# Habitat, water quality, nutrients, and tidal dispersion

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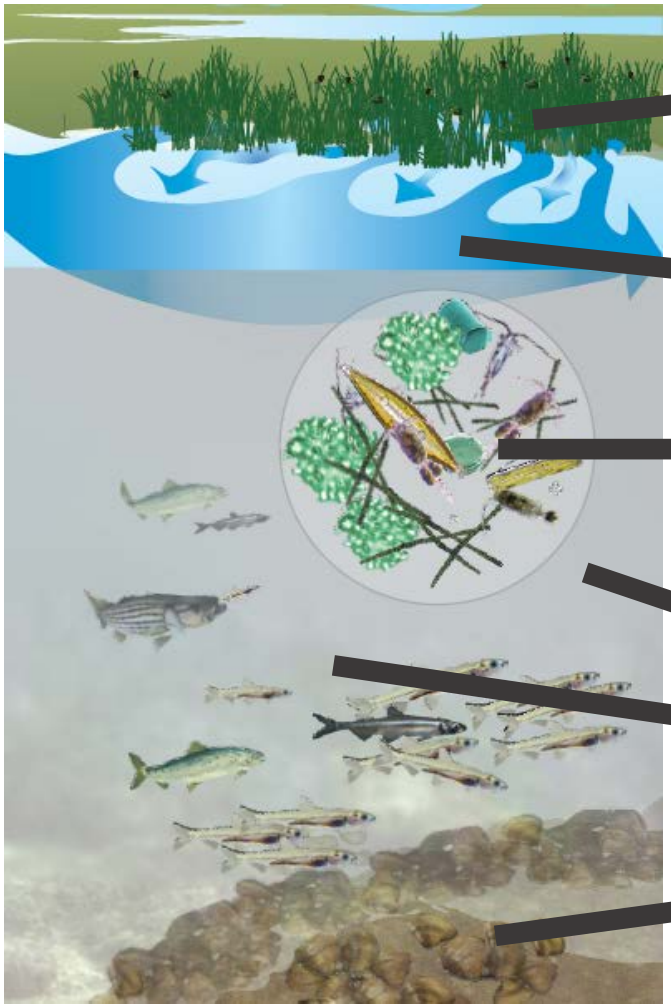
# The Charge

- What are the effects of altered interior Delta flows on other parts of the ecosystem such as phytoplankton, zooplankton, and benthos?
- How do non-flow stressors such as … physical habitat … and water quality interact with interior Delta flows to affect [native fish]?
- What metrics … are most useful to assess, predict and manage impacts to fish and the ecosystem?

# Topics (with apologies)



- Wetlands and shallow water environments
- Advective and dispersive flows. Residence time
- Phytoplankton and zooplankton
- Water quality and nutrients
- Water depth and channel geometry
- Clams
- Drinking water quality

# Topics

- Phytoplankton (zooplankton food)
- Nutrients
- Drinking water quality (Dissolved Organic Carbon and Bromide)

# Cross cutting issues

- Residence time
- Tidal interaction with wetlands
- Flow, velocity, mixing, and channel geometry
- Benthos

# Conclusions

Everything you change about flows……

……..changes the water and habitat quality

When flows change, we don't know enough to….

……predict……..or model…..

…….changes in water and habitat quality

We need to monitor the changes……

……on the timescales over which changes occur

# Nitrate Variability – San Joaquin River

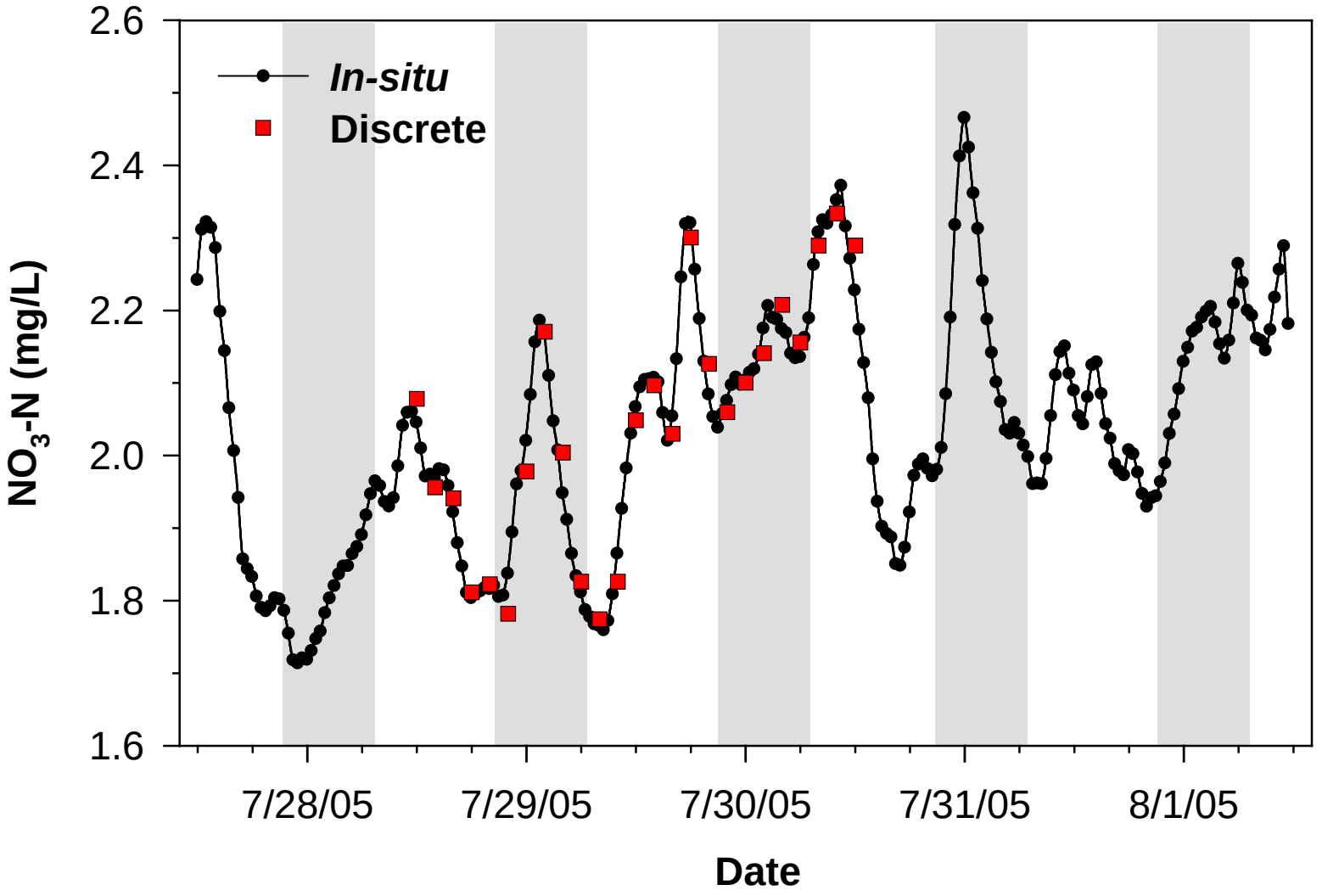
Assessing nitrate variability in the San Joaquin River, Crows Landing, CA
(Satlantic ISUS nitrate analyzer)




Pellerin et al., 2009

# Nitrate Variability – San Joaquin River

Assessing diurnal nitrate variability in the San Joaquin River, Crows Landing, CA
(Satlantic ISUS nitrate analyzer)

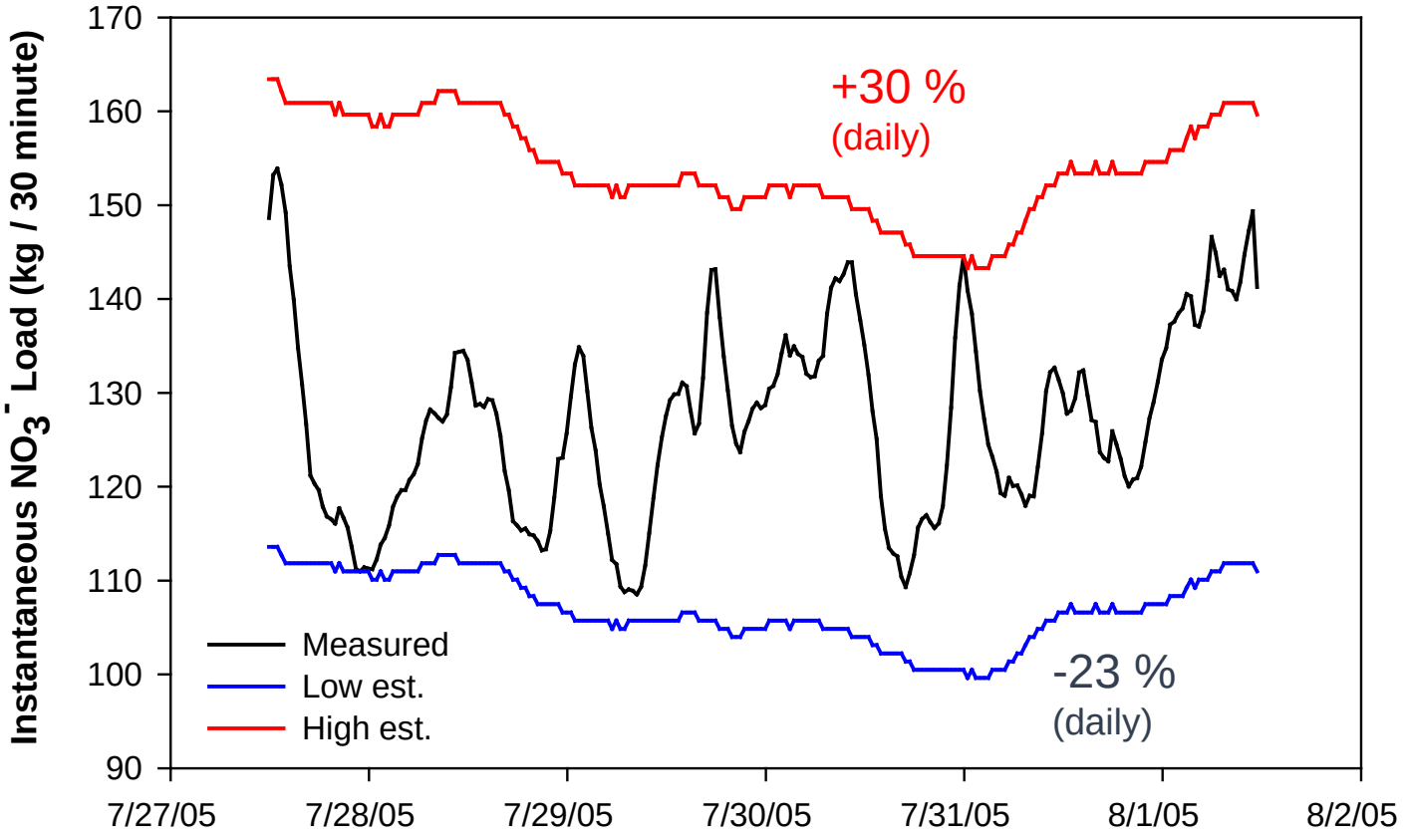



Pellerin et al., 2009

# Nitrate Loads – San Joaquin River

Difference in instantaneous and cumulative nitrate load at Crows Landing during the study period. **Daily loads were -23 to +30 % relative to measured load** using continuous data.

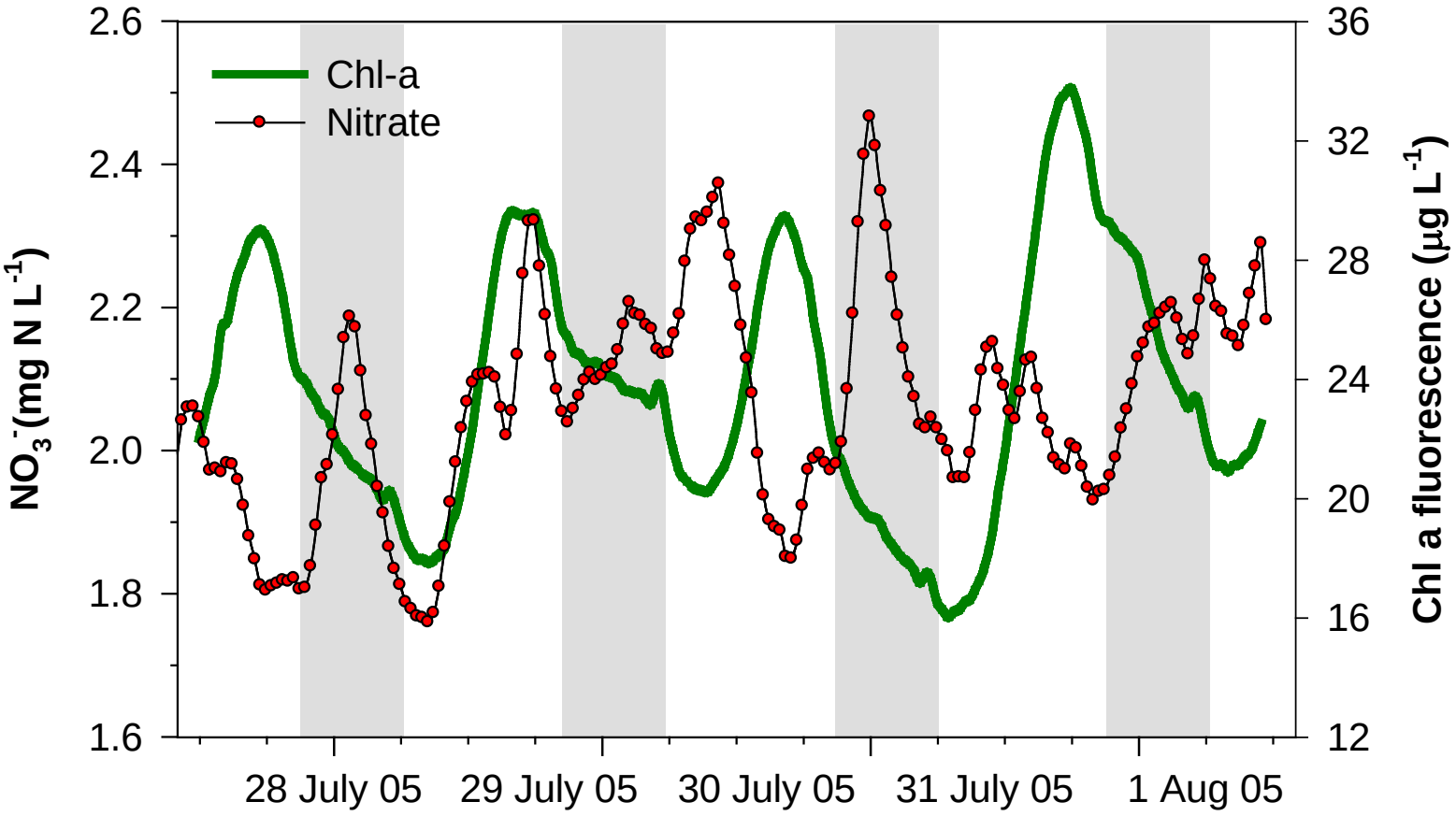
| | Daily Load (kg nitrate / day) | | | % Difference | |
|---|---|---|---|---|---|
| | Measured | Low est. | High est. | Low est. | High est. |
| **28-Jul** | 5875 | 5305 | 7631 | -10 | 30 |
| **29-Jul** | 6563 | 5064 | 7284 | -23 | 11 |
| **30-Jul** | 6160 | 4956 | 7130 | -20 | 16 |
| **31-Jul** | 6047 | 5024 | 7228 | -17 | 20 |




Pellerin et al., 2009

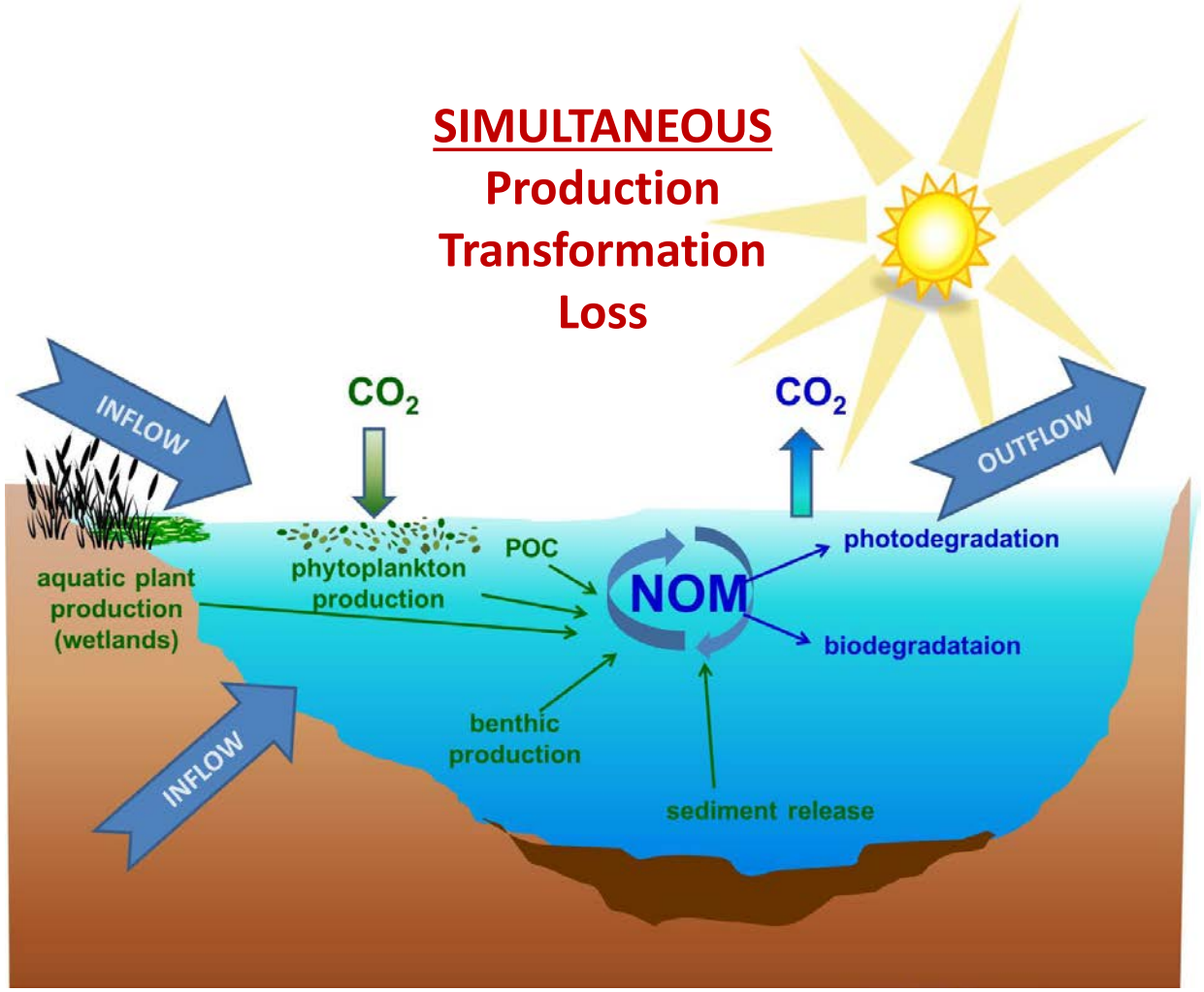
# Drivers of nitrate variability - SJR

Combination of discrete and in situ data show high biological activity in the SJR (*right*); evidence for link between $NO_3^-$ is not simple.




Pellerin et al., 2009

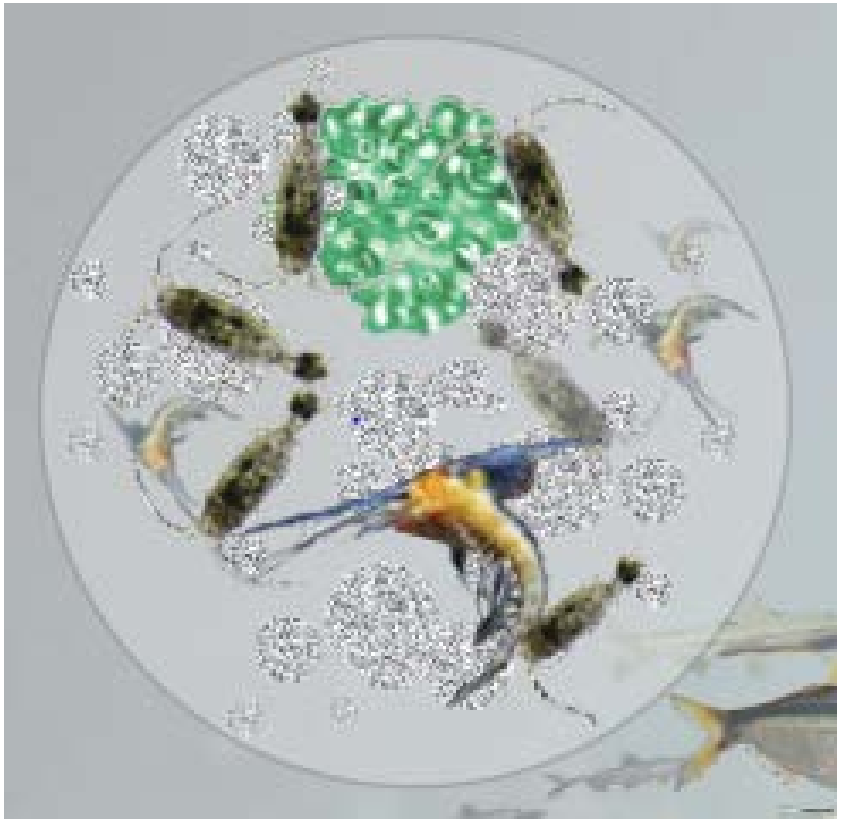
# What affects biogeochemical processes?




Biology
Weather
Flow
Water depth
Tidal Exchange
Diurnal cycles
Temperature
Light
Nutrients
Sediment
Waste water content
Contaminants
Etc.

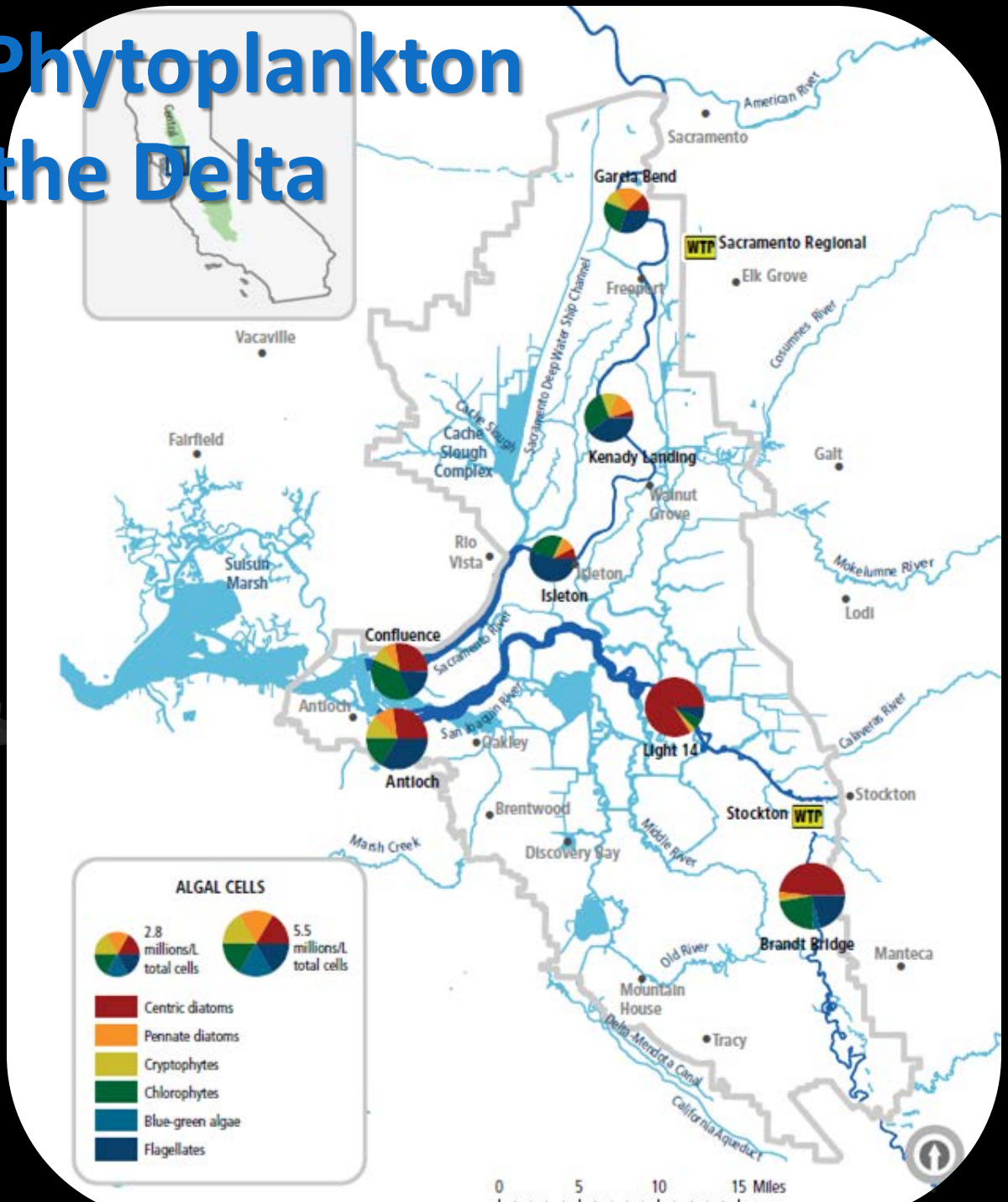
# What you need to know about Phytoplankton

- Phytoplankton are not all equal - Different phytoplankton support different parts of the foodweb
- Affected by residence time
- Affected by clams
- Compete for nutrients with wetlands



# Nutrients and Phytoplankton Production in the Delta

Credit: Alex Parker




*From Pulse of the Estuary 2012; Based on Kress 2012*

# What you need to know about Nutrients

- Nutrients needed for phytoplankton production
- Nutrients needed for wetland production
- Too many nutrients leads to eutrophication, HABs, DO problems
- Too few nutrients lead to fewer phytoplankton

# Nutrients can change the foodweb

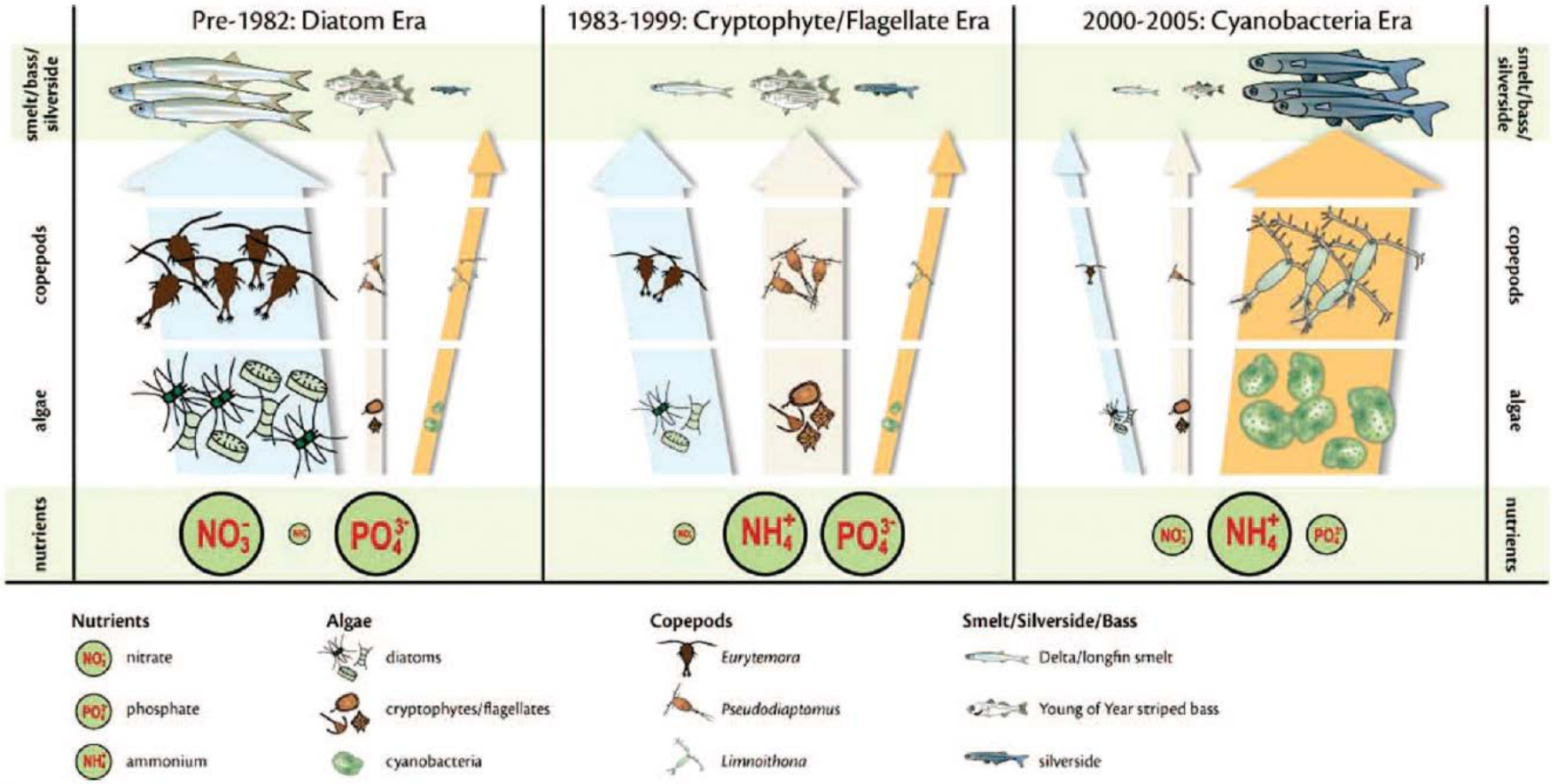
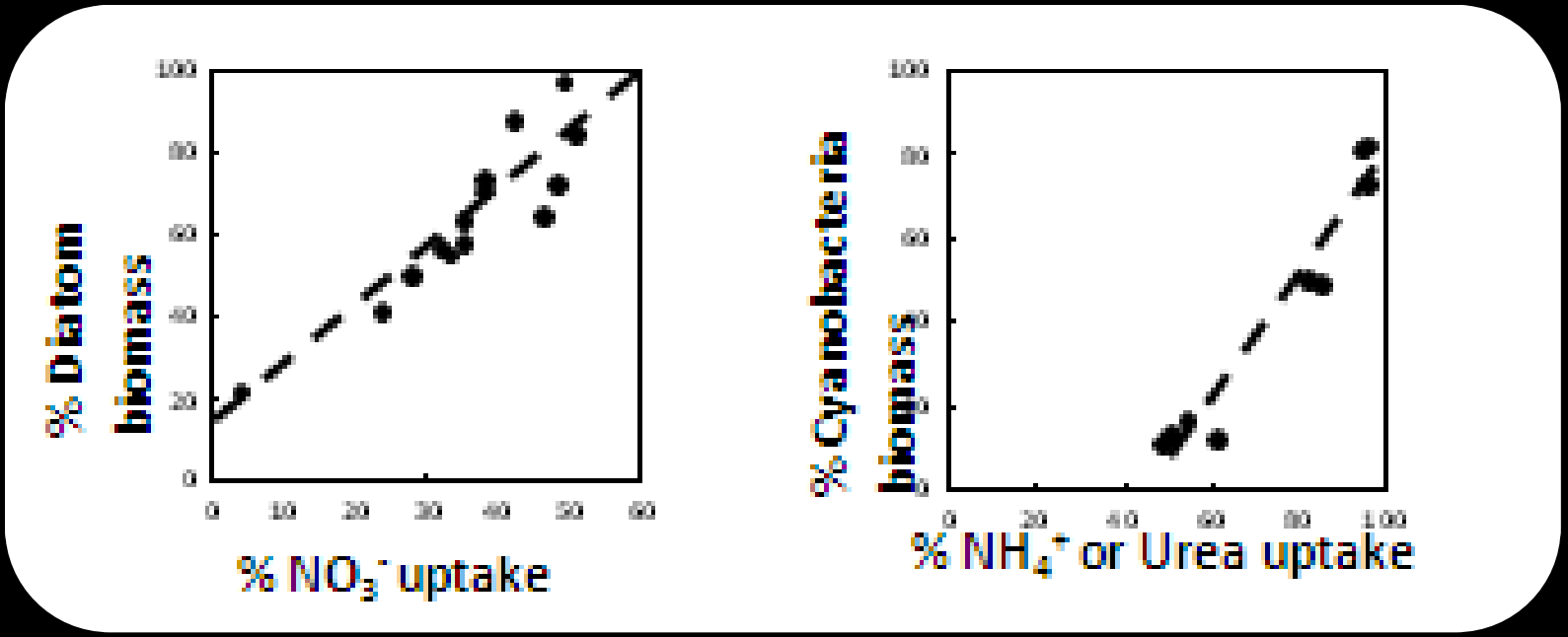



**Figure 23** Conceptual diagram of some of the hypothesized changes in the food chain from phytoplankton to fish that have occurred in the Sacramento-San Joaquin Estuary over the past 30 years. Each of these hypothesized food chains has different dominant nitrogen forms or amounts relative to phosphorus. This conceptual model is intended simply to highlight some of the major flows of energy and materials and does not include all organisms, pathways or flows. The size of the symbols is meant to infer relative importance.

Glibert 2010

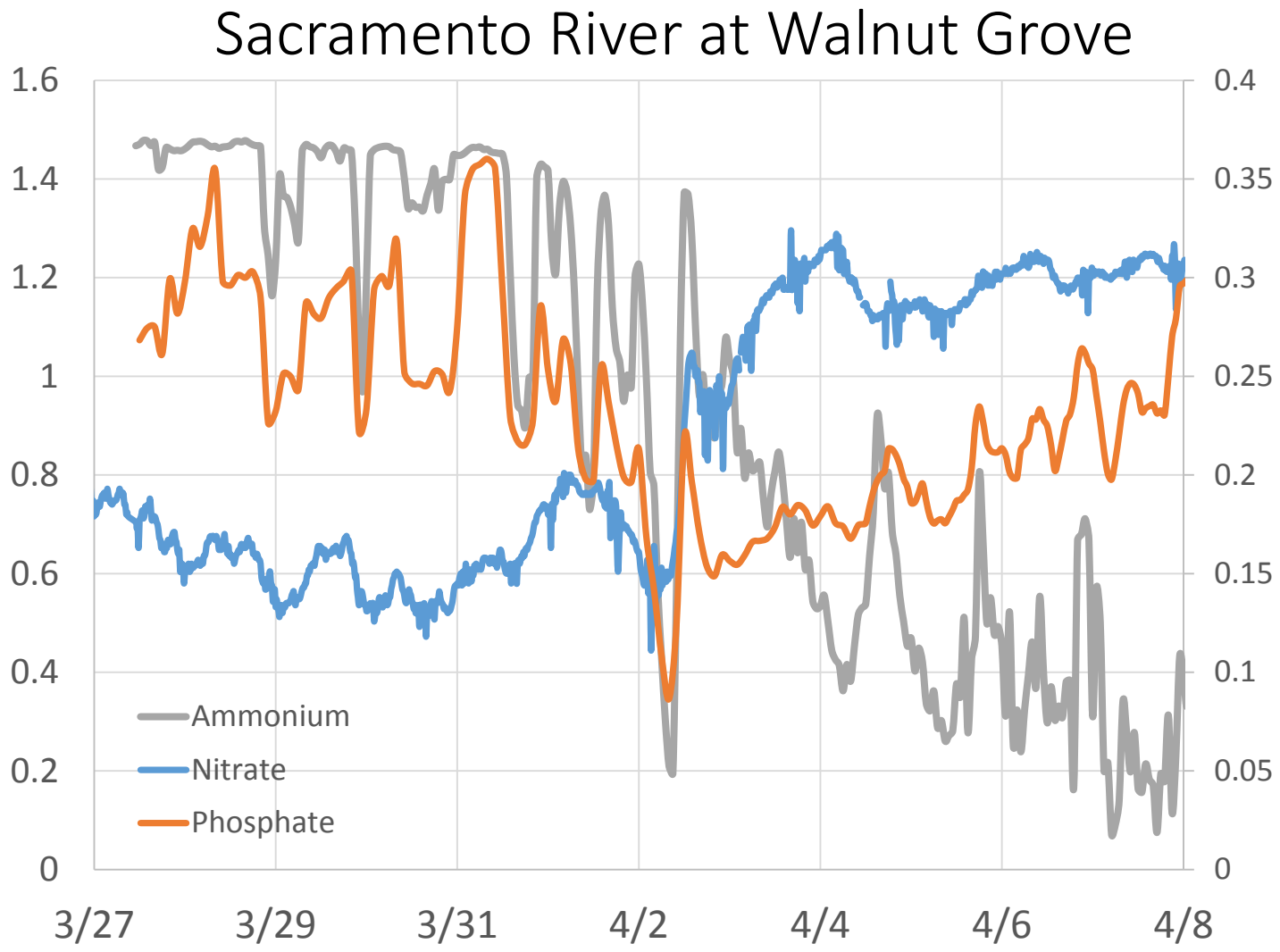
# Nutrients and Phytoplankton Production in the Delta




*Heil, Revilla, Glibert, Murasko*

Credit: Alex Parker

# Nutrient concentrations and ratios change rapidly



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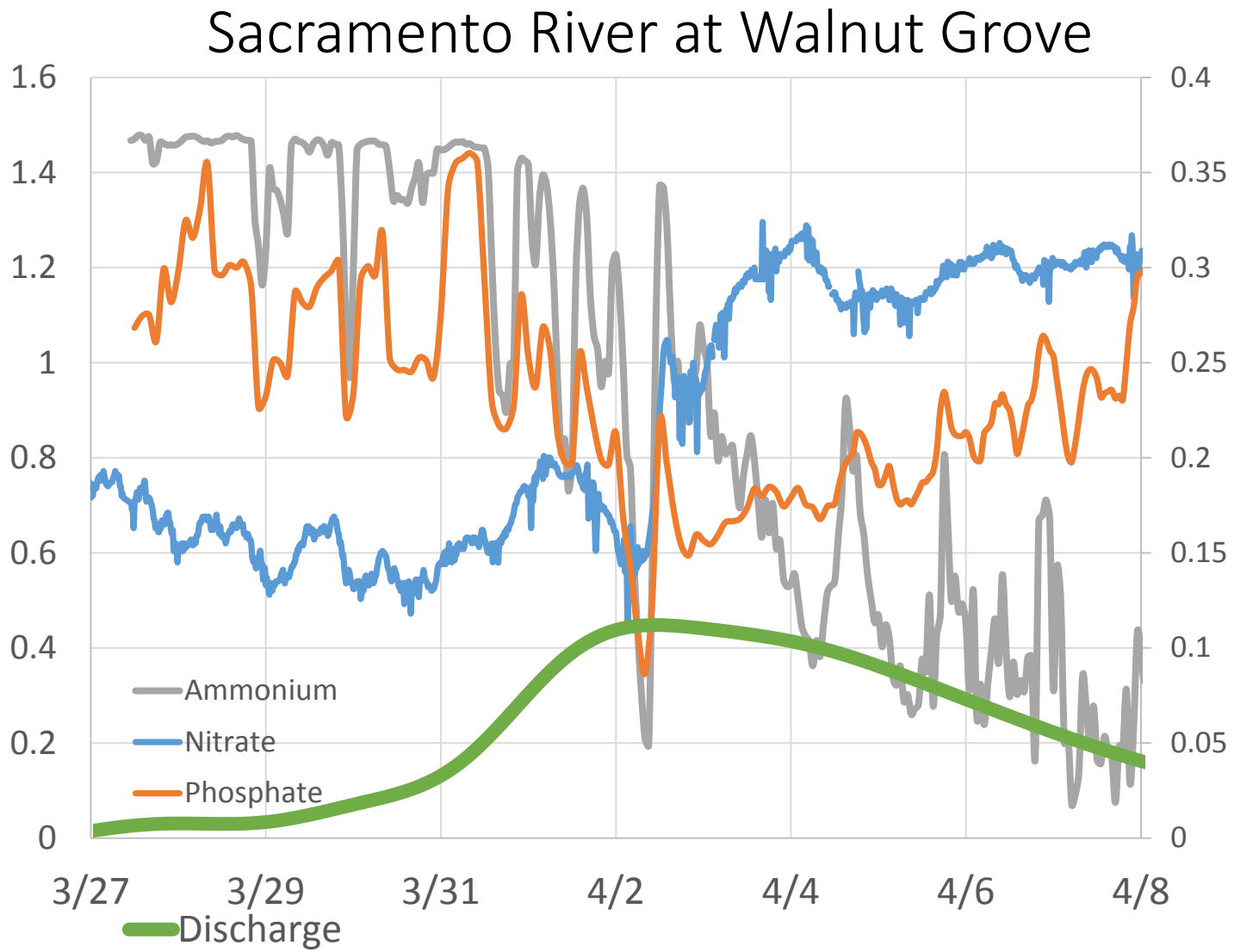
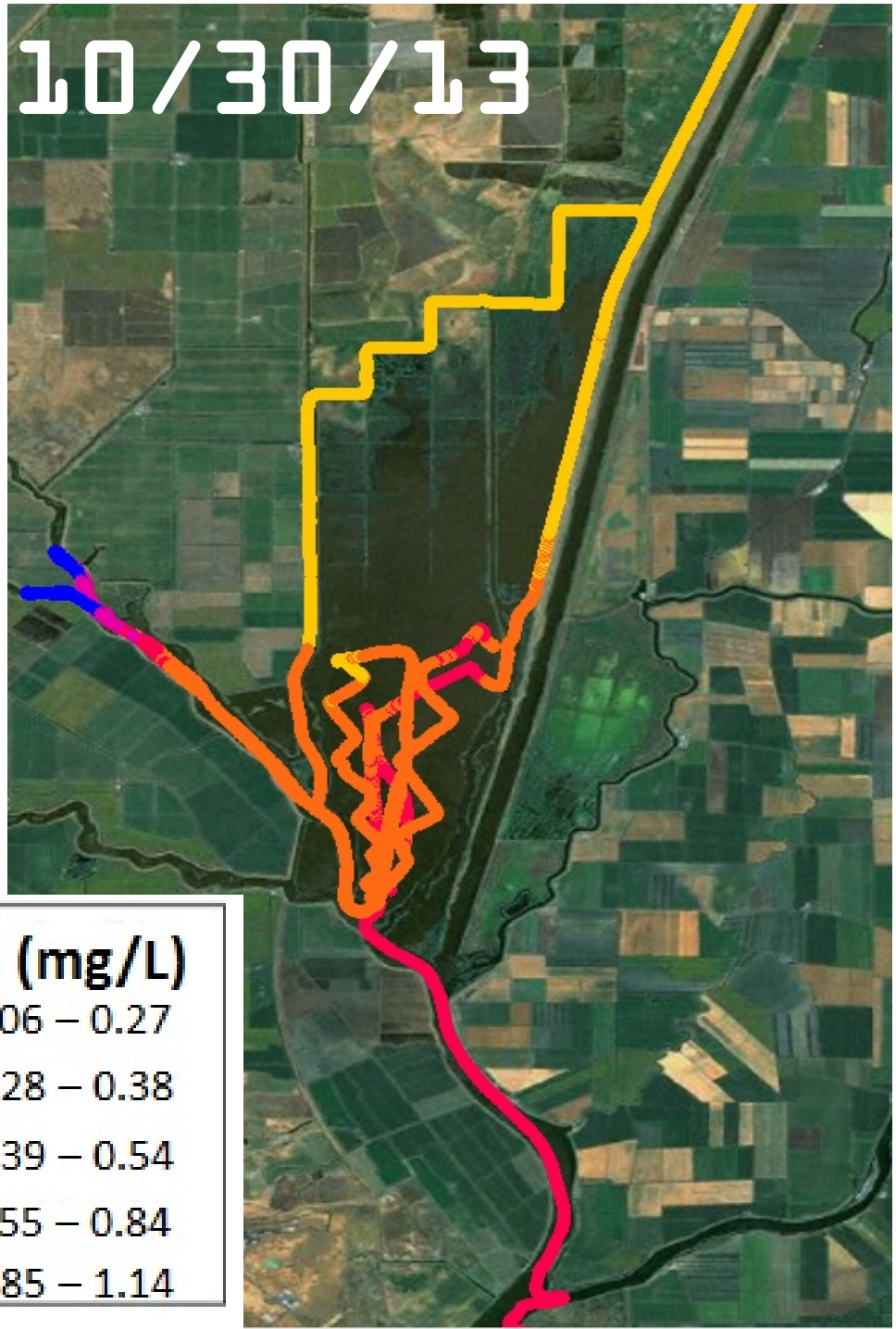


Nutrient concentrations and ratios change vary in space

Cache Slough Complex

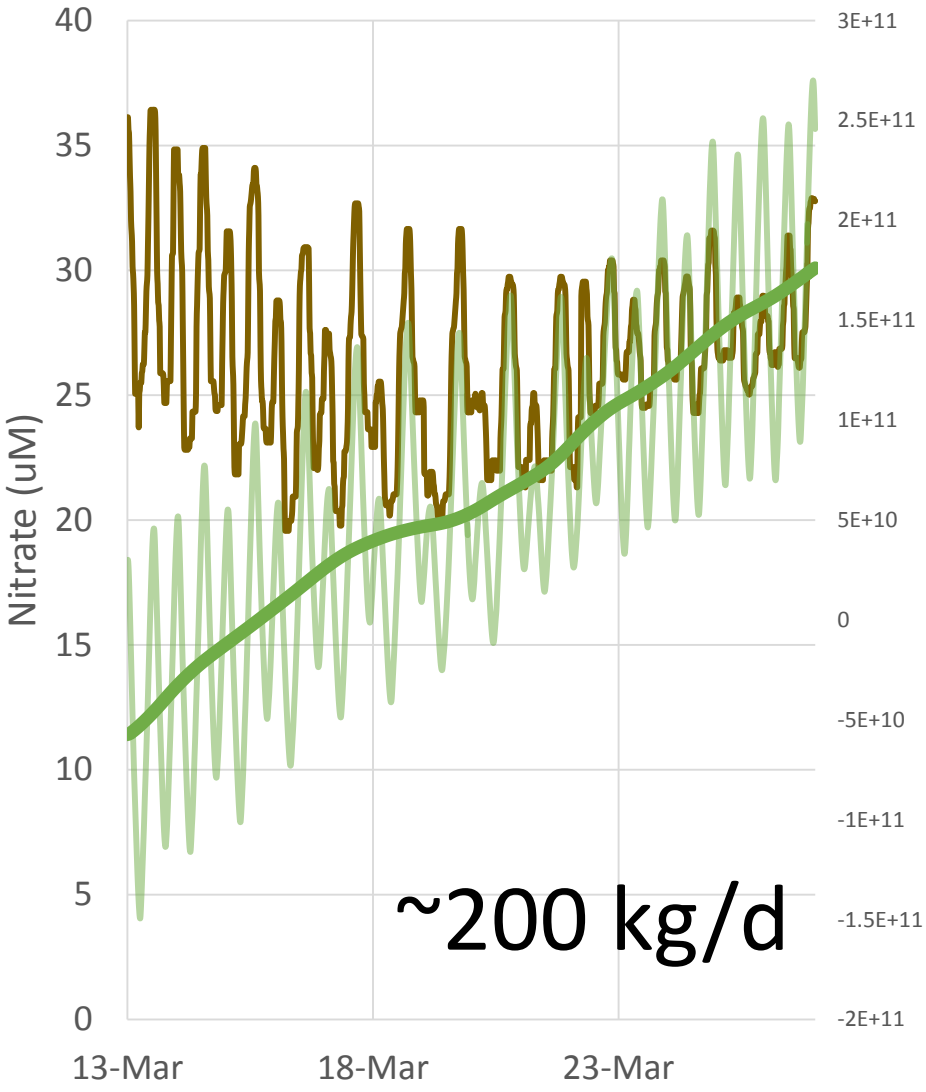
What long residence time does to nutrients

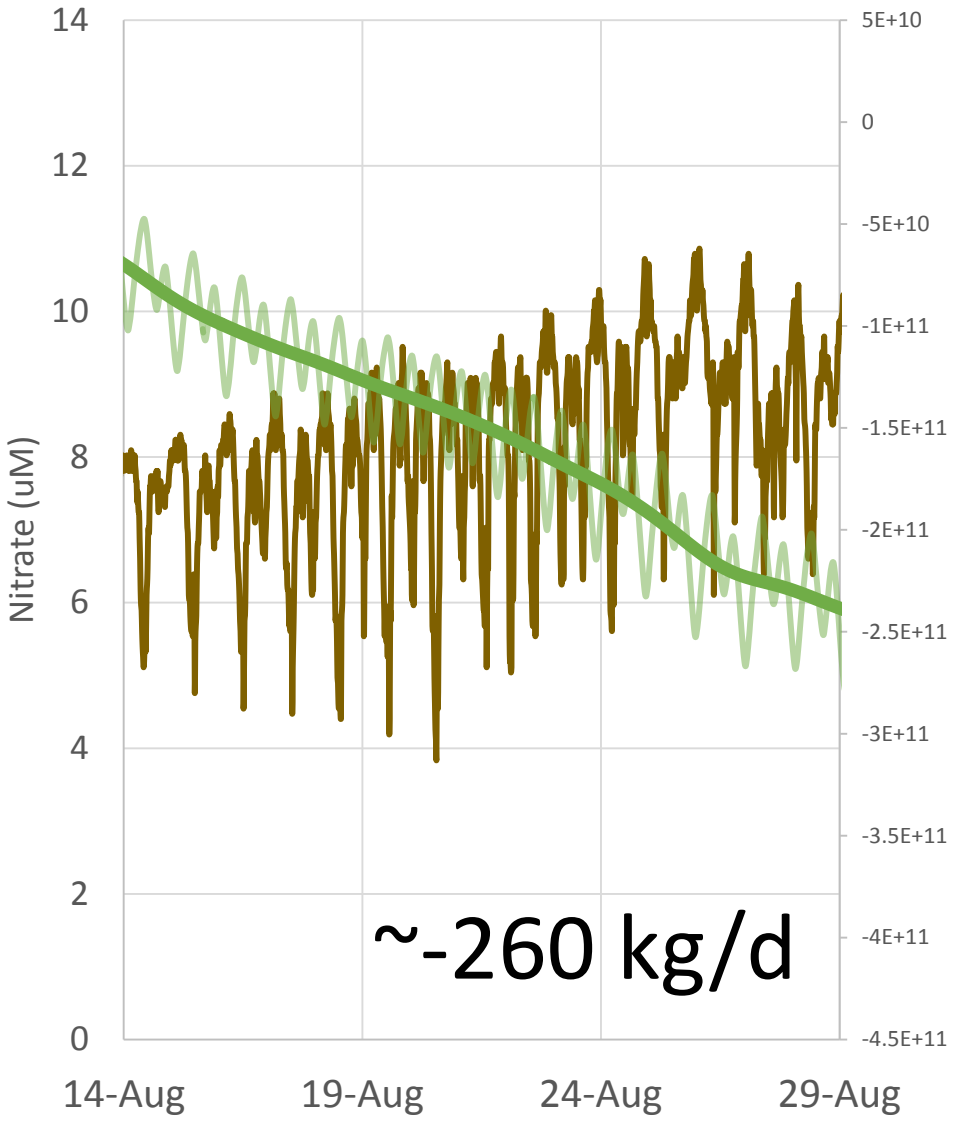


# What you need to know about wetlands

- Wetlands can be sources or sinks of nutrients
- Wetlands can be sources or sinks of phytoplankton and zooplankton
- Wetlands can switch from a source to a sink rapidly and unpredictably

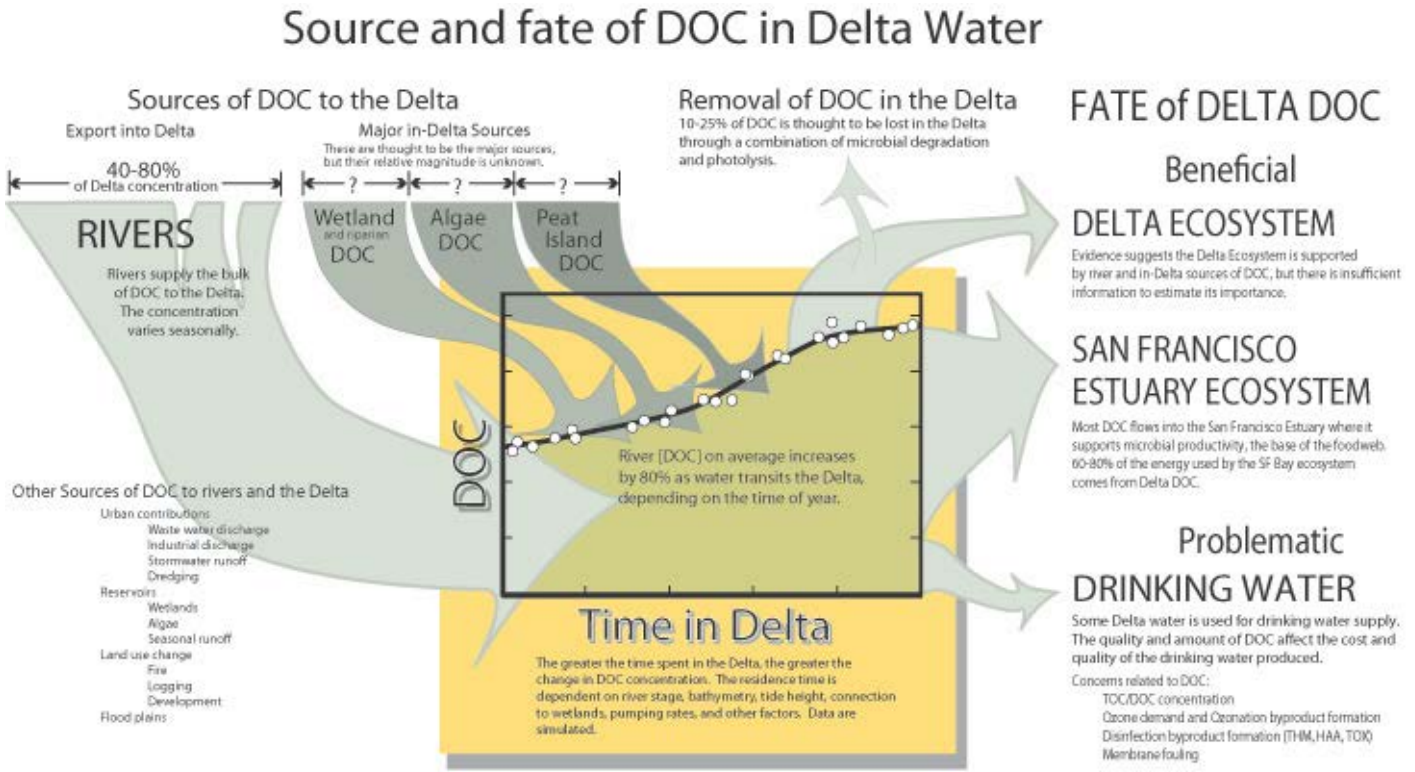
# Liberty Island Nitrate Flux



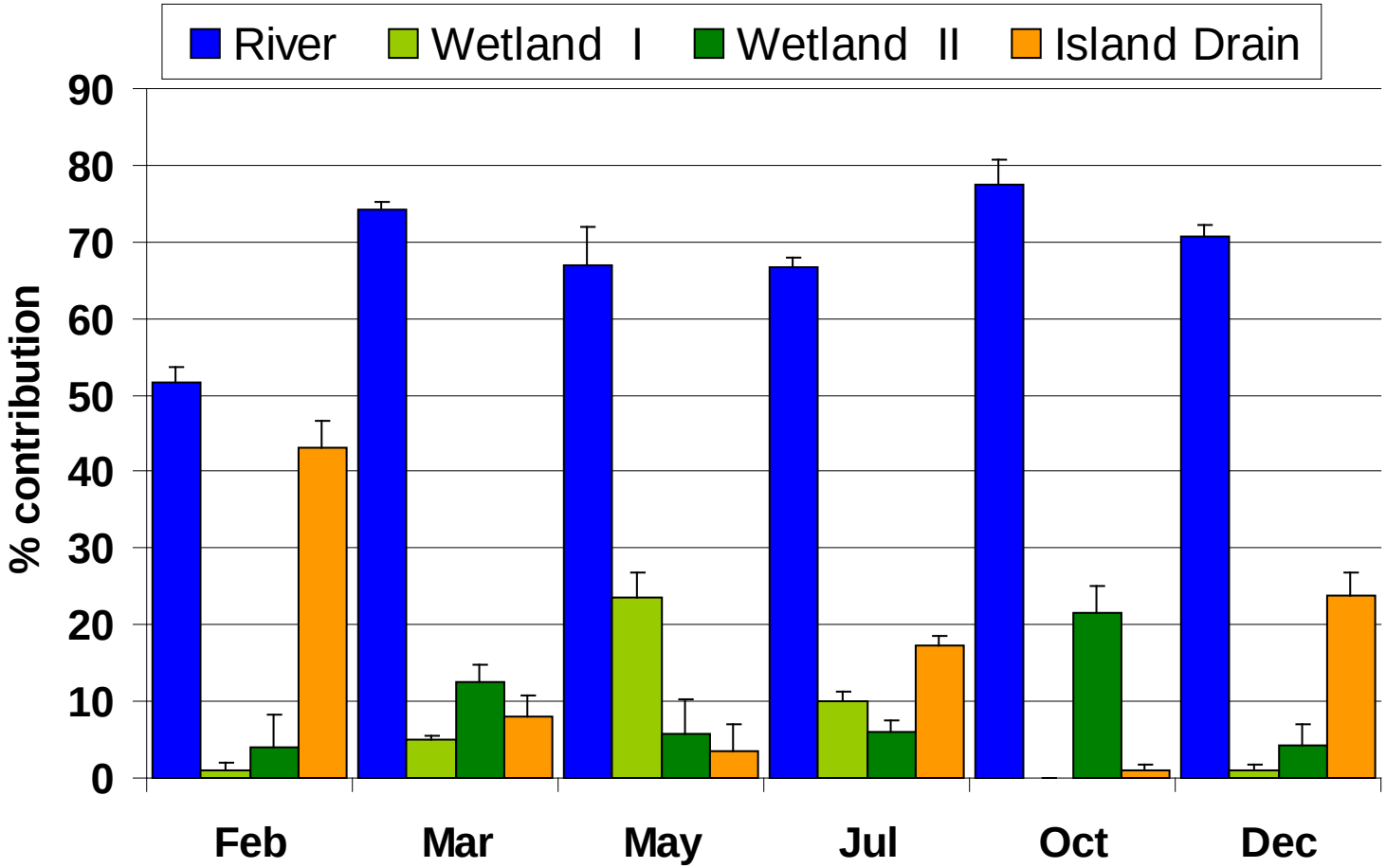
# What you need to know about Drinking Water Issues (Dissolved Organic Carbon)

- DOC is problematic in drinking water treatment
- DOC doubles in transit across Delta
- Sources – wetlands and islands
- Higher residence times lead to higher concentrations
- SIDE NOTE: Salt trapping has potential to lead to higher bromide



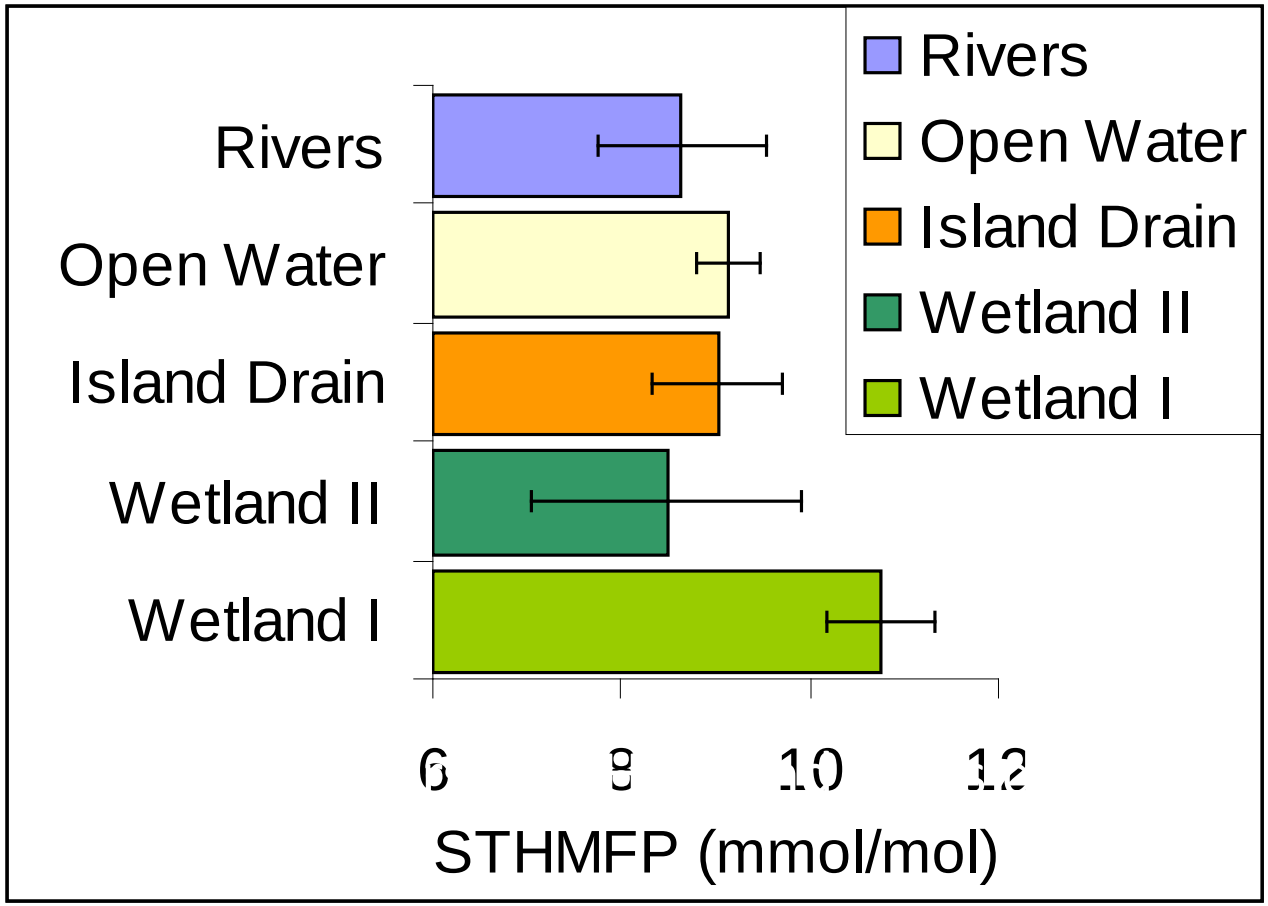
# Chemical Fingerprinting
# Relative DOC Contributions to Export Water

$$\Sigma P_{CC} = \Sigma f_R P_R + \Sigma f_W P_W + \Sigma f_W P_W + \Sigma f_D P_D$$



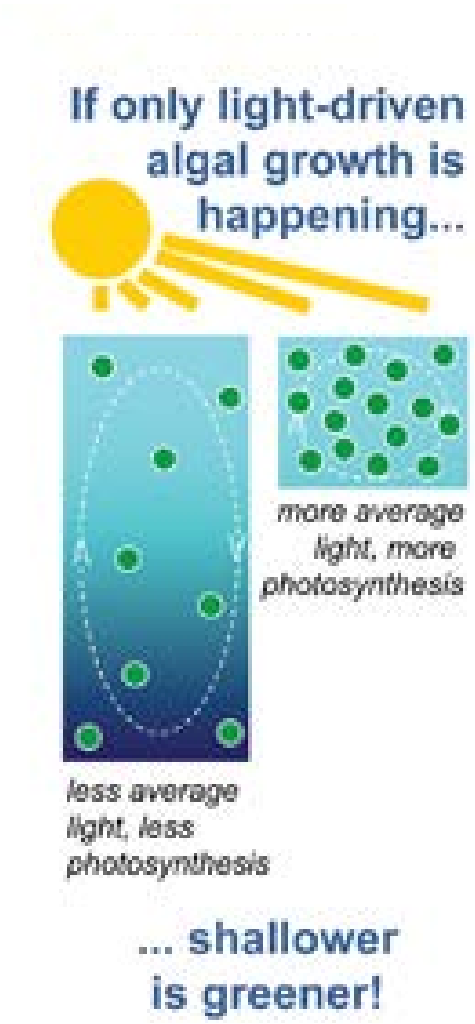

*Kraus et al., 2008*

# Wetland DOC forms more of some DBPs



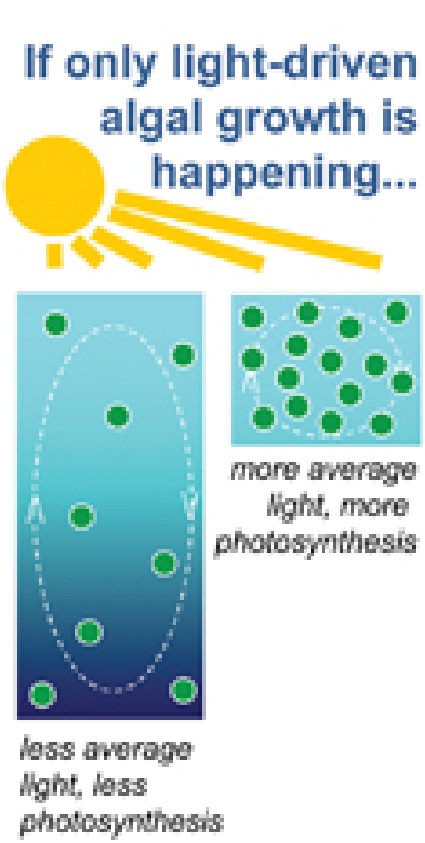

*Kraus et al., 2008*

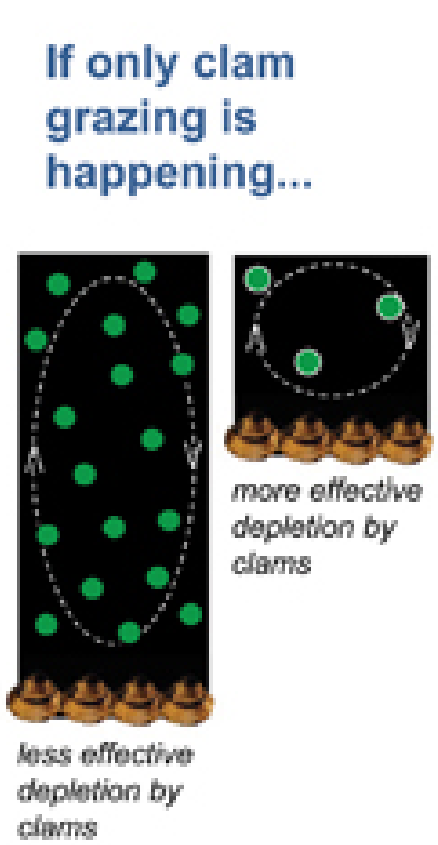
# What you need to know about channel geometry

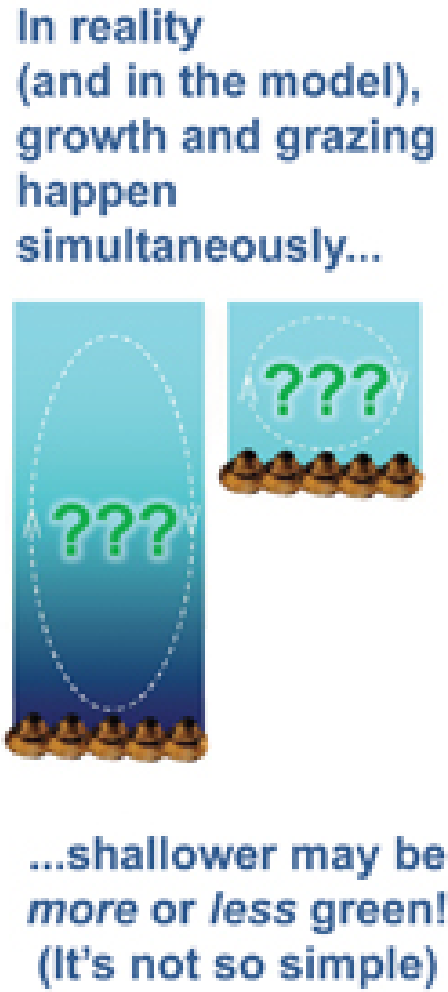



Credit: Lisa Lucas

# What you need to know about clams




Credit: Lisa Lucas

# Conclusions

Everything you change about flows……

……..changes the water and habitat quality

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# Recommendations for monitoring

## NETWORK OF HABITAT INDICATOR MONITORS

- Located in flow network
- Within tidal distance of each other

### PHYTOPLANKTON INDICATORS

- Pigment concentrations
- Basic phytoplankton taxonomy
- Biogeochemical variables – DO, $CO_2$, pH, nutrients, light

### FISH HABITAT INDICATORS

- Visual range and contrast
- Temperature profile
- Particle size distribution

### WATER QUALITY INDICATORS

- Conductivity
- DOC