Quantifying juvenile salmon prey quality and exploring trophic linkages in Puget Sound, WA, USA

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Introduction
Prey composition and quality are critically important to the growth of juvenile salmon and to their survival to adulthood. Juvenile fish need more than just sufficient caloric intake – they also need to have a balanced composition of essential nutrients to achieve high growth rates. Eicosapentaenoic acid (EPA, 20:5ω3) and docosahexaenoic acid (DHA, 22:6ω3) are essential fatty acids (EFA) needed for fish well-being and growth that must be acquired through diet (Bell et al. 1997, Daly et al. 2010, Glenoar 2009). High growth rates in the early marine period of a juvenile salmon may be critical to future survival (Beamish et al. 2004, Cross et al. 2009, Duffy & Beauchamp 2011). Puget Sound serves as an important nursery area for juveniles to feed and grow for the several weeks to months before migrating to the ocean.

The goal of this project was to gain insight into the lower trophic level food web that supports salmon growth by addressing these main objectives:

- Assess dietary quality of juvenile salmon prey taxa in Puget Sound and adjoining waters
- Assess spatial variability in availability of essential fatty acids (EFA) across Puget Sound basins
- Assess temporal variability in availability of EFAs

Results

Prey dietary quality

- Amphipods, mysids, crab larvae, krill (euphausiids), larval fish, are a good source of EPA & DHA.
- Shrimp & copepods are an inferior source of EPA.

Essential fatty acid content of zooplankton taxa

- Broad taxonomic groups show differences in fatty acid composition.
- 16:1ω7 & 16:3ω7 (Biomarkers for diatoms - a food source for many zooplankton) were dominant drivers of NMDS separation.

Fatty acid % composition of prey taxa

- EPA availability was primarily driven by patterns in carbon biomass

Spatial & Temporal availability of EFAs

- EPA availability observed as:
  - High in Bellingham Bay in spring & summer
  - Increasing from spring to summer in N. Whidbey Basin
  - Decreasing from spring to summer in N. Hood Canal
  - Low in South Sound & San Juan Islands in spring, increasing in summer

Conclusions
High EFA:

- EPA composition in salmon prey items varies — hyperiid and gammarid amphipods were the highest quality prey items followed by mysids, crab larvae, krill, and fish while the quality of copepods and shrimp was markedly lower.

- Chinook salmon juveniles negatively select for larval stages of the bay ghost shrimp (Neotrypetes californiensis) and small copepods (Schabetsberger et al. 2003). Thus, it seems that salmon select good quality diet items, but whether the selection is based on the food quality and is not coincidental remains to be explored in controlled feeding trials.

Spatial & Temporal availability of EFAs

- The timing and magnitude of peak availability of EPA and DHA vary among basins.
- Bellingham Bay had the highest availability of EPA and DHA in 2017, suggesting good offshore feeding conditions for hatchery stocks of Nooksack River Chinook salmon entering Bellingham Bay in April-May (Gamble et al. 2018).
- Conversely, the stations in South Sound had very low EPA+DHA availability in the spring 2017, suggesting that hatchery origin salmon juveniles from the Nisqually River that moved offshore early (Gamble et al. 2018) may have experienced poor feeding conditions in 2017.

This novel approach of using an integrated measure of food quantity and quality could be used to assess salmon prey fields from small-scale differences among habitat types to large-scale variation among regions. Future studies will reveal the potential value of EPA availability in explaining temporal and spatial variation in juvenile salmon performance.

Literature Cited


Methods

- Zooplankton samples collected from March - October 2017
- 335-μm mesh bongo nets, towed obliquely from 7 basins
- Samples for fatty acid analysis:
  - Collected opportunistically in deeper tows
  - Kept chilled & alive while sorted by species & size, dipped in tap water to remove salt, then frozen (-80°C) until analyses
  - Quantified 45 fatty acids
  - Multiplied the taxon-specific EPA+DHA (µg FA mg C⁻¹) values by the average monthly C biomass of the taxa in each station to estimate EPA availability at each site

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