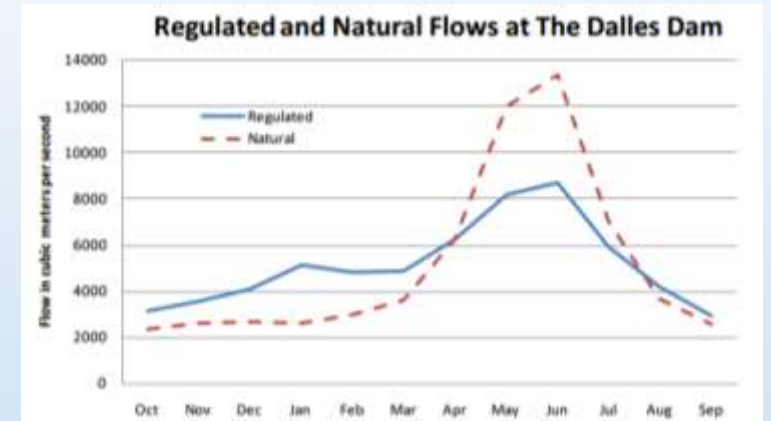


Inter-annual variability in phytoplankton dynamics in off-channel habitats of the Columbia River estuary

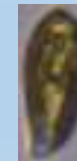
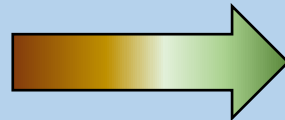
Claudia Tausz, Joseph Needoba, Michelle Maier,
Whitney Hapke, Amanda Hanson, Catherine Corbett,
Andrew Bryn and Tawnya Peterson

Phytoplankton and regulated rivers

- Dam impoundments trap sediment and detritus
- Downstream of dam: clear water
- “Greening” of the Columbia River?



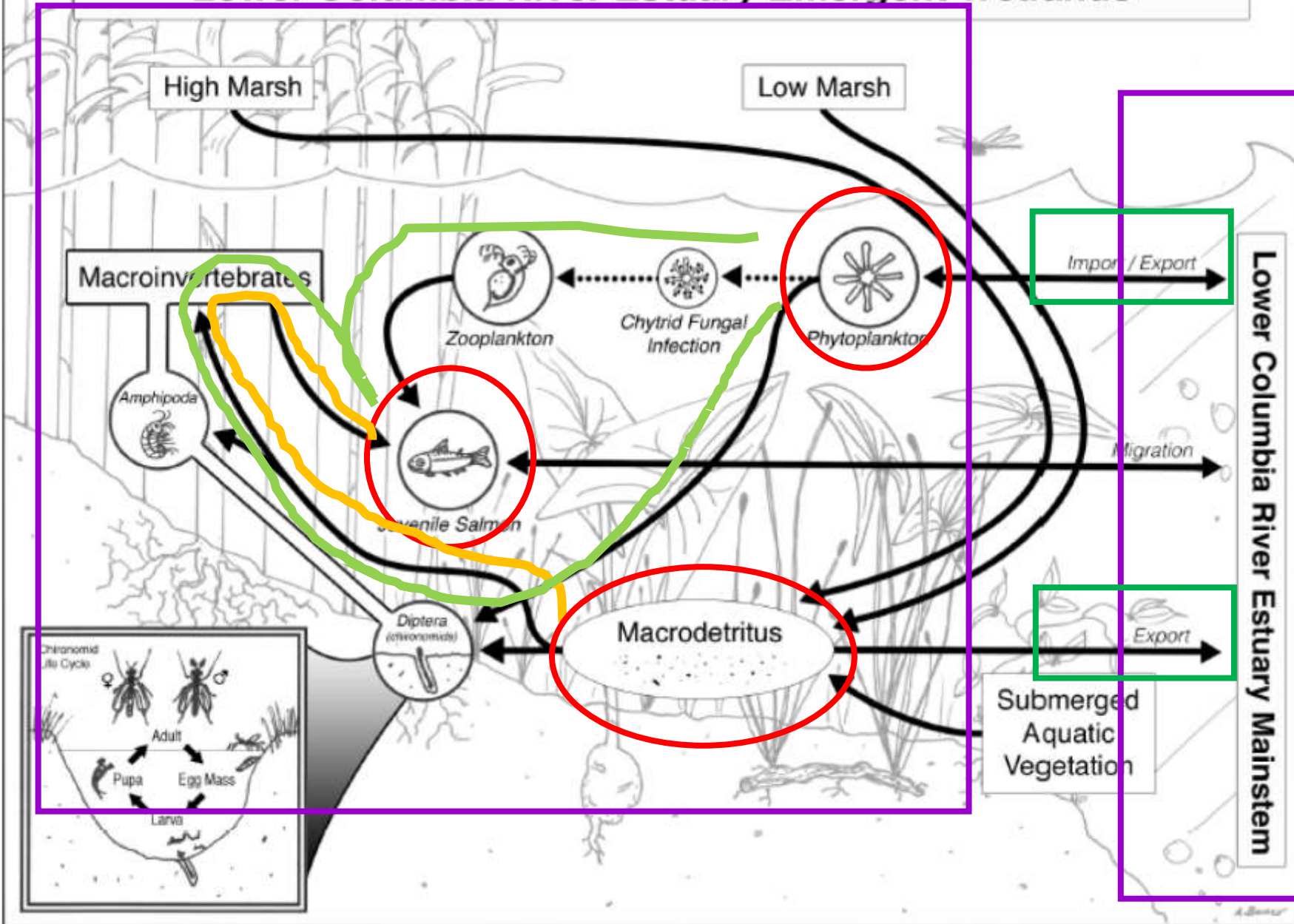
NPCC ISAB, 2011



Plant Detritus

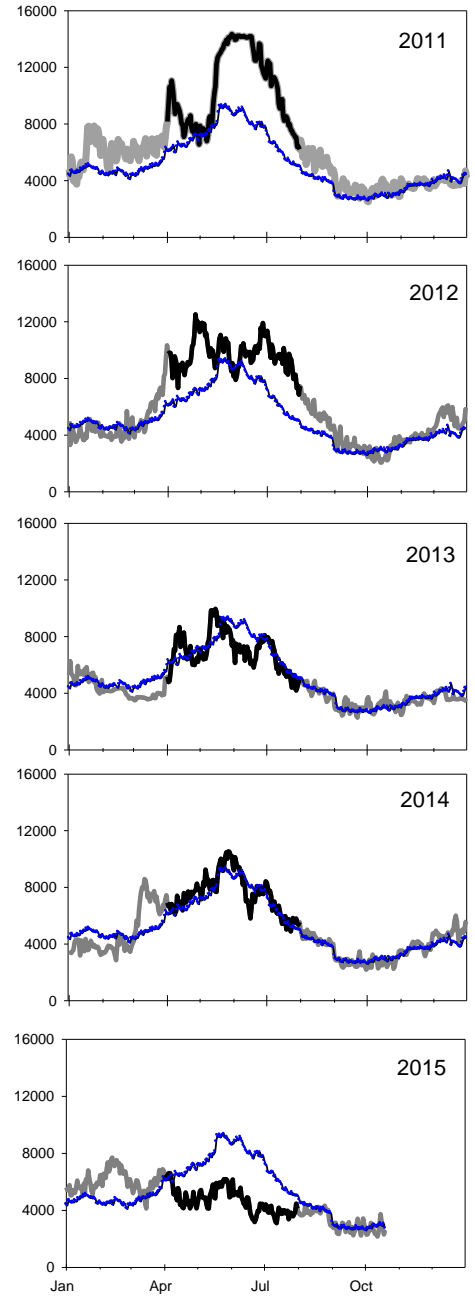
Phytoplankton

Lower Columbia River Estuary Emergent Wetlands



— mean daily discharge
— Apr-Jul
— 10-yr avg

Mean daily discharge from Bonneville Dam ($\text{m}^3 \text{sec}^{-1}$)



2011, 2012
High water years
large freshet

2013, 2014
Average water years
typical freshet

2015
Very low water year
no freshet

Current Objectives:

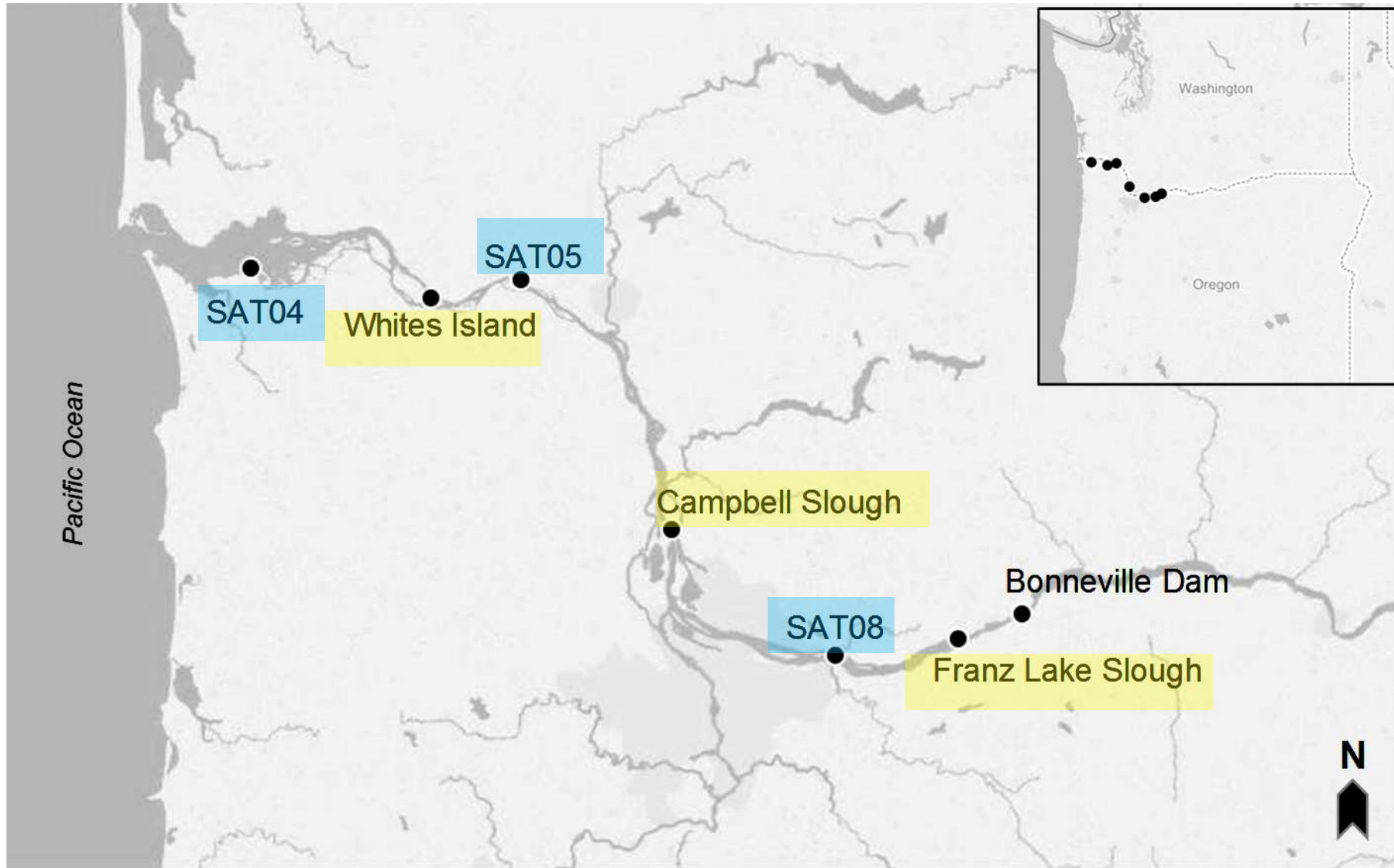
1. Identify seasonal patterns of phytoplankton succession in off-channel habitats that support juvenile salmon
2. Identify environmental drivers of change in phytoplankton communities
3. Determine how 2015 anomalous climate patterns affected phytoplankton community dynamics

Off-channel habitats and connectivity to the mainstem

- **“Connectivity”**: physical exchange of water and aquatic organisms
- Continuum of connectivity driven by river discharge
 - 100% connected: no difference between mainstem and off-channel habitats;
 - more disconnected, greater differences between mainstem and off-channel
- **Characteristics of disconnected, off-channel habitats:**
 - Slower moving water, longer residence time (τ), greater production
 - Higher density of phytoplankton and zooplankton



Simenstad et al., 2011



← Increasing tidal influence

Whites Island has more exchange with mainstem than Campbell or Franz

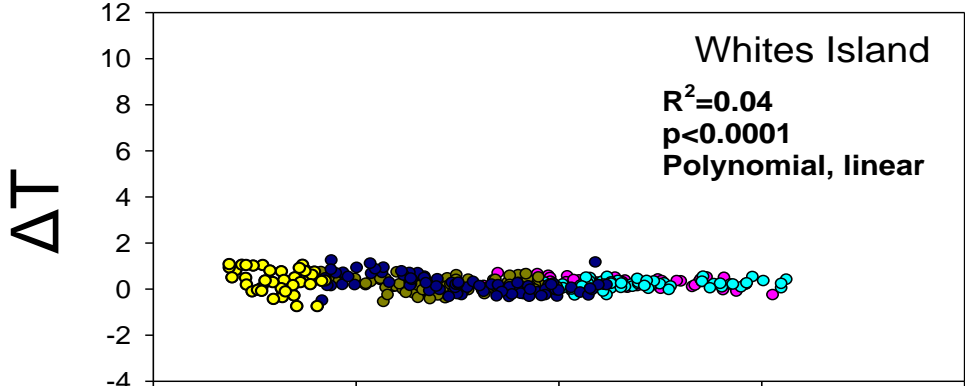
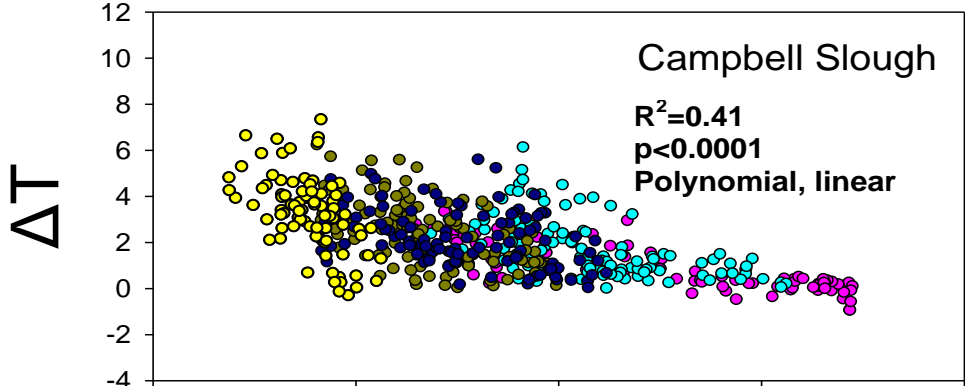
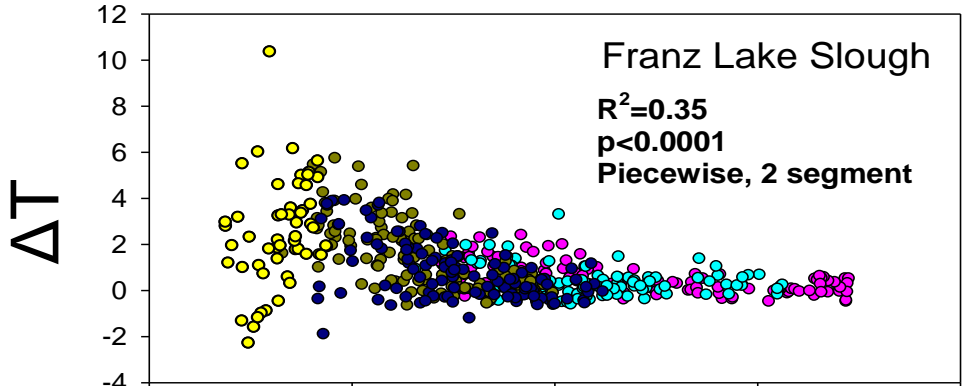
	Distance from mainstem (km)	Channel depth (m)	W:D ratio	Thalweg elevation (m, CRD)
Franz Lake Slough	0.35	0.60	28.6	0.99
Campbell Slough	1.5	0.56	37.7	0.77
Whites Island	0.2	0.78	47.1	0.37

Data from Sagar et al., 2013

Connectivity to mainstem is relative to water elevation

$\Delta T = \text{°C mainstem} - \text{°C off-channel site}$

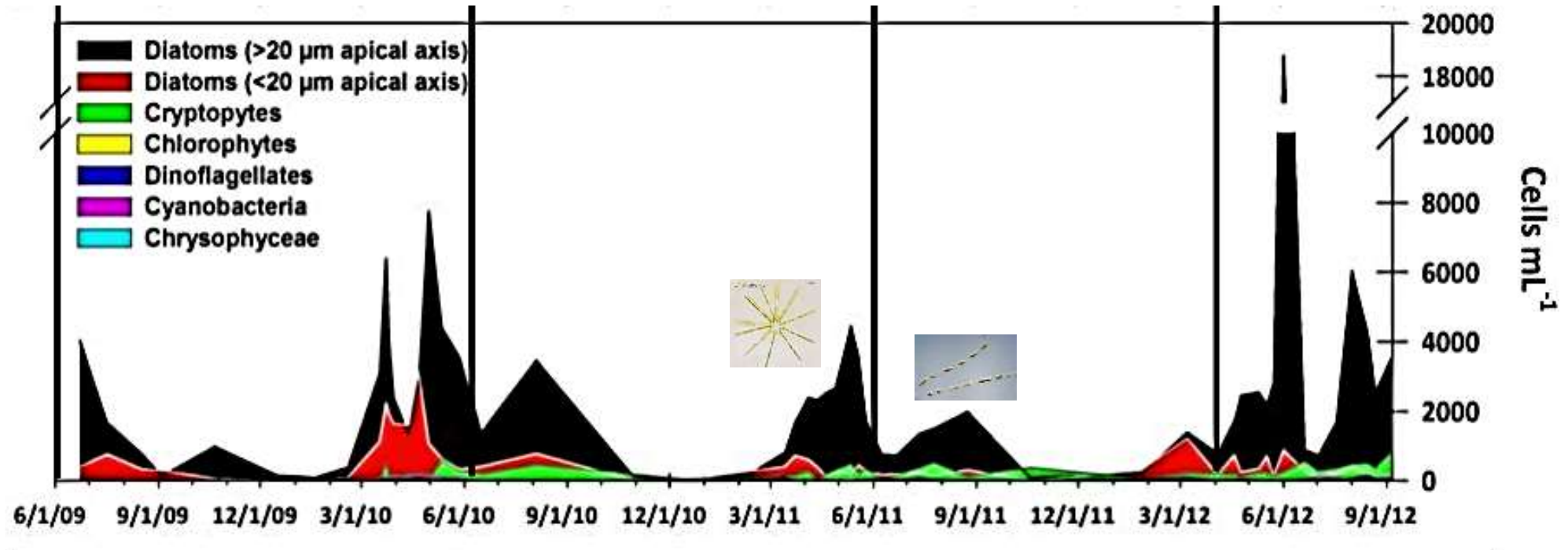
- At high water elevation, ΔT is near zero
- At low water elevation, ΔT is greatest
- ΔT greatest in 2015



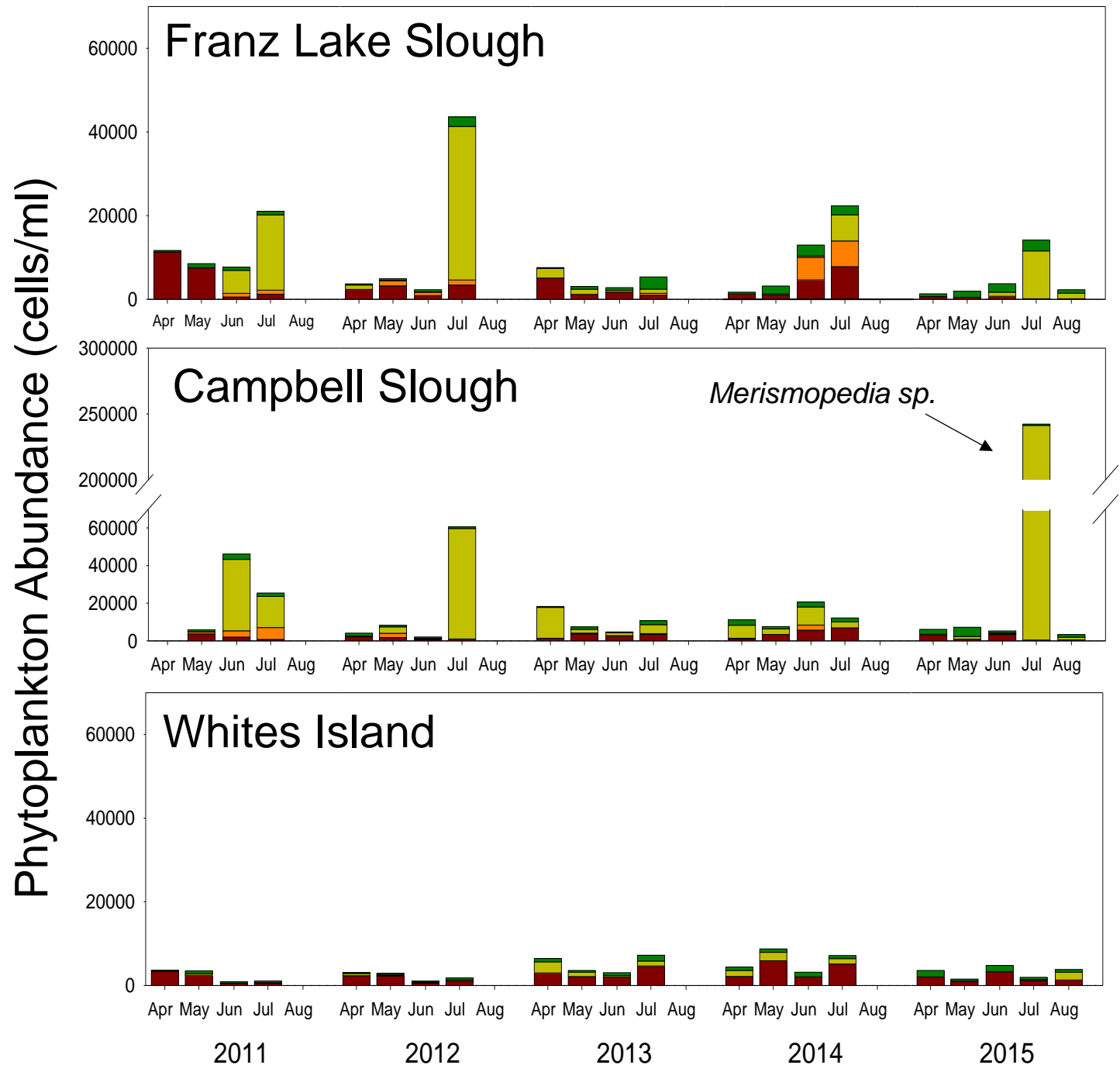
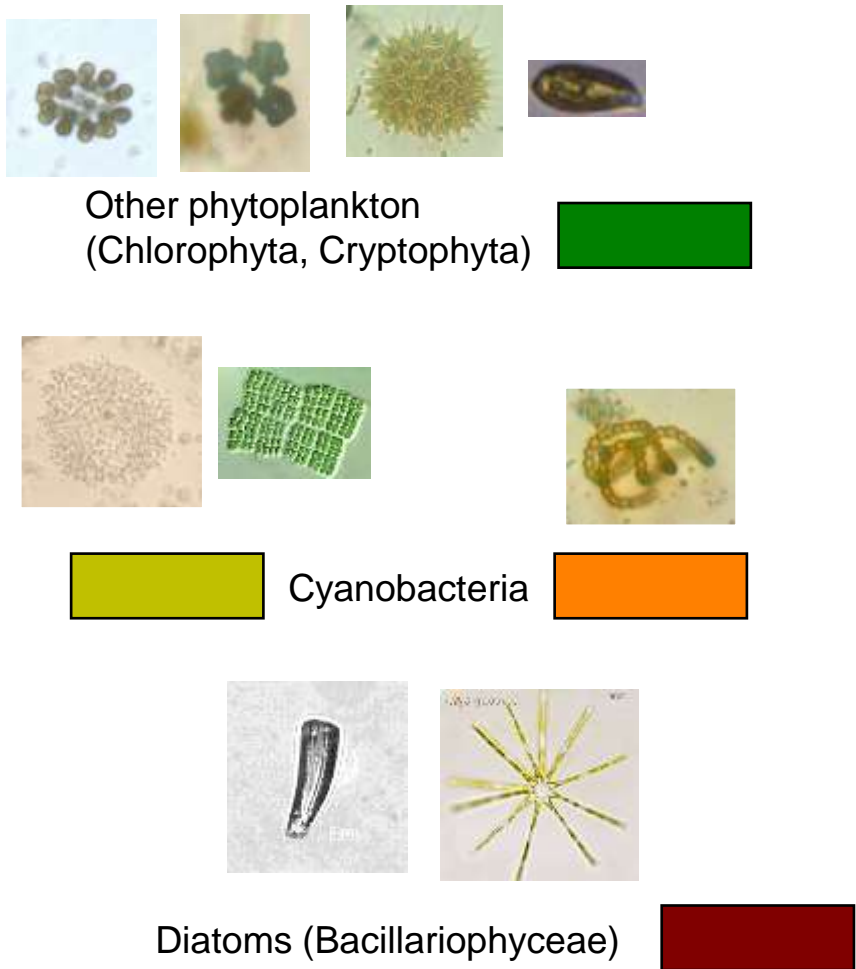
- 2011
- 2012
- 2013
- 2014
- 2015

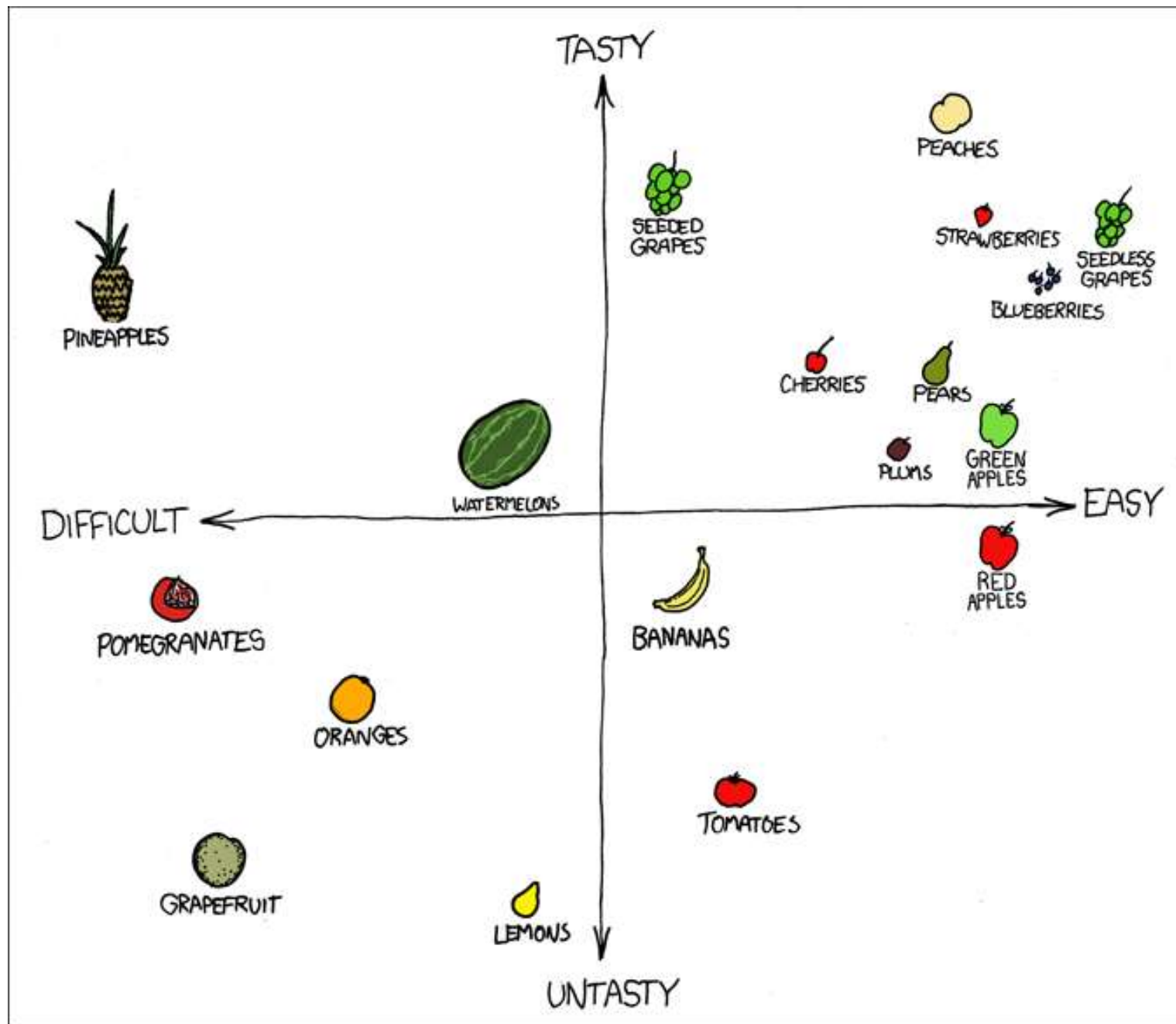
Gage height

Diatoms dominant in the mainstream

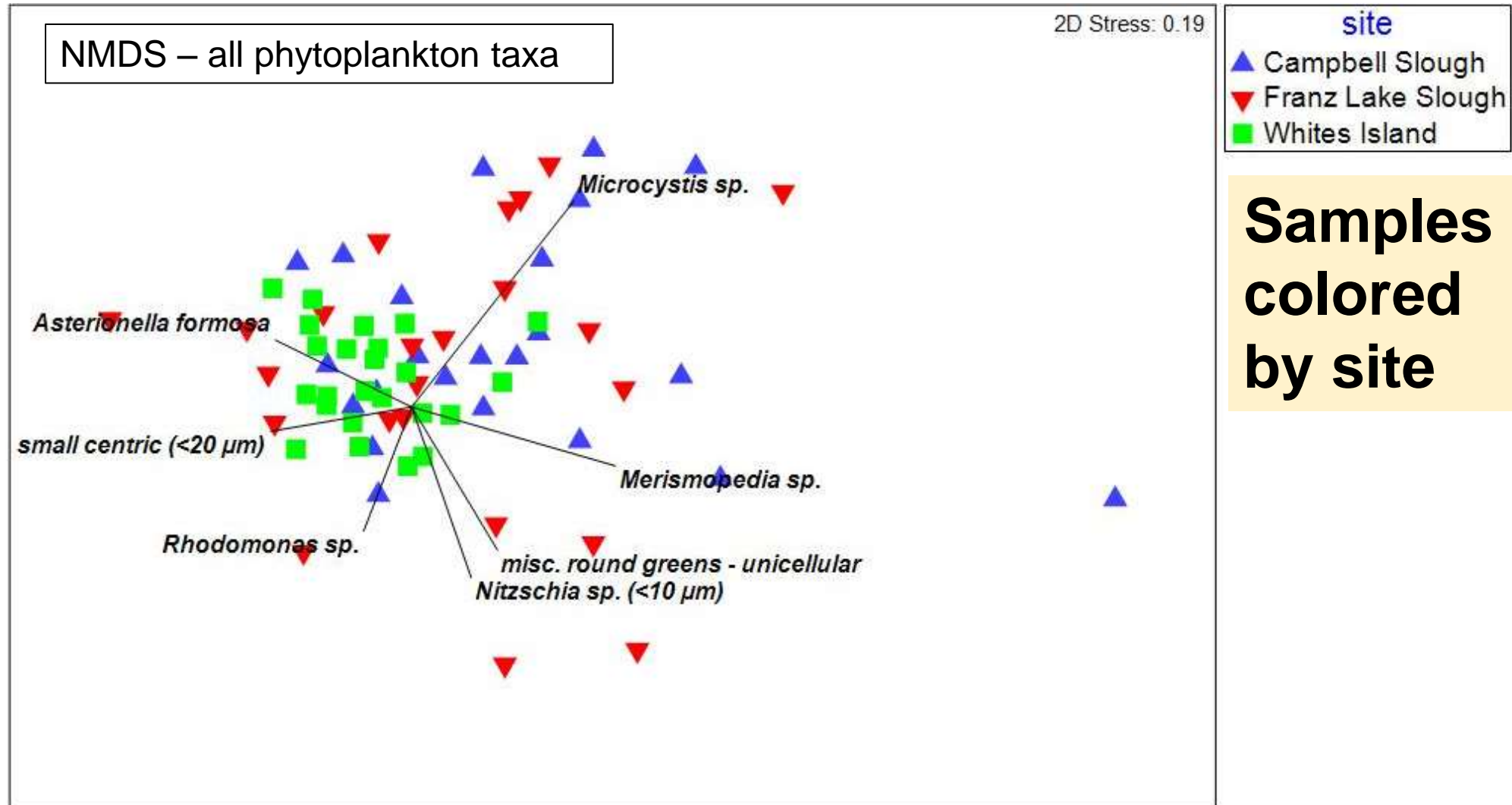


Phytoplankton more variable at poorly connected sites (Campbell and Franz)

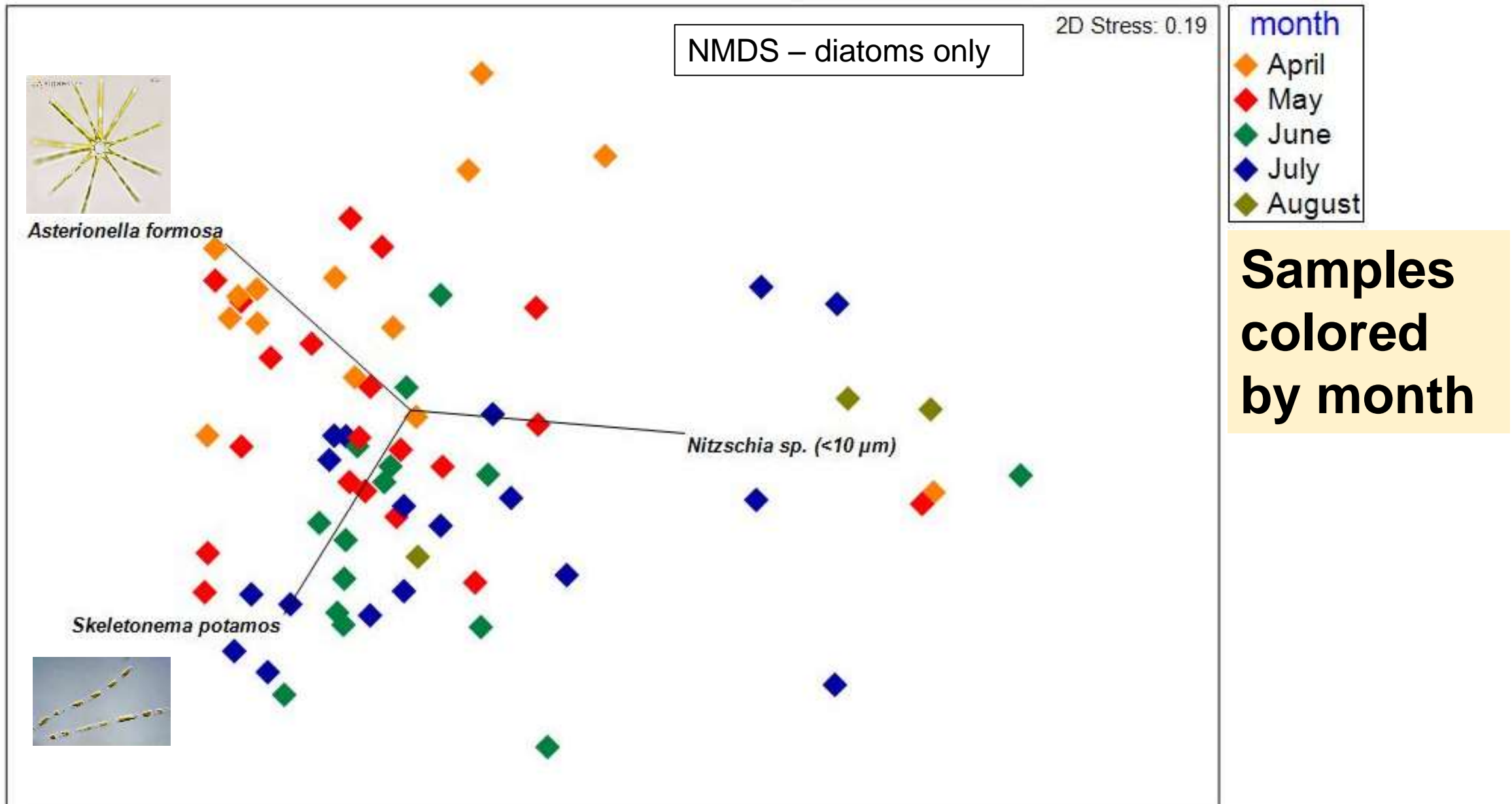




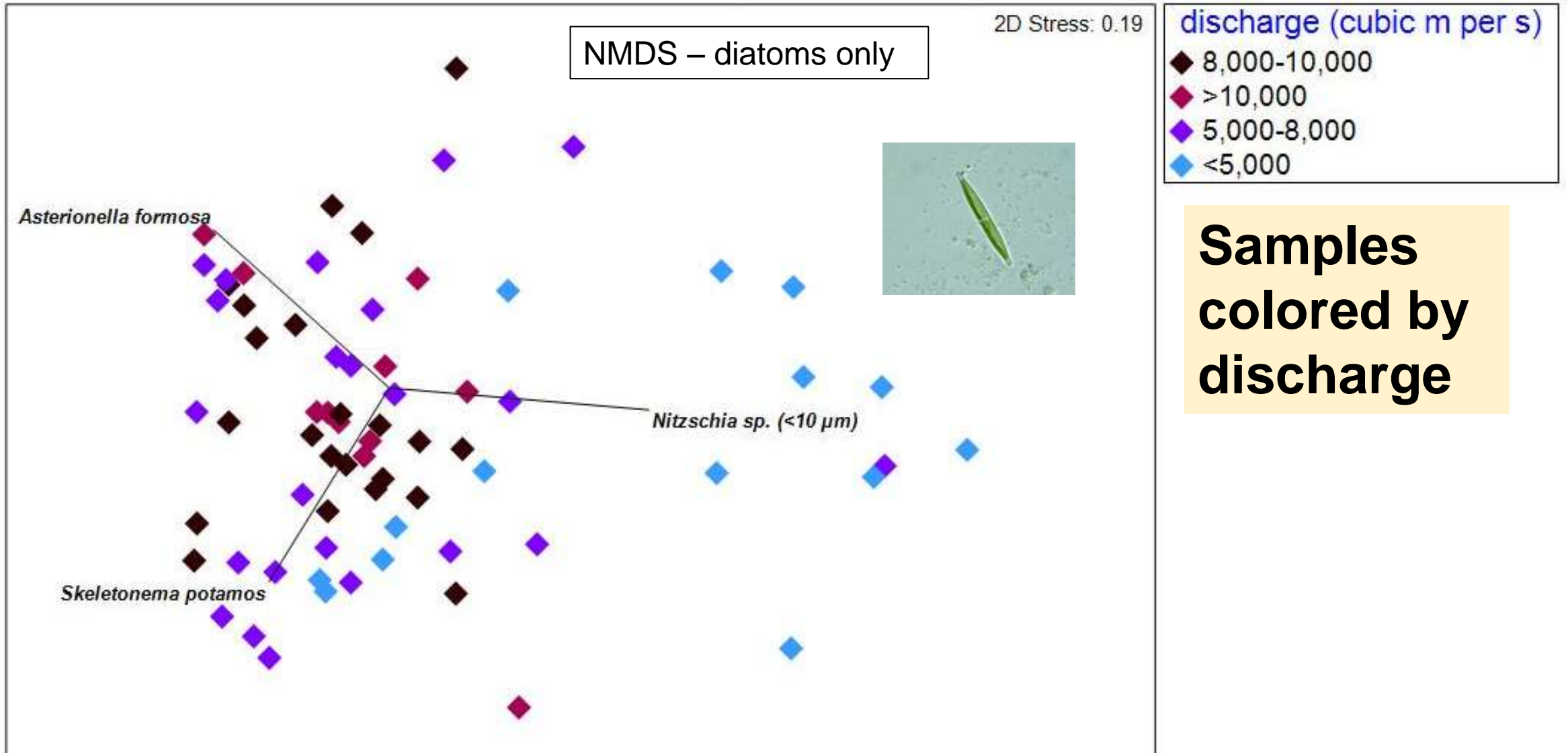
Phytoplankton more variable at poorly connected sites (Campbell and Franz)



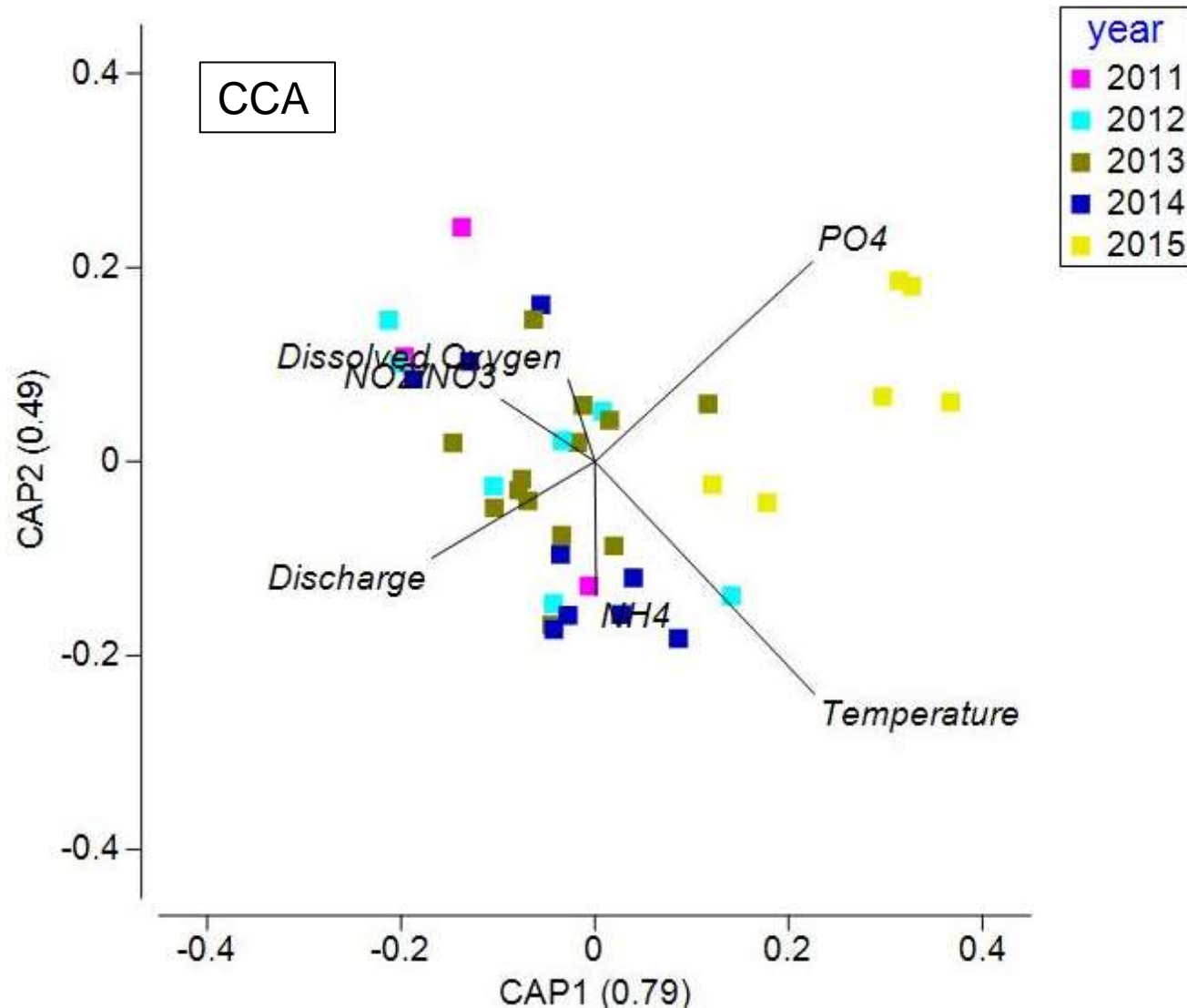
Shift in dominant diatom species spring → summer



Shift in diatom community at low discharge, regardless of season



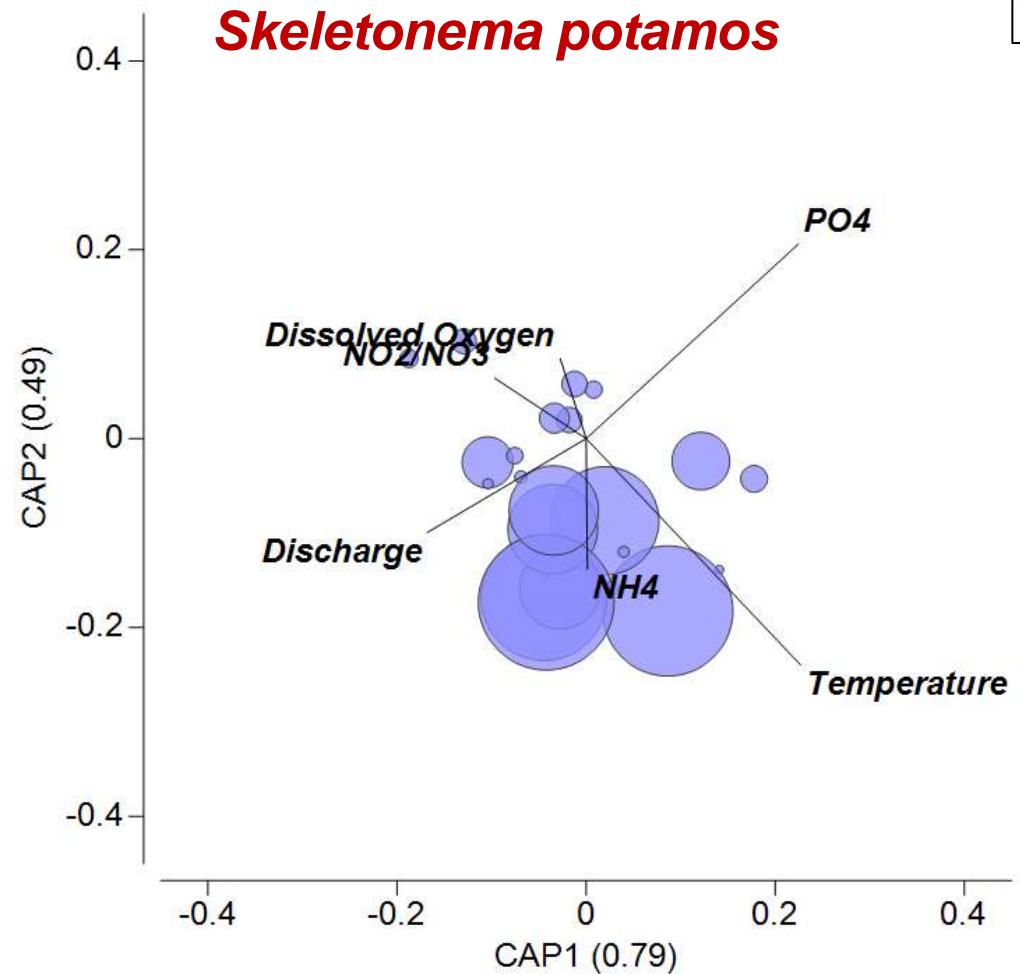
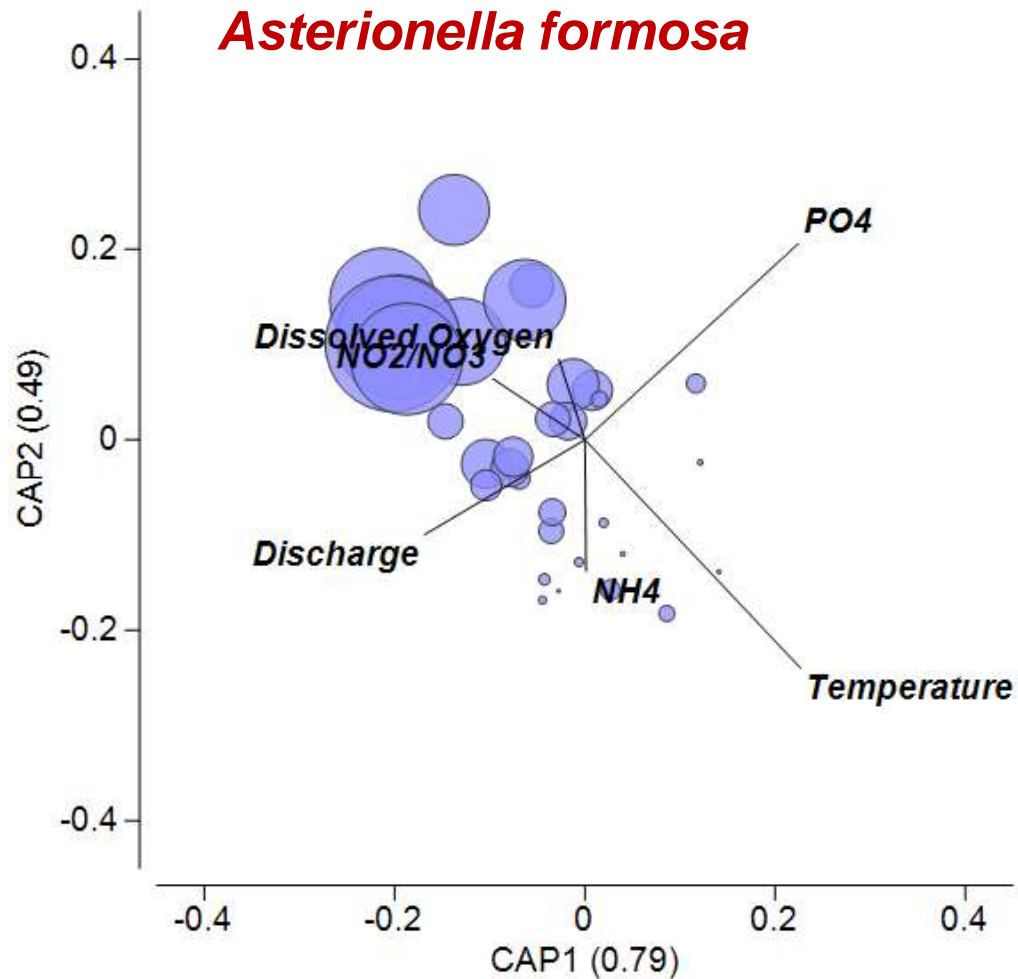
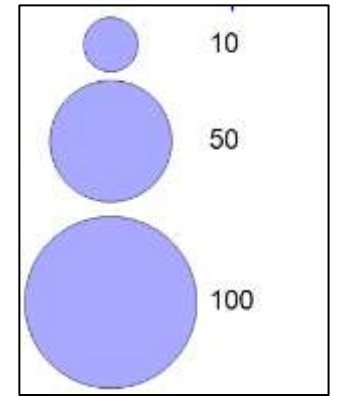
PO₄³⁻ and Temperature have strongest influence on phytoplankton variability



Samples colored by year

Variable	CAP1	CAP2
NO ₂ ⁻ +NO ₃ ⁻	-0.258	0.171
NH ₄ ⁺	0.003	-0.369
PO ₄ ³⁻	0.600	0.551
Temperature	0.604	-0.640
Dissolved Oxygen	-0.073	0.226
Discharge	-0.449	-0.266

Changing environmental conditions associated with seasonal shift in phytoplankton



Conclusions

1. Phytoplankton dynamics:

- Campbell Slough and Franz Lake Slough: more variable than Whites due to degree of connectivity
- *Asterionella* (spring) → *Skeletonema* (summer)
- Cyanobacteria dominant in summer at Campbell Slough and Franz Lake Slough

2. Environmental influences on phytoplankton:

- Temperature and phosphate are correlated with shifts in phytoplankton community composition

3. 2015 anomalous conditions:

- Difference in diatom abundance and taxa at Campbell and Franz

Relevance to Management

- Warmer, low water years (i.e. 2015) shift regular seasonal succession patterns in phytoplankton
 - Small *Nitzschia sp.*
 - *Merismopedia sp.*
 - Shift to earlier “summer” conditions
- Not all phytoplankton carry the same nutritional value
 - Smaller diatoms, chlorophytes and cyanobacteria likely provide a less nutritious base for the food web (juvenile salmon) than large spring-bloom diatoms

Acknowledgments

- OHSU Institute of Environmental Health
- Center for Coastal Margin Observation and Prediction (CMOP)
- Lower Columbia Estuary Partnership (LCEP)
- USGS Oregon Water Science Center

