sutula [a, *], Raphael Kudela [b], James D. Hagy III [c], Lawrence W. Harding Jr. [d], David Senn [e], James E. Cloern [f], Suzanne Bricker [g], Gry Mine Berg [h], Marcus Beck [c]

Data used to measure:

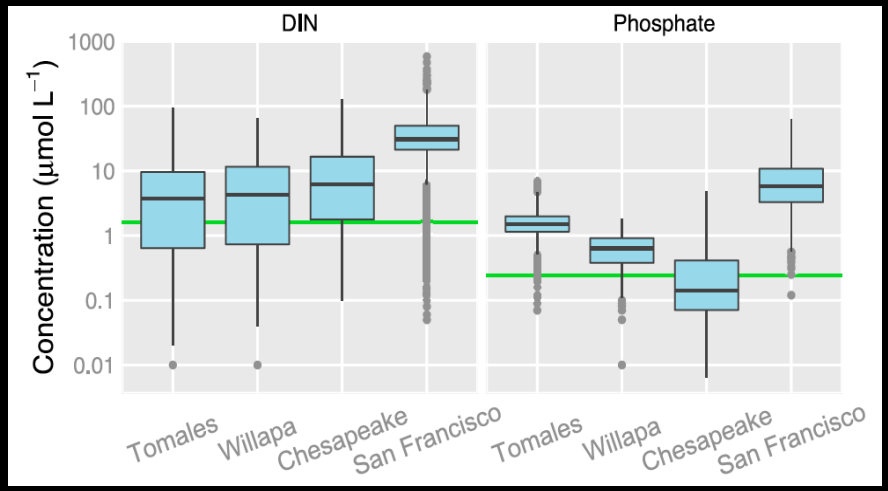
Status

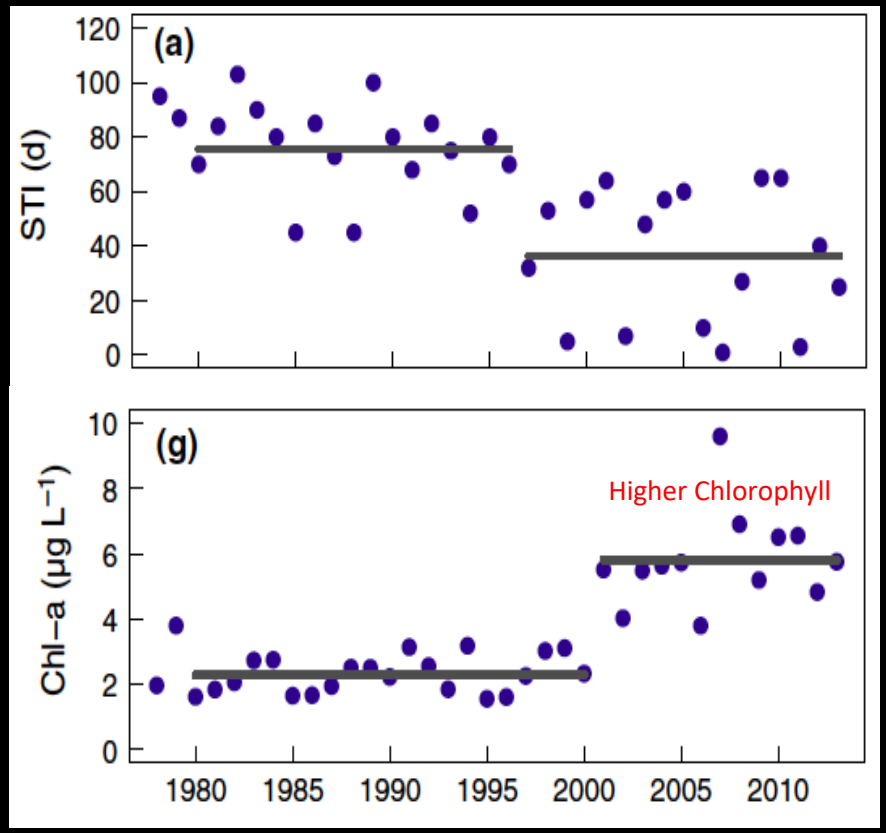


Trends



Data used to set scientific directions:





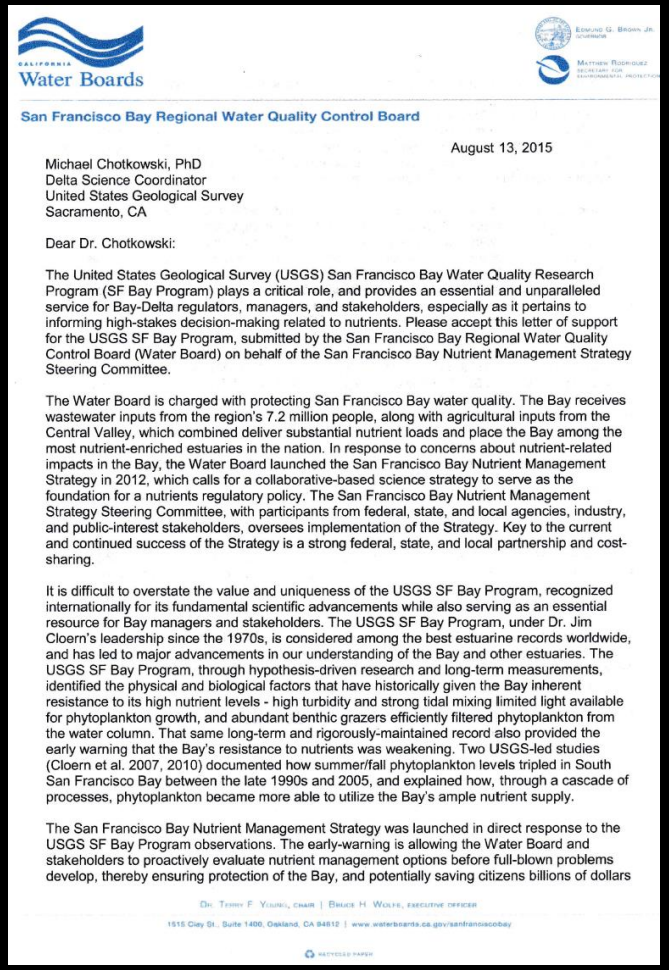
Nutrient Management Strategy

1970 1975 1980 1985 1990 1995 2000 2005 2010 2015

Data used to make decisions

The USGS San Francisco Bay Water Quality Research Program … plays a critical role, and provides an essential and unparalleled service for Bay-Delta regulators, managers, and stakeholders, especially as it pertains to informing high-stakes decision-making related to nutrients.

Thomas Mumley
Assistant Executive Officer
San Francisco Bay Regional Water Quality Control Board



CALIFORNIA Water Boards

San Francisco Bay Regional Water Quality Control Board

August 13, 2015

Michael Chotkowski, PhD
Delta Science Coordinator
United States Geological Survey
Sacramento, CA

Dear Dr. Chotkowski:

The United States Geological Survey (USGS) San Francisco Bay Water Quality Research Program (SF Bay Program) plays a critical role, and provides an essential and unparalleled service for Bay-Delta regulators, managers, and stakeholders, especially as it pertains to informing high-stakes decision-making related to nutrients. Please accept this letter of support for the USGS SF Bay Program, submitted by the San Francisco Bay Regional Water Quality Control Board (Water Board) on behalf of the San Francisco Bay Nutrient Management Strategy Steering Committee.

The Water Board is charged with protecting San Francisco Bay water quality. The Bay receives wastewater inputs from the region's 7.2 million people, along with agricultural inputs from the Central Valley, which combined deliver substantial nutrient loads and place the Bay among the most nutrient-enriched estuaries in the nation. In response to concerns about nutrient-related impacts in the Bay, the Water Board launched the San Francisco Bay Nutrient Management Strategy in 2012, which calls for a collaborative-based science strategy to serve as the foundation for a nutrients regulatory policy. The San Francisco Bay Nutrient Management Strategy Steering Committee, with participants from federal, state, and local agencies, industry, and public-interest stakeholders, oversees implementation of the Strategy. Key to the current and continued success of the Strategy is a strong federal, state, and local partnership and cost-sharing.

It is difficult to overstate the value and uniqueness of the USGS SF Bay Program, recognized internationally for its fundamental scientific advancements while also serving as an essential resource for Bay managers and stakeholders. The USGS SF Bay Program, under Dr. Jim Cloern's leadership since the 1970s, is considered among the best estuarine records worldwide, and has led to major advancements in our understanding of the Bay and other estuaries. The USGS SF Bay Program, through hypothesis-driven research and long-term measurements, identified the physical and biological factors that have historically given the Bay inherent resistance to its high nutrient levels - high turbidity and strong tidal mixing limited light available for phytoplankton growth, and abundant benthic grazers efficiently filtered phytoplankton from the water column. That same long-term and rigorously-maintained record also provided the early warning that the Bay's resistance to nutrients was weakening. Two USGS-led studies (Cloern et al. 2007, 2010) documented how summer/fall phytoplankton levels tripled in South San Francisco Bay between the late 1990s and 2005, and explained how, through a cascade of processes, phytoplankton became more able to utilize the Bay's ample nutrient supply.

The San Francisco Bay Nutrient Management Strategy was launched in direct response to the USGS SF Bay Program observations. The early-warning is allowing the Water Board and stakeholders to proactively evaluate nutrient management options before full-blown problems develop, thereby ensuring protection of the Bay, and potentially saving citizens billions of dollars

Dr. Terry F. Young, Chair | Bruce H. Wolfe, Executive Officer

1515 Clay St., Suite 1400, Oakland, CA 94612 | www.waterboards.ca.gov/sanfranciscobay

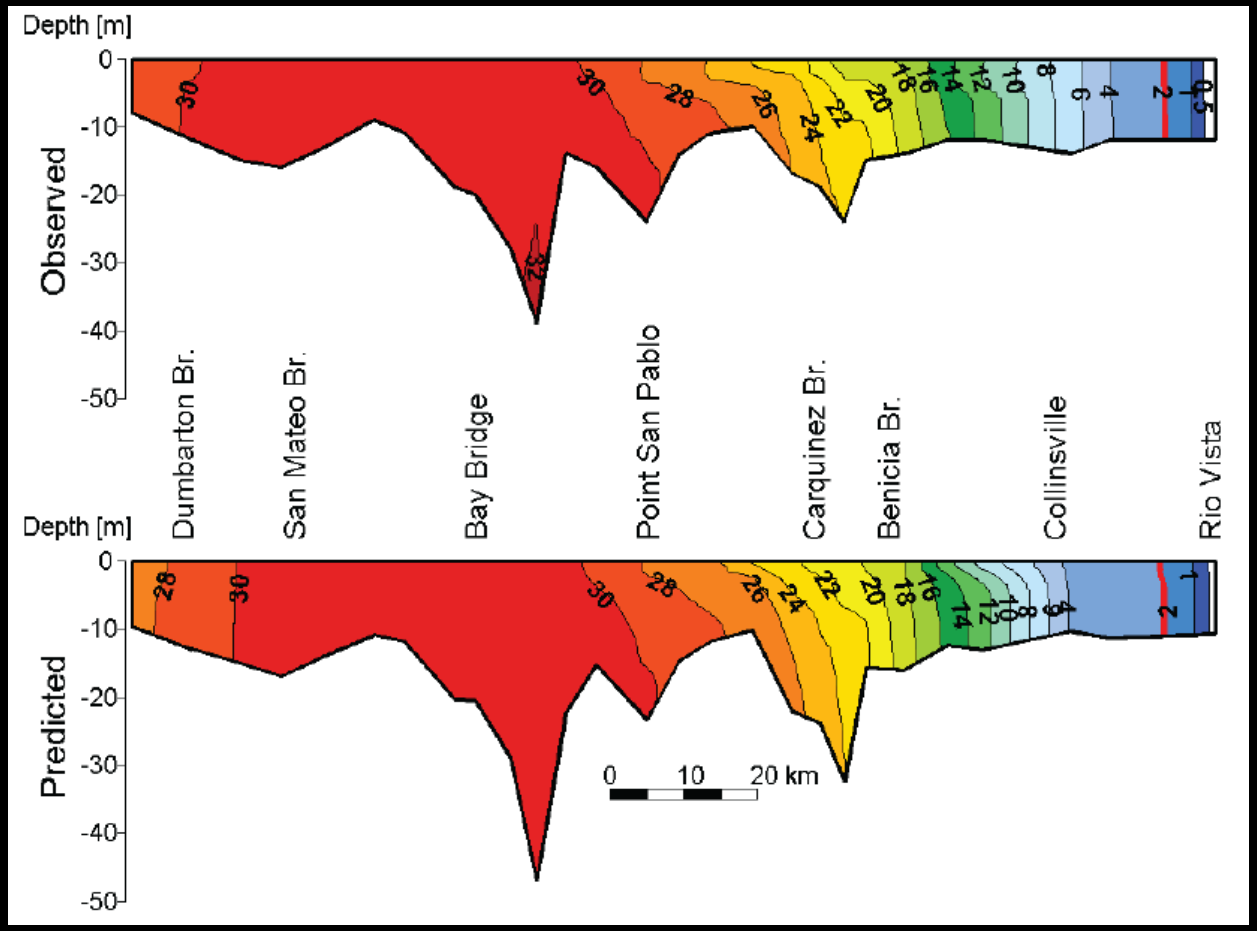
RECYCLED PAPER

Data used by the scientific community

50 examples, from archaeology to zooplankton ecology

Discipline	Measurements Used	Discovery/Application	Citation
anthropology	Salinity, Temperature	used oxygen-isotopes in clam shells to reconstruct human landscape use during the Late Pre-historic period	Eerkens, J. W., Byrd, B. F., Spero, H. J. & Fritschi, A. K. Stable isotope reconstructions of shellfish harvesting seasonality in an estuarine environment: implications for Late Holocene San Francisco Bay settlement patterns. Journal of Archaeological Science 40, 2014-2024 (2013).
biogeochemistry	Salinity, temperature, chlorophyll-a, SPM, DO, nutrients	concentrations of dissolved Mn, Co, Zn, and Pb all increased after a phytoplankton bloom decayed	Luengen, A. C., Raimondi, P. T. & Flegal, A. R. Contrasting biogeochemistry of six trace metals during the rise and decay of a spring phytoplankton bloom in San Francisco Bay. Limnology and Oceanography 52, 1112-1130 (2007).
biogeochemistry	Salinity, temperature, nutrients	showed that the Bay is heterotrophic, but net metabolism varies seasonally	Smith, S. V. & Hollibaugh, J. T. Water, salt, and nutrient exchanges in San Francisco Bay. Limnology and Oceanography 51, 504-517 (2006).
biogeochemistry	Salinity, temperature, chlorophyll-a, SPM, DO, nutrients	concentrations of dissolved methyl-mercury decreased as a phytoplankton bloom developed, and increased as the bloom decayed	Luengen, A. C. & Flegal, A. R. Role of phytoplankton in mercury cycling in the San Francisco Bay estuary. Limnology and Oceanography 54, 23-40 (2009).
bivalve ecology	Salinity	the alien clam *Potamocorbula amurensis* can complete its life cycle along most of the estuarine salinity gradient	Nicolini, M. H. & Penry, D. L. Spawning, fertilization, and larval development of Potamocorbula amurensis (Mollusca:Bivalvia) from San Francisco Bay,California. Pac. Sci. 54, 377-388 (2000).
bivalve ecology	Salinity, Temperature, Chlorophyll-a	seasonal reproduction of the clam *Potamocorbula amurensis* tracks seasonal patterns of the phytoplankton food supply	Parchaso, F. & Thompson, J. K. Influence of hydrologic processes on reproduction of the introduced bivalve Potamocorbula amurensis in northern San Francisco Bay, California. Pacific Science 56, 329-345 (2002).
conservation biology	Salinity	used salinity data to assess environmental controls on and	De la Cruz, S. E. W. et al. Resource selection and space use by sea ducks during the non-breeding season: Implications for
		strategies for conserving sea bird populations	habitat conservation planning in urbanized estuaries. Biological Conservation 169, 68-78 (2014).
ecosystem ecology	Salinity, Chlorophyll-a, DO	synthesized the data to describe key spatial and seasonal patterns of estuarine variability	Kimmerer, W. Open water processes of the San Francisco Estuary: physical forcing to biological responses. San Francisco Estuary and Watershed Science 2(1) (2004).
ecotoxicity	Chlorophyll-a	used a model to demonstrate how phytoplankton variability affects selenium bioaccumulation by mussels	Spencer, M., Fisher, N. S., Wang, W. X. & Ferson, S. Temporal variability and ignorance in Monte Carlo contaminant bioaccumulation models: A case study with selenium in Mytilus edulis. Risk Analysis 21, 383-394 (2001).
ecotoxicology	Chlorophyll-a	bioavailability of Cd and Zn increased during a phytoplankton bloom	Lee, B. G. & Luoma, S. N. Influence of microalgal biomass on absorption efficiency of Cd, Cr, and Zn by two bivalves from San Francisco Bay. Limnology and Oceanography 43, 1455-1466 (1998).
ecotoxicology	Salinity, SPM, Chlorophyll-a	calibrated and validated a model of selenium transport and accumulation in estuarine biota	Chen, L., Meseck, S. L., Roy, S. B., Grieb, T. M. & Baginska, B. Modeling Fate, Transport, and Biological Uptake of Selenium in North San Francisco Bay. Estuaries and Coasts, 1-20 (2012).
fish ecology	Chlorophyll-a	discovered a population decline of northern anchovy following introduction of the alien clam *Corbula amurensis*	Kimmerer, W. J. Response of anchovies dampens effects of the invasive bivalve Corbula amurensis on the San Francisco Estuary foodweb. Marine Ecology Progress Series 324, 207-218 (2006).
fish ecology	Temperature	used a bioenergetics model to calculate prey consumption by striped bass, an introduced species	Loboschefsky, E. et al. Individual-level and Population-level Historical Prey Demand of San Francisco Estuary Striped Bass Using a Bioenergetics Model. San Francisco Estuary and Watershed Science 10 (2012).
geochemistry	Chlorophyll-a	showed that seasonal patterns of sediment organic C and N track seasonal patterns of phytoplankton biomass	Lesen, A. E. Sediment organic matter composition and dynamics in San Francisco Bay, California, USA: Seasonal variation and interactions between water column chlorophyll and the benthos. Estuarine, Coastal and Shelf Science 66, 501-512 (2006).
geochemistry	Temperature	used data as input to a model of copper cycling and transport	Bessinger, B. et al. A Kinetic Model of Copper Cycling in San Francisco Bay. San Francisco Estuary and Watershed Science 4 (2006).
geochemistry	Salinity, Temperature, Chlorophyll-a, nitrate+nitrite	used data to measure/understand dissolved iron and iron-binding ligand distributions along the salinity gradient	Bundy, R. M. et al. Iron-binding ligands and humic substances in the San Francisco Bay estuary and estuarine-influenced shelf regions of coastal California. Marine Chemistry 173, 183-194 (2015).
geochemistry	Salinity, Temperature, Chlorophyll-a	used oxygen isotope ratios of phosphate to infer local sources of wastewater P along the salinity gradient	McLaughlin, K., Kendall, C., Silva, S. R., Young, M. & Paytan, A. Phosphate oxygen isotope ratios as a tracer for sources and cycling of phosphate in North San Francisco Bay, California. Journal of Geophysical Research 111 (2006).
geochemistry	Temperature	used data asinputs to a box model for assessing long-term fate of PCBs in the Bay	Davis, J. A. The long-term fate of polychlorinated biphenyls in San Francisco Bay (USA). Environ. Toxicol. Chem. 23, 2396-2409 (2004).
geochemistry	Salinity, DO, SPM, nitrate + nitrite	deduced a wastewater source of rare-earth elements based on their co-variaton with nutrients (nitrate + nitrate)	Hatje, V., Bruland, K. W. & Flegal, A. R. Increases in Anthropogenic Gadolinium Anomalies and Rare Earth Element Concentrations in San Francisco Bay over a 20 Year Record. Environ Sci Technol 50 (2016).
hydrodynamics	Salinity	initialized and validated a 3D hydrodynamic and salinity model	Chua, V. P. & Fringer, O. B. Sensitivity analysis of three-dimensional salinity simulations in North San Francisco Bay using the unstructured-grid SUNTANS model. Ocean Modelling 39, 332-350 (2011).
hydrodynamics	Salinity	initialized a 3D hydrodynamic model to project salinity intrusion under scenarios of sea level rise	Chua, V. P. & Xu, M. Impacts of sea-level rise on estuarine circulation: An idealized estuary and San Francisco Bay. Journal of Marine Systems 139, 58-67 (2014).
hydrodynamics	Salinity	validated a model of salt dispersion between the coastal ocean and Bay	Fram, J. P., Martin, M. A. & Stacey, M. T. Dispersive fluxes between the coastal ocean and a semienclosed estuarine basin. Journal of Physical Oceanography 37, 1645-1660 (2007).
hydrodynamics	Salinity	used an empirical relationship between the salinity gradient and freshwater inflow in a sediment-transport model	Ganju, N. K. & Schoellhamer, D. H. Calibration of an estuarine sediment transport model to sediment fluxes as an intermediate step for simulation of geomorphic evolution. Continental Shelf Research 29, 148-158 (2009).
hydrodynamics	Salinity	Initialized, calibrated and validated a 3D tidal hydrodynamic model	Gross, E. S., MacWilliams, M. L. & Kimmerer, W. J. Three-dimensional Modeling of Tidal Hydrodynamics in the San Francisco Estuary. San Francisco Estuary and Watershed Science 7 (2009).
hydrodynamics	Salinity	data were used to initialize and validate a 3D tidal hydrodynamics and salinity model	MacWilliams, M., Bever, A., Gross, E., Ketefian, G. & Kimmerer, W. Three-Dimensional Modeling of Hydrodynamics and Salinity in the San Francisco Estuary: An Evaluation of Model Accuracy, X2, and the Low-Salinity Zone. San Francisco Estuary and Watershed Science 13 (2015).
hydrodynamics	Salinity	discovered how salt intrusion into the estuary is related to river inflow	Monismith, S. G., Kimmerer, W., Burau, J. R. & Stacey, M. T. Structure and flow-induced variability of the subtidal salinity field in northern San Francisco Bay. Journal of Physical Oceanography 32, 3003-3019 (2002).
meiofauna ecology	Salinity, temperature, chlorophyll-a	showed that abundances of benthic foraminifera increase during phytoplankton blooms	Lesen, A. E. Relationship between benthic foraminifera and food resources in South San Francisco Bay, California, USA. Marine Ecology Progress Series 297, 131-145 (2005).
microbial ecology	Salinity	ammonia-oxidizing bacteria and archaea have different abundances and spatial structure along the salinity gradient	Mosier, A. C. & Francis, C. A. Relative abundance and diversity of ammonia-oxidizing archaea and bacteria in the San Francisco Bay estuary. Environmental Microbiology 10, 3002-3016 (2008).
microbial ecology	Salinity, Temperature, Chlorophyll-a, SPM	showed that bacterial metabolism covaries with river flow and organic-matter input	Murrell, M. C., Hollibaugh, J. T., Silver, M. W. & Wong, P. S. Bacterioplankton dynamics in northern San Francisco Bay: Role of particle association and seasonal freshwater flow. Limnology and Oceanography 44, 295-308 (1999).
microbial ecology	Salinity, Temperature, Chlorophyll-a, SPM, nutrients	measured and explored controls on nitrification rates	Damashek, J., Casciotti, K. L. & Francis, C. A. Variable Nitrification Rates Across Environmental Gradients in Turbid, Nutrient-Rich Estuary Waters of San Francisco Bay. Estuaries and Coasts 39, 1050-1071 (2016).
microzooplankton ecology	Salinity, Temperature, Chlorophyll-a, nutrients	measured anomalously low microzooplankton grazing rates in low-salinity regions of the estuary	Murrell, M. C. & Hollibaugh, J. T. Microzooplankton grazing in northern San Francisco Bay measured by the dilution method. Aquatic Microbial Ecology 15, 53-63 (1998).
paleoecology	Salinity	benthic foraminifera assemblages remained stable over a 125-ky period, but changed after a recent species introduction	Lesen, A. E. & Lipps, J. H. What have natural and human changes wrought on the foraminifera of San Francisco Bay late Quaternary estuaries? Quaternary Research 76, 211-219, doi:10.1016/j.yqres.2011.06.005 (2011).
phytoplankton ecology	Chlorophyll-a, nutrients	assessed effects of wastewater effluent on phytoplankton communities	Esparza, M. L. et al. Impact of atypical ammonium concentrations on phytoplankton abundance and composition in fresh versus estuarine waters. Aquatic Biology 21, 191-204, doi:10.3354/ab00588 (2014).
phytoplankton ecology	Salinity, chlorophyll-a, SPM, silicate, light extinction	showed that diatom primary production and Si uptake decreased after introduction of the clam *Corbula amurensis*	Kimmerer, W. Long-term changes in apparent uptake of silica in the San Francisco estuary. Limnology and Oceanography 50, 793-798 (2005).
remote sensing	SPM	measured sediment deposition in restored marshes using satellite reflectance data calibrated with measured sediment concentrations	Newcomer, M. E. et al. Estuarine sediment deposition during wetland restoration: a GIS and remote sensing modelling approach. Geocarto International 29, 451-467 (2014).
sclerochronology	Chlorophyll-a	used synchrony between chlorophyll-a and $\delta^{13}C$ of *Crassostria gigas* shells to infer timing of invasion by this non-native oyster	Goodwin, D. H., Cohen, A. N. & Roopnarine, P. D. Forensics on the half shell: A sclerochronological investigation of a modern biological invasion in San Francisco Bay, United States. Palaios 25, 742-753 (2010).
sclerochronology	Chlorophyll-a	used $\delta^{13}C$ of *Crassostria gigas* shells as a proxy for phytoplankton primary productivity and bloom timing	Goodwin, D. H., Gillikin, D. P. & Roopnarine, P. D. Preliminary evaluation of potential stable isotope and trace element productivity proxies in the oyster Crassostrea gigas. Palaeogeography Palaeoclimatology Palaeoecology 373, 88-97 (2013).
sediment dynamics	Salinity	set initial conditions of a 3D hydrodynamic, wind wave, sediment transport model	Bever, A. J. & MacWilliams, M. L. Simulating sediment transport processes in San Pablo Bay using coupled hydrodynamic, wave, and sediment transport models. Marine Geology 345, 235-253 (2013).
sediment dynamics	Salinity	measured settling velocities of flocculated cohesive sediments along the salinity gradient	Manning, A. J. & Schoellhamer, D. H. Factors controlling floc settling velocity along a longitudinal estuarine transect. Marine Geology 345, 266-280 (2013).
sediment dynamics	Salinity	inferred sediment transport pathways in the coupled Bay-ocean system	McGann, M., Erikson, L., Wan, E., Powell, C. & Maddocks, R. F. Distribution of biologic, anthropogenic, and volcanic constituents as a proxy for sediment transport in the San Francisco Bay Coastal System. Marine Geology 345, 113-142 (2013).
sediment dynamics	Salinity	discovered that the sediment supply for restoring salt marshes varies with the slope of the estuarine salinity gradient	Shellenbarger, G. G., Wright, S. A. & Schoellhamer, D. H. A sediment budget for the southern reach in San Francisco Bay, CA: Implications for habitat restoration. Marine Geology 345 (2013).
sediment dynamics	SPM	showed that suspended sediment concentrations decreased and estuarine waters cleared suddenly after 1998	Schoellhamer, D. H. Sudden clearing of estuarine waters upon crossing the threshold from transport- to supply-regulation of sediment transport as an erodible sediment pool is depleted: San Francisco Bay, 1999. Estuaries and Coasts 34, 885-899 (2011).
species introductions	Salinity	assesed potential for different non-native fish species to survive if introduced to the Bay	Chang, A. L. et al. Tackling aquatic invasions: risks and opportunities for the aquarium fish industry. Biological Invasions 11, 773-785 (2009).
teaching estuarine hydrology	Salinity, Chlorophyll-a, SPM	online data were used to teach a graduate-level course, *Hydrology of San Francisco Bay and Delta*	Schoellhamer, D. H. Teaching Estuarine Hydrology with Online Data. Estuaries and Coasts 32, 1069-1078 (2009).

Data used to build & test models



Three-Dimensional Modeling of Tidal Hydrodynamics in the San Francisco Estuary

Edward S. Gross[1], Michael L. MacWilliams[2], and Wim J. Kimmerer[3]

Data used by teachers

Dear Jim, Thanks very much for the material. I'd really like to get the students working on more USGS data. I teach an undergraduate interdisciplinary course (Water Resources Management) every spring and this will be a great addition.

Professor Katherine Cushing
Department of Environmental Studies
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Teaching Estuarine Hydrology with Online Data

David H. Schoellhamer

Estuaries and Coasts (2009) 32:1069–1078

Data used by graduate students

Hi, I am Khushali Desai. I am Graduate Student at San Jose State University, currently working on my thesis. I am using "USGS Measurements of Water Quality in San Francisco Bay (CA), 1969-2015" data as part of my thesis analysis. I have few questions, it would be great if you answer them for my study. Thank you for your precious time.

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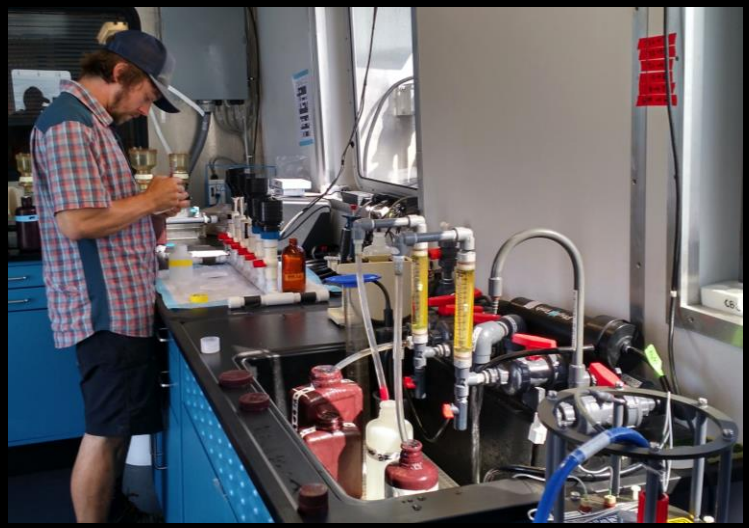
Limnol. Oceanogr., 52(3), 2007, 1112–1130

Contrasting biogeochemistry of six trace metals during the rise and decay of a spring phytoplankton bloom in San Francisco Bay

Allison C. Luengen[1]
Environmental Toxicology Department, WIGS Group, University of California at Santa Cruz, 1156 High Street, Santa Cruz, California 95064

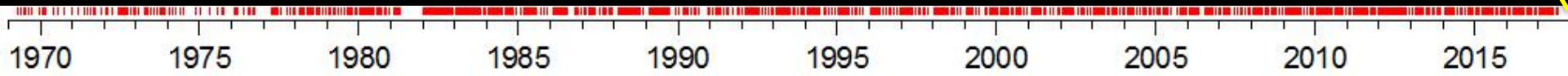
Data used by others

Dear Mr. Cloern, I am following up with you to say thank you so much for your time and attention. I got so much good information from you, and I am very grateful. I am almost done with my article, and will send it to you as soon as I finish!! Thanks again, Noa



September 28, 2017

1134 sampling dates, 1969 –2017




CONGRATULATIONS !!
RMP