

Oncorhynchus keta (NOAA Fisheries)



Oncorhynchus nerka (NOAA Fisheries)

Stable Isotopes Link Coastal Foraging to Juvenile Salmon Body Size

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INTRODUCTION

The **critical size–critical period hypothesis** proposes that **juvenile salmon** must reach a sufficient body size before their first marine winter to survive predation and prey scarcity[1].

Foraging conditions on the continental shelf during the **summer outmigration** vary interannually, and are thought to influence whether juvenile salmon reach their critical size[2].

Using stable isotope ($\delta^{13}C$, $\delta^{15}N$) values of juvenile chum and sockeye salmon sampled in late winter 2019-2022, we **estimated the relative contributions of continental shelf versus open ocean waters to growth.**

We predict that juveniles with a stronger continental shelf influence will have a larger body size.

METHODS

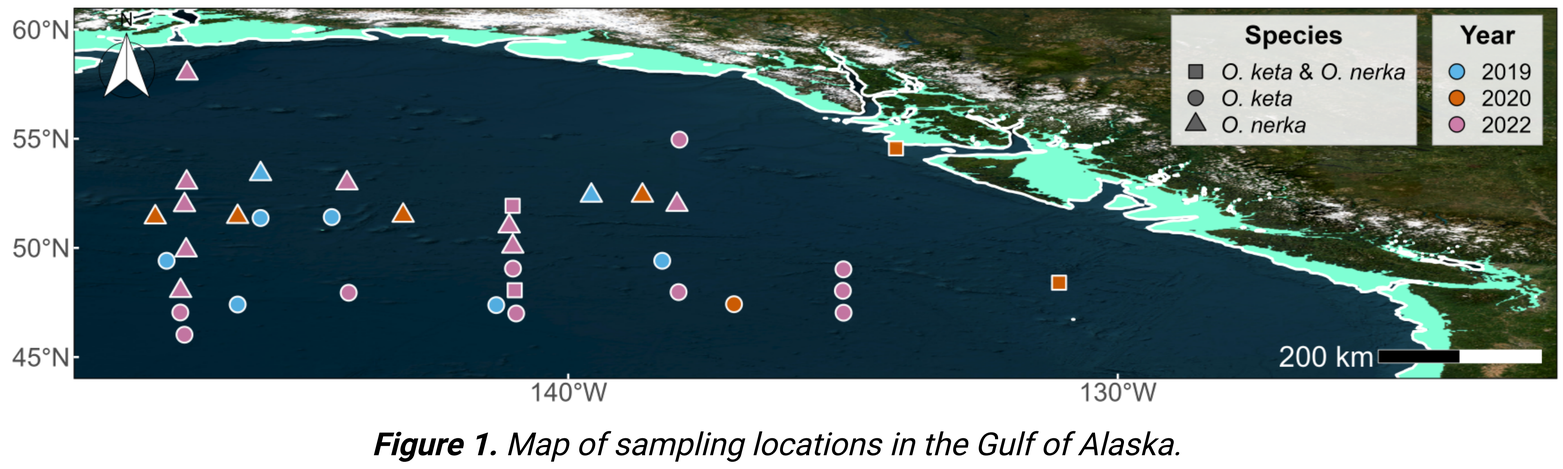


Figure 1. *Map of sampling locations in the Gulf of Alaska.*

Sample Collection

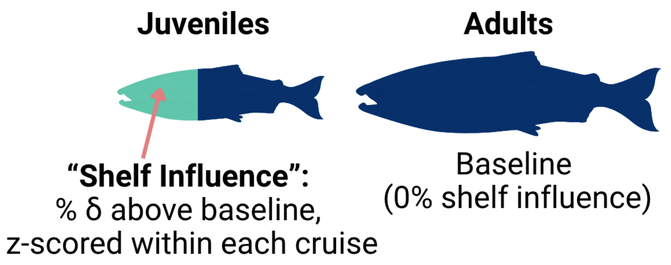
Chum (*O. keta)* and sockeye (*O. nerka)* juvenile salmon were collected from the **Gulf of Alaska** during the International Year of the Salmon (IYS) expeditions in 2019, 2020, and 2022 (*Fig. 1*).

Zooplankton abundance from the **North Pacific Continuous Plankton Recorder (CPR) Survey** approximated foraging conditions during the summer outmigration.

Stable Isotope Analysis

Muscle tissue was analysed for **carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$) stable isotopes.**

Juveniles were delineated from adults using a **maximum fork length threshold**, derived from scale analysis.



RESULTS

1. **$\delta^{15}N$ enrichment predicted fork length** in both chum and sockeye but $\delta^{13}C$ enrichment did not.
2. **2019 & 2022:** shelf influence was **negatively correlated with length** in chum and sockeye.
   2020: shelf influence was **positively correlated with length** in chum and sockeye.

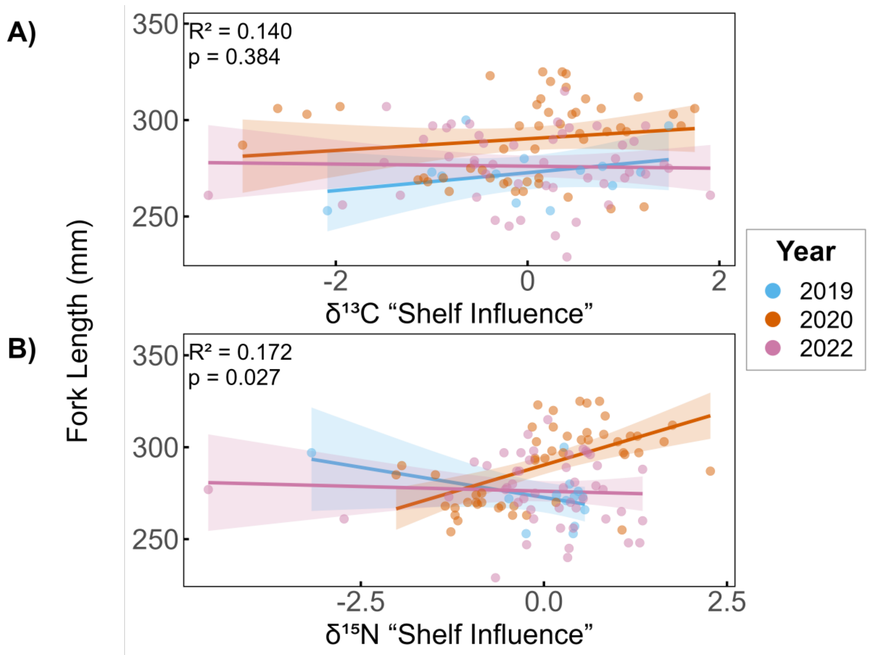


Figure 2. *Relationship between standardised $\delta^{13}C$ (A) and $\delta^{15}N$ (B) enrichment and fork length in juvenile **chum.***

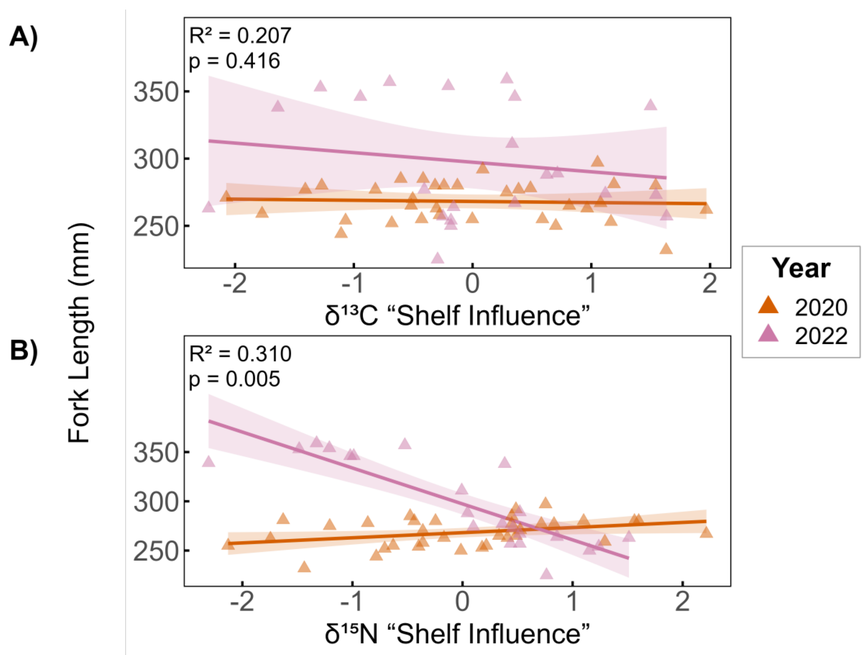


Figure 3. *Relationship between standardised $\delta^{13}C$ (A) and $\delta^{15}N$ (B) enrichment and fork length in juvenile **sockeye**.*

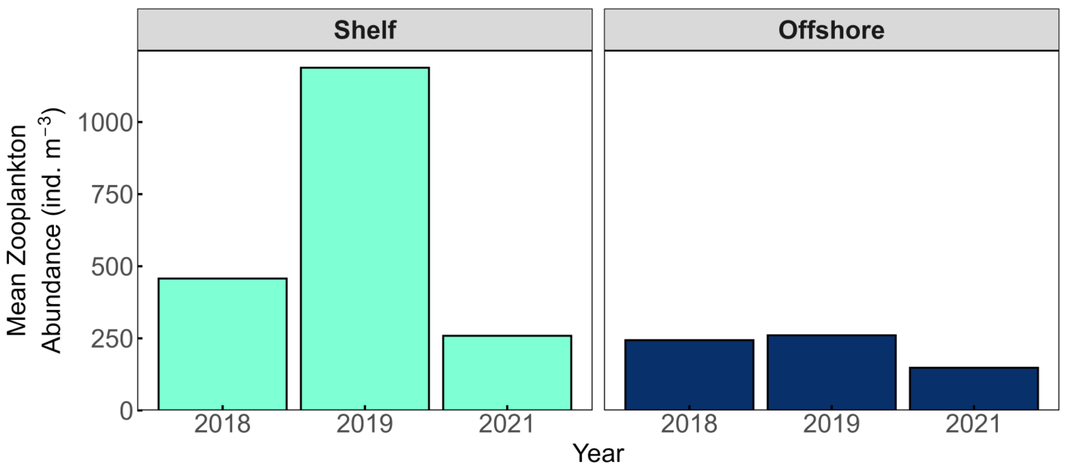


Figure 4. *Mean zooplankton abundance (ind. m^{-3}) on the shelf and offshore during the summer outmigration.*

1. Mean **zooplankton abundance on the shelf was ~ 3x higher in 2019** (during the 2020 summer outmigration) than other years.
2. Offshore abundance was relatively stable across years.

CONCLUSION

The relative contribution of shelf and open ocean feeding to salmon size attained at the end of their first winter varied between years.

- The $\delta^{15}N$-length relationship appears sensitive to **interannual shifts in shelf foraging conditions.**
- Size attained may vary with changing prey availability in shelf vs offshore waters, and depend on **stock specific migration timing** and **relative use of shelf and offshore habitats.**

Future Directions:

- Test other Pacific salmon species to see how life history shapes this relationship.
- Expand temporal coverage to identify interannual patterns and their environmental drivers.

PELAGIC ECOSYSTEMS LABORATORY

INTERNATIONAL YEAR OF THE SALMON

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1. Beamish, R. J., & Mahnken, C. (2001). A critical size and period hypothesis to explain natural regulation of salmon abundance and the linkage to climate and climate change. Progress in Oceanography, 49(1–4), 423–437. https://doi.org/10.1016/S0079-6611(01)00034-9;
2. Mueter, F. J., Pyper, B. J., & Peterman, R. M. (2005). Relationships between Coastal Ocean Conditions and Survival Rates of Northeast Pacific Salmon at Multiple Lags. Transactions of the American Fisheries Society, 134(1), 105–119. https://doi.org/10.1577/T-04-033.1

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