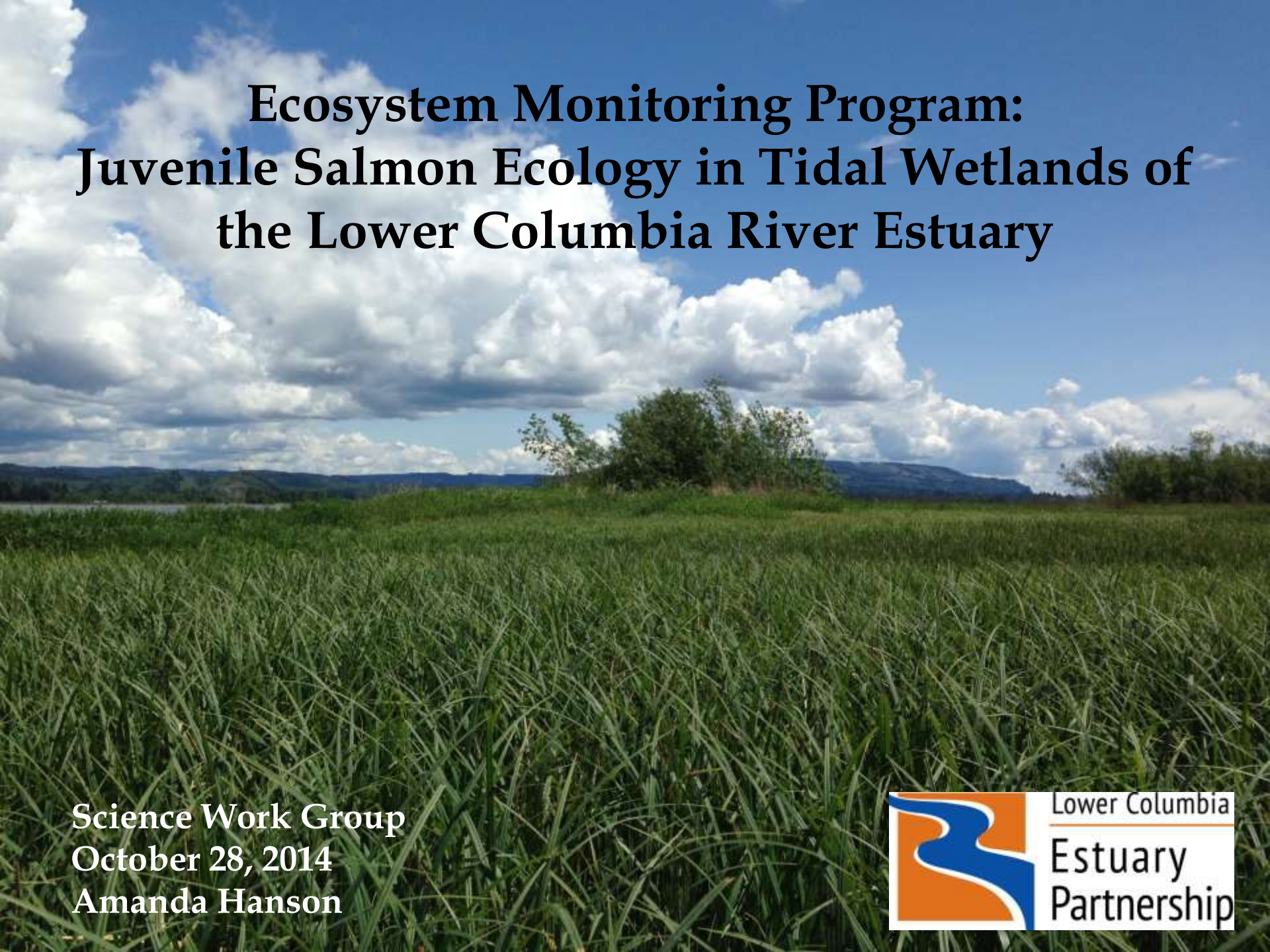
Ecosystem Monitoring Program: Juvenile Salmon Ecology in Tidal Wetlands of the Lower Columbia River Estuary



Science Work Group
October 28, 2014
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Lower Columbia Estuary Partnership

Presentation Outline

- **Introduction to the Ecosystem Monitoring Program (EMP)**
- Sampling Methods
- Information Provided by the EMP

Lower Columbia Estuary Partnership

Lower Columbia Estuary Partnership

- CCMP calls for long-term monitoring to understand conditions in the river and evaluate impacts of management actions over time

- Long-term aquatic monitoring strategy is implemented through our Ecosystem Monitoring Program (EMP)

Why is Monitoring Needed?

- Historical changes to the river
  - 70% loss of vegetated tidal wetlands
  - changes in hydrology
  - non-native species introduction/expansion
  - chemical contaminants
  - climate change
- Listed salmonid species use shallow-water wetland habitats in the river
- Juvenile Chinook, chum, and coho are abundant, with long rearing periods in estuary (e.g., ocean-type Chinook)
- Baseline data on high quality habitats to track changes in ecosystem condition

Ecosystem Monitoring Program Objectives

- Comprehensive and integrated assessment of status (spatial variation) and trends (temporal variation) of habitat, fish, food web, and abiotic conditions in the lower river
  - Focus on shallow-water and vegetated habitats used by juvenile salmonids for rearing and refugia
- Improve understanding and address knowledge gaps of food web structure and spatial-temporal dynamics to evaluate habitat opportunity, capacity, and function
  - Provide baseline data about estuarine resources
  - Inform regional restoration strategies and salmon recovery planning
  - Integrate with action effectiveness monitoring to enhance evaluation of restoration actions

Ecosystem Monitoring Program Progress

- Pre-2004: research focused on lower reaches, lack of information from tidal freshwater reaches
- 2004-2007: habitat and toxic contaminant monitoring in water, sediment, and fish
- 2007-2014: focus on understanding role of estuarine habitats in juvenile salmon life history
- Synthesis of results:
  - 2005 to 2010: habitat structure, hydrology, water quality, fish
  - 2005 to 2013: variability of habitat structure, hydrology, fish; food web synthesis

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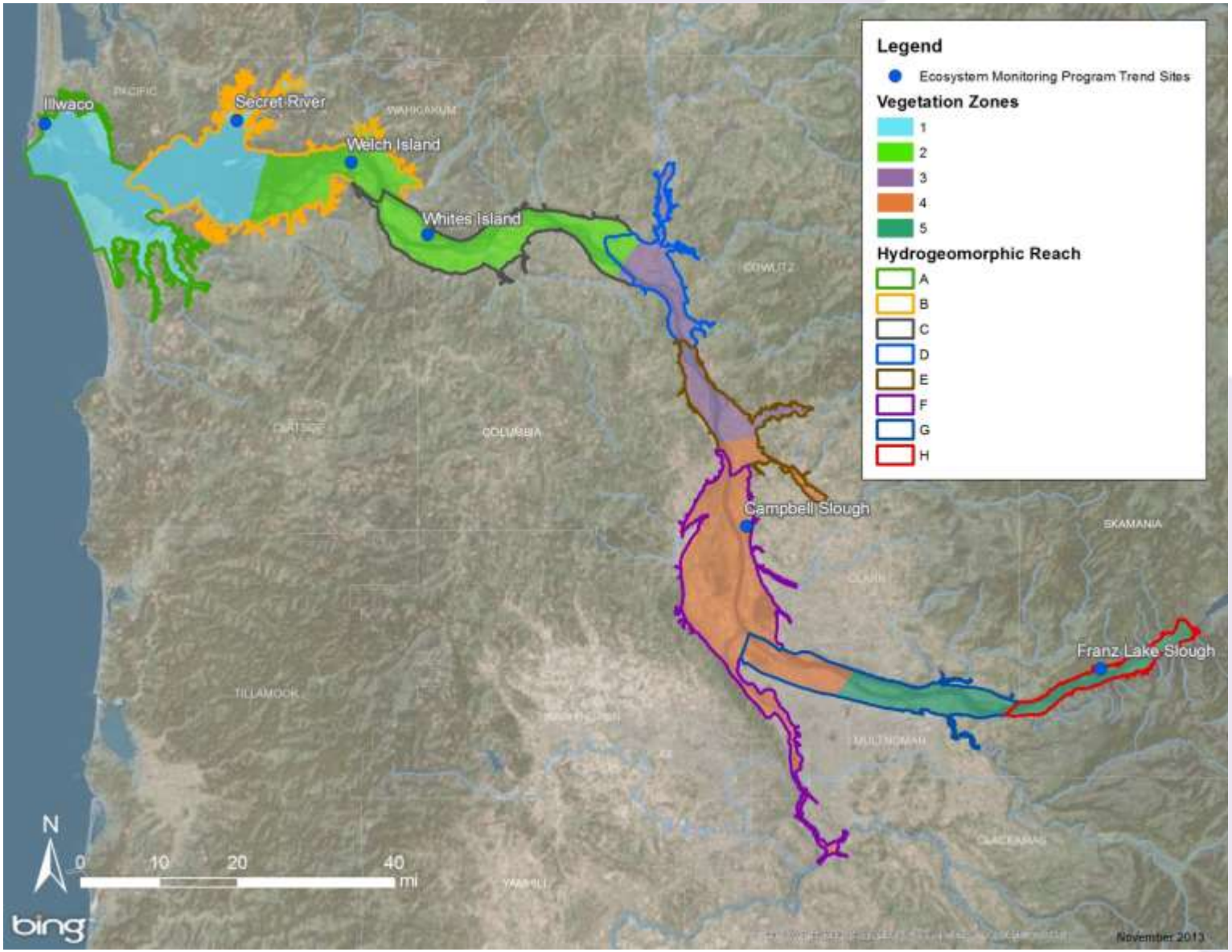
EMP Sampling Design (2005-2014)

- Stratified sampling based on 8 hydrogeomorhpic reaches (A-H) :
  - Co-located fish, fish prey and vegetation sampling initiated in 2007
  - Addition of food web monitoring in 2011
  - Spatial analysis of habitats (or "status") across the lower river
  - Fixed sites for inter-annual variability (or "trends")
- Sampling occurs primarily in **relatively undisturbed tidally influenced emergent wetlands**

EMP Trends Sampling - Stratified by Reach



Habitat Structure and Hydrology (PNNL)

2005-2014, Reaches A-H

- Summer and winter biomass
- Percent cover along transects, dominant species, species richness, vegetation elevation, water level elevation, channel morphology, sediment grain size

Fish and Fish Prey (NOAA)

2007-2014, Reaches A-H

- Monthly beach seine sampling
- Fish: Species richness, abundance, CPUE, stock id, length, weight, stomach contents, otoliths for growth rates, marked/unmarked, condition, contaminants, residency
- Fish Prey: Tows in open water and emergent vegetation, taxonomy, abundance, biomass

Abiotic Site Conditions (USGS)

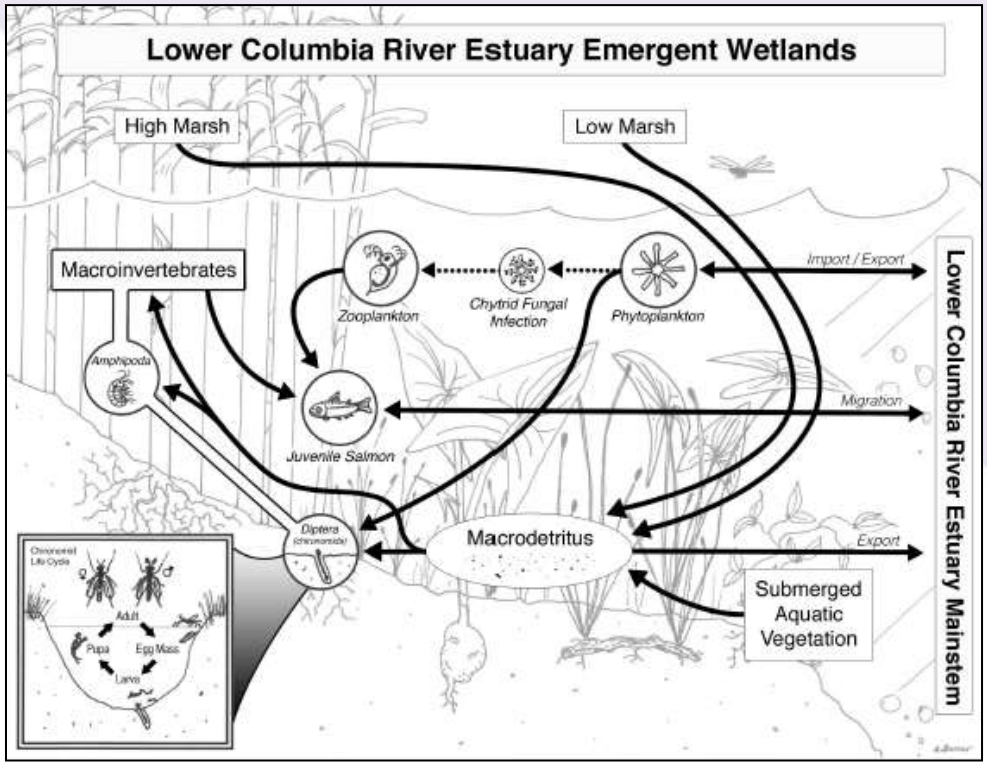
2005-2014, Reaches A-H

- Continuous water-quality data (water temperature, dissolved oxygen, pH, and specific conductance) – April to July
- Factors limiting primary productivity and food-web resources during juvenile salmonid migration

Food Web (OHSU, USGS, PNNL)

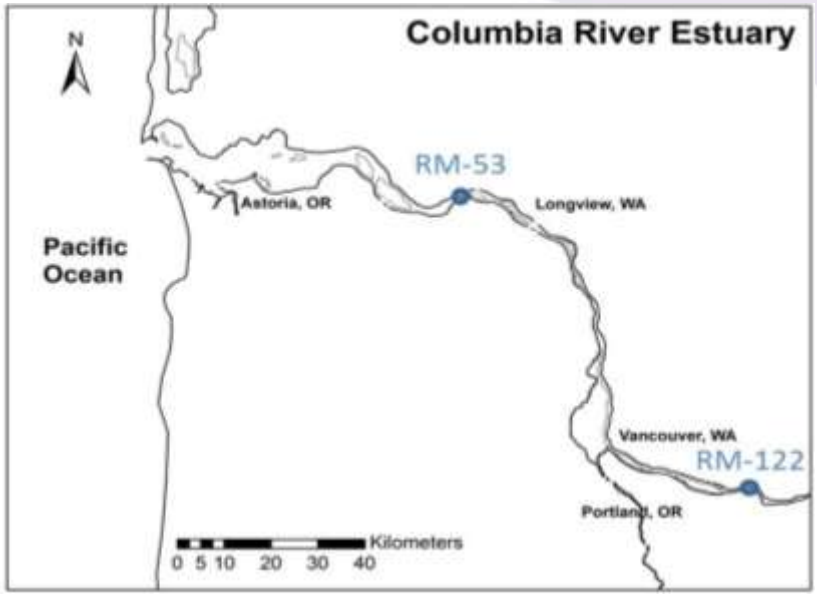
2011-2014, Reaches A-H

- Food web monitoring at trend sites – April to July
- Primary Production: biomass and net productivity of phytoplankton (free-floating algae) and periphyton (attached algae), stable-isotope analysis (plant, insect, and fish tissue), nutrient concentrations
- Secondary Production: zooplankton abundance, species composition



Mainstem Conditions (OHSU)

- Center for Coastal Margin Observation and Prediction (CMOP) platforms
  - RM53 (Beaver Army Terminal; Reach C), 2009-2014
  - RM122 (Port of Camas-Washougal; Reach G), 2012-2014
- Temperature, conductivity, chlorophyll *a* fluorescence, dissolved oxygen, colored dissolved organic matter, nitrate, nitrite, and dissolved ortho-phosphate



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Habitat Opportunity, Capacity, and Realized Function

Habitat Opportunity - capability of juvenile salmon to access and benefit from habitat (e.g., tidal elevation)

Habitat Capacity - habitat conditions that improve juvenile salmon performance (e.g., availability and quantity of preferred invertebrate prey, physiochemical conditions that maintain prey communities, etc.)

Realized Function - physiological or behavioral responses attributable to occupation of the habitat that promote fitness and survival (e.g., habitat-specific residence time, foraging success, growth)

Simenstad and Cordell (2000)

Habitat Opportunity

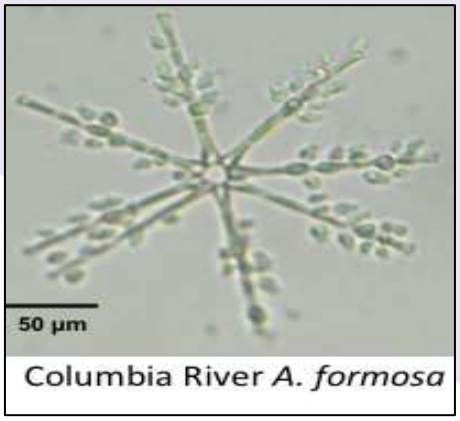
- Identified links between vegetation characteristics (e.g., species composition) and elevation
  - 90% of sampling in emergent marshes ranged 0.8-2.6 m CRD; species diversity highest 1.5-2.5 m
- Channel thalweg and channel bank accessibility
  - Upper river sites have higher inundation frequency than lower river sites during migration period
  - Inundation frequency highly dependent on flow conditions and tidal elevation
- Hydrologic data provide context for inundation anticipated at restoration sites and elevation data help identify where invasive species thrive.

Habitat Capacity

- Spatial patterns of vegetation cover, species diversity, and species dominance
  - Lower reaches: more native species, greater cover
  - Middle reaches: highest species diversity
  - Upper reaches: more non-native species, reduced cover
- Salmon prey source, availability, and selection:
  - Prey density greatest in emergent vegetation
  - Preferred prey: **Dipterans**, crustaceans (Amphipods, Cladocerans and Copepods), Hemipterans (true bugs), and Trichopterans (caddisflies)
- High summer water temperatures (>19ºC) and presence of contaminants in Chinook salmon (downstream of urban areas).

Habitat Capacity

- Spatial patterns in salmon prey diet source (upper reaches – phytoplankton in early season; lower reaches – plant detritus)
- Seasonal phytoplankton blooms (spring, summer), phytoplankton community dominated by diatoms
- River discharge appears to drive phytoplankton abundance and plant detritus production/export
- Elevated chlorophyll *a* concentrations indicate potential nutrient enrichment
- Water quality differences downstream and upstream of the Willamette River confluence (CDOM, nitrate, turbidity)



Columbia River *A. formosa*

Realized Function

- Fish community dynamics vary by reach and by season
  - Chinook density highest in May/June; Chum in April
  - Unmarked Chinook in reaches B and C; marked Chinook reaches E-H
  - Lower Columbia Fall Chinook most common
- Measures of fitness (condition, lipid content, growth) within normal ranges for subyearling Chinook
  - Marked Chinook were larger with less size class diversity than unmarked fish
  - Condition factor highest in summer
- Residency - PIT tag array at Campbell Slough

Summary

- Shallow water emergent wetlands provide habitat for salmon, cover/complexity for salmon prey, and area of phytoplankton deposition
- Vegetation zones highlight differences in vegetation patterns and inundation in the lower river
- Hydrology influences wetland vegetation cover and pelagic phytoplankton species composition/abundance
- Macrodetritus and fluvial phytoplankton may both be important energetic sources for preferred salmon prey
- Evidence of human influence at relatively "undisturbed" sites: non-native species, high summer water temps, dominance of marked salmon, chemical contaminants
- Differences among genetic stocks in terms of size range, growth rates, and lipid content – may help evaluate the influence of habitat condition on salmon performance
- Mainstem conditions data useful for determining if "greening of river" is occurring and whether the system is nutrient limited or nutrient enriched

Questions?

Sampling Adjustments in 2014

- Reduced trend sites from six to four (removal of Ilwaco Slough and Secret River)
- Frequency of fish sampling reduced and salmon diet component removed
- Benthic macroinvertebrate data collection eliminated
- Delayed operation of the CMOP station
- Reduced food web sampling duration
- Plant biomass sampling not conducted at the trend sites