NUTRIENT SCIENCE STRATEGY

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With input from…

RMP Nutrient Workgroup

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Dick Dugdale (SFSU)

REGIONAL MONITORING PROGRAM

RMP ANNUAL MEETING

Pollutant Effects on Aquatic Life

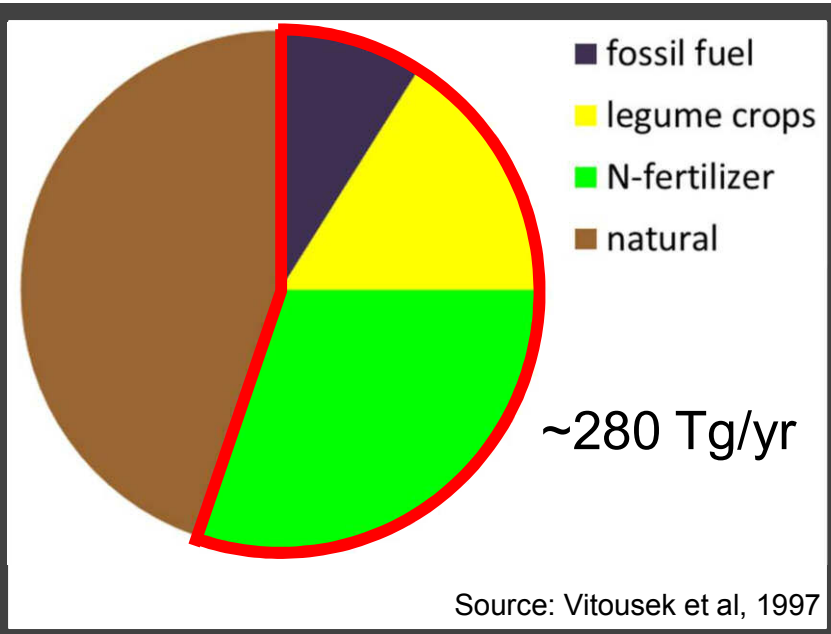
Outline

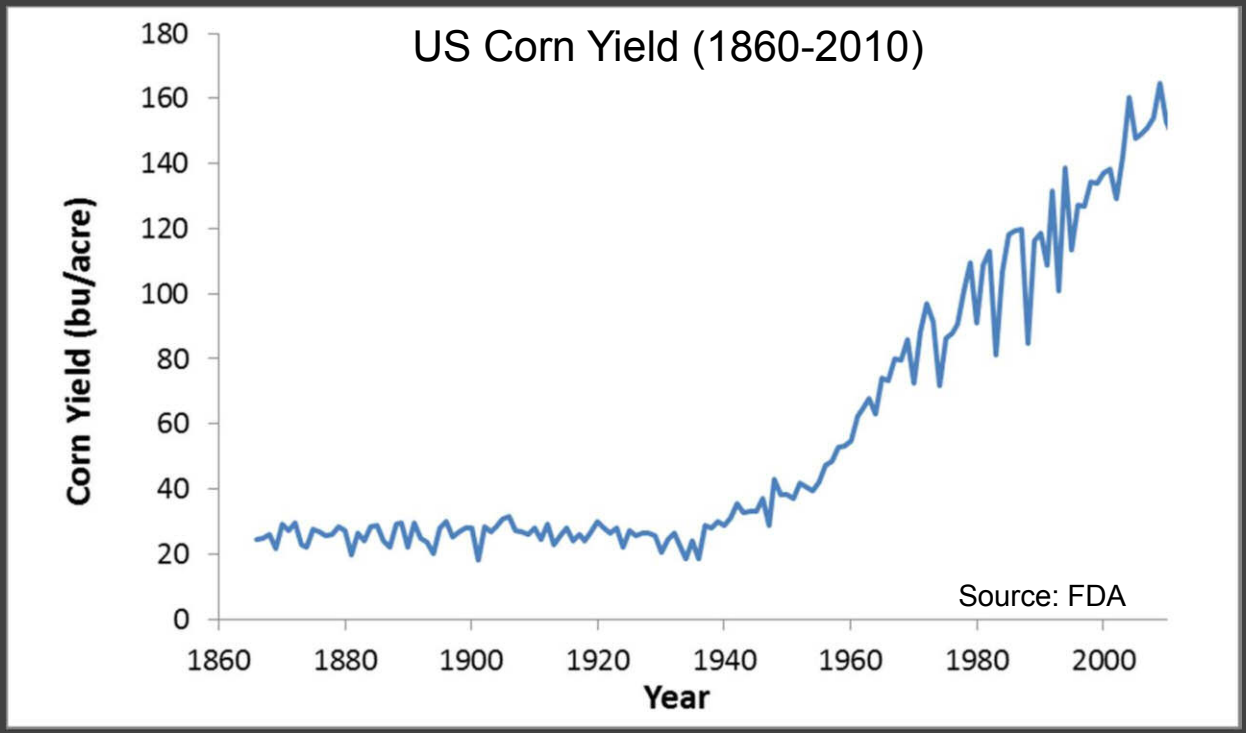
- Background – Nutrients and Coastal Eutrophication
- Nutrients and the Resilience of San Francisco Estuary
- Nutrient Science Strategy

RMP 2011 ANNUAL MEETING

Human activities have doubled the rate at which bio-accessible N is delivered to terrestrial ecosystems

N_2 → nitrate, ammonium, org. nitrogen





++ Pro ++

Higher agricultural yields in the US and globally

Human activities have doubled the rate at which bio-accessible N is delivered to terrestrial ecosystems

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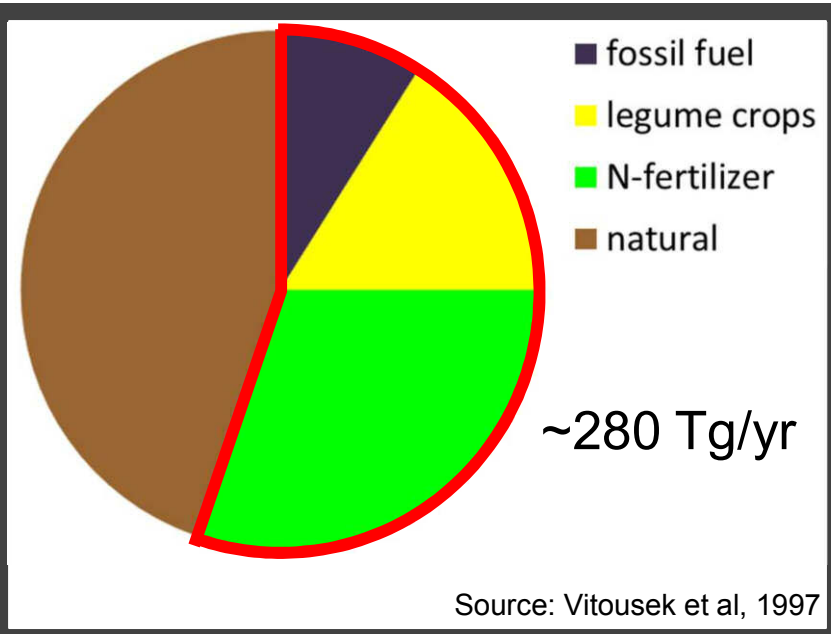
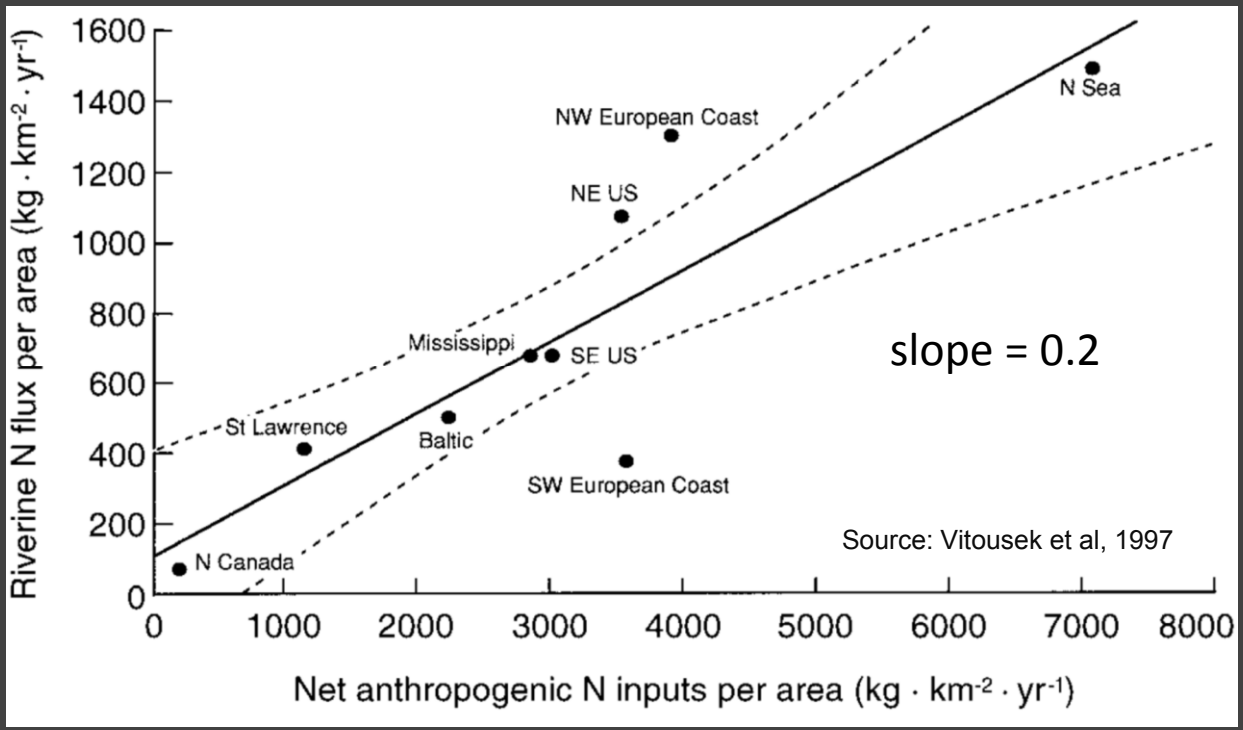
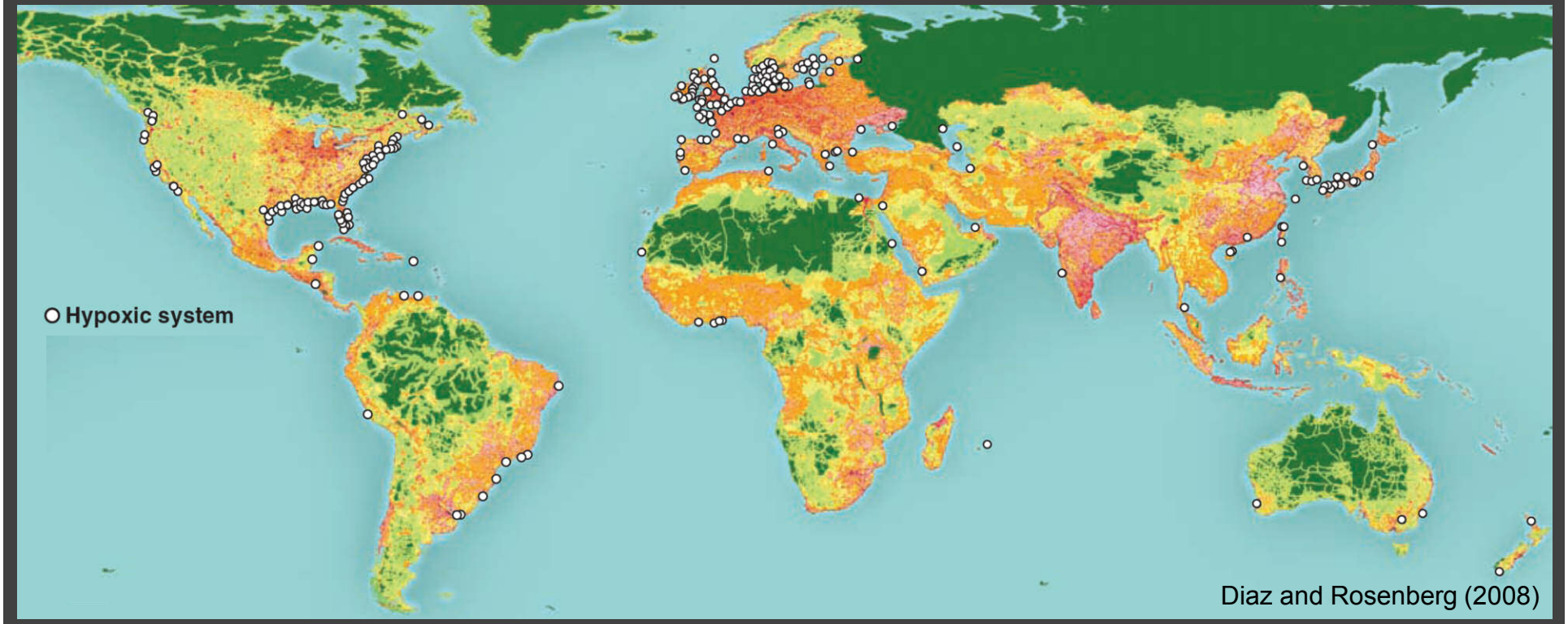




- - Con - -

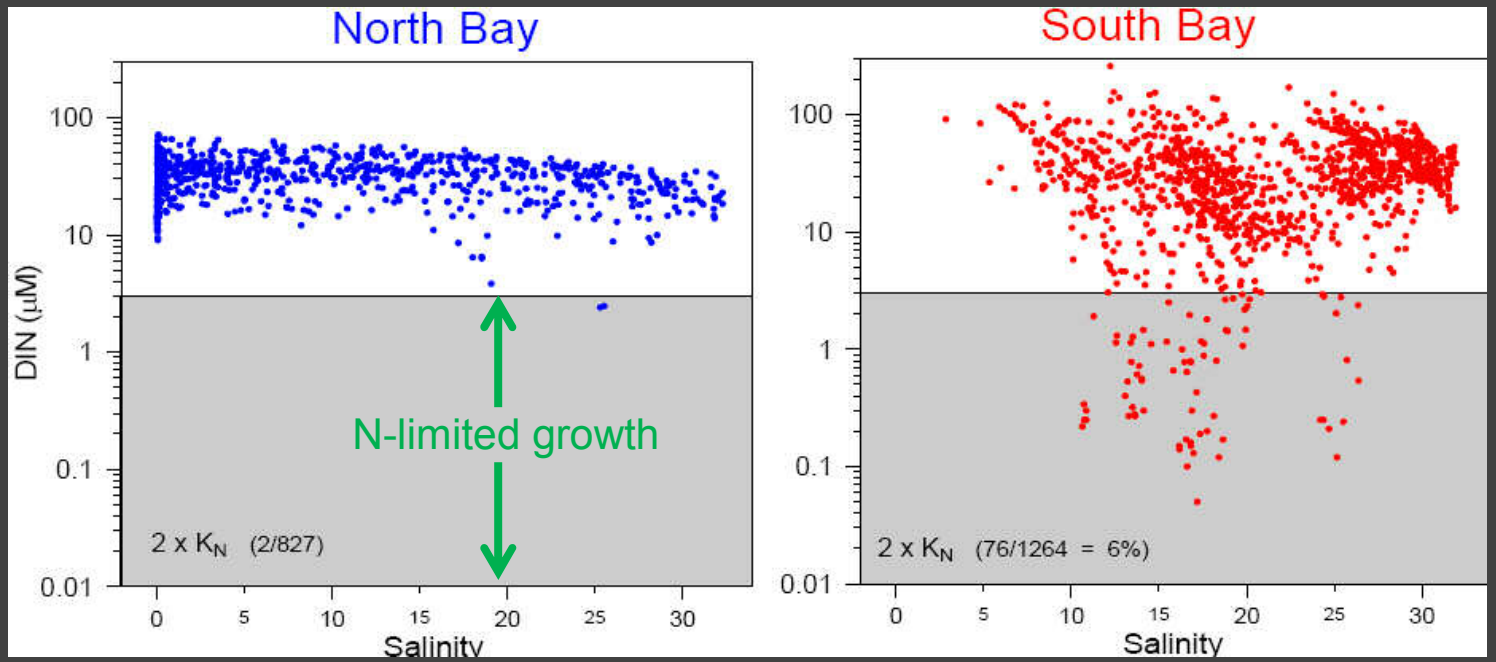
Large fraction of anthropogenic N inputs are exported to coastal waters

Globally…400+ coastal hypoxic “dead zones”



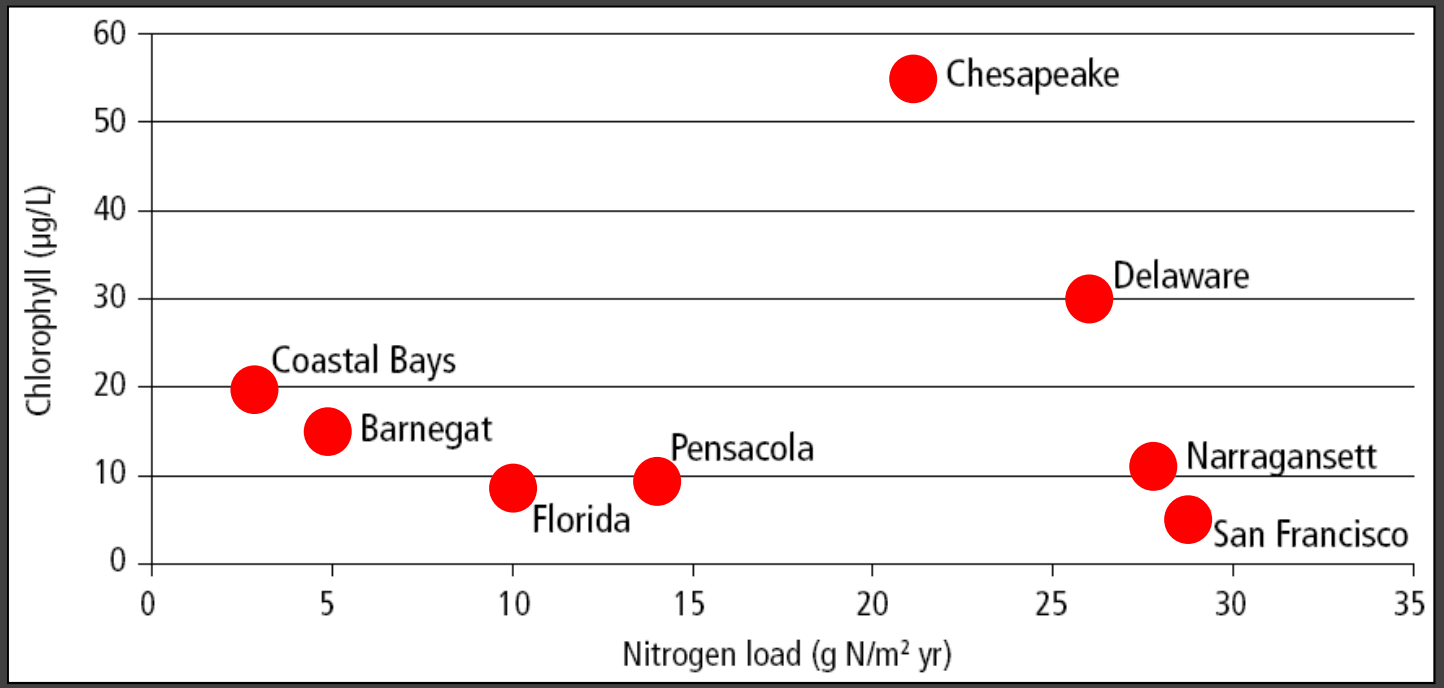
Diaz and Rosenberg (2008)

San Francisco Bay



High inorganic nitrogen levels (nitrate and ammonium)

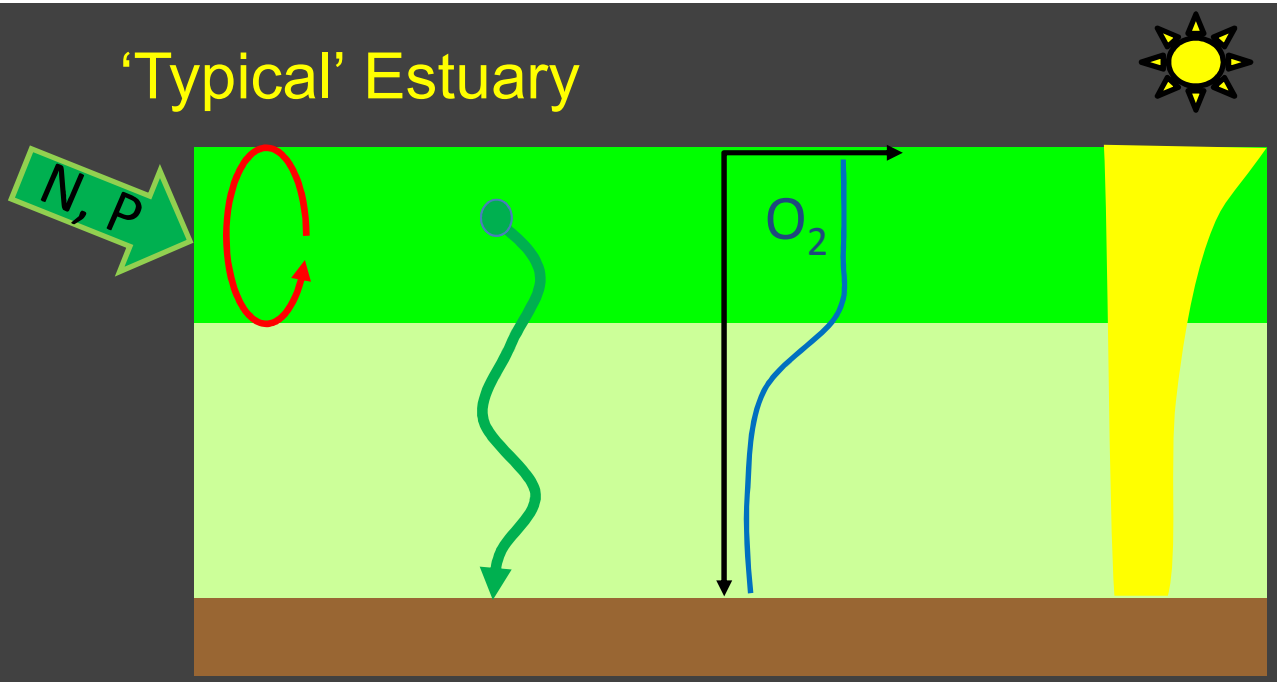
Dugdale and Cloern (2010)



but "classic" symptoms of eutrophication are not widespread

National Estuarine Experts Workgroup (2010)

‘Typical’ Estuary



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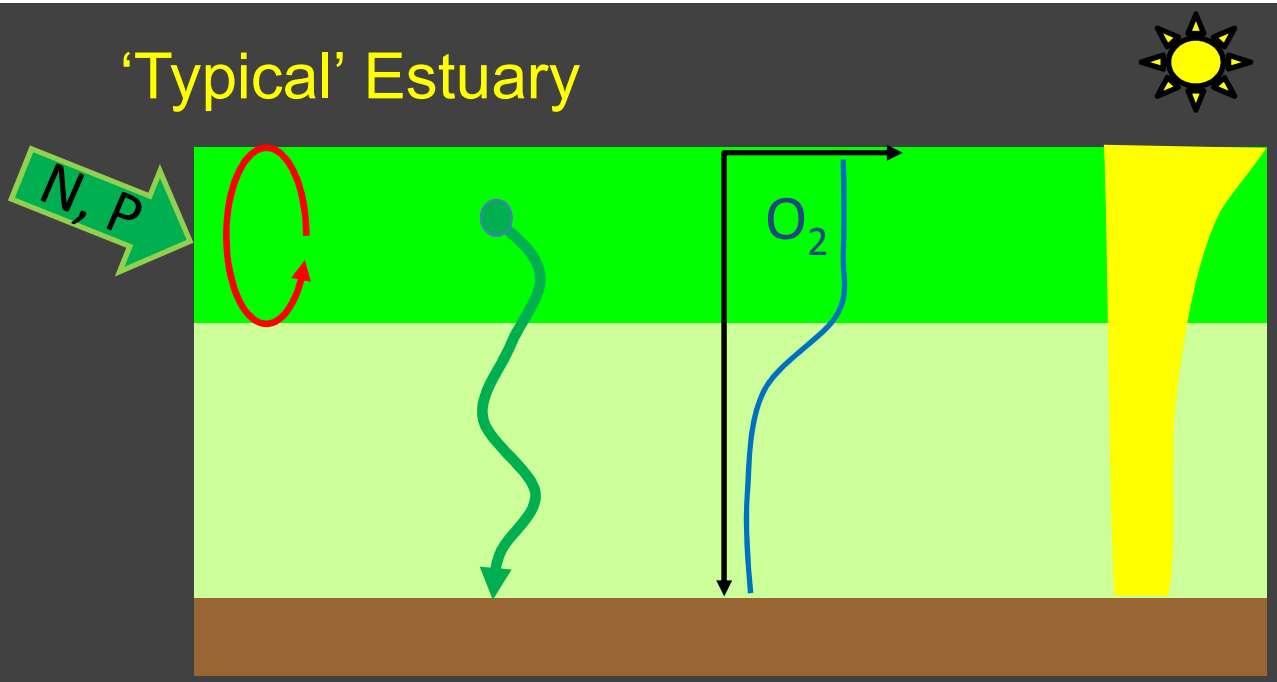
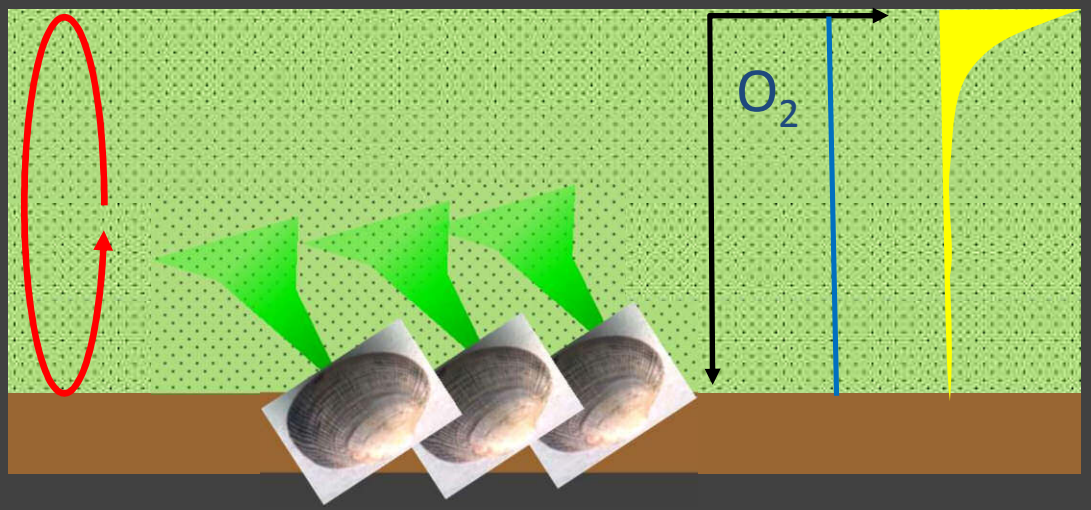
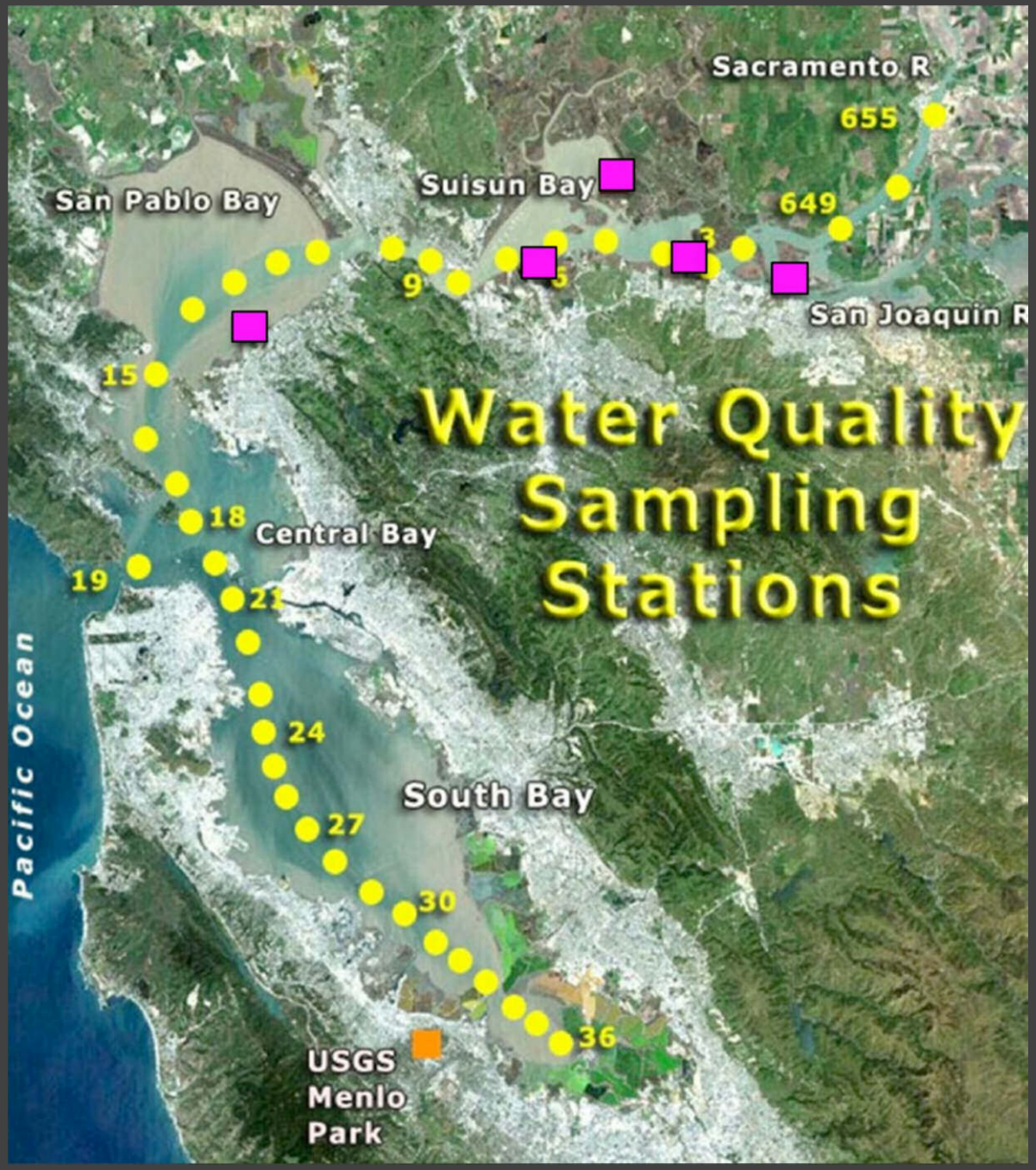


Resilience of San Francisco Bay

1) Strong tidal mixing
2) Filter-feeding clams
3) High turbidity

- **Subject to change?**
- **Spatial variation?**

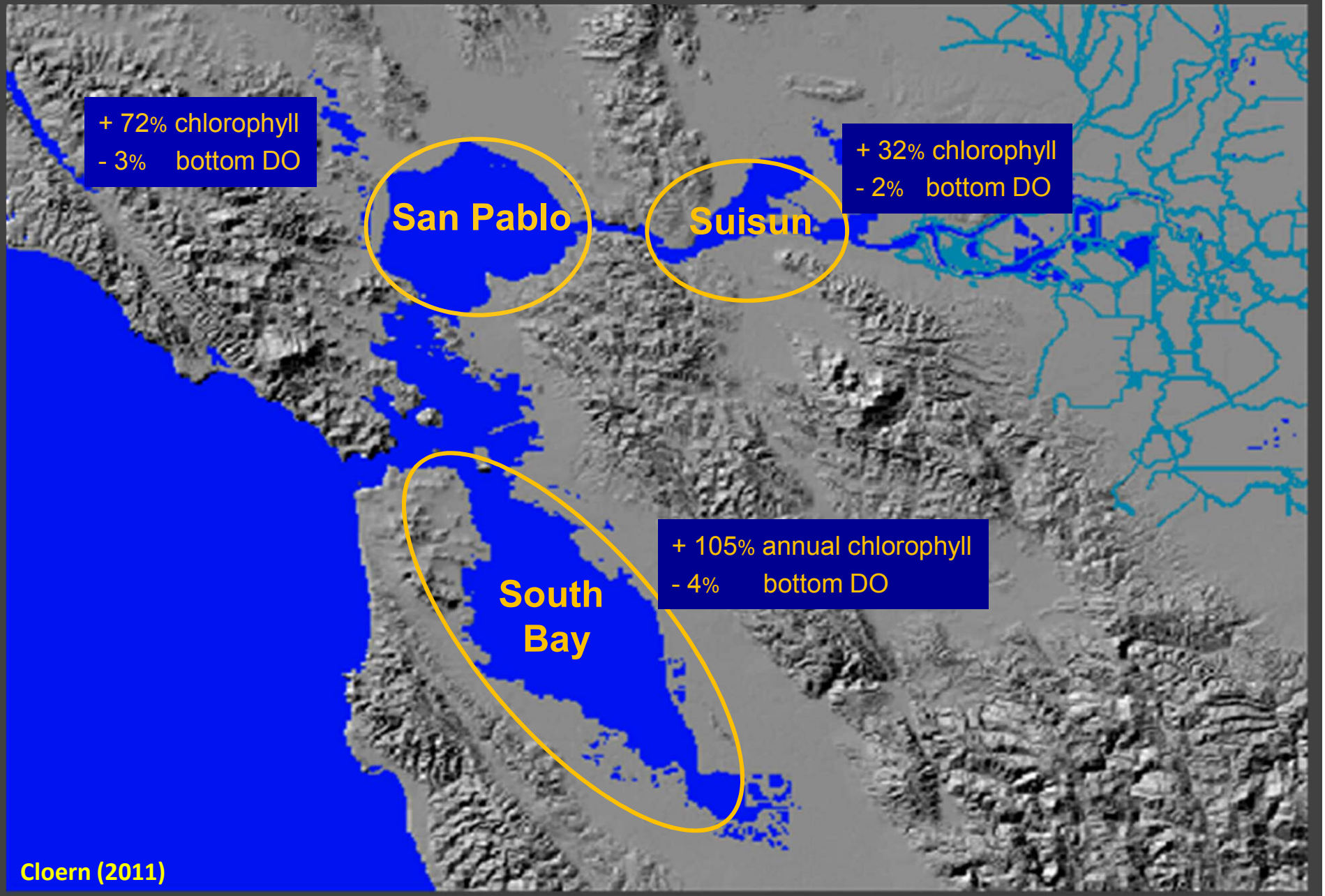




Monthly sampling by USGS from 1969-present, combined with IEP

- USGS
- IEP

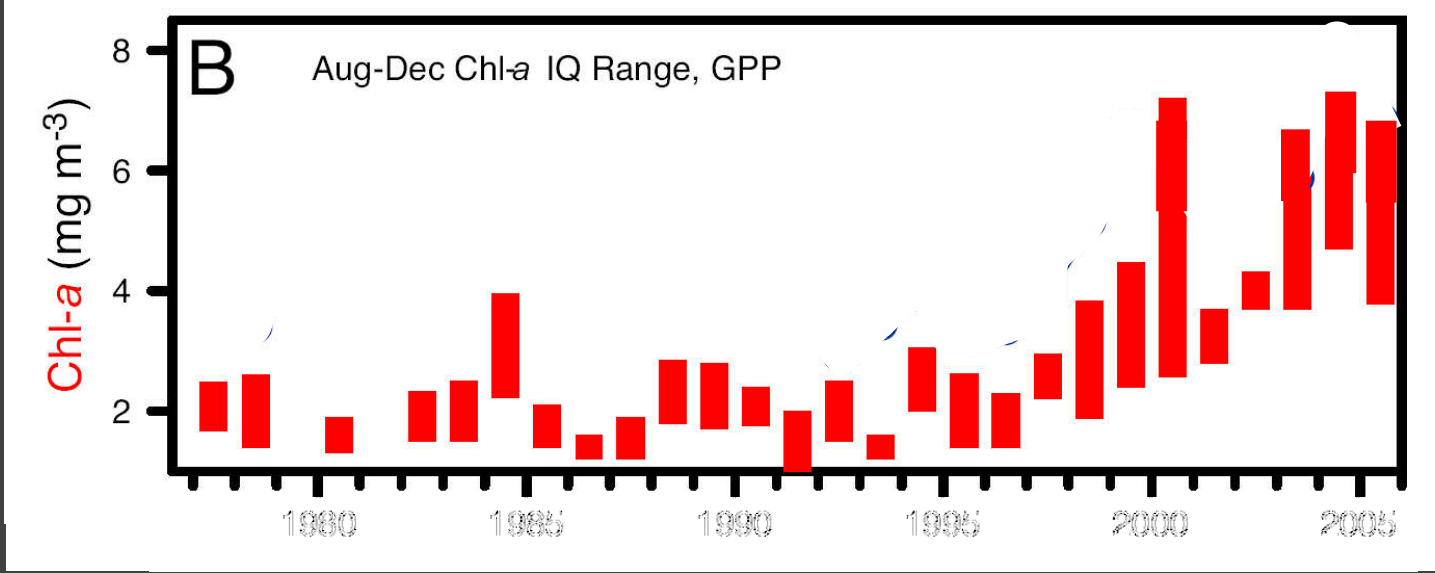
Changes over the last 20 years…



South Bay

~200% increase (Aug-Dec)

Cloern et al. (2007)



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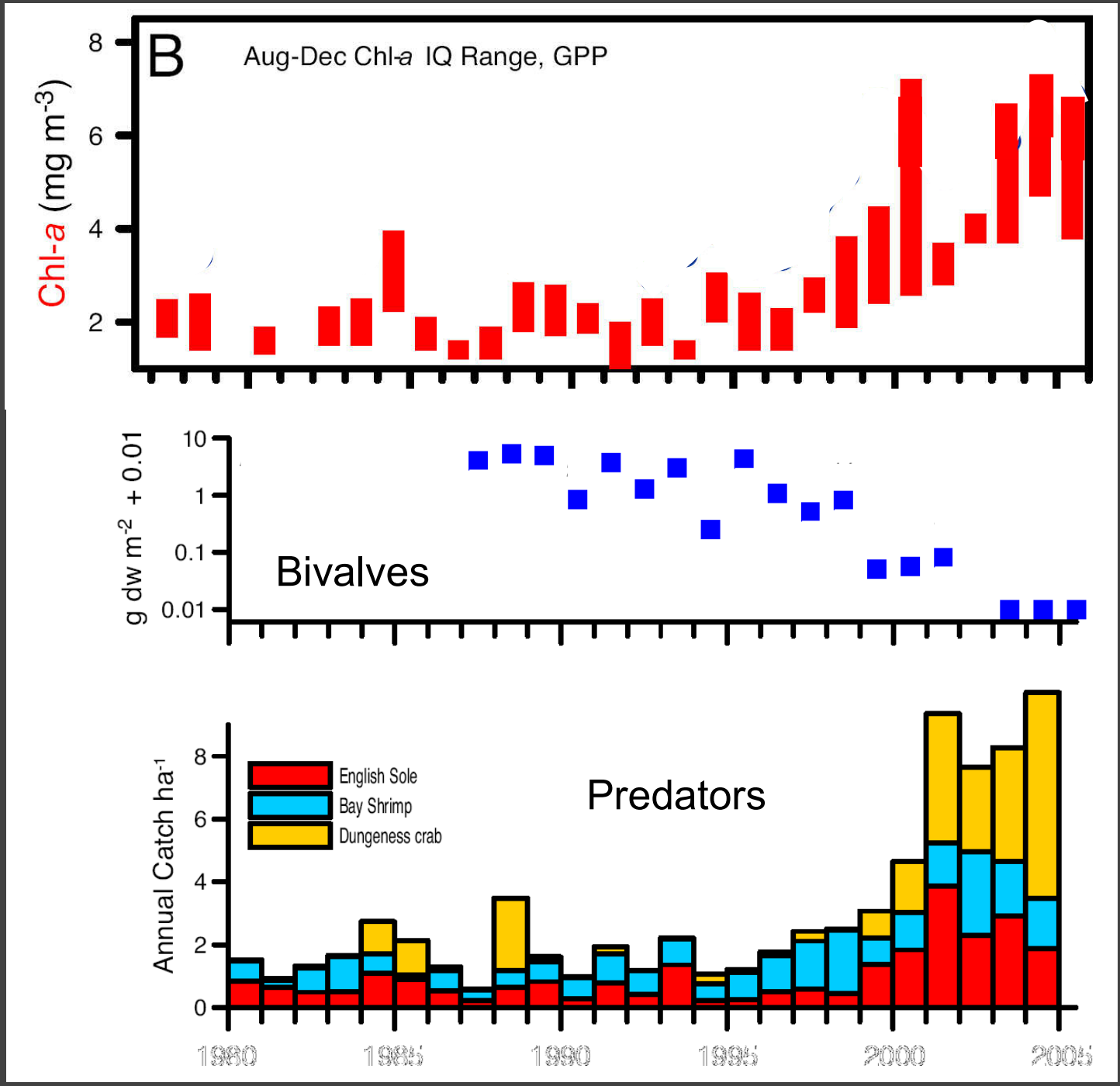
- Large influx of benthic predators

- Change in North Pacific Gyre Oscillation



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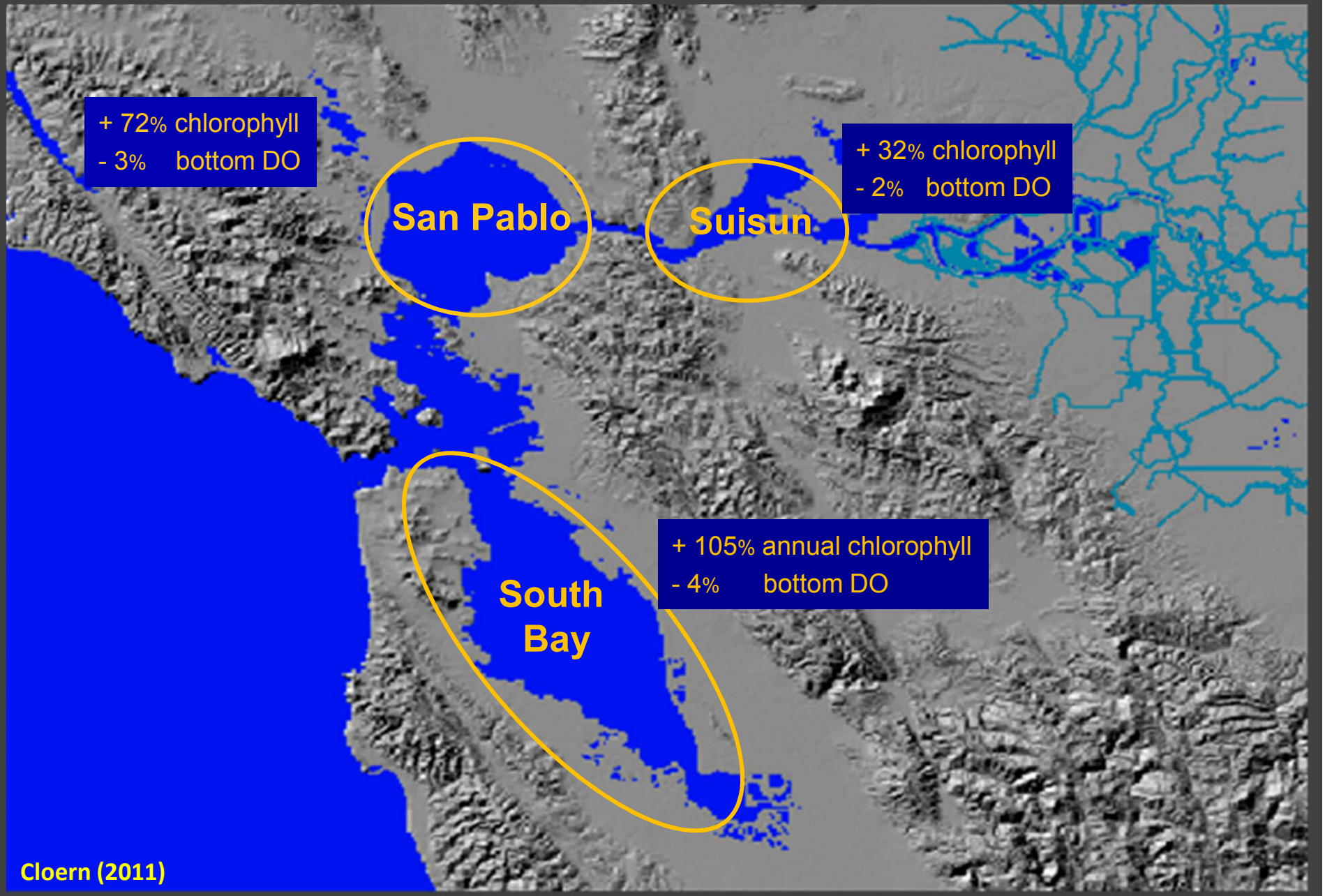
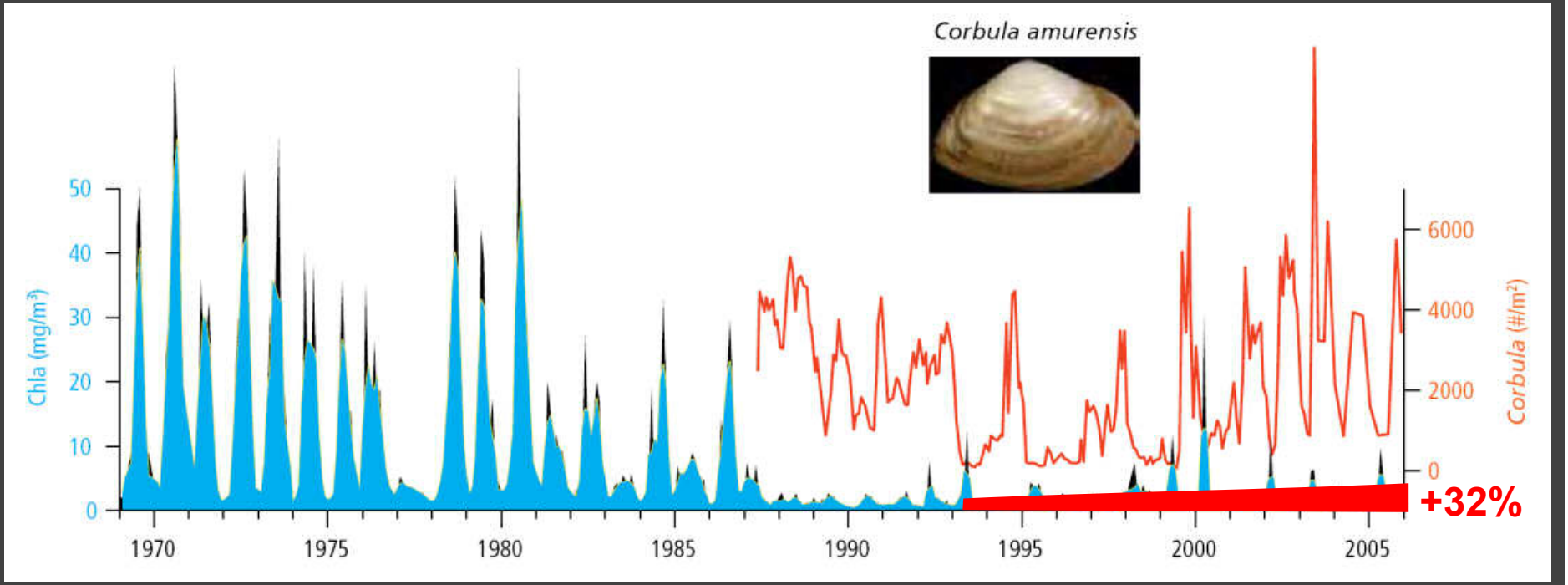


Suisun Bay…Low *(but increasing)* Primary Production



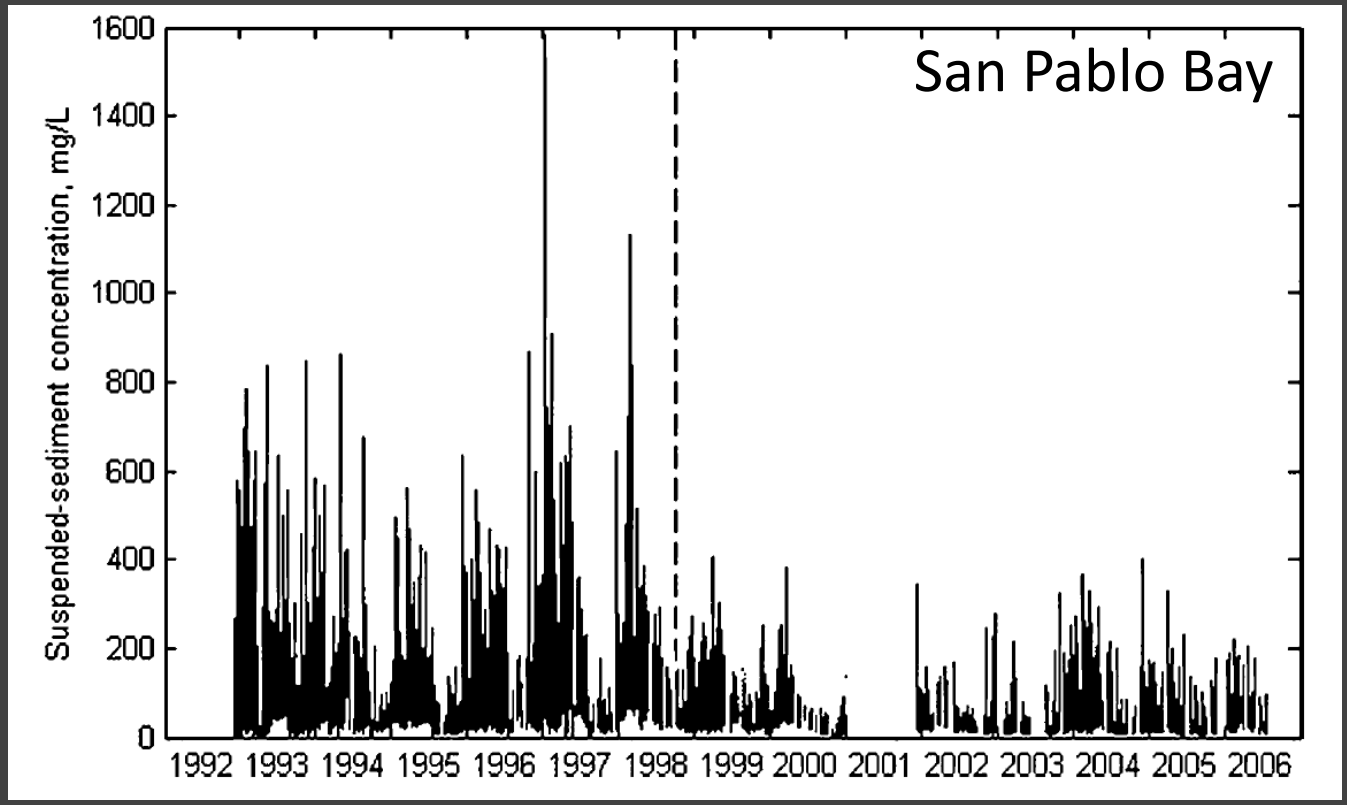
Data: Interagency Ecological Program

Also contributing…

High NH_4^+ levels causing slow primary production rates

Dugdale et al. (2007)

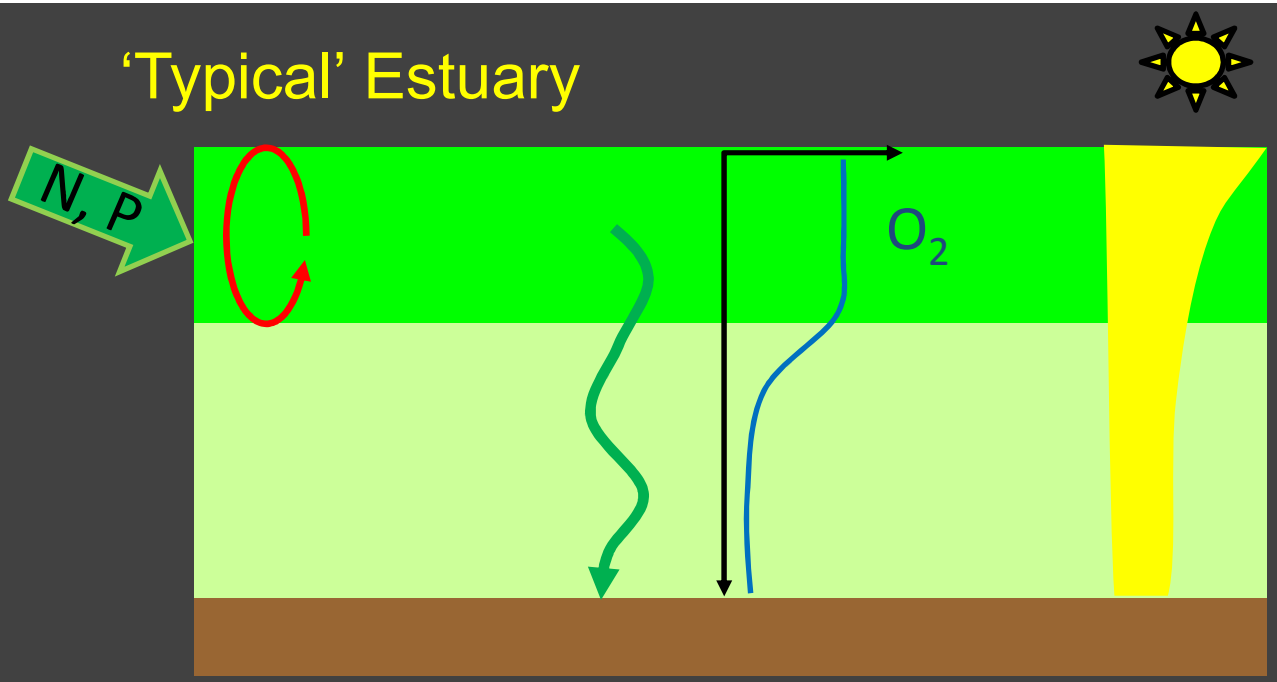
Suspended Sediment Concentrations Declining…



Schoellhamer (2011)

- Bay-wide: 36% decrease in suspended sediment concentration

‘Typical’ Estuary



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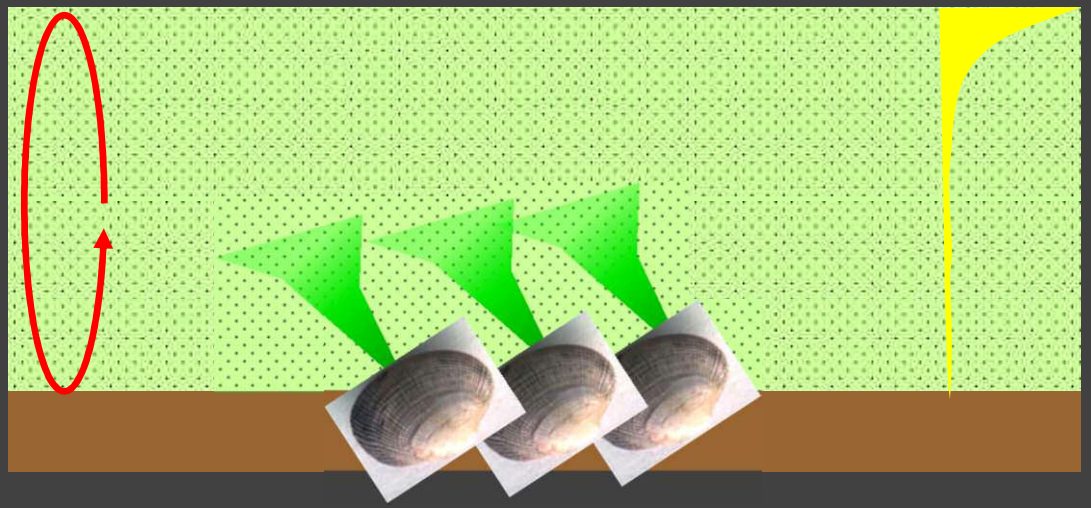
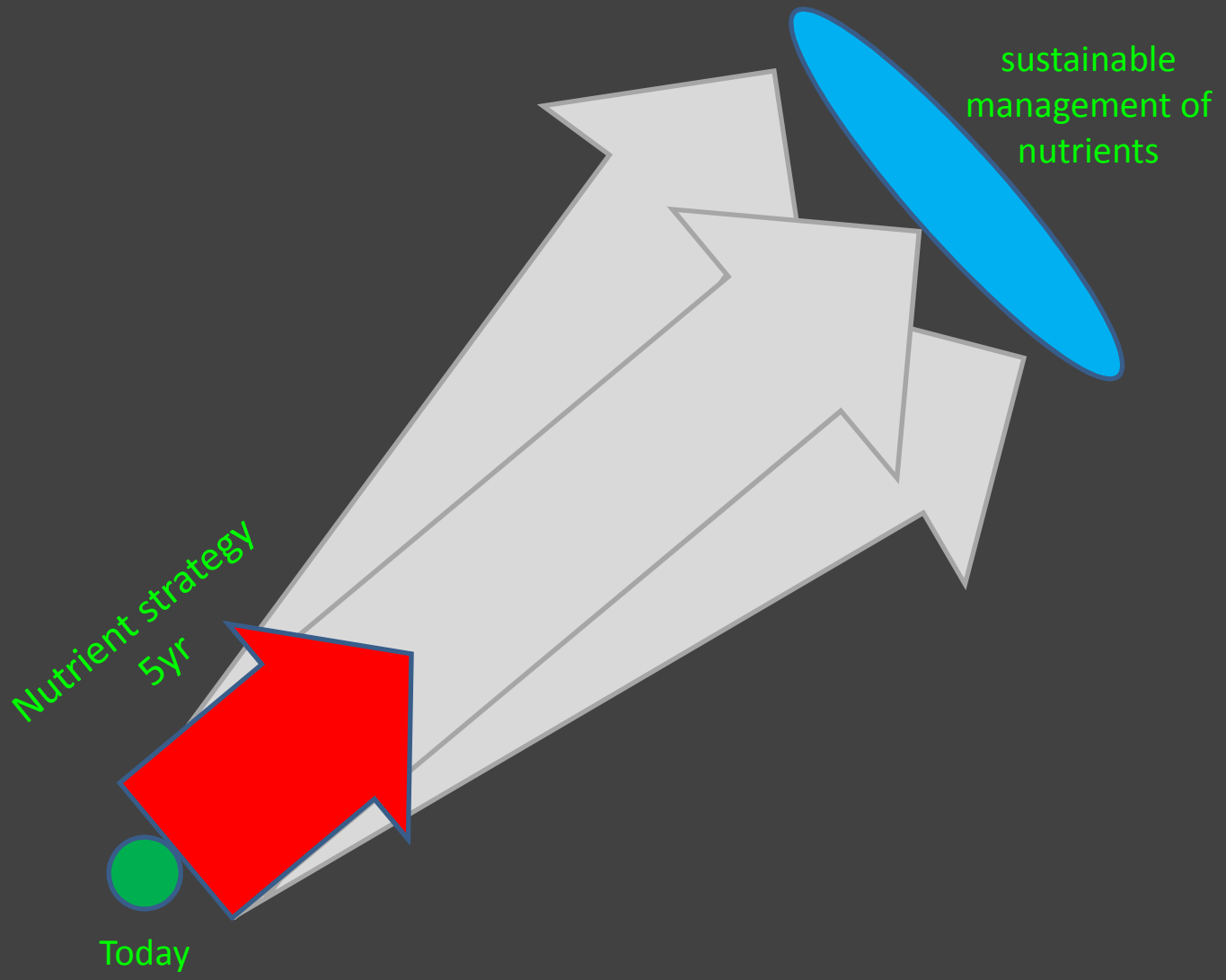


Developing a Nutrient Strategy



Goals of 5-year Nutrient Strategy

1) Synthesize current understanding and define the problem

2) Establish guidelines for adverse effects of nutrient over-enrichment

   - *water quality objectives, assessment framework*

3) Implement a monitoring program

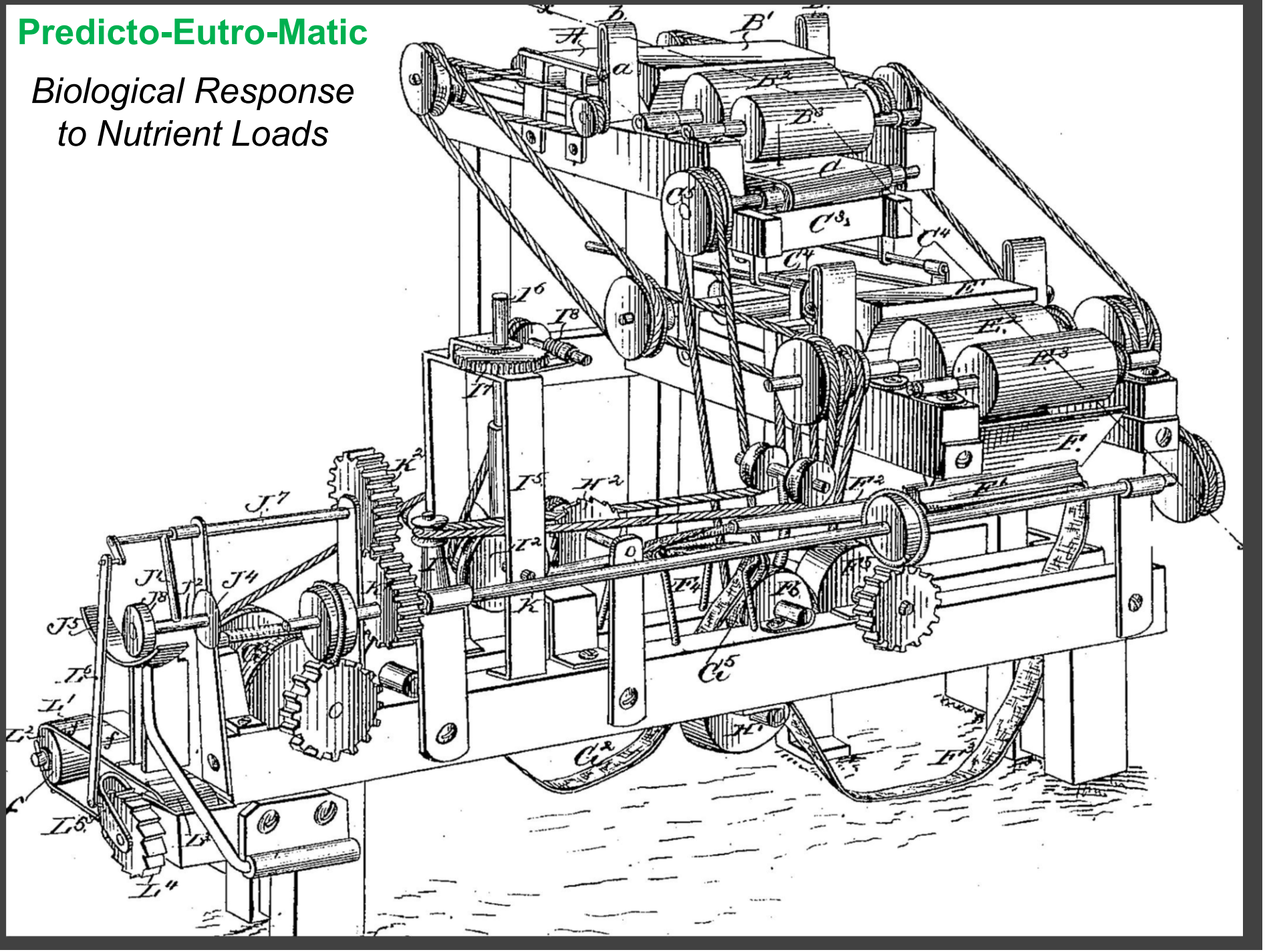
   - *cooperation with other agencies/initiatives (e.g., IEP)*

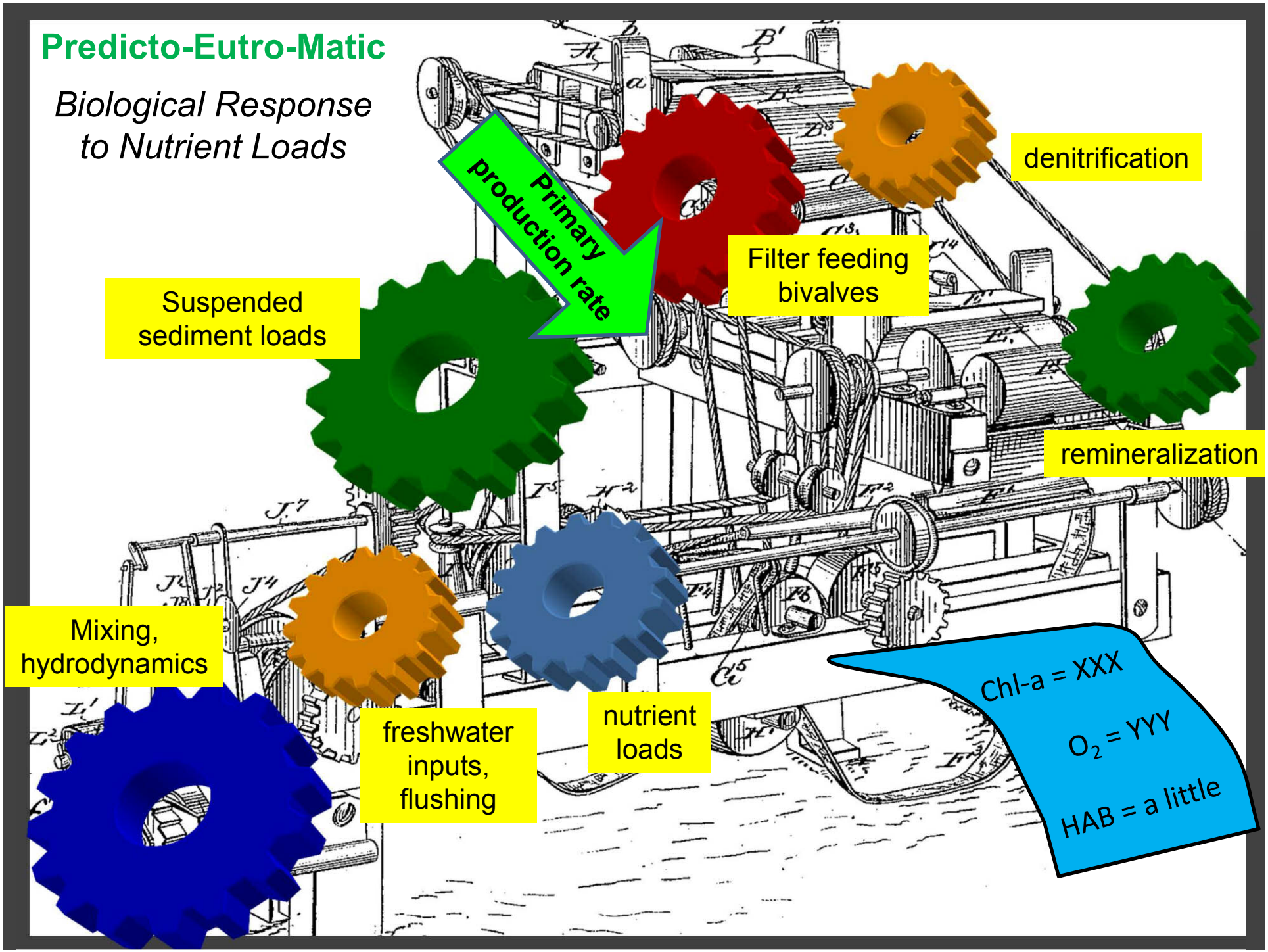
4) Quantify nutrient loads and estimate coarse nutrient budget

5) Develop a modeling strategy to support management decisions

Predicto-Eutro-Matic

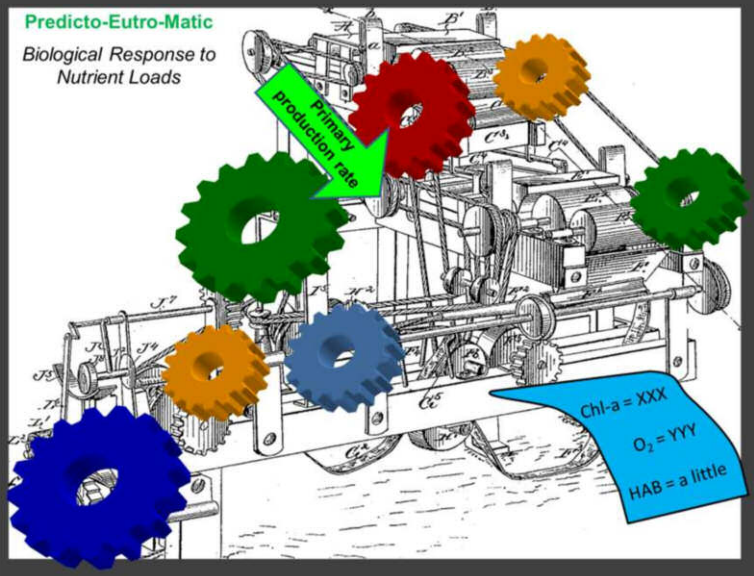
Biological Response to Nutrient Loads




Predicto-Eutro-Matic
Biological Response to Nutrient Loads
Primary production rate
denitrification
Filter feeding bivalves
Suspended sediment loads
remineralization
Mixing, hydrodynamics
freshwater inputs, flushing
nutrient loads
Chl-a = XXX
O2 = YYY
HAB = a little

Defining the Problem (*2012*)

1. Conceptual models for the Bay



2. Scenarios

change management forcings

change natural forcings

e.g.,
- 1% per year decrease in sediment load
- stronger thermal stratification
- change in North Pacific Gyre Oscillation
- increase or decrease in loads from POTW
- changes in freshwater flows at Delta

Defining the Problem (*2012*)

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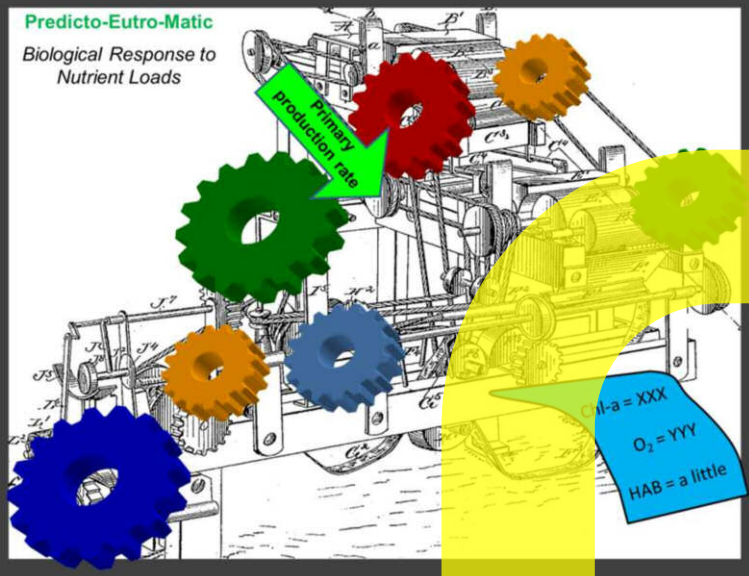


2. Scenarios

change management forcings

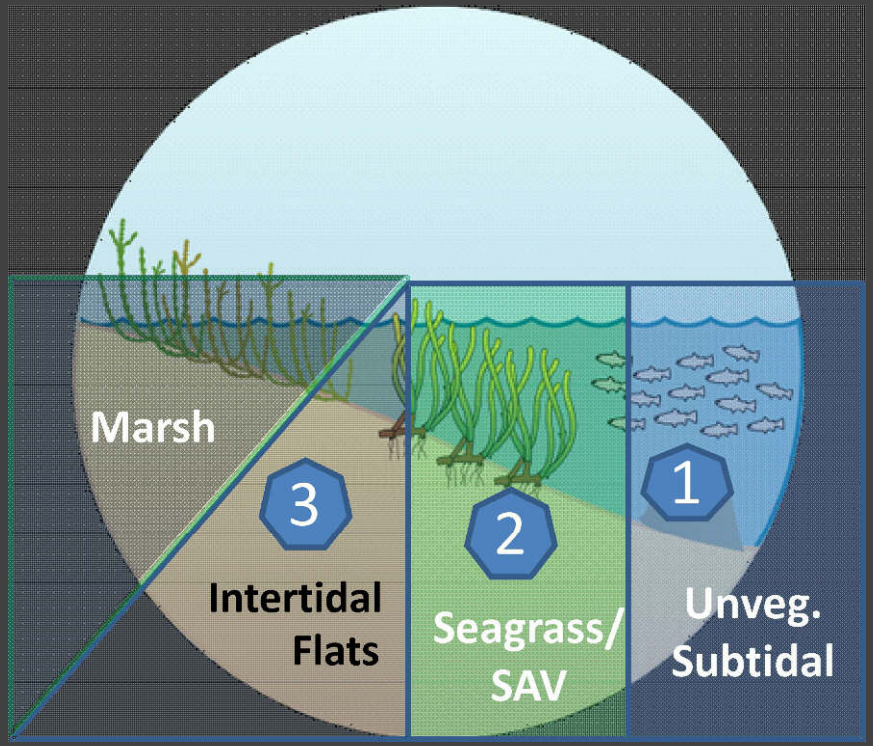
change natural forcings

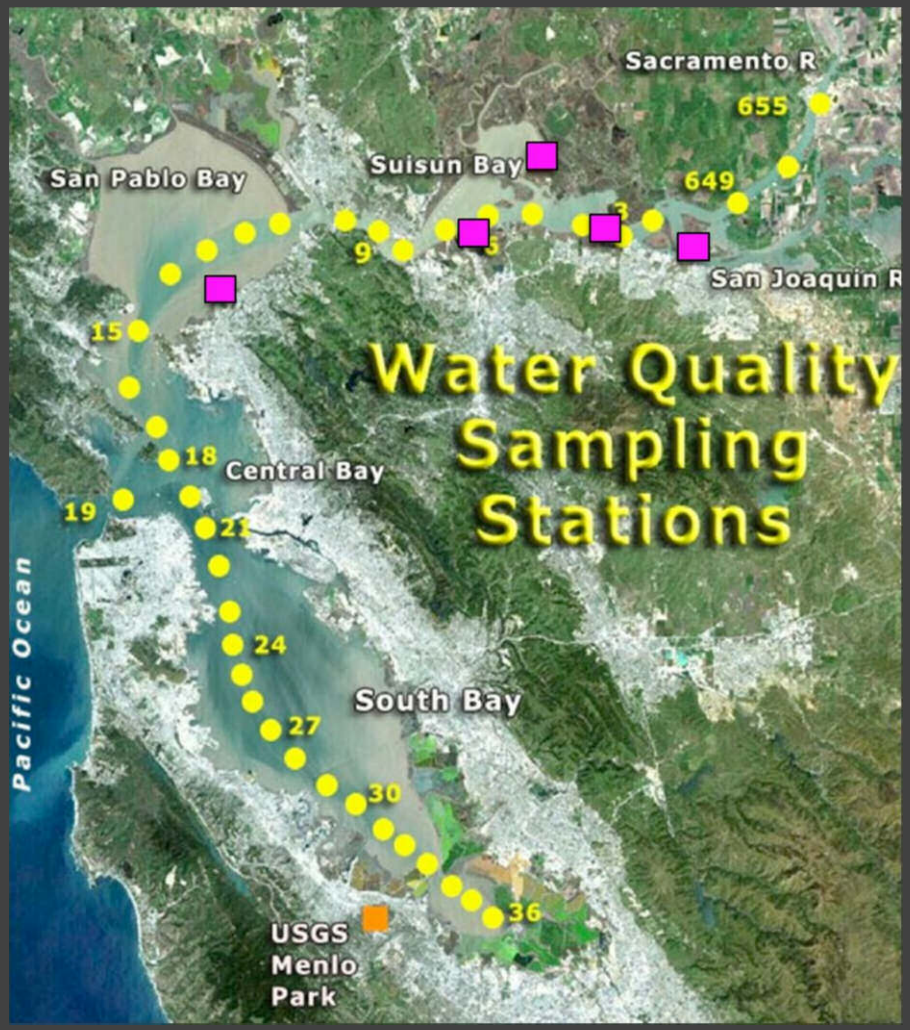
- Identify critical knowledge gaps
- Prioritize/rank

- ‘Consensus’ statement(s) on nutrient outlook for the Estuary

- Recommendations for monitoring and modeling programs

Monitoring Strategy





Quantifying External Nutrient Loads

- current estimates are coarse (spatial/temporal) and uncertain
- basic but critical input for…
  - modeling load-response
  - considering potential effectiveness of load reduction scenarios

Acknowledgements

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RMP 2011 ANNUAL MEETING