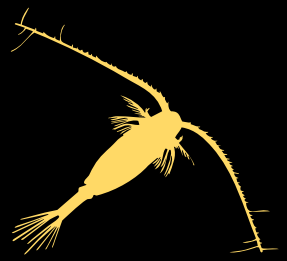
Multi-year diet analysis of young of the year Walleye Pollock (*Gadus chalcogrammus*) in the Western Gulf of Alaska, USA



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NOAA FISHERIES

Who? : **E**cosystems & **F**isheries-**O**ceanography **C**oordinated **I**nvestigations (**EcoFOCI**) program at the **A**laska **F**isheries **S**cience **C**enter (**AFSC**)

Where? : 3 **L**arge **M**arine **E**cosystems (LMEs) of Alaska

When & Who? Est. 1984: AFSC (fisheries) & PMEL (physical oceanography), Seattle, WA , USA

What?

- Early life history of fish and zooplankton ecology

Why?

- **Ecosystem-Based-Fisheries Management**
  - **Definition**: "A systematic approach to fisheries management in a geographically specified area that contributes to the resilience and sustainability of the ecosystem…"*
  - Incorporates lower trophic level data into fisheries management decisions

Importance of Pollock Diet Analysis

- Walleye pollock commercial value from 2021 WGOA: **$27 billion USD** (Abelman et. al. (2023)
- **E**cosystem **B**ased **F**isheries **M**anagement
  - Diet plays a critical role in the early life history of pollock, where availability and quality of prey influences growth rates, predation pressure, and potential overwinter survival to age-1
  - Diet analysis provides a **direct trophic linkage** between lower and upper trophic levels

What is driving inter-annual variation in diets of juvenile pollock?

- Are particular environmental conditions associated with prey availability and quality?

Methods: Field Sampling Data
Space and Time

Data Presented:

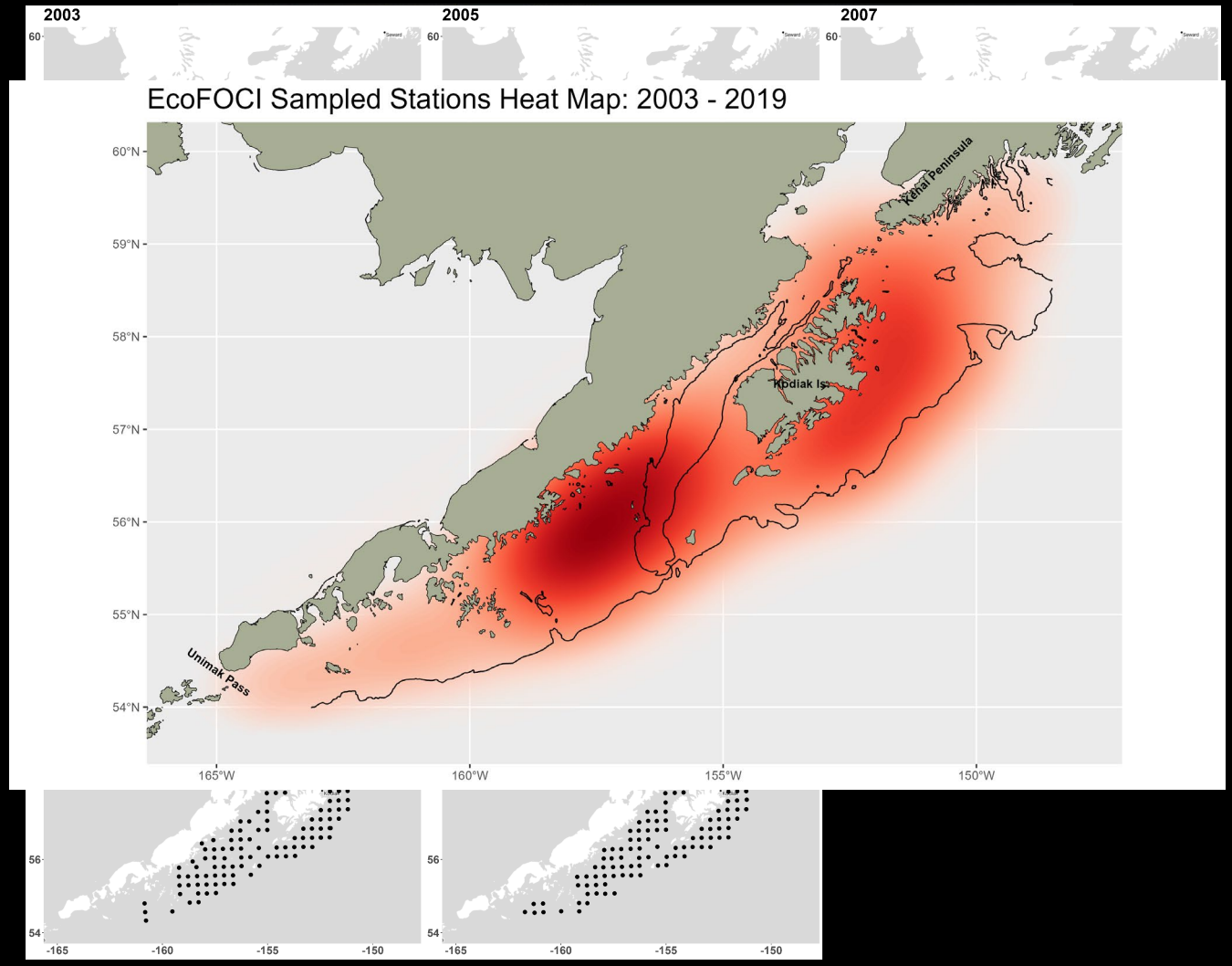
Temperature and Walleye pollock diets from fall juvenile fish surveys 2003 - 2019

Space:

- Surveys expanded over time
- Most frequent sampling in dark red

Time:

- Surveys conducted between mid-August to early October



Methods: Field Sampling
Gear

Fish Trawls (All Years):

- **Anchovy Trawl (a.k.a** Stauffer Trawl, Wyllie-Echeverria, et al., 1990)
- a midwater trawl (3 mm mesh)

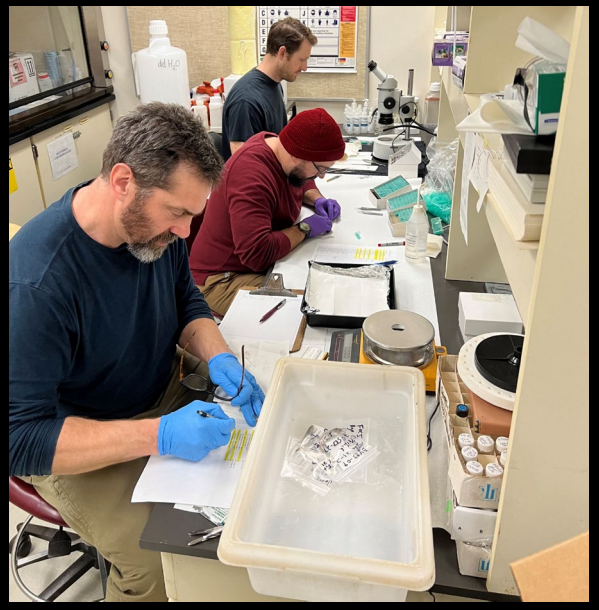
Oceanography (T & S):

- Sea-bird Seacat (2003-09) or Fascat (2013-19)

Methods: Diet Processing

Laboratory Processing

- Frozen pollock selected for analysis were measured (nearest 1-mm standard length), and weighed (nearest 1 g).
- Gut contents identified:
  - organized by taxa levels (lowest possible)
  - Determine life-history stage (if possible)
  - Qualitative digestion level
- Individual prey taxa groups were enumerated, dried, and weighed separately (nearest 0.01 mg).



Methods: Statistical Analysis

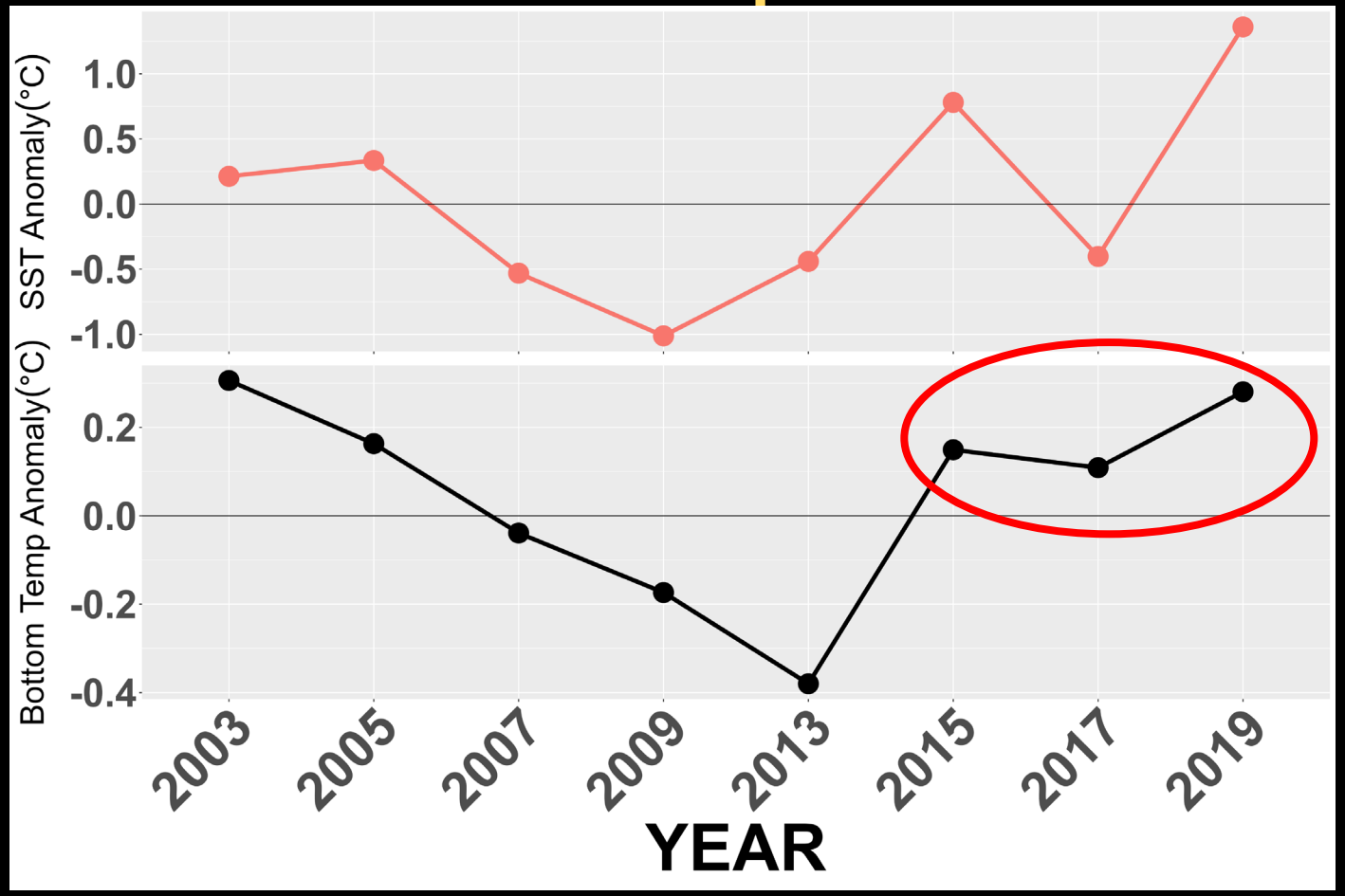
Fish Length, Weight, & Condition

- Fish lengths and weights were taken from diet pollock ONLY
- Pollock body condition was calculated from residuals of a regression of log weight (g) as a function of log length (mm)

Diets

- **%PSIRI: P**rey-**S**pecific **I**ndex of **R**elative **I**mportance (Brown, et al. (2012)
- Prey frequency of occurrence (%FO) is combined with prey-specific numbers (%PN) and weights (%PW)
- Allows to compare taxa in order of importance
- %PSIRI = %FO x (%PN + %PW)

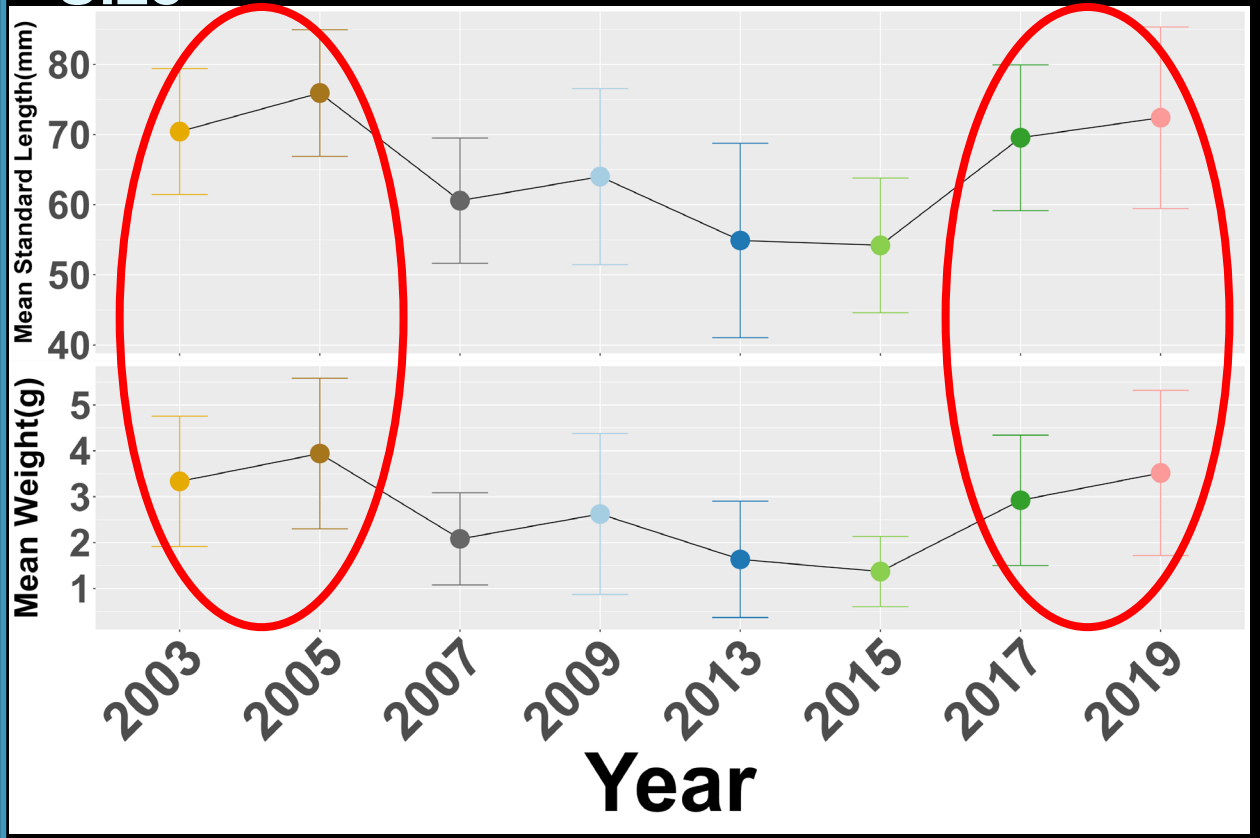
Results: Temperature



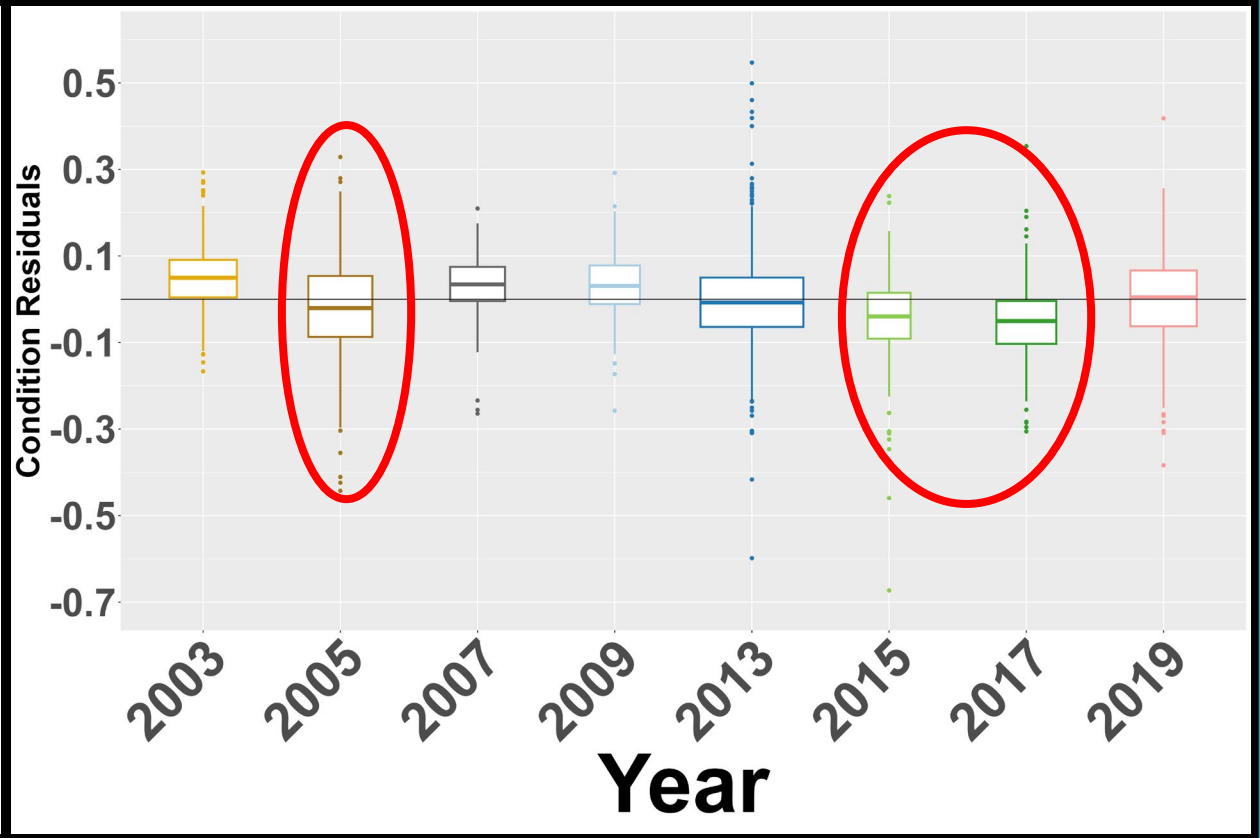
- Temperature Anomalies calculated from Fall Surveys 2003 – 2019
- Warm and Cold periods represented
- Dramatic increase in Bottom Temperature during and after 2015 (Marine Heat Wave 2014 – 2016)

Results: Pollock Size & Condition

Size

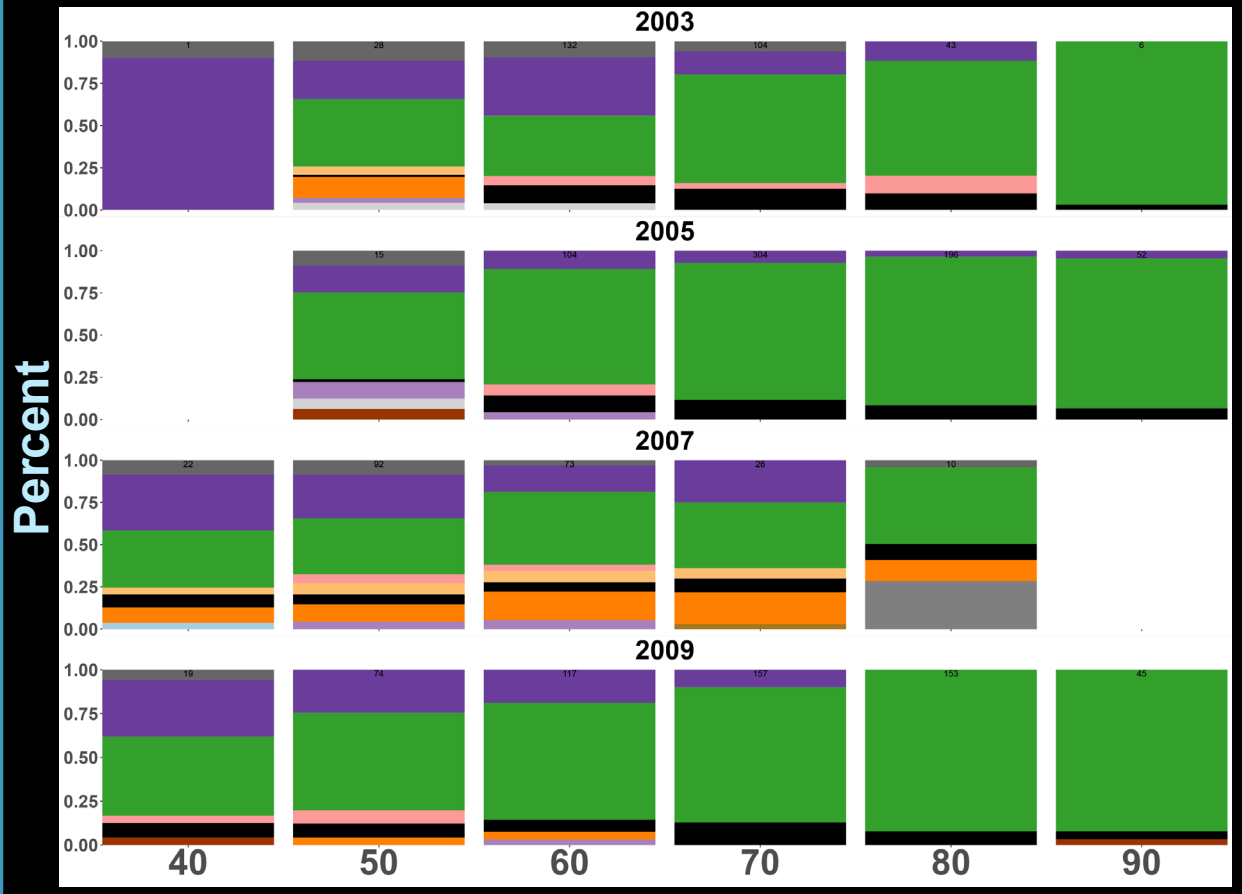


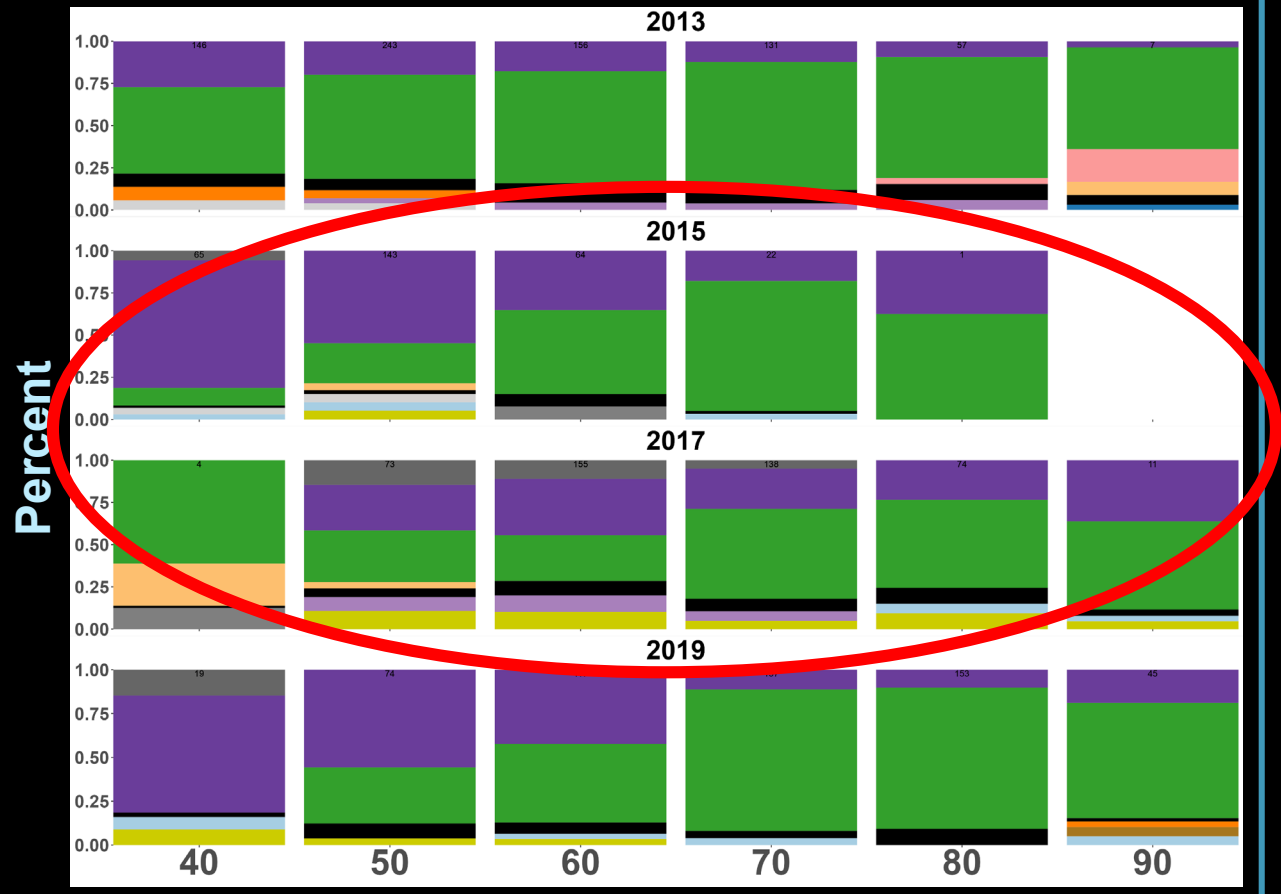
Condition



- Larger pollock found in warmer years, except 2015
- Negative body condition found 2005, 2015, and 2017

Results: Pollock Diets





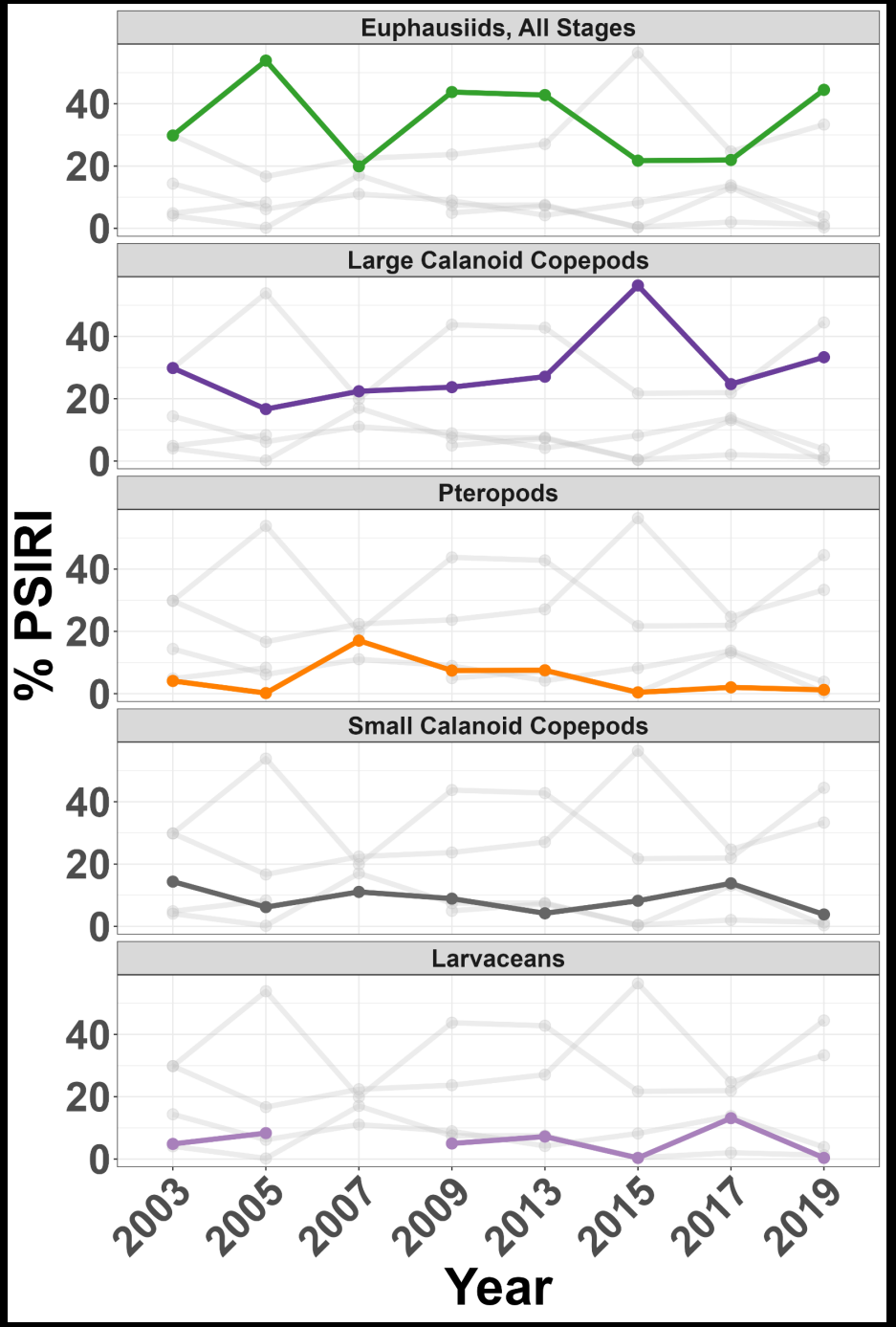
- Given variability in climate, remarkable consistency in the diets
- Large calanoid copepods (mostly *Calanus marshallae*) (**purple**) & euphausiids (**green**) consumed most often and transfer to mostly euphausiids as fish size increases
- 2015 & 2017: increase in amount of *C. marshallae* consumed in larger pollock

Legend: Common Taxa

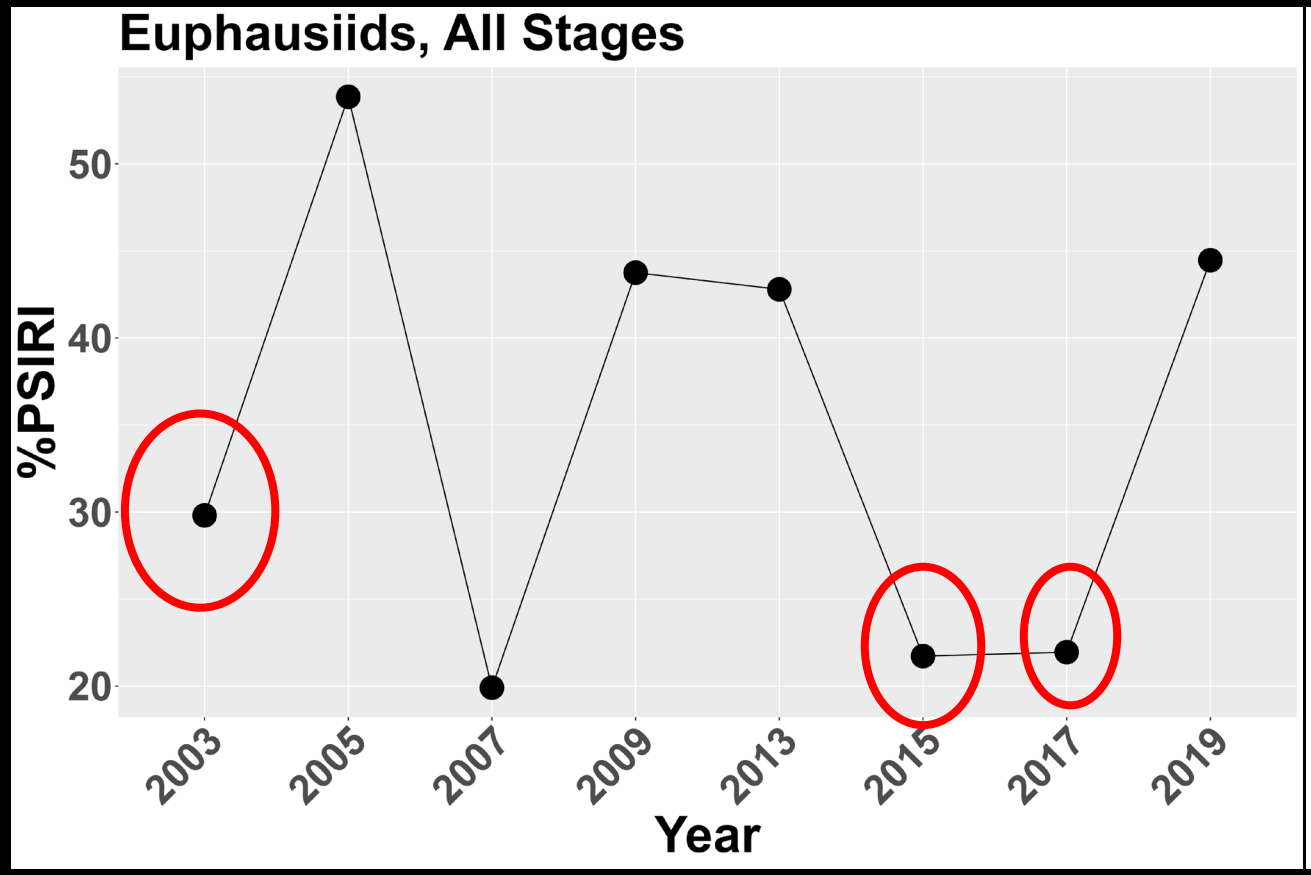
- Small Calanoid Copepods
- Large Calanoid Copepods
- Euphausiids, All Stages
- Fishes
- Hyperiids
- Other
- Pteropods
- Larvaceans

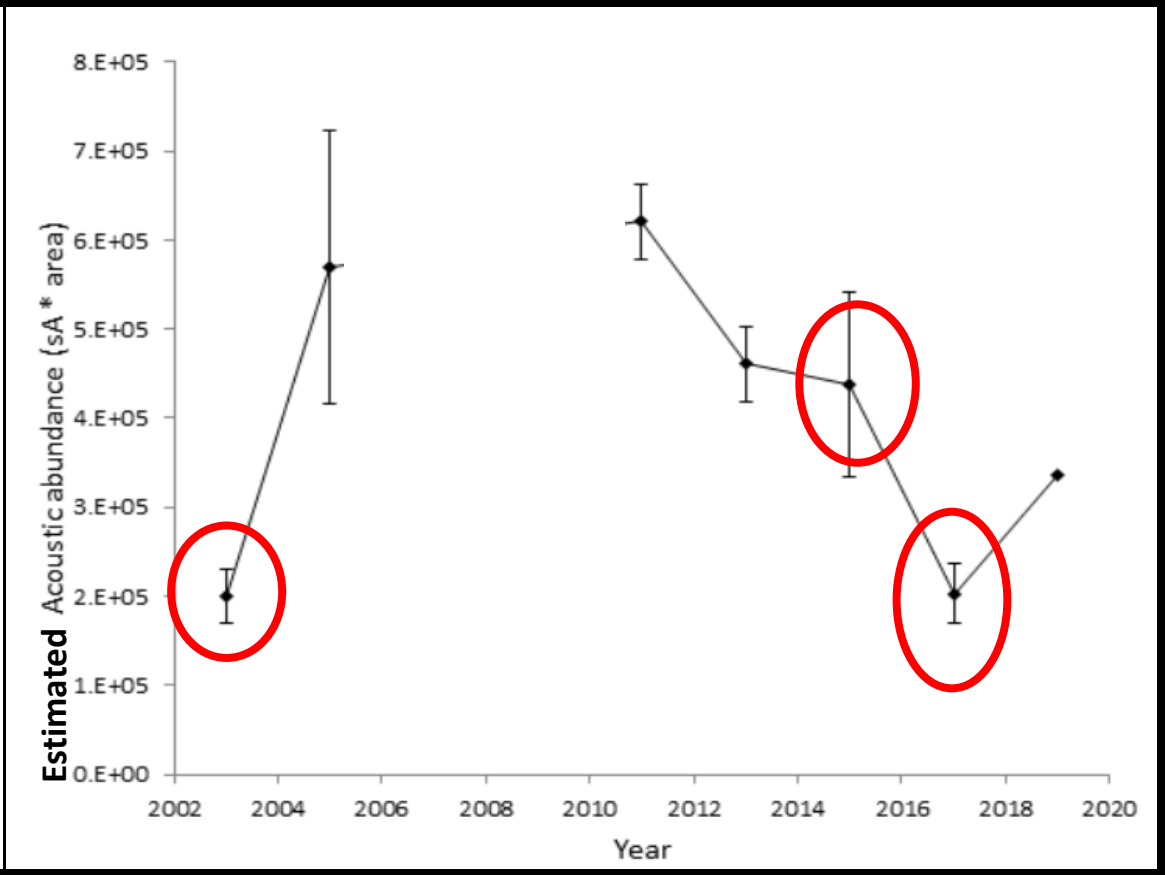
Results: %PSIRI

- %PSIRI Euphausiids (*Thysanoessa* spp.) & Large Calanoids (*C. marshalle*) rate highest consistently
- Euphausiids and *C. marshallae* are high lipid taxa (Mazur et al. (2007))
- Shows year to year differences & variability in prey importance
- Brings up more questions!



Results: %PSIRI, cont.

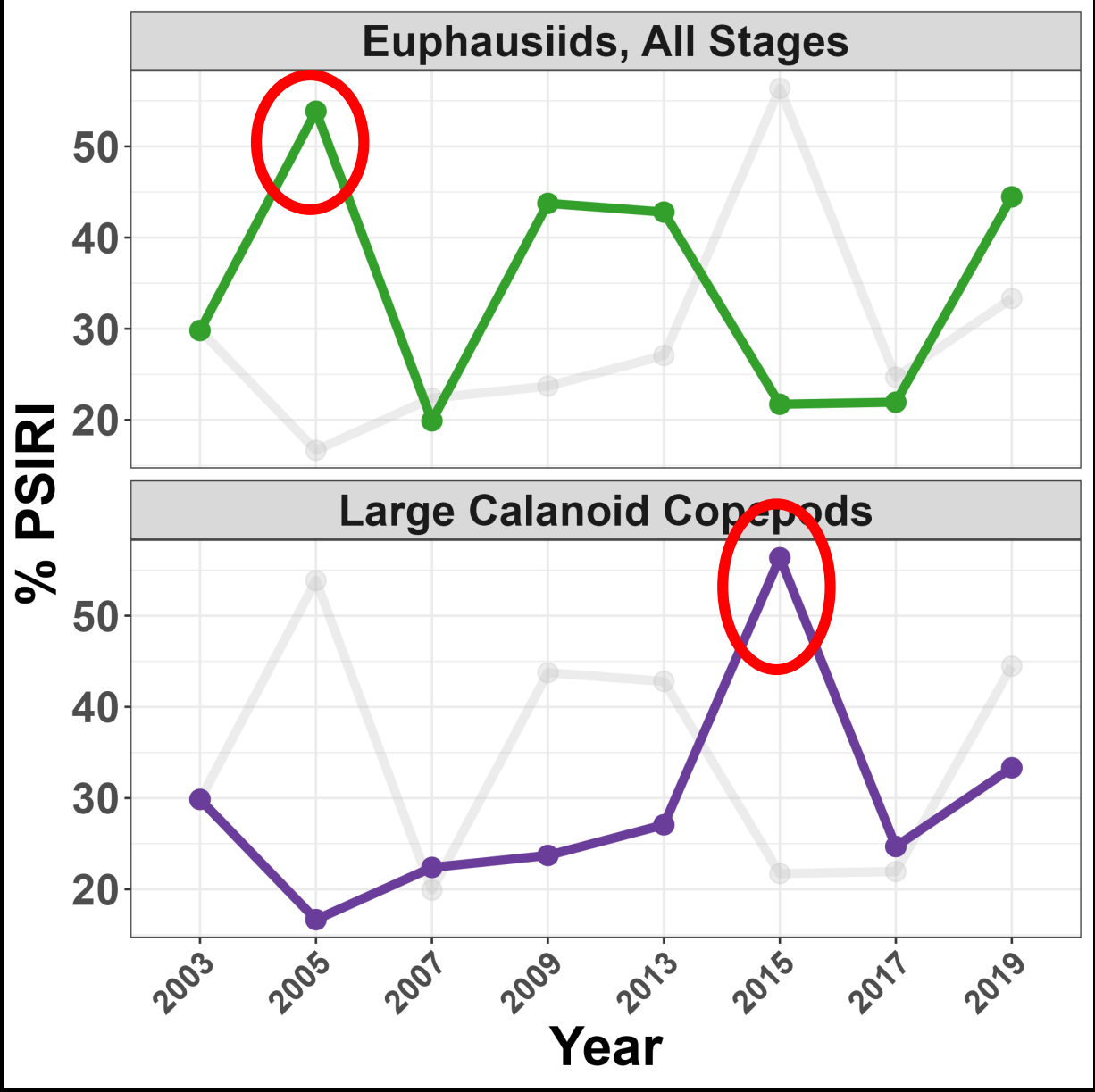




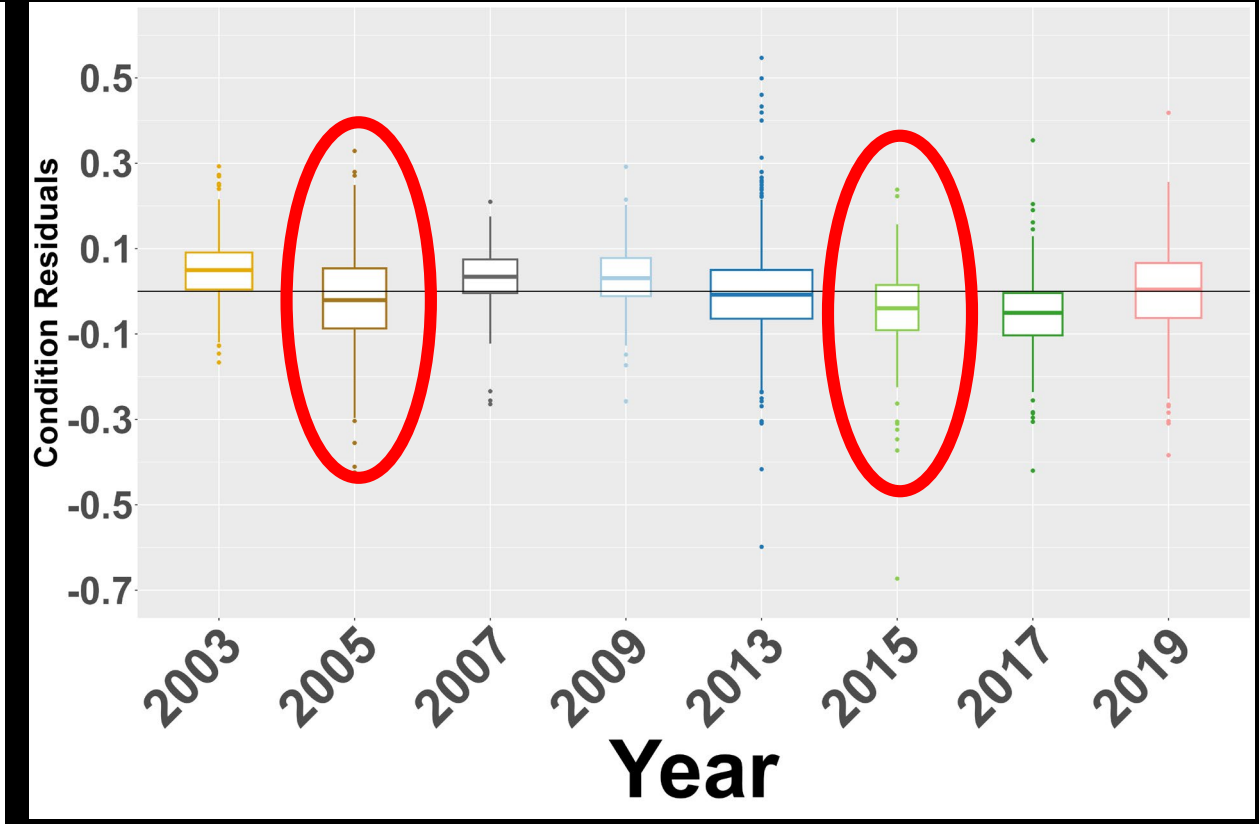
From figure 47, Zador, et al. (2019, based on Simonsen, et al. (2016)

- Euphausiid abundance estimates from acoustic surveys were lowest in 2003 & 2017, reflecting low %PSIRI values
- Not as simple as high vs low abundance

% PSIRI



Fish Condition



- Generally, higher prey indicator % euphausiids and *C. marshallae* = neutral to positive body condition
- Sometimes high prey indicator % does not reflect body condition (2005 & 2015)
- What could be the cause??

Next Steps: Prey Lipid Values

- Can variability in prey lipid content determine prey ***quality*** ?
- Starting in 2017: collecting euphausiids & *C. marshallae* for lipid analysis (Cody Pinger, RECA)
- Goal: Year to year comparisons of available lipid found in prey

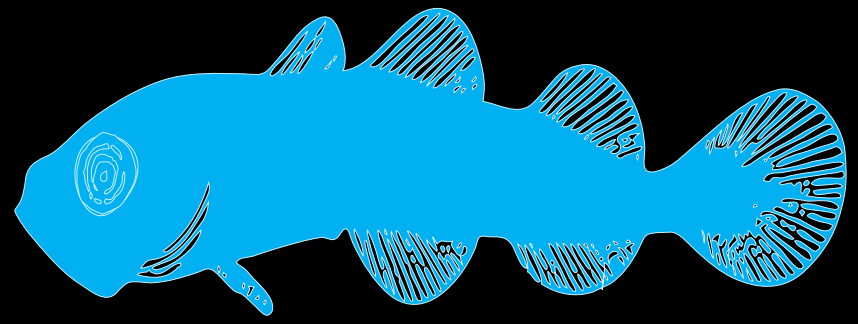
High Lipid Prey

Low Lipid Prey

Less

More

Optimum Size for Overwinter



Time may run out!

Conclusions

- Negative body condition was associated with anomalously warm ocean temperatures: 2005,2015, and 2017
- Juvenile pollock consumed similar proportions of *C. marshallae* and euphausiids in both warm and cold oceanic conditions
- 2015 (Marine Heatwave) was poorest for juvenile pollock: smallest size, negative body condition, with large consumption of *C. marshallae* at larger fish sizes
- %PSIRI values consistently showed importance of euphausiids and C. marshallae, but much variability with year to year euphausiids values
- **Future Work:** Examine year to year lipid availability of important prey taxa *C. marshallae* and euphausiids

Acknowledgments

- Diet Sorters: Crissy Jump, Nissa Ferm, & Samantha Zeman
- All participants (crew and scientists) who collected this data: R/V Miller Freeman (2003 – 09), R/V Oscar Dyson (2009 – Present), F/V Northwest Explorer (2015)
- Zooplankton Team: Julie Keister, Adam Spear, Colleen Harpold (3/21 @ 9:30am (S10)), and Deana Crouser (3/21 @ 2:45pm (S6))
- Past and present members of EcoFOCI