Cyanobacteria Science Work Group Meeting
CyanoHAB Literature Review
Agenda

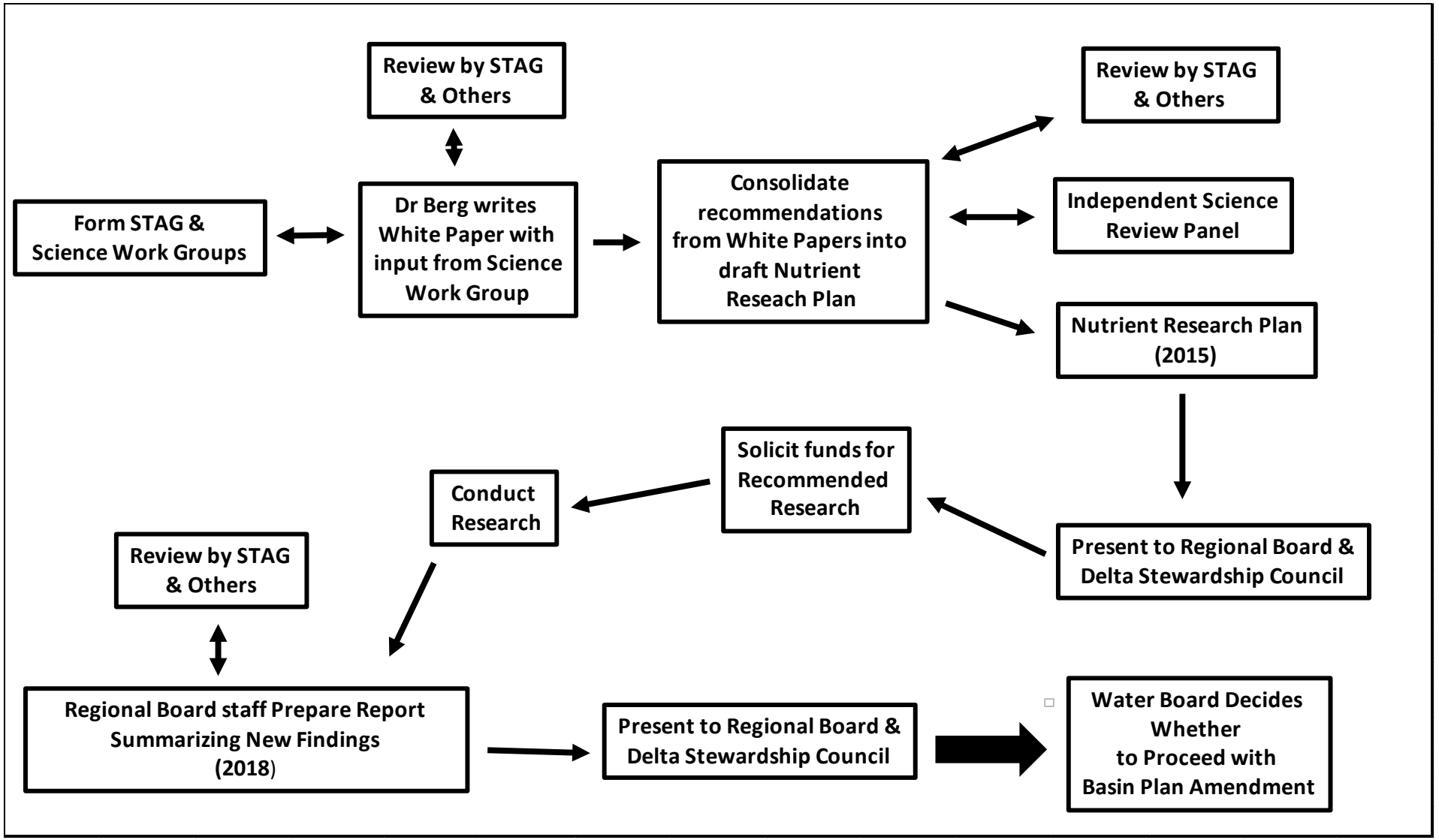
Meeting Context: The Central Valley Water Board is developing a research plan to scope the need for nutrient objectives for the Delta. Cyanobacteria blooms are one of three areas of potential impairment that could be linked to nutrients. A literature review was commissioned to review the factors that could influence the presence of cyanobacterial blooms in the Delta and a conceptual model was developed.

Meeting Goal: The purpose of this meeting is to provide an opportunity for the Cyanobacteria Science Work Group members to review the draft and provide feedback.

Time	Item
10:00 – 10:10	Basic Housekeeping Information 1) Lunch Selection from pre-selected menu (cash only) if you did not bring your own lunch
10:10 – 10:30	Introduction, Charge and Meeting Goals 1) Introduce Science Work Group Members 2) Overview of the Charge 3) Review Agenda
10:30 – 12:00	Presentation of Literature Review Conceptual Model and Findings
12:00 – 12:45	Working Lunch
12:45 – 2:00	Continuation of Feedback on Literature Review
2:00 –2:15	Break
2:15 – 3:20	Modeling Discussion 1) Discuss Model Parameters and Model Needs
3:20 – 4:00	Wrap Up, Action Items, Schedule Next Meeting 1) Wrap up Discussion with Key Points 2) Review Action Items 3) Schedule Next Meeting

Cyanobacteria Science Work Group Meeting
CyanoHAB Literature Review

3 April 2015


Review by STAG & Others
Review by STAG & Others
Form STAG & Science Work Groups
Dr Berg writes White Paper with input from Science Work Group
Consolidate recommendations from White Papers into draft Nutrient Reseach Plan
Independent Science Review Panel
Nutrient Research Plan (2015)
Solicit funds for Recommended Research
Conduct Research
Present to Regional Board & Delta Stewardship Council
Review by STAG & Others
Regional Board staff Prepare Report Summarizing New Findings (2018)
Present to Regional Board & Delta Stewardship Council
Water Board Decides Whether to Proceed with Basin Plan Amendment

Key Question

Do you agree that nutrient management is not going to reduce the frequency or magnitude of cyanobacteria blooms or toxin production in the Delta now or in the foreseeable future?

Questions?

Mine Berg
Applied Marine Sciences
Martha Sutula
Southern California Coastal Water Research Project

Factors Affecting Growth of Cyanobacteria

With special emphasis on the Sacramento-San Joaquin Delta region

Goals of the Review

- Provide a basic review of biological and ecological factors that influence the growth of cyanobacteria and the production of cyanotoxins
- Summarize observations of cyanobacterial blooms and associated toxins in the Delta
- Synthesize literature to provide an understanding of what ecological factors, including nutrients, may be at play in promoting cyanobacterial blooms in the Delta

Overview of Presentation

- Key Findings
- Recommendations

Findings

I. Five Principal Drivers of CyanoHABs
II. CyanoHAB Trends and the Role of Nutrients Vs Other Factors Cannot Be Discerned in the Delta
III. Current Risk to Delta Ecosystem Services is Likely Low
IV. Climate Change and Anthropogenic Activity can potentially Increase CyanoHABs

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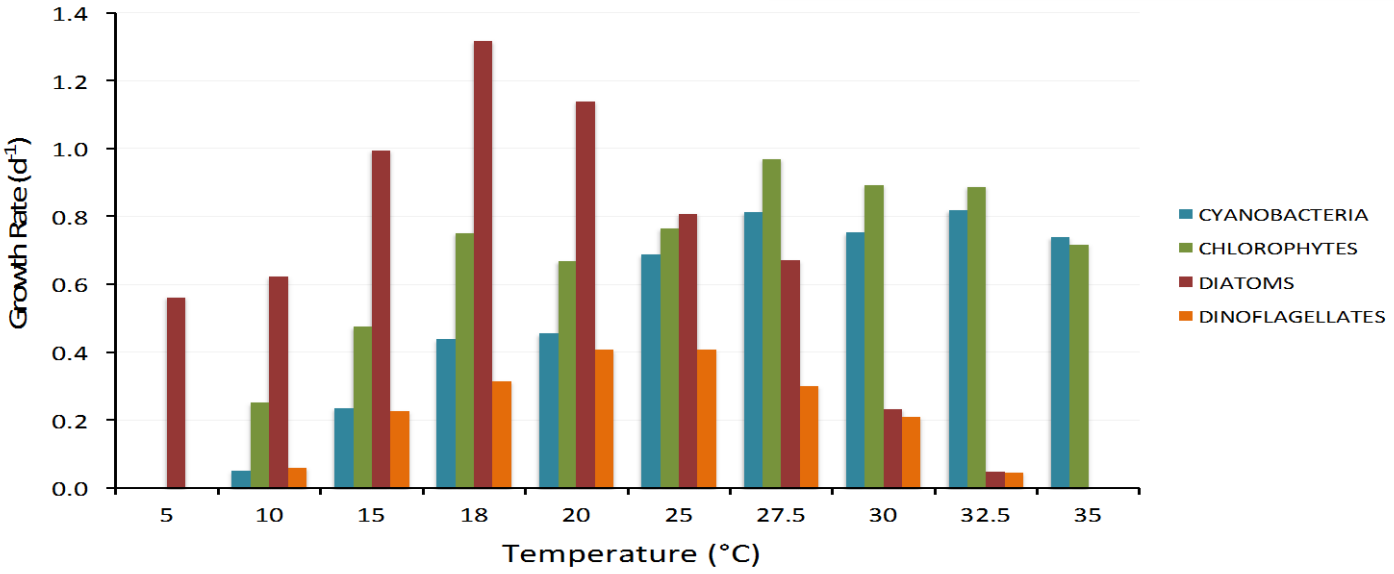
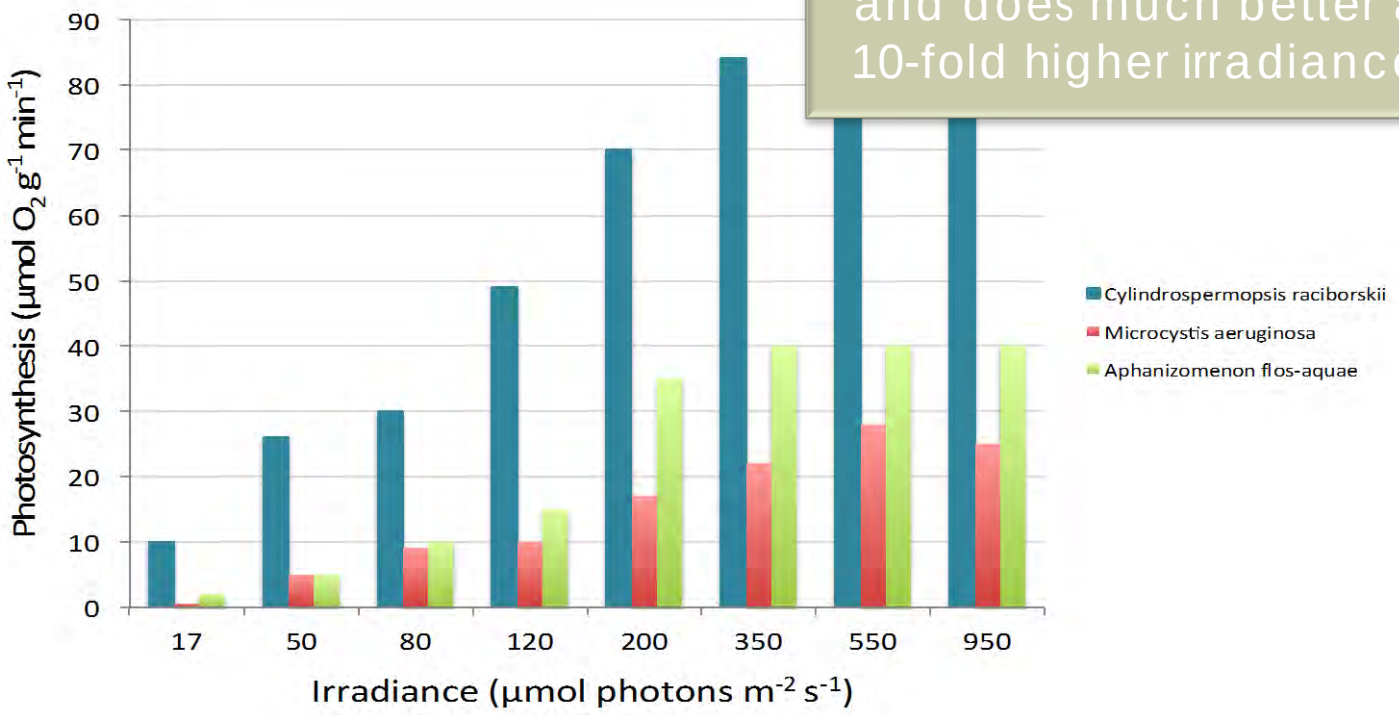
1. Temperature

Cyanobacterial growth rates catch up with diatom growth rates at 25°C

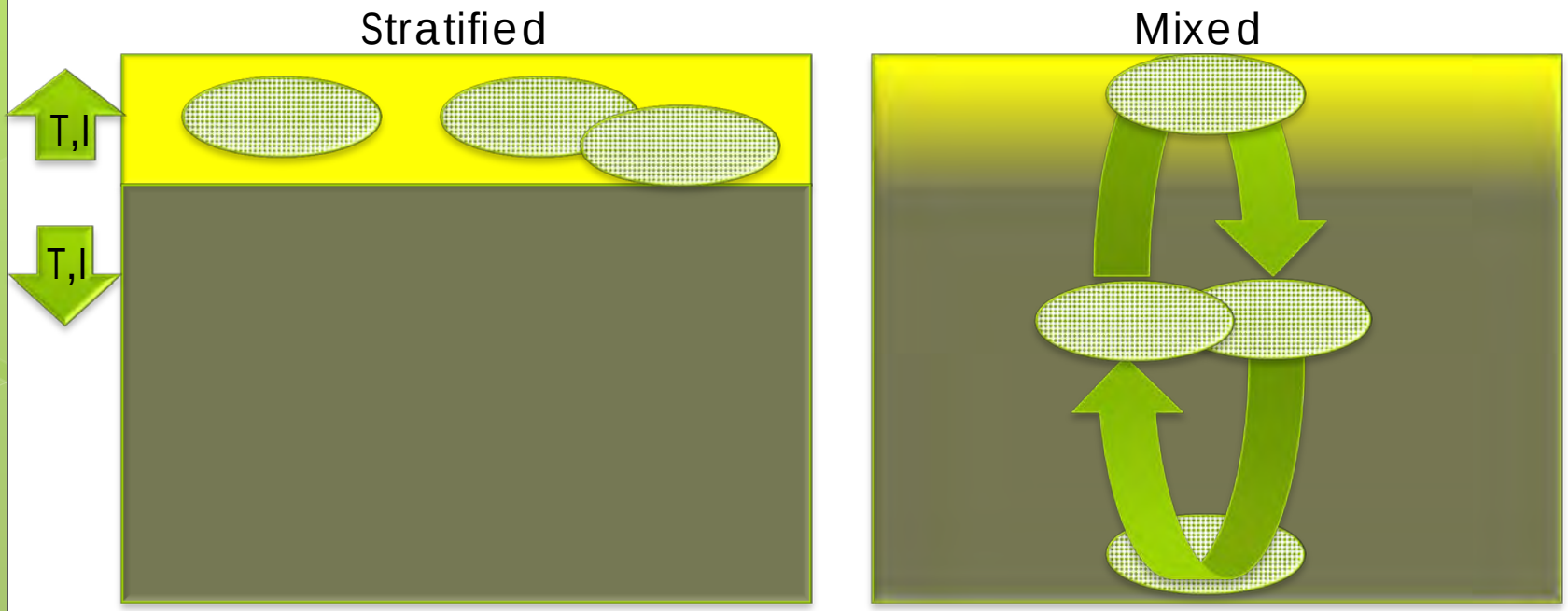


2. Irradiance and water clarity

Microcystis cannot grow below 50 µmol phot m^{-2} s^{-1}, and does much better at 10-fold higher irradiances

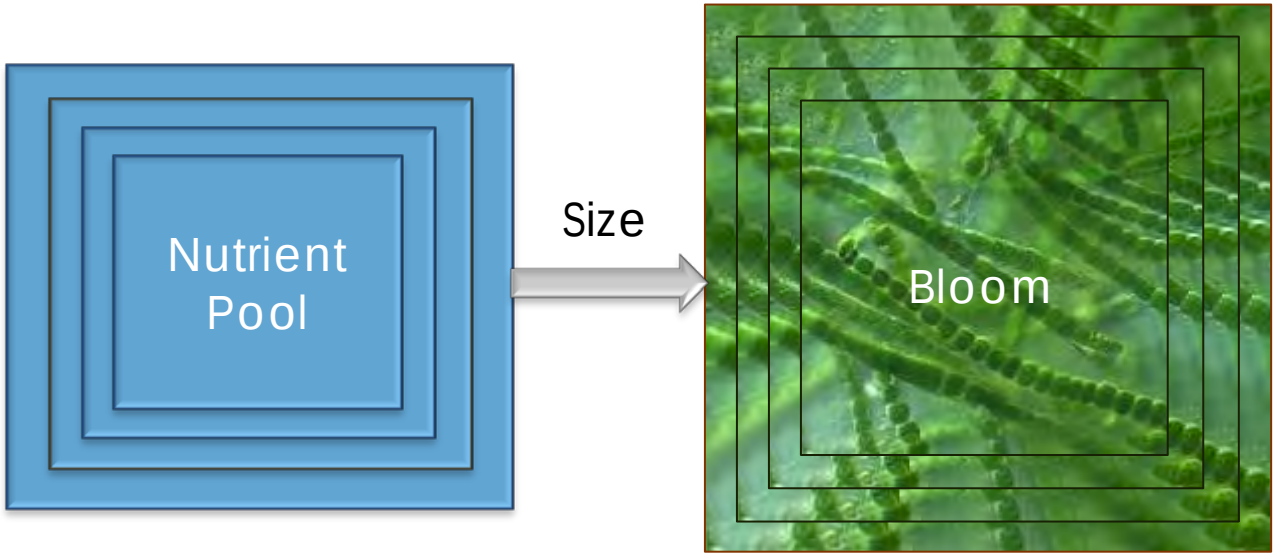


3. Stratified Water Column and Long Residence Times



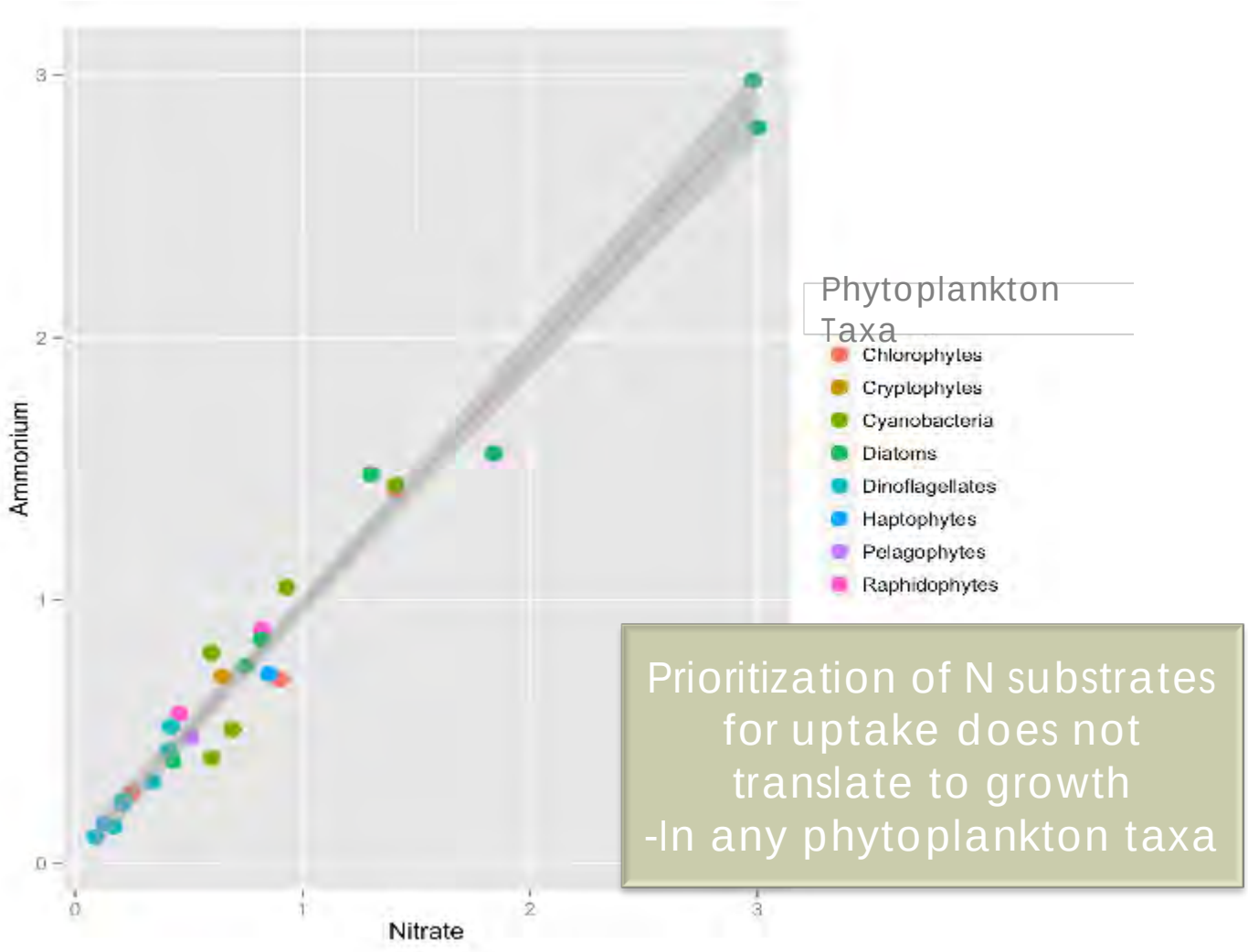
Rapid water flow and mixing in the Delta reduces stratification, warming of water, and light availability
-Providing a natural breaking mechanism of cyanoHABs

4. Availability of Nutrients



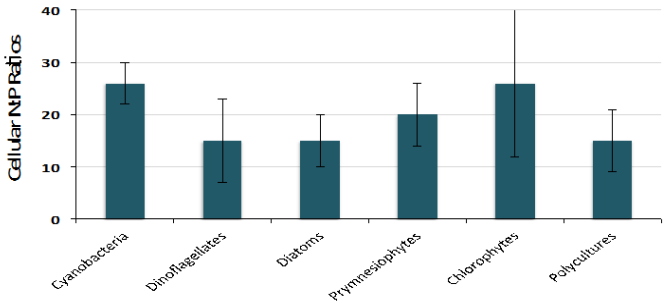
The size of the nutrient pool will determine the size of the bloom *IF* other factors are not limiting growth

4b. Impact of different N sources



Prioritization of N substrates for uptake does not translate to growth
-In any phytoplankton taxa

4c. Impact of high cellular N:P Ratio



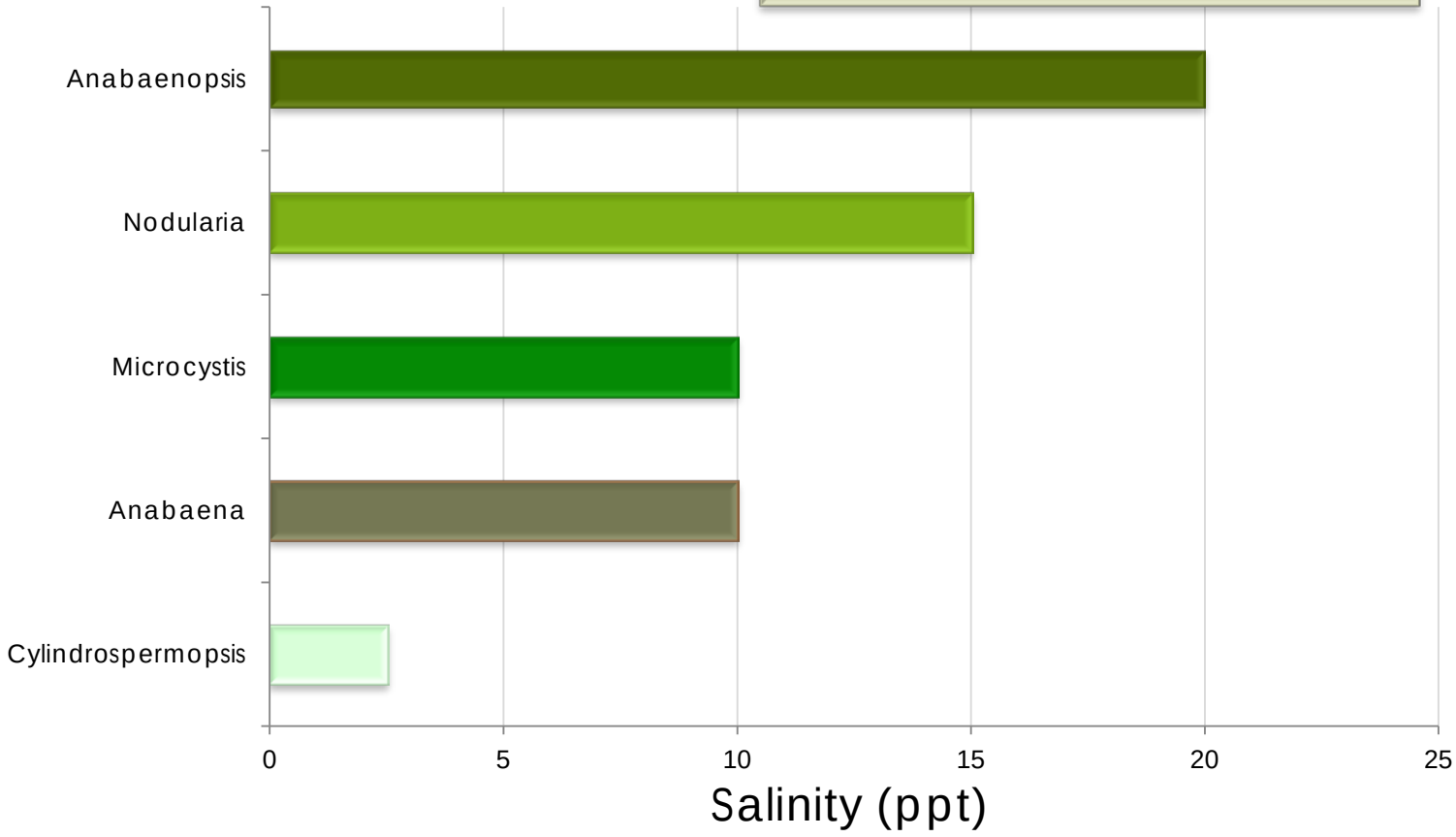
Need N in excess of the Redfield Ratio

Only partially offset by N_2 fixation; no more than 20% of total N demand

Decrease in P only, or increase in N, may not reduce cyanoHABs

5. Salinity

Salinities below 10 ppt promote growth of cyanoHAB species observed in the Delta



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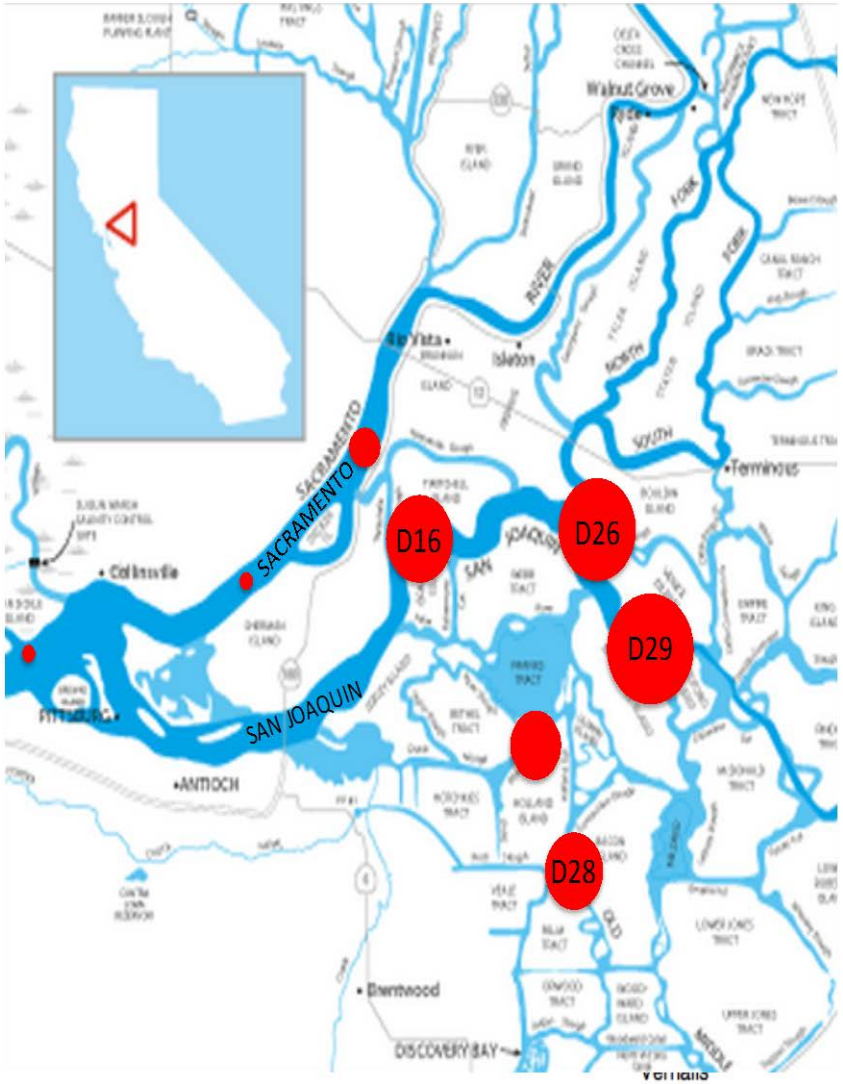
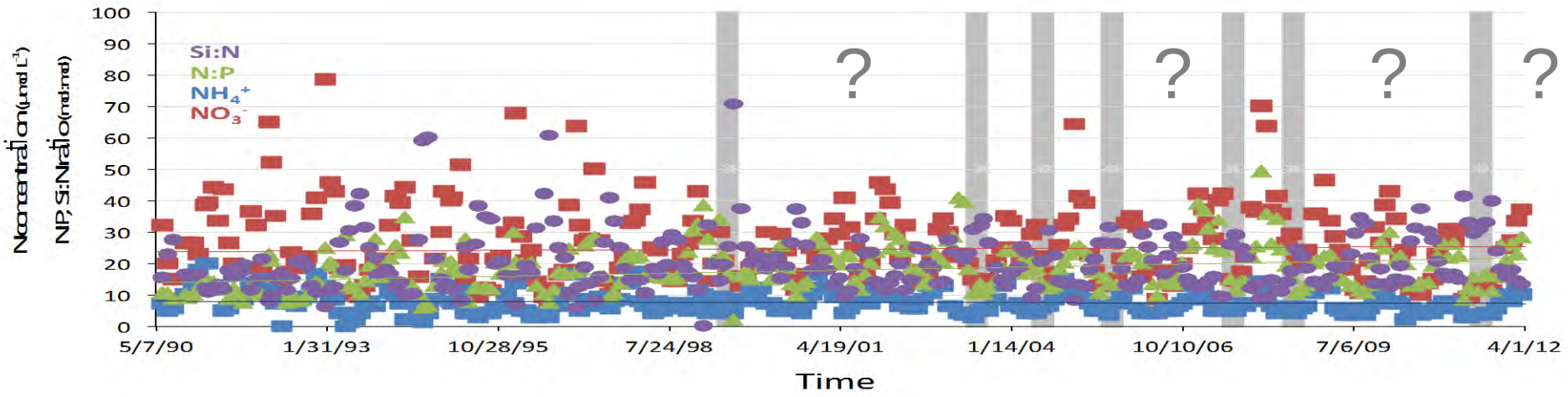
Distribution in the Delta



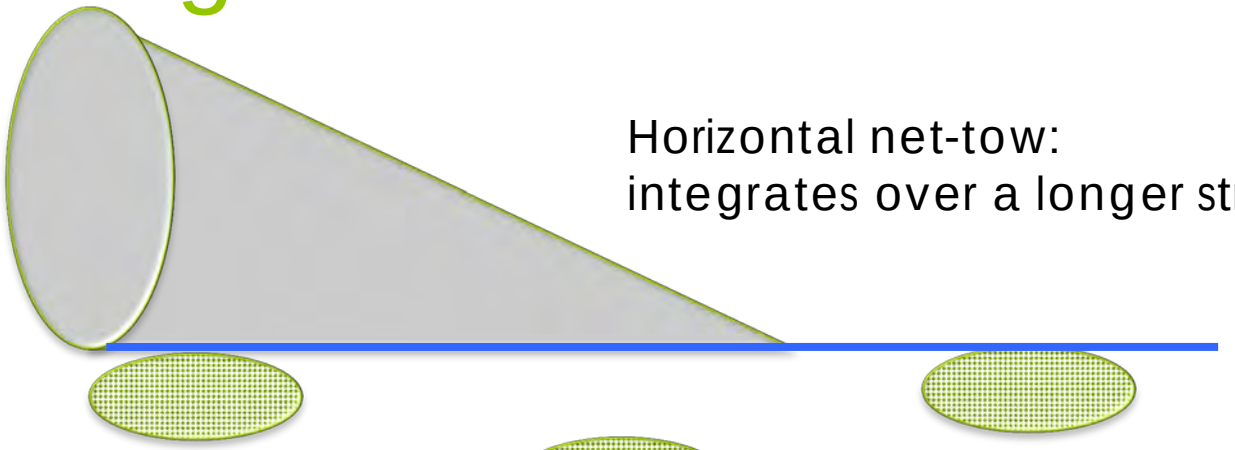
Largest bubble is 0.5 µg Chl a L^{-1}

D26 Long-term Nutrient Record:

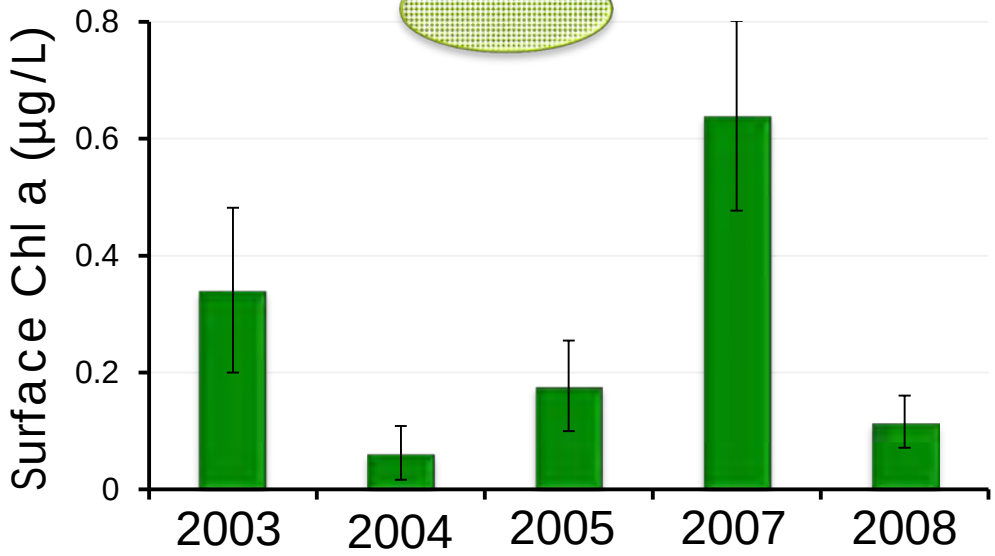
PDO Sign Change



Integrated surface Chl *a*:



Horizontal net-tow:
integrates over a longer stretch



<1µg Chl a L^{-1}

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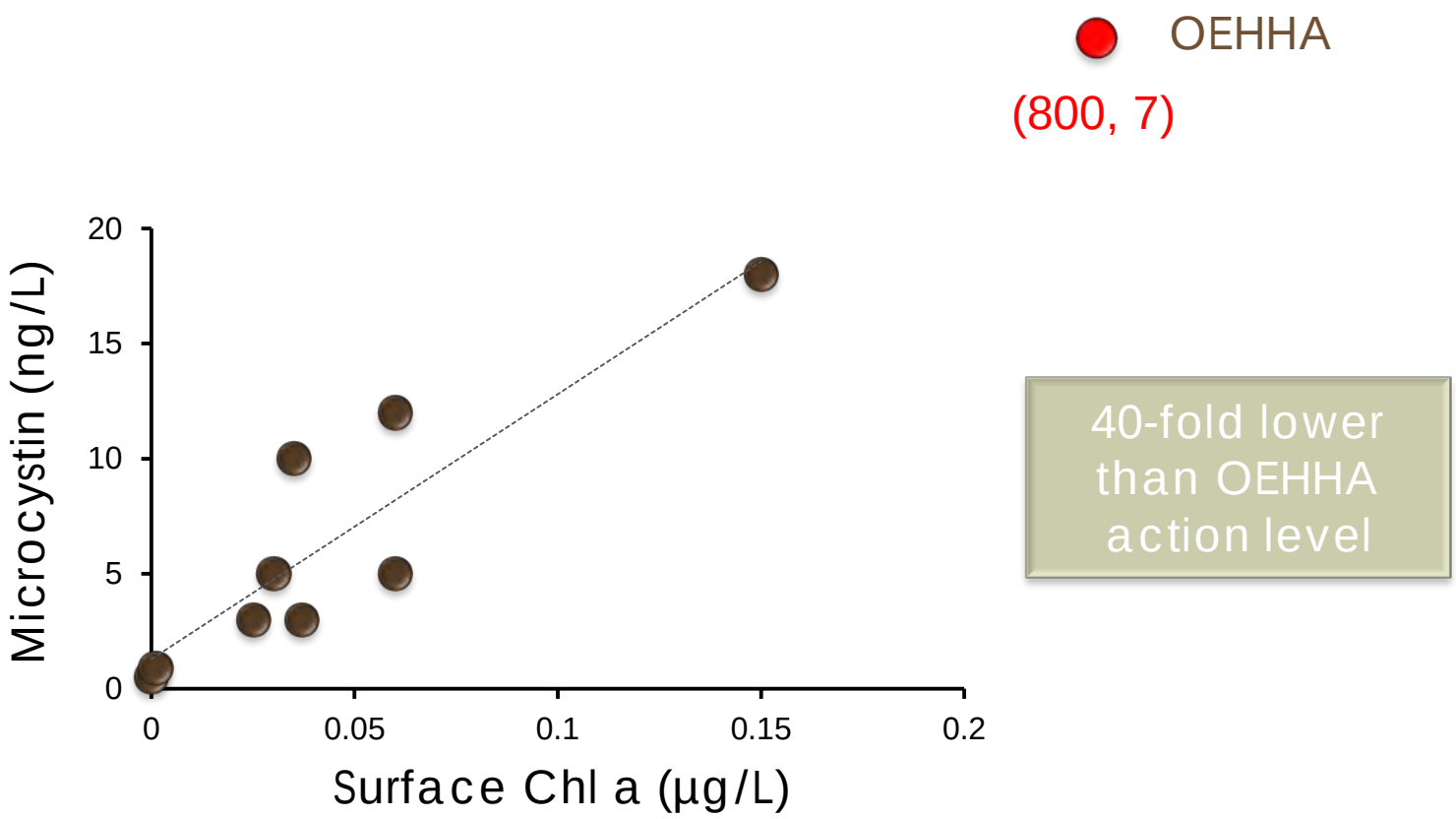
Microcystin toxin levels as a function of surface Chl *a*:



40-fold lower than OEHHA action level

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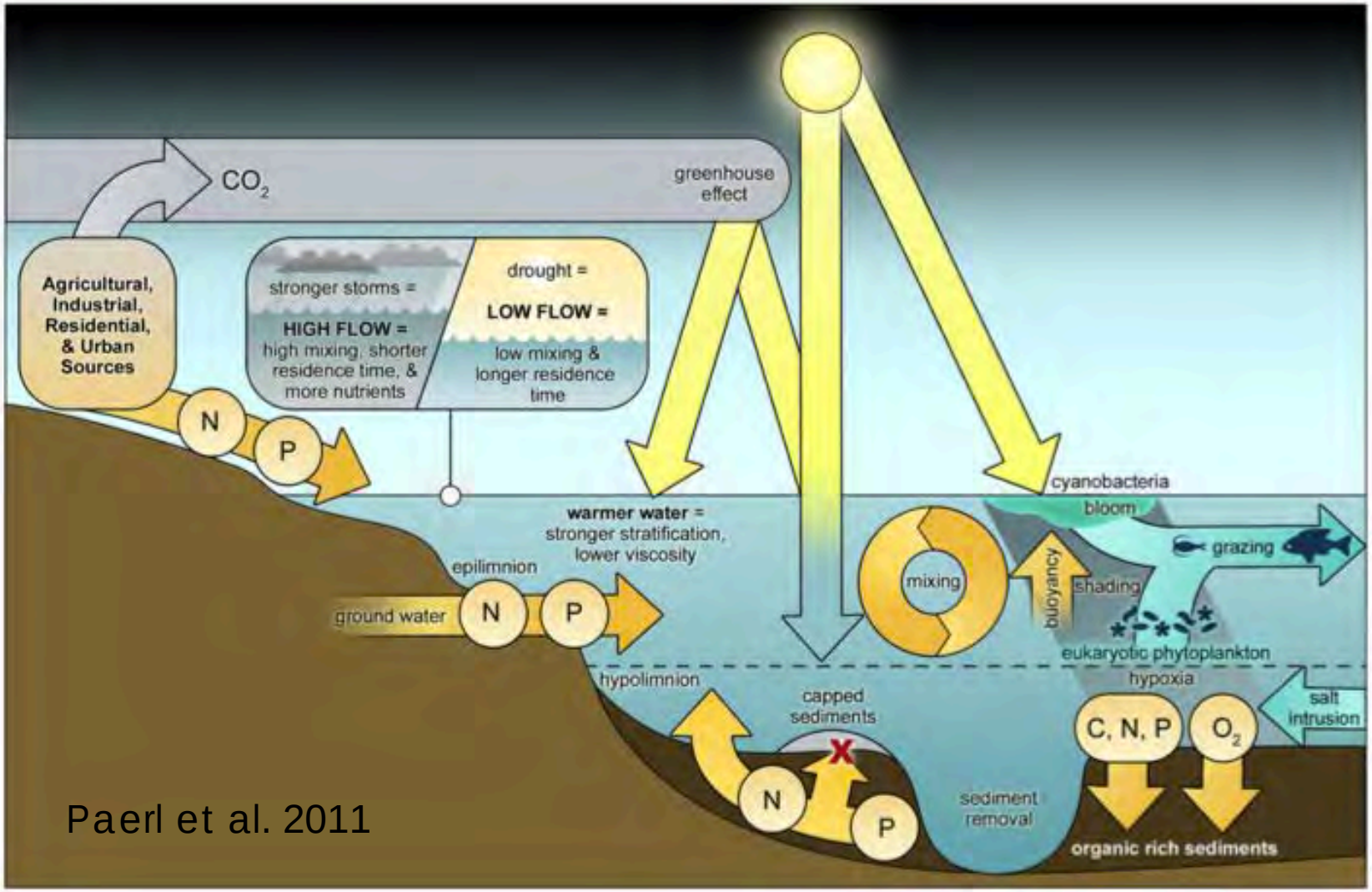
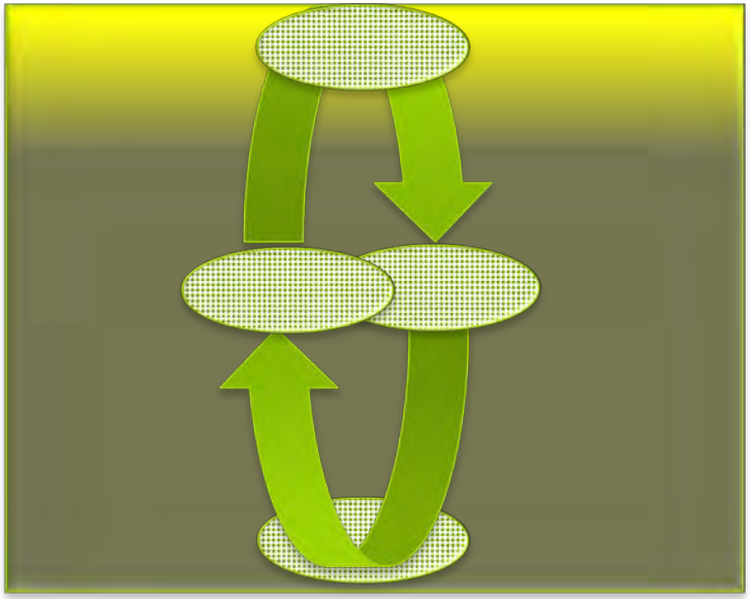
Climate Change:



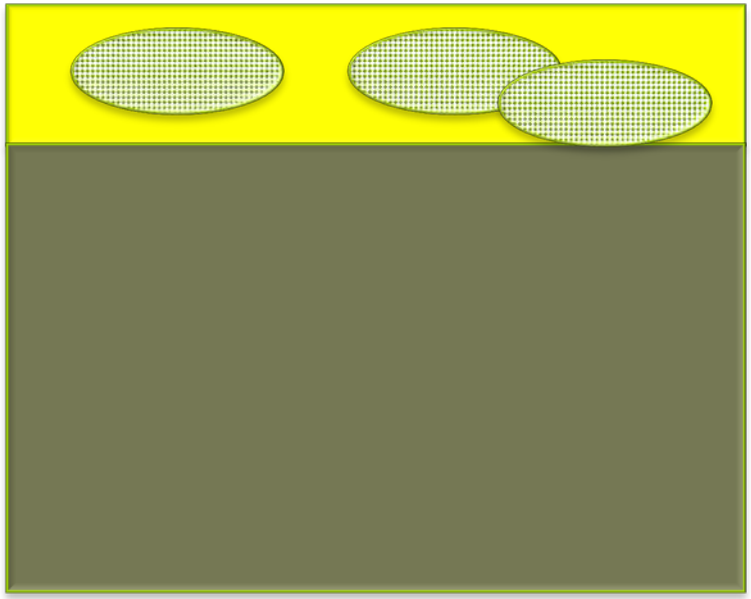
Paerl et al. 2011

Anthropogenic Activity:

Mixed (currrent)



Stratified (future)



Discussion and Consensus on Key Findings?

- **Five principal drivers emerged as important determinants of CyanoHABs in a review of the global literature.**
- **Spatio-temporal trends and an understanding of the role of nutrients vis-à-vis other environmental factors in influencing cyanoHABs in the Delta is severely hampered by the lack of routine monitoring data.**
- **Based on existing data, the current risk of cyanoHABs to Delta ecosystem services appears to be on the lower end of the spectrum.**
- **Climate change and anthropogenic activity associated with land use changes have the potential to alter cyanoHAB prevalence in the Delta in the future.**

Overview of Presentation

- Key Findings
- Recommendations

Recommendations:

- Perform trend analyses of nutrients with other environmental variables over time at key stations in the Delta
- Start to monitor surface Chl *a* at key stations in the Delta
- Input existing and future monitoring data into an ecosystem model to characterize risk of cyanoHABs under various scenarios

Discussion & Consensus on Recommendations

- Do you agree with recommendations?

Cyanobacteria Science Work Group Meeting
Modeling

3 April 2015

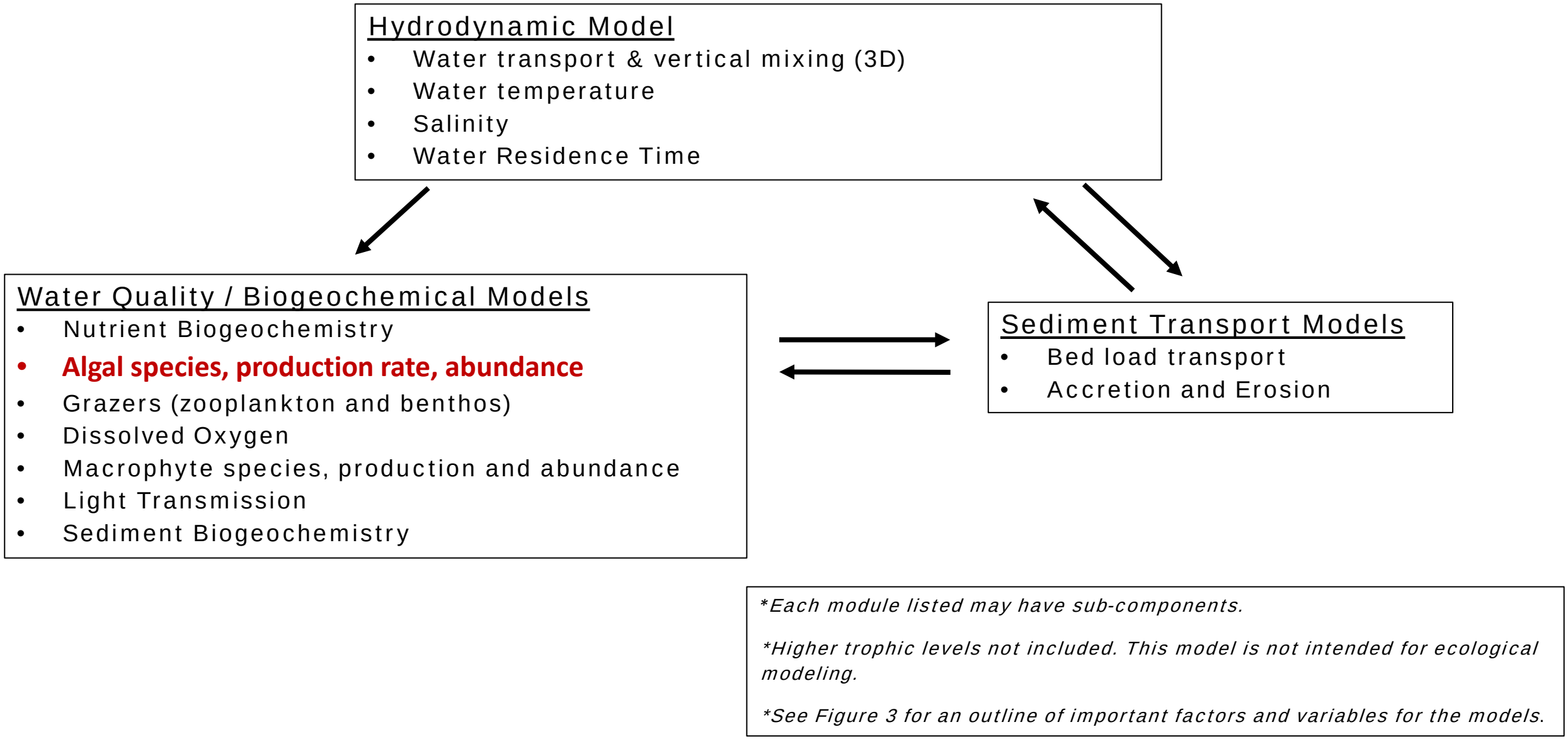


Figure 2. Preliminary framework for the hydrodynamic, water quality/biogeochemical, and sediment transport models and sub-models needed to inform nutrient-related questions. Others researchers may use the model to investigate non-nutrient related issues.

Current Nutrient Sources, Hydrodynamic Transport and Rates of Transformation	
1	What are the main sources and loads of nutrients to the Delta now?
2	How much do nutrient loads from known sources contribute to ambient nutrient concentrations in different sections of the Delta by season?
3	Do the models indicate that all the major sources of nutrients to the Bay are accurately being measured?
4	What are the important processes that transport and transform nutrients in the Delta and what are the rates at which these processes occur?
Which Factors are Most Important	
4	What are the main factors* affecting: • The algal biomass and primary production rates; • The algal species composition; • The distribution and abundance of macrophyte species; • The magnitude and frequency of cyanobacteria and diatom blooms. • How does the relative importance of these factors vary with space & time?
Effects of Nutrient Load Reductions	
5	After the already permitted reductions in nutrient loads from NPDES dischargers have been implemented: a) What will be the main sources of nutrients in the Delta? b) What will be the new ambient nutrient concentrations in different sections of the Delta in each season? c) How much will nutrient loads from known sources contribute to ambient nutrient concentrations in different sections of the Delta by season?

6	After the already permitted reductions in nutrient loads from NPDES dischargers have been implemented, what changes are expected for: • The algal biomass and primary production rates; • The algal species composition; • The distribution and abundance of macrophyte species; • The magnitude and frequency of cyanobacterial and diatom blooms. How will these changes vary with space and time?
Effects of Long-Term Climate and Hydrology Changes	
7	What effect will predicted climate change, changes in Delta hydrology, and wetland restoration have on the following effects (1) under current nutrient loads and (2) under a future predicted nutrient load scenario: • The algal biomass and primary production rates; • The algal species composition; • The distribution and abundance of macrophyte species; and • The magnitude and frequency of cyanobacterial and diatom blooms?

Questions?