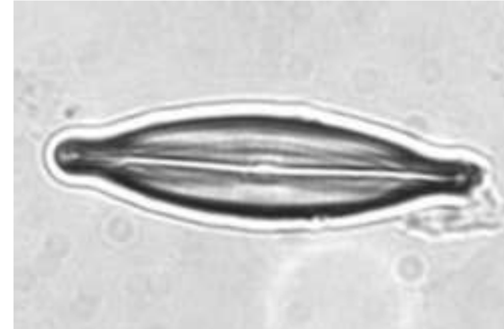
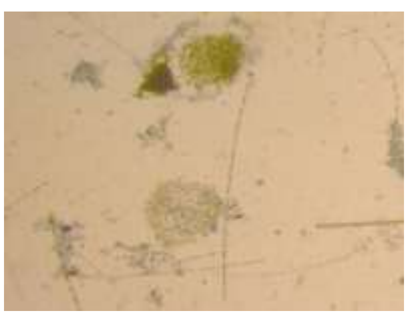
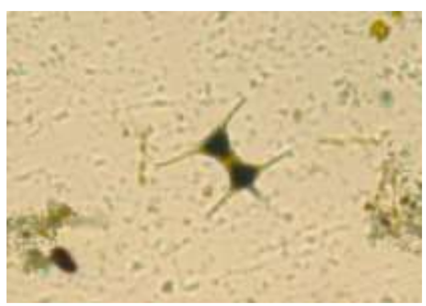
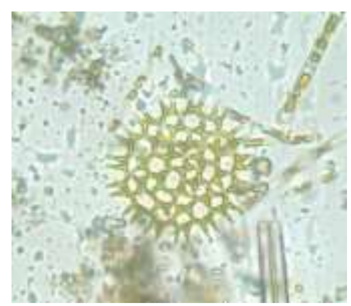
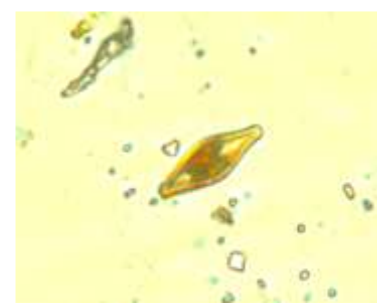


Ecosystem Monitoring Program

2015: Foodweb Update

Tawnya D. Peterson, Claudia E. Tausz, Joseph A. Needoba, Amanda Hansen & Estuary Partnership

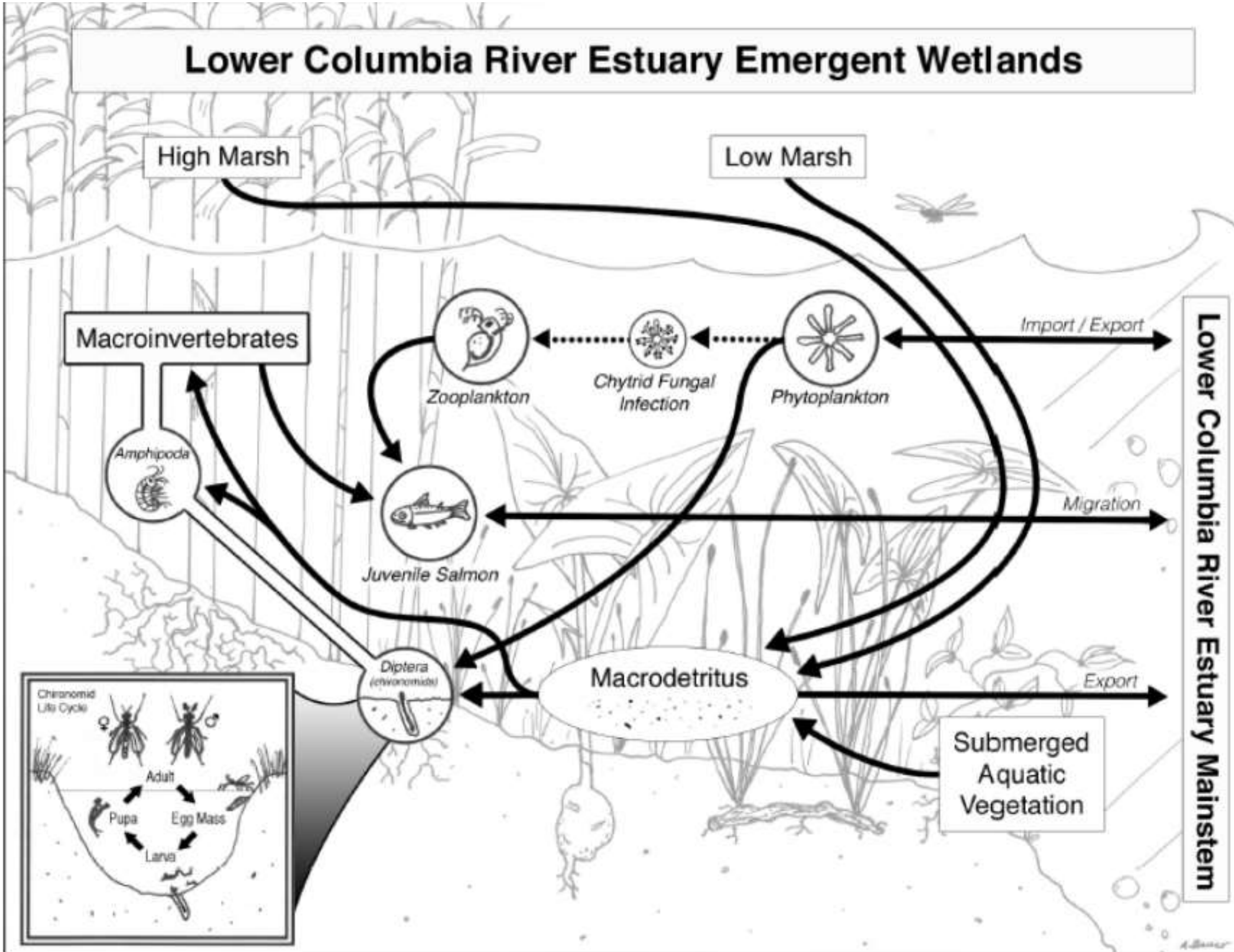





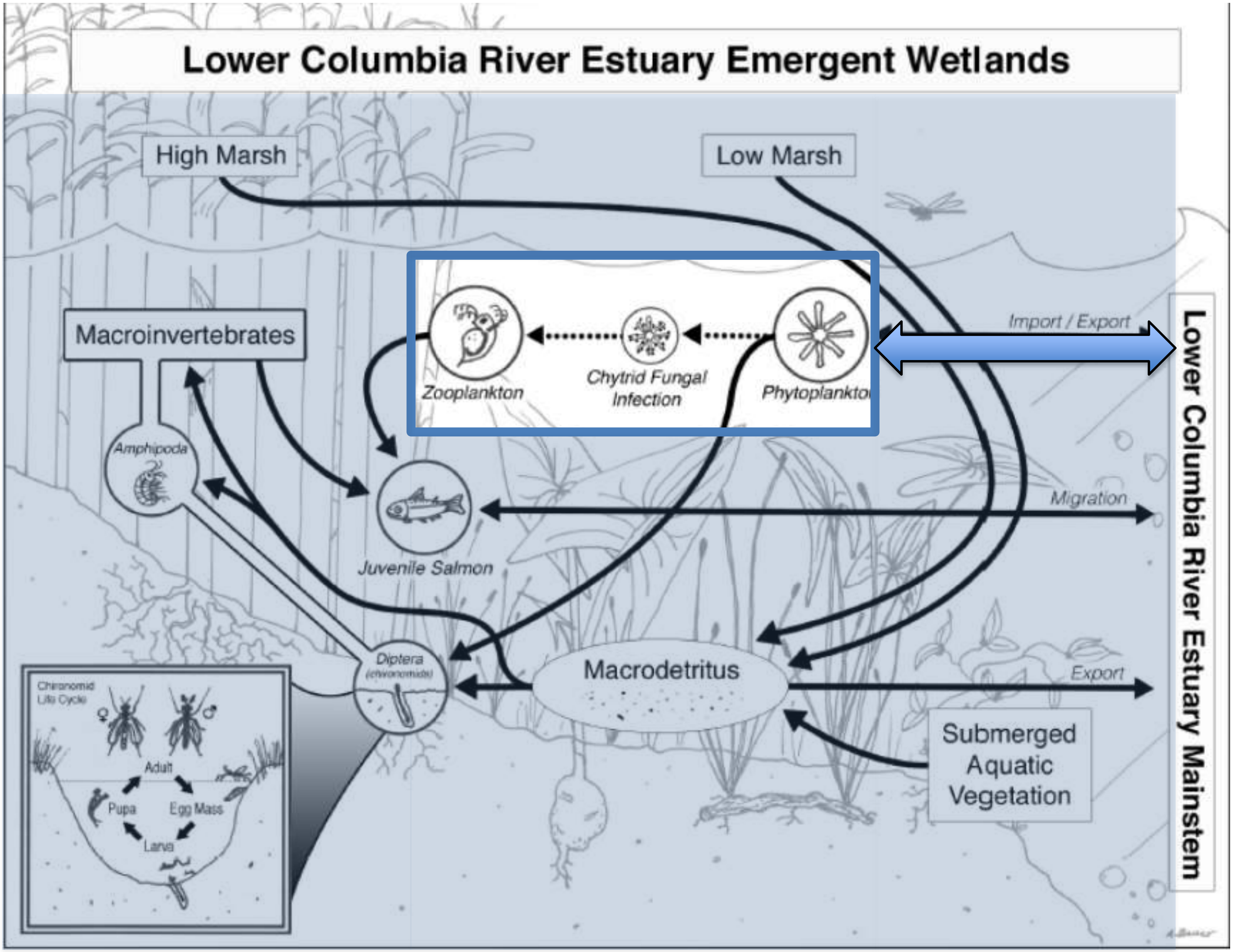
OHSU OREGON HEALTH & SCIENCE UNIVERSITY

Lower Columbia Estuary Partnership

Questions

Near-term	Long-term
What are the primary sources of organic matter fueling salmonid food webs?	How have dams influenced organic matter sources to salmonid food webs?
Do these primary organic matter sources vary in space and time?	Can river flows be managed to influence organic matter sources for juvenile salmonids?
Do these primary organic matter sources differ among sites or times in ways that predict abundance, condition, and diversity of salmonids?	


Lower Columbia River Estuary Emergent Wetlands
High Marsh
Low Marsh
Macroinvertebrates
Zooplankton
Chytrid Fungal Infection
Phytoplankton
Import / Export
Amphipoda
Juvenile Salmon
Migration
Diptera
Macrodetritus
Export
Submerged Aquatic Vegetation
Lower Columbia River Estuary Mainstem
Chironomid Life Cycle
Adult
Pupa
Egg Mass
Larva



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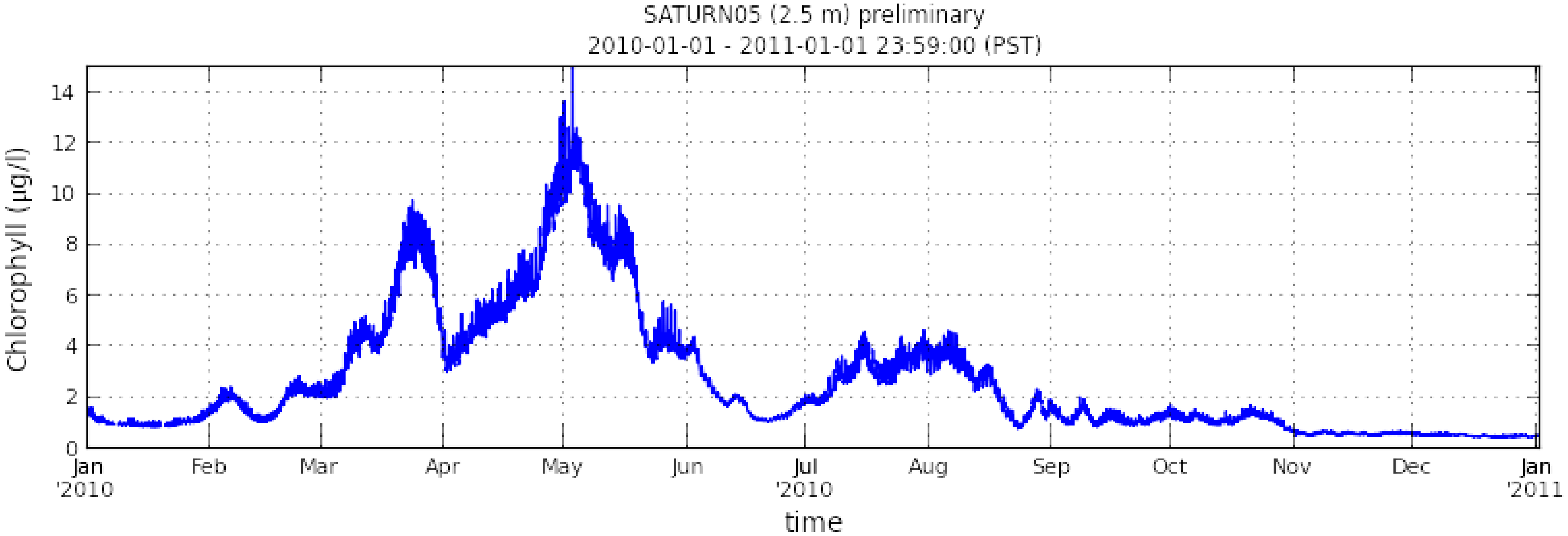
What role do plankton play in salmon food webs?

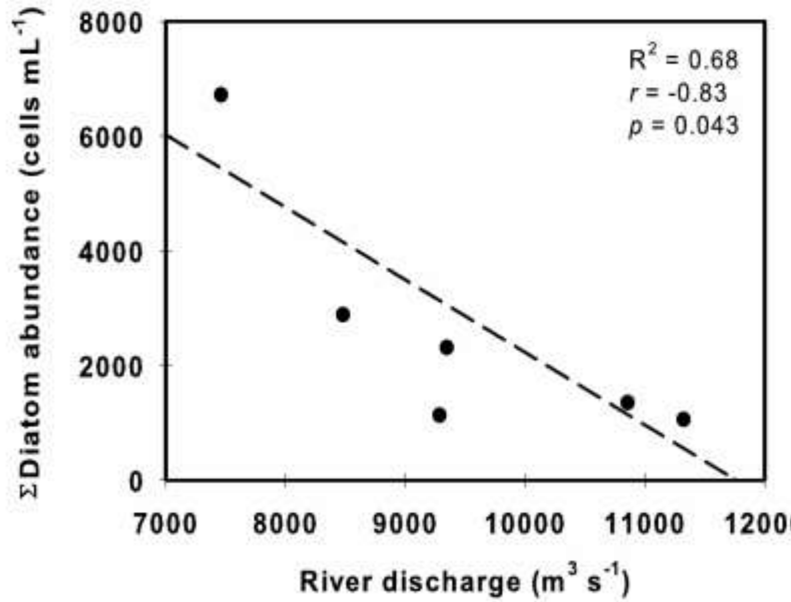
- Phytoplankton abundances consistently highest in early spring (Mar-May)
- Stable isotope data suggest they are important in the food web mainly during the spring period (Maier & Simenstad, 2009)

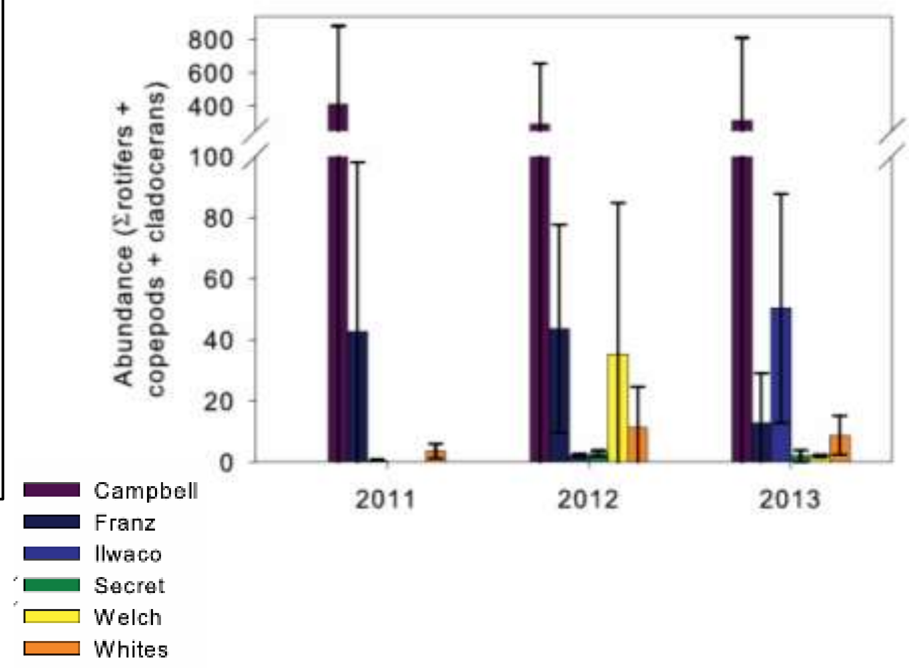


Trends in plankton abundance

- Phytoplankton abundance
  - inversely correlated with river discharge;
  - higher in shallow water habitats compared to mainstem;
  - abundances higher in areas of longer retention than well-flushed areas

- Zooplankton abundance
  - highest at Campbell Slough





Primary hypotheses

- Standing stocks (i.e., amount) of plankton is inversely related to river flow
- Areas with longer residence time will be able to support larger plankton populations

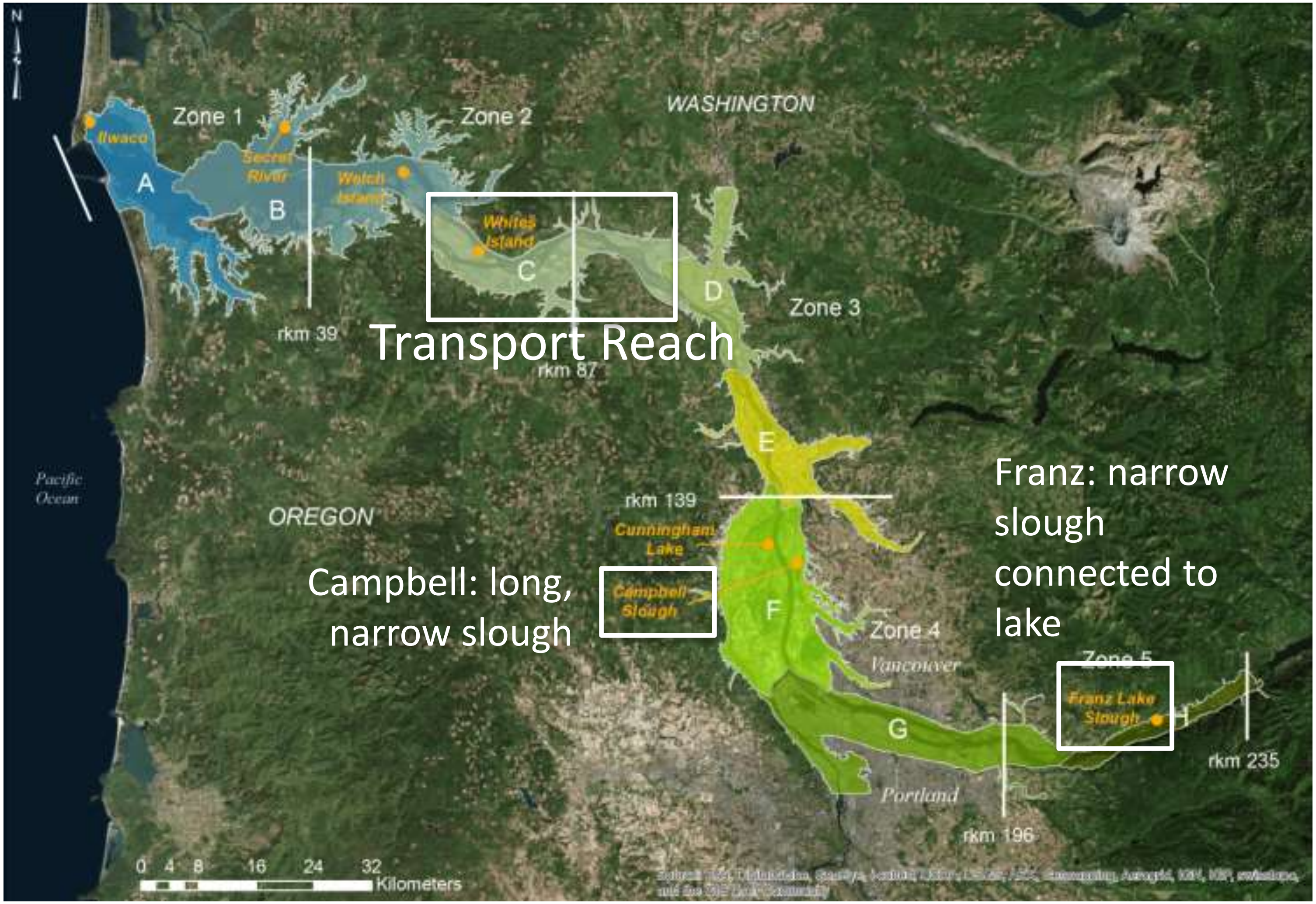
Project overview

Aim: Characterize water quality and the lower food web of juvenile salmonids in space and time.

- 6 fixed sites (Franz, Campbell, Whites, Welch, Grays, Ilwaco)
  - nutrients, chlorophyll, phytoplankton, zooplankton species & abundance
- 4 sites (Franz, Campbell, Whites, Ilwaco)
  - stable isotope signatures of organic matter fueling food webs
  - Continuous (hourly) water quality data
- Mainstem (Beaver Army Terminal, Camas)
  - Periodic observations of above parameters for comparison with shallow water sites

		Pre-freshet	Freshet		Post-freshet	Low flow	
	MAR	APR	MAY	JUN	JULY	AUG	SEPT
Nutrients		●	●	●	●	●	
Chl		●	●	●	●	●	
Phytoplankton		●	●	●	●	●	
Zooplankton							
Stable isotopes							

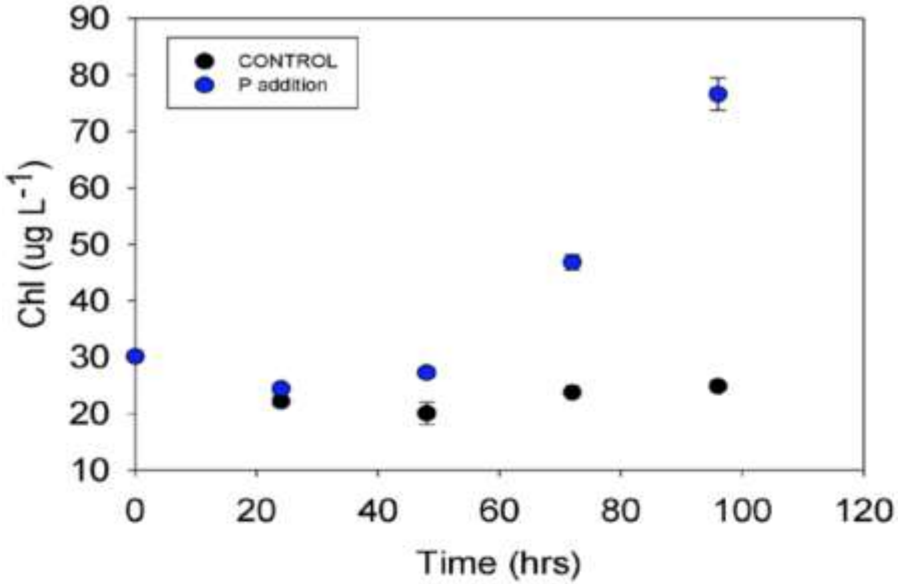
● completed



Increasing tidal influence

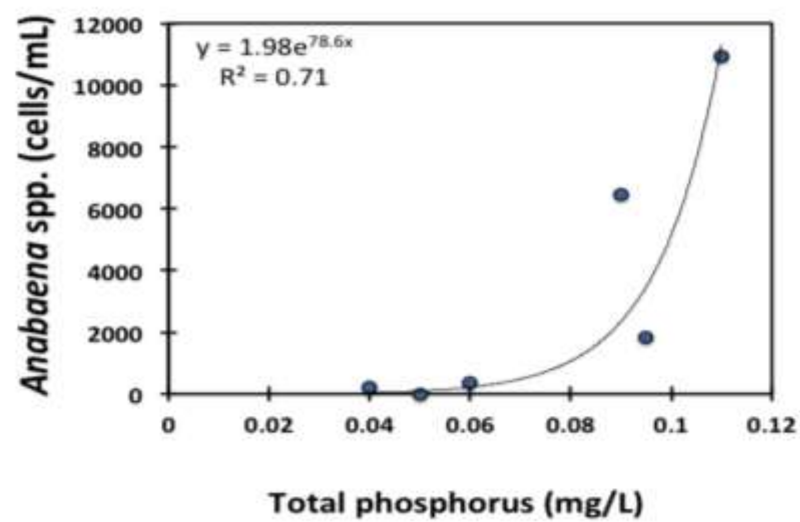
Working Hypothesis

- Phytoplankton growth is controlled by available phosphorus
- River provides a source of phosphorus (likely through adsorption of P to particles)
- Size of freshet determines P load to off-channel habitats where residence times can be high
- Years with high discharge lead to high abundances of N-fixing cyanobacteria in the summer



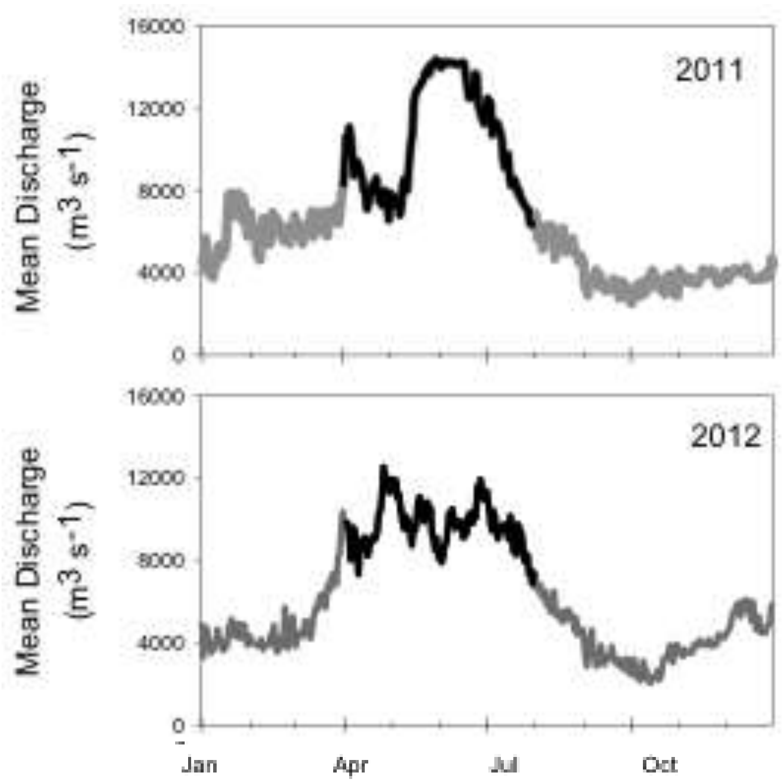
When ortho-phosphate was added to whole water from the mainstem river in the summer, phytoplankton biomass increased

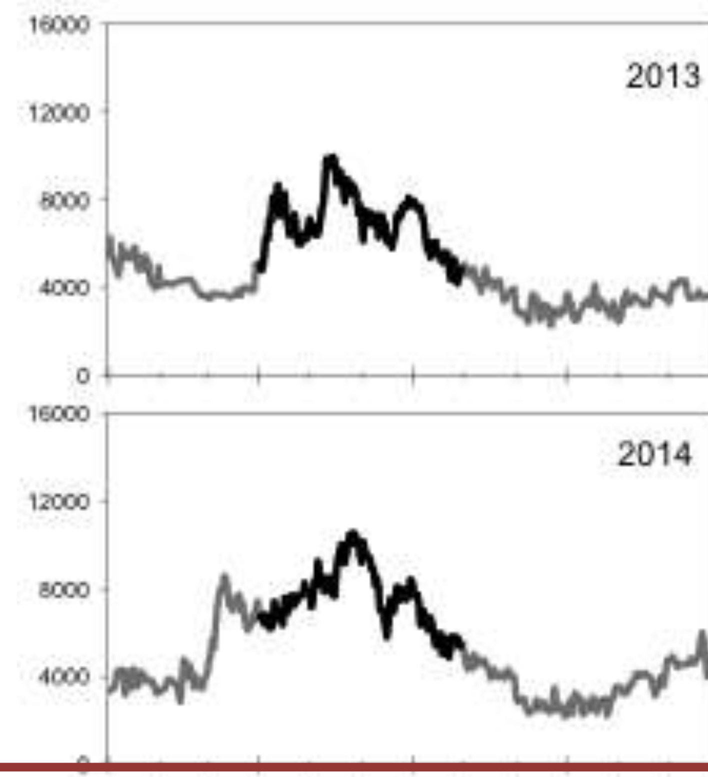
- Within Campbell Slough, there was a positive relationship between total phosphorus (Hapke, USGS) and *Anabaena* spp.
- Campbell Slough tends to have cyanobacteria blooms in the summer when N:P molar ratios become low (<10)



Why is this important?

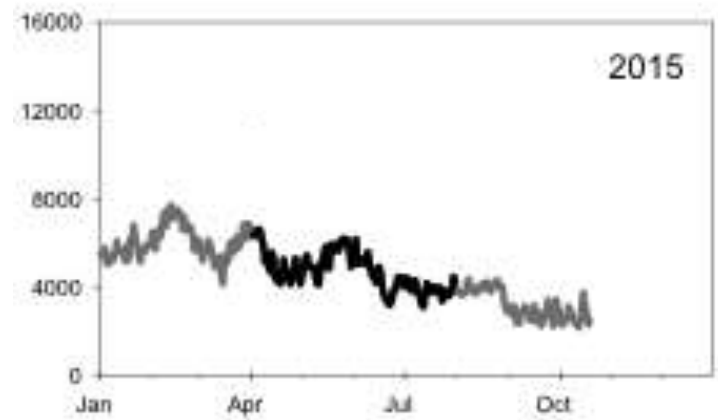
- Many N-fixing cyanobacteria species produce toxins
- We hypothesize that maintaining high levels of flow during the post-freshet months serves to dilute out potential blooms and create a more favorable environment for high-quality food (i.e., diatoms)
- It is possible that the loading of nutrients into long-residence time environments like Campbell Slough could have effects that last beyond a given water year
- Nutritional quality of primary producers likely influences quality of prey





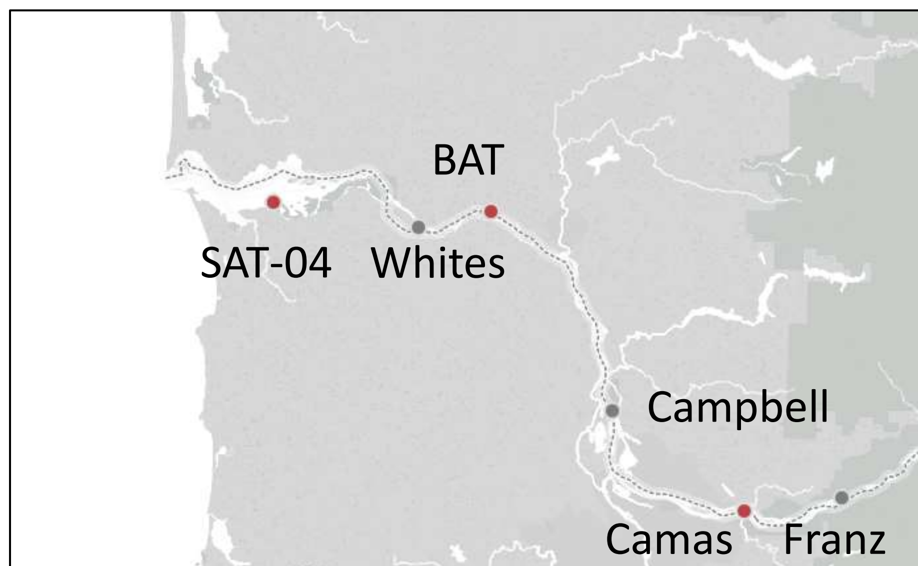
2015 had low flows and warm temps

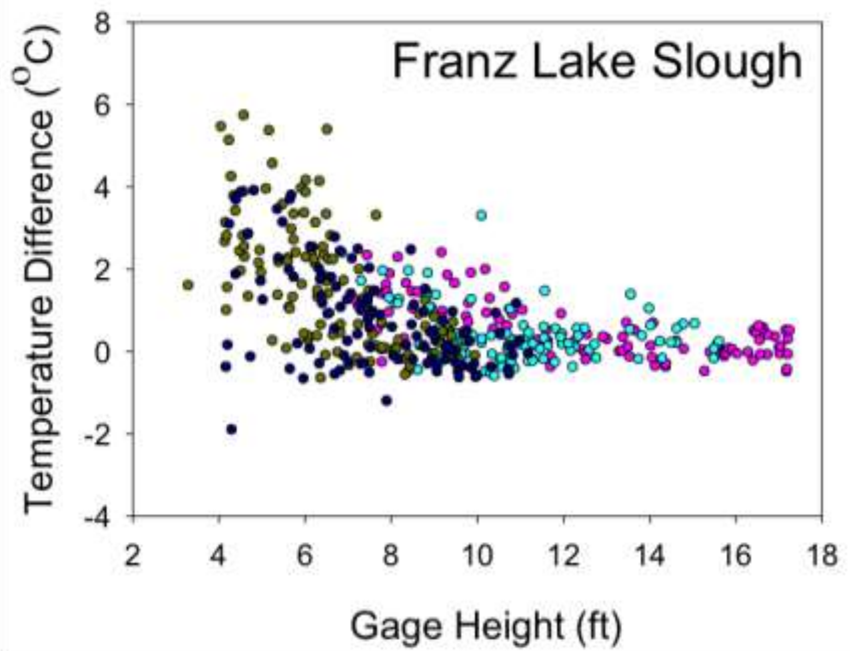
- 2011: high water
- 2012: high water
- 2013: moderate flow
- 2014: moderate flow
- 2015: **low flow**

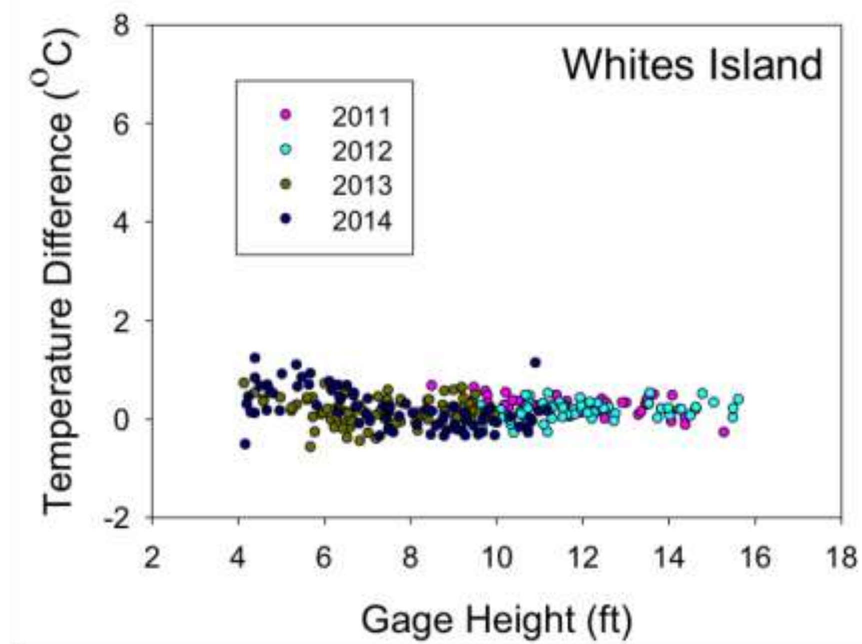


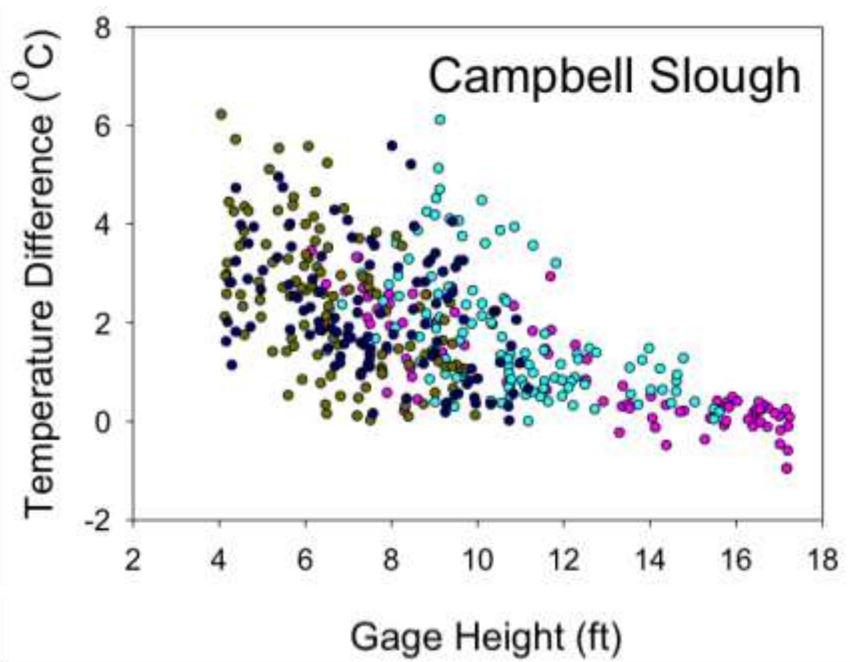
How do off-channel sites from different reaches differ?

- Compare Franz Lake Slough (Reach H), Campbell Slough (Reach F), Whites Island (Reach C) to data from mainstem
- Calculate difference between mainstem and fixed sites



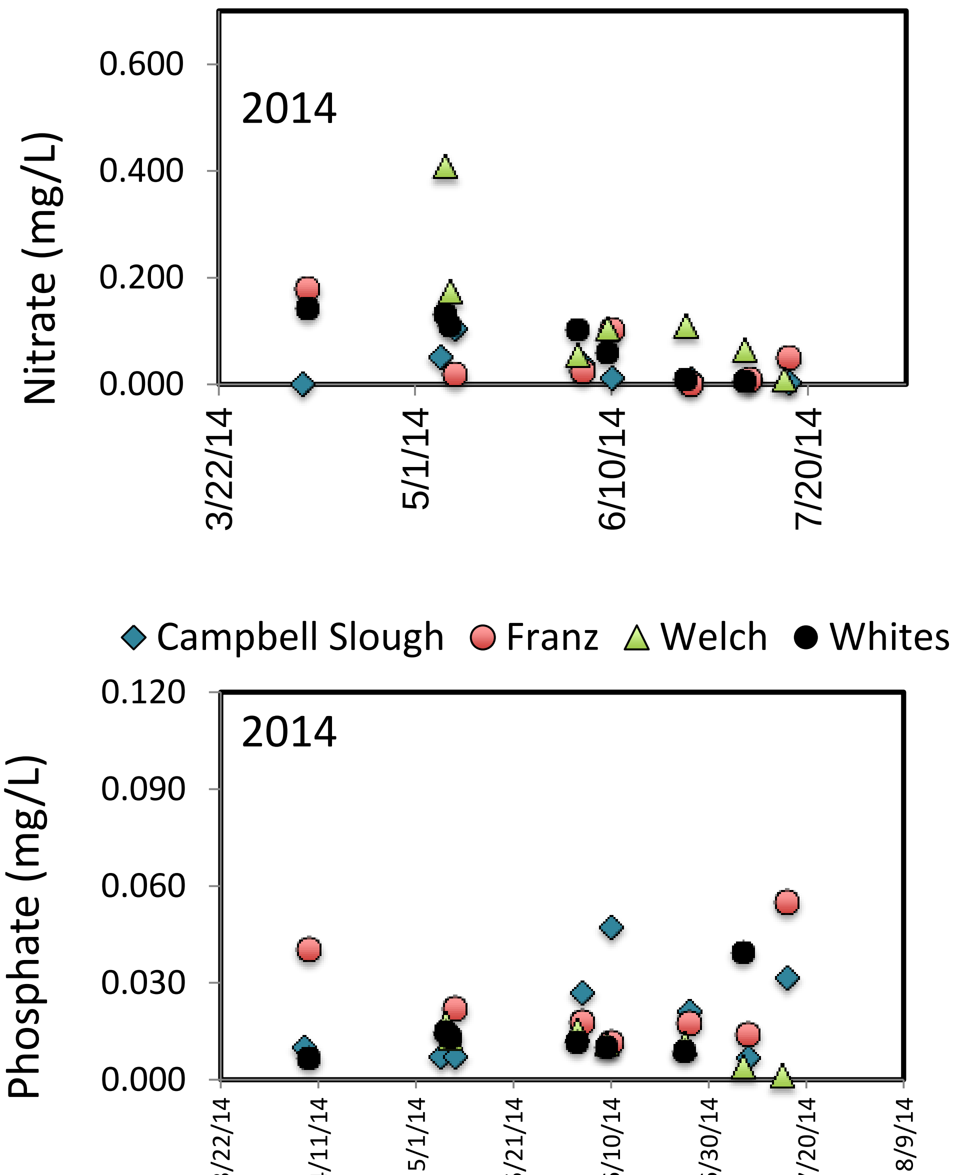


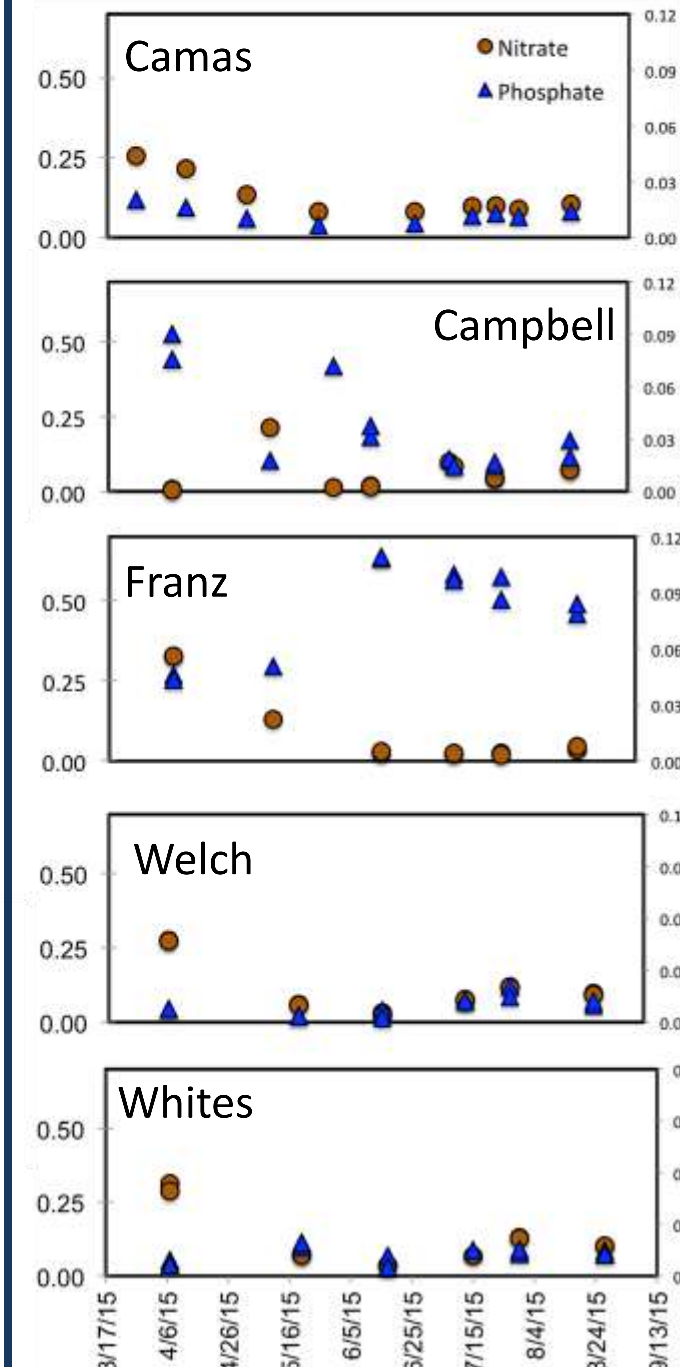




- Temperatures at Whites Island do not differ very much from the mainstem
- In contrast, temperatures at Franz Lake and Campbell Slough differ from the mainstem when river levels are low

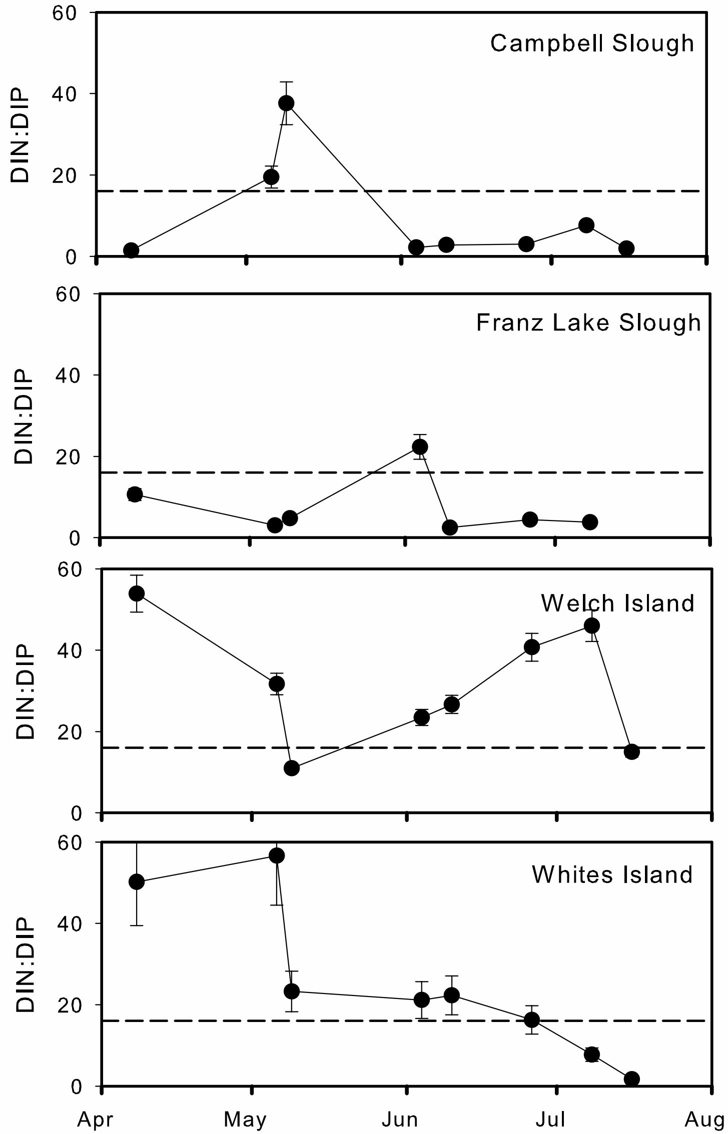
Nutrients (2014-2015)





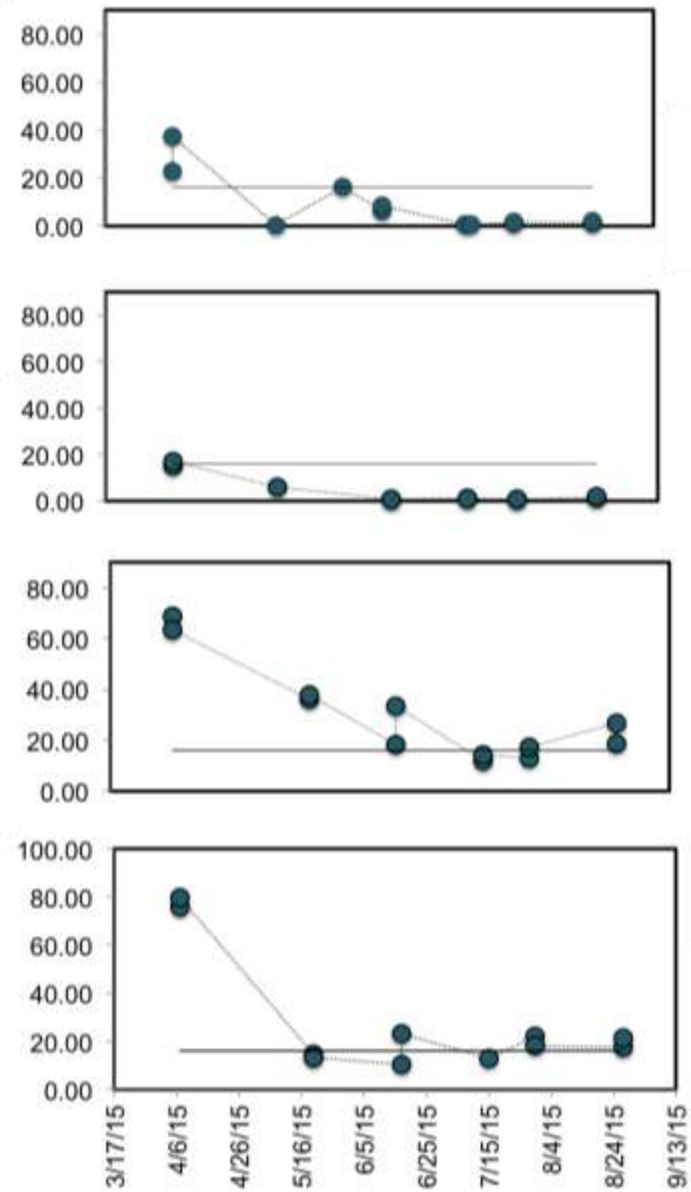
N:P

2014



Campbell Slough
Franz Lake Slough
Welch Island
Whites Island
DIN:DIP
60
40
20
0
Apr
May
Jun
Jul
Aug

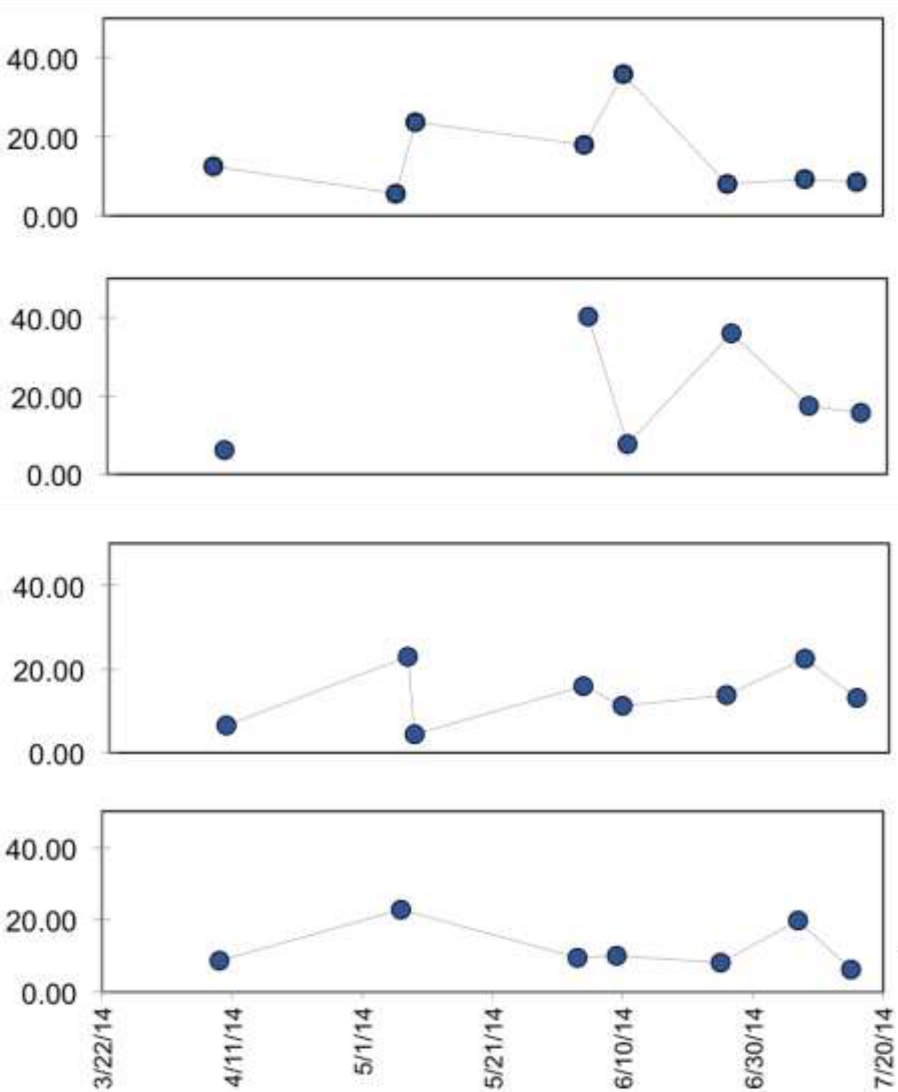
2015



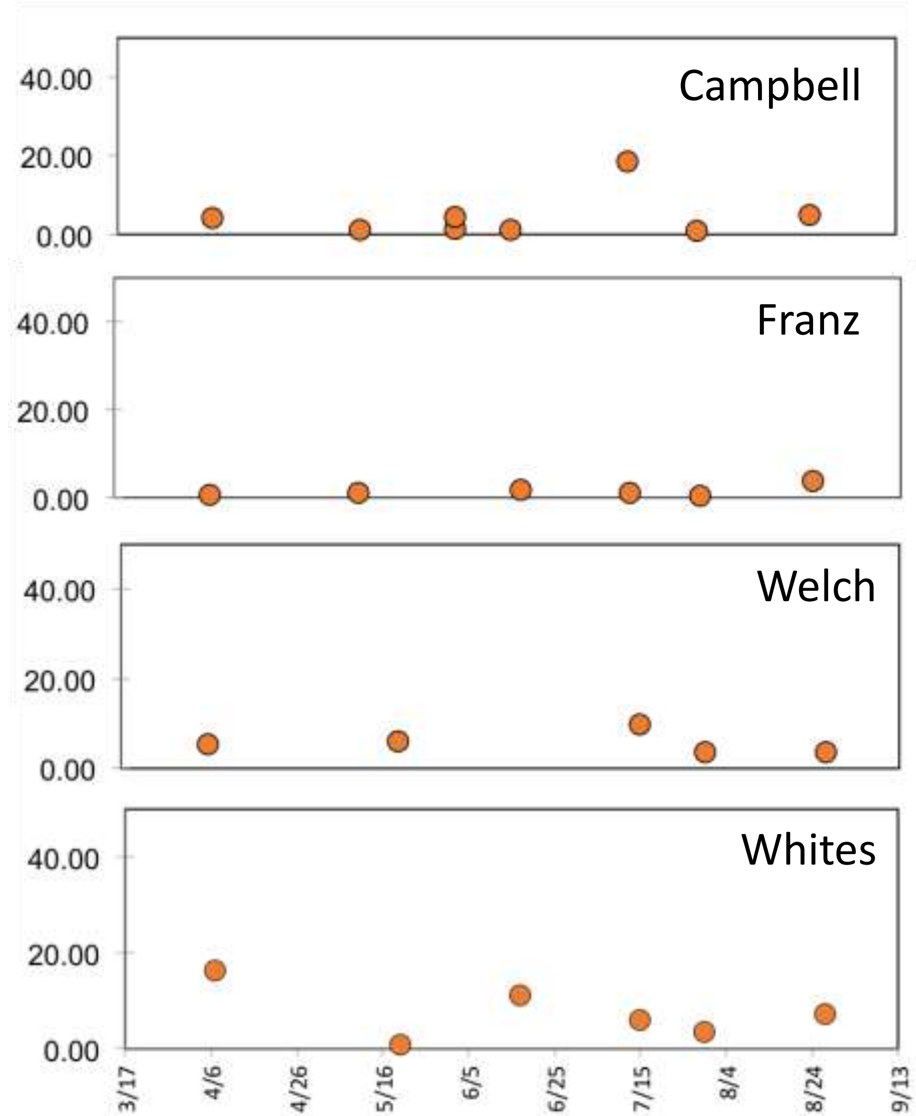
100.00
80.00
60.00
40.00
20.00
0.00
3/17/15
4/6/15
4/26/15
5/16/15
6/5/15
6/25/15
7/15/15
8/4/15
8/24/15
9/13/15

Chlorophyll

2014



2015



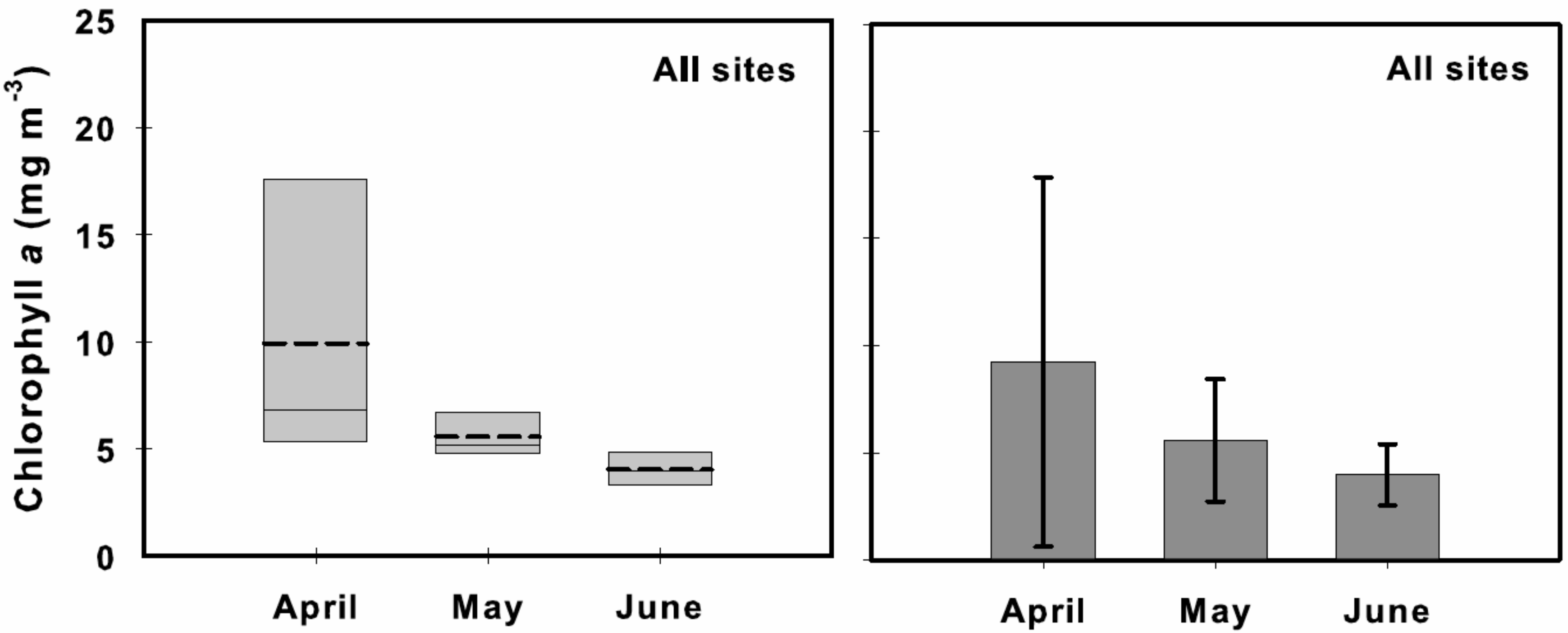
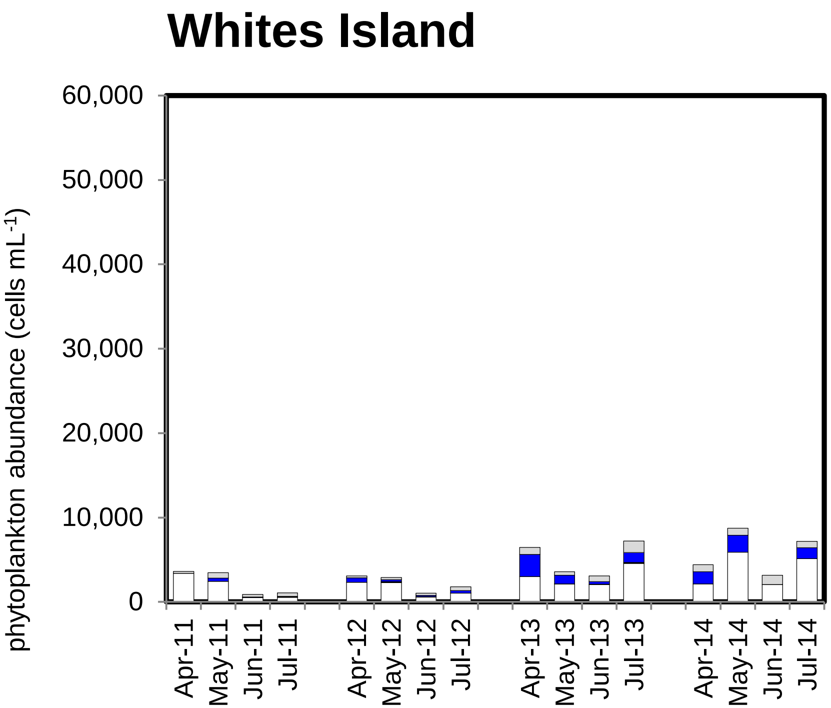
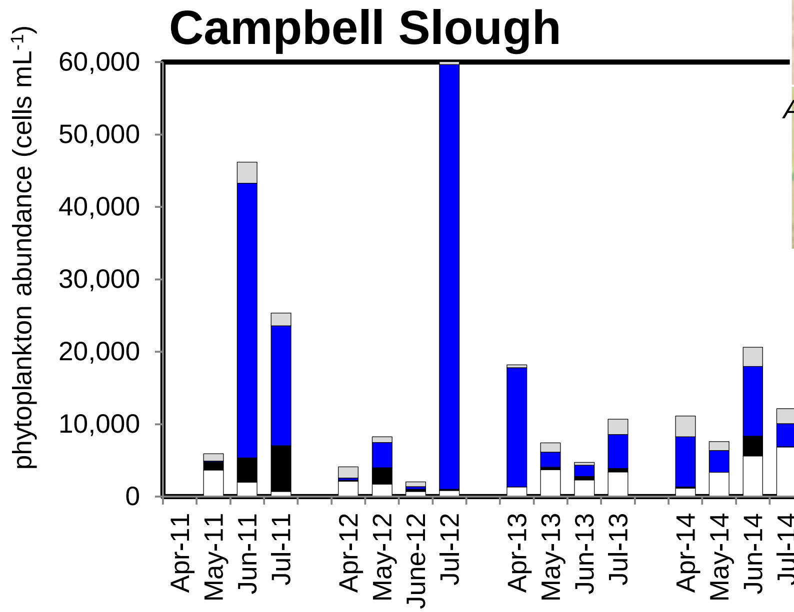
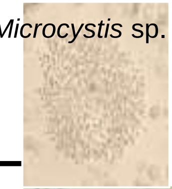


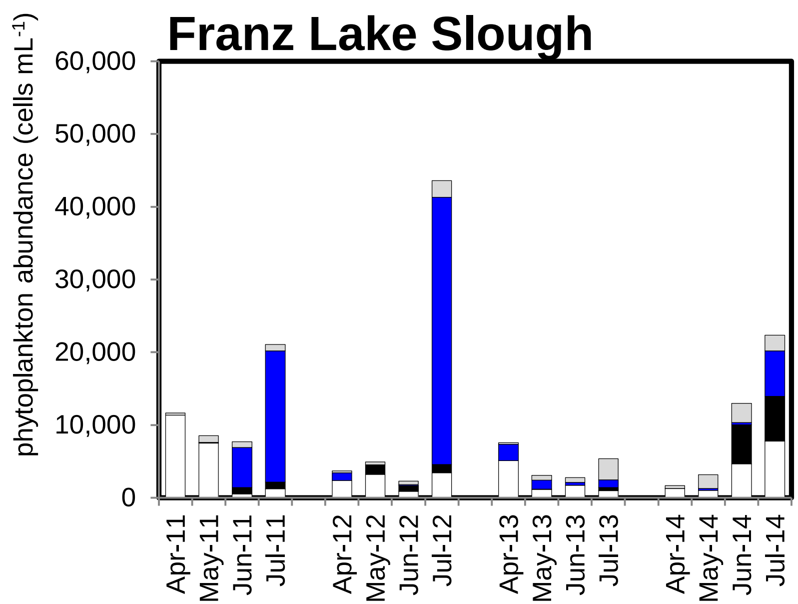
Figure 56. Variability in chlorophyll *a* concentration (in mg m^{-3}) in phytoplankton in the LCRE between 2011 and 2013 at four fixed sites: Ilwaco (Reach A), Whites Island (Reach C), Campbell Slough (Reach F), and Franz Lake Slough (Reach H). Values obtained for each of the months of April, May, and June after averaging across space (all sites included) and time (all years included) are shown. *Left*: box plots showing the range, median (thin line), and mean (bold dotted line) values for observations collected in each of the three months. *Right*: averages and standard deviations for the same data.

Phytoplankton: 2011-2014



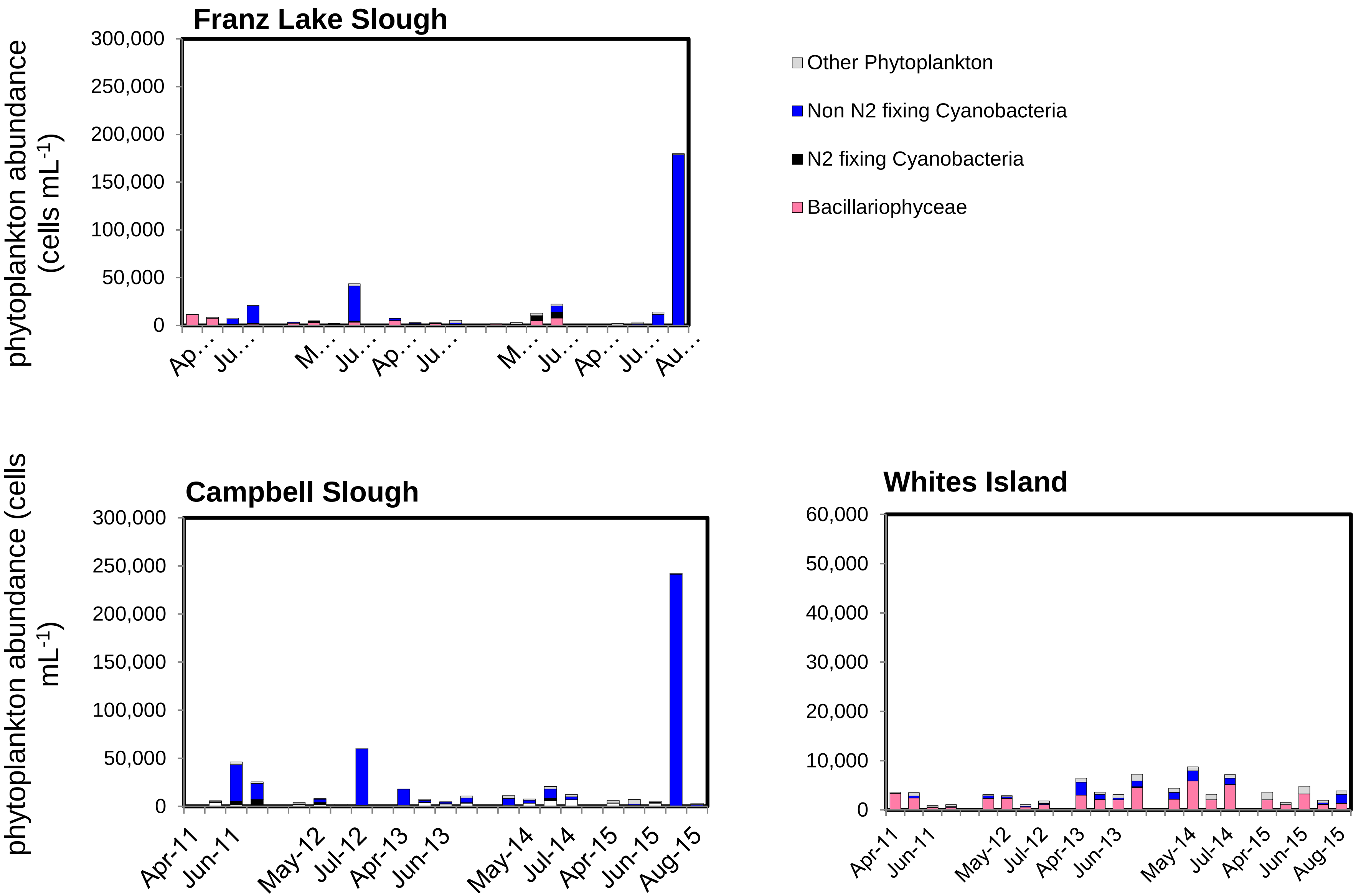




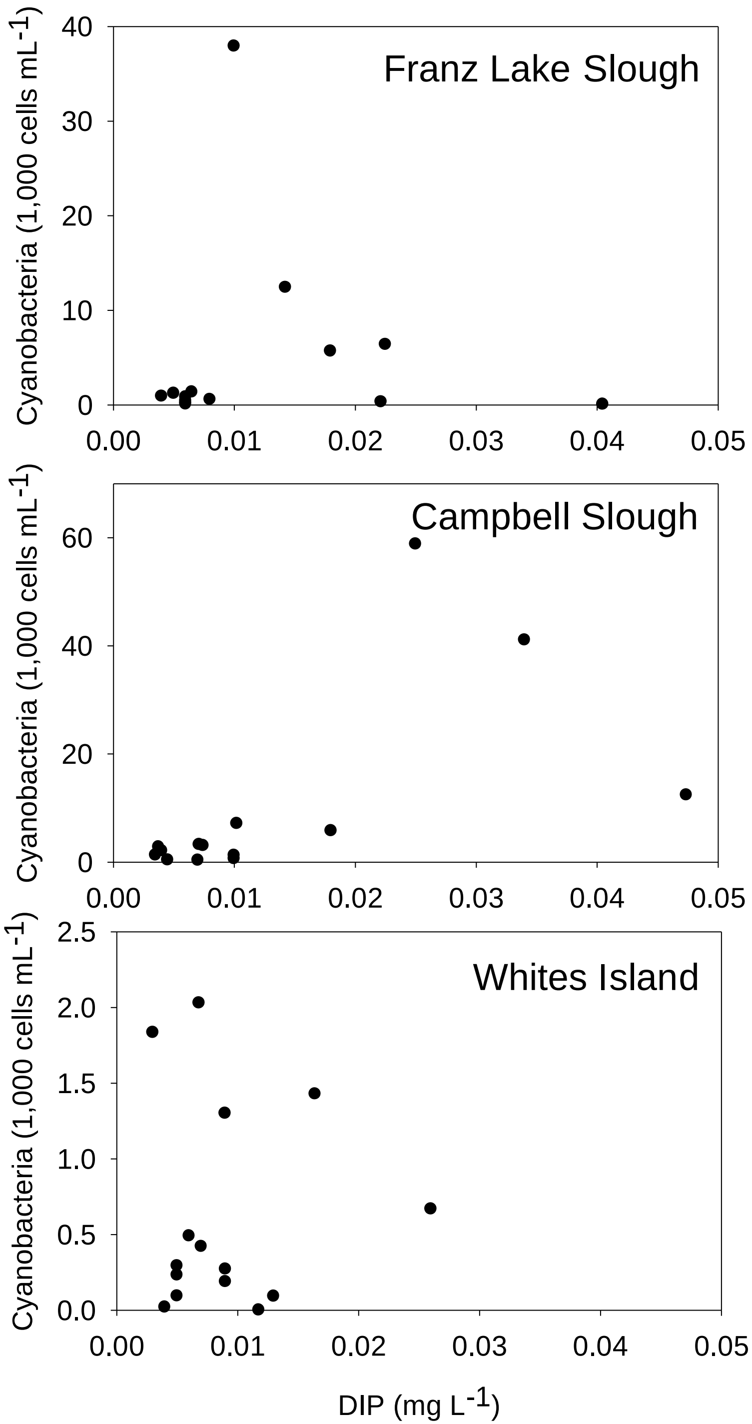


- Other Phytoplankton
- Non N2 fixing Cyanobacteria
- N2 fixing Cyanobacteria
- Bacillariophyceae

Phytoplankton: 2015

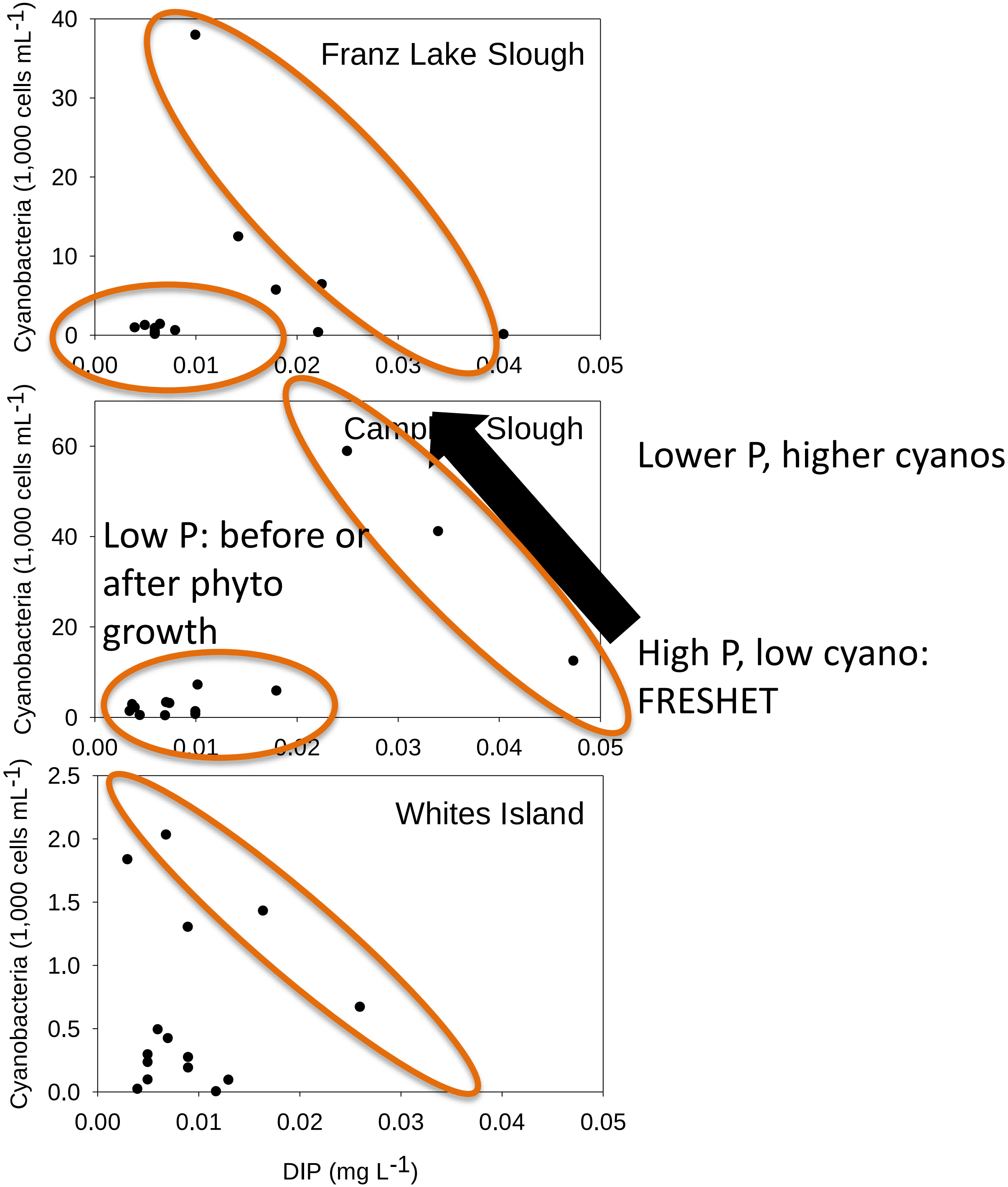


Are cyanobacteria populations related to phosphorus concentrations?



Data from 2011-2014

Data consistent with an axis of time since P inputs



Next steps

- Stable isotope samples have been sent for analysis
- Incorporate C13 and N15 data into isotope mixing model to determine organic matter sources fueling salmon growth
- Finish zooplankton counts for 2015

Thanks to…

- Andy Bryn (OHSU)
- Michelle Maier (OHSU, now EPA)
- Whitney Hapke (USGS)
- NOAA fish crew
- EMP team

BONNEVILLE POWER ADMINISTRATION
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NSF

Summary

- 2015 had relatively low phytoplankton biomass compared to 2014
- N:P ratios were favorable for competition for resources by cyanobacteria
- There were high abundances of colony forming, small cyanobacteria (*Merismopedia* and *Microcystis*)
- Hypothesize that lower river flow in 2015 led to smaller inputs of sediment-derived P to the system and that managed river flow likely helped to dilute cyanobacteria populations before blooms could develop

Program elements

- Phytoplankton and zooplankton abundance and species composition (2011-present)
- Chlorophyll (USGS: 2011-2013; OHSU 2014-present)
- Nutrients (USGS: 2011-2013; OHSU 2014-present)
- Mainstem conditions as viewed by in situ sensors (OHSU: 2011-present)
- Water quality of shallow water habitats (USGS: 2008-2014; OHSU: 2015-onward)
- Natural abundance stable isotopes for dietary analysis (USGS: 2011-2014; OHSU: 2015-onward)
- Other stuff: rates of primary production (USGS: 2011-2013); gut contents of macroinvertebrate prey (chironomids)