Differential response of copepods to climate across three regions of the North Pacific

Julie Keister[1,2], David Kimmel[2], Amanda Winans[1], BethElLee Herrmann[1]

and numerous collaborators!


Arctic
N. Bering Sea
SE Bering Sea
Gulf of Alaska
Southern Salish Sea
North Pacific Ocean
UNITED STATES
CANADA
MEXICO


Arctic
N. Bering Sea
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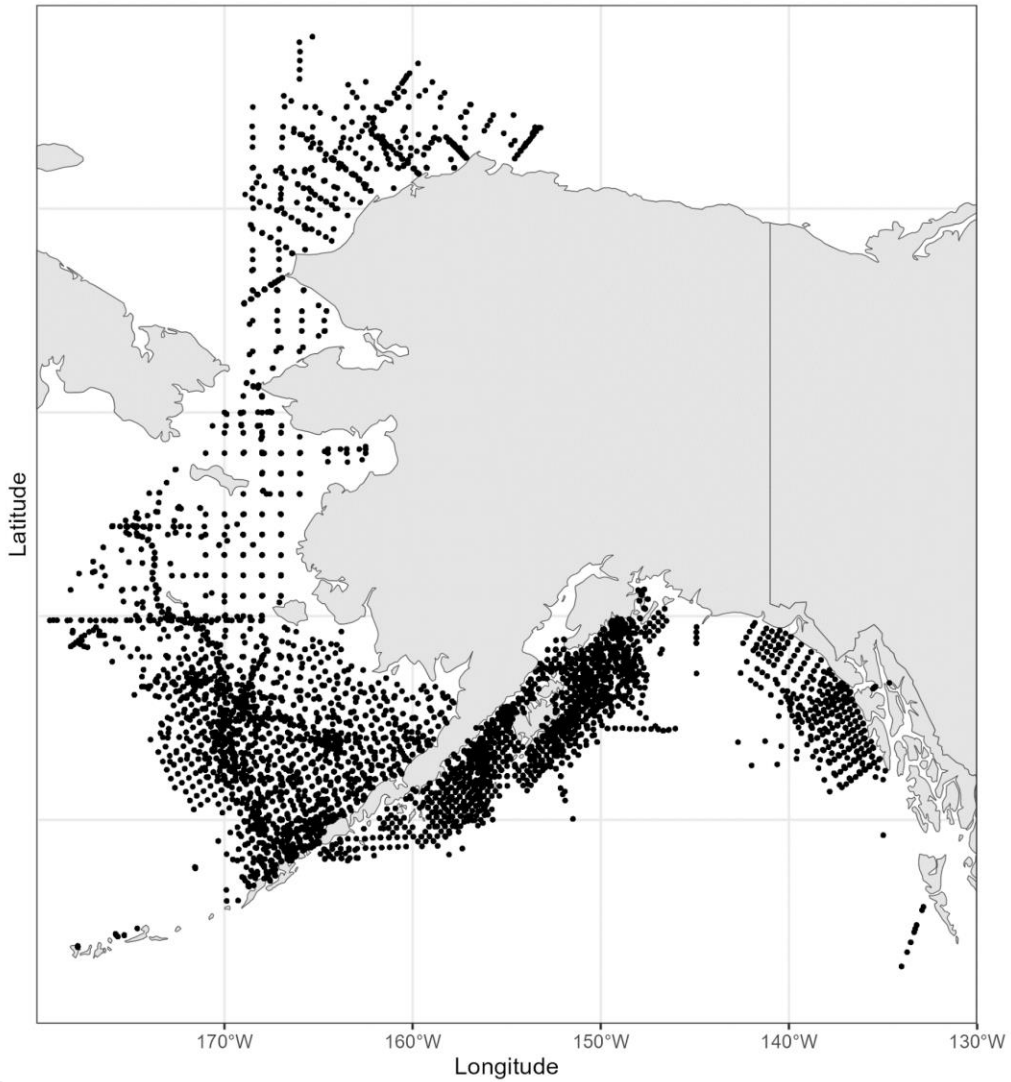
E D E R A T I O N
C A N A D A
UNITED STATES
North Pacific Ocean
MEXICO

NOAA's Ecosystems and Fisheries-Oceanography Coordinated Investigations (EcoFOCI)



NOAA FISHERIES

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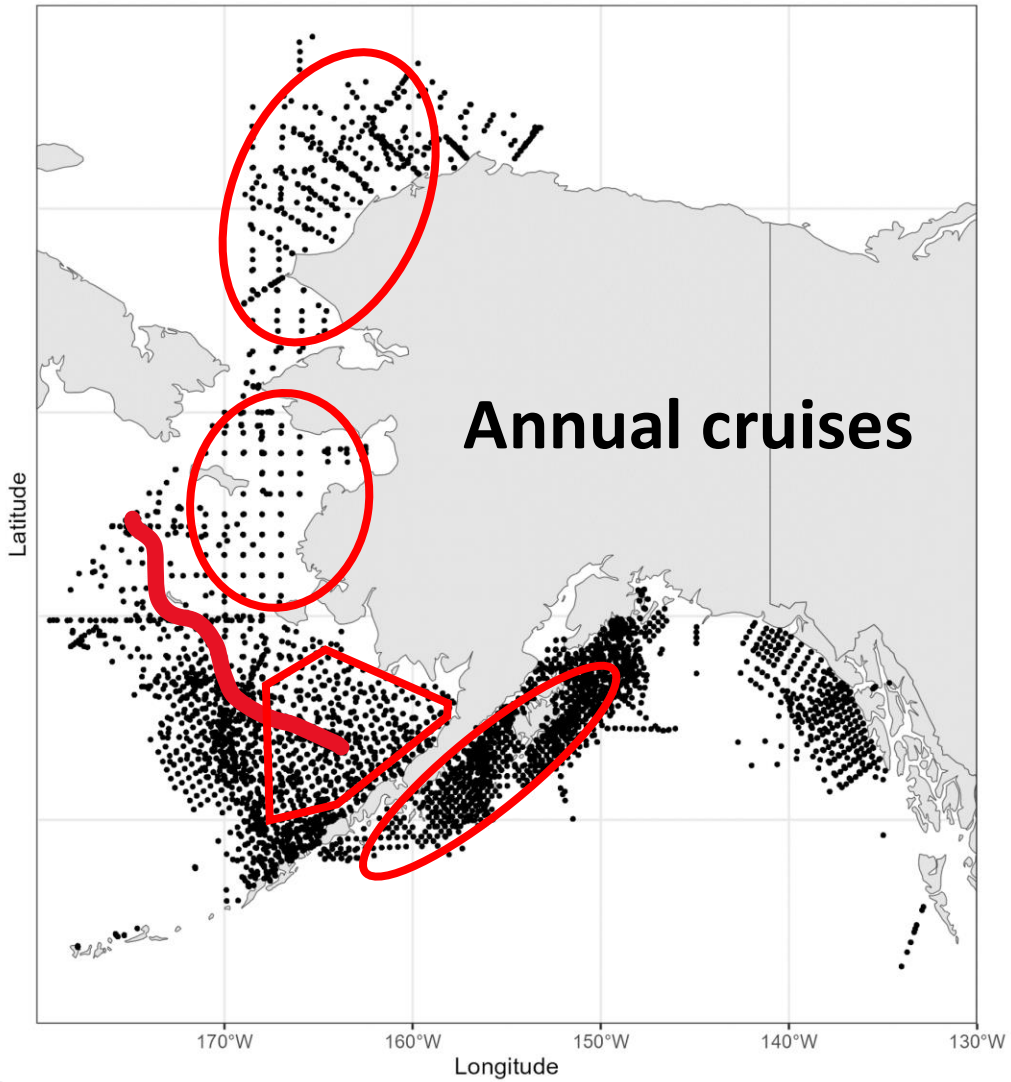
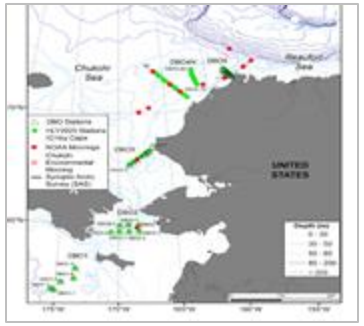
PMEL
Pacific Marine Environmental Laboratory

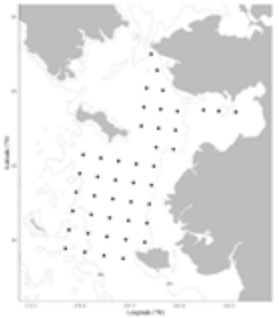
NOAA's Ecosystems and Fisheries-Oceanography Coordinated Investigations (EcoFOCI)



Arctic
Early Fall

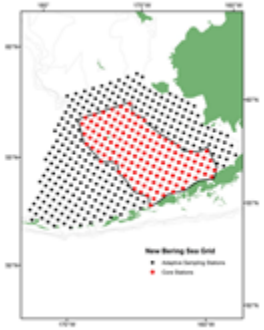


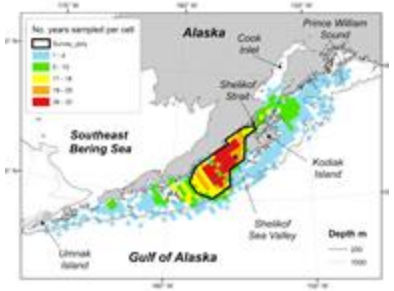
Northern Bering Sea
Late summer



Bering Sea 70-m isobath
Spring and Fall

SE Bering Sea (even years) or Western GoA (odd years)
Spring and Summer





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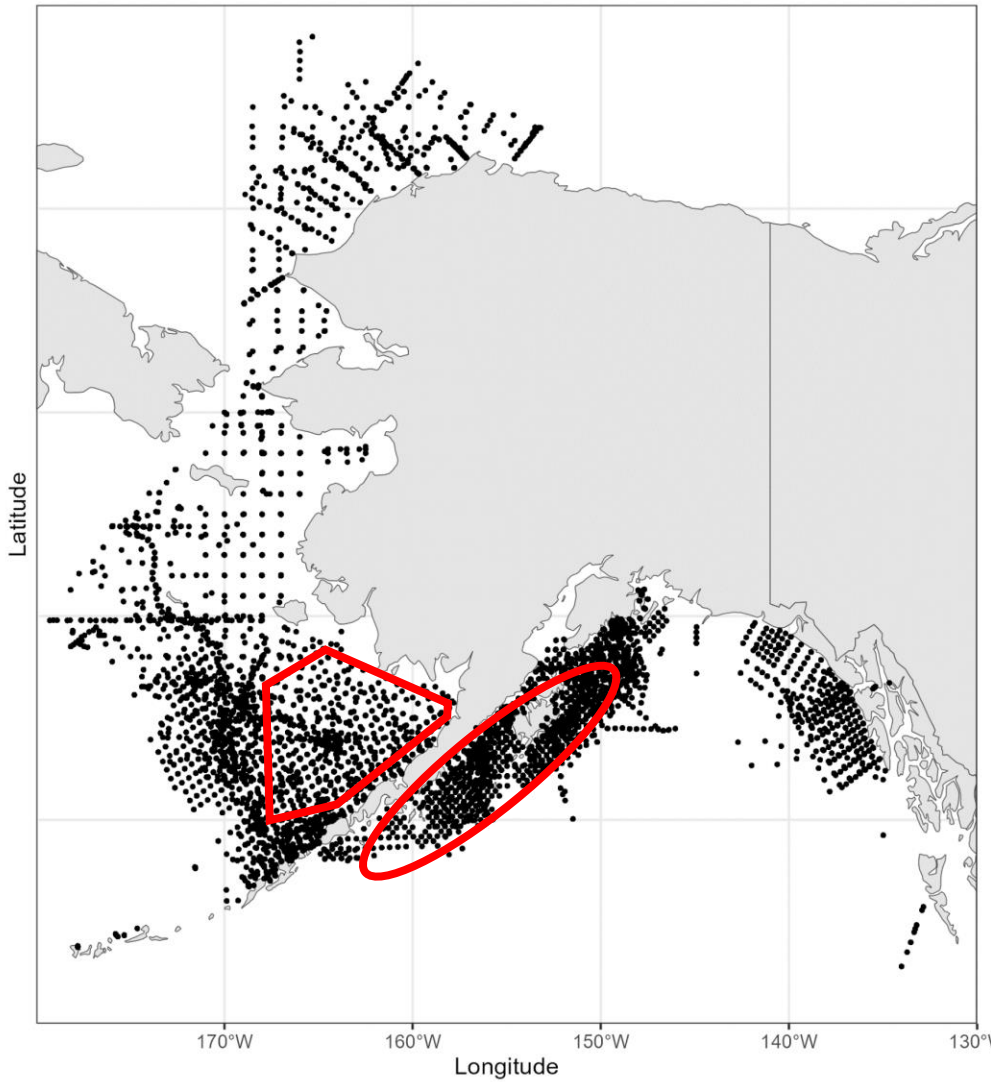

Plankton: Since 1984 (GOA) and 1993 (EBS)

Oblique bongo net tows

- Upper 100 m
  - 20 cm diameter, 153 µm mesh size
  - 60 cm diameter, 505 µm mesh size
- 1000's of samples shipped to Poland Plankton Sorting and Identification Center annually
- Identified to species (where possible)
- Measured for displacement volume (reported to COPEPOD database)

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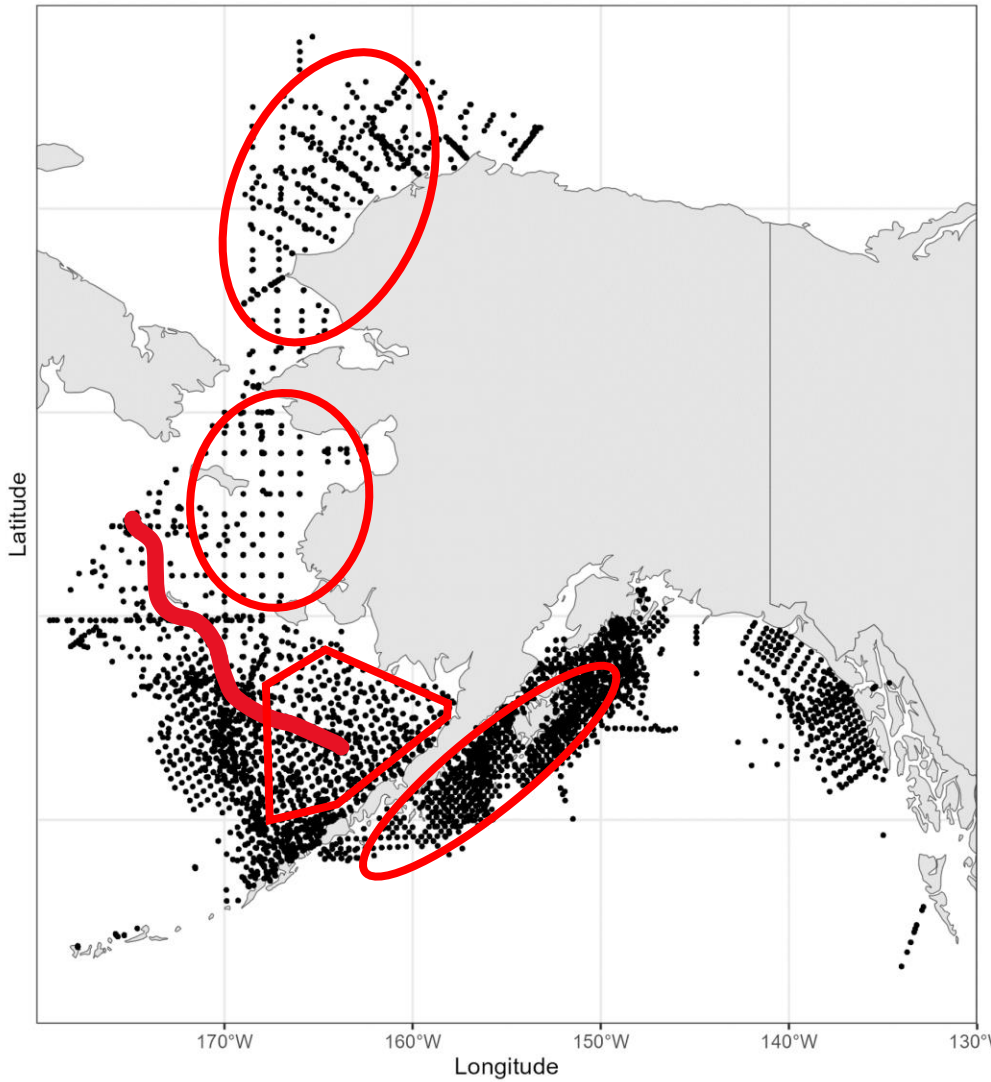
NOAA's Ecosystems and Fisheries-Oceanography Coordinated Investigations (EcoFOCI)



Additional sampling:

- Midwater and bottom trawls
  - On summer surveys: Juvenile fish, benthos
- CTD casts and water sampling
- Biophysical and passive acoustic moorings deployed

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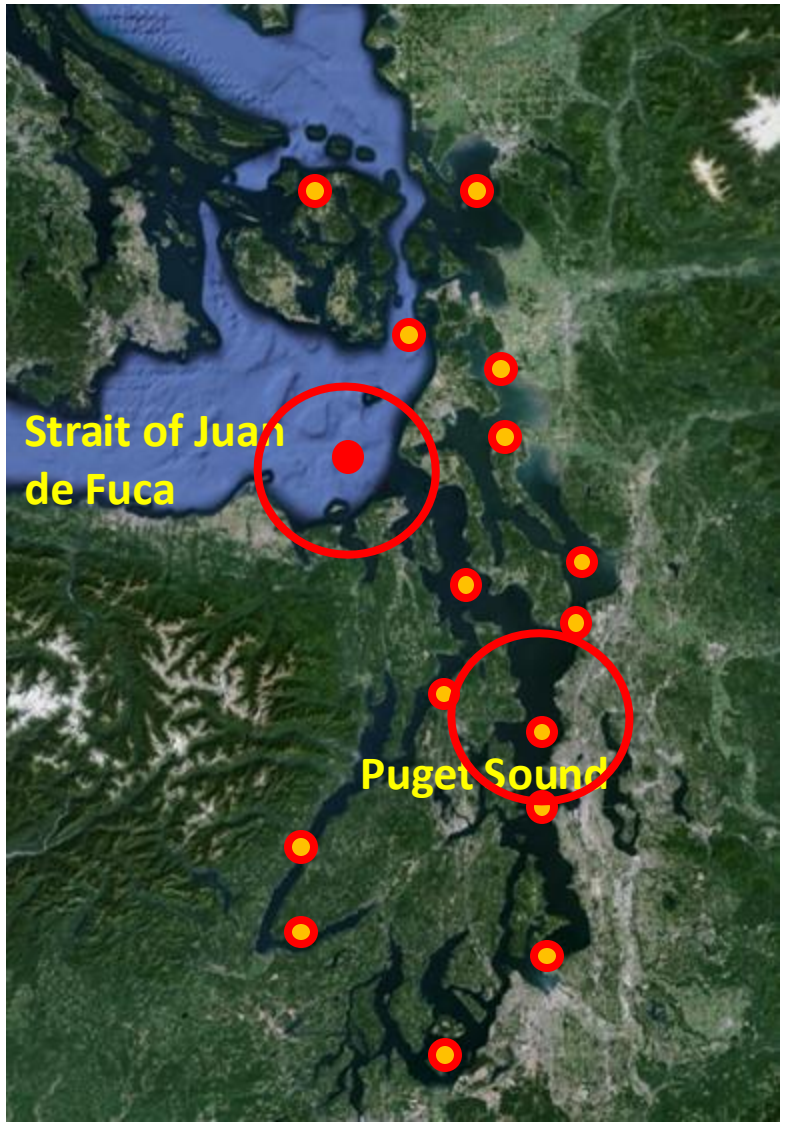
E D E R A T I O N
C A N A D A
UNITED STATES
MEXICO
North Pacific Ocean
Southern
Salish Sea
(Puget Sound)

Puget Sound Zooplankton Monitoring Program (PSZMP):



Began in 2014 (except ● = 2003)

Bi-weekly (spring-fall); Monthly (winter)

- **Vertical net tows**
  60-cm dia., 200-µm mesh
- **Oblique bongo net tows**
  Upper 30 m
  60-cm dia., 335-µm mesh

Washington Department of FISH and WILDLIFE

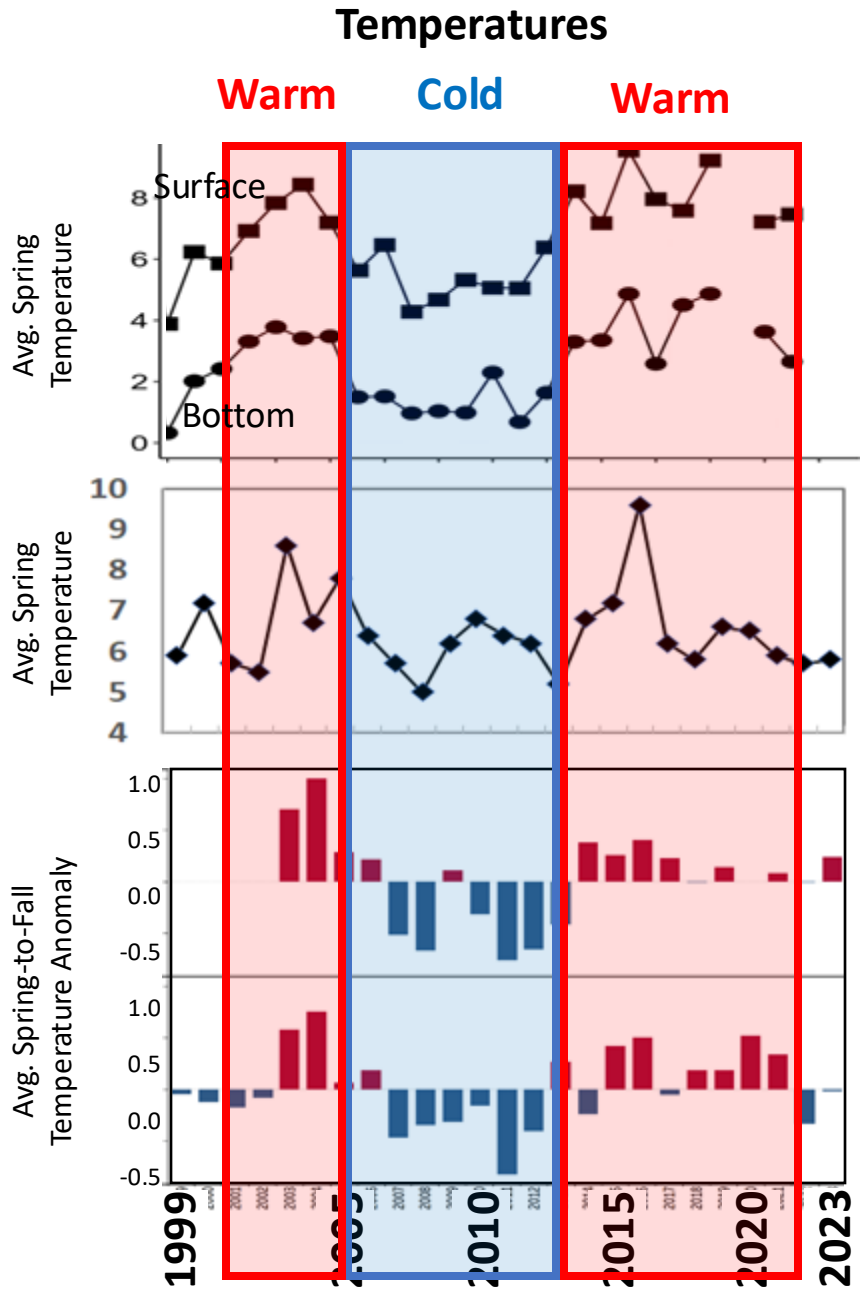
Warm and cold stanzas are largely coherent across regions

Extensive shelf system, Sea ice controlled

Downwelling system, Complex coastal circulation

Connection to CCS upwelling ecosystem

Warmer, protected and stratified system



Zooplankton Indicators

1) Total Copepod abundance

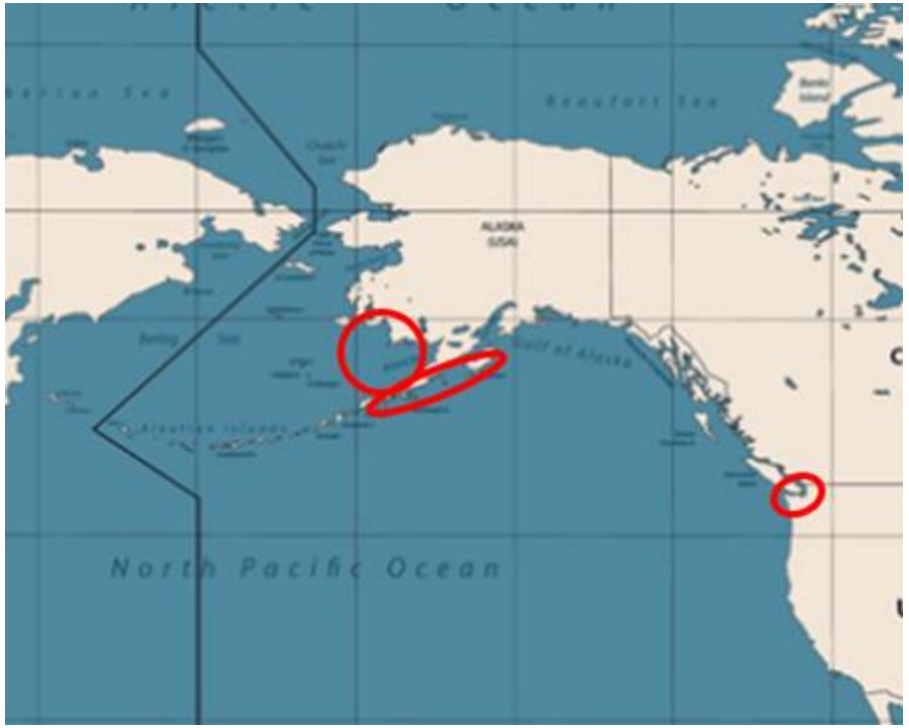
2) *Calanus marshallae* – large-bodied (3.5 mm), high lipids. Northern distribution. Dominates in the SEBS (*C. glacialis*?).

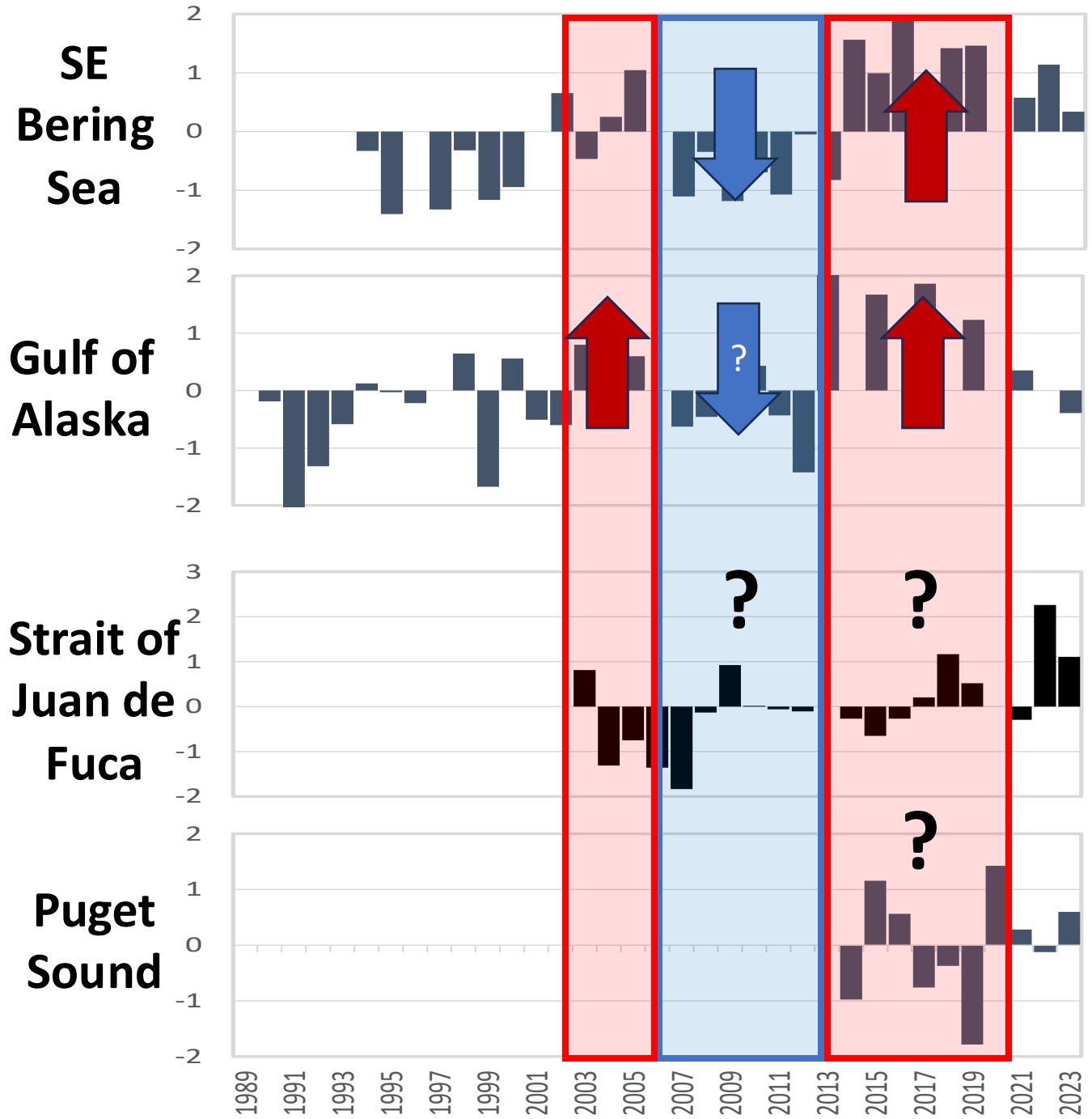
3) *Calanus pacificus* – large-bodied (2.5 mm), medium lipids, temperate distribution. Dominant in Puget Sound.

4) *Acartia longiremis* – small bodied (0.9 mm), low lipids. Northern distribution. Summer upwelling in California Current. Occasionally in Puget Sound.

Total Copepods

abundance anomalies

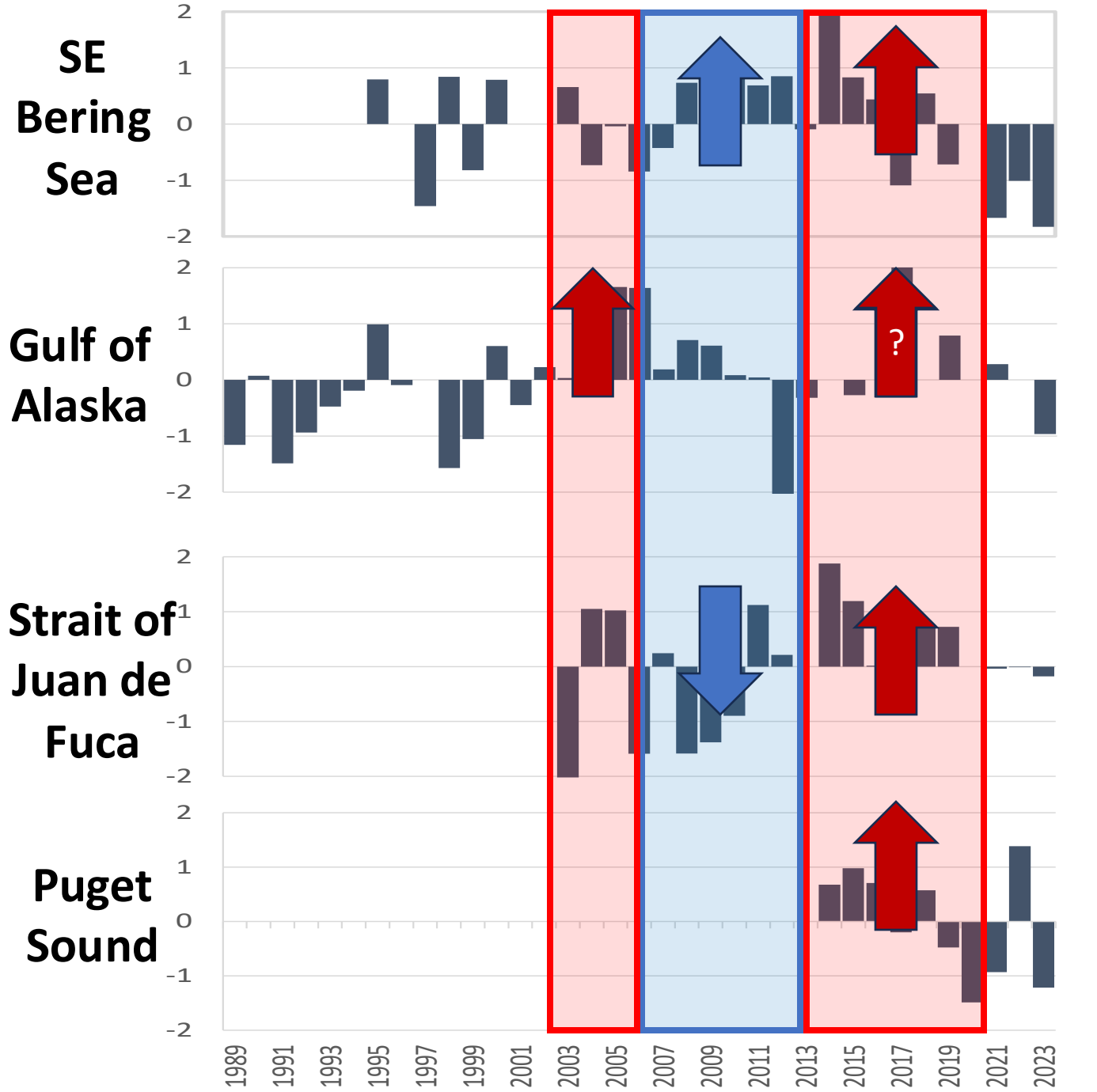




Calanus marshallae

Abundance Anomalies

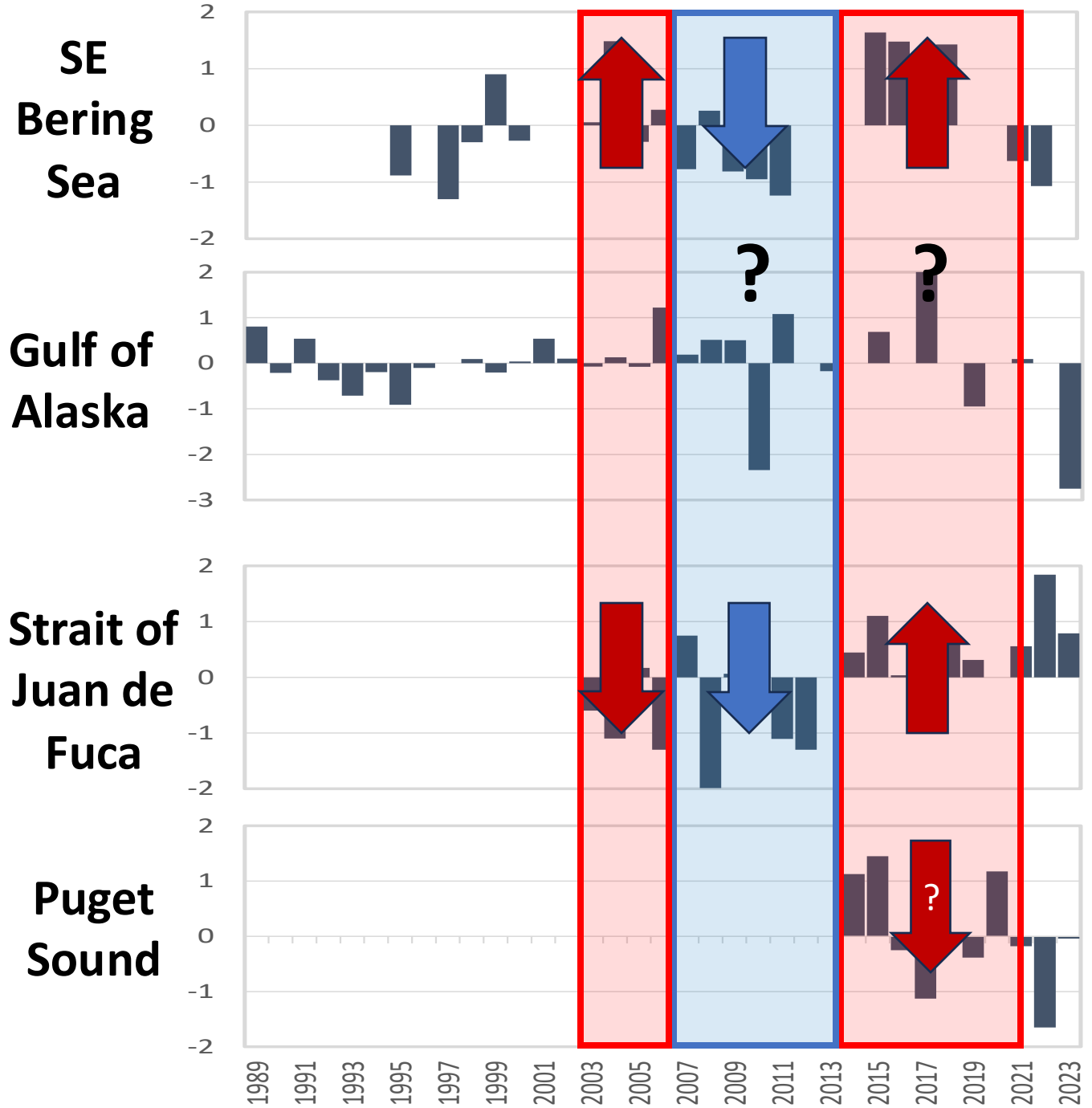
- **Large-bodied**
- **High lipids**
- **Increasing dominance to N**



Calanus pacificus

Abundance Anomalies

- **Large bodied**
- **Medium lipids**
- **Dominant in Puget Sound**

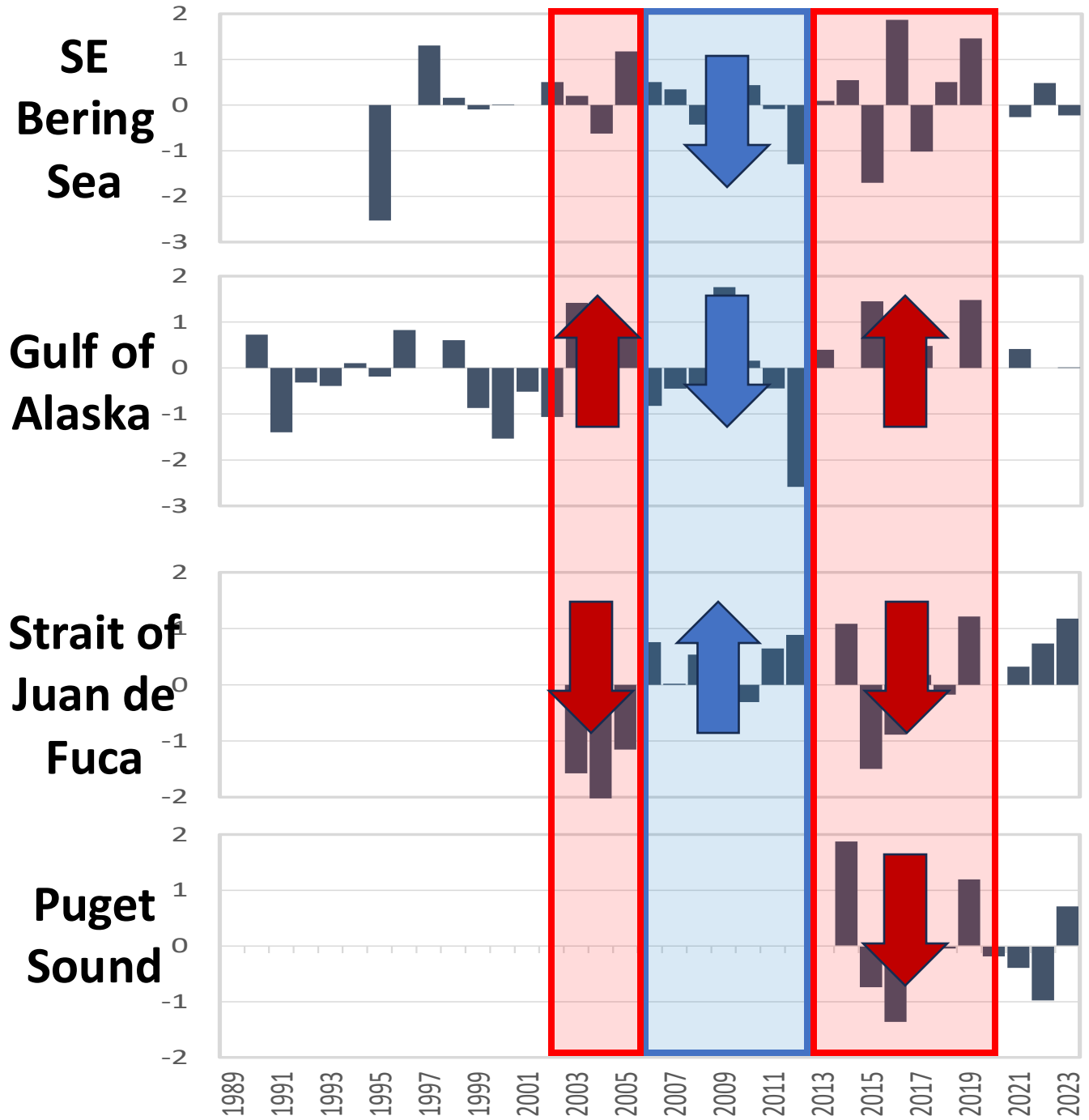


Acartia longiremis

Abundance Anomalies

Small-bodied, low lipids

- **Small bodied Low lipids**
- **Rare in Puget Sound**



Conclusions

Baier and Napp 2003 (SEBS)
Kimmel and Duffy-Anderson 2020 (GoA)
Keister et al. 2020 (SJdF)
Winans et al. 2023 (PS)
Fisher et al. 2020 (NEP synthesis)

- Coherence in temperature patterns across LMEs.
- Differential responses across species, systems, and periods to warm/cold stanzas.
- Temperature alone does not index zooplankton changes well, especially across different systems.
- Comparisons across systems can elucidate mechanisms driving changes.
- Region-specific monitoring is needed to understand ecosystem, and hence fisheries, changes.

Acknowledgments

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Olga Kalata
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