Habitat conditions & juvenile Chinook salmon food webs in tidal emergent wetlands in the Lower Columbia River

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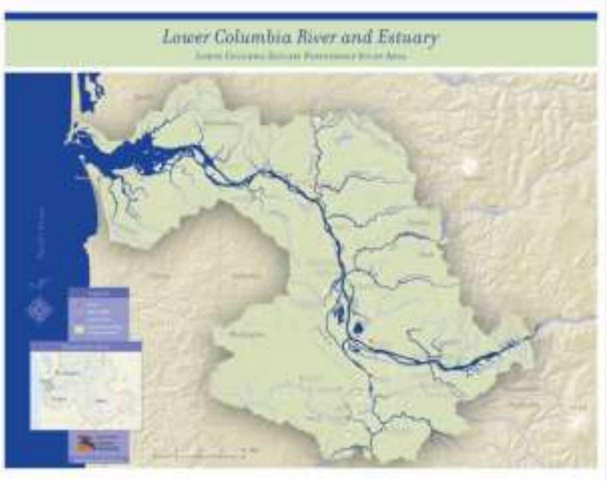
Background

- 13 Columbia River salmon species are Threatened/Endangered

- Habitat loss and alterations to food webs identified as potential factors in population declines



- Loss of emergent wetland habitat, greening of the river
  - Shift in organic matter loadings
  - Effects on juvenile salmon food webs not well understood
  - Conditions of existing habitats need to be monitored

Ecosystem Monitoring Program (EMP)

- Physical, chemical, and biological conditions of shallow, tidal wetland habitats used by out-migrating juvenile salmon

- Previous focus: vegetation, salmon utilization of sites, prey availability, & fish condition

- Findings:
  - Juvenile Chinook diet preference, regardless of invert diversity at sites:
    - Dipteran larvae, especially chironomids
    - Amphipods (estuarine sites)
  - Emergent vegetation provides important habitat for invertebrate prey

Habitat characterization

- Water-quality monitors:
  - Temperature
  - pH
  - Dissolved oxygen
  - Specific conductance
  - Turbidity (2008—09)
  - 15/30 minute logging
  - April – July (2011 – 2014)

- In-stream primary production

- Food web utilization

Sites

Ilwaco (reach A)

rkm 5

Whites Island (C)

rkm 72

Campbell Slough, Ridgefield (F)

rkm 149

Franz Lake Slough (H)

rkm 221

Habitat conditions: water quality

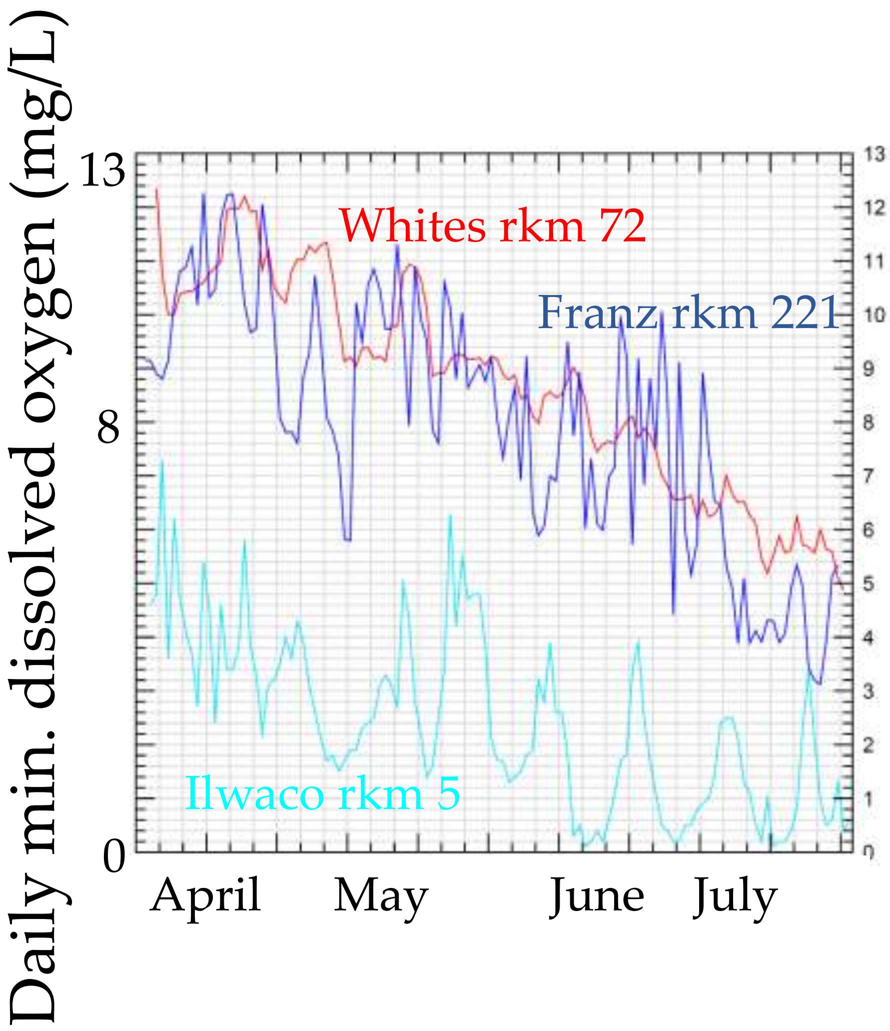
- Sites had best water-quality conditions in April-May

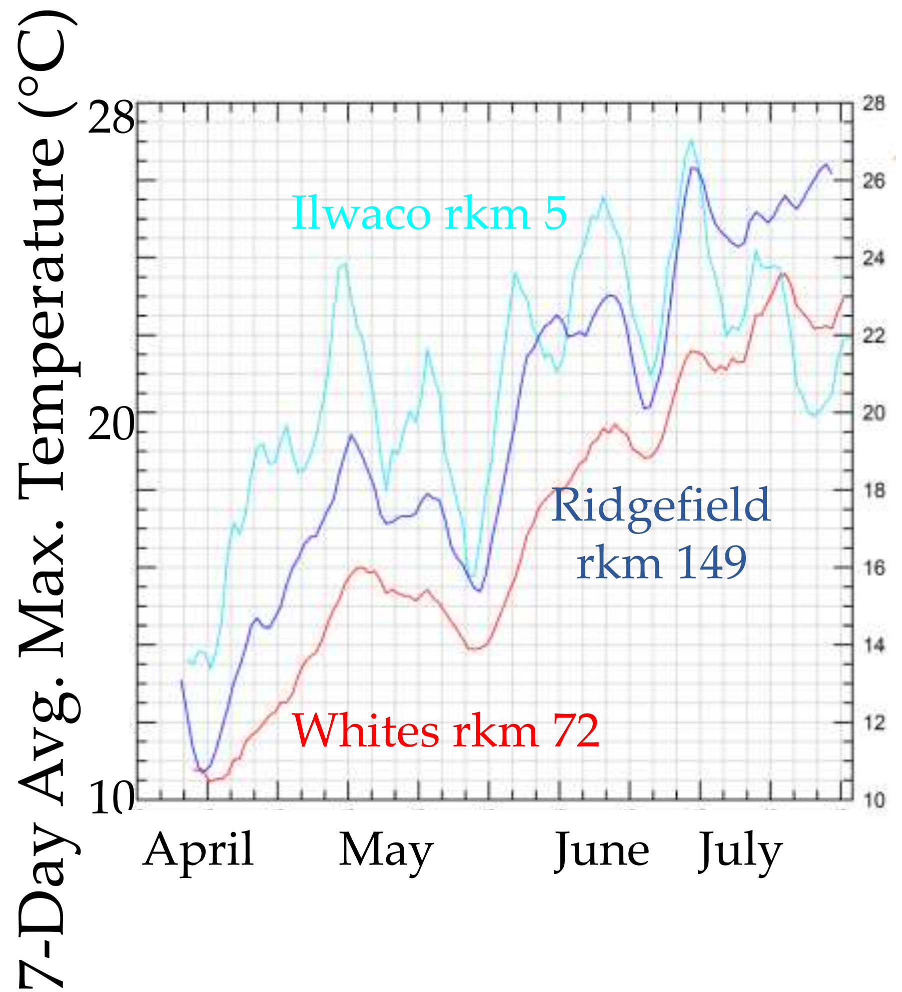
- All sites experience unsuitable conditions by ~July most years
  - High temperature, low dissolved oxygen

- Sites differed in frequency and duration of unsuitable conditions

- Primary drivers:
  - Columbia River flows
  - Site position: tidal influence and distance from mainstem → flushing rate

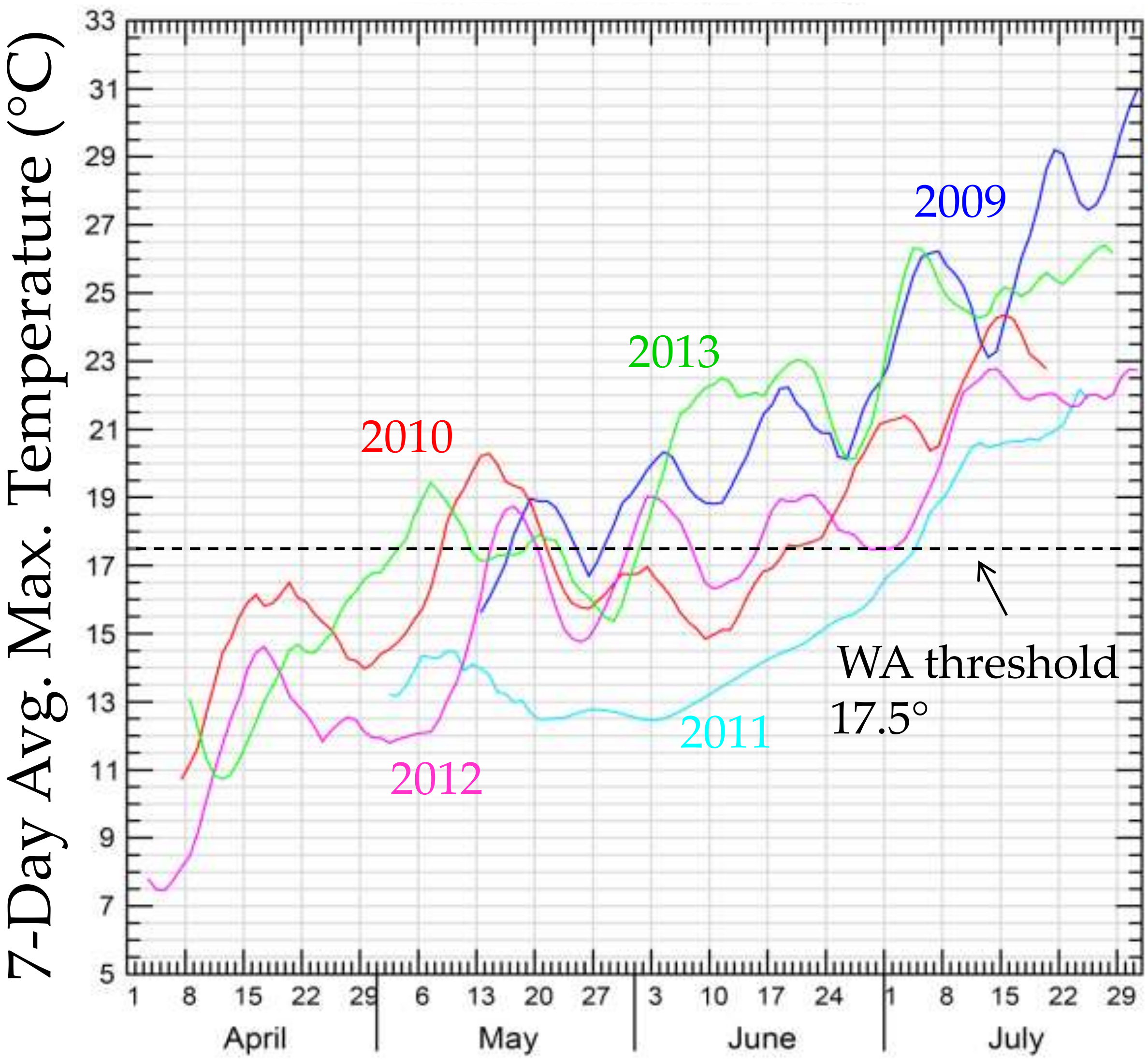
Inter-site variability



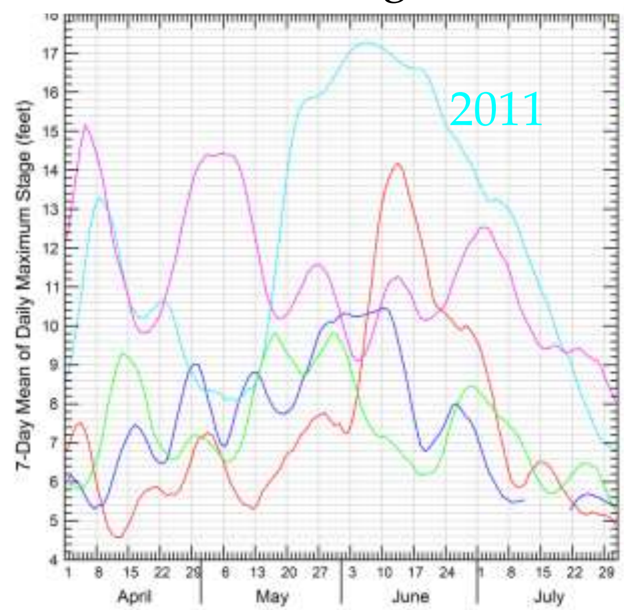


Inter-annual variability

Campbell Slough, Ridgefield NWR



Columbia River Discharge



Habitat Conditions: Primary Productivity

- Examine patterns in **abundance/composition of primary & secondary producers** in shallow wetland habitats during juvenile salmon migration

- Primary and secondary production (USGS, OHSU):
  - phytoplankton abundance, productivity rates, species composition
  - periphyton abundance, productivity rates
  - zooplankton abundance, species composition

Phytoplankton

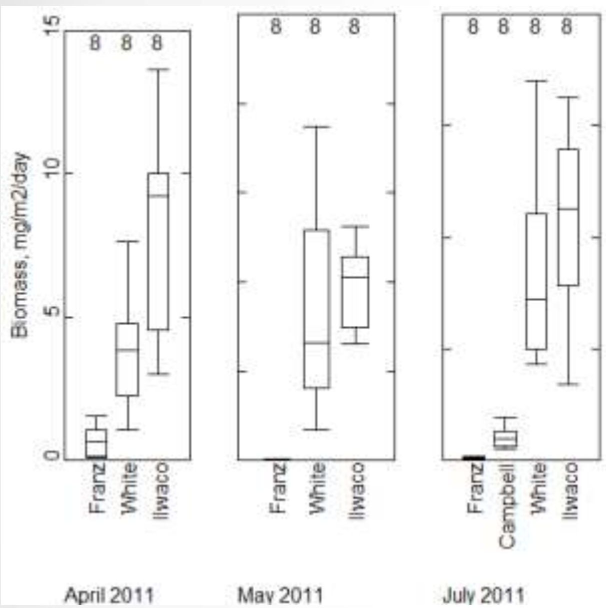
- Phytoplankton abundance decreases downstream

- Repeatable spring bloom with minor blooms, dominated by similar species (*Asterionella formosa*, *Aulacoseira granulata*, *Skeletonema potamos*, etc.);

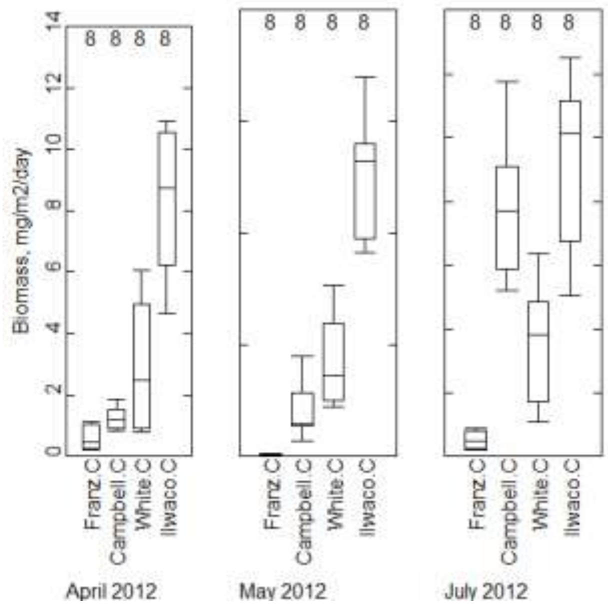
- Phytoplankton biomass/abundance/species composition strongly influenced by river flow

Periphyton

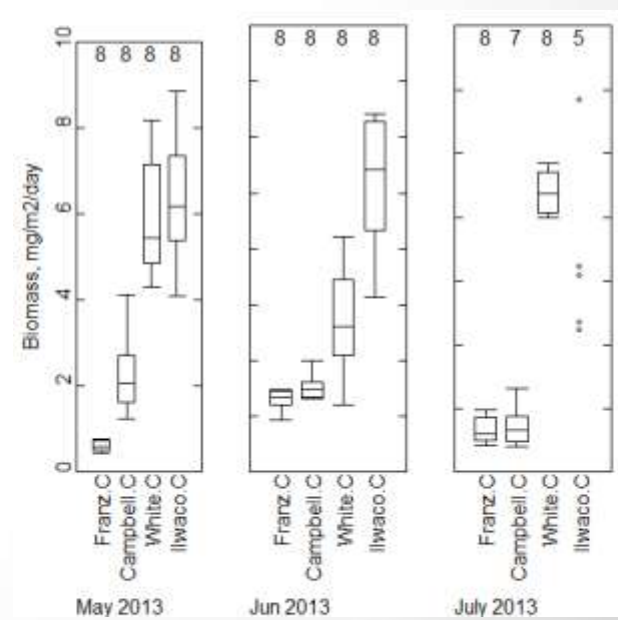
- Periphyton productivity increases downstream
- No clear seasonal trends



2011



2012



2013

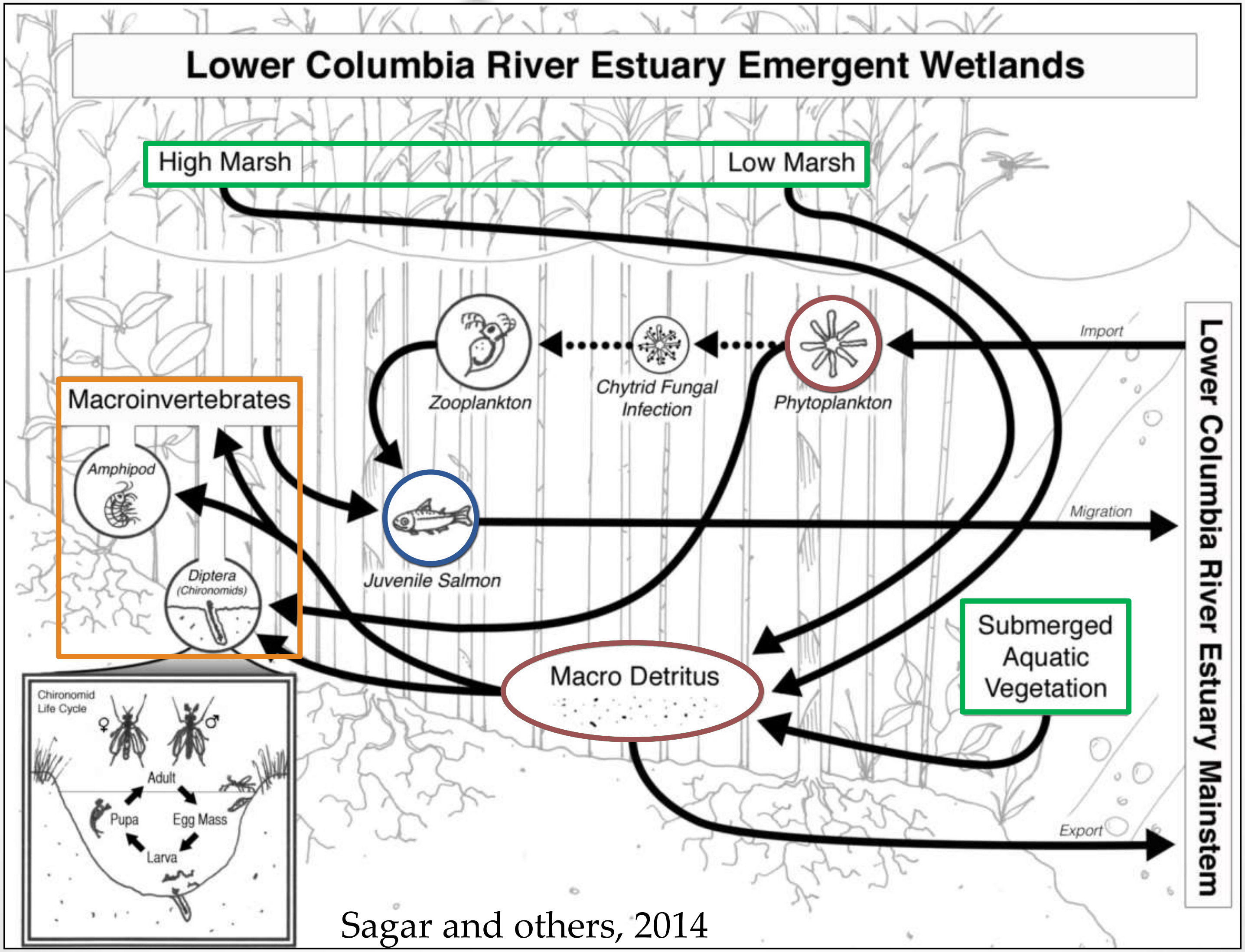
Food Web Analysis

- Goal: determine the important food web components supporting juvenile salmon

- Study question: **What are the dominant organic matter sources supporting juvenile Chinook salmon food webs in the LCRE?**
    - **Changes in dominant sources by time, site?**




Conceptual model



Sagar and others, 2014

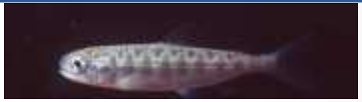
Approach: Stable Isotopes

- **Natural abundance stable isotopes of C, N as food web tracers**
- δ values: ratio of heavy to light isotope, vs. a standard
- δ values of consumers' tissues reflect food sources
- Metabolic loss of light isotopes → consumers in higher trophic levels become enriched in heavy isotope ("trophic enrichment")
- Trophic enrichment factors (Post, 2002)
    - 0.4 ±1.3 ‰ ($\delta^{13}C$)
    - 3.4 ±1.3 ‰ ($\delta^{15}N$)

Sampling Design

- 4 wetland sites in LCRE, April-July

- Juvenile Chinook salmon muscle



- Invertebrates
- Hatchery food

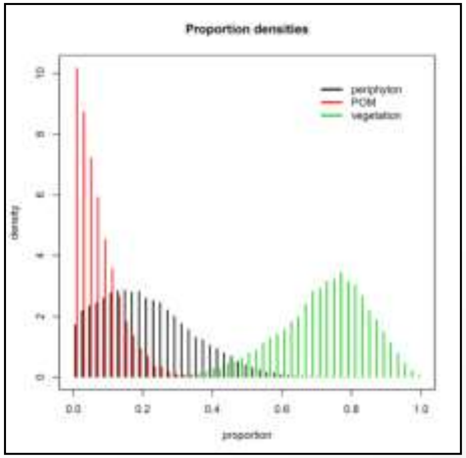
- Phytoplankton, periphyton
- Marsh vegetation
- Submerged aquatic vegetation

SIAR Mixing Model

- SIAR food web mixing model (Parnell & others, 2010)

- Estimates proportions of food sources in a consumer's diet
  - Allows for many food sources
  - Incorporates variability in SI signatures of food sources
  - Model output: density of estimated dietary proportions

- Model runs:
  - Chinook salmon as consumers
  - Invertebrates as consumers



Preliminary Results: salmon diets (2010-12)

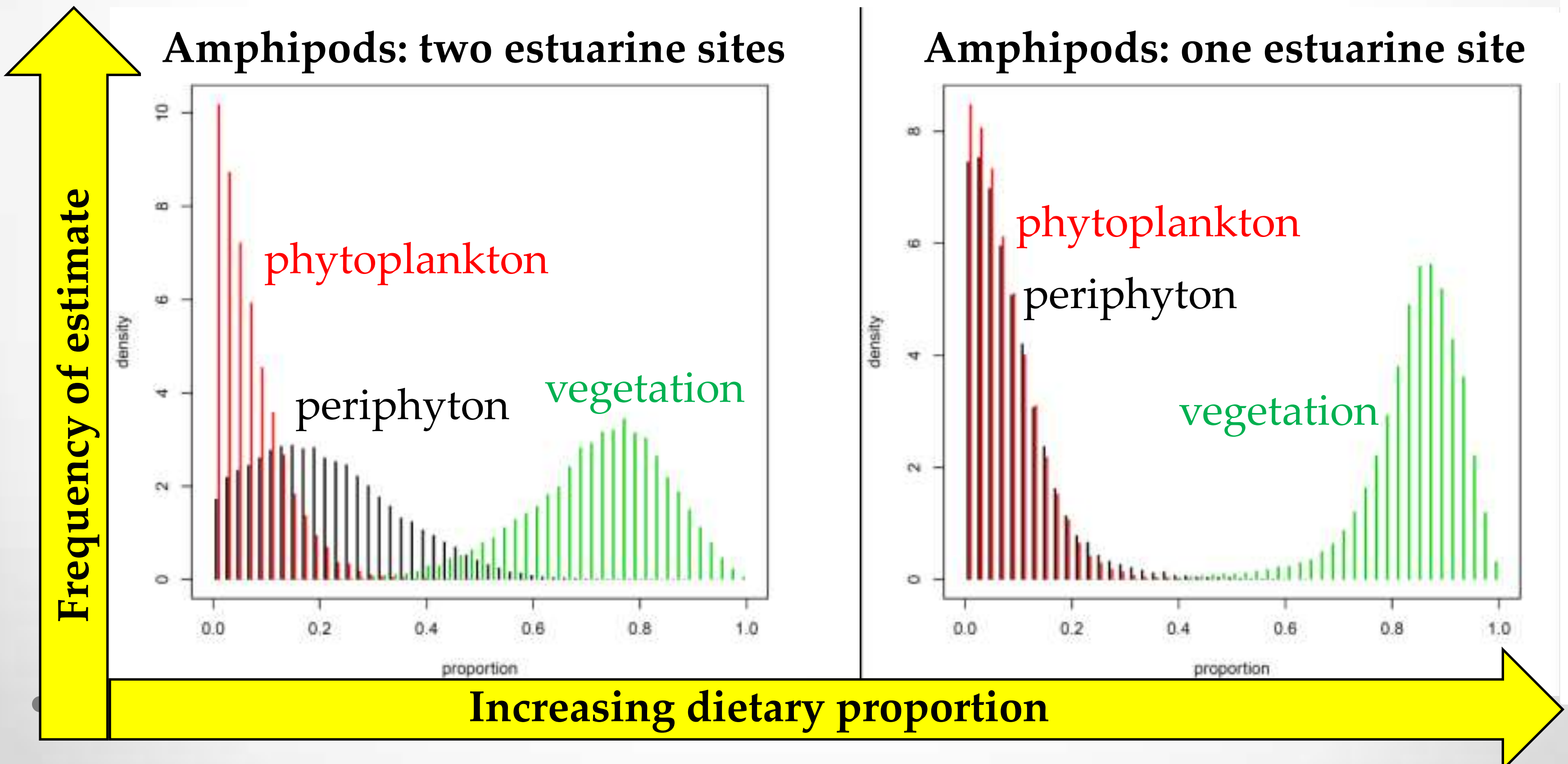
- **Hatchery food** largest dietary source for **marked juvenile Chinook**

- **Chironomids** contribute increasingly to **unmarked Chinook** diets with later months of fish catch

- **Hatchery/maternal influence** on SI of Chinook muscle
  - Muscle: long-term integrator
  - **Mucus, liver: more recent diet sources**
  - Muscle, liver, mucus from all salmon 2013-14

Preliminary Results: invertebrate diets (2010-12)

- **Chironomids**: **Phytoplankton** largest food source overall during season, esp. early season (May)
- **Amphipods**: **Vegetation**; phytoplankton not likely



Summary

- Phytoplankton and vegetation both contribute to selected prey organisms' diets
    - Different locations, timing
    - Preliminary findings consistent with similar study in Columbia R. estuary and primary production patterns

- Importance of spring freshet magnitude & duration
    - affects wetland vegetation cover and phytoplankton productivity/species composition → food resources
    - water-quality conditions

- Leading to better understanding of how shallow emergent wetlands habitats support salmon, invertebrate prey, and primary producers

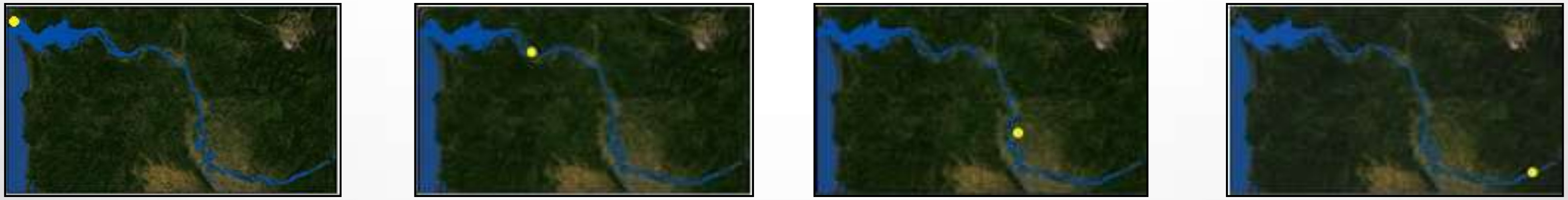



Next steps

- Incorporate 2013-14 data
  - Fill spatial, temporal data gaps
  - Focus on invertebrate sampling

- Put into context of other EMP work
  - Invertebrate prey production from different vegetation types
  - Wetland macrodetritus export calculations

- Understanding resources required by juvenile salmon and their prey & the conditions that limit or improve those resources will help restoration planners maximize benefits for juvenile salmon and the resources they rely on



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