MAKING CONNECTIONS TO HABITATS: FEEDING ECOLOGY OF JUVENILE CHINOOK SALMON DURING EMIGRATION

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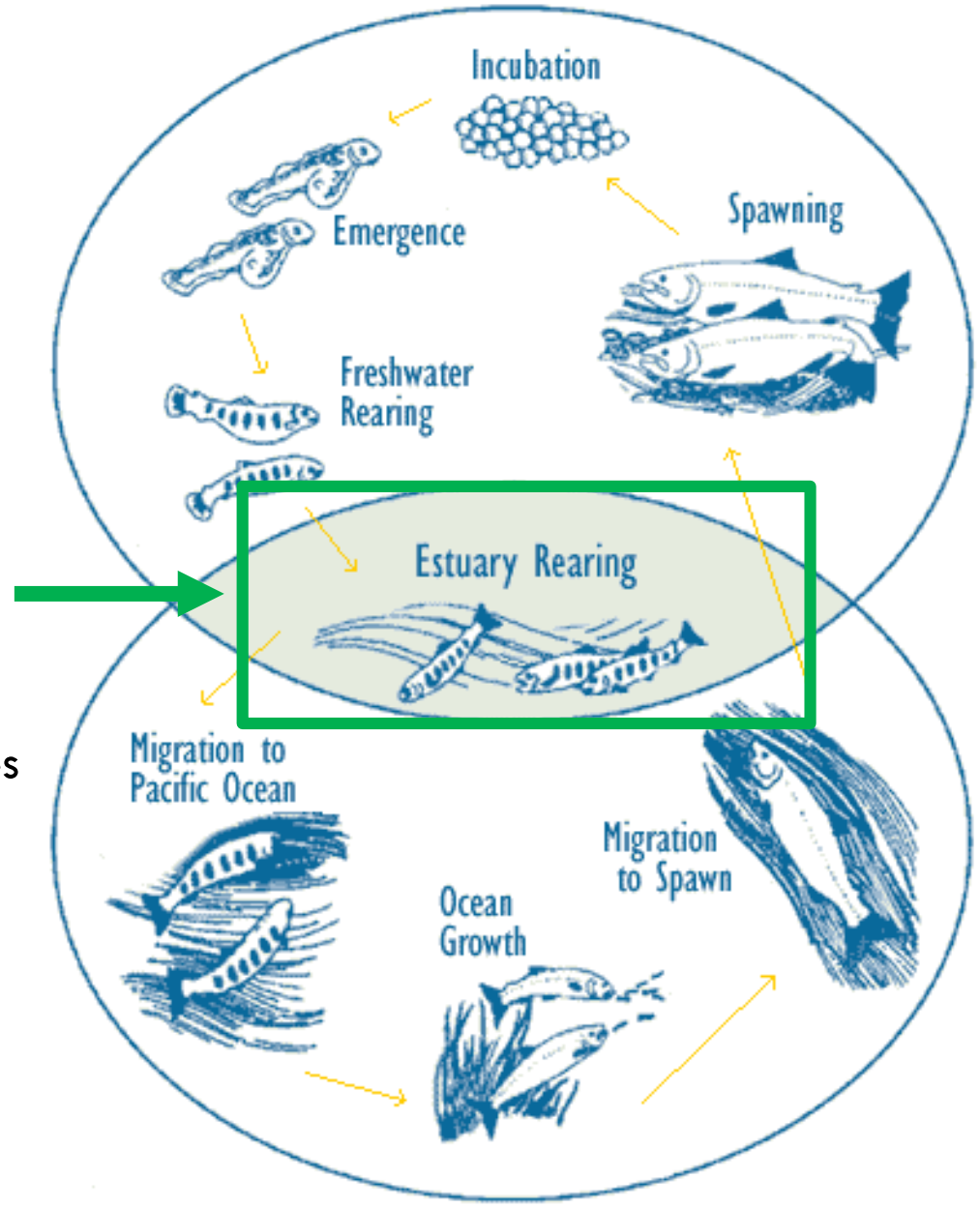
PACIFIC SALMON

Estuary rearing

- Duration in estuary can differ by species and stock group during emigration
- Subyearlings tend to use estuaries the most
- Yearlings are thought to move through the system quickly

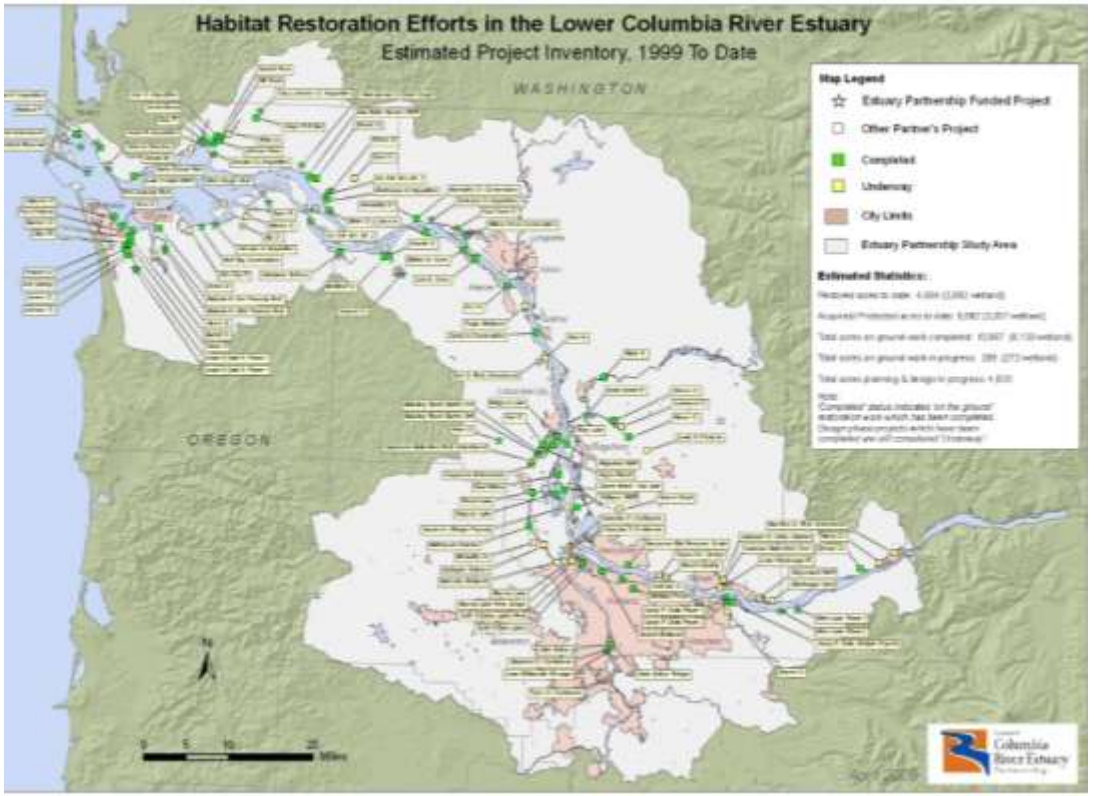


SALMON RECOVERY

- Restoring estuaries to improve habitat for 13-ESA listed salmonid populations

Interior Chinook Salmon stocks

- Upper Columbia
- Snake River



WETLAND RESTORATION: INDIRECT BENEFITS

Yearling migration rates:
30-60 km/day

MANAGEMENT QUESTION

- Are the estuary habitat restoration actions achieving expected biological and environmental benefits?

  - Specifically for ESA-listed interior stocks of Chinook salmon

Is restoration working and can we detect it??

Action Effectiveness Monitoring and Research (AEMR) Project, funded by the Army Corp of Engineers

Questions

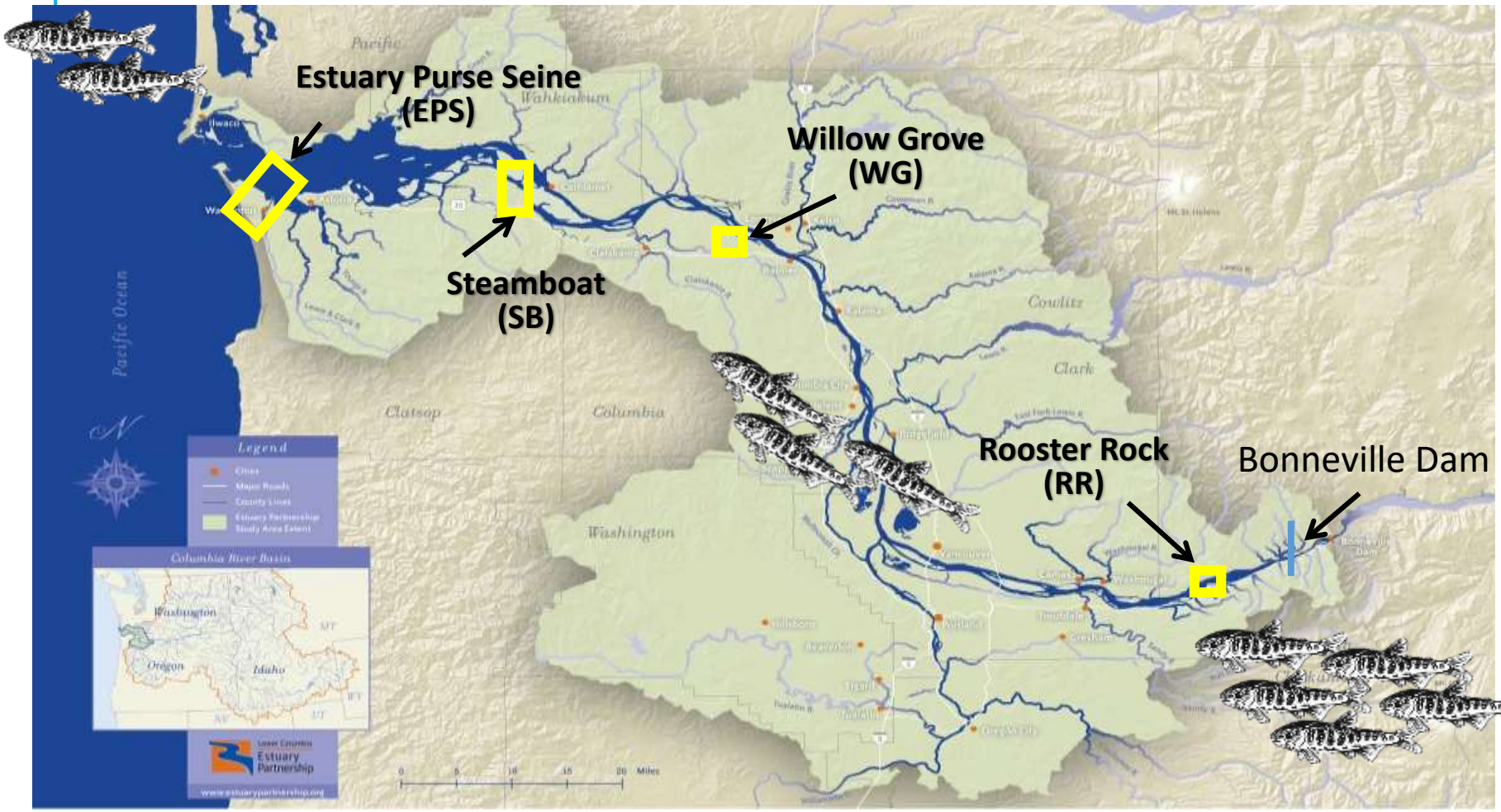
FOLLOWING A COHORT: TRACKING CHANGES LINKED TO POTENTIAL RESTORATION BENEFITS

1. **Growth? (increase in size and condition)**
2. **Does diet change among sites (terrestrial reliance)?**
3. **Is there variation in source prey stable isotope signature?**
4. **Do muscle and fin tissue stable isotope signatures differ as fish emigrate?**

Approach

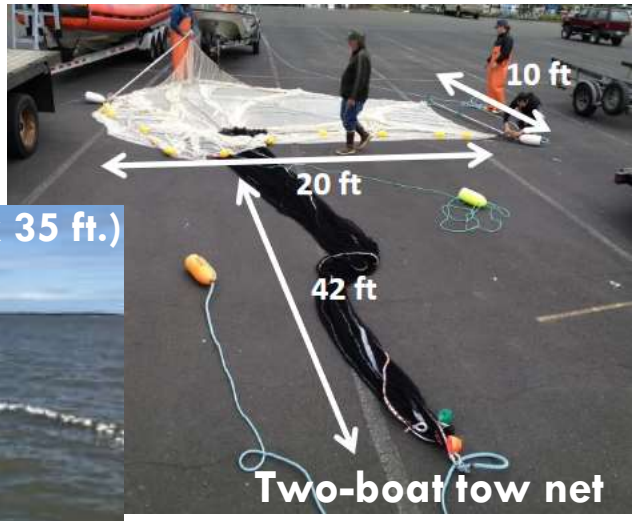
1. **Characterize food habits of emigrating yearling Chinook**
   - --Diet composition
   - --Stomach fullness
2. **Determine contribution of prey from distinct habitat groups**
   - --Terrestrial vs Aquatic
3. **Identify nitrogen and carbon sources supporting recent meals (<30hrs)**
   - --Stable isotope signatures of common prey found in diets
4. **Determine if there are changes in food sources (stable isotope signatures)**
   - --Fin and muscle tissue

FOLLOWING A COHORT: SAMPLING SITES



FIELD COLLECTIONS

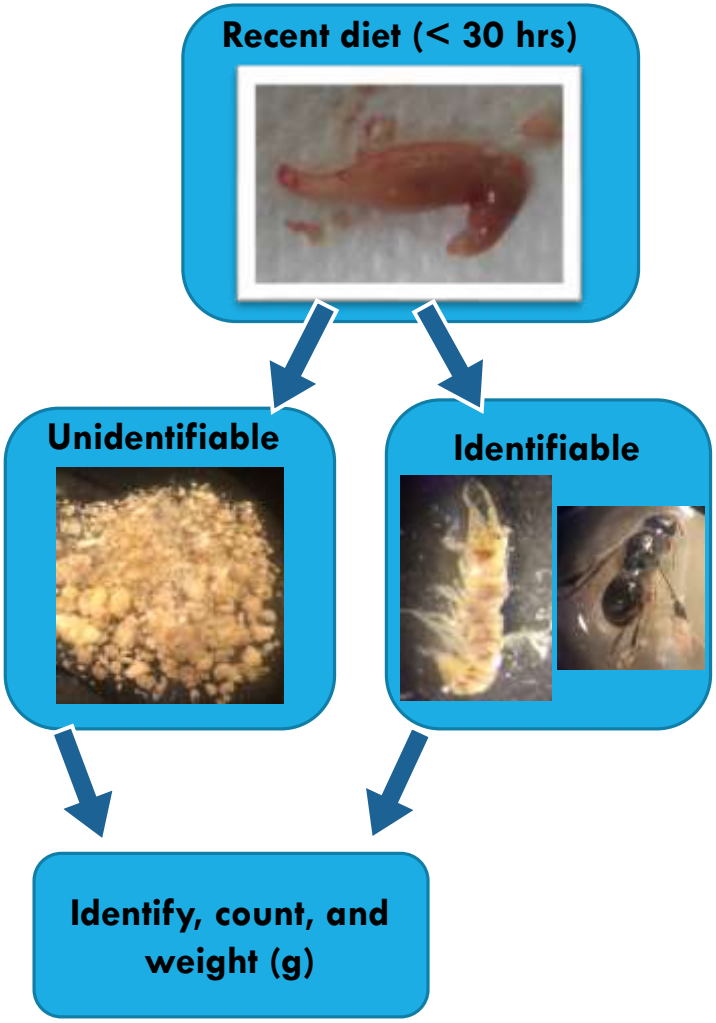
- Sampled all four sites over a two-week period (sampled monthly)
- 2016: April-July
- 2017: April- June
- Surface drift (neuston) tows for a snapshot of available salmon prey



DATA COLLECTION

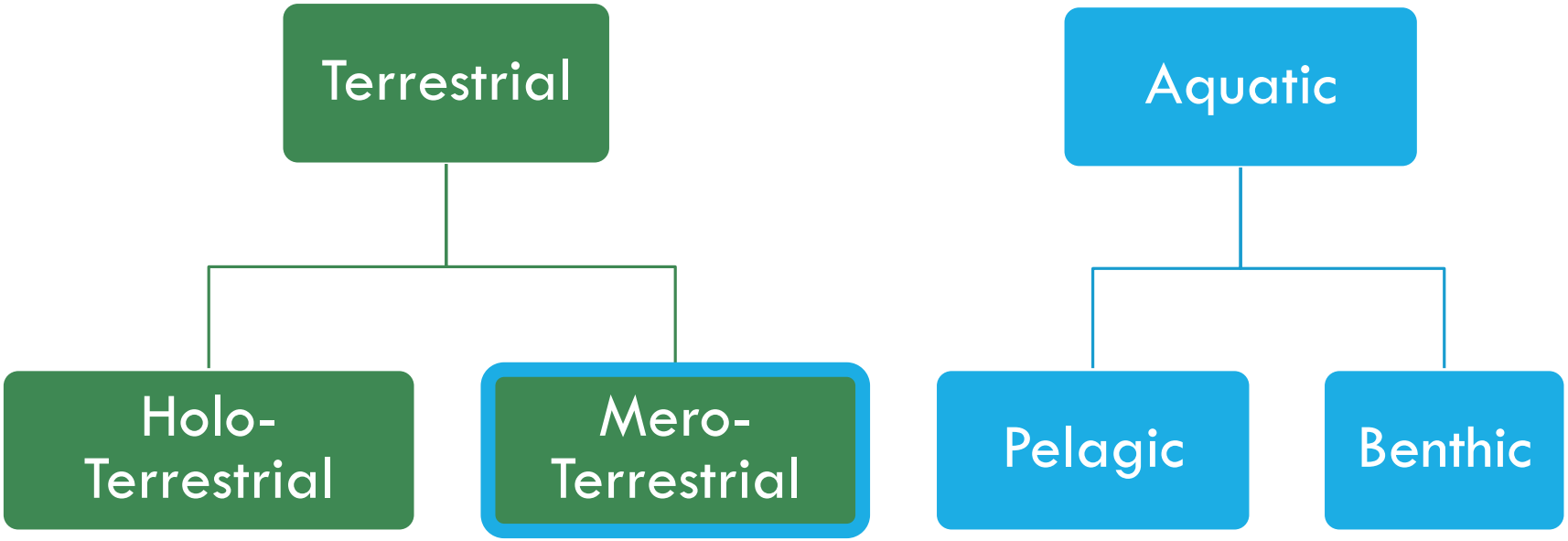
- Identified salmon to species
- Length (mm) and weight (g)
- Fin clip for genetic stock analysis
- Stomachs for diet analysis
- Fin and muscle tissue for stable isotope analysis (SIA)

STOMACH CONTENT ANALYSIS



PREY HABITAT GROUPS:

Based on habitats needed to complete life cycle



- **Holo-Terrestrial:** *Entire* life cycle in terrestrial habitats
- **Mero-Terrestrial:** Need terrestrial habitats for *part* of their life cycle
- **Nondescript (Insects or Other):** Insect groups of unknown life history strategy were binned in ND insects. All other items were grouped in ND other (i.e., plastic, plant material, etc.)

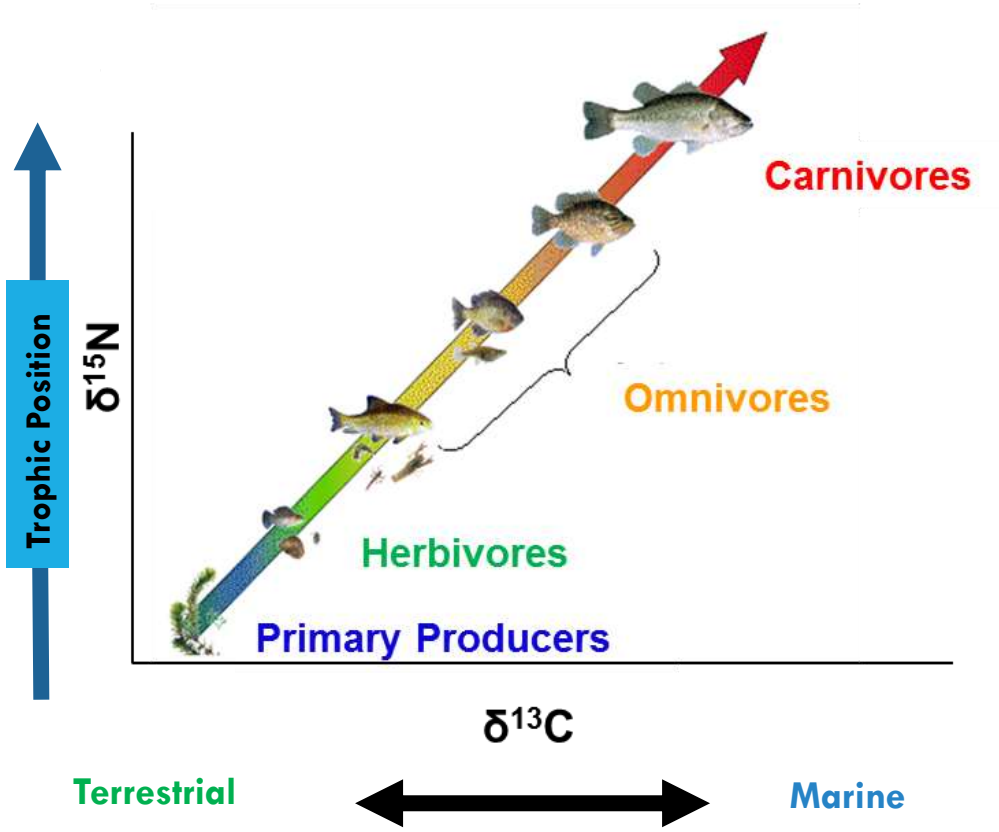
NOT ALL PREY ARE CREATED EQUALLY

- Insects such as **wasps, ants, caddisflies, beetles,** and **flies** can have **2-4x** the energy as amphipods

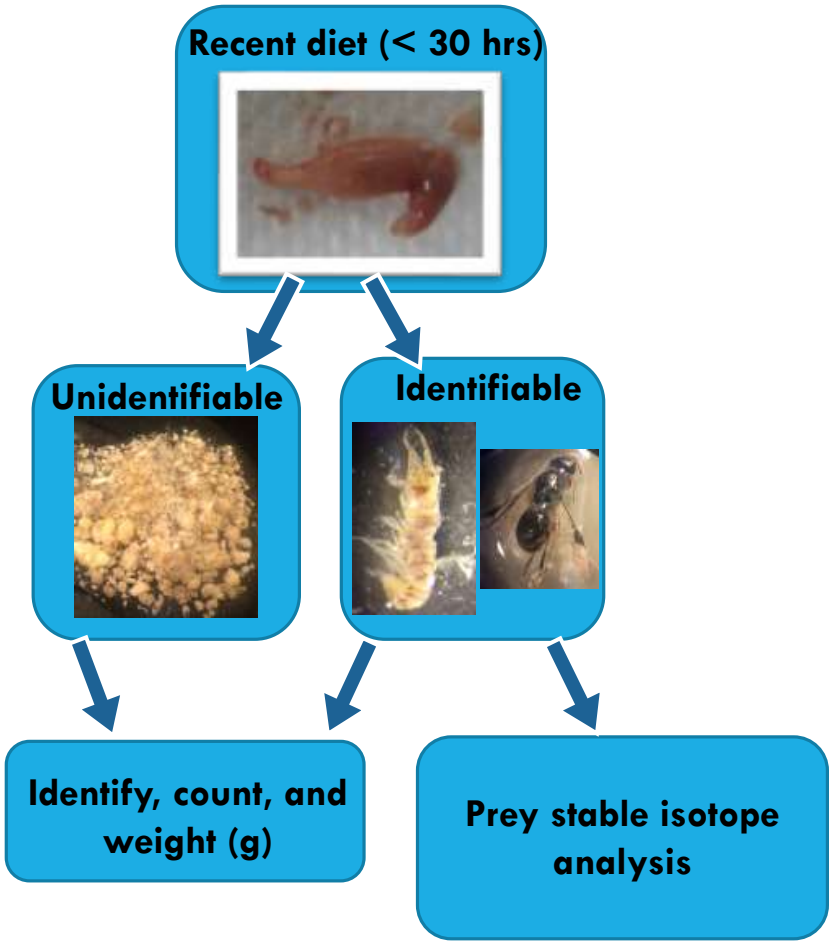
(Adapted from David 2014)

STABLE ISOTOPE ANALYSIS (SIA)

- Powerful tool in diet and food web studies
- Measured as a ratio of heavy to light isotope
- **Carbon** – Primary producers (carbon sources)
- **Nitrogen** - Trophic position

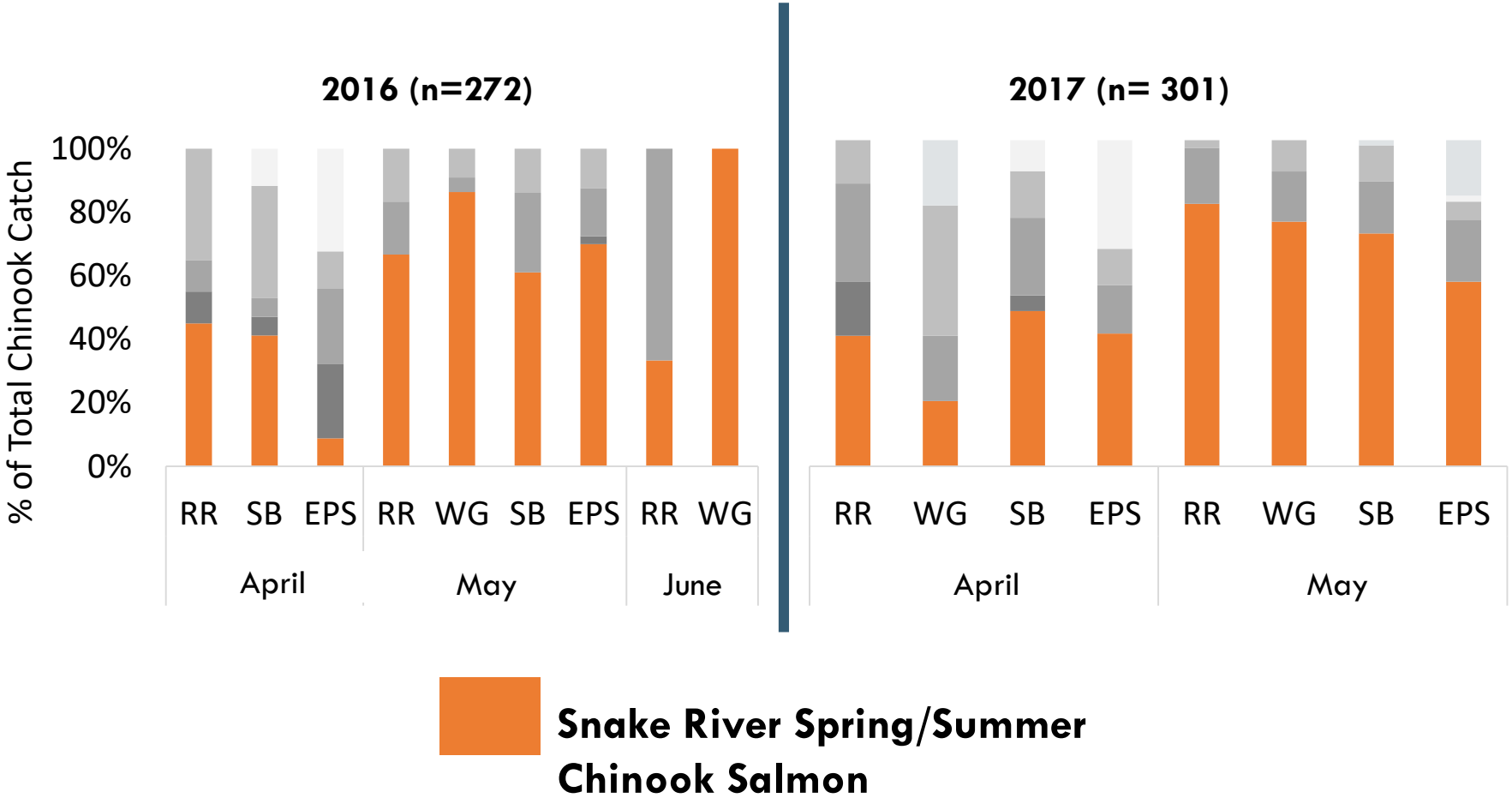


STABLE ISOTOPE ANALYSIS OF DIET AND TISSUES



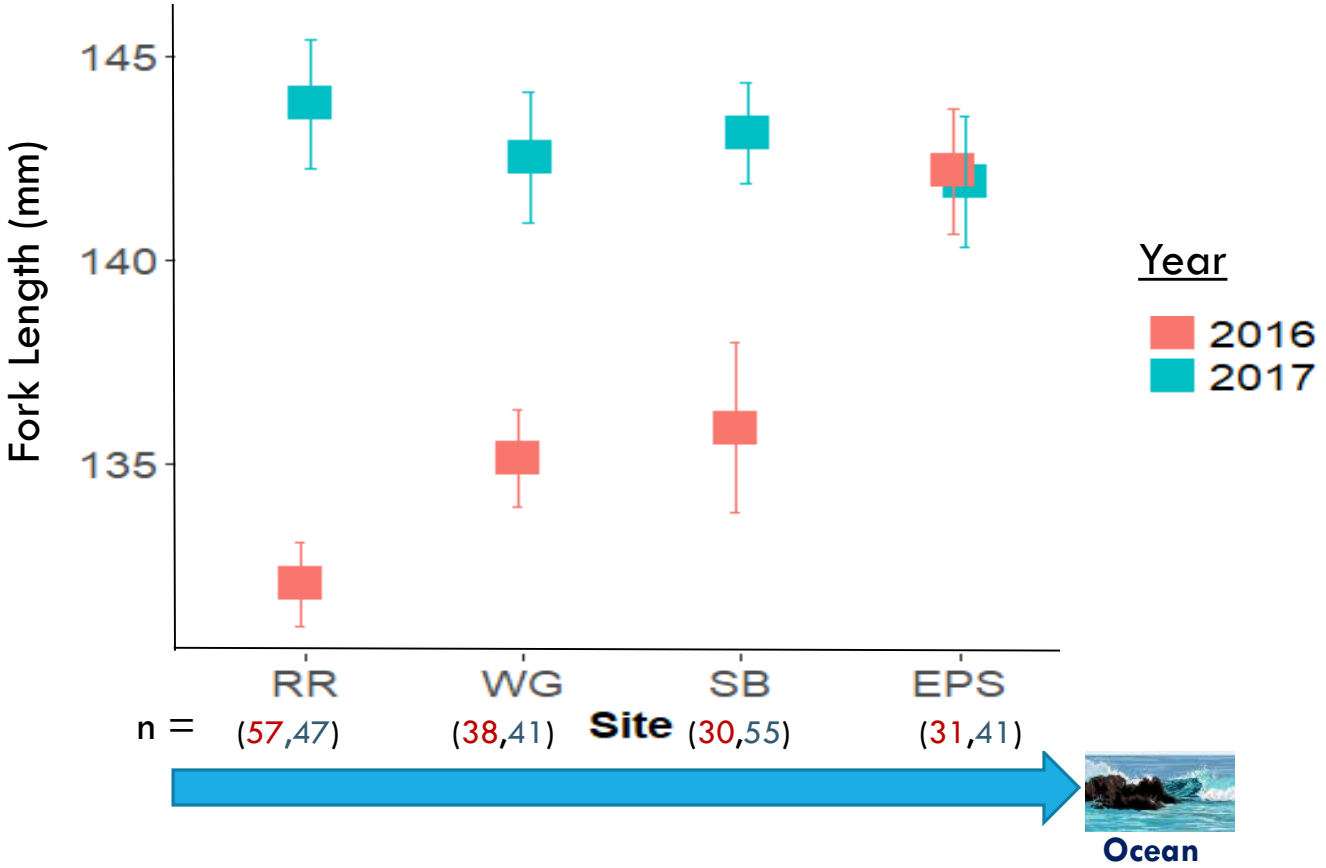
- **Turnover rate:** The amount of time it takes for the carbon and nitrogen from the diet to incorporate in the tissues
- **Stable isotope analysis of tissues**
  - **Short term:** Fin (7-10 days)
  - **Long term:** Muscle (Weeks to months)

Snake River Spring stock >50% of total Chinook catch



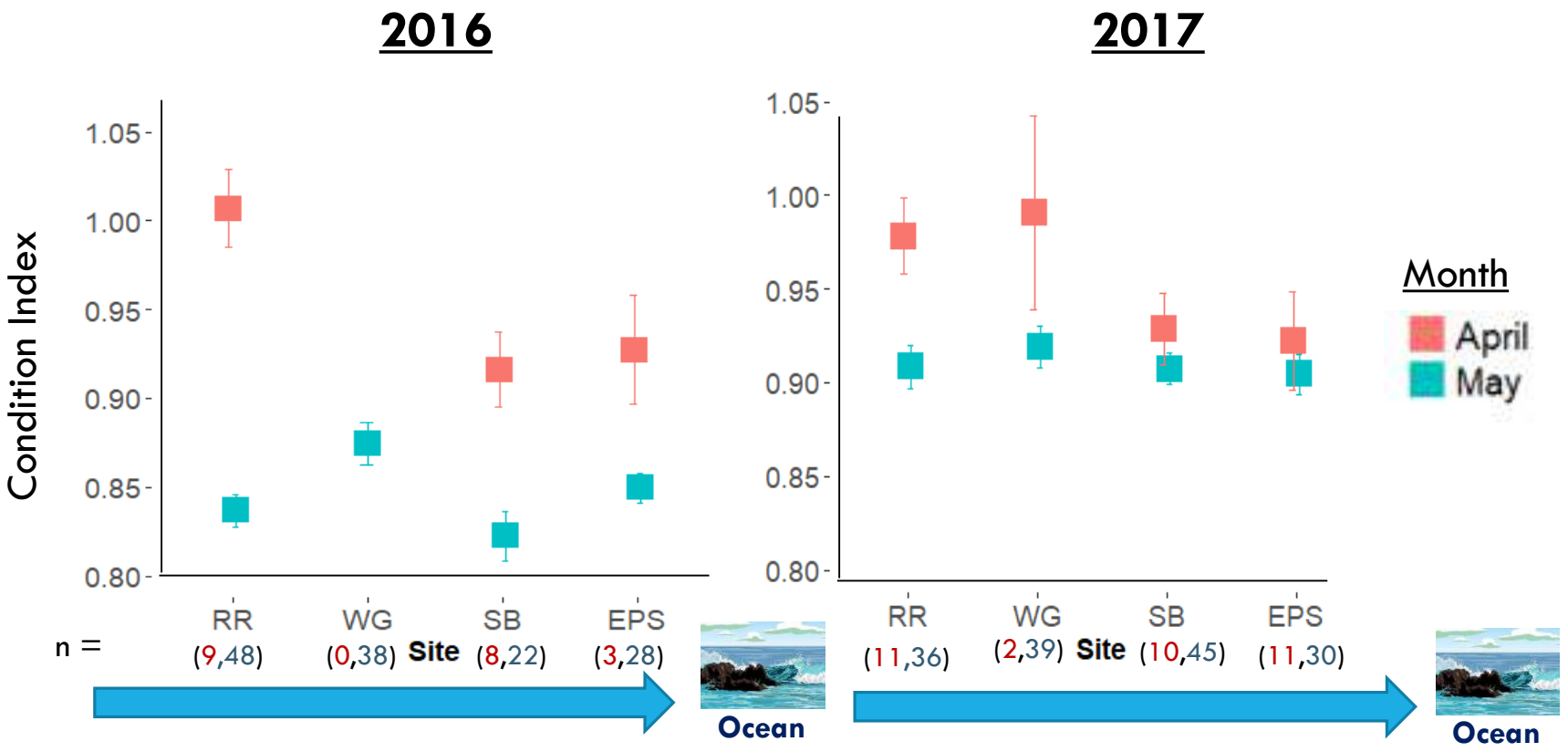
MEAN FORK LENGTHS (2016-2017)

2016: All sites significant different from EPS, except SB



CONDITION OF JUVENILE CHINOOK SALMON

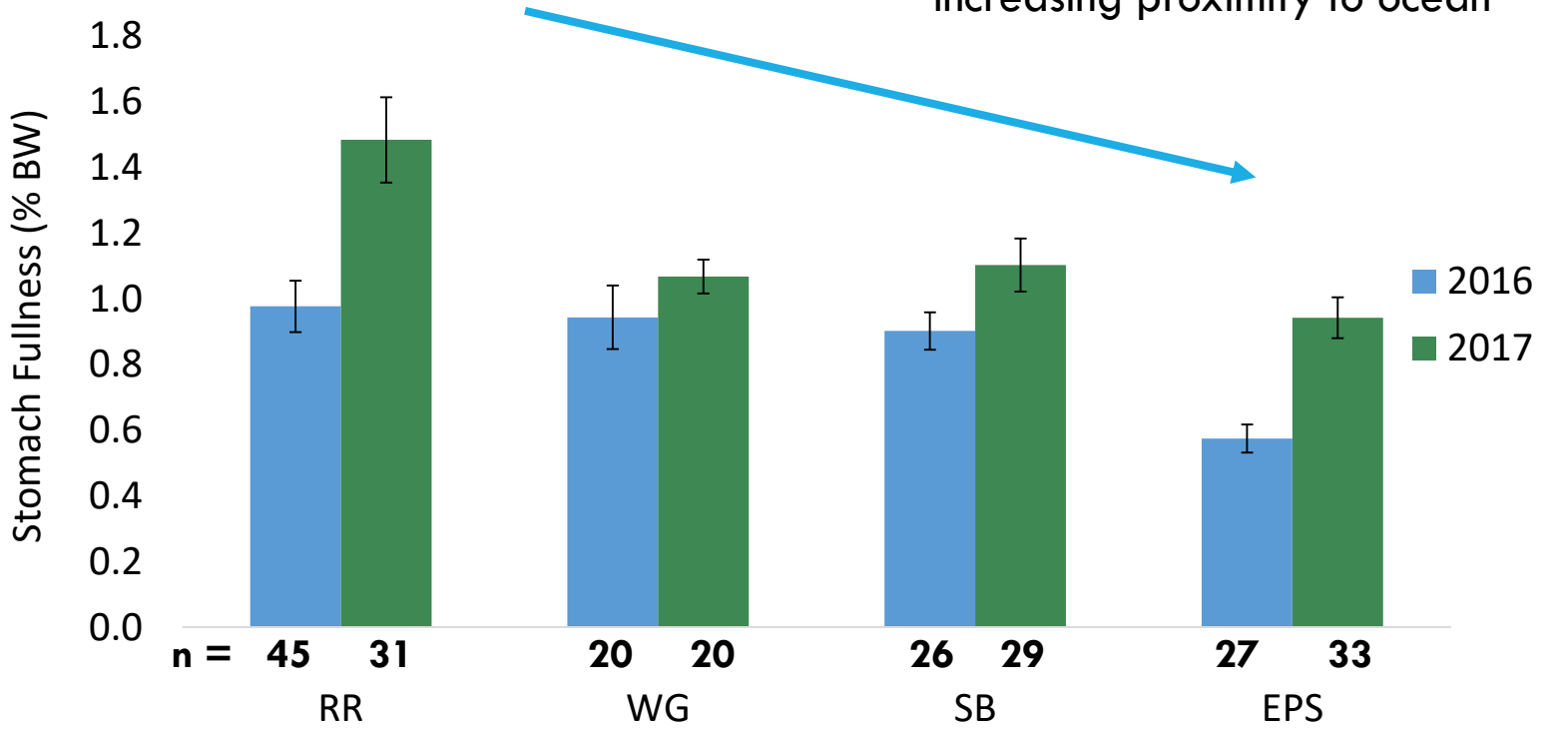
Fish collected in **April** were in greater condition than those in **May**



% Stomach Fullness (SF) :

$$\frac{wwt\ of\ stomach\ contents\ (g)}{Fish\ weight\ (g) - wwt\ of\ stomach\ contents\ (g)} \times 100$$

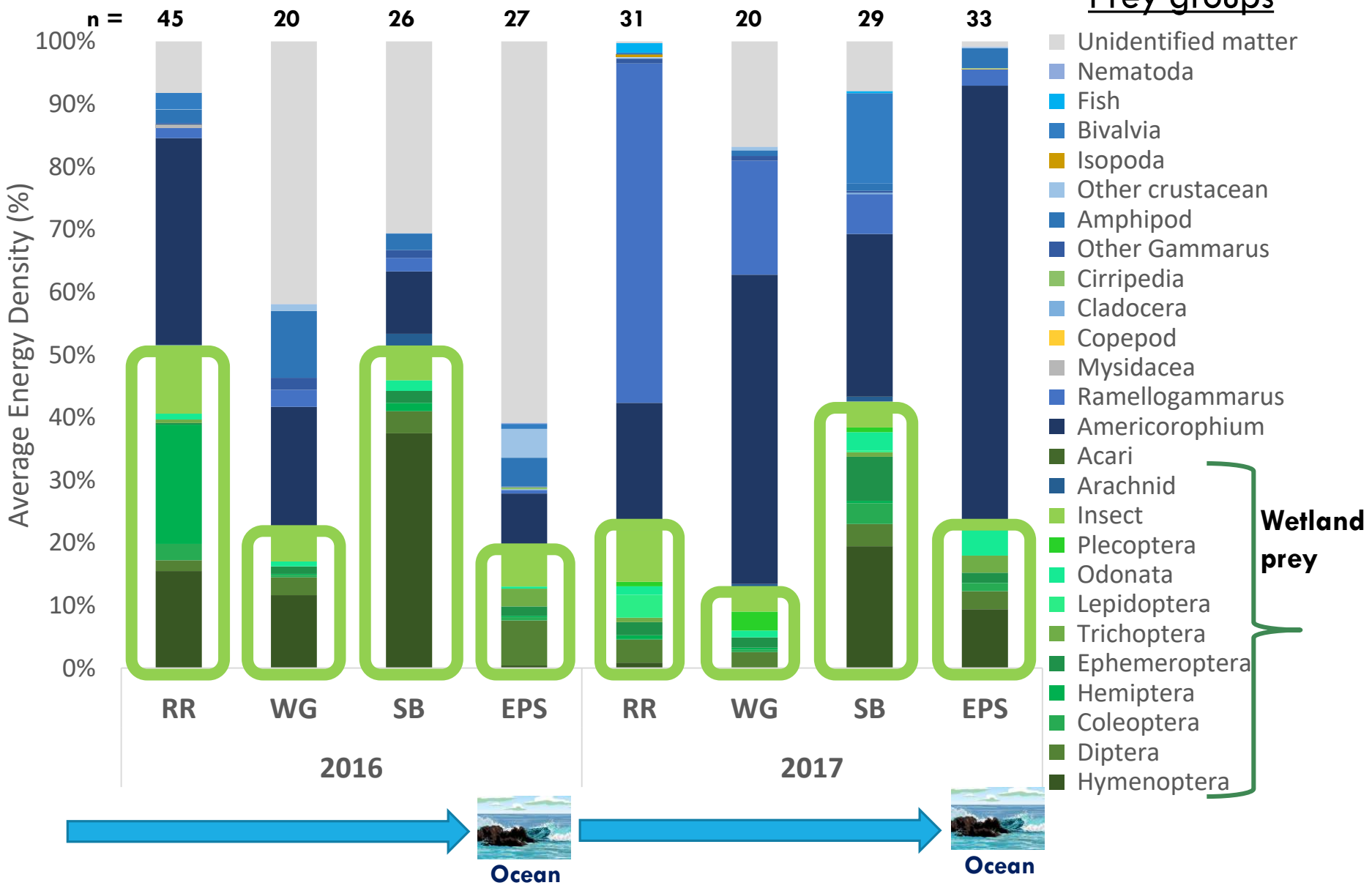
Decreasing stomach fullness with increasing proximity to ocean



Dam

Ocean

DIET COMPOSITION: ENERGY DENSITY



DIET COMPOSITION: PREY HABITAT GROUPS

	% increase from conversion of WWT to ED of insects	
Site	**2016**	**2017**
RR	26.0	8.9
WG	13.9	4.8
SB	1.4	10.2
EPS	8.9	12.4

Average Energy Density (%)

2016

Wetland produced Insects*

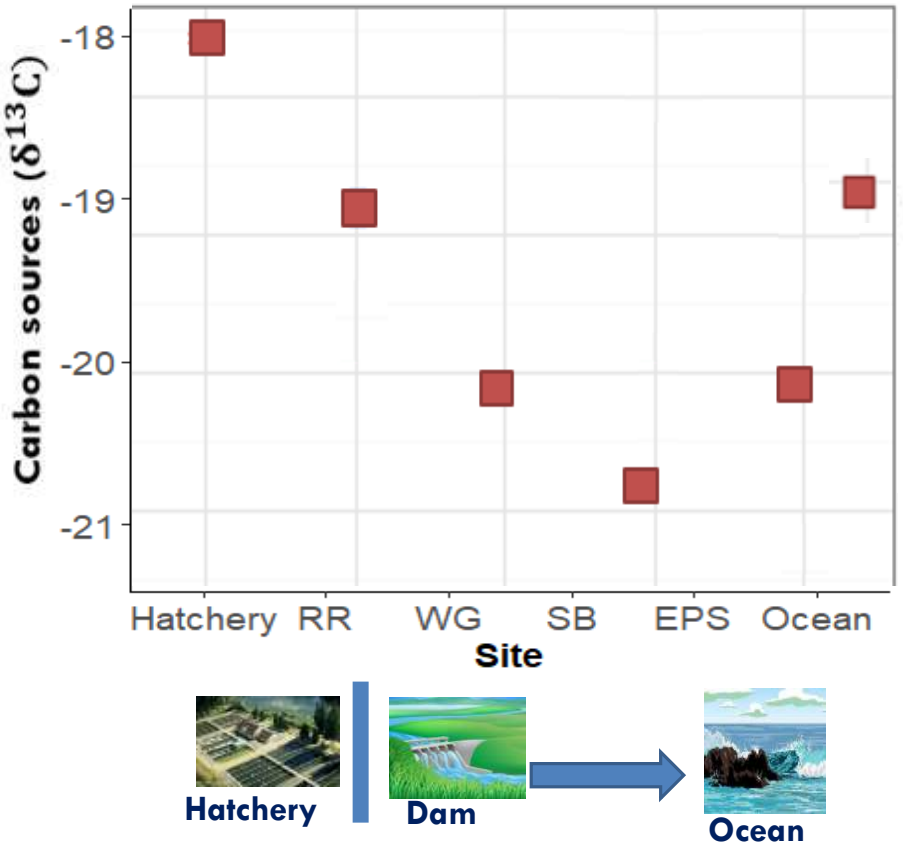
2017

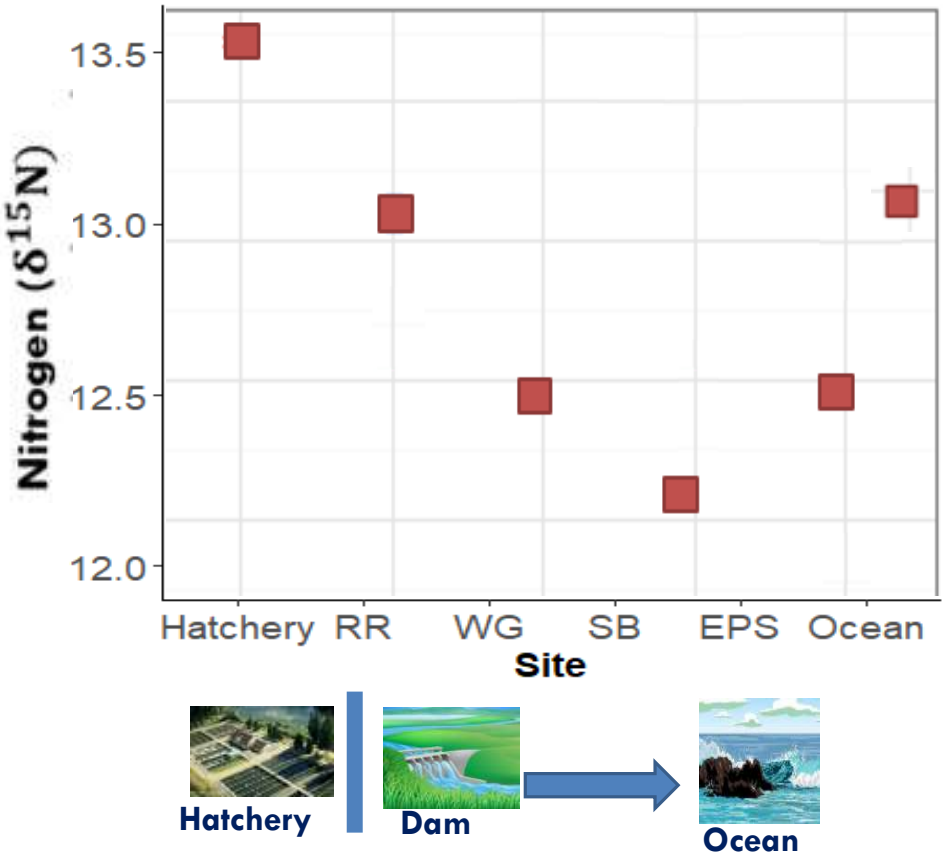
*Based on insect surveys in LCRE wetlands

Preliminary Results

Fish Tissue Stable Isotope Signatures

Expected



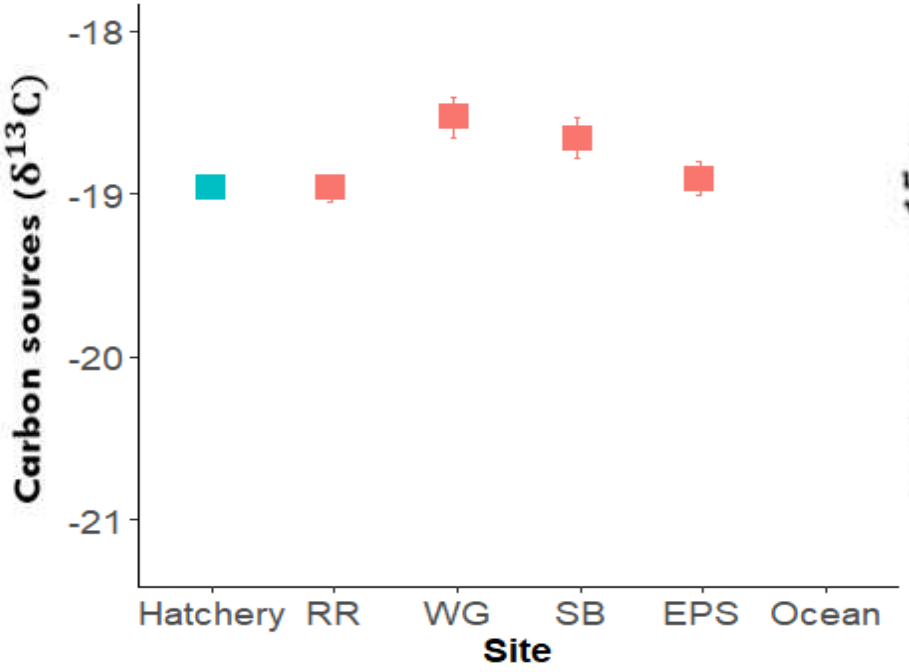


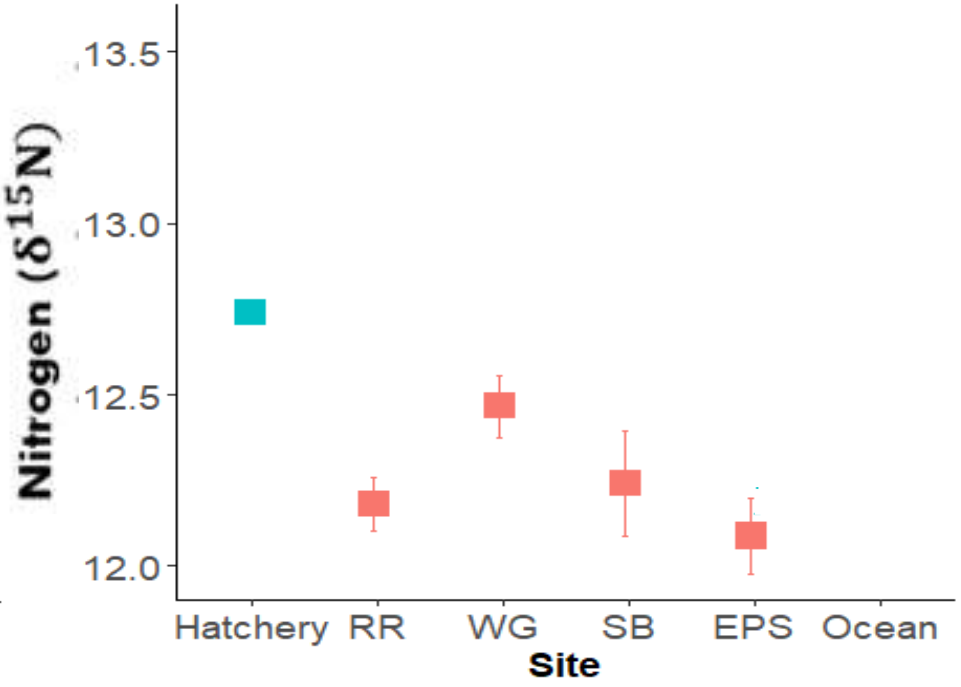
Preliminary Results

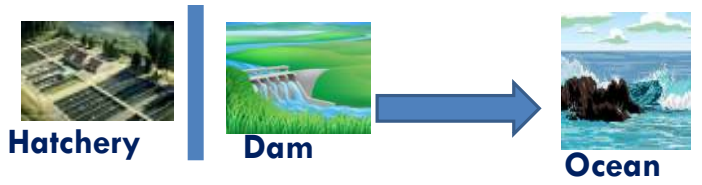
Fish Tissue Stable Isotope Signatures

Year
2016

Actual

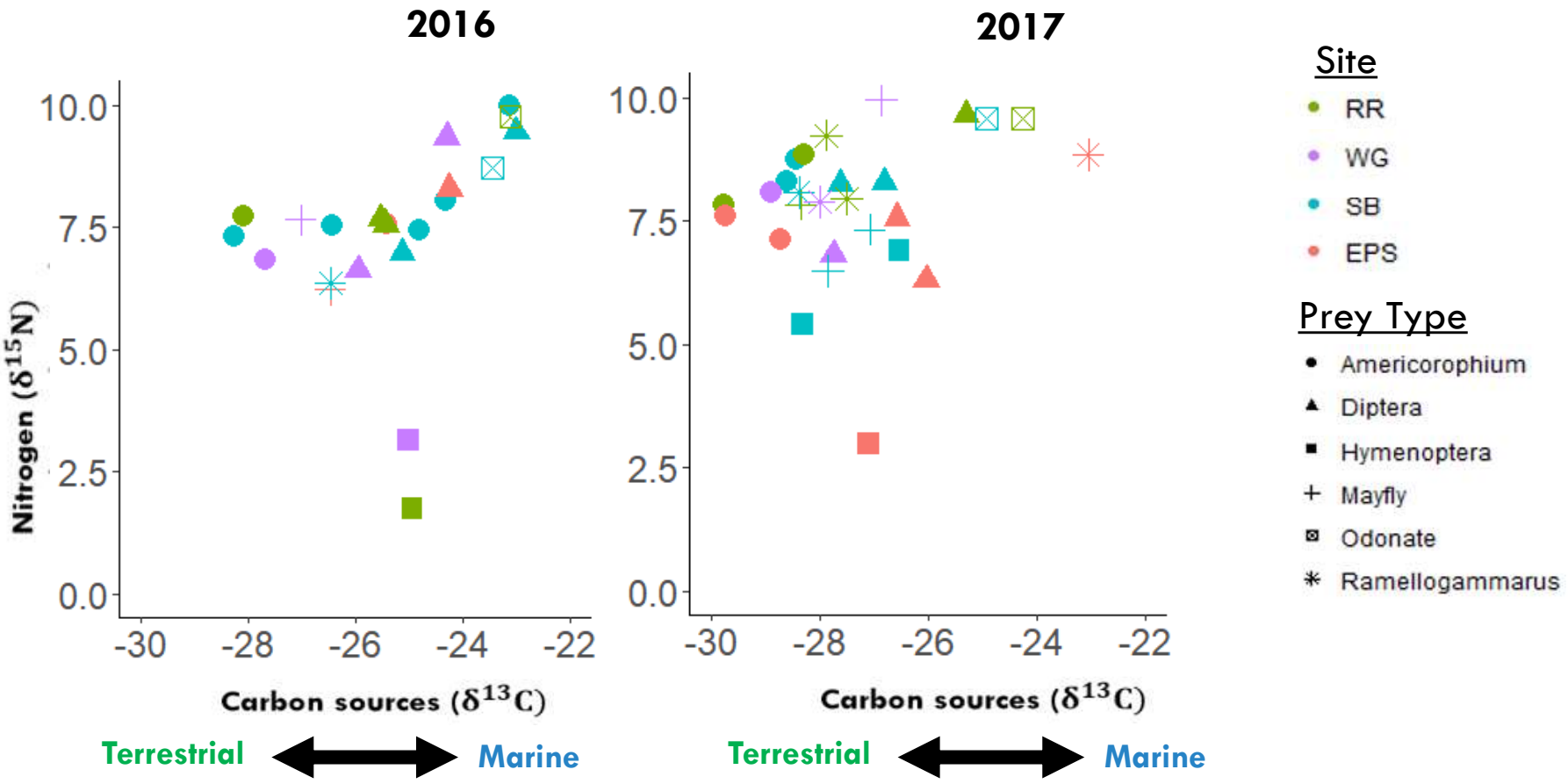






Preliminary Results

CHANGES IN STABLE ISOTOPE SIGNATURES OF COMMON YEARLING PREY



CAN WE DETECT CHANGES AS WE FOLLOW A COHORT?

In 2017, yearlings were on average larger, in similar condition, and their stomachs were more full compared to those collected in 2016

YES	1.	Growth? (increase in size and condition)
YES	2.	Does diet change among sites (terrestrial reliance)?
YES, UNCLEAR	3.	Is there variation in source prey stable isotope signature?
YES, UNCLEAR	4.	Do muscle and fin tissue stable isotope signatures differ as fish emigrate?

WHAT DOES THIS ALL MEAN?

- Yearling Chinook are benefitting from wetland subsidies and can be quantified using habitat prey groups
  -Prey with a greater terrestrial reliance and more nutritious
- Multiple tissue stable isotope signatures and diet were able to capture changes across sites, they were feeding!
  -Other tissues or tracers could provide more recent changes (e.g. fatty acids, sulfur)
- It's complicated, but having a baseline from other hatcheries before in-river migration would be useful for future field studies using stable isotope

NEXT STEPS

- Address variability in fish diets and tissue stable isotope signatures
  - -Flow data (2016-Low flow, 2017- High Flow)
  - -Tagging data
  - -Barium marker in otoliths?
- Determine if prey in diets are reflective of those exported from wetlands
  - -Compare to prey from wetlands

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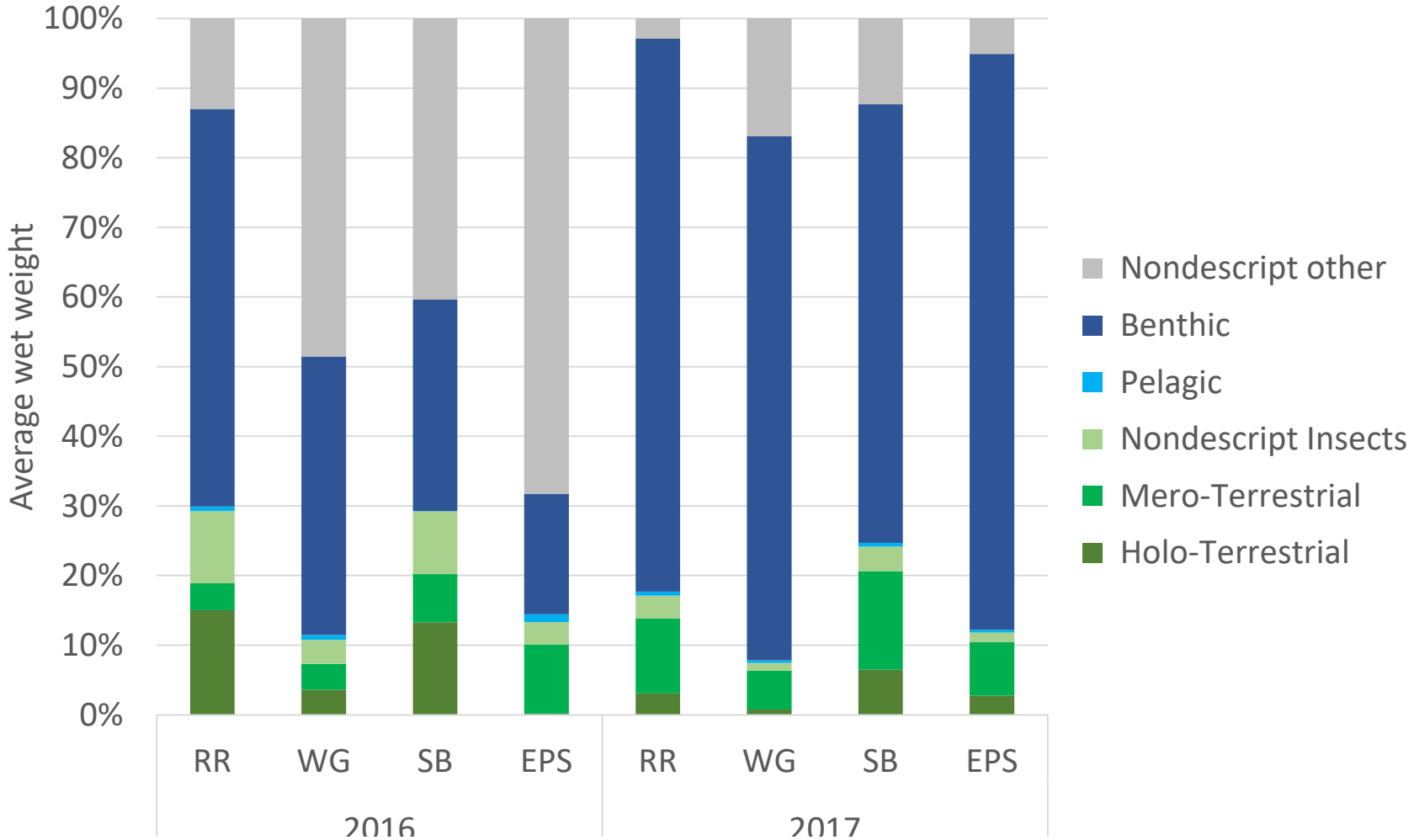
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Average wet weight
RR
WG
SB
EPS
RR
WG
SB
EPS
2016
2017
Nondescript other
Benthic
Pelagic
Nondescript Insects
Mero-Terrestrial
Holo-Terrestrial