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

January 28, 2014

Lower Columbia Estuary Partnership

Presentation Outline

- **Introduction to the Ecosystem Monitoring Program (EMP)**
- Sampling Methods
- Highlights from 2005-2010 Synthesis
- 2010-2013 Synthesis

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 conditions over time

- Long-term aquatic monitoring strategy is implemented with our Ecosystem Monitoring Program

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 (lethal and sub-lethal effects)
  - climate change
- Listed species of salmon using shallow-water wetland habitats in the river
- Juvenile Chinook, chum and coho higher abundances, longer rearing in estuary (ocean-type salmon)
- Need more information on key uncertainties, baseline data on "good-quality" habitats to track changes in condition

Ecosystem Monitoring Program Objectives

- A comprehensive assessment of status (spatial variation) and trends (temporal variation) of habitat, fish, food web, and abiotic conditions in the lower river, focusing on relatively undisturbed shallow-water and vegetated habitats used extensively by juvenile salmonids for rearing and refugia;
- A coordinated effort to gather baseline data about estuarine resources;
- A better understanding of salmon habitat associations to improve predictions of habitat opportunity in order to improve restoration strategies

Ecosystem Monitoring Program Partners

- Funding from BPA/NPCC
- Collaboration with UW, PNNL, USGS, NOAA, OHSU and CREST
- Supports multiple 2008 FCRPS BiOp RPAs and Estuary Module RME actions for salmon recovery

Presentation Outline

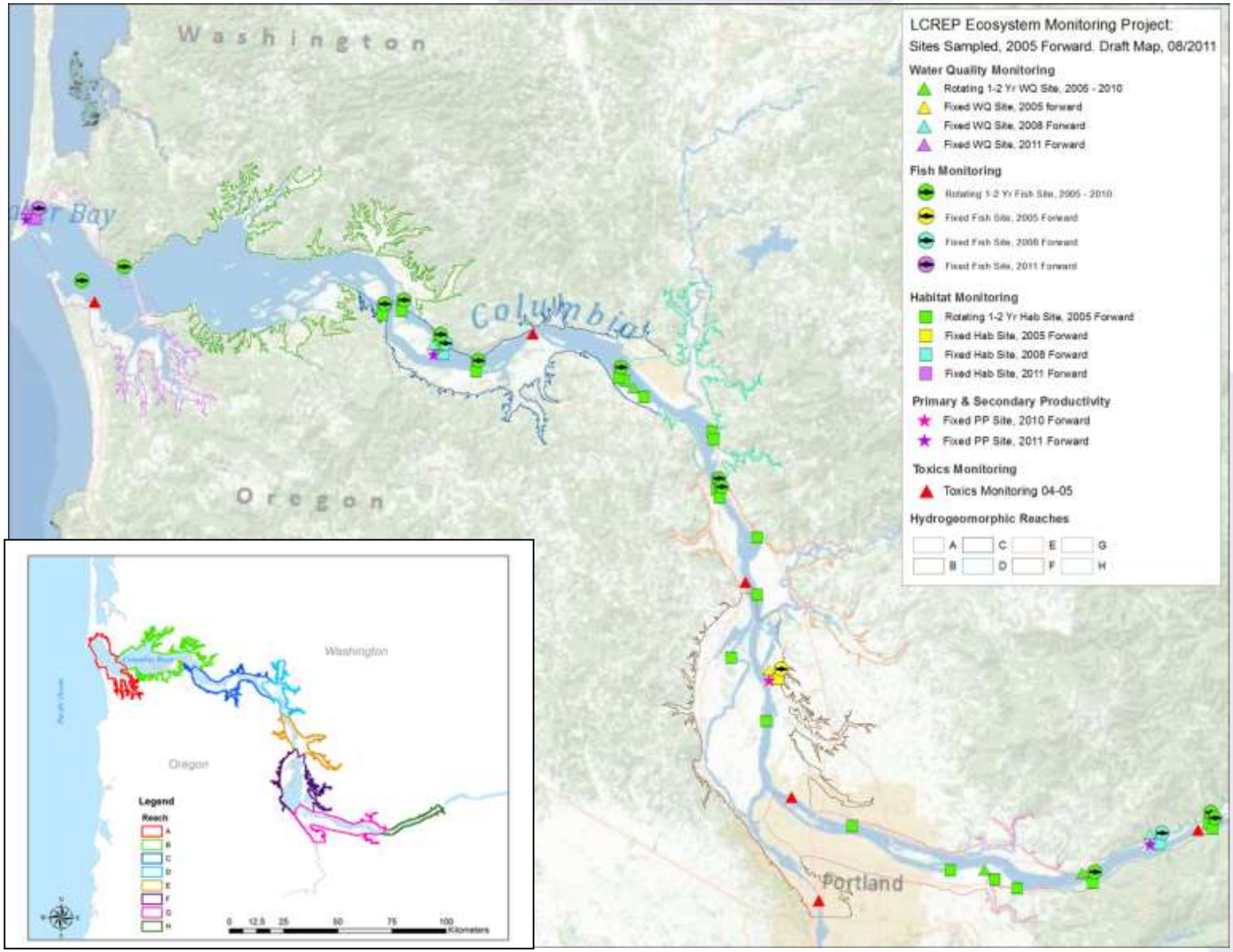
- Introduction to the Ecosystem Monitoring Program
- **Sampling Methods**
- Key Findings Synthesis 2005-2010
- Components of the 2010-2013 synthesis

Lower Columbia Estuary Partnership

EMP Sampling Design (2005-2013)

- Stratified sampling based on 8 hydrogeomorhpic reaches (A-H) :
  - spatial analysis of habitats (or "status") across the lower river
  - a growing number of fixed sites for inter-annual variability (or "trends")
  - Starting in 2007, co-located fish, fish prey and vegetation sampling
- Sampling occurs primarily in **relatively undisturbed tidally influenced emergent wetlands**

EMP Sampling Stratified by Reach



Habitat Structure and Hydrology Methods (PNNL)

Sampling

- During peak biomass (July/August), one day per site
- Biomass sampling in summer and winter
- Percent cover along transects, dominant species, species richness, vegetation elevation, water level elevation, sediment grain size, water temperature

2005-2010 Synthesis Analysis

- total 39 sites, Reaches C-H, 2005-2010

Fish and Fish Prey Methods (NOAA)

Fish and Fish Prey Sampling

- Monthly beach seine sampling between March and December
- Fish: Species richness, abundance, CPUE, stock id, length, weight, stomach contents, otoliths for growth rates, marked/unmarked, condition, contaminants
- Fish Prey: Open water and emergent vegetation tows, taxonomy, abundance, biomass

2005-2010 Synthesis Analysis

- **12 sites, Reaches C-H, 2007-2010**

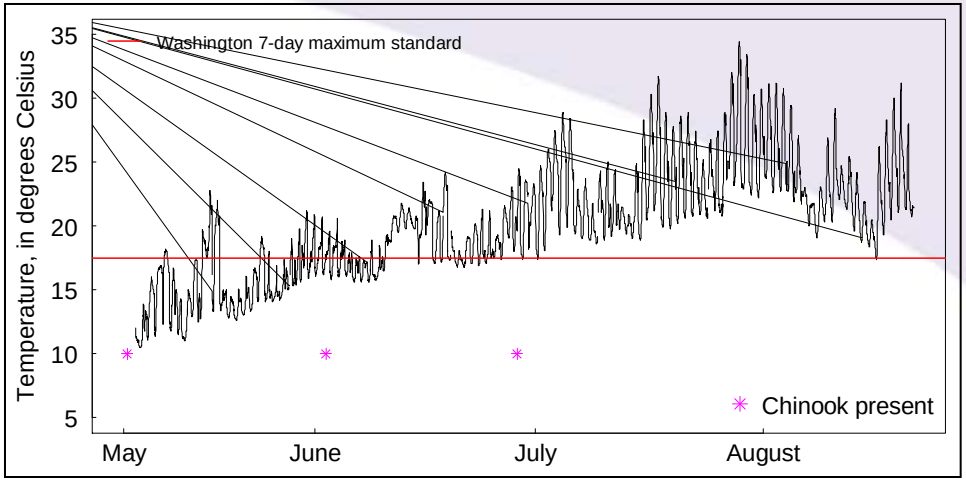
Abiotic Site Conditions (USGS)

Sampling

- In 2011, continuous water-quality data (water temperature, dissolved oxygen, pH, and specific conductance) from April through July
- Factors limiting primary productivity, and food-web resources during juvenile salmonid migration.

2005-2010 Synthesis Analysis

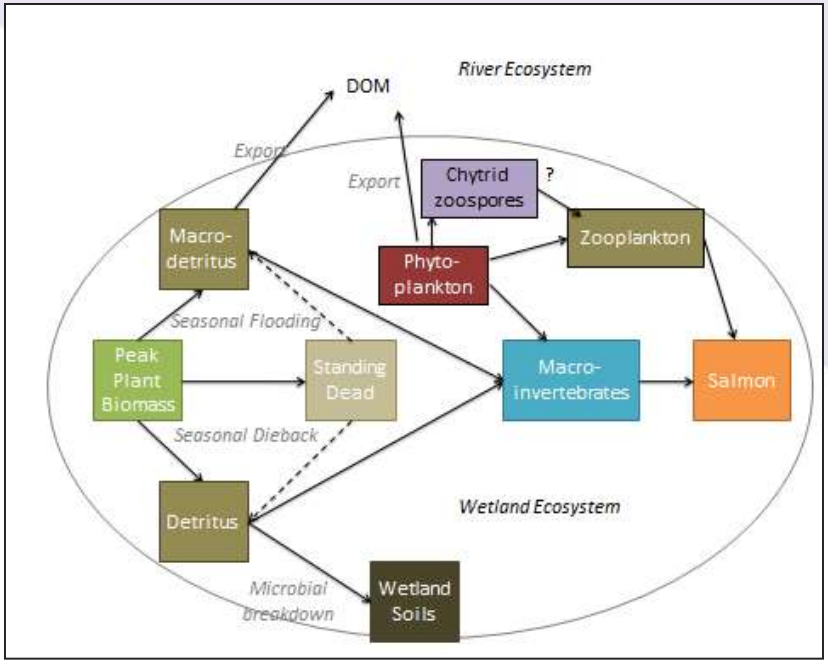
- Two years of data from **one site, Reach F,** 2009-2010



Food Web (USGS, OHSU, PNNL)

Sampling

- Food web monitoring at fixed sites starting in 2011 (periphyton, phytoplankton etc.) between April and July
- Primary Production: biomass and net productivity of phytoplankton (free-floating algae) and periphyton (attached algae), stable-isotope analysis (of plant, insect, and fish tissue), nutrient concentrations
- Secondary Production: phytoplankton and zooplankton species composition, abundance and taxonomy



Mainstem Conditions (OHSU)

Sampling

- Water quality biogeochemical monitoring LOBO platform (RM 122) provide context for EMP data in the mainstem
- Wet Labs WQM (temperature, conductivity, chlorophyll a fluorescence, and dissolved oxygen), a Wet Labs CDOM fluorometer (colored dissolved organic matter), a Satlantic SUNA (nitrate and nitrite), and a Wet Labs Cycle-P (dissolved ortho-phosphate).

Presentation Outline

- Introduction to the Ecosystem Monitoring Program (EMP)
- Sampling Methods
- **Highlights from 2005-2010 Synthesis**
- 2010-2013 Synthesis

Lower Columbia Estuary Partnership

Habitat Capacity, Opportunity and Realized Function

From Simenstad and Cordell (2000)

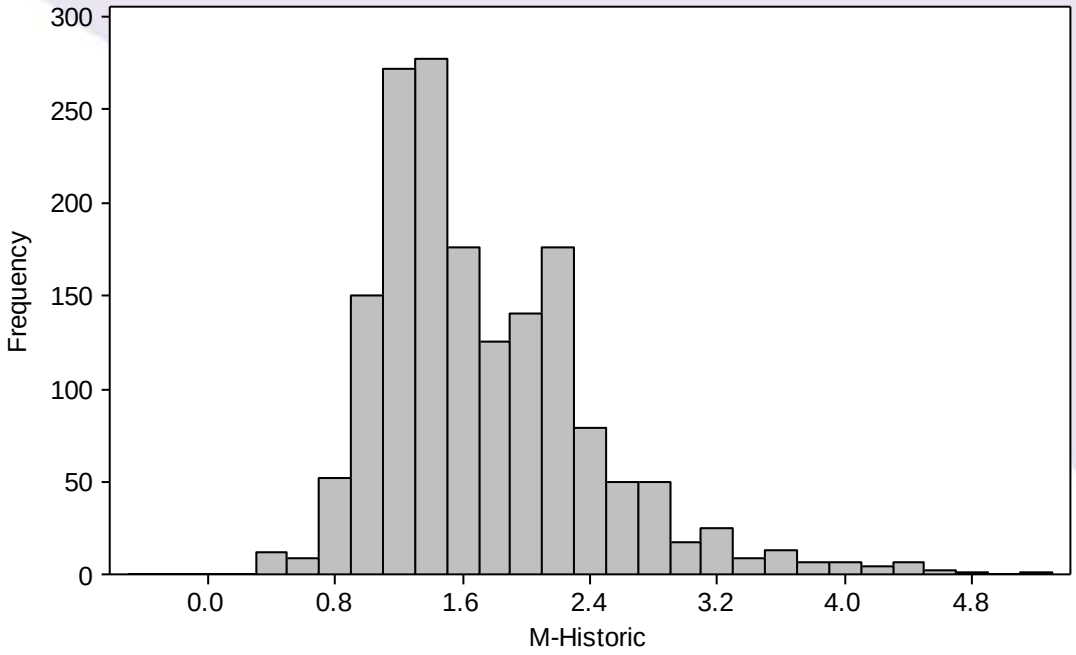
- ***Habitat Opportunity*** – capability of juvenile salmon to access and benefit from habitat (e.g. tidal elevation)

- ***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)

Habitat Opportunity-Vegetation

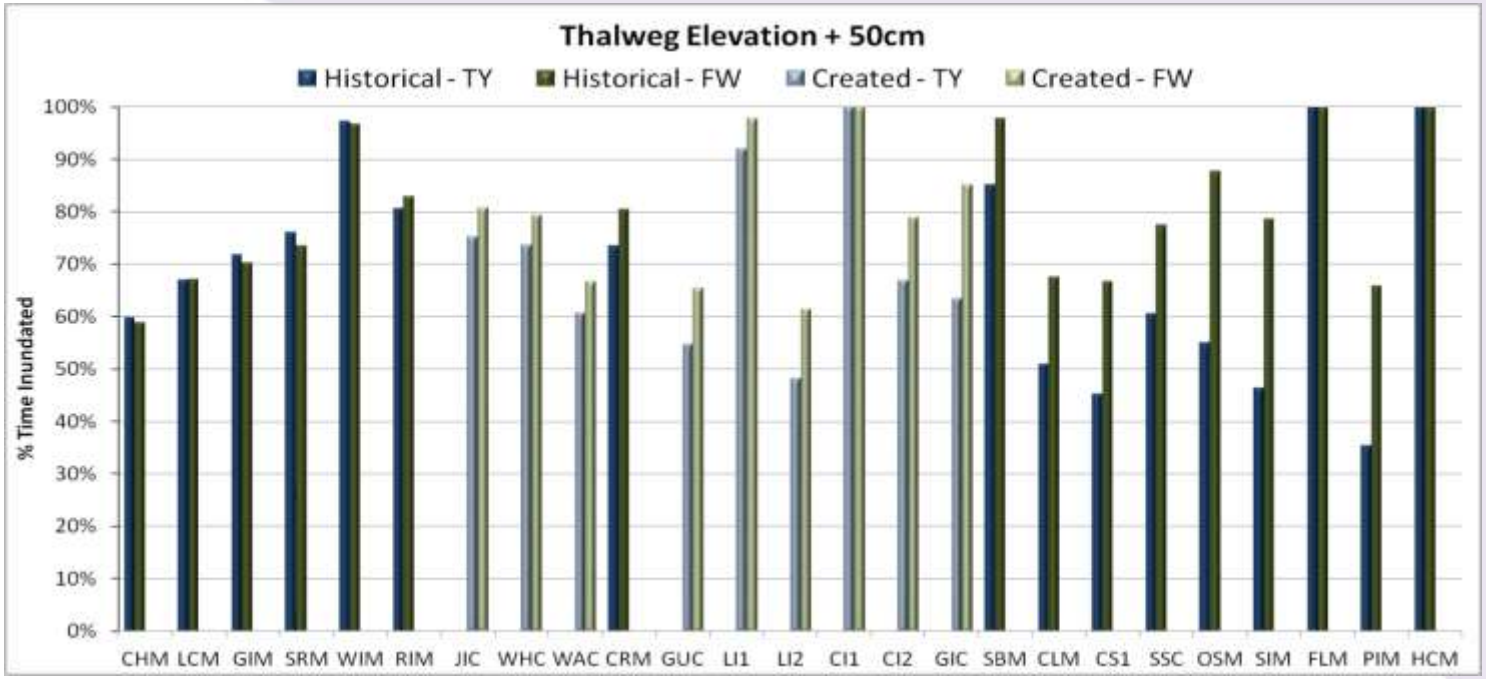
- Emergent marshes occupy very small elevation range (0.5-3.0 m CRD), highest plant species diversity between 1.5 m and 2.5 m
- Boundaries between vegetation species consistent between years, but high water years may shift elevational ranges



Habitat Opportunity-Fish

- Most channels (50 cm water) were accessible 50-80% percent of the estimated peak juvenile salmonid migration period

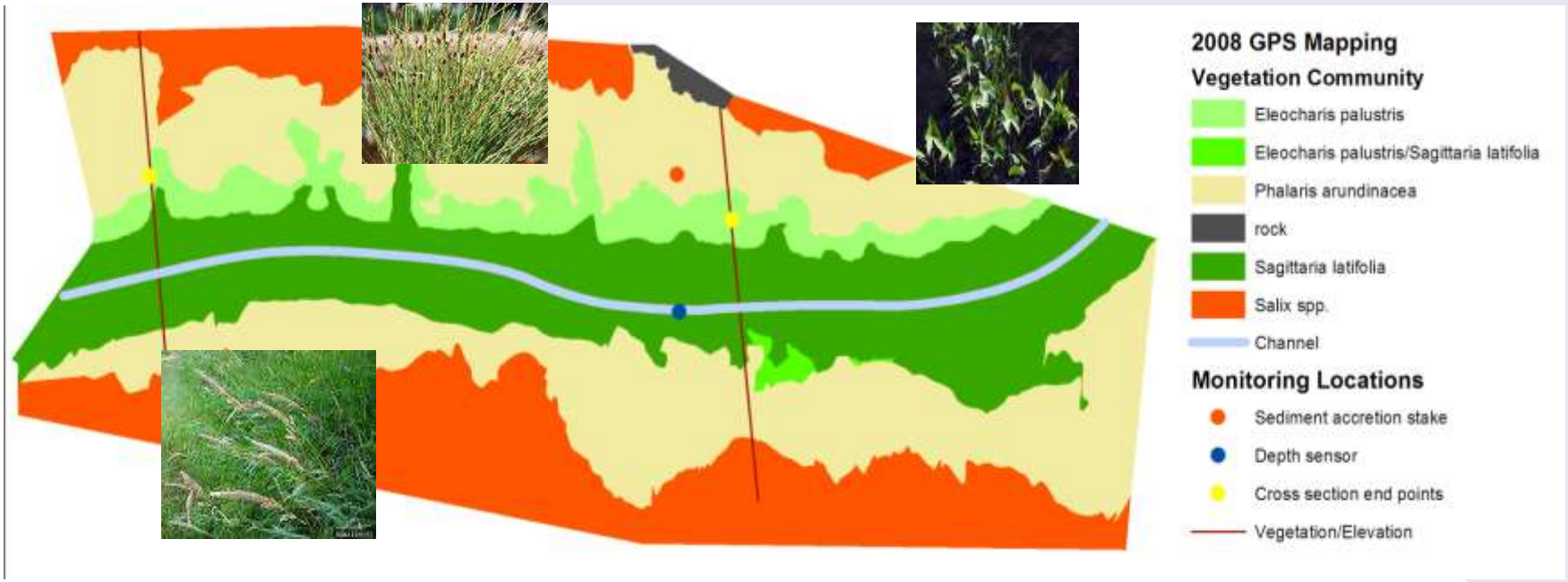
- The channel bank (with 10 cm water) was accessible 20% to 30% of the time in the lower river. Above 60 rkm the frequency increased to 30% to 60% of the time.



Habitat Capacity-Vegetation

Vegetation

- Four distinct hydrologic zones with the number of species (and non-native species) generally greatest in the lower middle portion of the river (rkm 53-89)
- Seven taxa made up 68% of the cumulative cover
- Reed canary grass greatest cover at 28% followed by common spikerush and wapato



Habitat Capacity-Fish Prey

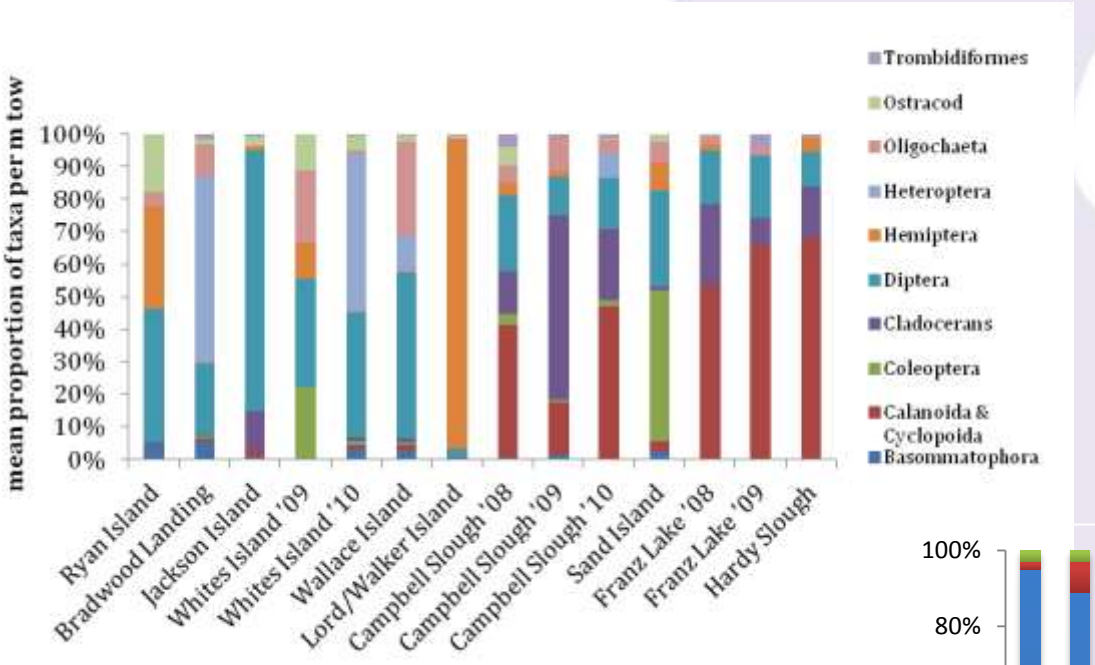
Fish Prey

- Diverse assemblage of prey available, though no distinct patterns

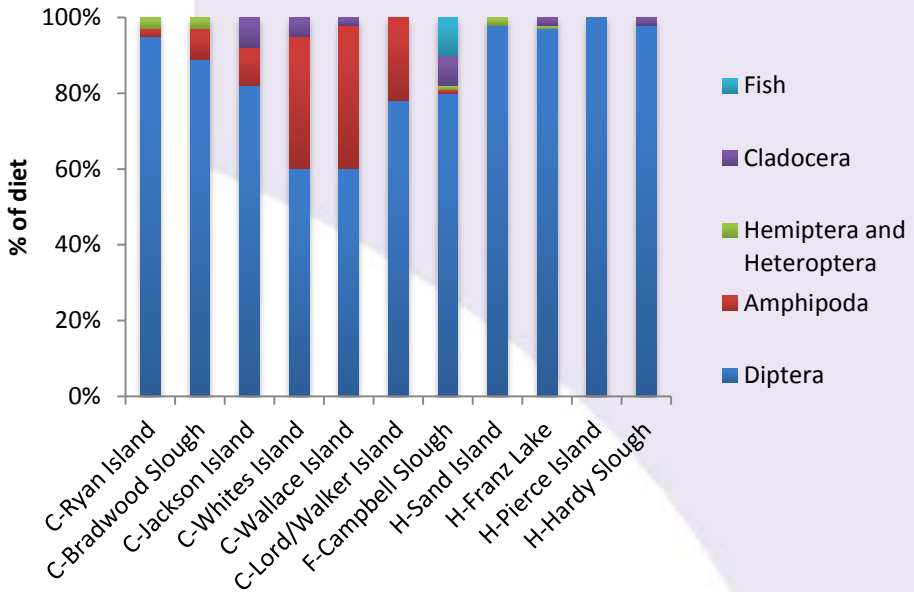
- Dipterans strongly preferred prey
  - Top 5: Dipterans, crustaceans (Amphipods, Cladocerans and Copepods), Hemipterans (true bugs), and Trichopterans (caddisflies)

- Greatest density of Diptera, and most other preferred taxa, in emergent vegetation tows

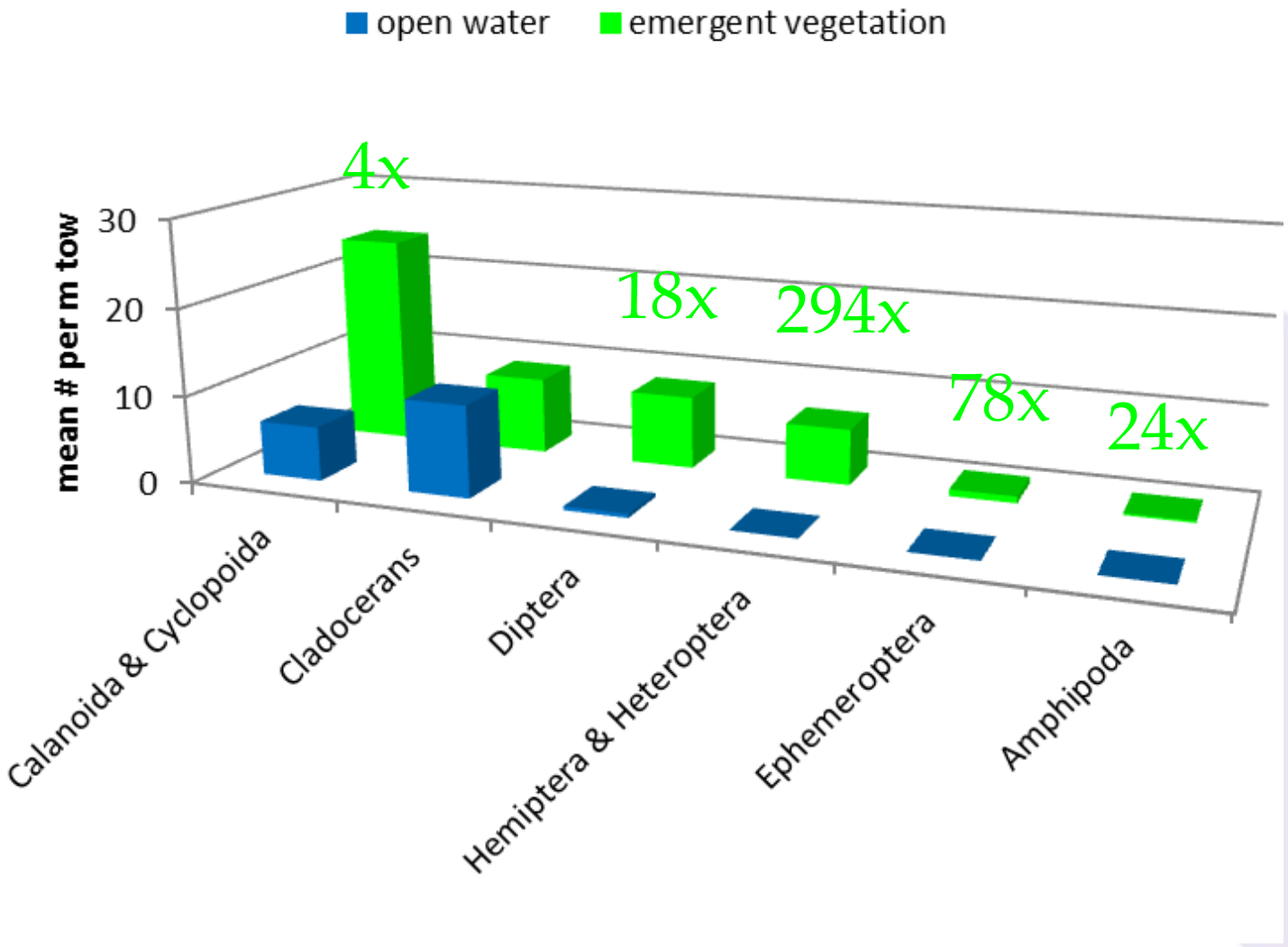
Macroinvertebrate availability versus selection in Chinook diets



87% of prey were Diptera



Source of Macroinvertebrates, Emergent Vegetation

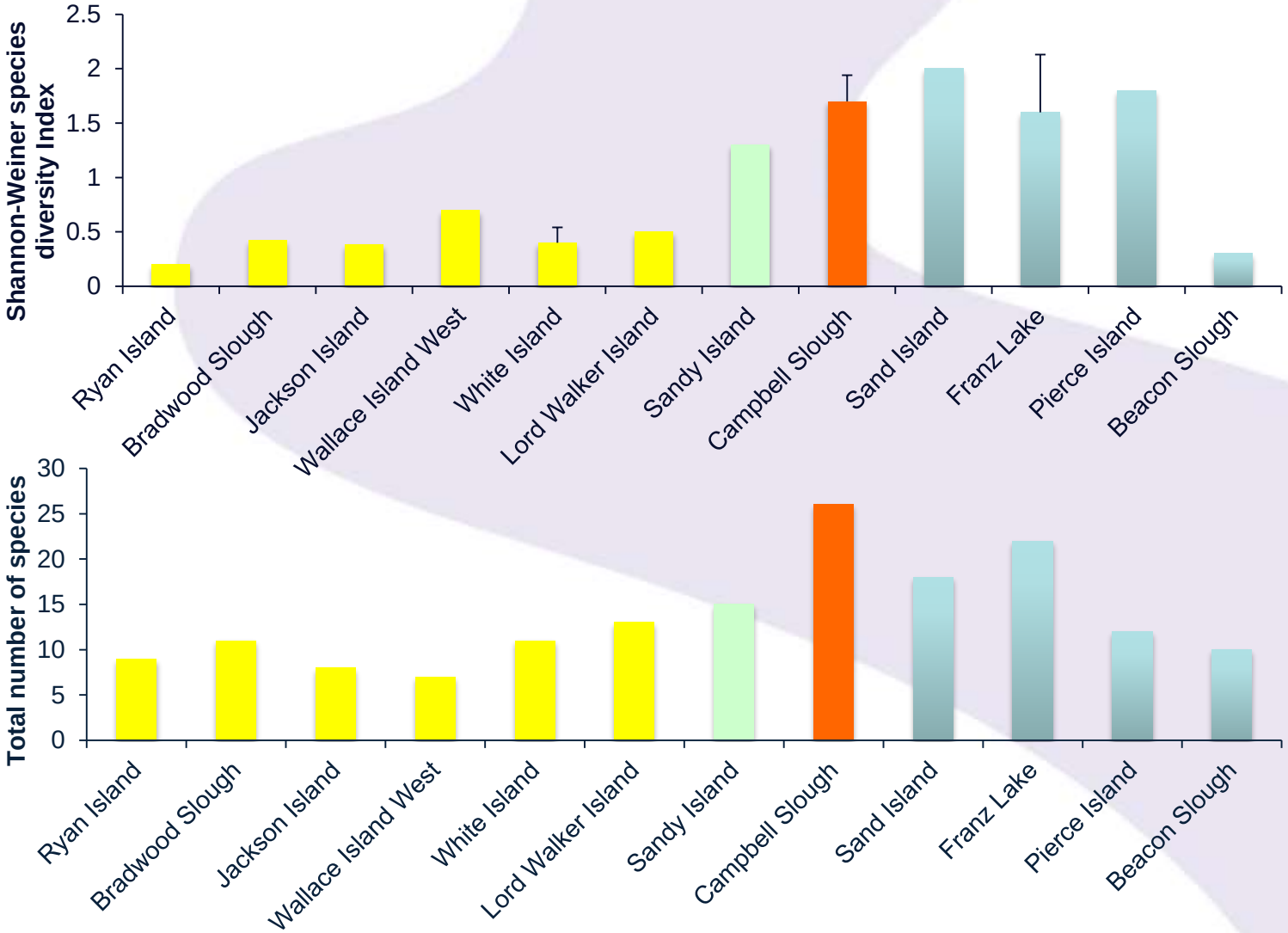


Habitat Capacity-Fish

Fish

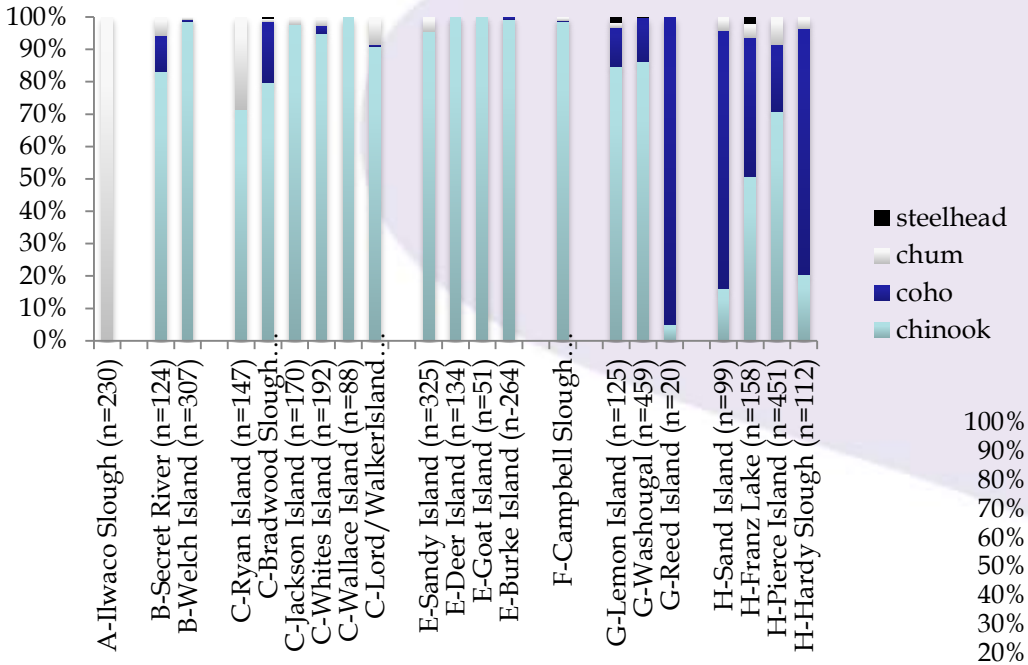
- Distinctive fish communities by reach, juvenile salmon found at all sites and in multiple months
- Chinook at highest densities in May and June; chum in April
- High summer water temperatures, limiting factor at many sites
- Chemical contaminants in Chinook salmon above toxic injury thresholds especially below Portland/Vancouver

Species diversity and richness

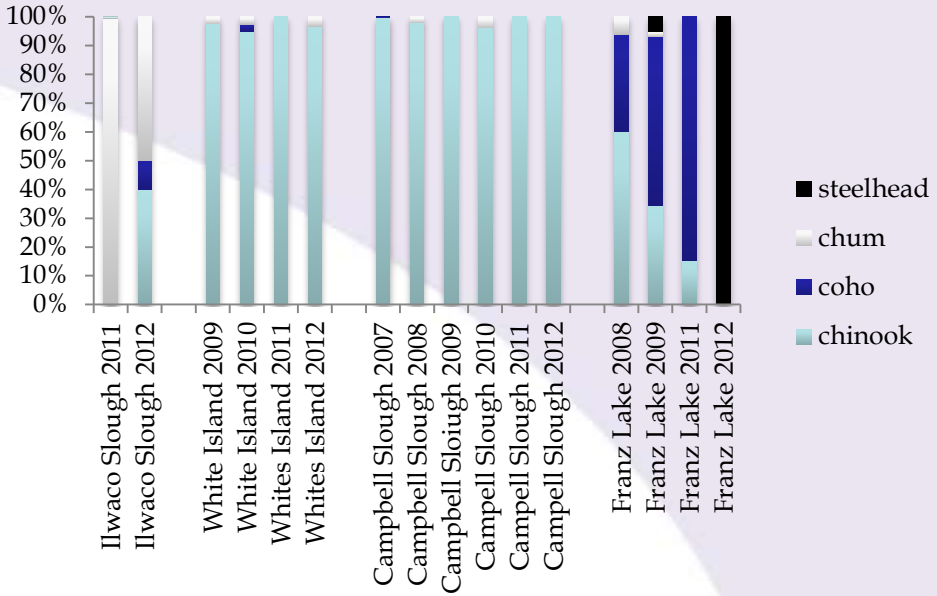


Composition of Salmon Catch

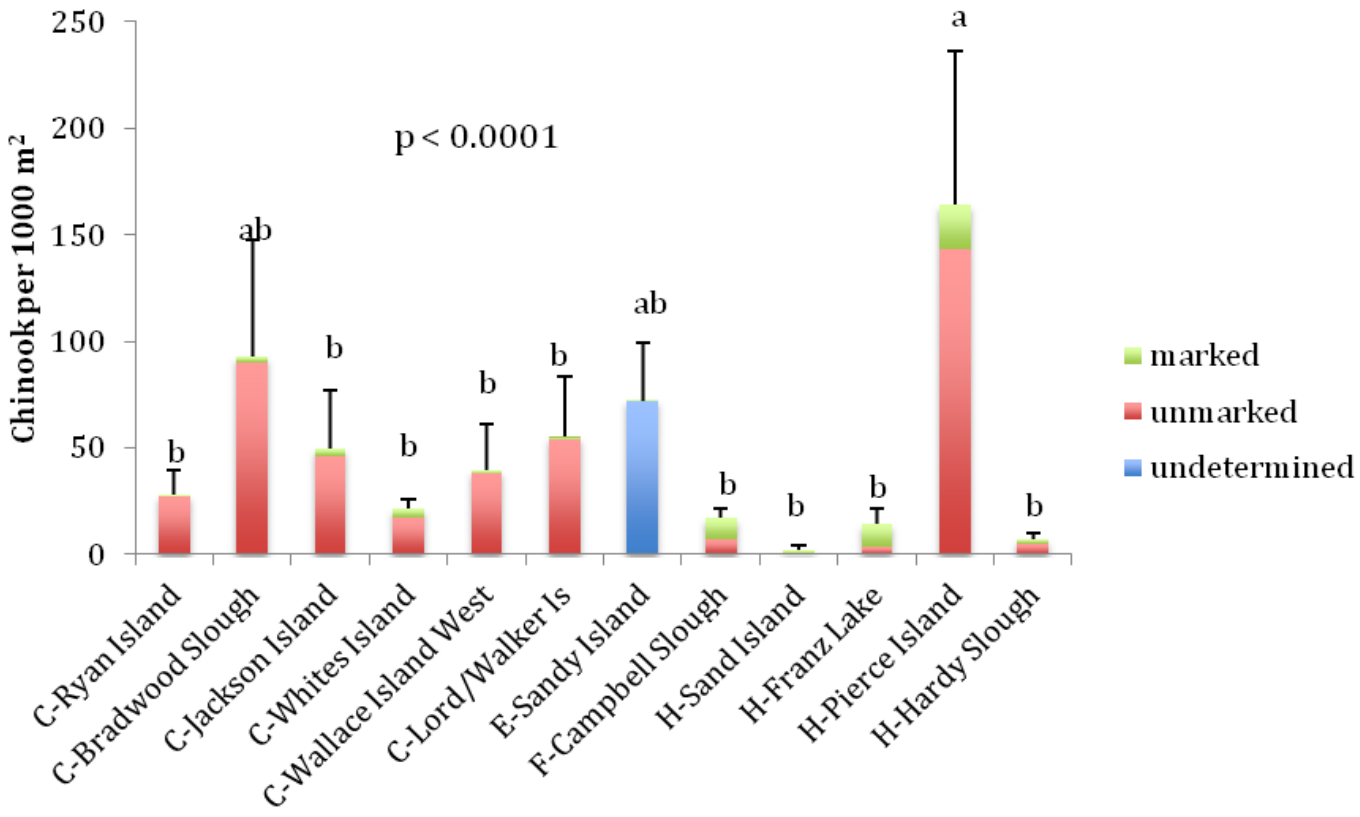
Status Sites



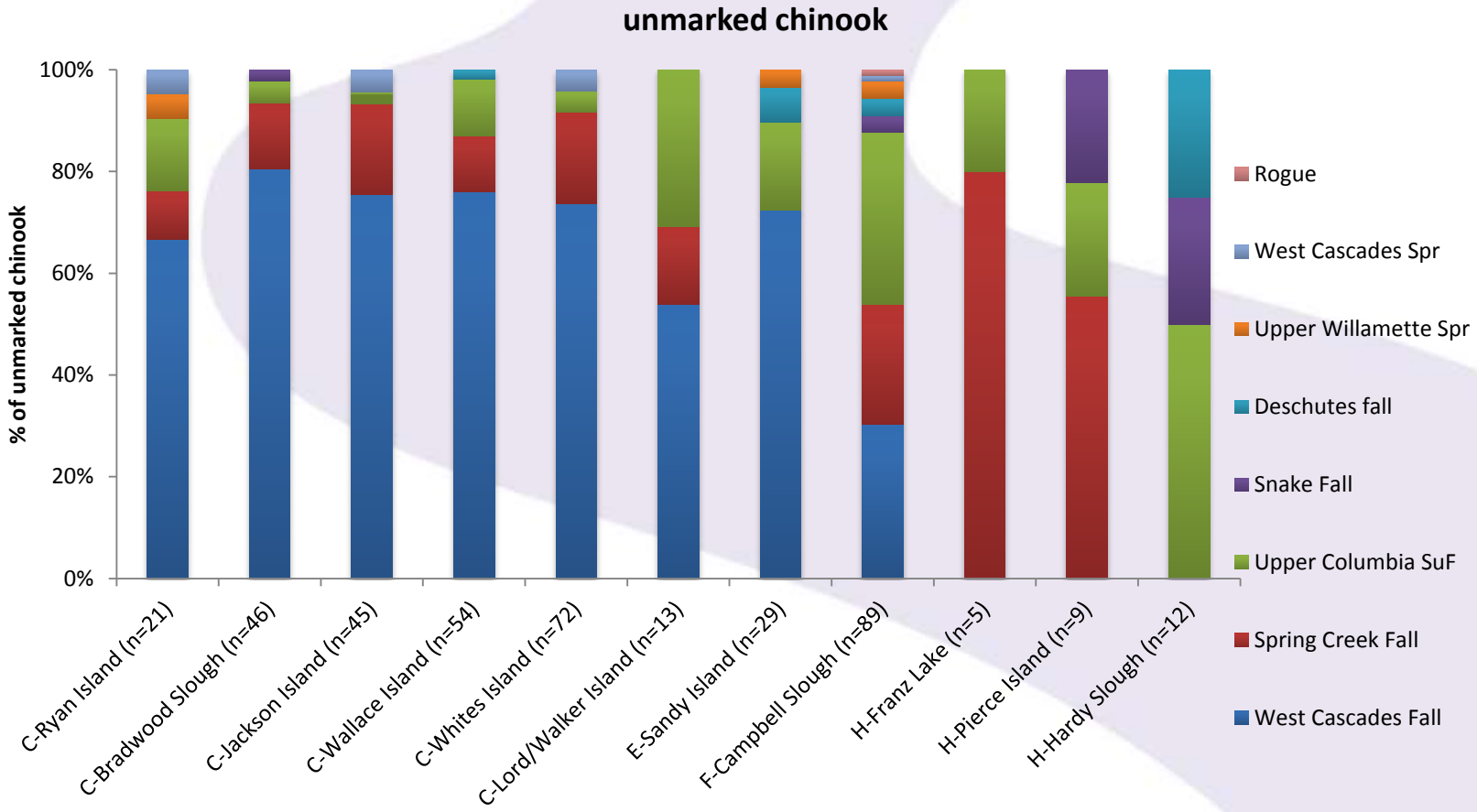
Trend Sites



Marked vs. Unmarked Salmon

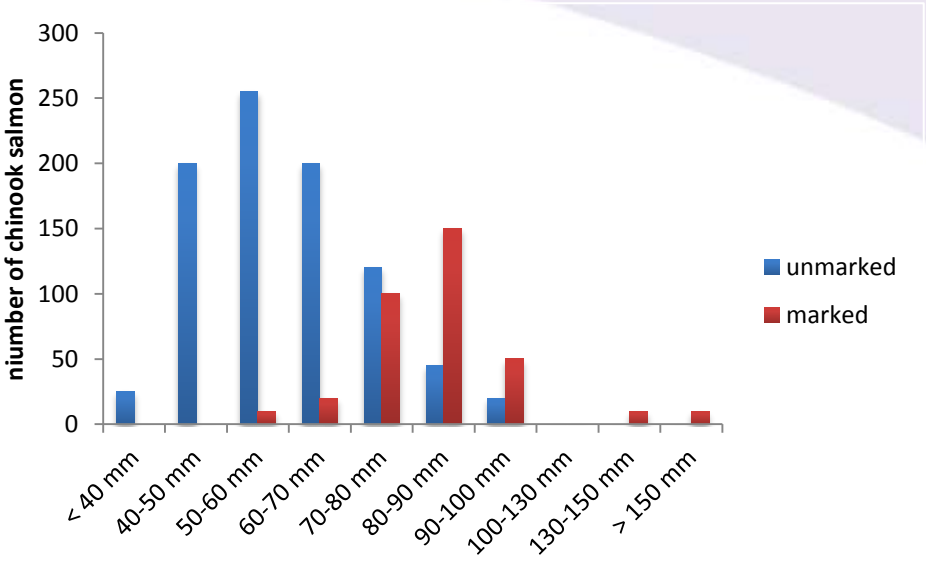


Unmarked Chinook Stocks



Realized Function

- Measures of fitness (condition factor, lipid content and growth rates) were within normal ranges for subyearling Chinook
- Increase in unmarked Chinook length and weight over the sampling season; not for marked Chinook
- Greater diversity of size classes for unmarked Chinook
- Growth rates lower in fish from Reach C



Implications for Management

- Tidal marshes providing productive rearing and refuge areas for multiple juvenile salmon species and stocks
- Narrow elevation range of emergent marshes-- vulnerable to hydrologic changes
- Quality of these habitats would be maintained and improved by activities that :
  - Preserve/restore nearshore emergent vegetation and hydrograph that supports that vegetation community
  - Moderating summer water temperatures
  - Reducing the spread of non-native species
  - Reducing chemical contamination

2011-2013 Synthesis

1. Trend sites in Reaches A and B
2. Variability Analysis
   - Habitat Structure and Hydrology
   - Fish
   - Fish Prey
3. Salmon Food Web Analysis
   - Primary Production: quantity, rates, species composition, export
   - Secondary Production: quantity, species composition
   - Mainstem vs. shallow water habitats
   - Trophic Pathways: Stable isotope analysis
4. Multivariate Analysis

Questions?