Species-specific foraging strategies in Pacific salmon revealed by multi-tissue stable isotope analysis

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PELAGIC ECOSYSTEMS LABORATORY

PICES

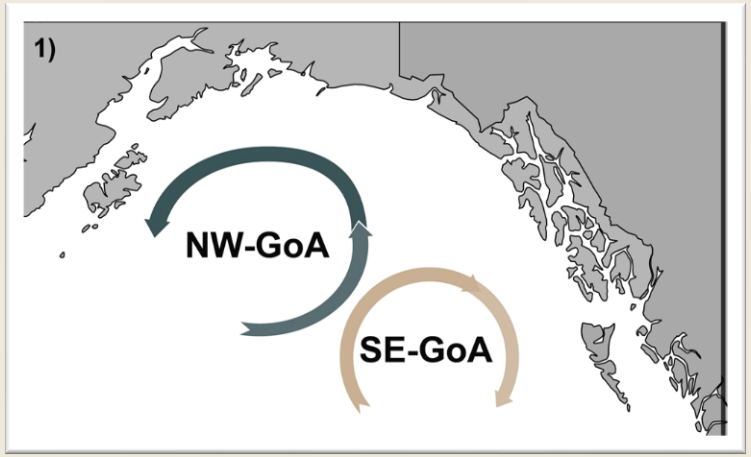

FOOD ALLERGY?
ASK BEFORE YOU EAT!
GUESTS WITH FOOD ALLERGIES:
PLEASE SPEAK WITH A MANAGER
FOR INDIVIDUALIZED ASSISTANCE.
FOOD SERVED HERE MAY CONTAIN OR
HAVE COME IN CONTACT WITH:
The Allergen Promise
Levy
Made without
gluten
but may contact
gluten

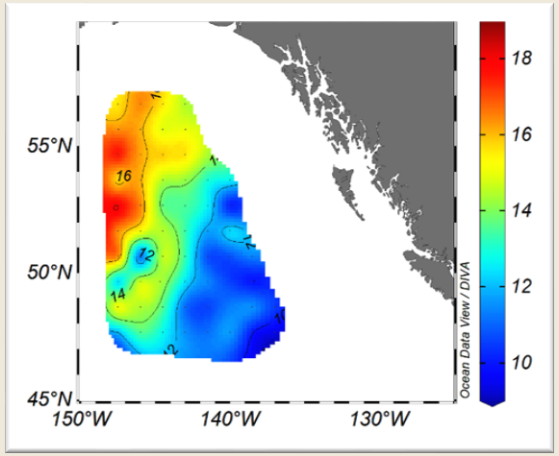
Pacific salmon face the same challenge

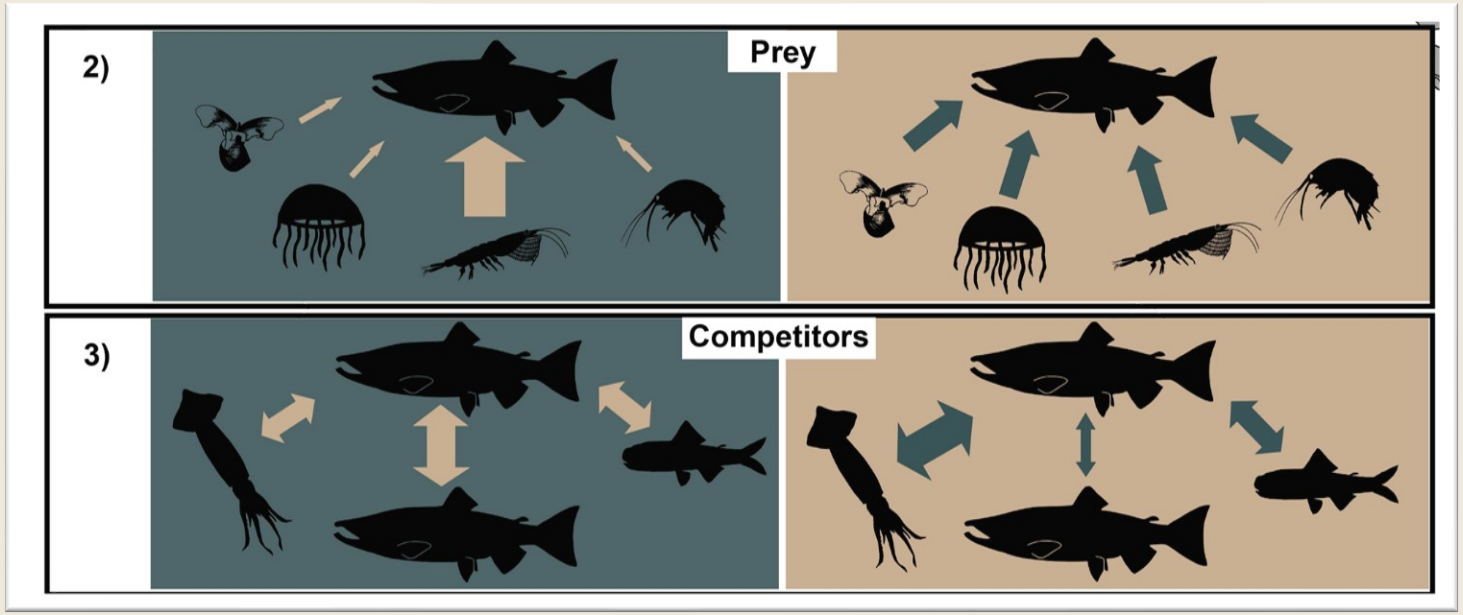
- **Sympatry**
- **Limited winter productivity**
- **How do they coexist?**



What we learned about the ecology of Pacific salmon during the open ocean phase:







Troina et al. 2024; 2026

Introduction

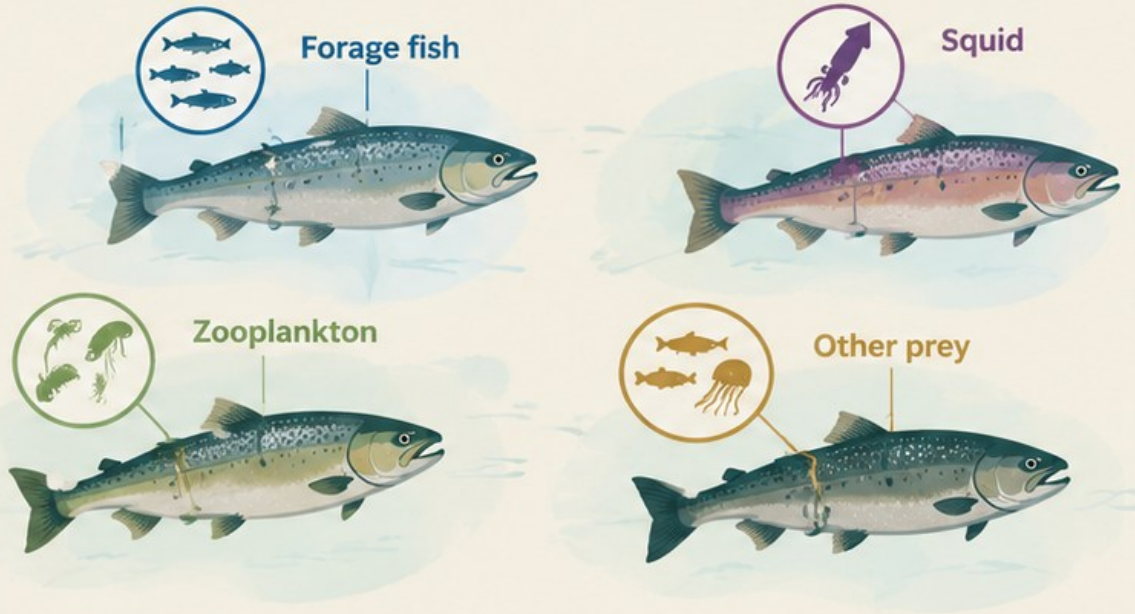
Population-level

Populations treated as homogeneous
→ individuals rarely considered



Individual-level

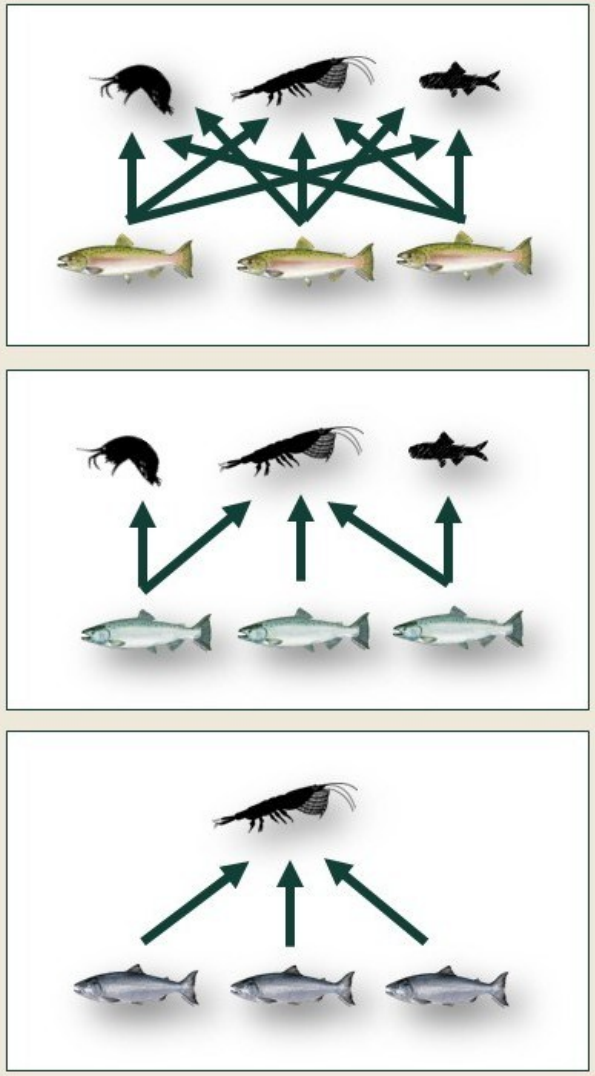
Different feeding strategies, habitat use, and trophic roles



How do individual-level patterns differ from the whole population, and are these differences contributing to coexistence?

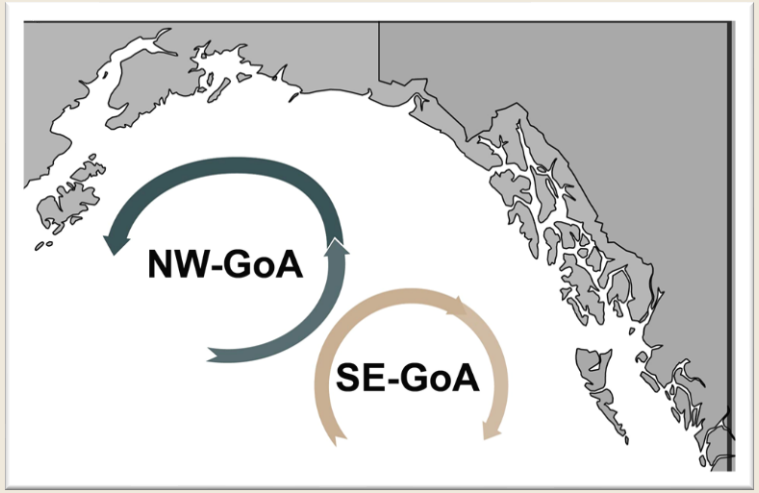
1

Do species differ in specialization?



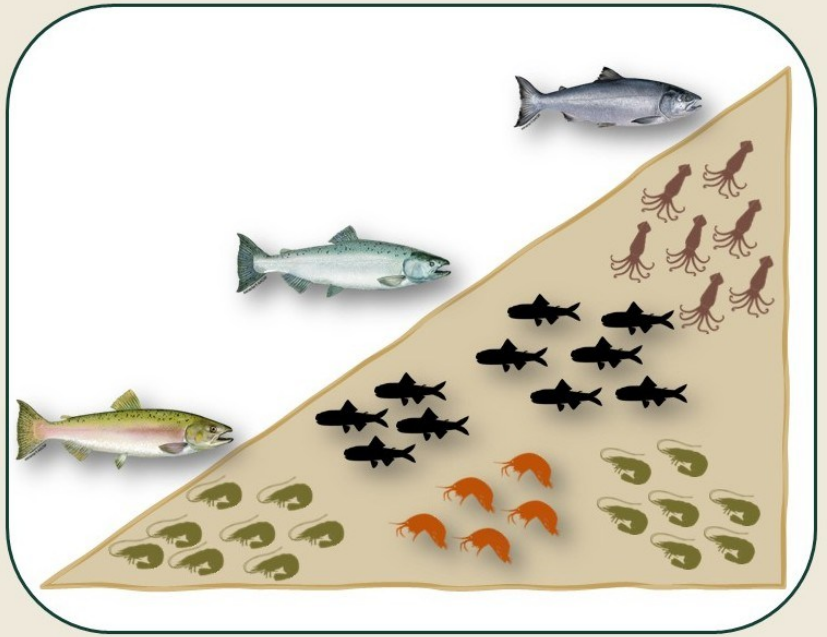
2

Does environment influence specialization?

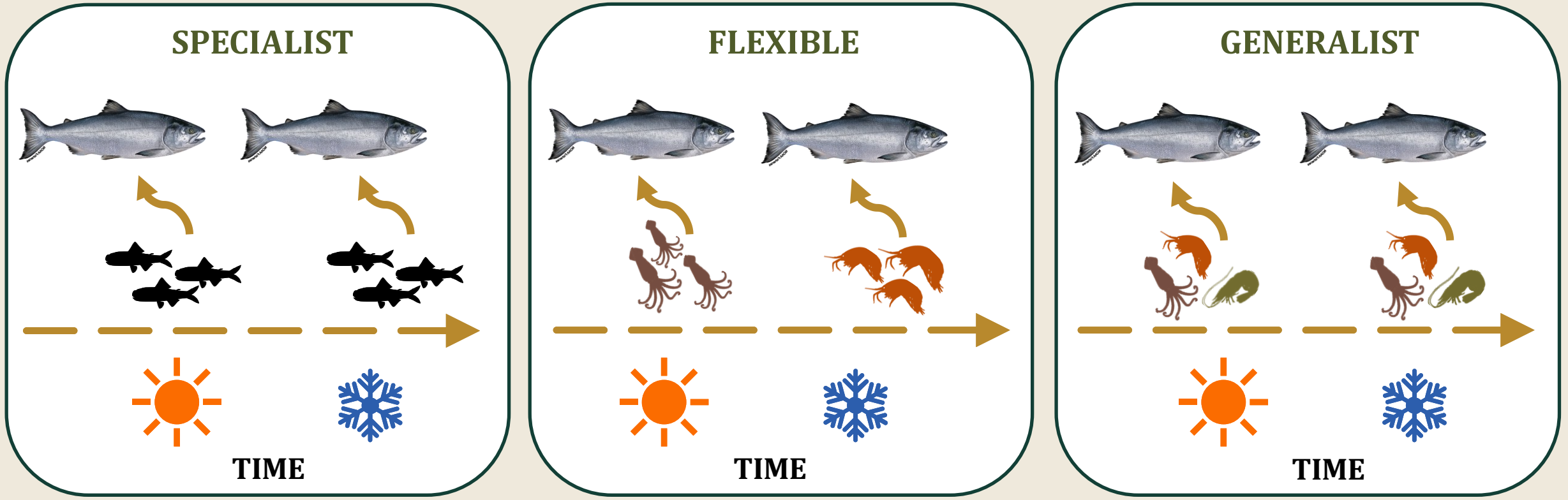


3

Which species are specialists vs. generalists?



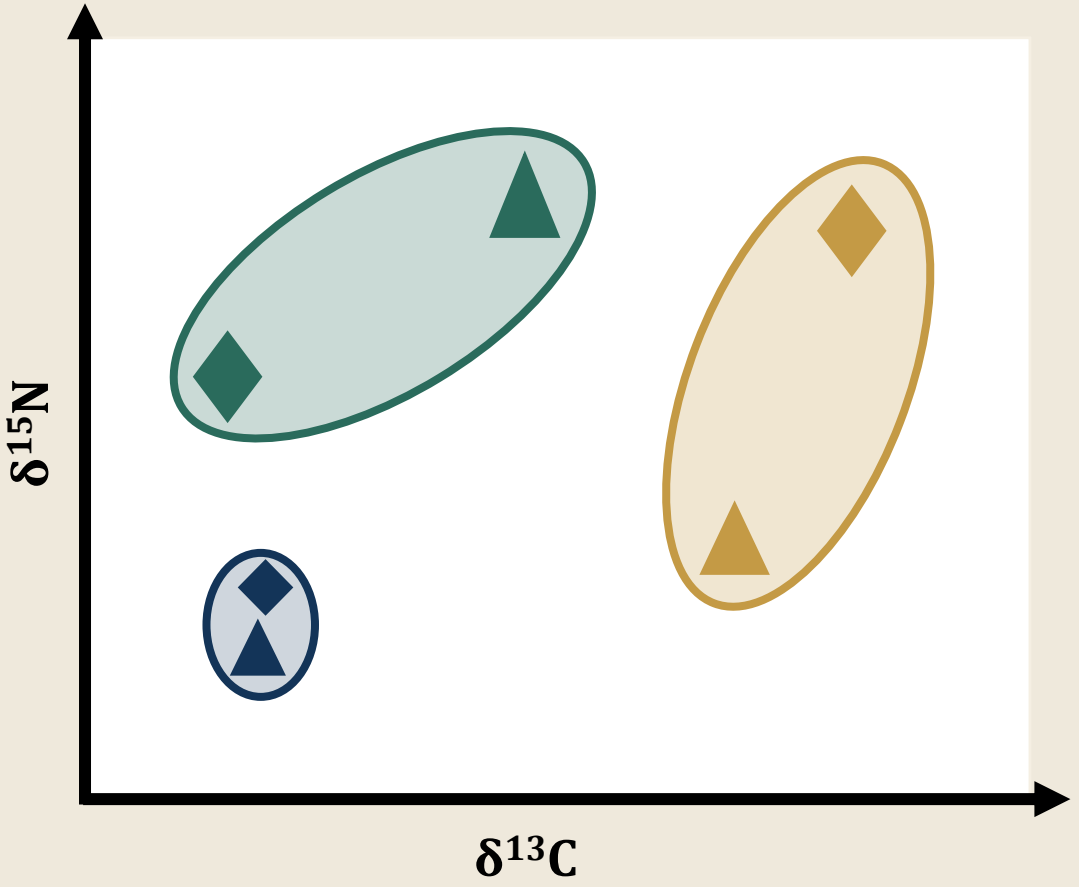
How do we assess individual diet specialization?

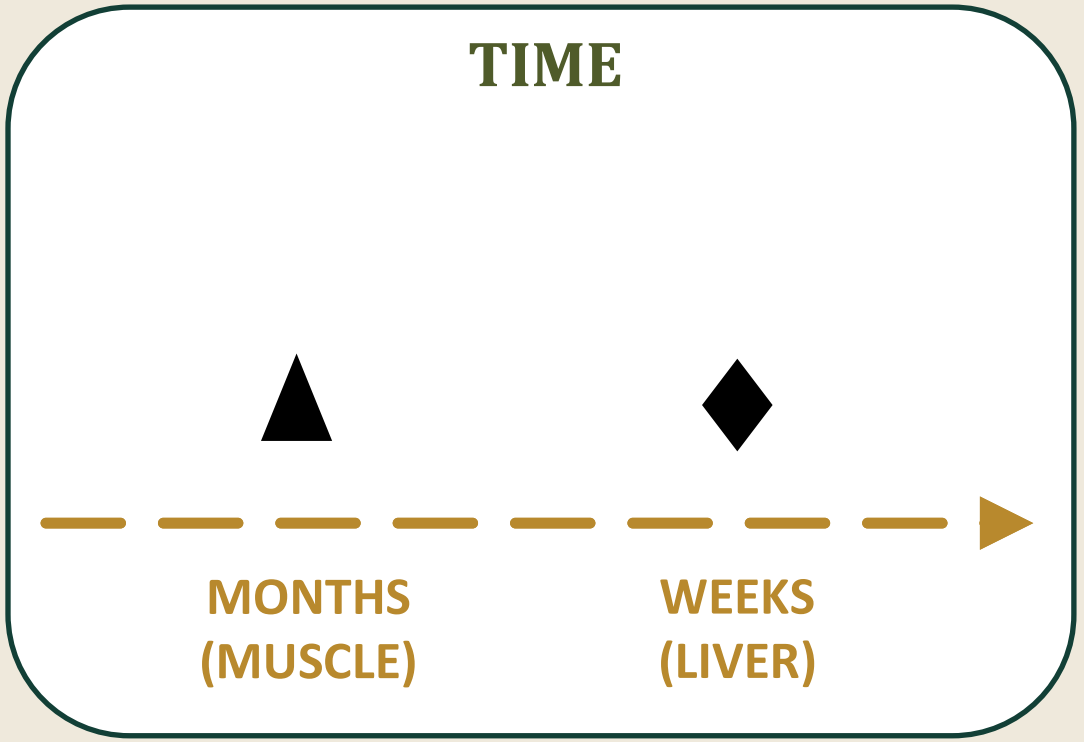


How do we assess individual diet specialization?

- **Must obtain repeated samples**
- **Stomach content → snapshot**
- **Stable isotope analysis**
  - **Multiple tissues** with different turnover rates (e.g., **liver** *vs*. **muscle**)

Individual isotopic variation (δ-space)





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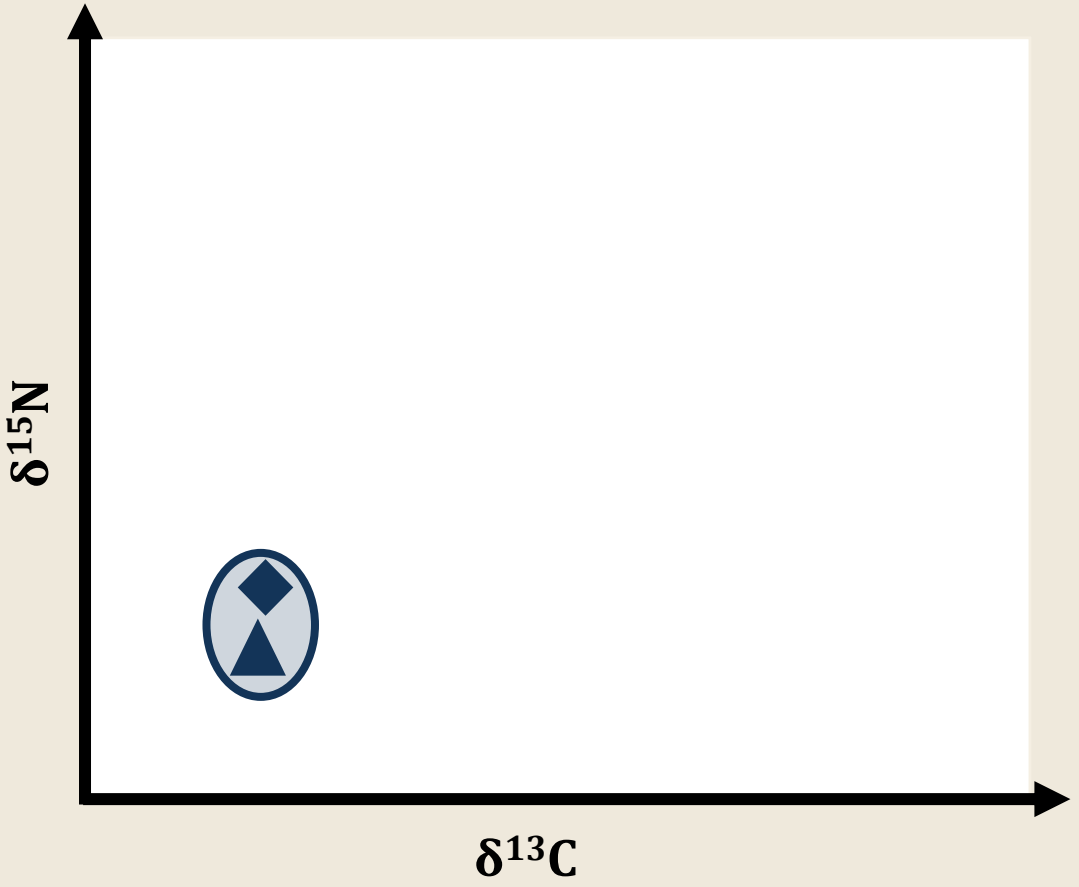

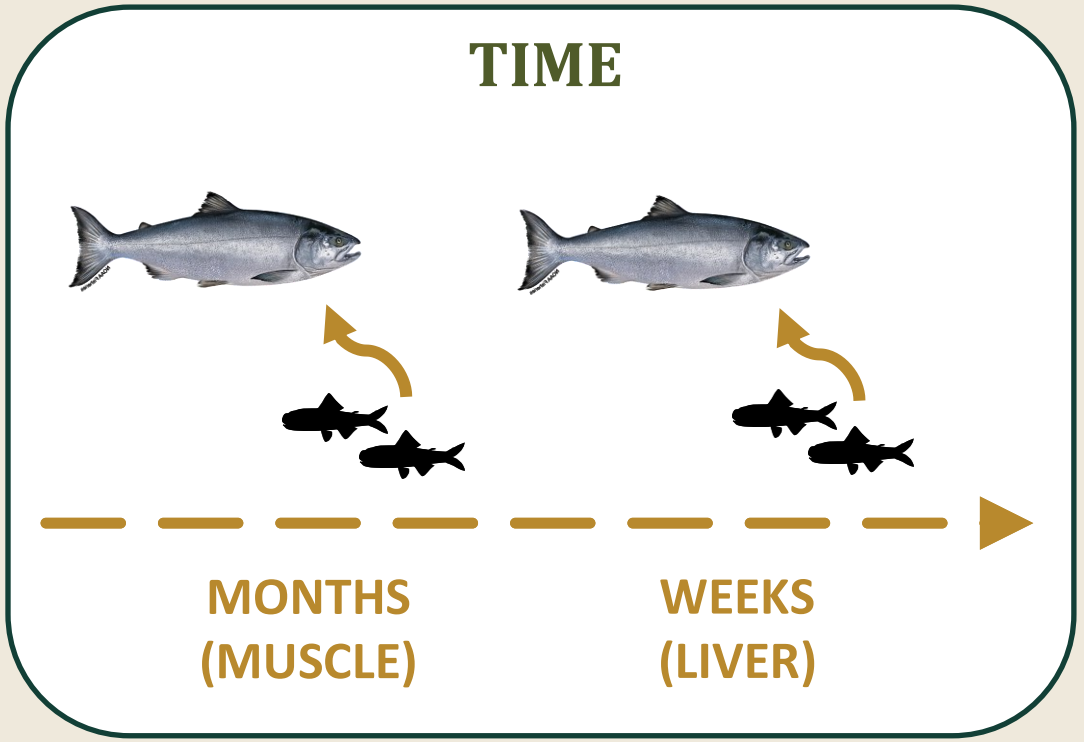

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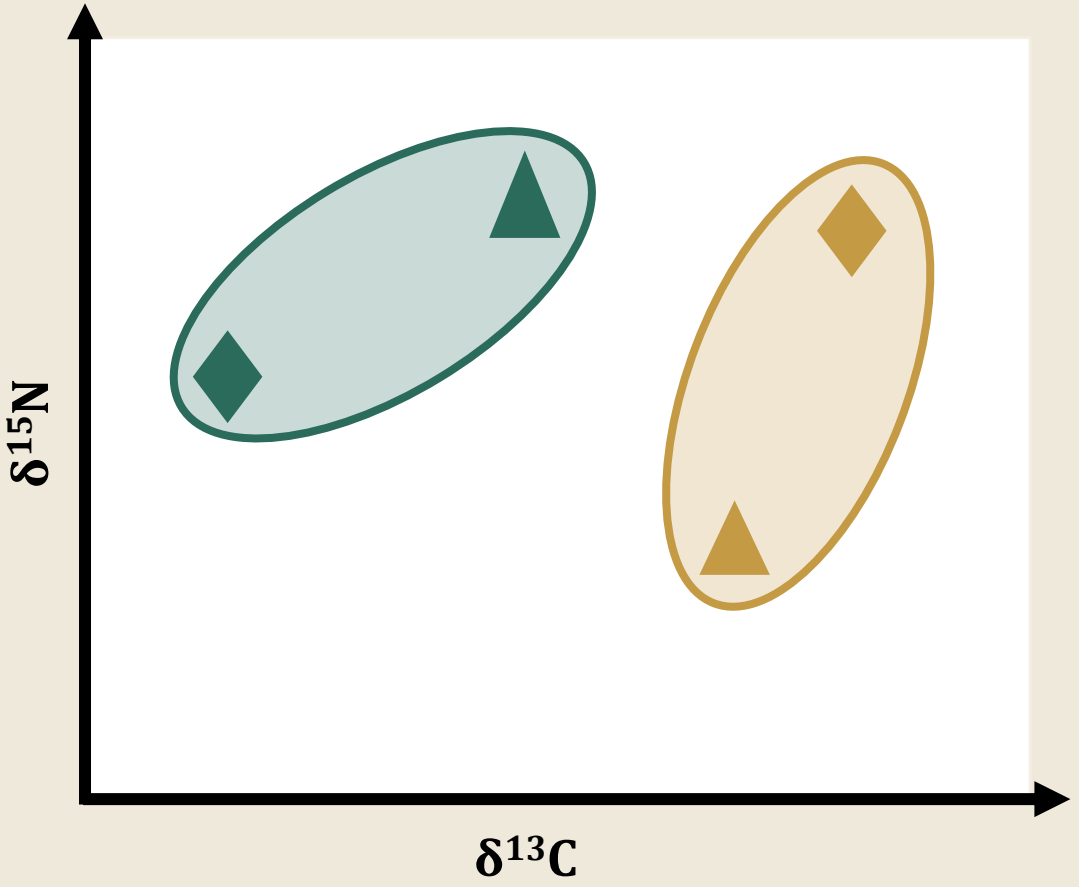
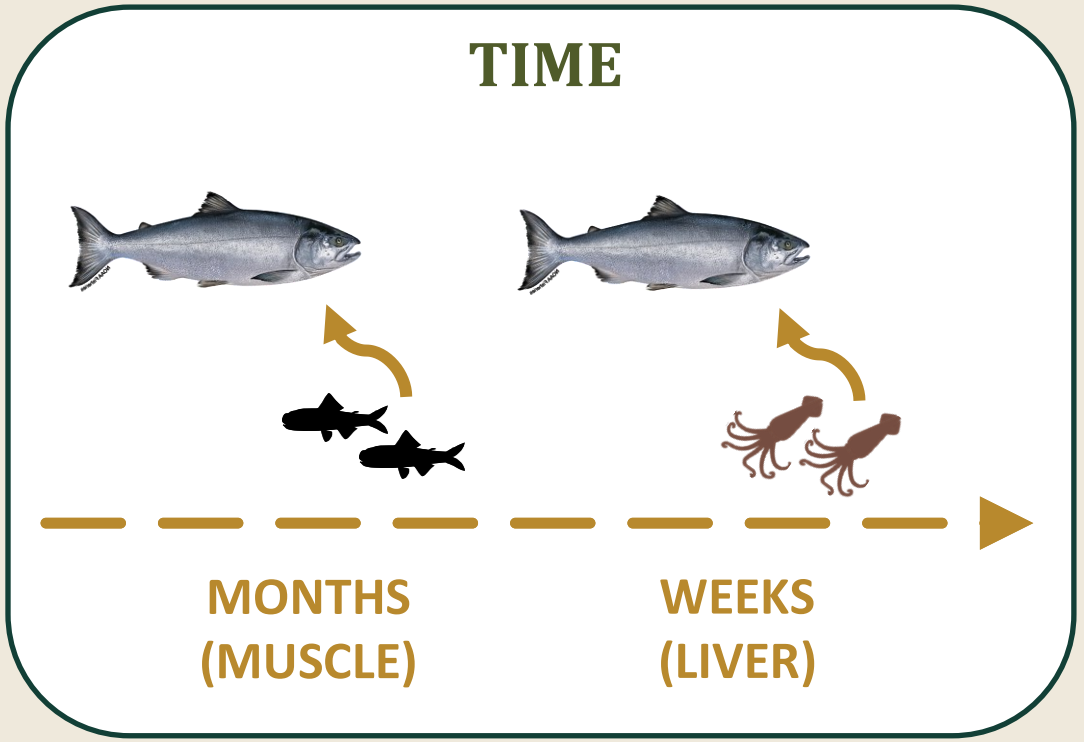
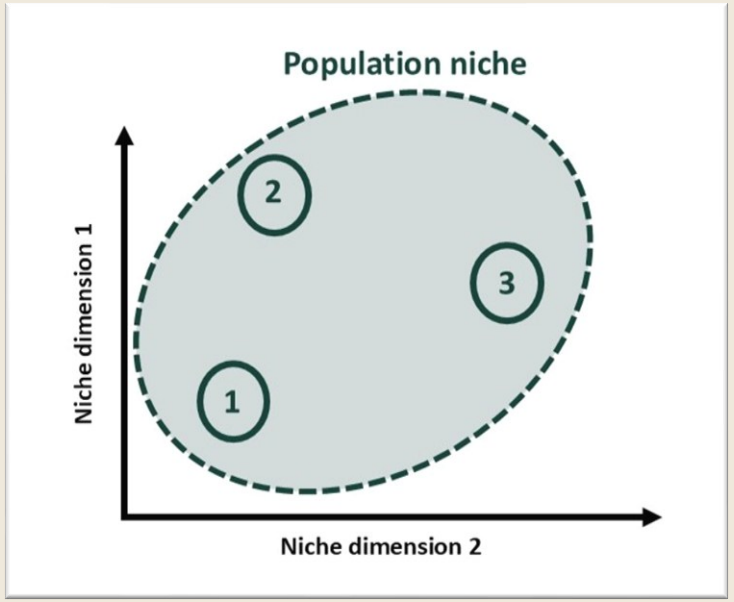
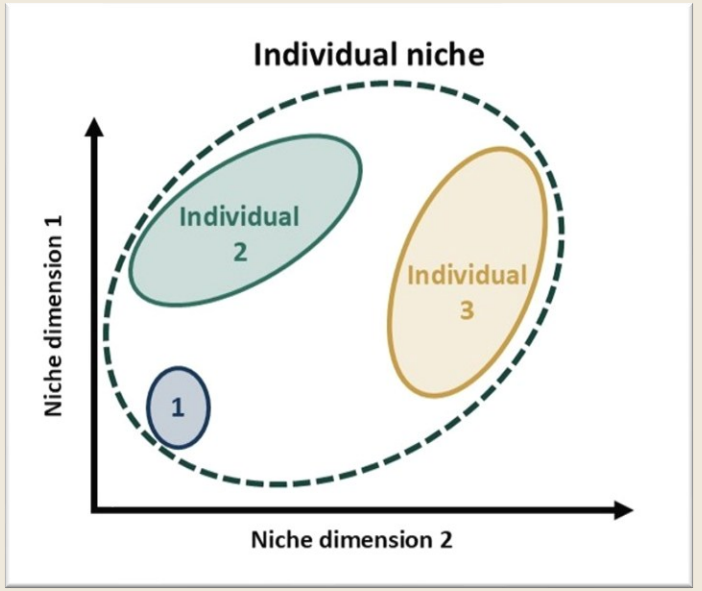


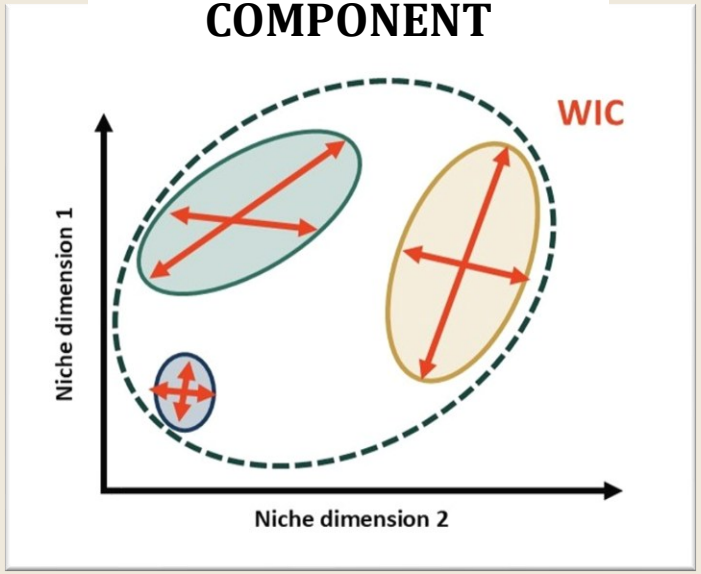


Population *vs.* individual niche

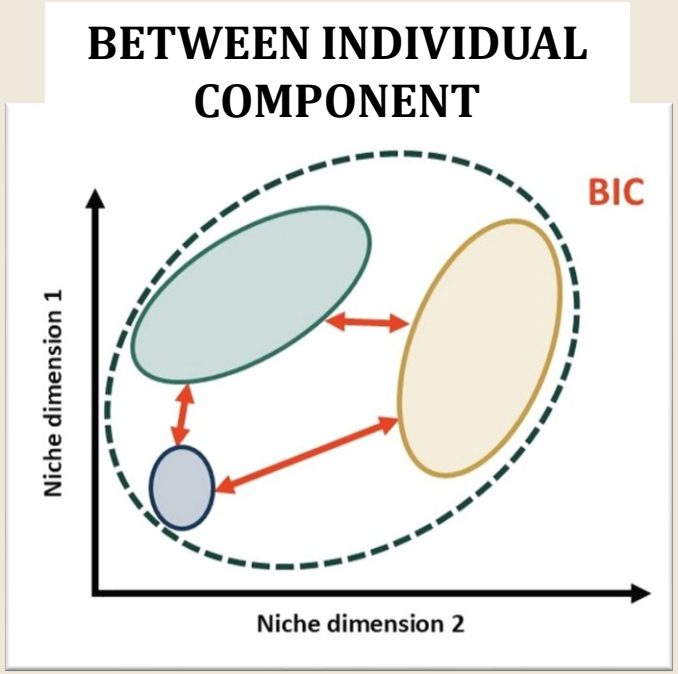




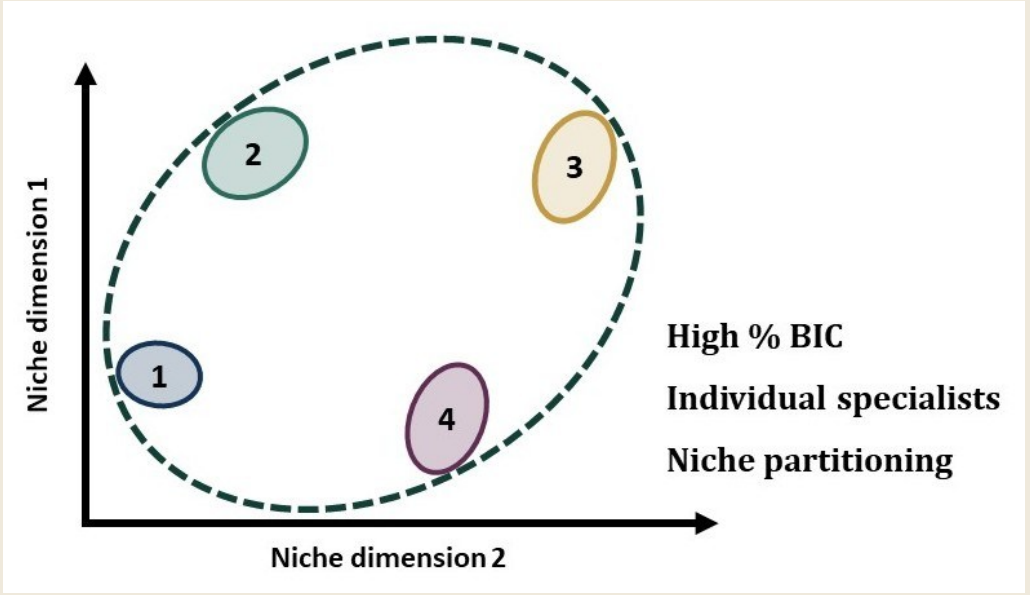
WITHIN INDIVIDUAL COMPONENT

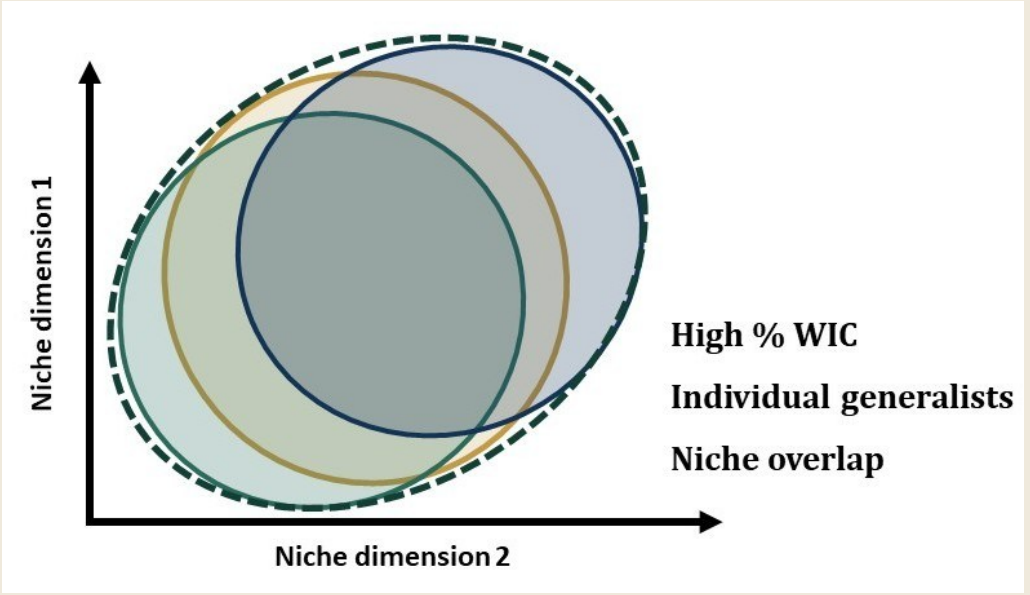


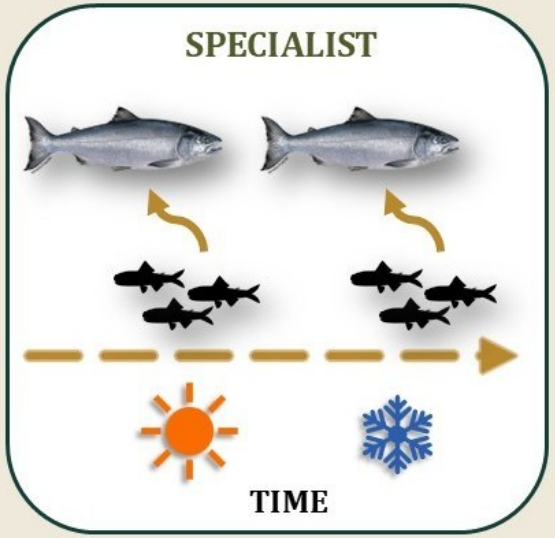
BETWEEN INDIVIDUAL COMPONENT

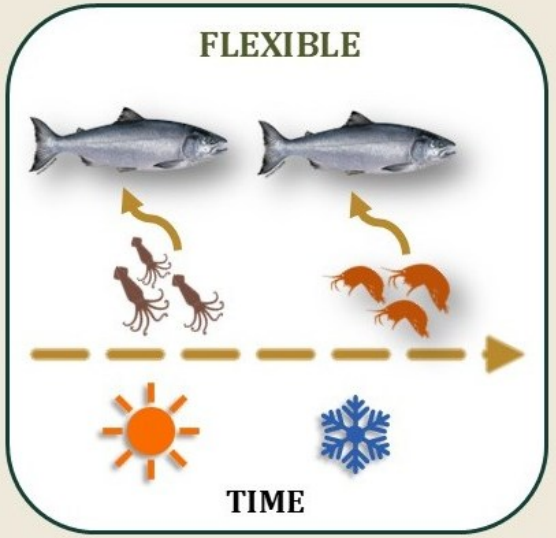


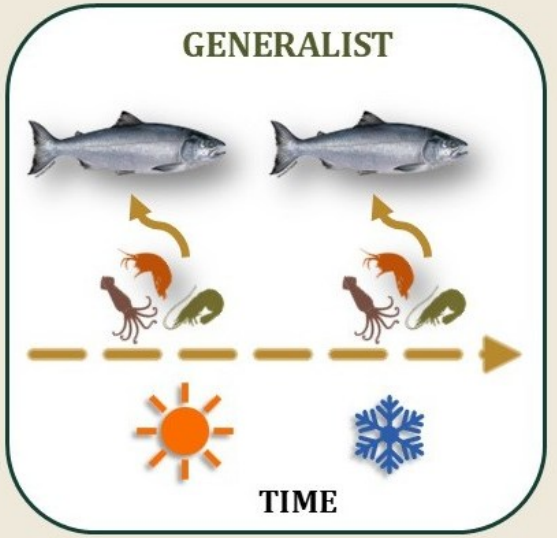
Specialist *vs.* Generalists



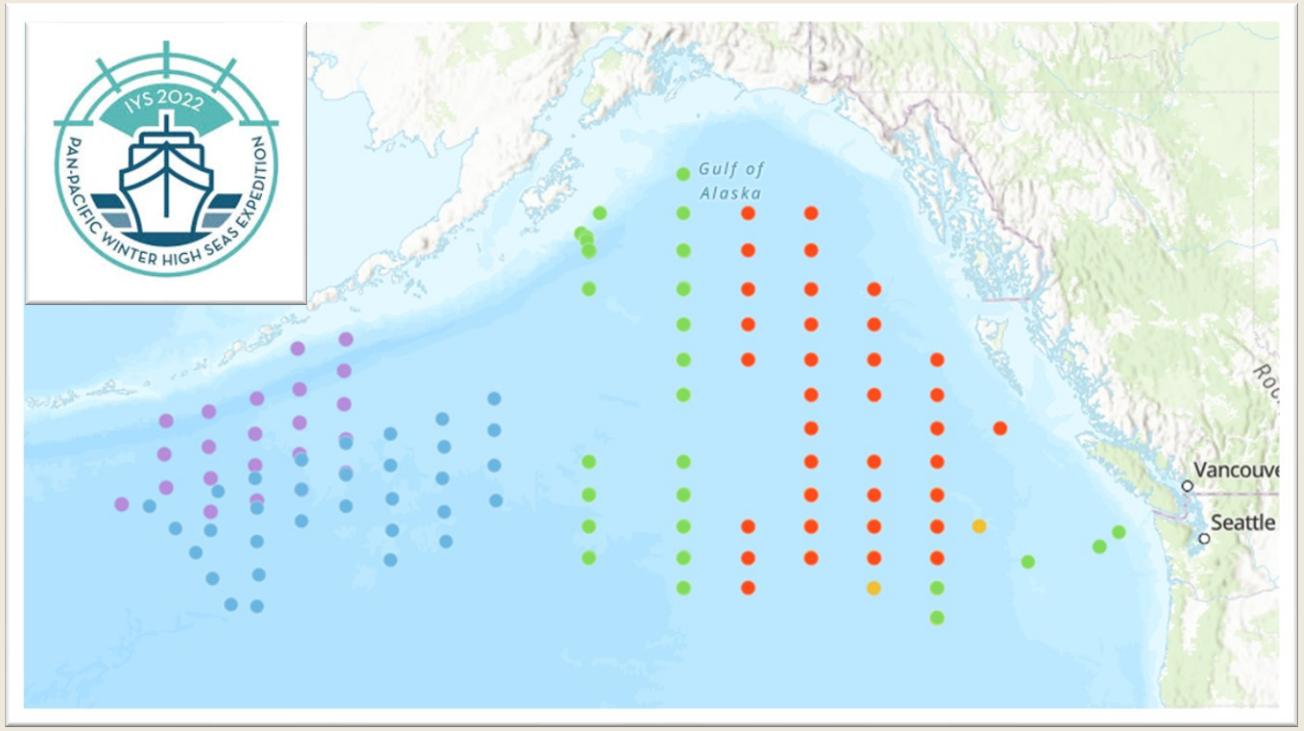








2022 Pan-Pacific International Year of the Salmon expeditions

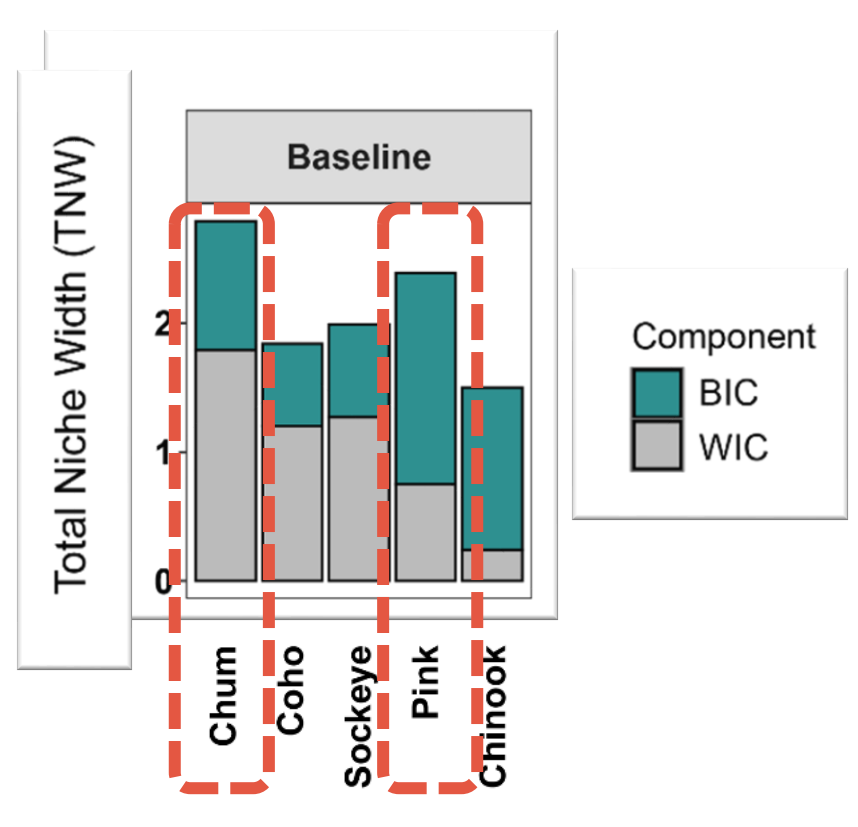


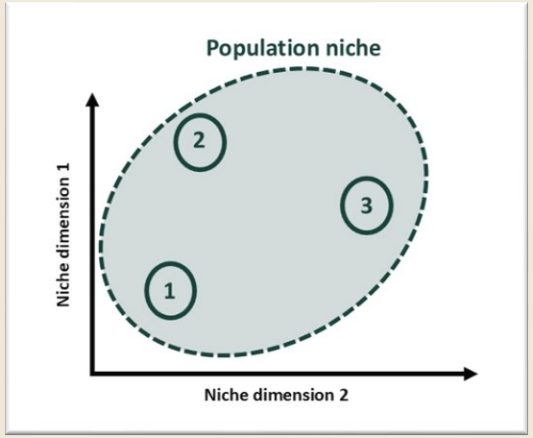
What we did:

- Pacific salmon **muscle** and **liver** stable isotopes
- Linear mixed-effects models
  - **Fish ID** = random intercept
  - **BIC** (**intercept**)
  - **WIC** (**residual**)
  - **TNW** (**WIC + BIC**)
- Estimate contributions of WIC and BIC to TNW:
  - **WIC/TNC = % WIC**
  - **BIC/TNW = % BIC**
- **Size-class, sex, bioregion, trawl ID**

What we found:

Total Niche Width (BIC + WIC)





Highlights

- **Chum & pink: wide population niche**
- Chinook: narrow population niche
- Sockeye & coho: intermediate TNW
- Trawl: Best model → Spatial context

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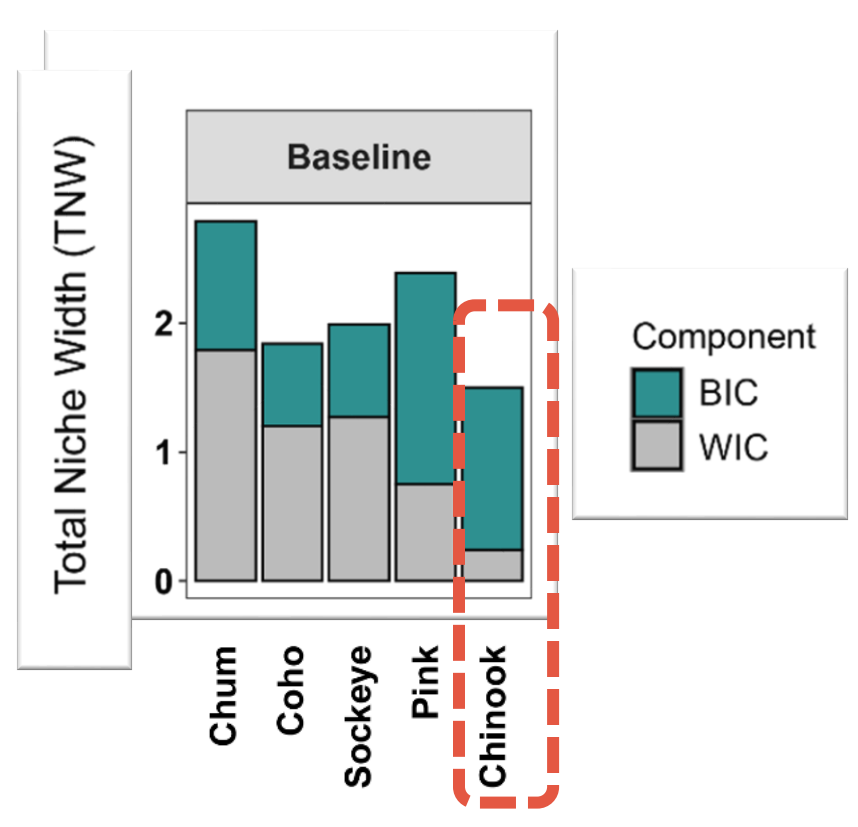

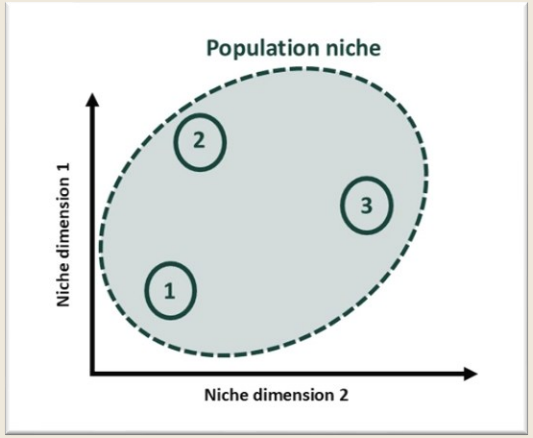

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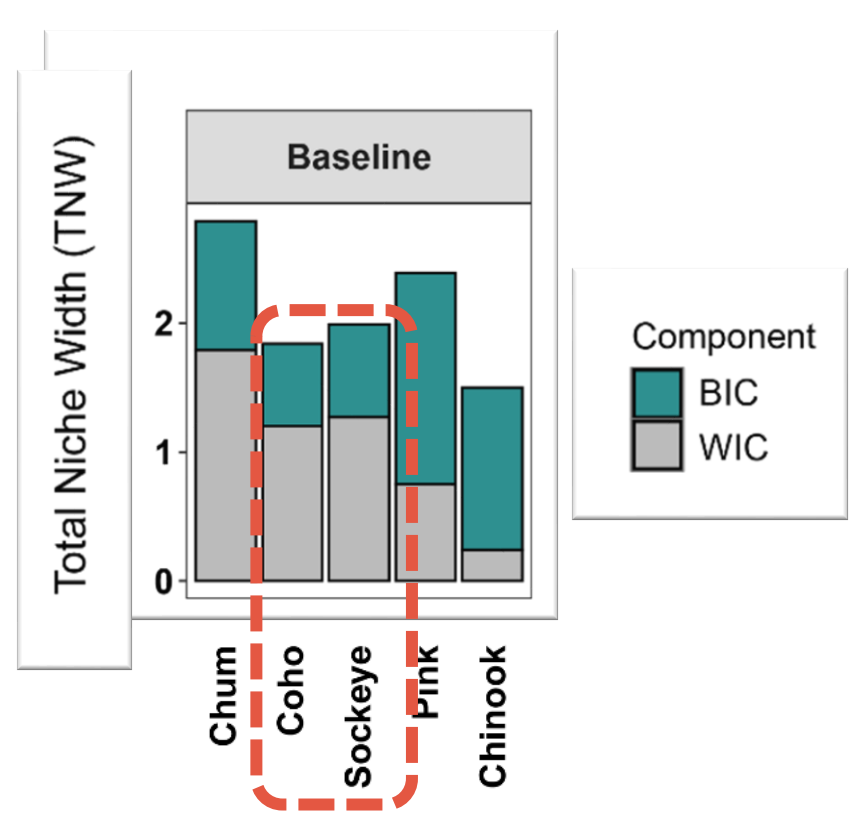

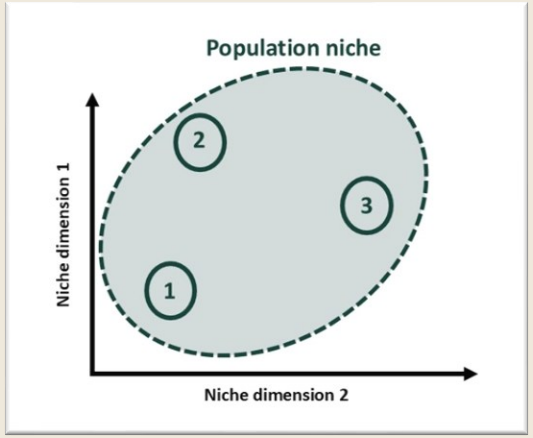

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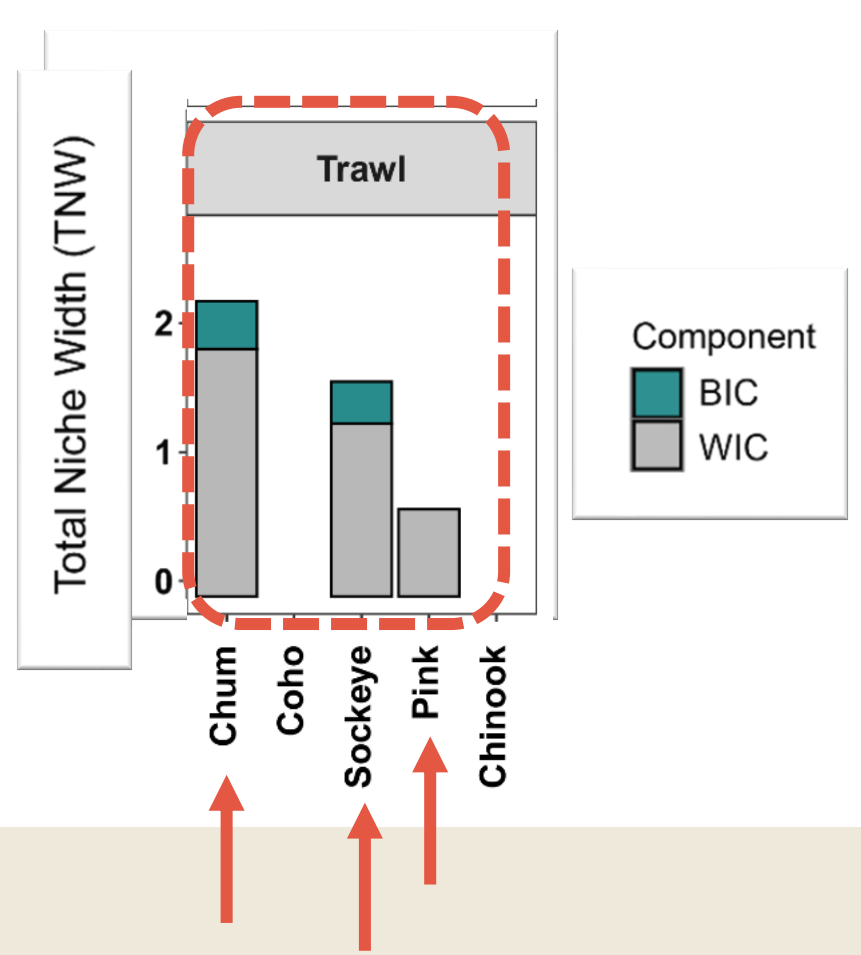

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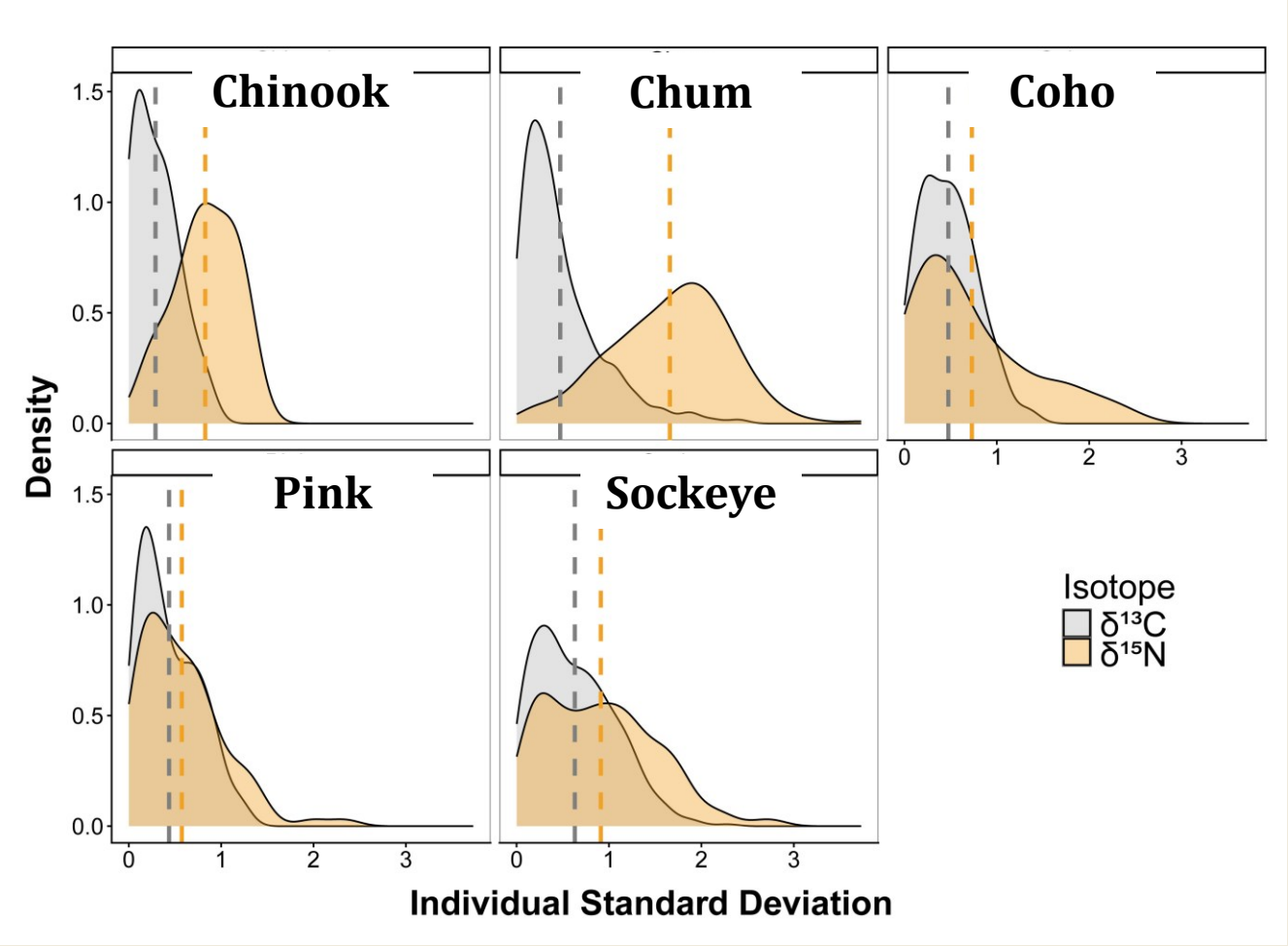
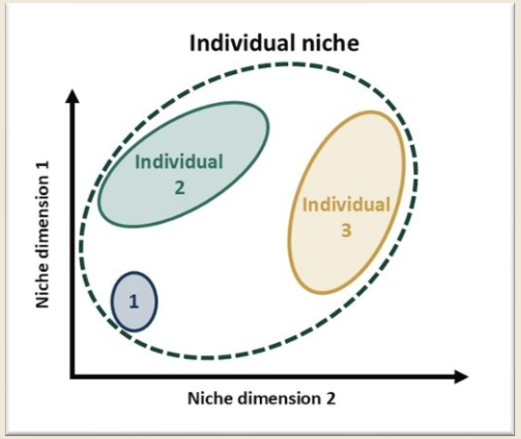
Individual variability (standard deviation)





Highlights

- Chinook & Chum: higher δ^{15}N-SD
- Chinook & pink: low SD
- Chum & sockeye: high SD values
- Coho: low SD, tailed

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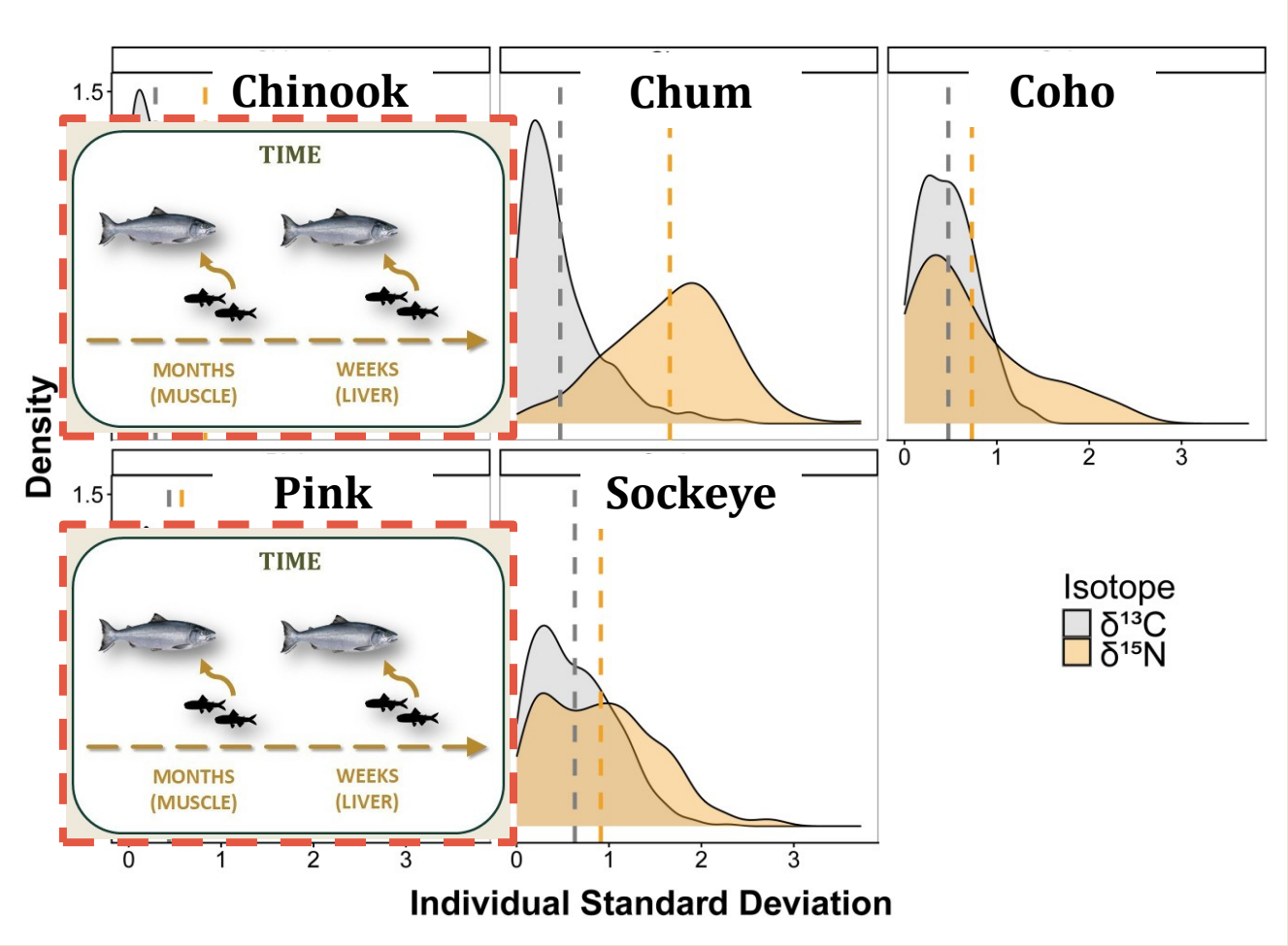

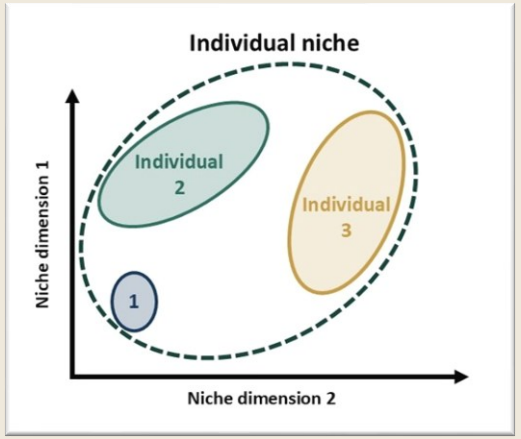

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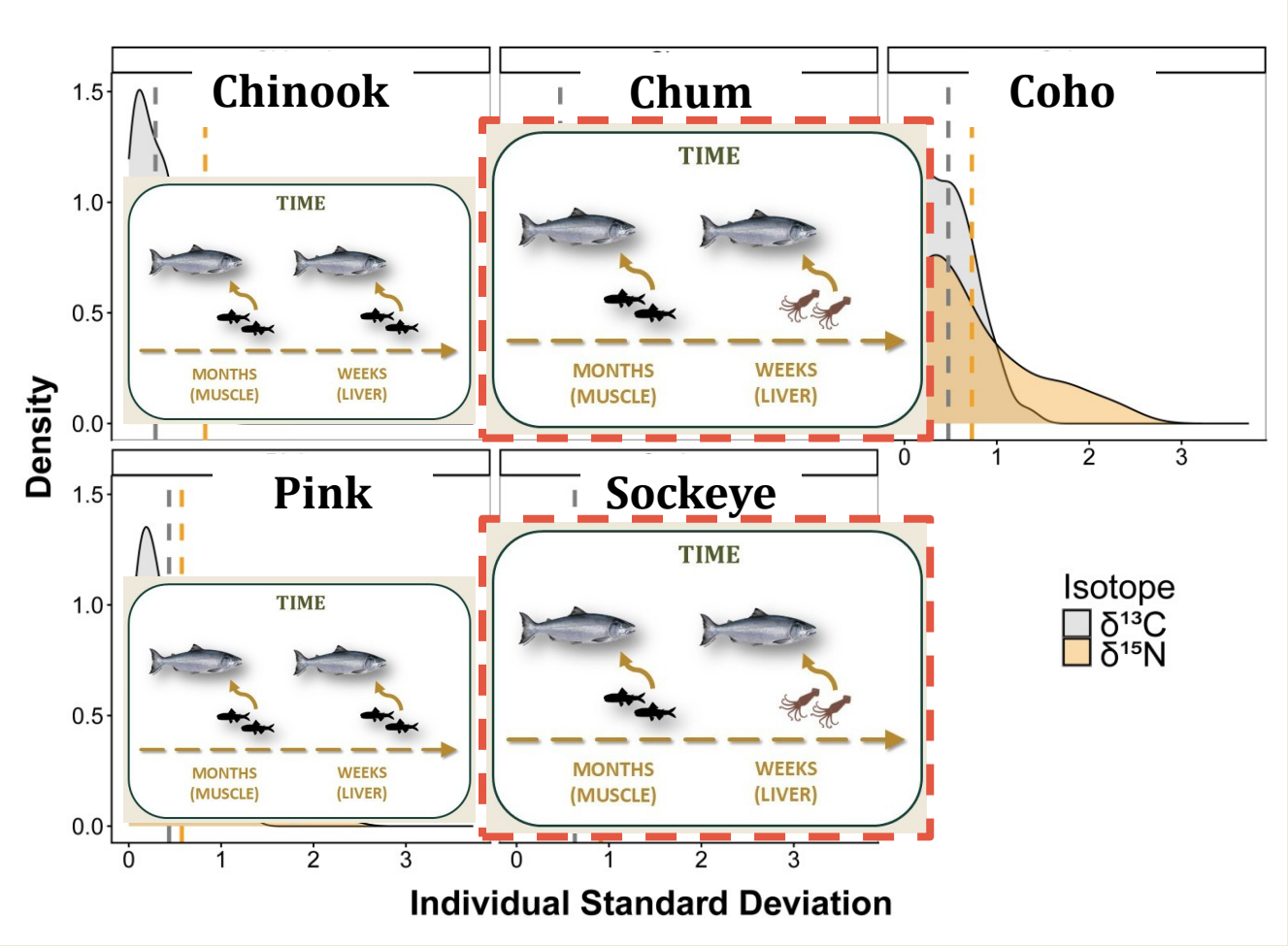

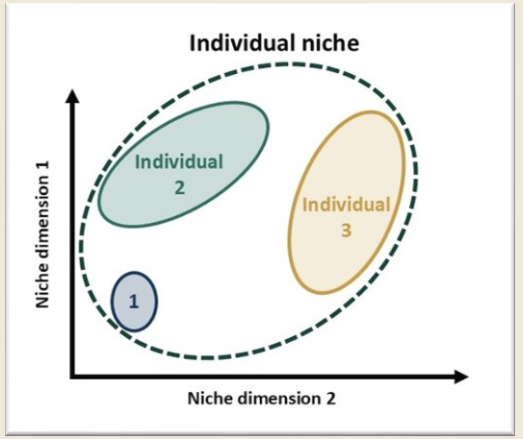

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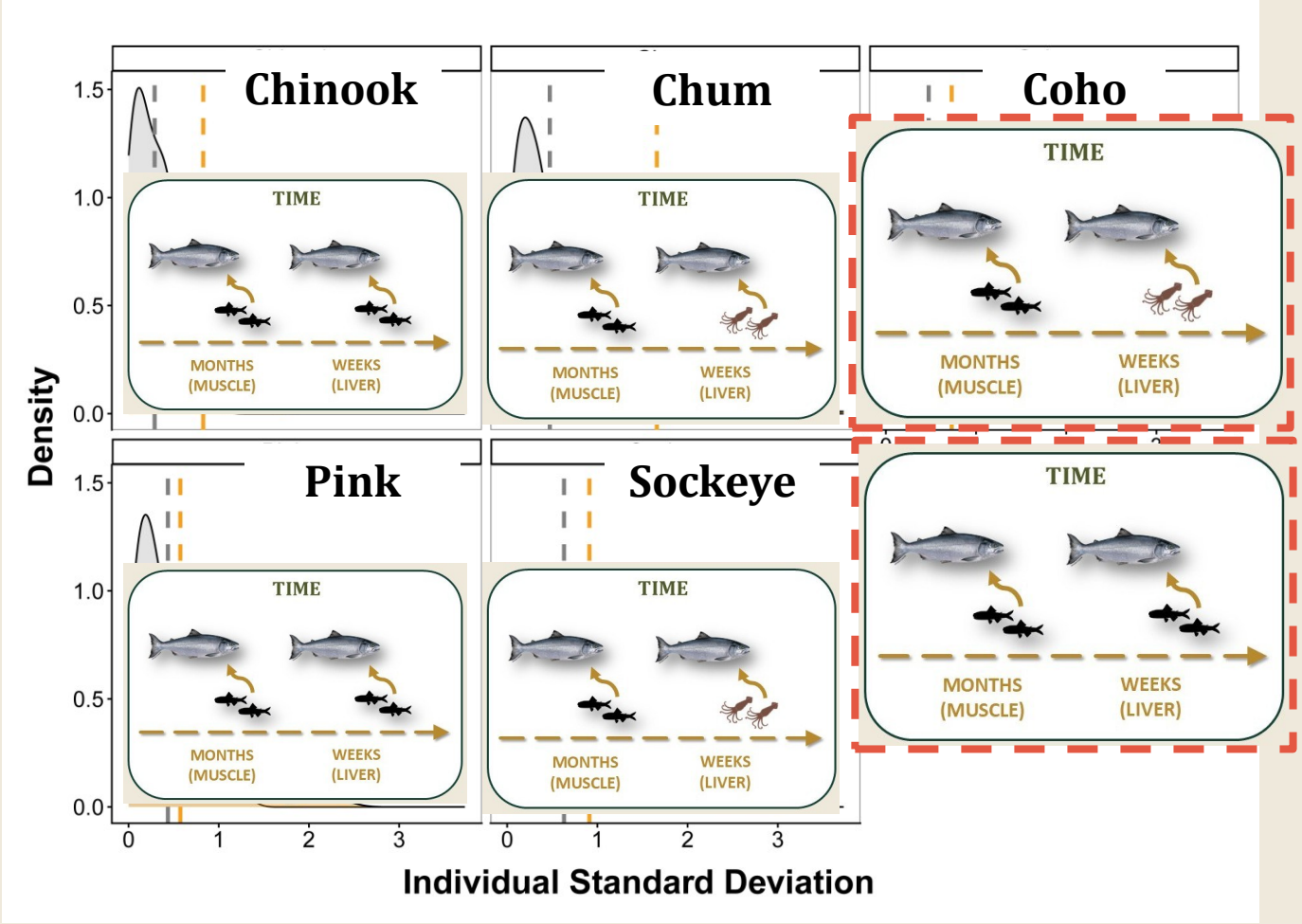

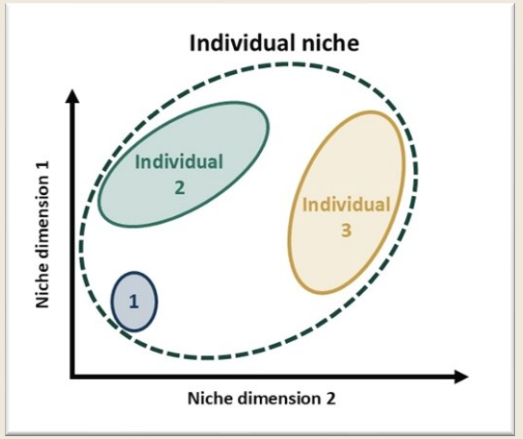

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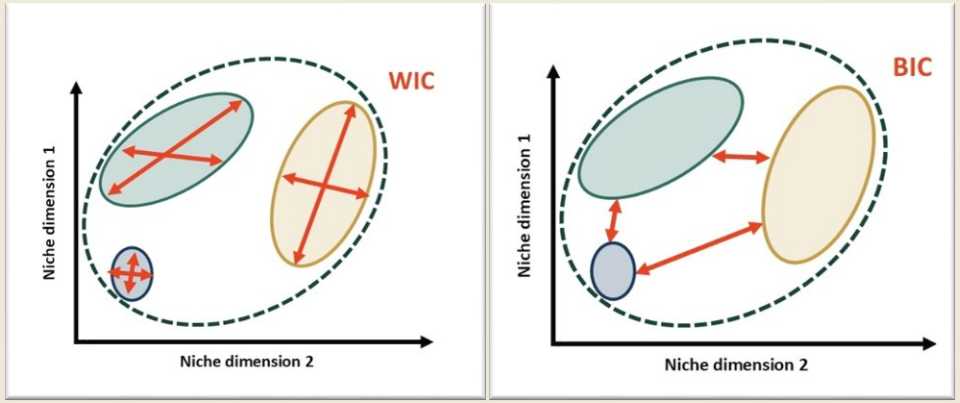
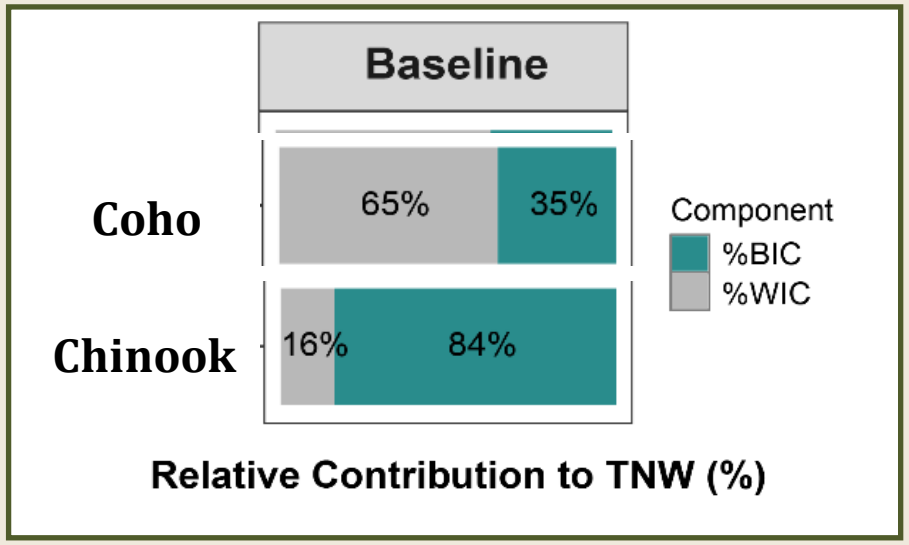
WIC and BIC contribution to TNW





Highlights

- Coho: high %WIC
- Chinook: high %BIC

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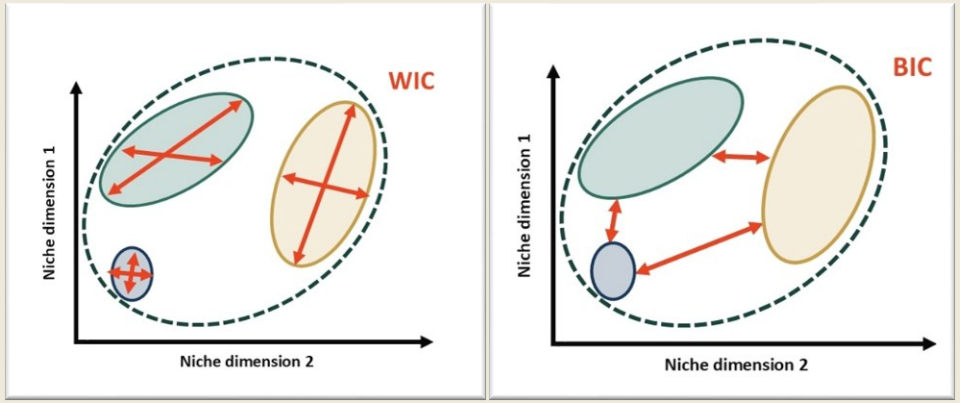
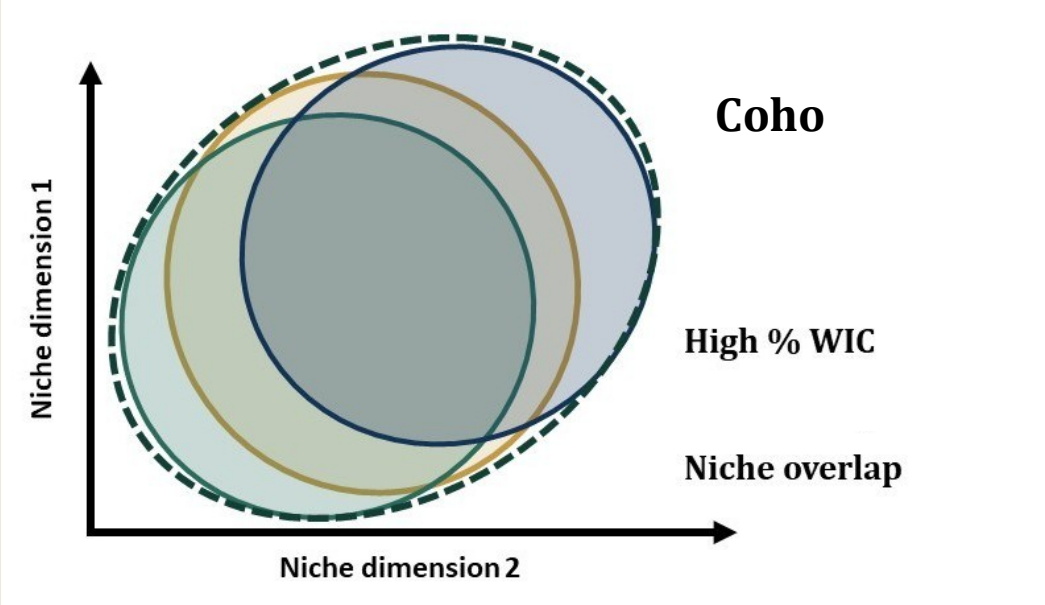
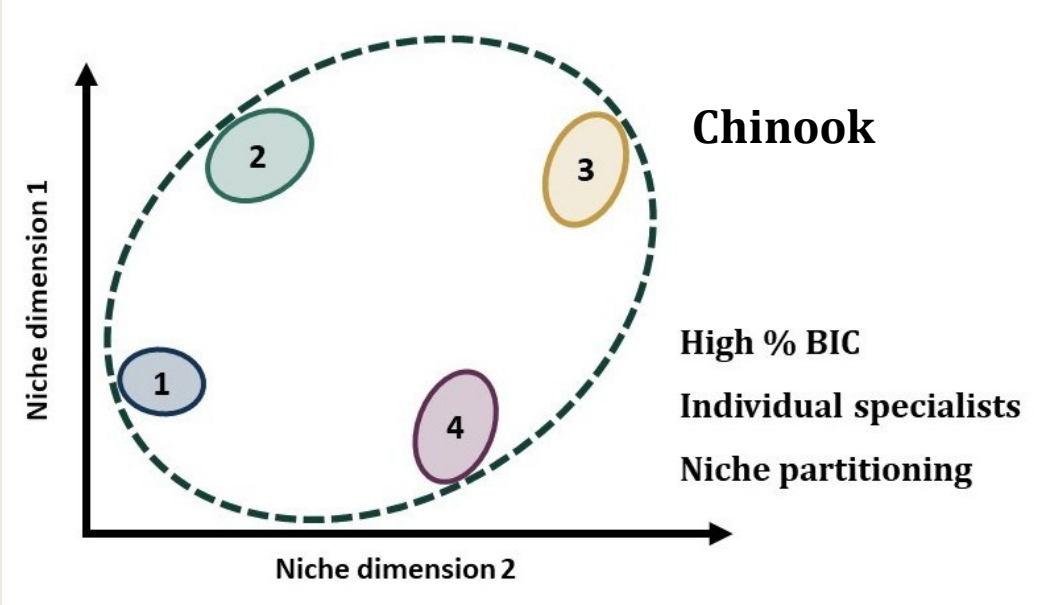
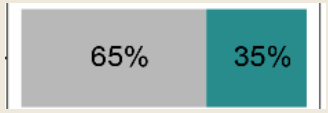
WIC and BIC contribution to TNW

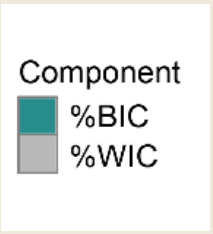


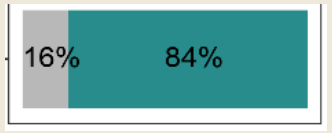






Coho





Chinook

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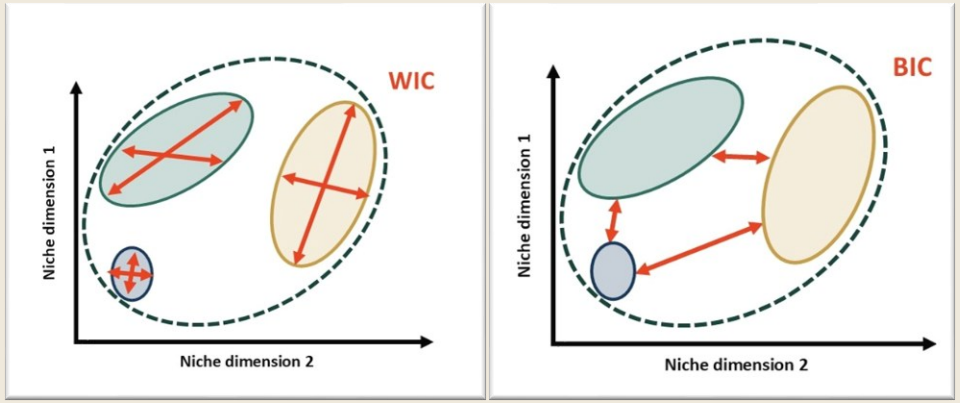
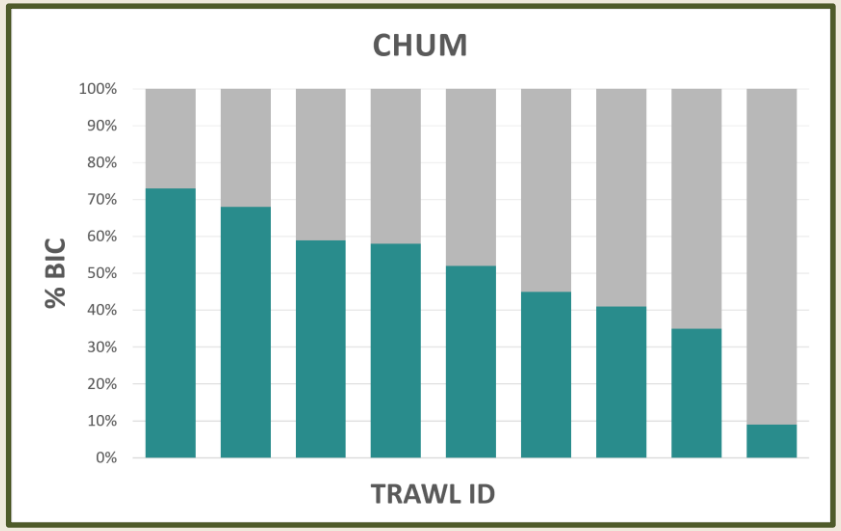
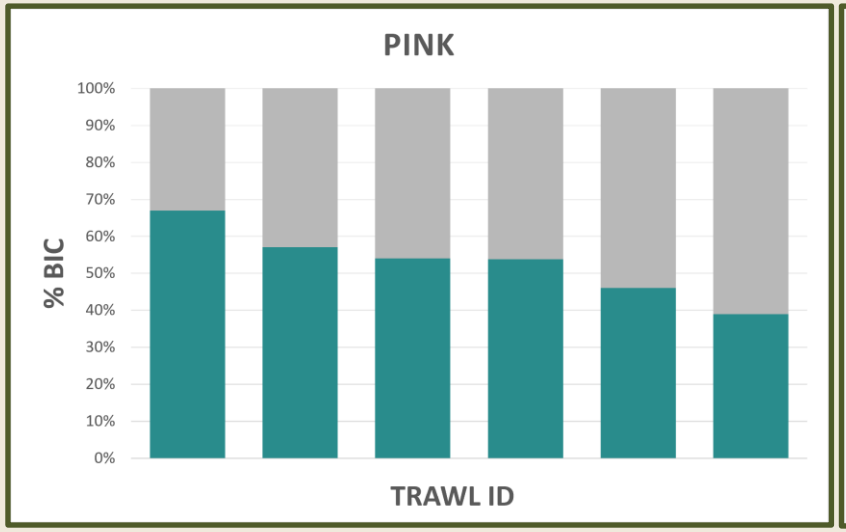
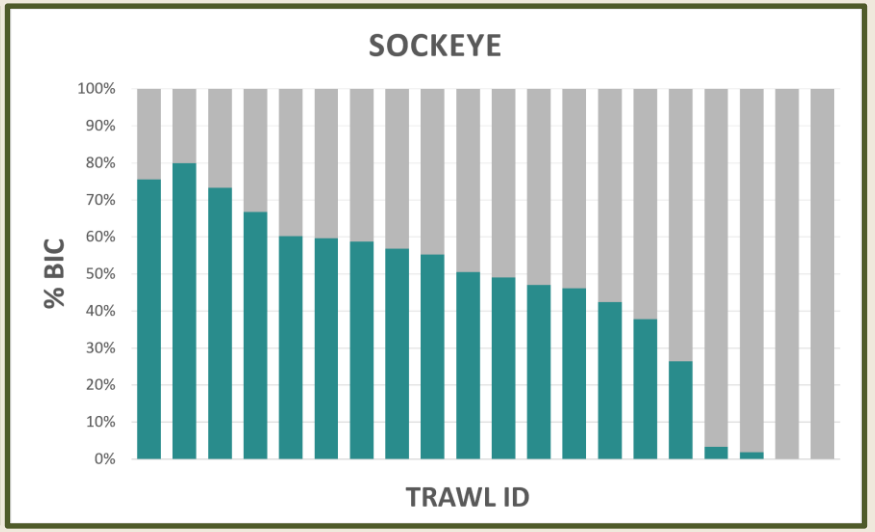


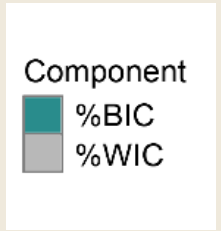
Highlights

- Chum, sockeye & pink: high partition (↑BIC) to overlap (↓BIC) among individuals









What we found:

1. **Do species differ in specialization?** → **Yes. All five species showed differences in foraging strategies**

2. **Does environment influence specialization?** → **Yes. Evidence from pink, chum, and sockeye**

3 Which species are specialists *vs.* generalists?

Chum



- Generalist population
- Generalist individuals
- Overlap or partition, depending on context



Sockeye



- Intermediate population niche
- Generalist individuals
- Overlap or partition, depending on context



Pink



- Wide population niche
- Specialist individuals
- Varying degree of partition



Chinook



- Narrow population and individual niches
- High partition among individuals



Coho



- Intermediate population niche
- Mixed strattegy





Lessons from Salmon: Coexistence Requires Diversity

Different forms of individual specialization may facilitate coexistence among Pacific salmon species.

Protecting ecosystems requires protecting the societies that care for them.

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Thank you!

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