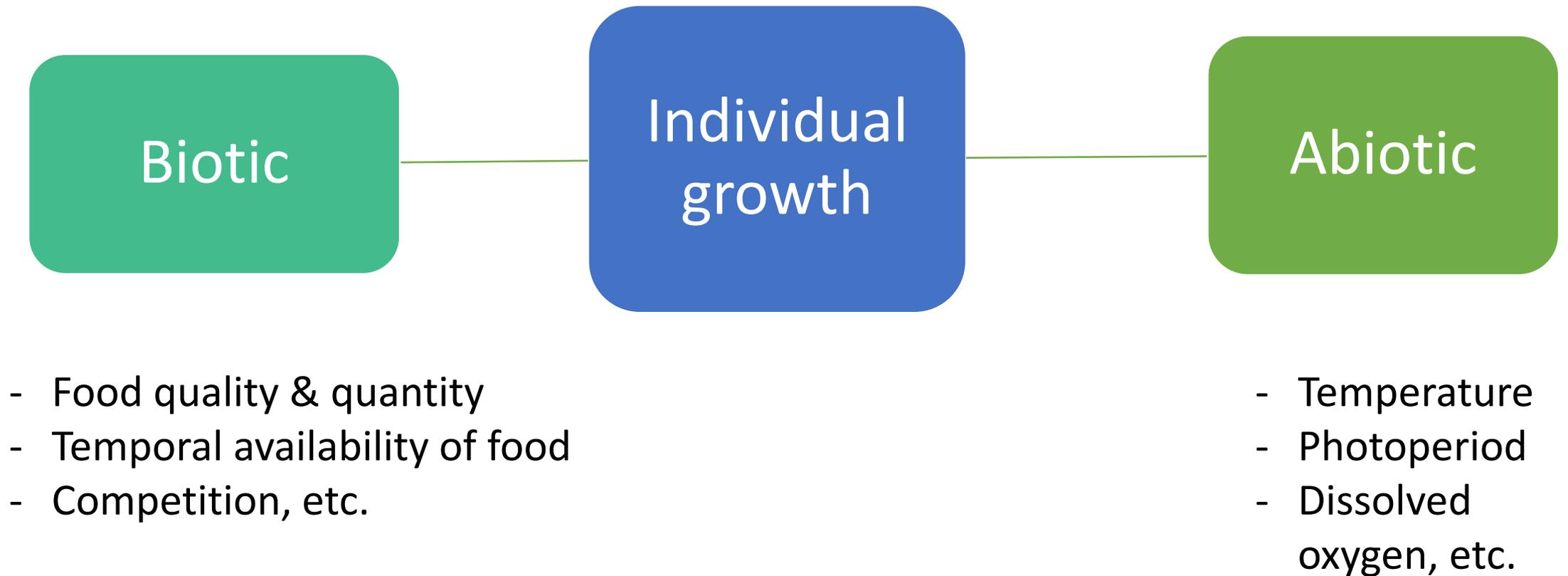




## Population-specific consumption of Pacific herring in juvenile and sub-adult Chinook salmon in the Salish Sea

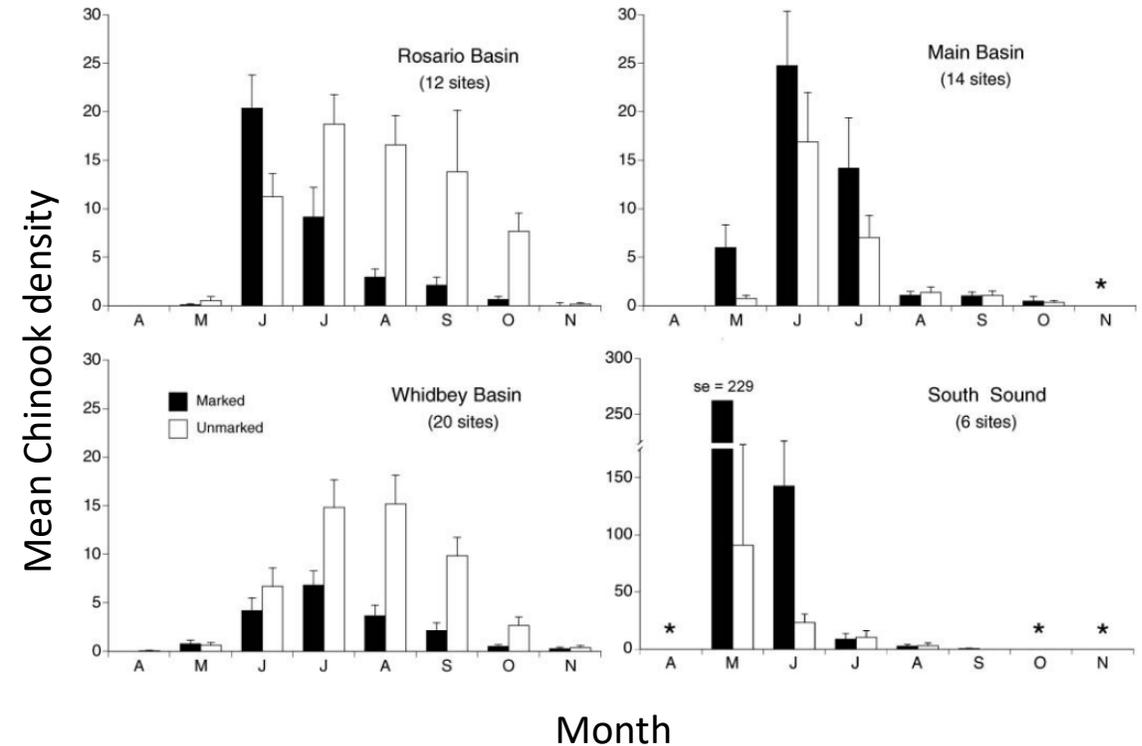
Josh Chamberlin (*NOAA*), Eleni Petrou (*UW*), Dave Beauchamp (*USGS*), Will Duguid (*UVIC*),  
Russel Barsh (*Kwiacht*), Emily Iversen (*UW*), and Lorenz Hauser (*UW*)

# Factors influencing individual growth



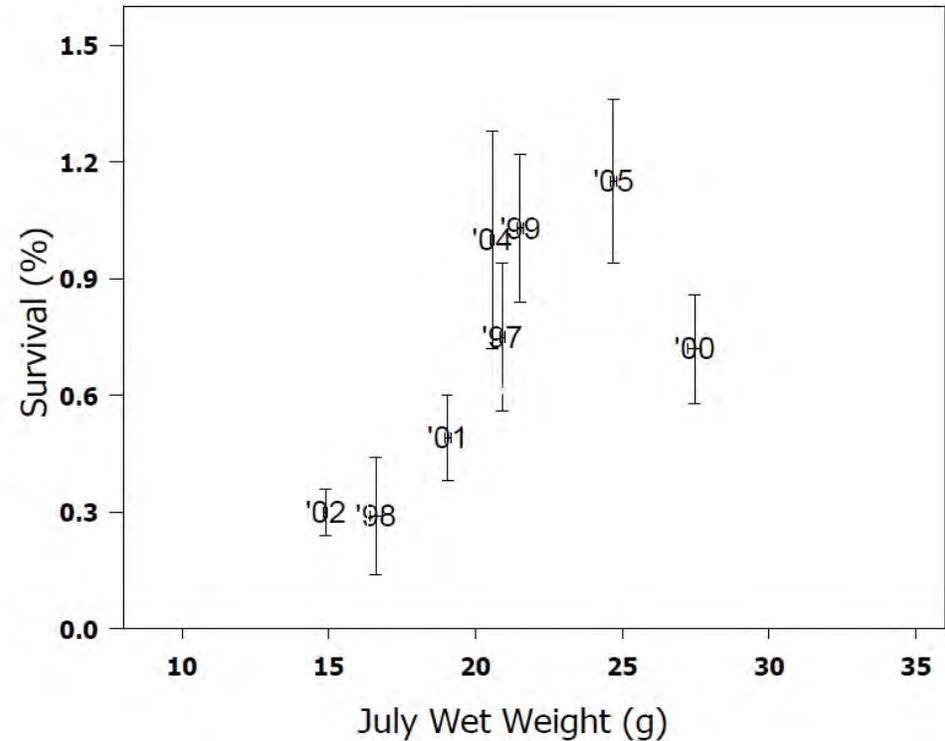
# Juvenile Chinook salmon in Puget Sound

- Rear in nearshore from June to September (*Rice et al. 2011*)



# Juvenile Chinook salmon in Puget Sound

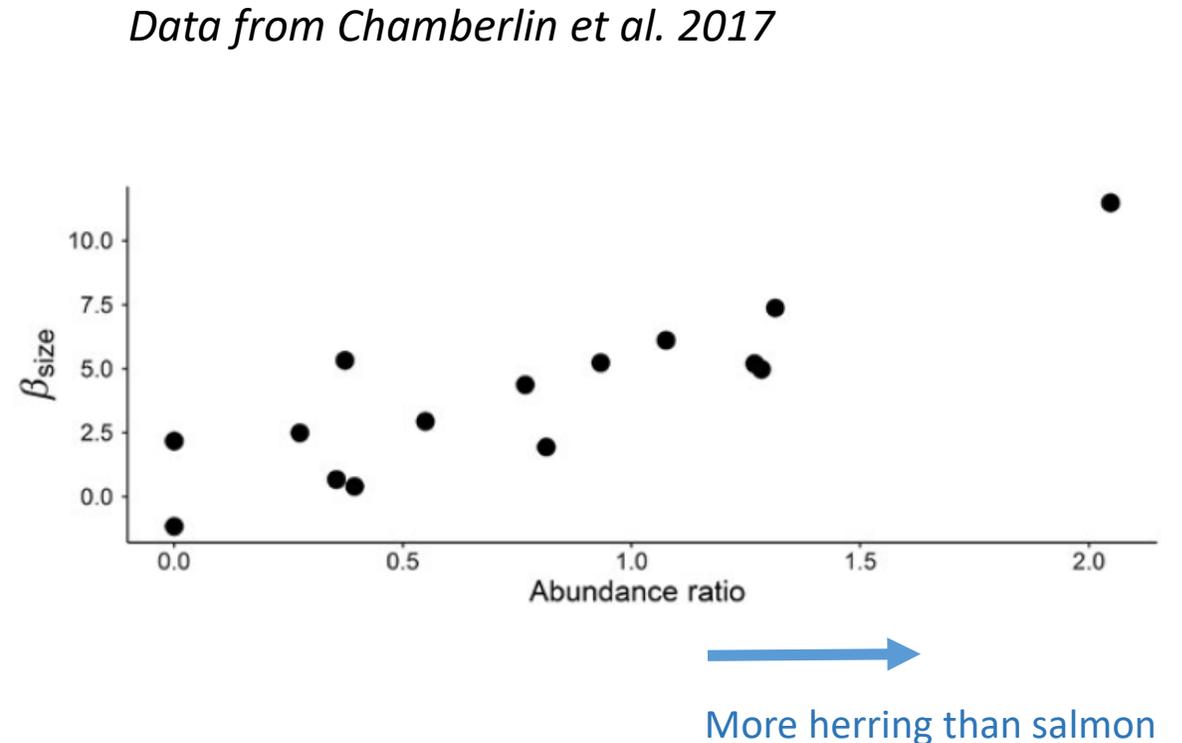
- Rear in nearshore from June to September (*Rice et al. 2011*)
- Early and fast growth is linked to increased survival (*Beamish et al. 2004; Duffy & Beauchamp 2011*)



# The importance of herring in Chinook diets

- Ontogenetic shifts in diet (*Duffy et al. 2010*):
  - Larger -> piscivorous
  - This shift can occur at different times or sizes, based on sizes of predator & prey
- Juvenile Chinook have high growth rates where small herring are abundant (*Chamberlin et al. 2017*)

Increased growth opportunities for salmon



More herring than salmon

# Research questions

- Which herring populations are important prey for juvenile and adult Chinook salmon?
- Does this vary seasonally and spatially?
- Does it vary by predator size/age?

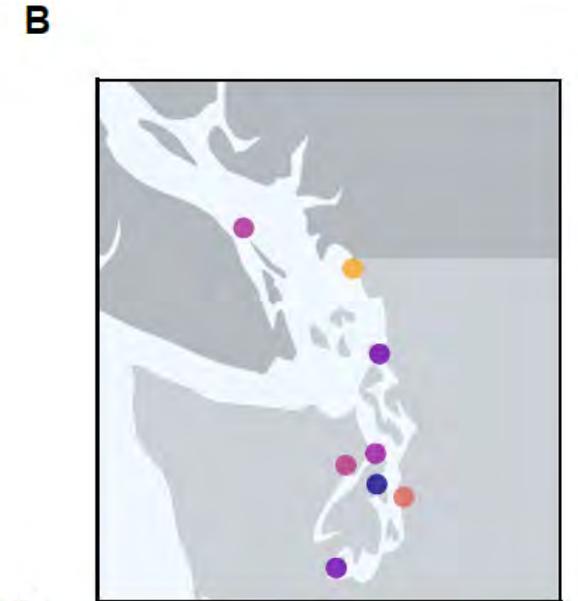
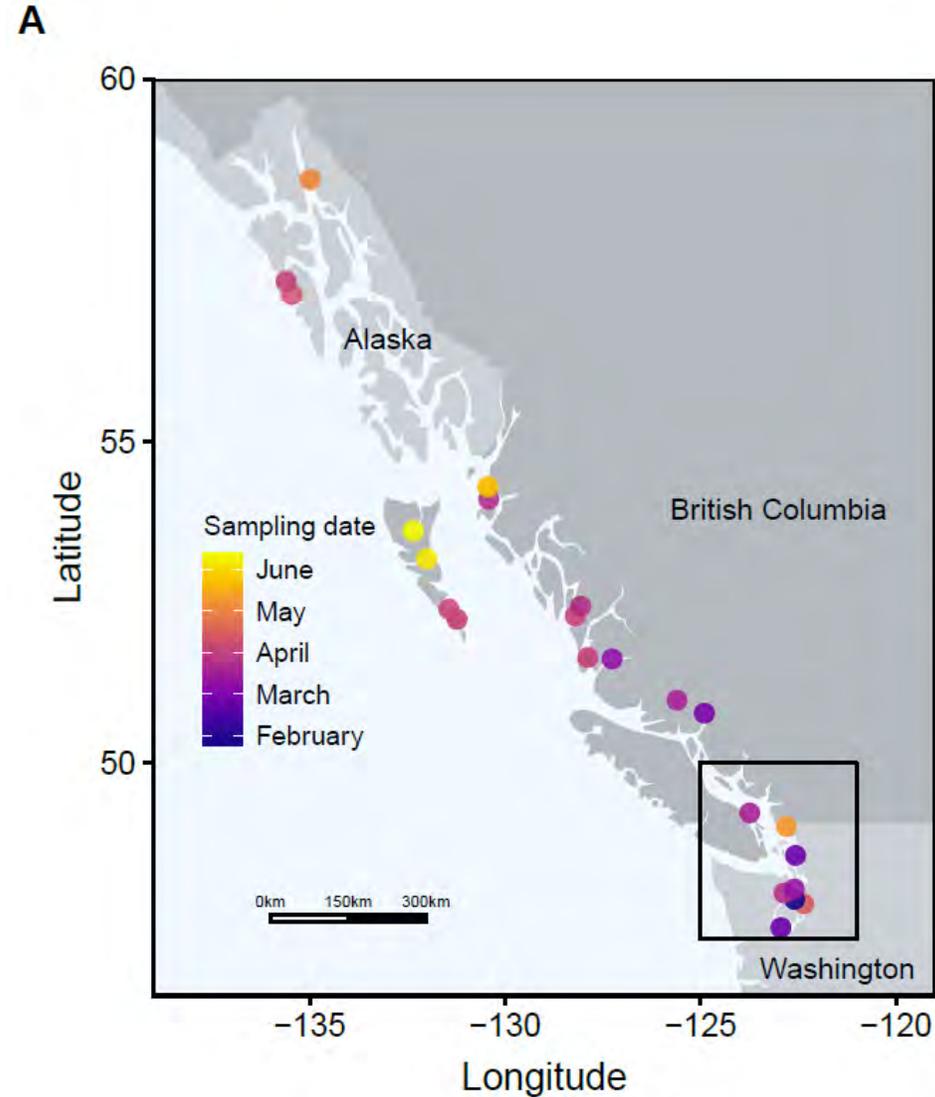


*Image by Whalebone Studio*

# Population-level diversity in herring

Variation in:

- Month of reproduction
- Ranges from Jan-June



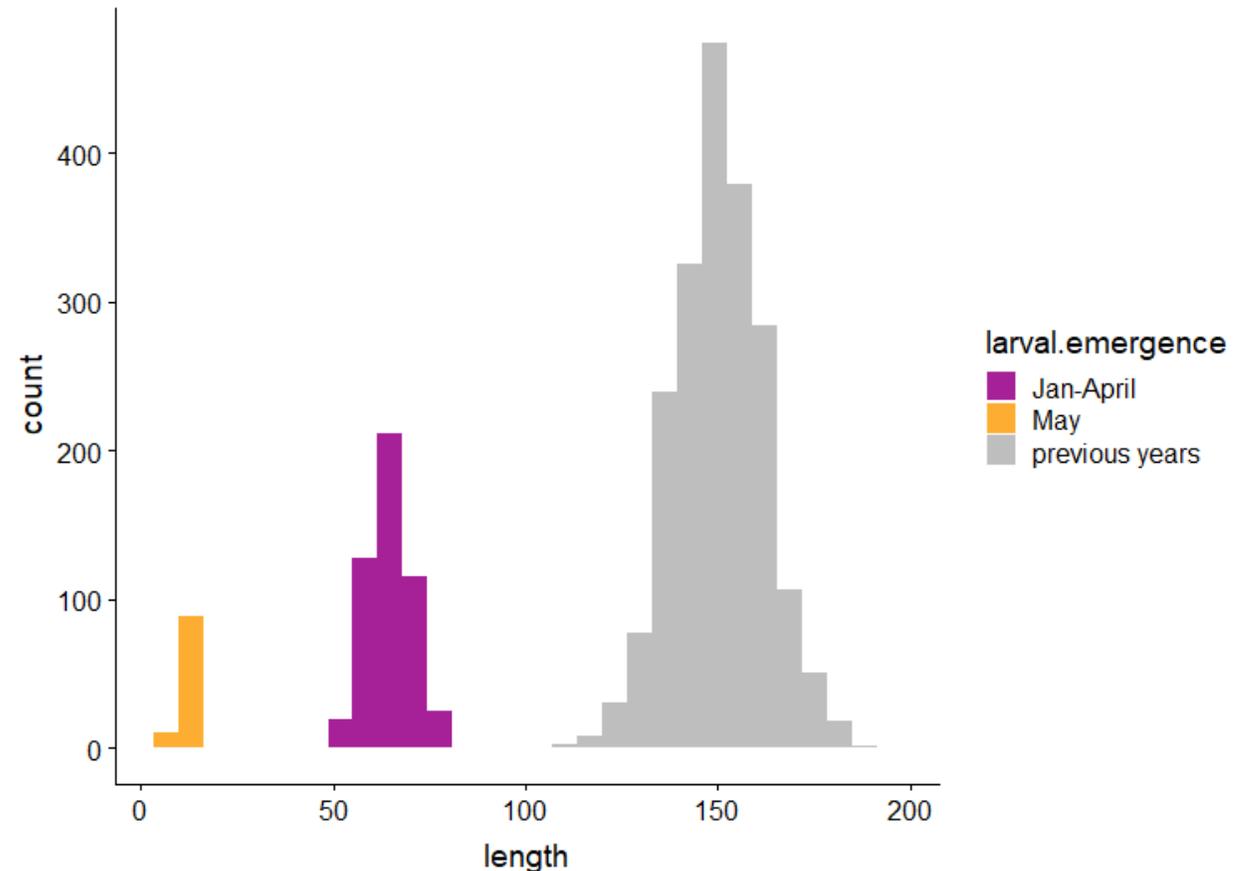
# Population-level diversity in herring

## Variation in:

- Month of reproduction
- Ranges from Jan-June
- Larval emergence

- Wide distribution of prey length expands the potential pool of prey for Chinook of different sizes/life stages

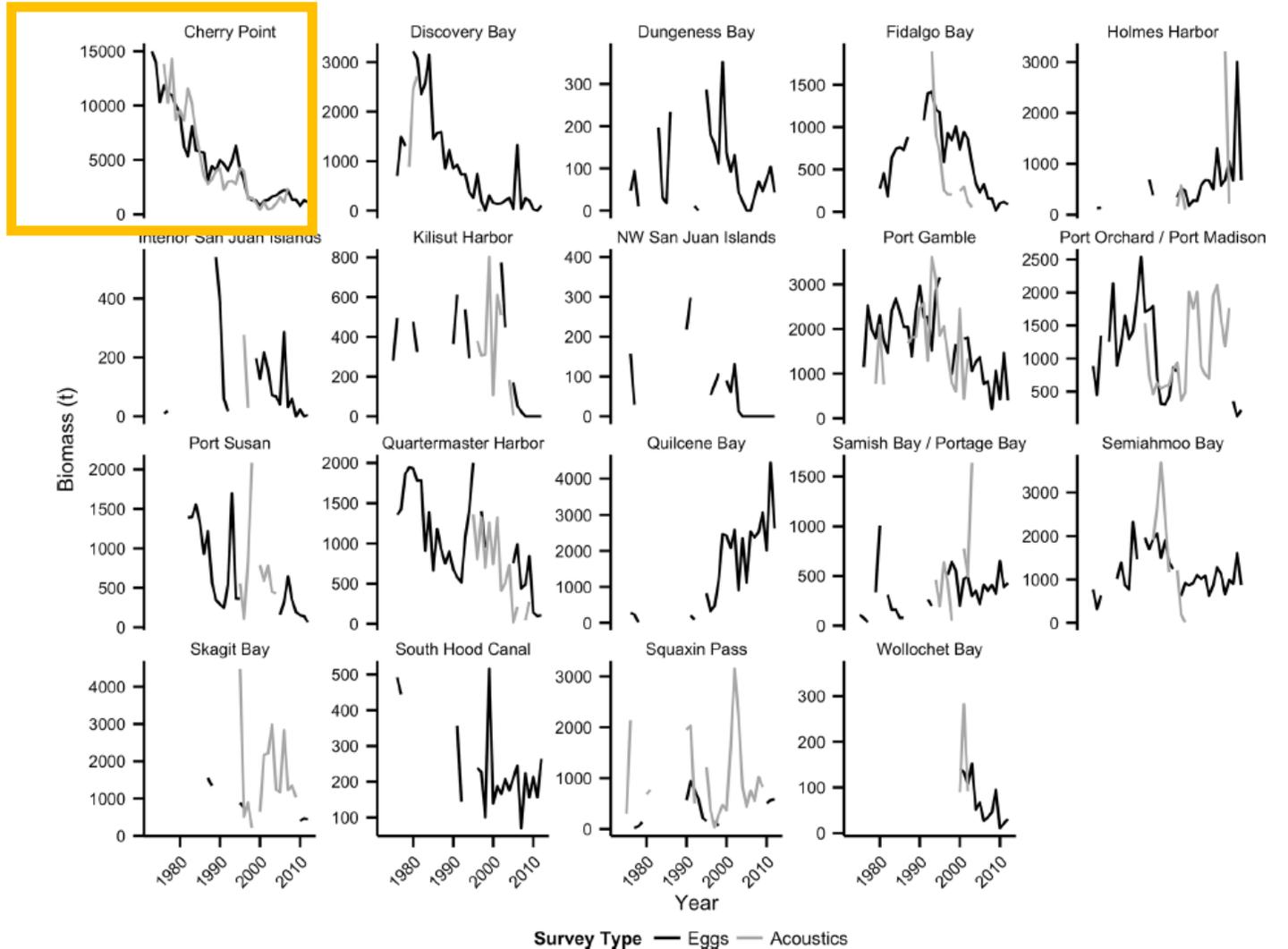
*Hypothetical distribution of herring length in summer*



# Population-level diversity in herring

Variation in:

- Month of reproduction
- Abundance



Data from Siple & Francis, 2016

# Population-level diversity in herring

## Variation in:

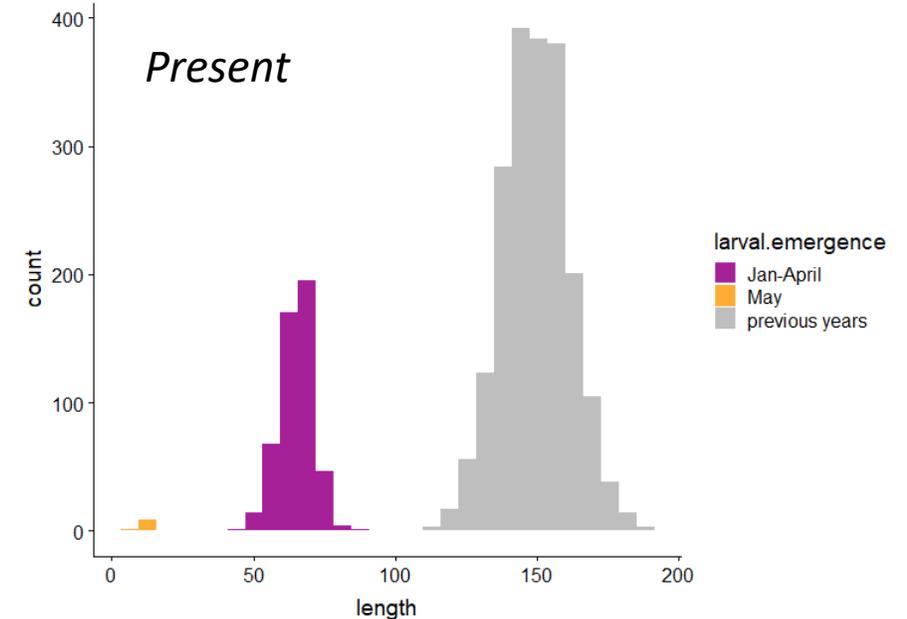
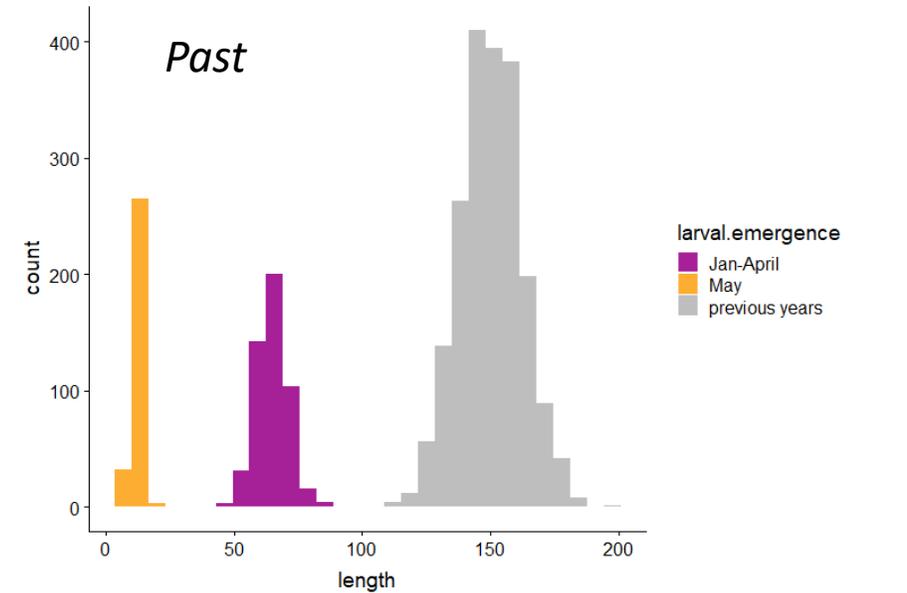
- Month of reproduction & larval emergence
  - Abundance
  - Movement patterns (resident vs. migratory-  
*Gao et al. 2001*)
- 
- These attributes can make herring accessible (or not) to juvenile Chinook



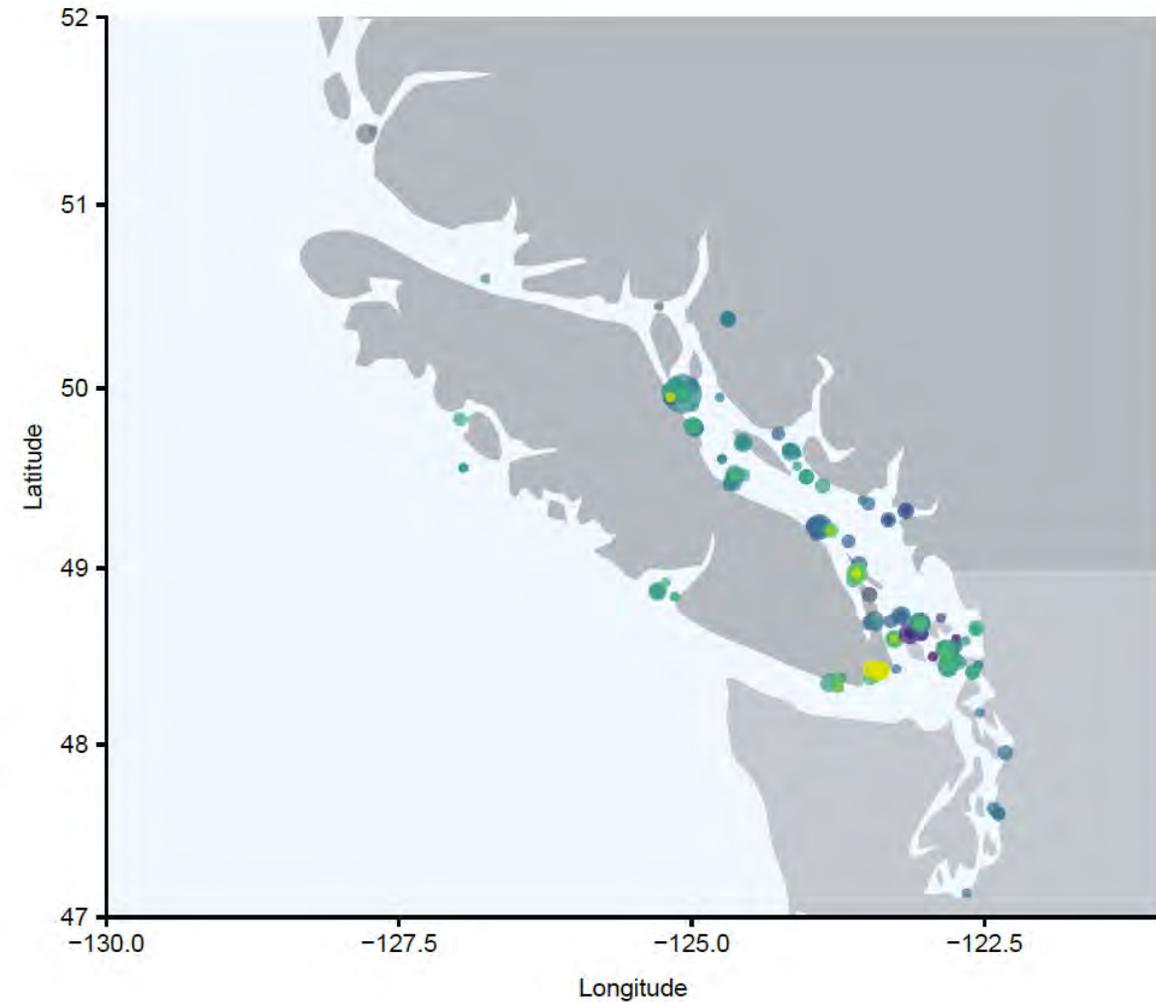
*Photo credit: fishbio.com*

# Hypotheses

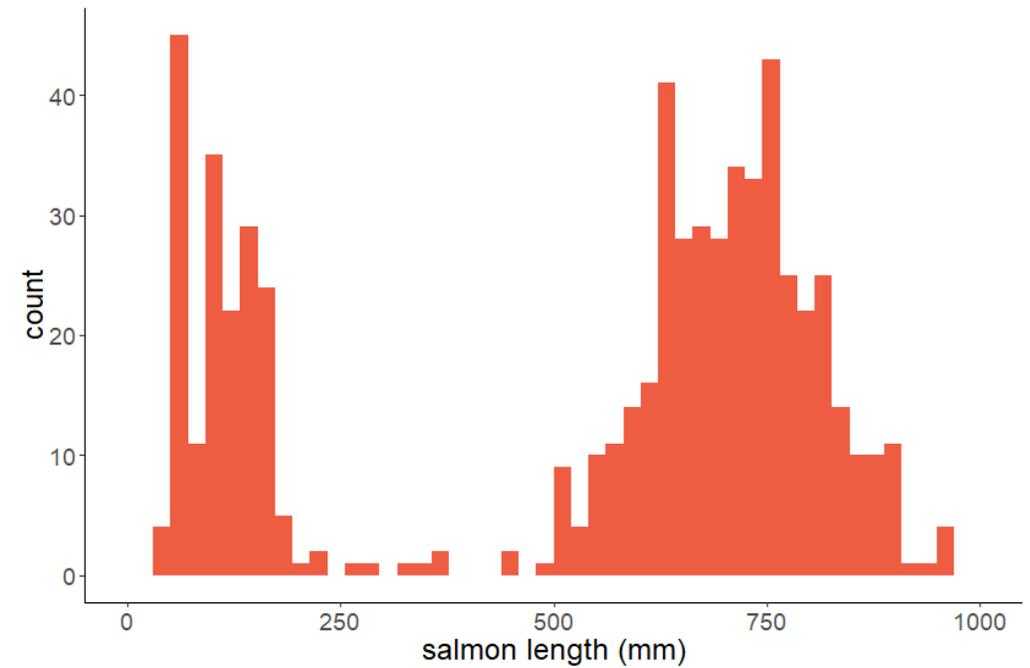
- Diverse herring populations extend foraging opportunities for mobile predators
- Late-spawning herring stocks contribute tiny herring that are preferred food for juvenile Chinook in the summer
- Decline of late-spawning stock limits the amount of herring that juvenile Chinook can access



# Sampled Chinook

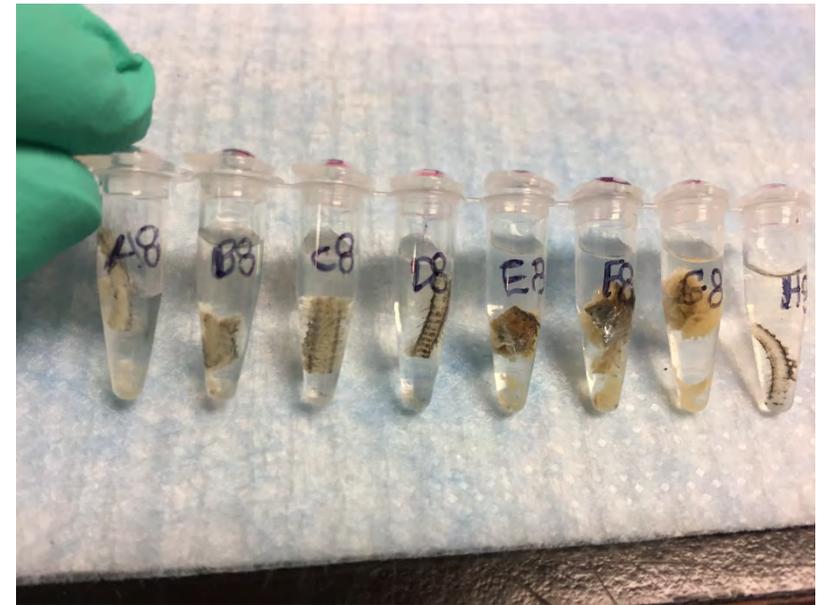


$N = \sim 800$  herring from  
 $\sim 560$  salmon



Sampled  
Chinook

Isolated  
herring from  
gut contents

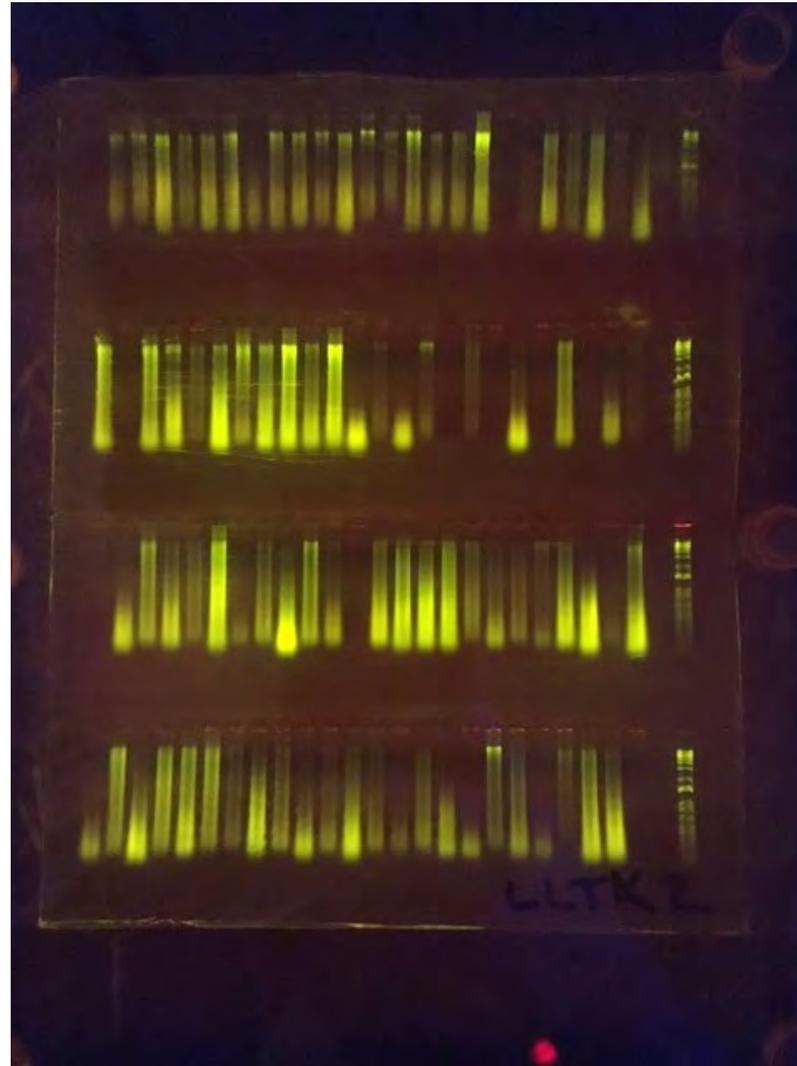
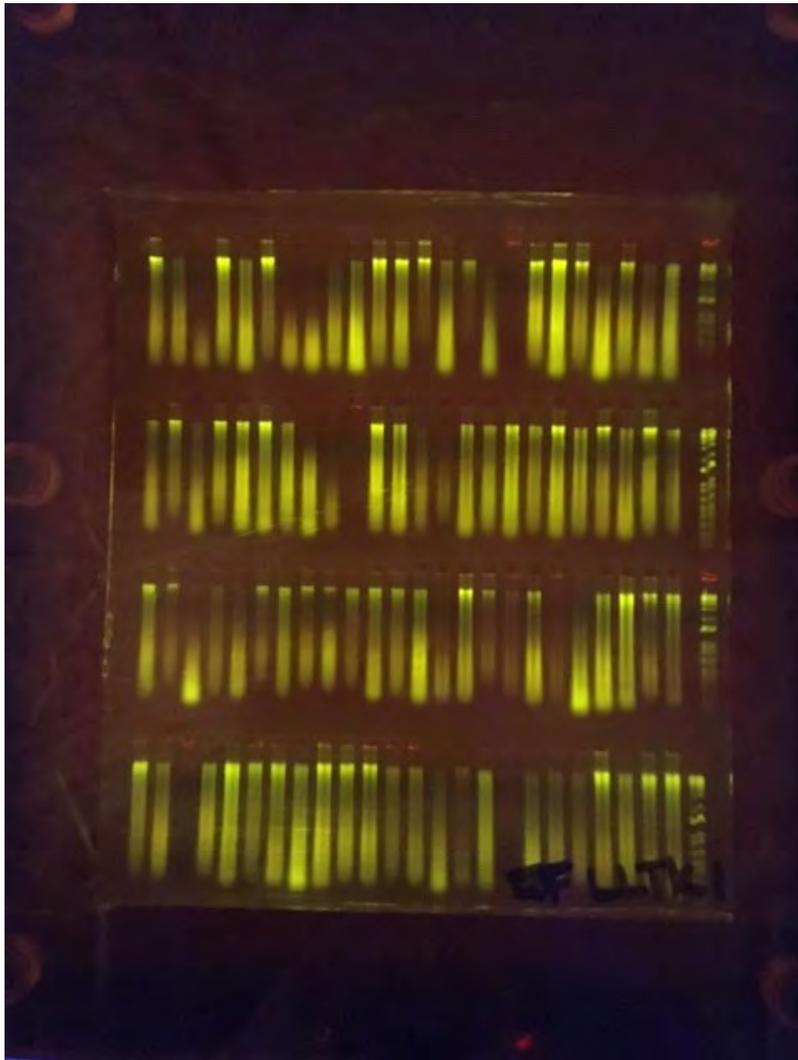


Samples were rinsed with bleach, to  
remove any contamination

Sampled  
Chinook

Isolated  
herring from  
gut contents

Extracted  
herring DNA



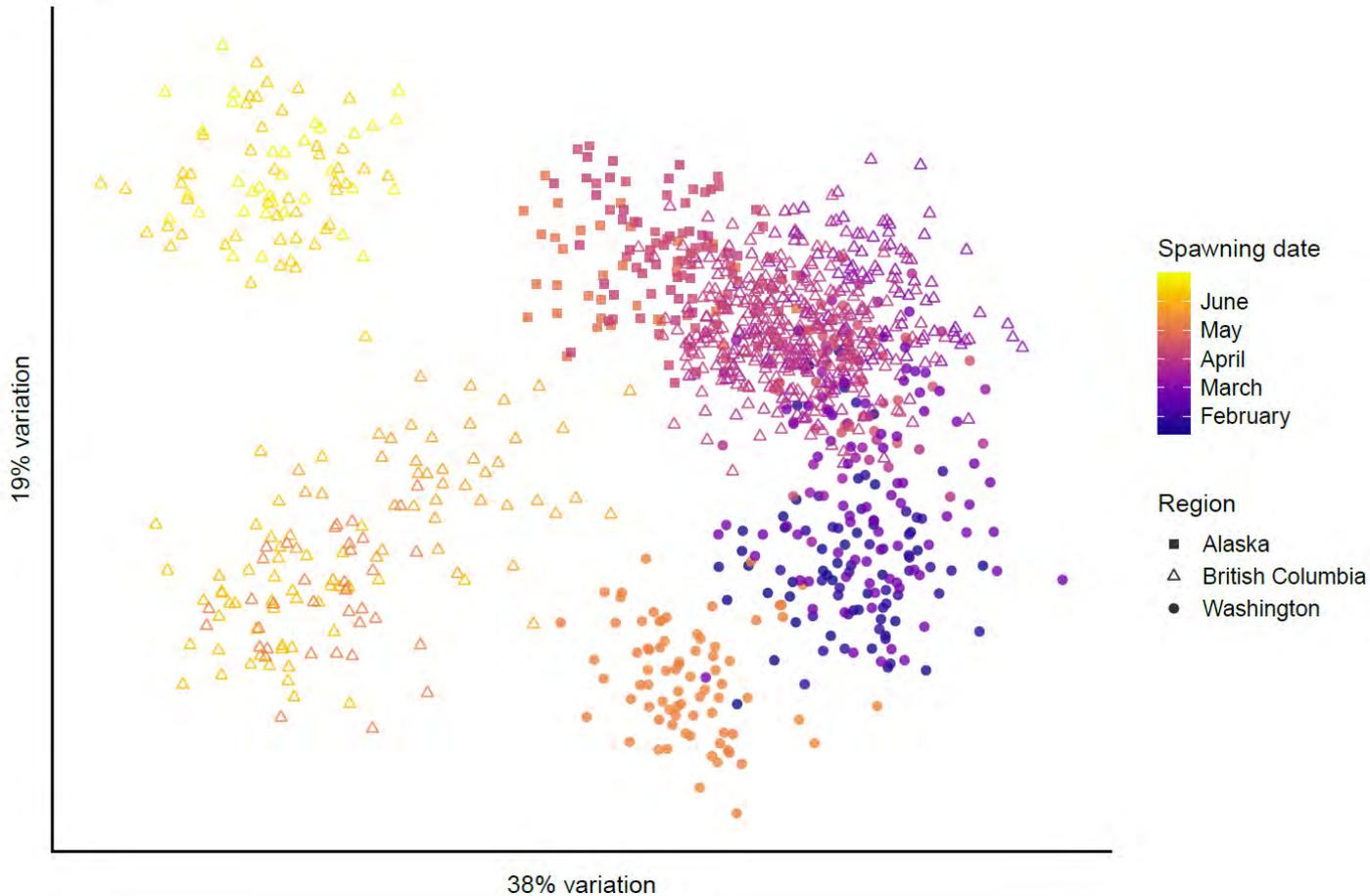
- DNA was degraded
- But in ample quantities!

Sampled  
Chinook

Isolated  
herring from  
gut contents

Extracted  
herring DNA

Genotyped  
herring



- Populations spawning in different months are genetically differentiated from each other



~ 7,000 DNA markers

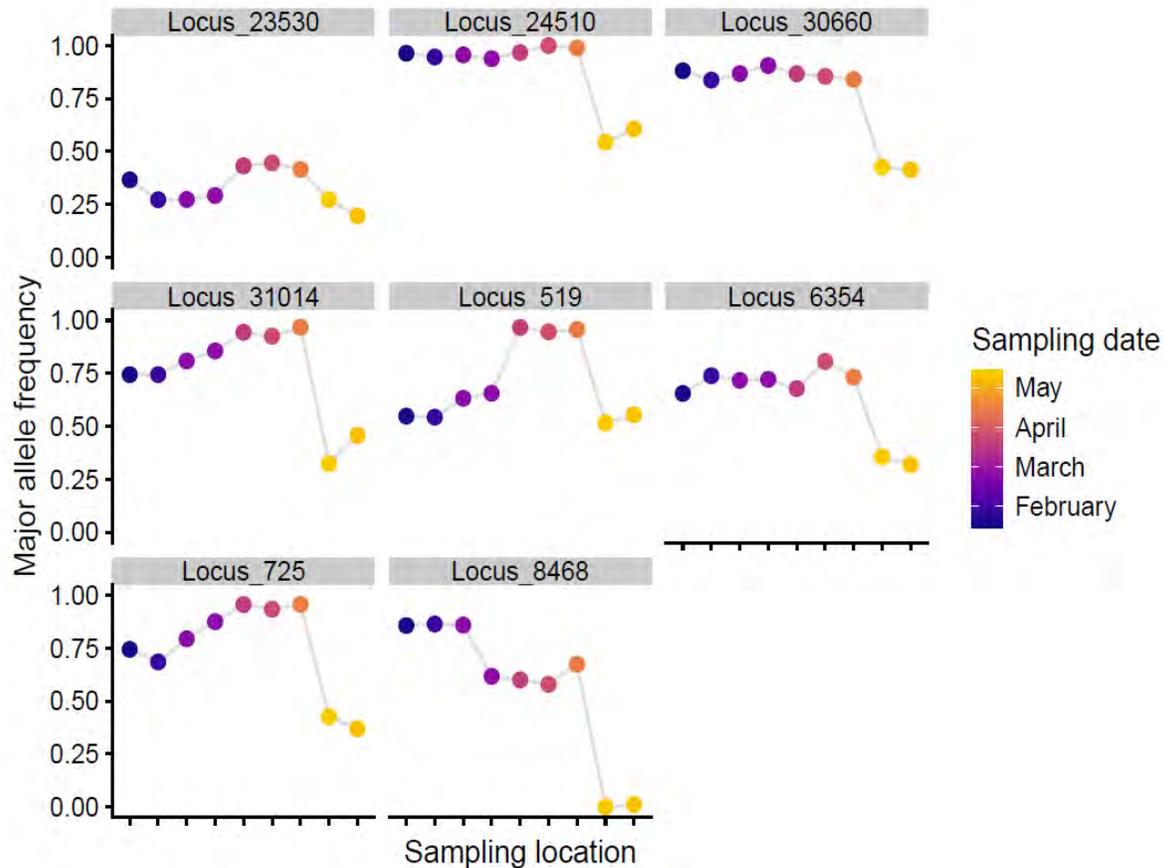
*Data from Petrou et al., in prep*

Sampled  
Chinook

Isolated  
herring from  
gut contents

Extracted  
herring DNA

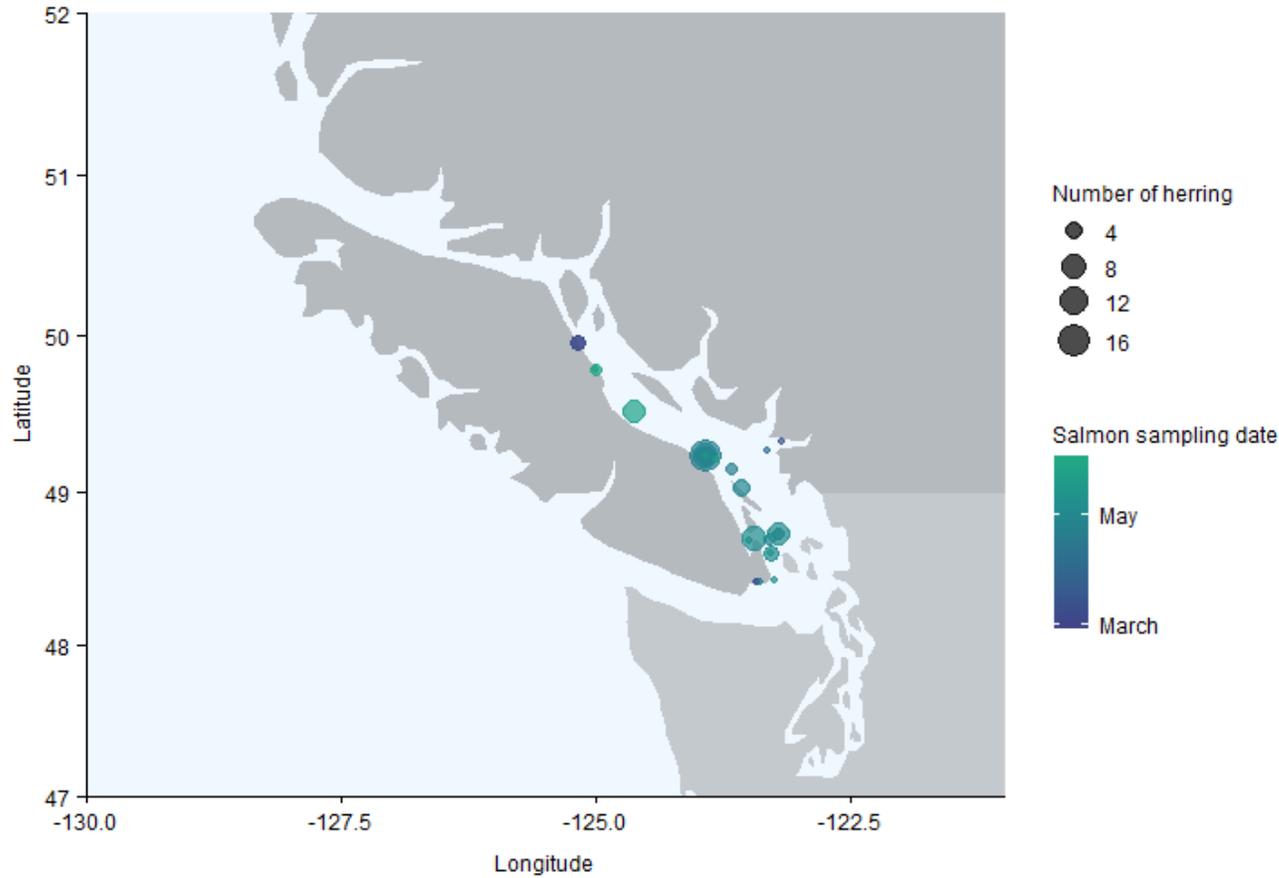
Genotyped  
herring



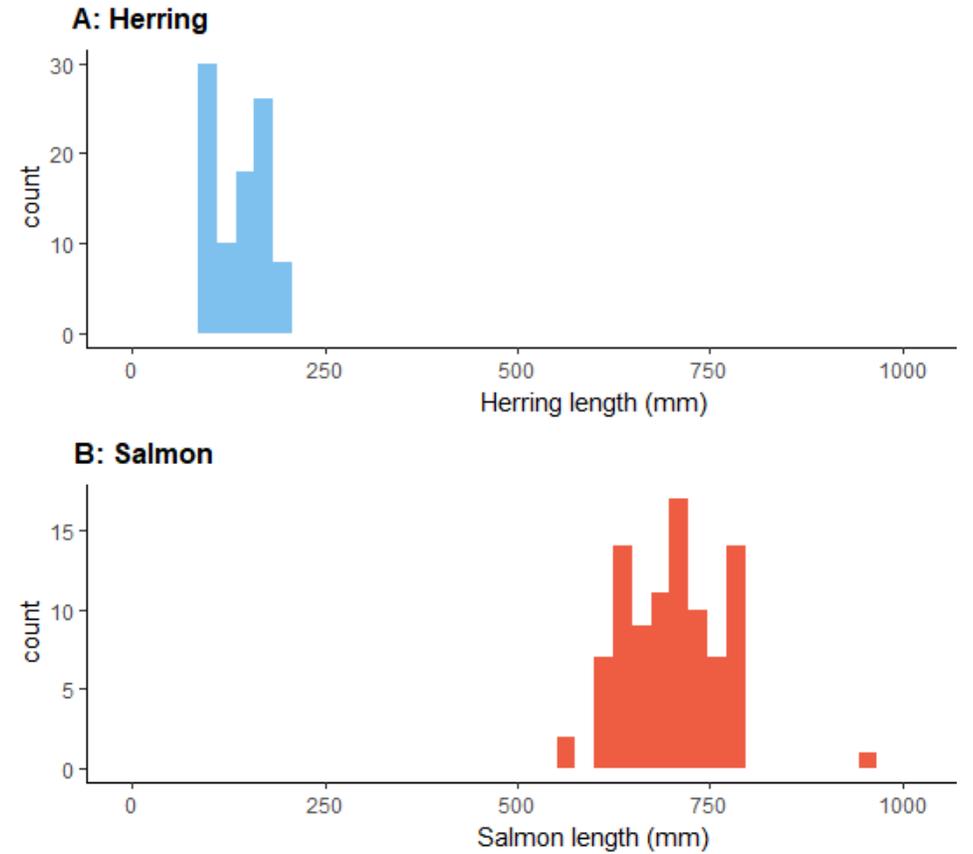
*Data from Petrou et al., in prep*

- DNA markers are natural tags, and can assign individual herring to a spawning group
- We chose 8 DNA markers that differentiate between:
  - a) May spawners (Cherry Point)
  - b) Jan-April spawners (other populations)

# First results: SOG samples collected in spring

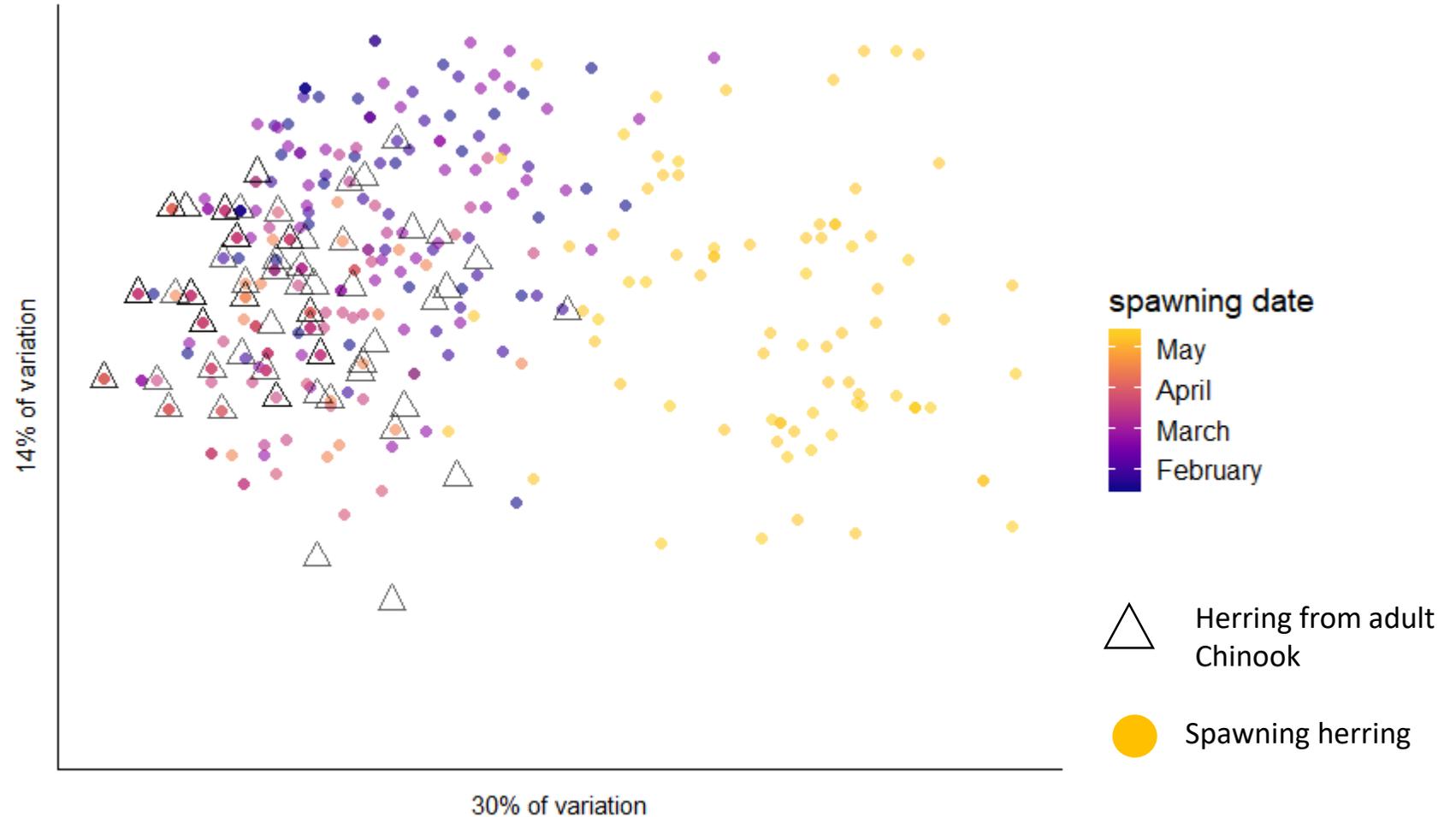


$N = 96$  herring from 60 salmon



# First results: SOG samples collected in spring

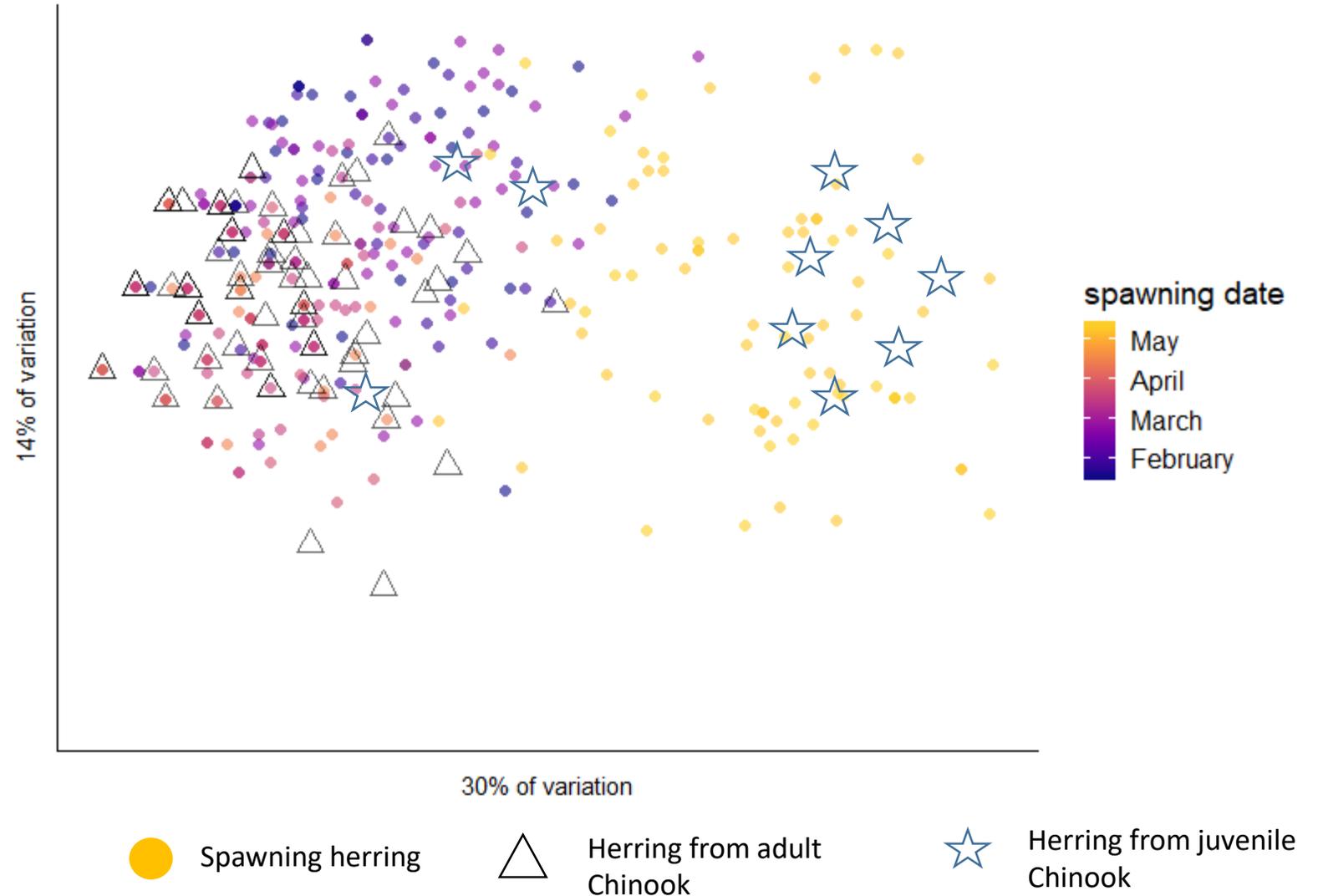
- Gut content samples cluster with January – April spawners
- Given size (90- 200 mm), they were not spawned that year
- Reflective of relative biomass of herring stocks?



# Stay tuned!

Perhaps we will observe ontogenetic shifts in prey selection

- May-spawning herring populations preferred prey for juvenile Chinook



# Acknowledgements

- WDFW
  - Chad Paul, Samantha Bond, Ann Stephenson, Karen Kloempken
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  - Marshal Hoy, Steve Rubin, Nancy Elder, Kim Larsen, Lisa Wetzell
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- San Juan Islands community
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