The Ecosystem Monitoring Program: Food Web Dynamics in the Lower Columbia River

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Lower Columbia Estuary Partnership

Pacific Northwest National Laboratory

Oregon Health & Science University

Importance of Tidally-Influenced Habitats

- Off-channel and floodplain habitats provide rearing and refugia opportunities to juvenile salmonids
- Wetlands are productive
  - Flux of OM to fuel the food web
  - Direct and indirect benefits
- Source of structure and OM to salmon prey

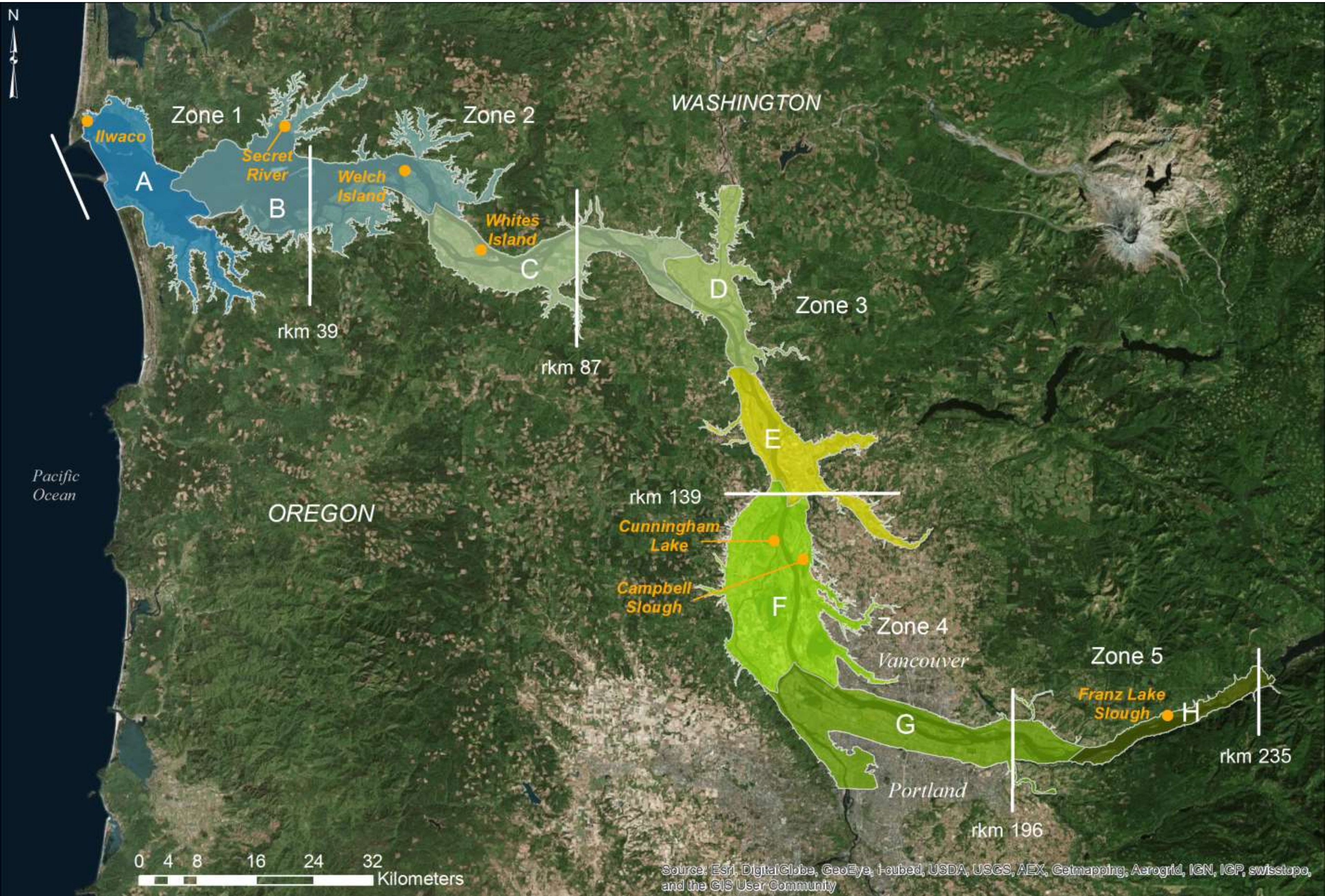
Lower Columbia River Food Web

- Historical importance of macrodetritus
- Hydropower development, diking, urbanization
  - Habitat Loss = reduction of macrodetrital inputs
  - "Greening" of the river (Sullivan et al., 2001)
- Phytoplankton could be important for fueling the salmon food web in the spring (Maier and Simenstead, 2009)

Estuary Partnership Ecosystem Monitoring Program (EMP)

- Annual monitoring since 2005
  - Status and trends of ecosystem condition
    - Comprehensive assessment of spatial and temporal variation of habitat, fish, food web, and abiotic conditions in the lower river
    - *Relatively undisturbed* shallow water vegetated habitats
    - Baseline conditions
- Integrated and collaborative effort with multiple partners
- Supported by funding from BPA/NPCC
- *What are the important juvenile salmon food web components and how does the food web vary in space and time?*

EMP Trends Sampling Sites



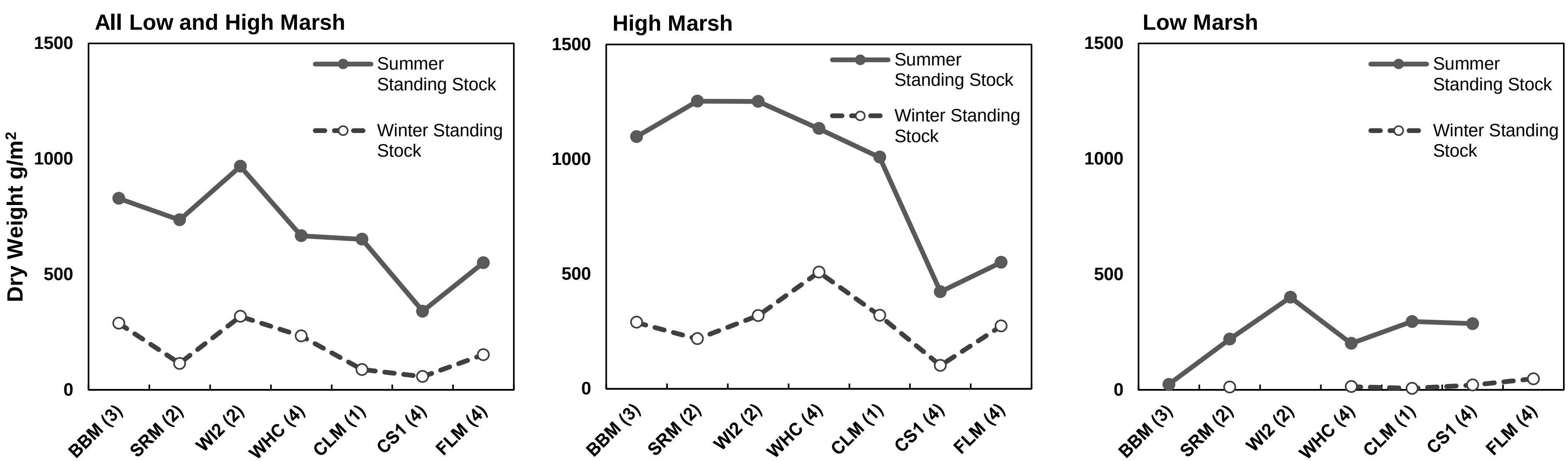
Macrodetritus Collection

- Summer peak vegetation biomass – estimate of annual primary production
  - Each year annual production dies back in winter, decomposes
- Macrodetritus production
  - Above-ground biomass (0.10 m^2, attached live/dead)
  - Separated by strata and dominant species
  - Twice annually
    - August = summer peak biomass
    - February = remaining biomass after winter die-off

Summer standing stock – Winter standing stock = Estimated annual detritus production

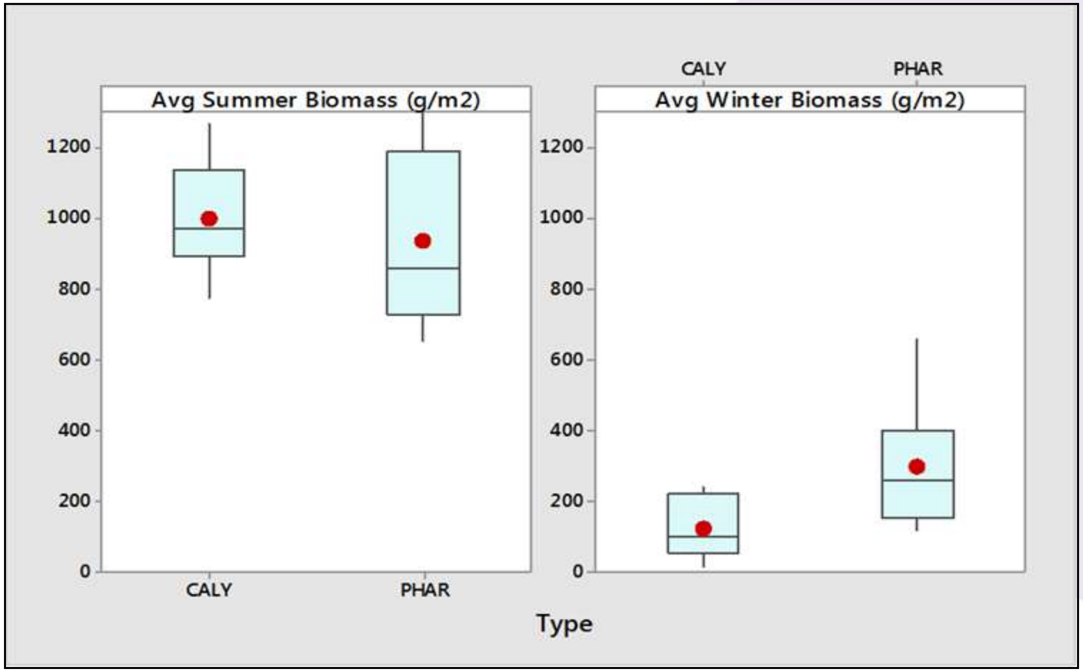
Vegetation Biomass and Macrodetritus Production

- Greatest biomass typically occurs in high marsh
- Production varies spatially (upper reaches < lower reaches)
- Species-specific differences in detrital production
  - Avg annual macrodetrital contribution:
    - CALY (1161 g/m^2) > PHAR (627 g/m^2)

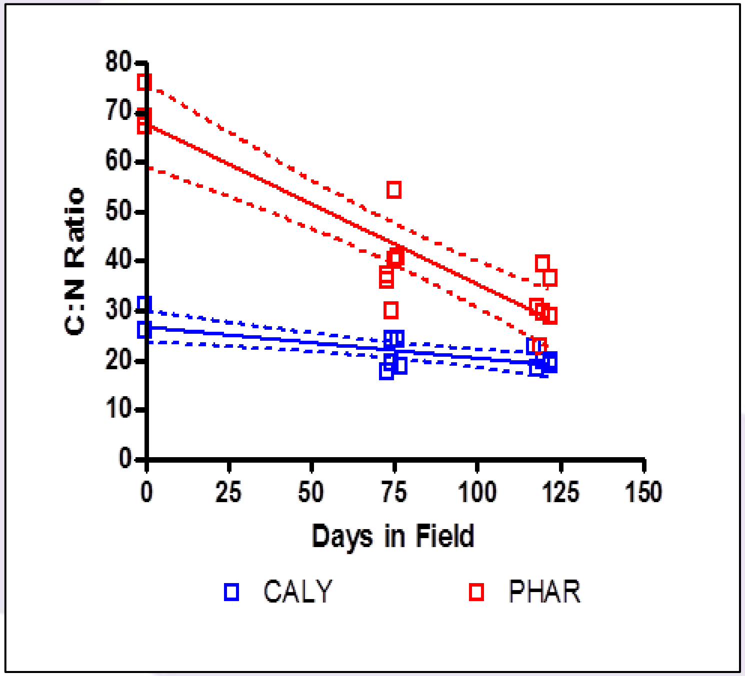


Macrodetritus Timing and Quality

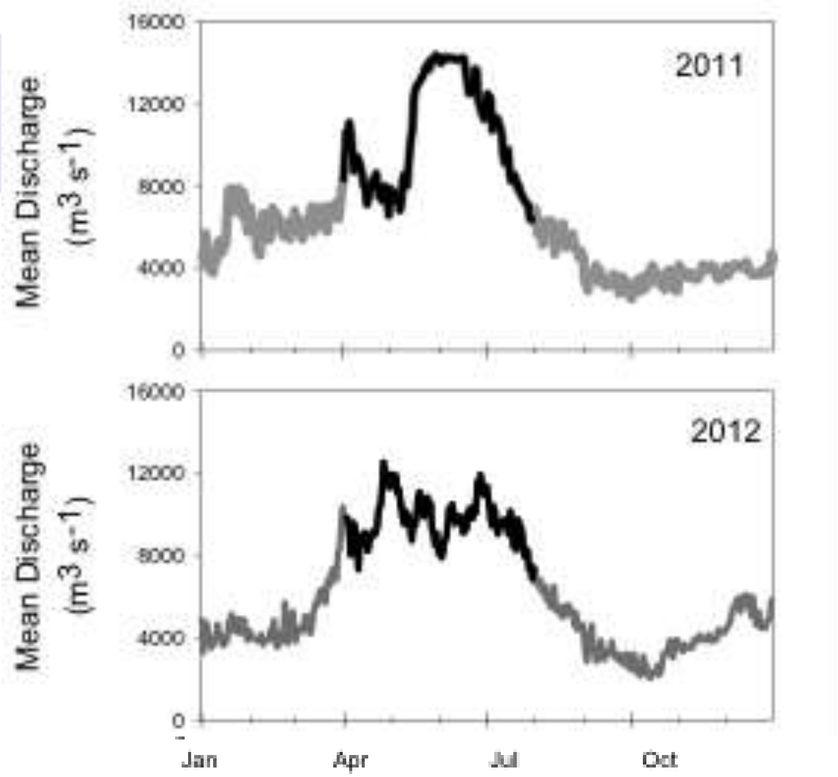
- Winter breakdown is variable according to species
  - PHAR breaks down at slower rate than CALY
- Detrital quality higher in CALY than in PHAR in spring

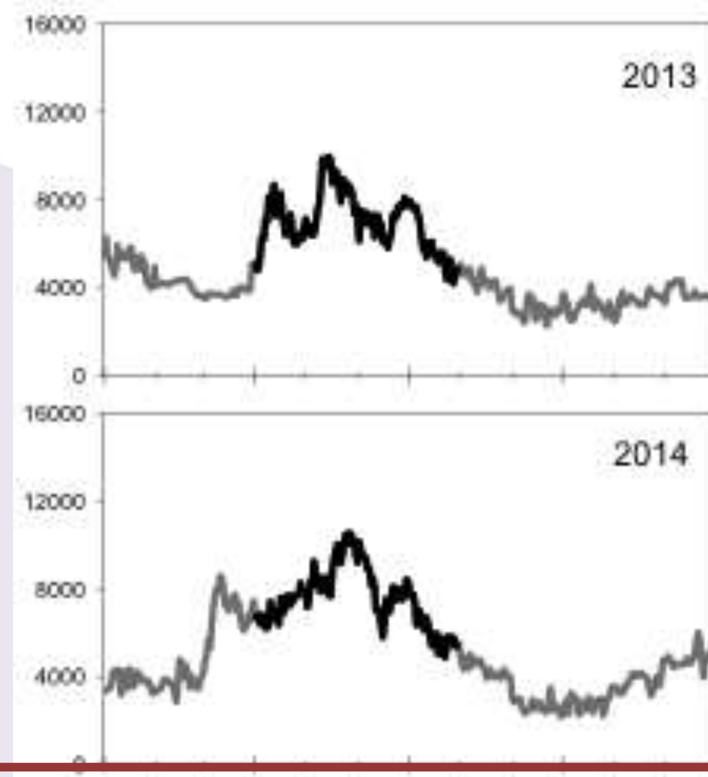


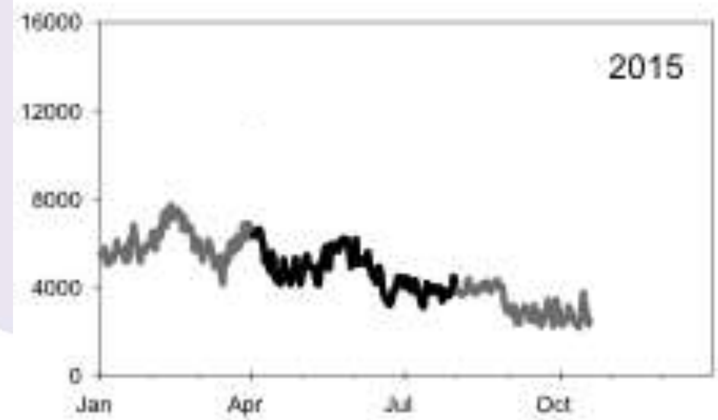
Winter standing stock higher in PHAR (p=0.037)



Higher quality in CALY (p<0.001)







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

2015 Vegetation and Macrodetritus

- Lower inundation
  - Greater productivity and summer standing stock in low marsh
  - Morphological differences in some plant species
    - *Sagittaria latifolia*: taller, higher cover

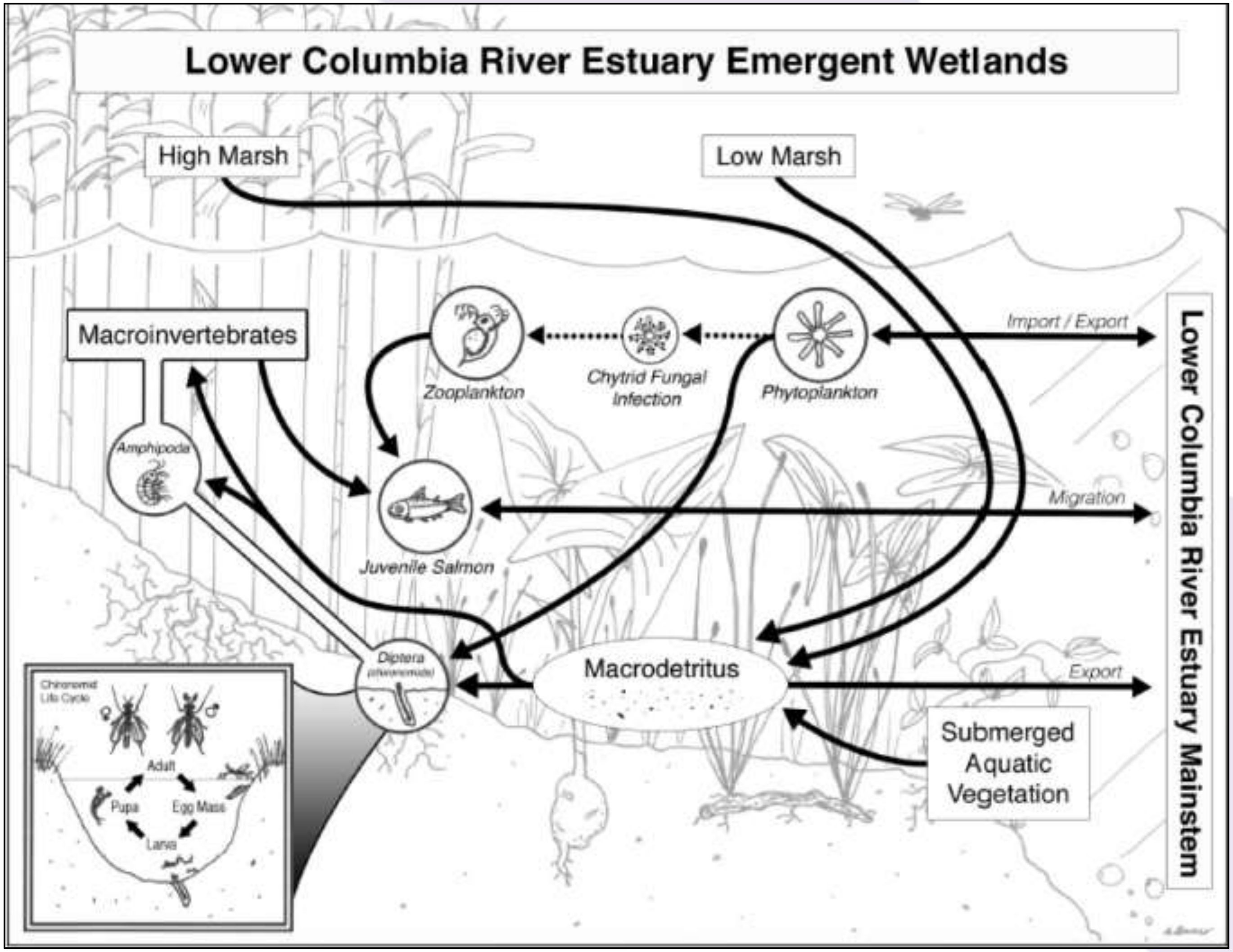
Campbell Slough, Reach F

Phytoplankton Collection

- 2011-2015
- Annual monitoring at trend sites – April to July
- Primary Production: biomass/abundance phytoplankton (free-floating algae) and periphyton (attached algae), stable-isotope analysis, nutrient concentrations
- Secondary Production: zooplankton abundance, species composition
- Continuous water quality monitoring (site-specific and mainstem)

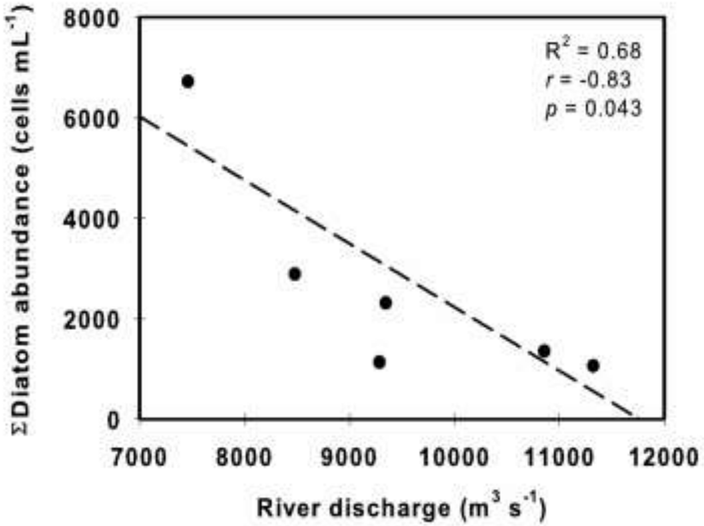
Role of Phytoplankton in Salmon Food Web

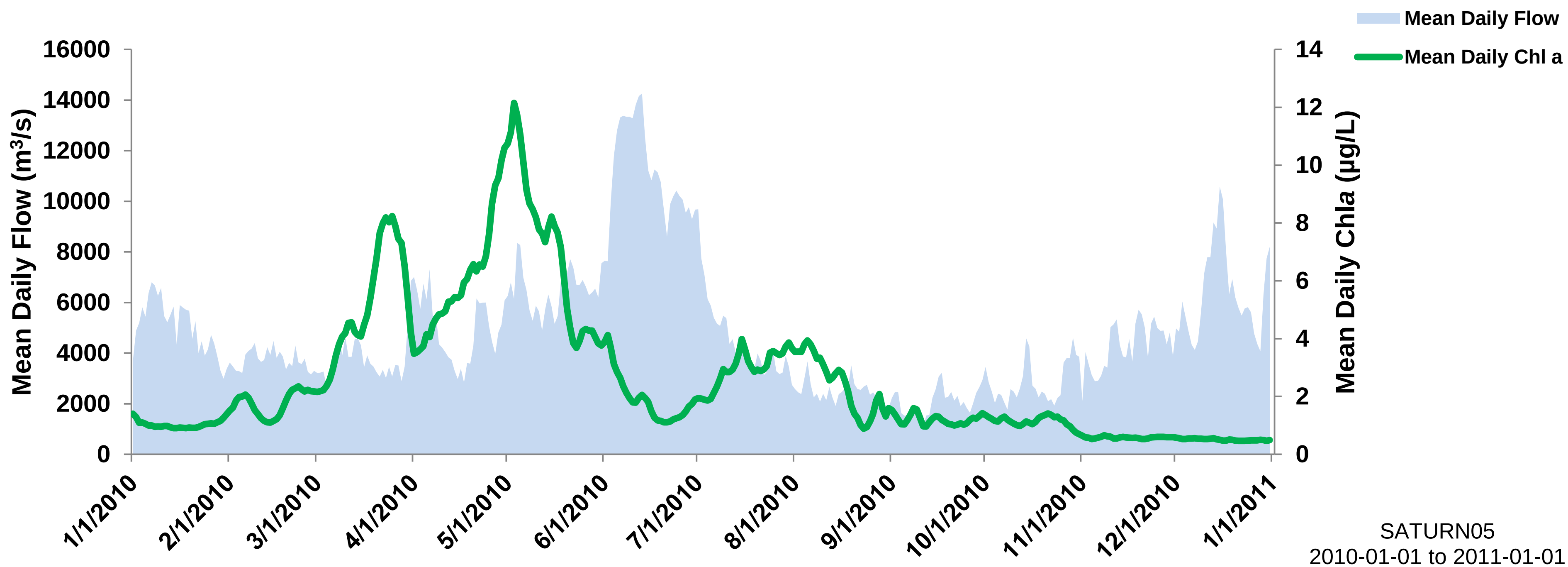
- Phytoplankton abundance consistently highest in early spring (Mar-May)
  - Dominated by diatoms
- Phytoplankton fuel zooplankton and macroinvertebrate production



Trends in Phytoplankton Abundance

- Phytoplankton abundance
  - Inversely correlated with river discharge
  - Greater in shallow water vs. mainstem
  - Greater in areas of high retention vs. flushed
  - Driven by nutrient loadings





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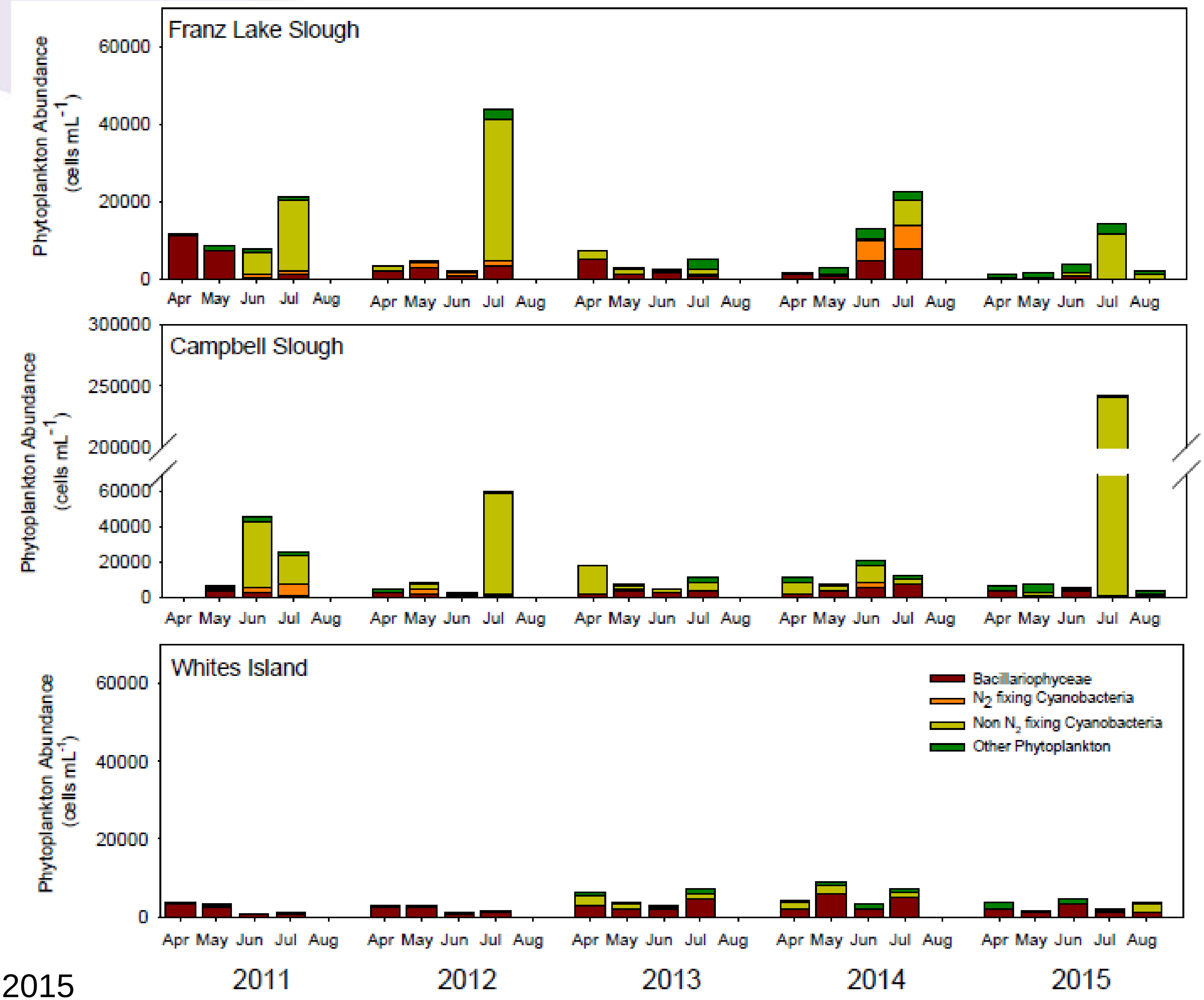
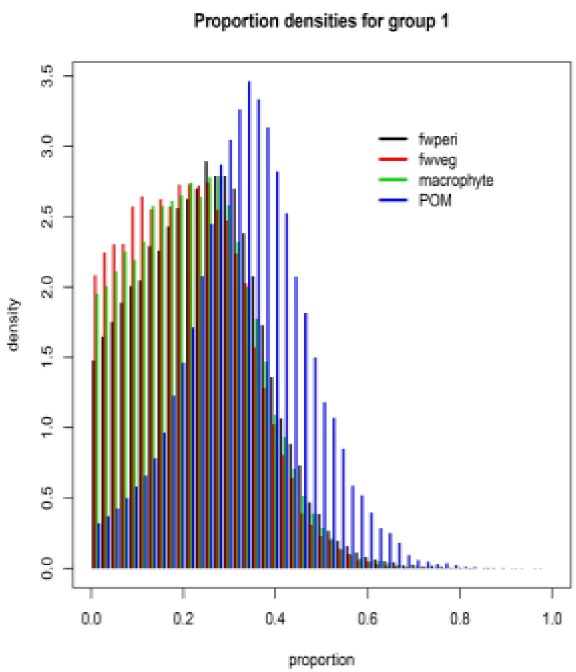


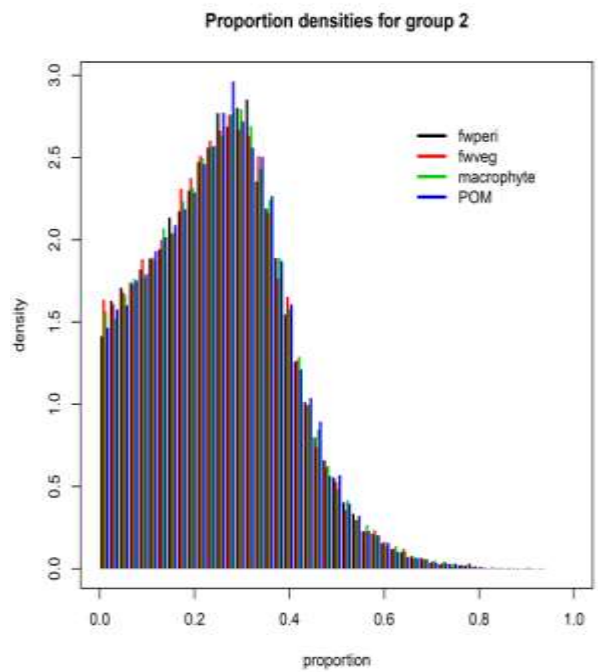
Tausz 2015

Stable Isotope Analysis

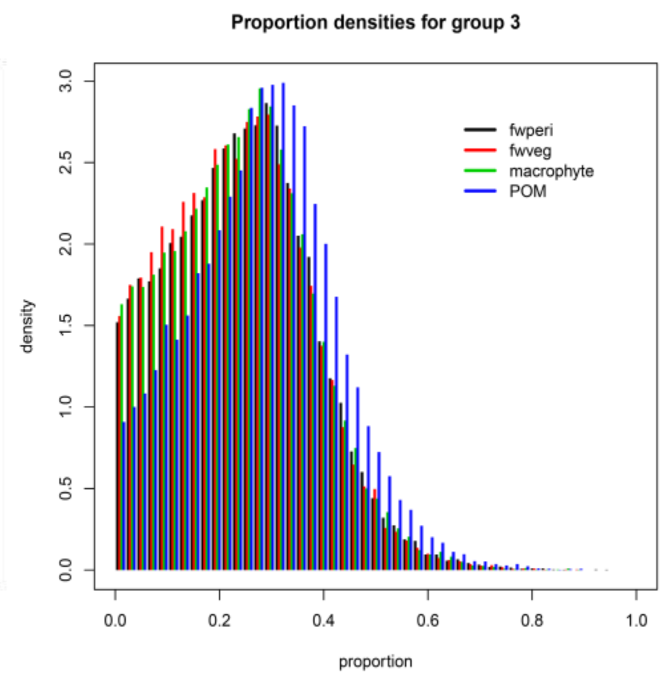
- Phytoplankton important for chironomids in spring, then switches to mixed diet (vegetation and phytoplankton sources) later in season



May



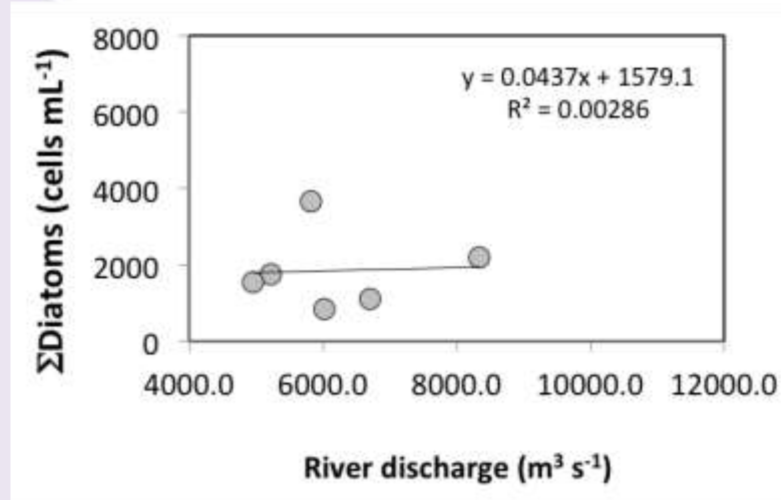
June

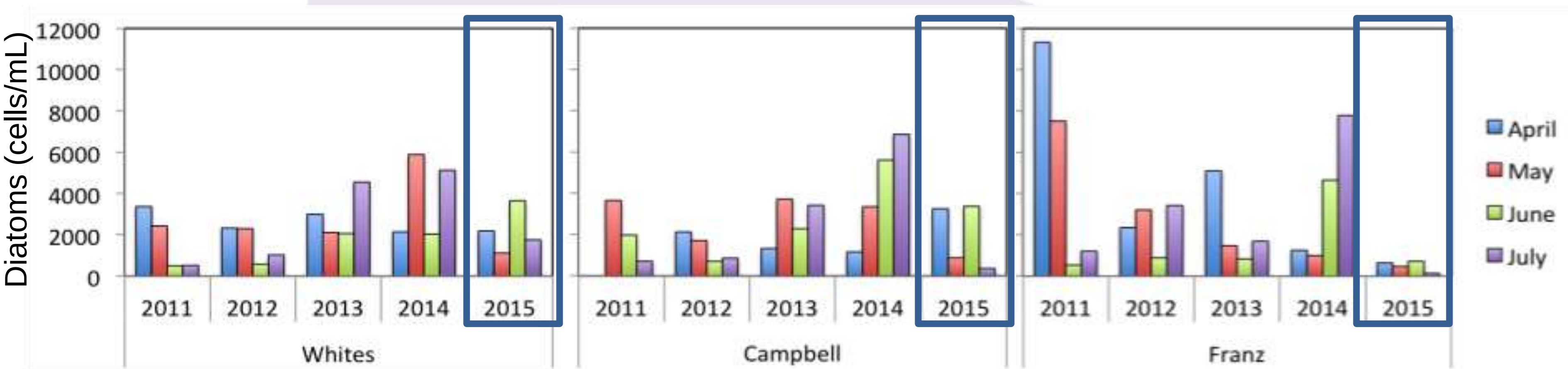


July

2015 Conditions

- Lower discharge: diatom abundances were not negatively associated with discharge
- Franz Lake Slough had lower diatom abundances in 2015
- Lower diatom abundances in May and July, but not June (2015) at other sites





Summary

- Macrodetritus and phytoplankton may both be important food web components
- Food web dynamics driven by a variety of factors (hydrology, community composition, nutrient loading, flushing)
- Species-specific differences in macrodetrital production may affect food web dynamics
  - RCG = reduced food quality and availability to prey = low abundance of prey during juvenile salmon migration
- High marsh are productive and should be preserved
- In spring, phytoplankton are available when macrodetrital material is not
  - Phytoplankton could benefit prey community during salmon migration

Implications for Climate Change

- Shifts in plant growth and community, affecting amount and timing of macrodetrital inputs
- Proliferation of invasive species could cause reduced macrodetrital quality
- Lower flows may disrupt phytoplankton dynamics
- Poorly flushed areas will experience increased cyanobacteria blooms

Knowledge Gaps and Future Directions

- Continued vegetation biomass and phytoplankton sampling
  - Fill spatial gaps, capture annual variability, food web role
- Assess macrodetrital production more frequently
  - Understand timing and quality of macrodetrital inputs
- Phytoplankton sampling above BON
  - Identify sources of phytoplankton - Site specific vs. impoundments
- Gut contents of salmon prey
  - Diptera diets and diatom source
- Continued and refined stable isotope analysis

Thanks!

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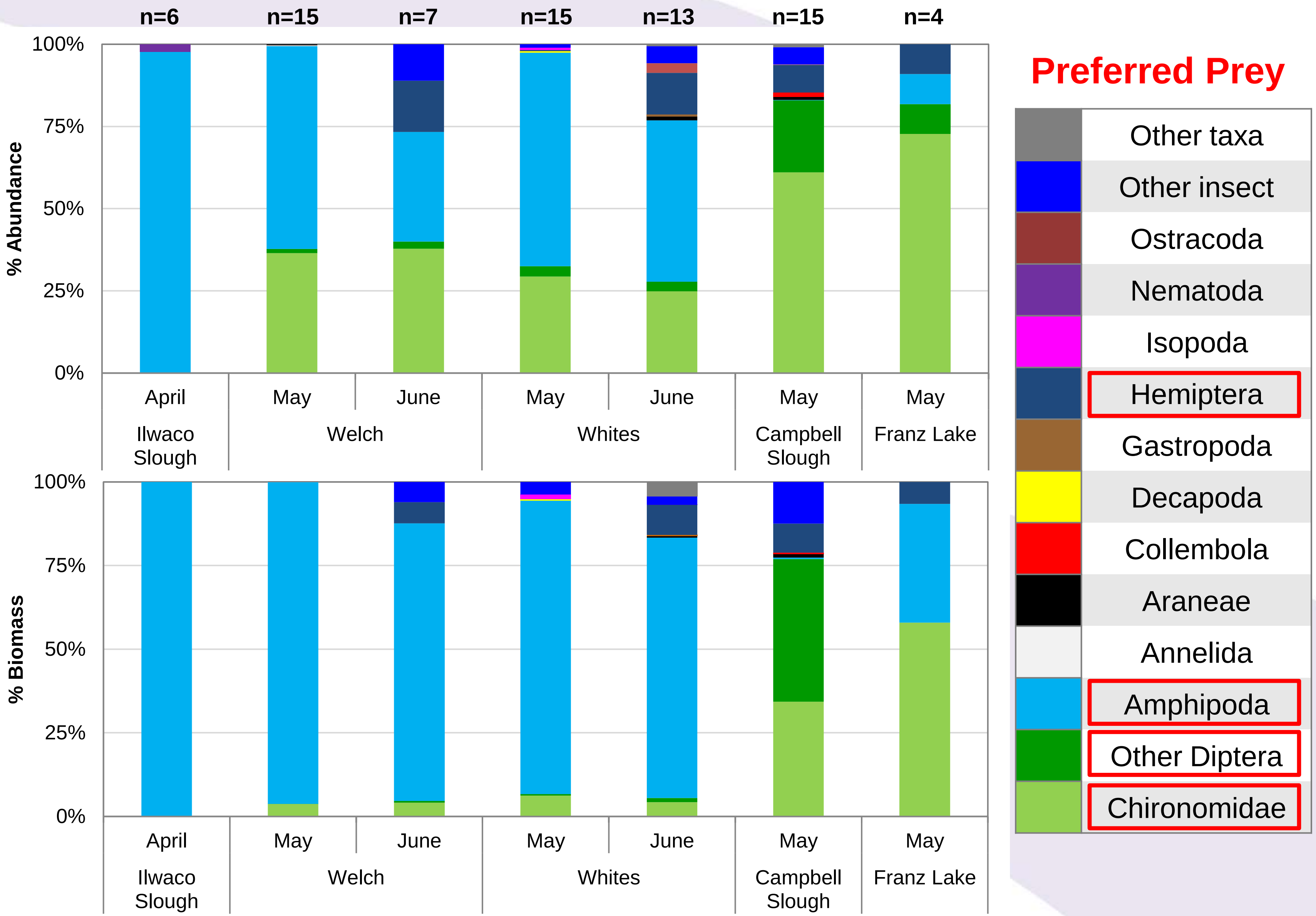
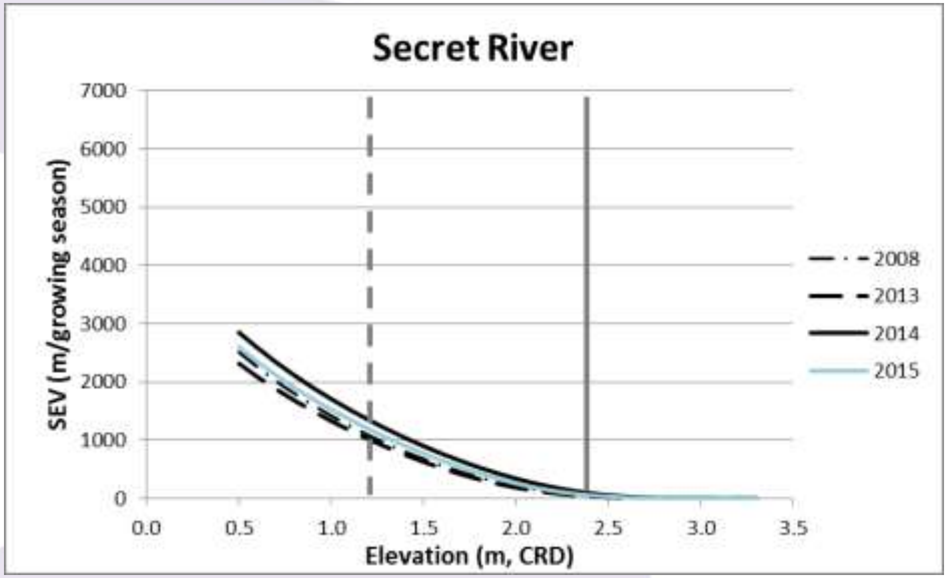
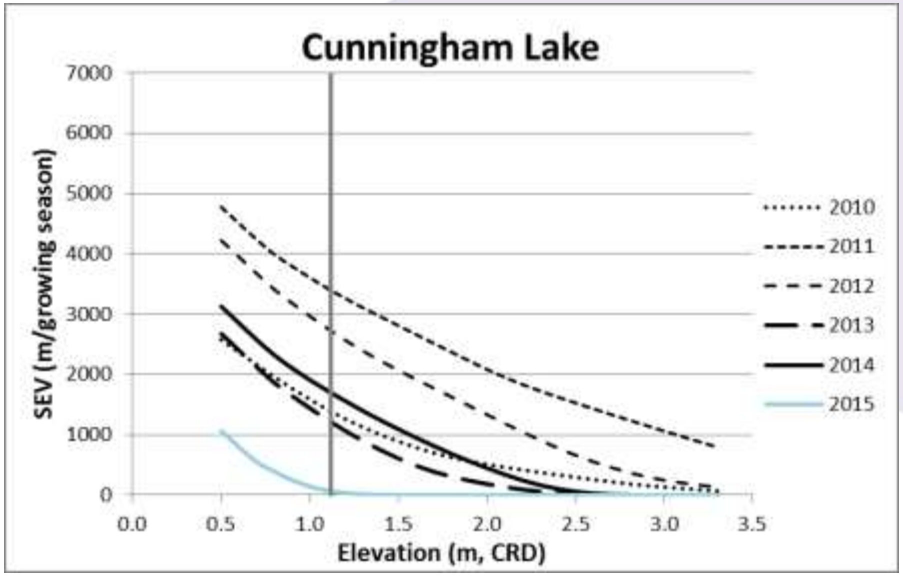
Salmon Prey

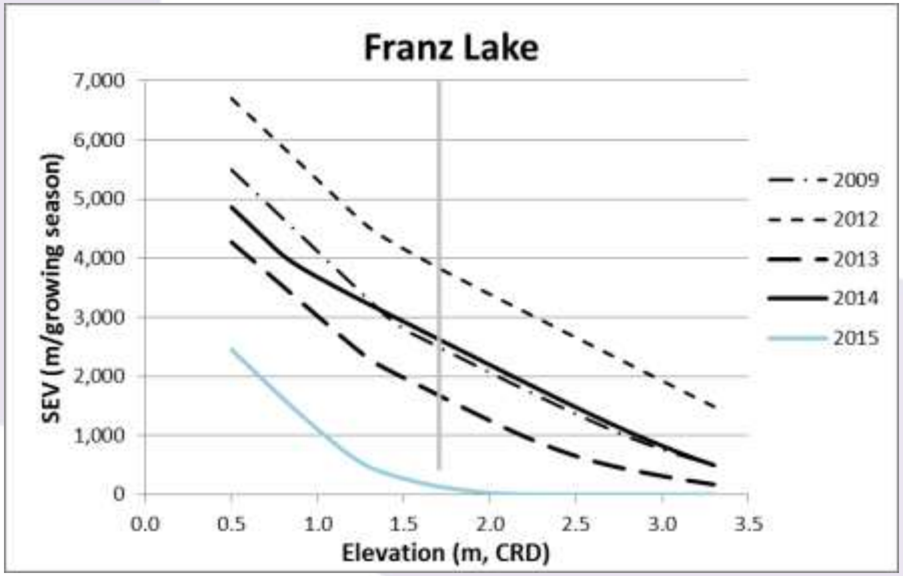
2015 Diet Composition



Site Inundation







Hydrology dictates inundation levels at sites and data help identify where and how well vegetation species thrive.

2012 – 2013 Mainstem Conditions