Investigating habitat use and trophic overlap among North Pacific predators and their implications for Pacific salmon

Genyffer C. Troina, Philip Riekenberg, Marcel T.J. van der Meer, Evgeny Pakhomov, Brian P.V. Hunt

Introduction

- Inter-specific competition for food may have significant impacts on the distribution and abundances of marine species.
- Analysis of the pelagic food webs in the North Pacific open ocean using data collected in the winter of 2019 provided evidence for high niche overlap and potential for competition among mid-trophic level (meso-) predators (Troina et al. *in press*).
- A first step to determine whether co-occurring species compete for food is to define their preferred habitats and dietary overlap.
- **This study applies a combination of methods to investigate the trophic interactions and habitat use of North Pacific (Fig. 1) predators in the open ocean during winter.**

Methods

- International Year of the Salmon (IYS) expeditions in the winter of 2022 (Fig. 1).
- Analysis of **carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$) stable isotopes (bulk-tissue) and $\delta^{15}N$ in individual amino acids** in pelagic cephalopods and fishes.

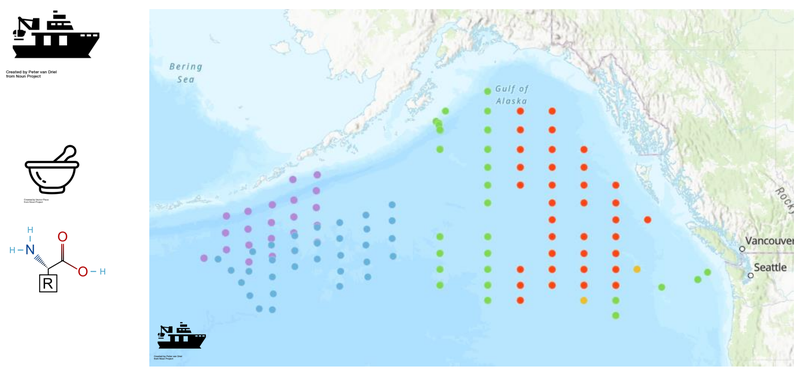


Figure 1: Sampling stations during the IYS expeditions to the North Pacific high seas in the winter of 2022.

Results

1. Variation in bulk-tissue $\delta^{15}N$ values are driven by baseline gradients in $\delta^{15}N$ values and not by variation in trophic position.

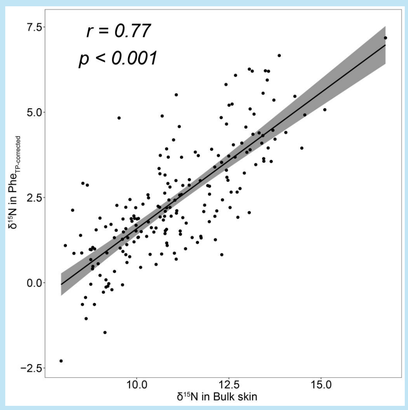
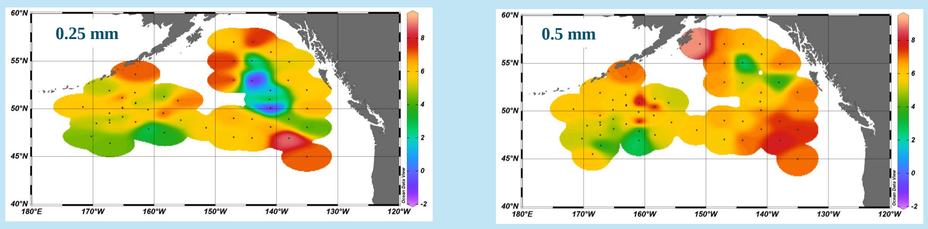


Figure 2: Spearman rank correlations for meso-predator species to test the relationship between $\delta^{15}N$ values in bulk-skin and trophic corrected phenylalanine ($Phe_{TP\text{-}corrected}$) [left]; and between bulk-tissue and the difference in $\delta^{15}N$ values between mean trophic and mean source amino acids (Tr-Sr) [right].

2. Spatial gradients in baseline (zooplankton, bulk tissue) $\delta^{15}N$ values.



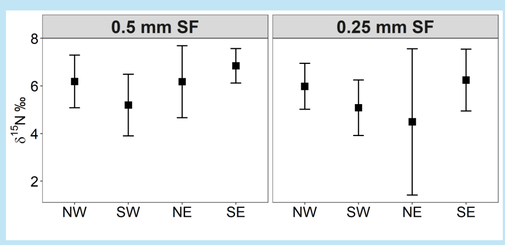


Figure 3: Bulk-$\delta^{15}N$ values in zooplankton 0.25 mm and 0.5 mm size-fractions (SF).

3. Phe-$\delta^{15}N$ values in the different meso-predators followed zooplankton-$\delta^{15}N$ spatial trends, allowing to identify habitat use.

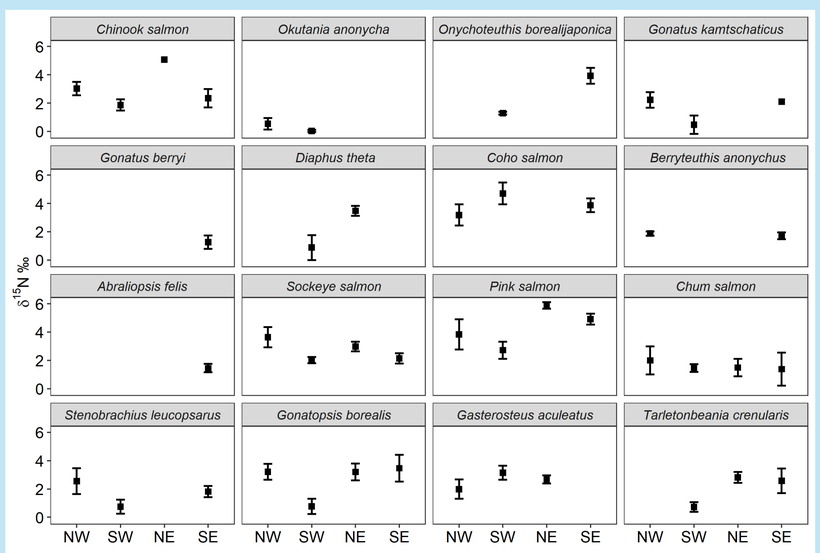


Figure 4: $\delta^{15}N$ values in the *source* amino acid phenylalanine (Phe) in different meso-predator species.

4. Squid and myctophids have similar trophic position (~ 3.3) to Pacific salmon: potential for trophic overlap

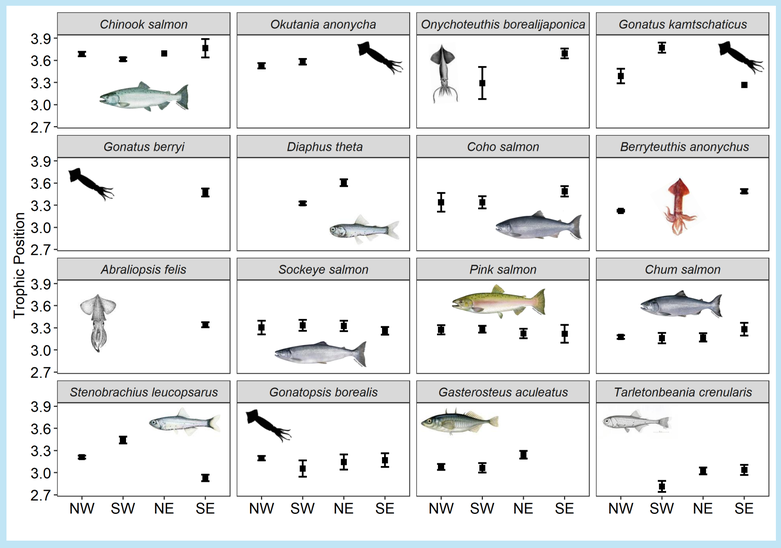


Figure 5: Trophic position of North Pacific meso-predators estimated using $\delta^{15}N$ values in multiple trophic and source amino acids.

2. High isotopic overlap at the base of the food webs used by North Pacific meso-predators

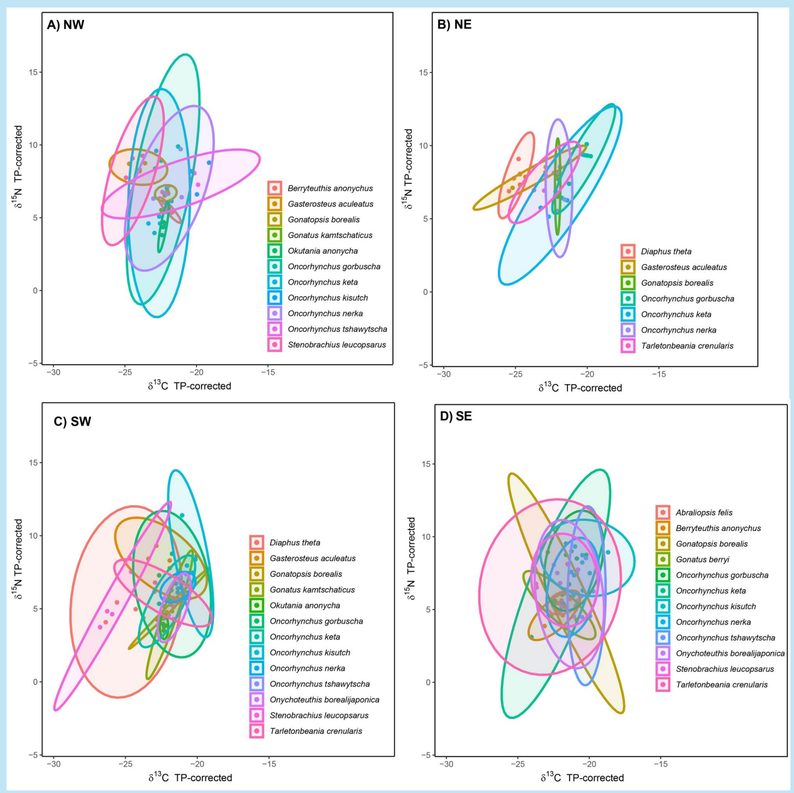


Figure 6: Isotopic ellipses and niche overlap at the base of the food webs used by the different meso-predator species in each zone, estimated using bulk-tissue $\delta^{13}C$ and $\delta^{15}N$ values corrected for the effect of trophic position:

$\delta^{13}C_{TP\text{-}corrected} = \delta^{13}C\text{-}(TDF_{\delta 13C} \times (TP - 2))$
$\delta^{15}N_{TP\text{-}corrected} = \delta^{15}N\text{-}(TDF_{\delta 15N} \times (TP - 2))$

Take-home:

- Spatial gradients in baseline $\delta^{15}N$ (zooplankton and Phe) allow identification of species-specific fidelity to feeding areas with spatially different nitrogen sources.
- Squid and myctophids occupy similar trophic position to Pacific salmon.
- Our findings support overlap in resource use among North Pacific meso-predators in the high seas, with potential implications for foraging salmonids.
- The results from this study will be used to inform food web models to investigate the impacts of competition when resources are limited and / or consumer abundance changes.

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#BCSRIF
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g.troina@oceans.ubc.ca

Thank you!