Variability in the copepod community structure, diversity, and biomass in the northeast Pacific (Newport, Oregon, USA) over the last 22 years

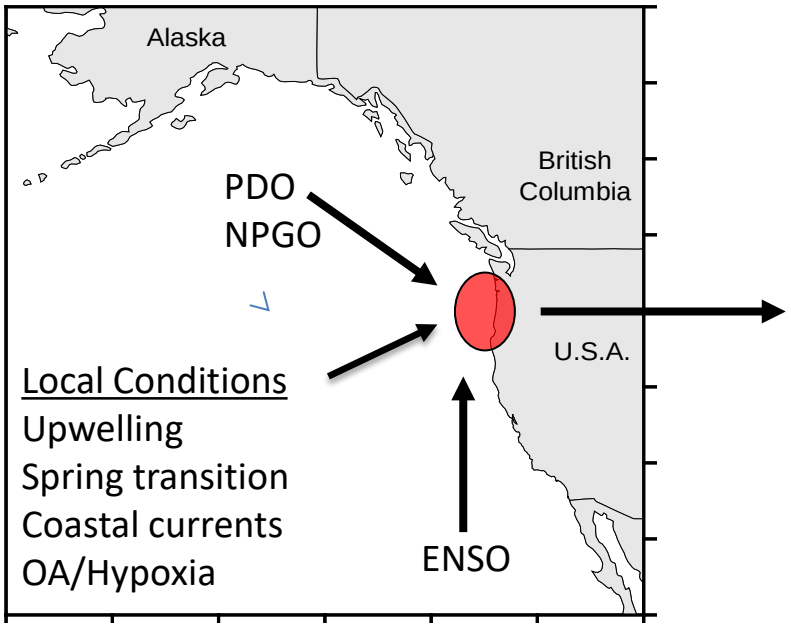
Kym Jacobson[1], Jennifer L. Fisher[2],
William T. Peterson[1]

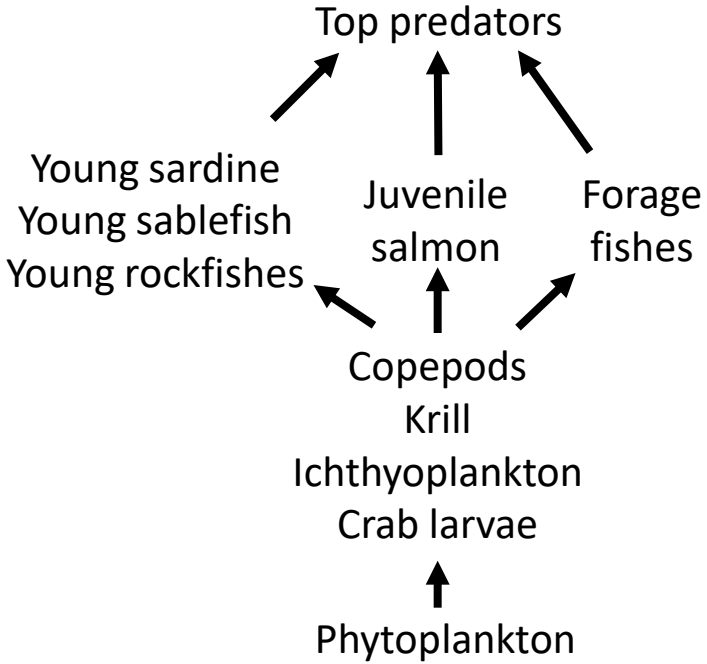
[1]NOAA, Northwest Fisheries Science Center
[2]Cooperative Institute for Marine Resources Studies, Hatfield Marine Science Center, Oregon State University, Newport, OR USA

William T. Peterson, Biological Oceanographer 1942 -2017

Studied zooplankton in the NE Pacific off Oregon with Oregon State University in the 1970's and returned with NOAA, sampling the Newport Hydrographic Line 1996-2017

Large scale and local physical forces influence biological processes important for ocean productivity and food web structure

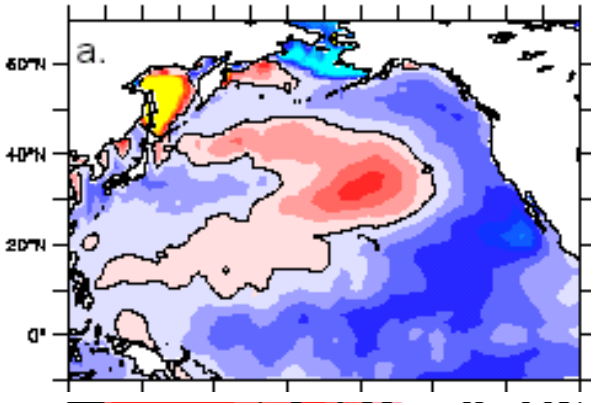




We measure a suite of physical and biological metics to index ocean conditions that relate to different fisheries

Basin scale influences: different phases of the Pacific Decadal Oscillation = different SST patterns

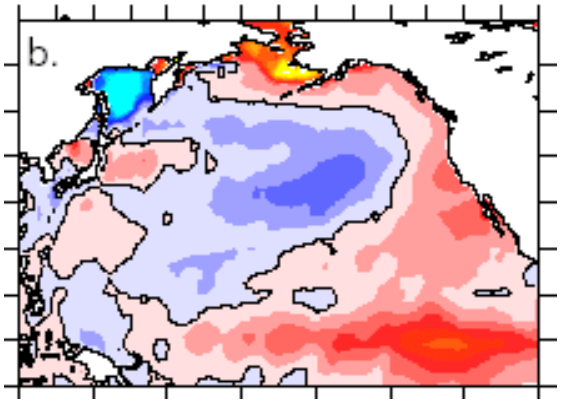
Negative PDO
(cool coastal phase)



Weaker Aleutian Low
Blue is anomalously cold

Increased equatorward transport

Positive PDO
(warm coastal phase)

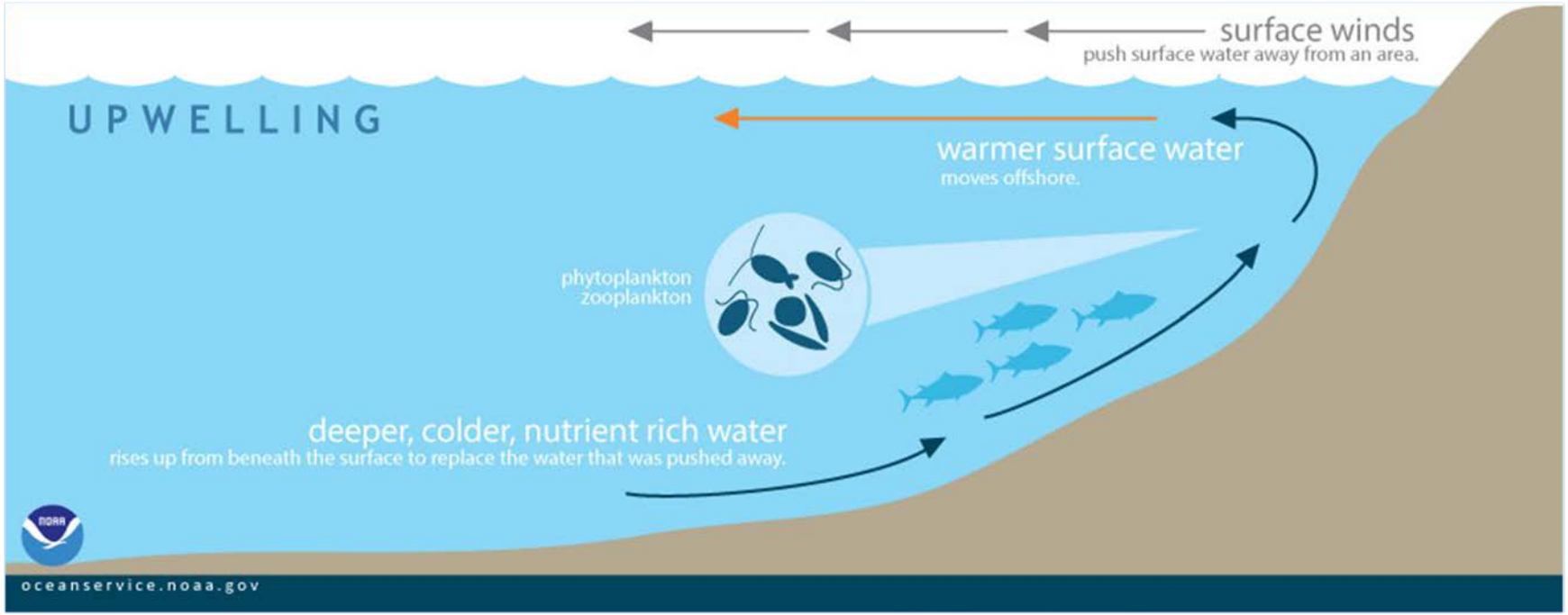


Stronger Aleutian Low
Red is anomalously warm

Increased poleward transport

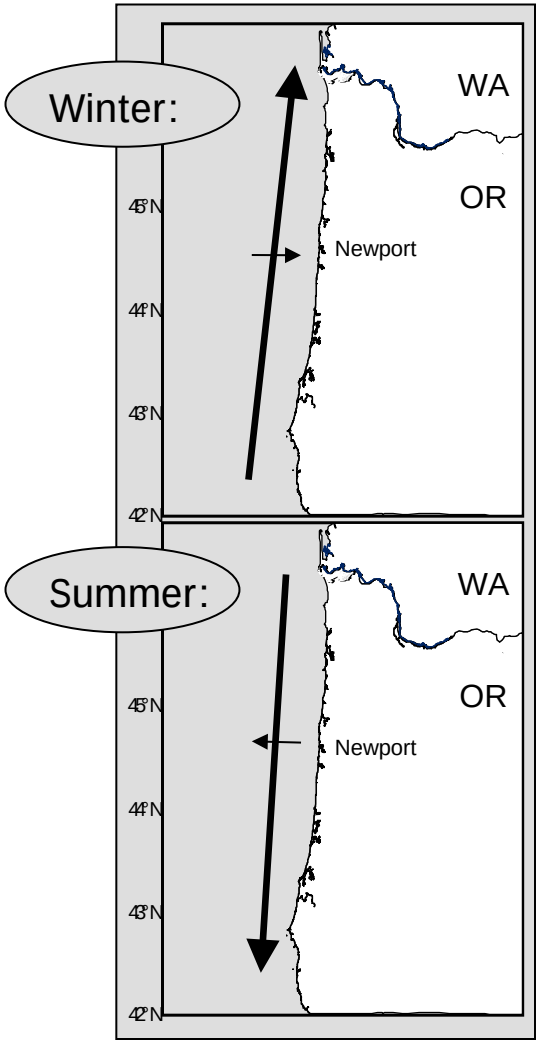
Peterson and Schwing, 2003

Local influences: upwelling drives primary and secondary productivity…

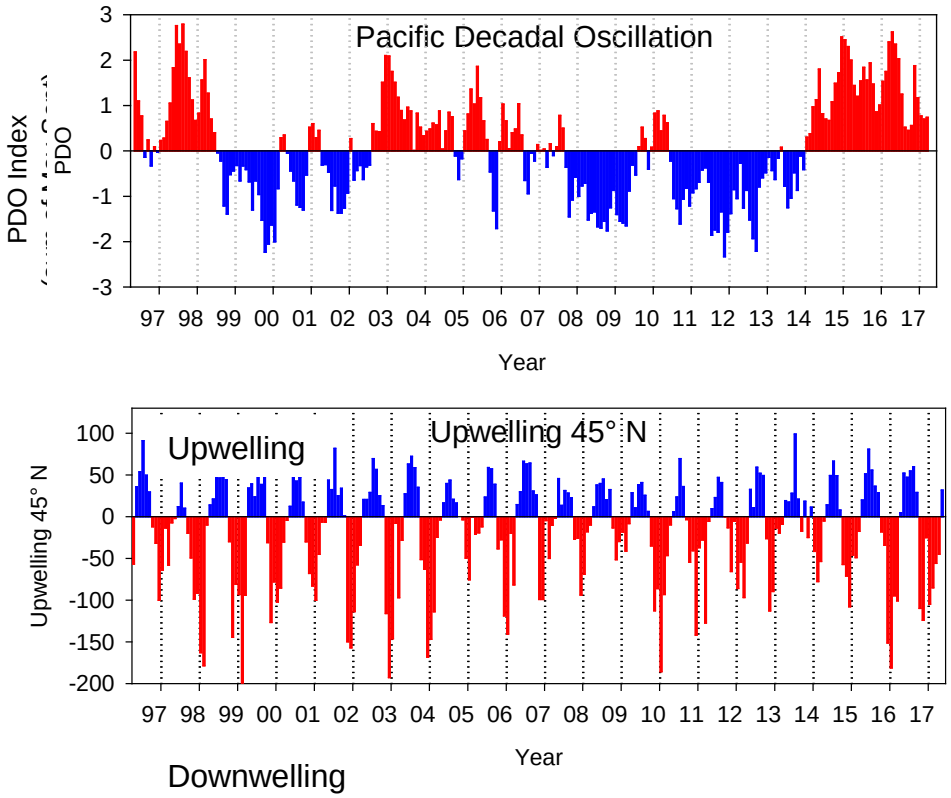


Seasonal cycle of winds and currents influence copepod community structure

- Winter
  - Winds from the South = downwelling
  - Poleward-flowing Davidson Current
  - Southern copepods are transported northward & onshore
- Summer
  - Strong winds from the North = upwelling
  - Equatorward alongshore transport
  - Boreal/northern copepods transported southward



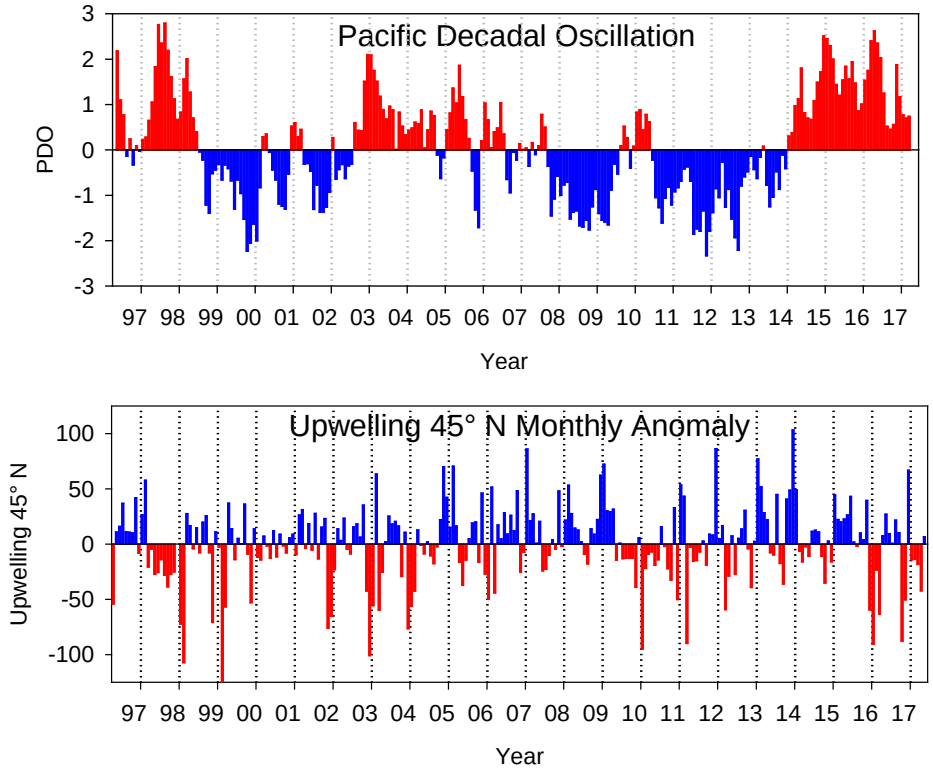
Basin and local forcings: PDO and Upwelling index



- From 1925-1998, PDO shifted every 20-30 years
- Recent periods of persistent sign changes:
  - 1999-2002
  - 2003-2006
  - 2009-10 El Niño
  - 2014-2017 Blob/El Niño

Seasonal structure of coastal upwelling

PDO and Upwelling Index not coupled



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  - 2009-10 El Niño
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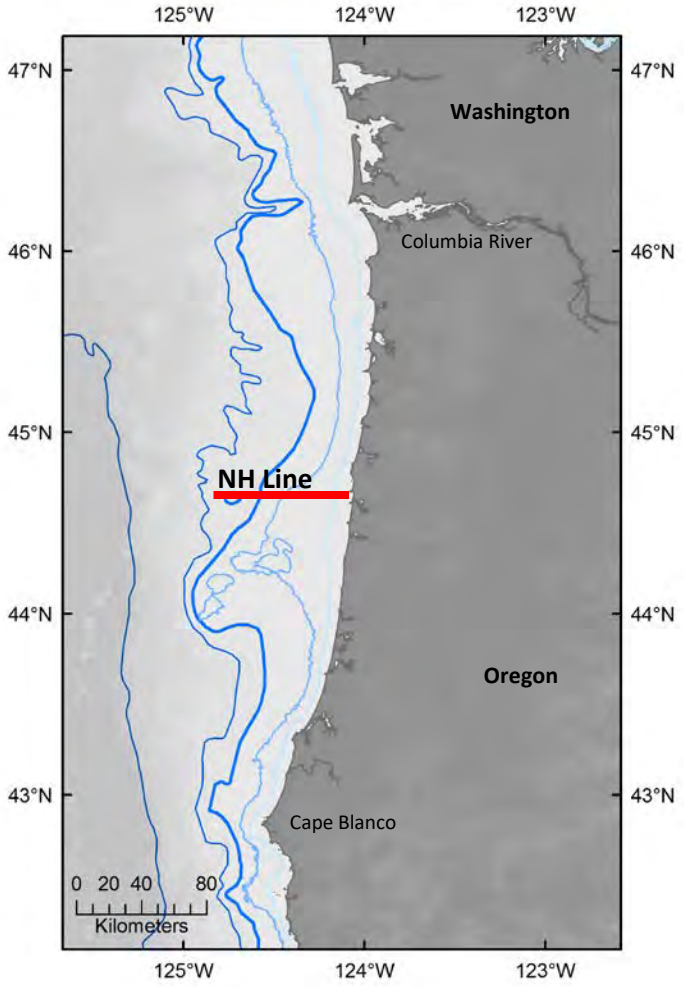
- Monthly anomalies of upwelling index show no coupling to PDO

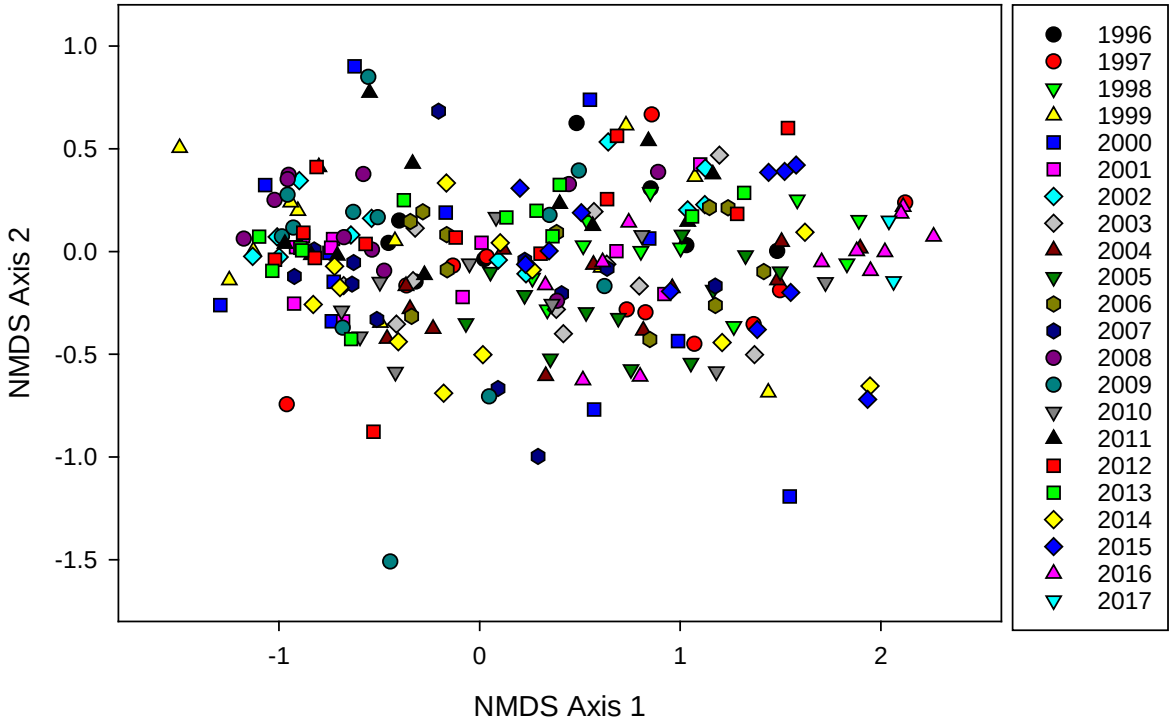


Newport Hydrographic Line:

44.6°N off coast of Oregon

- Sampled biweekly
- 1996 - present
- 7 stations: 1 – 25 nm (46 km)
- CTD, nutrients, chl-*a*
- Phytoplankton, zooplankton, ichthyoplankton
- **NH-5 (9 km), 60 m water depth, sentinel station**

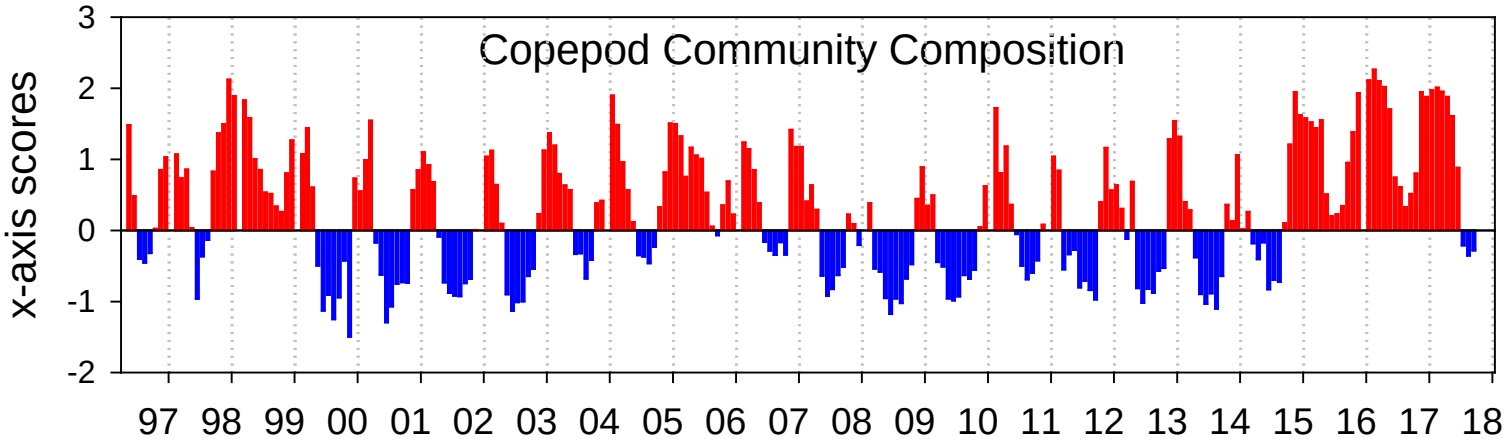
Copepod Community Structure over 22 years
>40 species of copepods



X-axis explains 76% of the variance

Y-axis explains 9% of the variance

X-axis score shows seasonality of the copepod community at NH-5



Warm

Cold

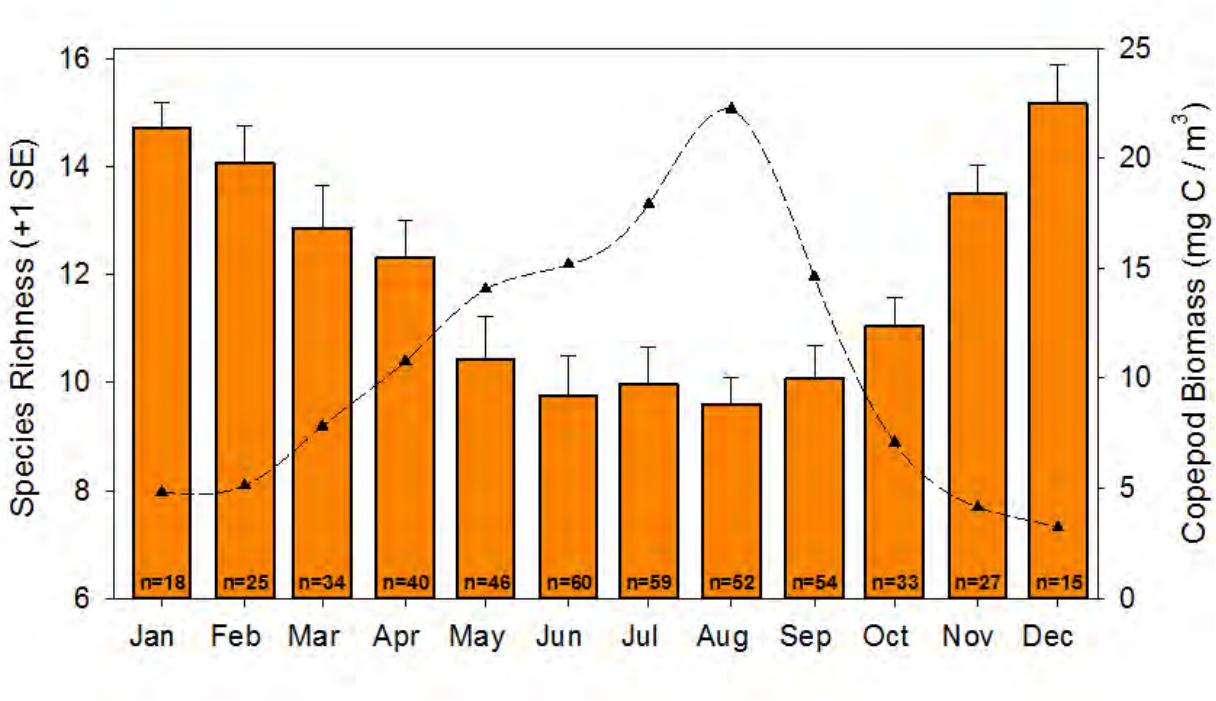
Warm water community; usually in winter

Cold water community; usually in summer

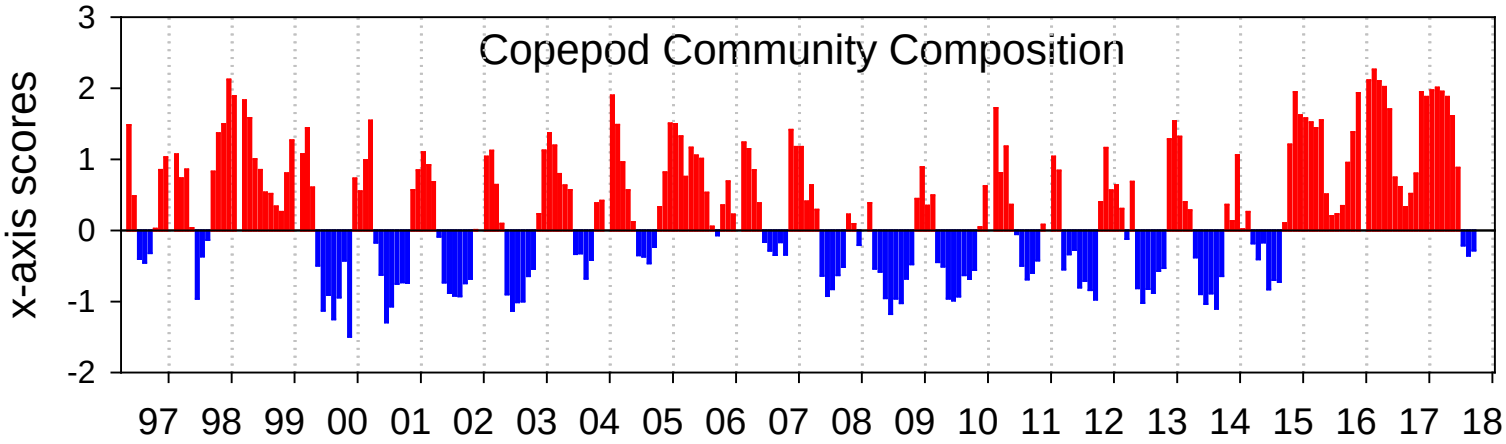
Small lipid poor

Large lipid-rich

Copepod species richness and biomass varies seasonally: larger northern copepods in summer = greater biomass



X-axis score shows seasonality of the copepod community at NH-5



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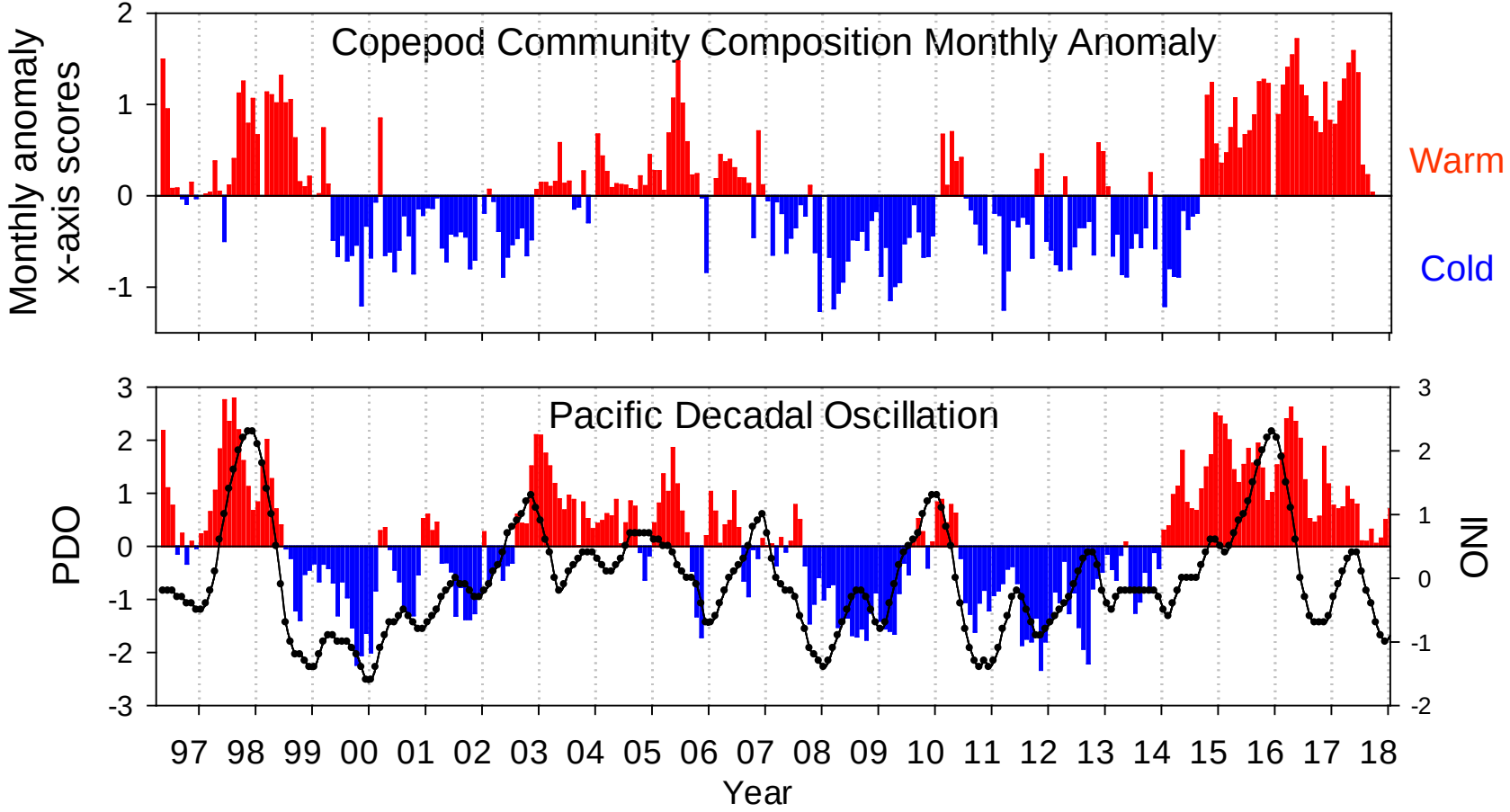
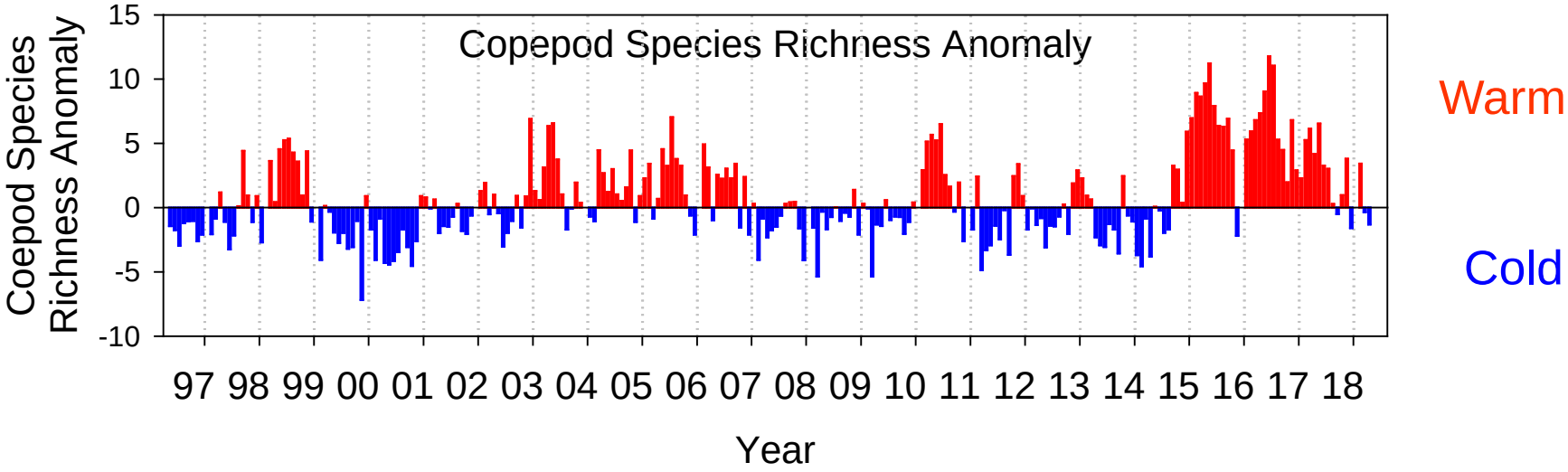
Monthly anomalies of the Copepod Community resemble patterns of the PDO and Oceanic Nino Index

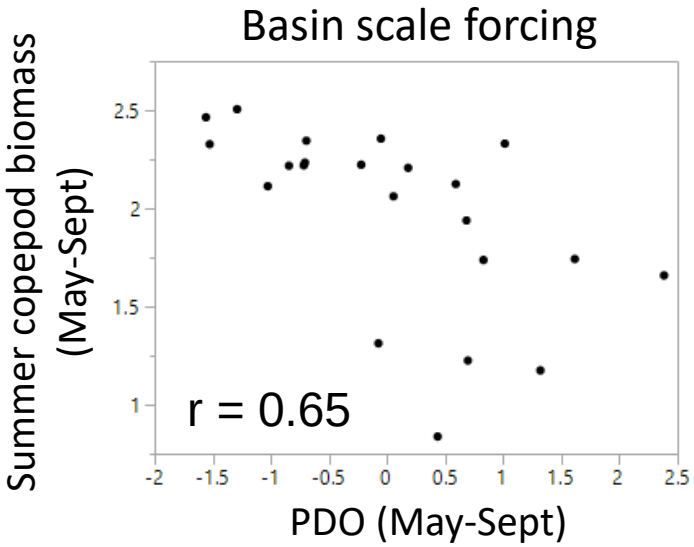


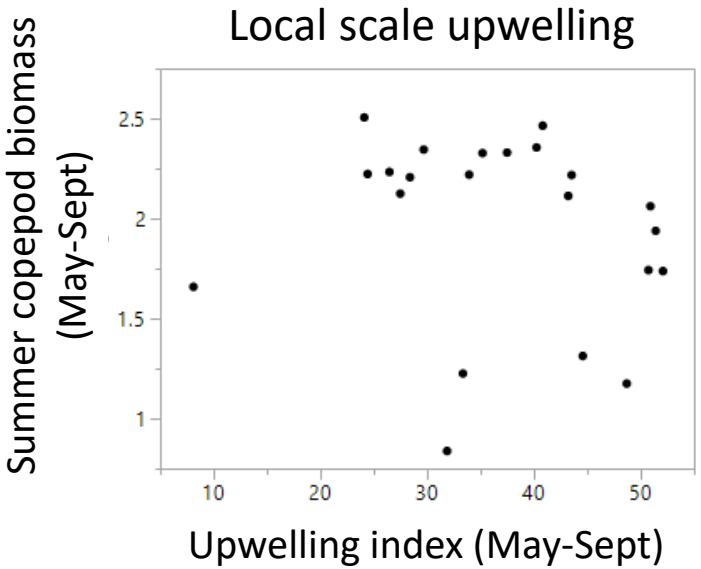
Copepod diversity increases during warm events



Recent warm anomalous event brought greater species richness than seen prior off of Oregon

Summer copepod biomass vs. basin and local-scale forcing

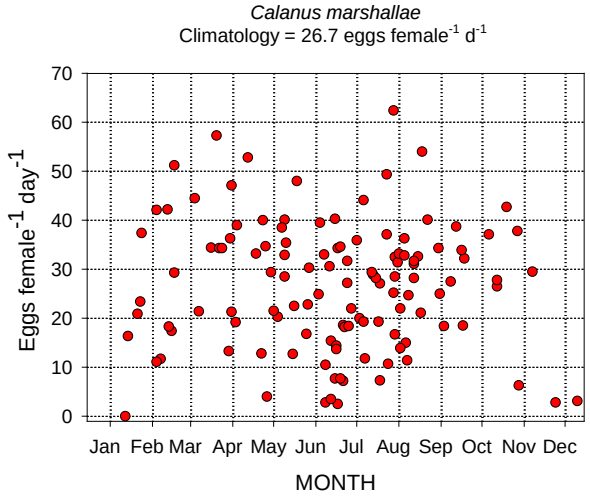




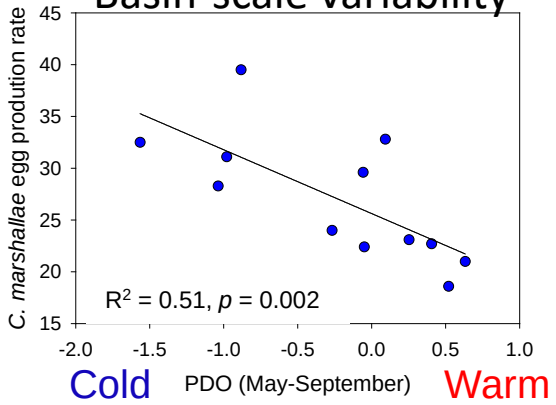
Secondary (egg) production is also NOT driven by upwelling

Seasonality

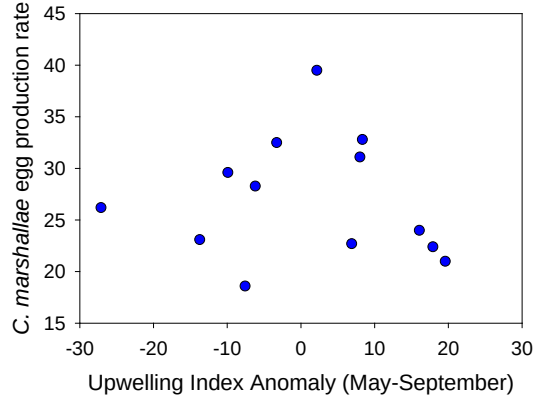
n = 138 incubations 2002 - 2015



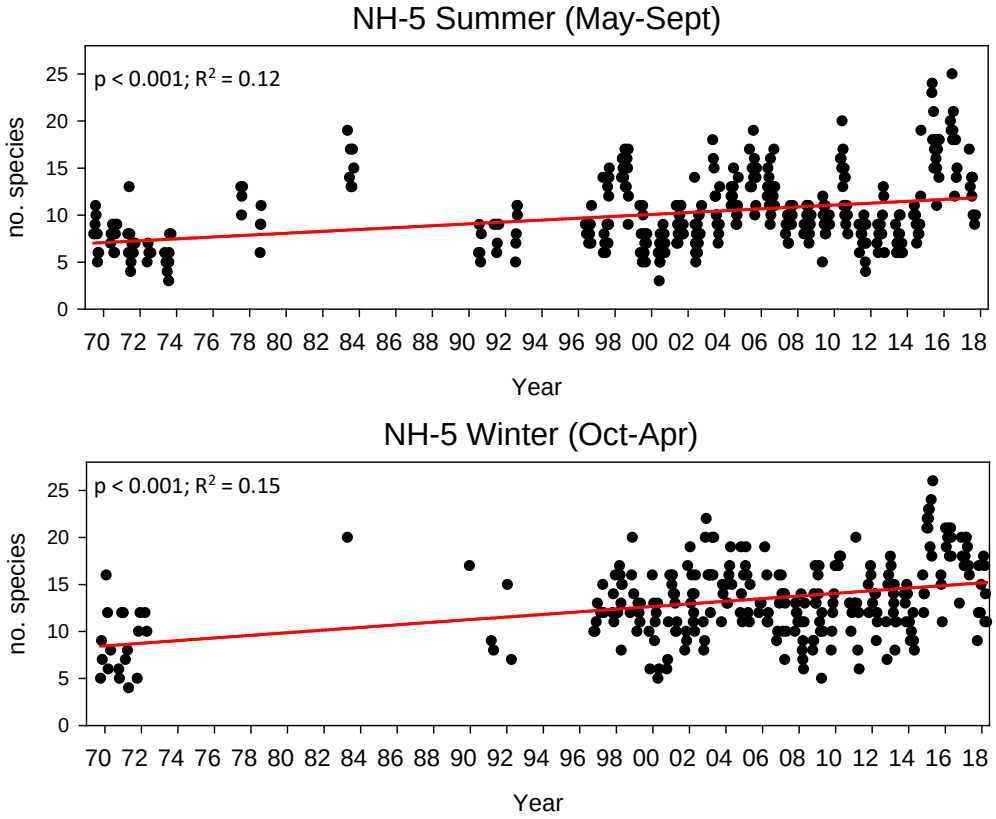
Basin-scale variability



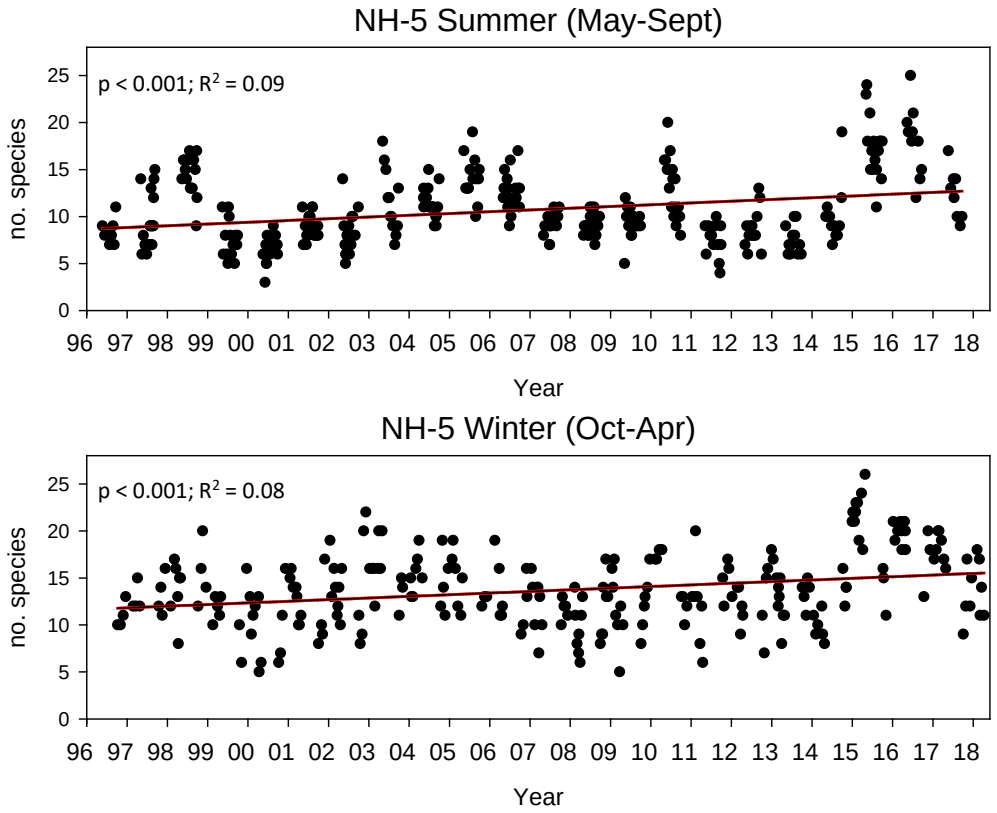
Local-scale upwelling



Is copepod species richness increasing?

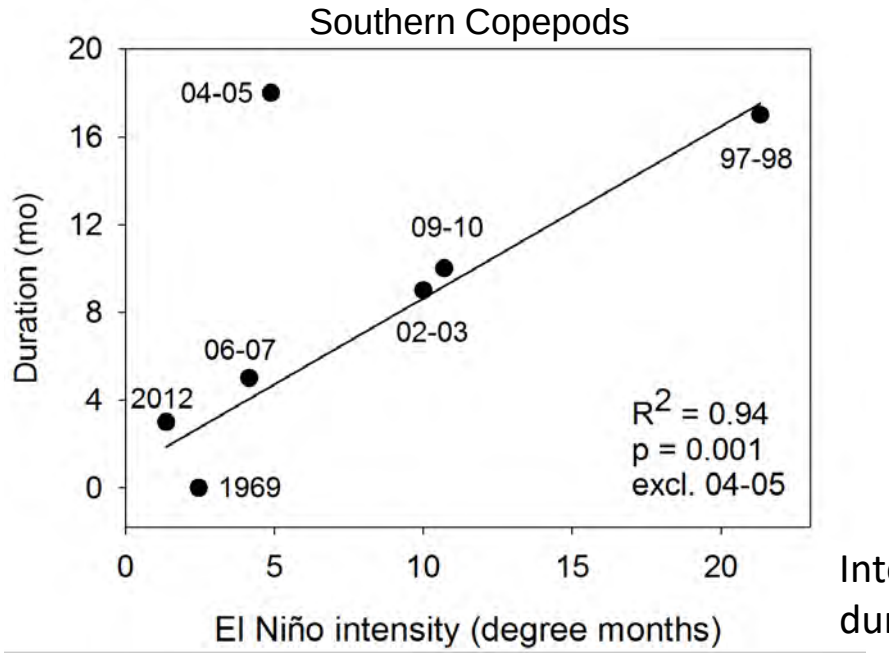


Copepod species richness increasing? (1996 - 2018)



Ecosystem implications of a warm ocean: persistence of warm water copepods

(from 7 past El Niño events)

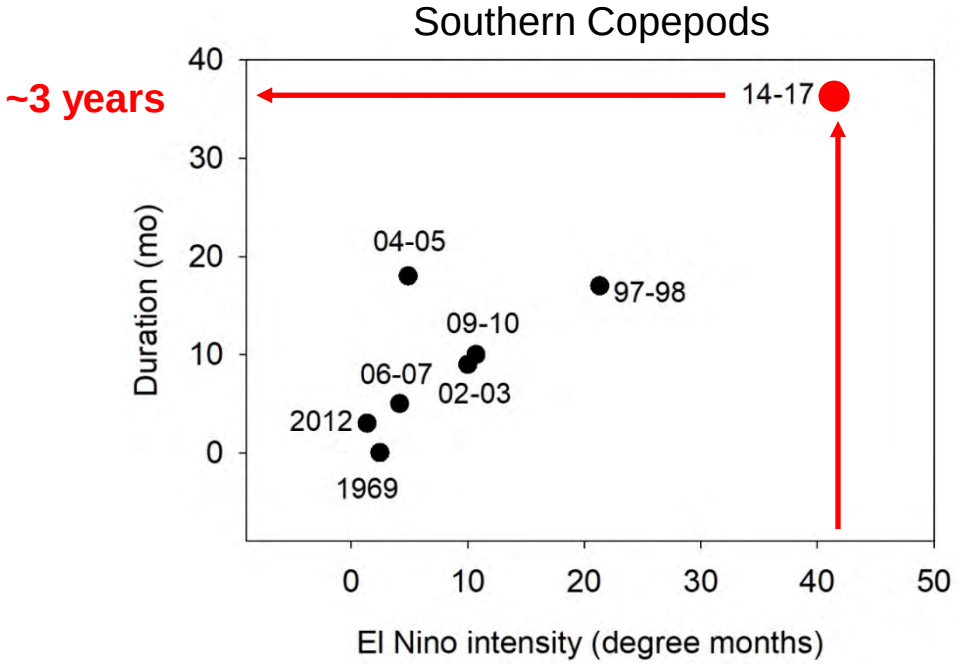


Intensity = average monthly SST during the 'event' times the number of months there was a +0.5°SST

Fisher et al. 2015, Global Change Biology

Ecosystem implications of a warm ocean: persistence of warm water copepods

(from 7 past El Niño events *plus* the anomalous warming of 2014-17)



Summary and Future Questions

- The highest frequency signal in the copepod community is the seasonal cycle
- Inter-annual fluctuations in the biomass and diversity of copepod communities relate to basin scale forcing
- Species richness may be increasing?
- The last anomalously warm ocean conditions resulted in 3 years of lipid poor copepod communities
- Short and long-term is uncertain. Currently a mix of southern and northern species
- Need a mechanistic understanding of how basin scale processes affect local scale drivers (e.g., transport, upwelling)
  - Advertising for a postdoc to explore linkages between basin-scale drivers, local coastal upwelling, and zooplankton communities

Acknowledgements

- Past and present Peterson Lab-Newport Line scientists

THANK YOU!

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- FATE
- Bonneville Power Administration
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