# Controls on zooplankton composition in the Strait of Juan de Fuca, USA

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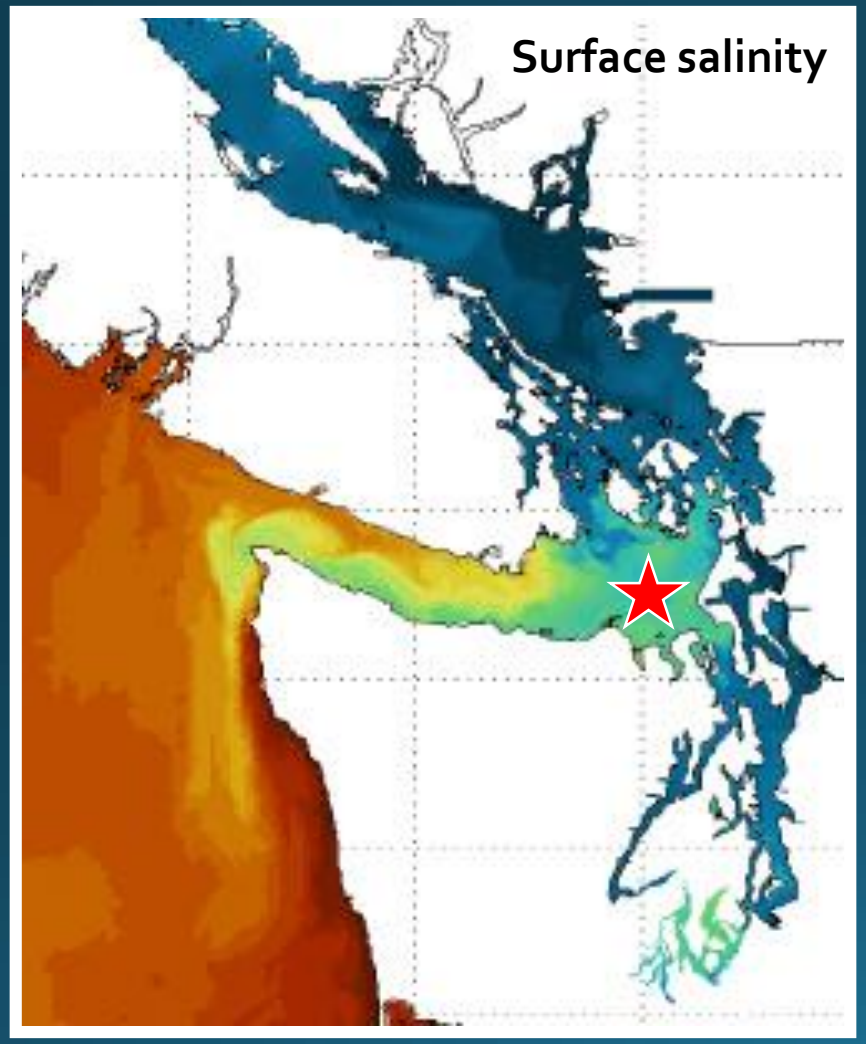
# The Salish Sea




*MacCready: MOSSEA Model*

# JEMS time series site

- 2003-present, monthly (with many gaps)
- 140 m water depth
- CTD casts (T, S, D, DO)
- Bottle chlorophyll, nutrients, oxygen
- Zooplankton net tows
  - 75-cm diameter closing net
  - 150-µm mesh
  - Surface (0-40 m and 80-120 m) vertical net tows
  - *No flow meter until 2014

DEPARTMENT OF ECOLOGY
State of Washington

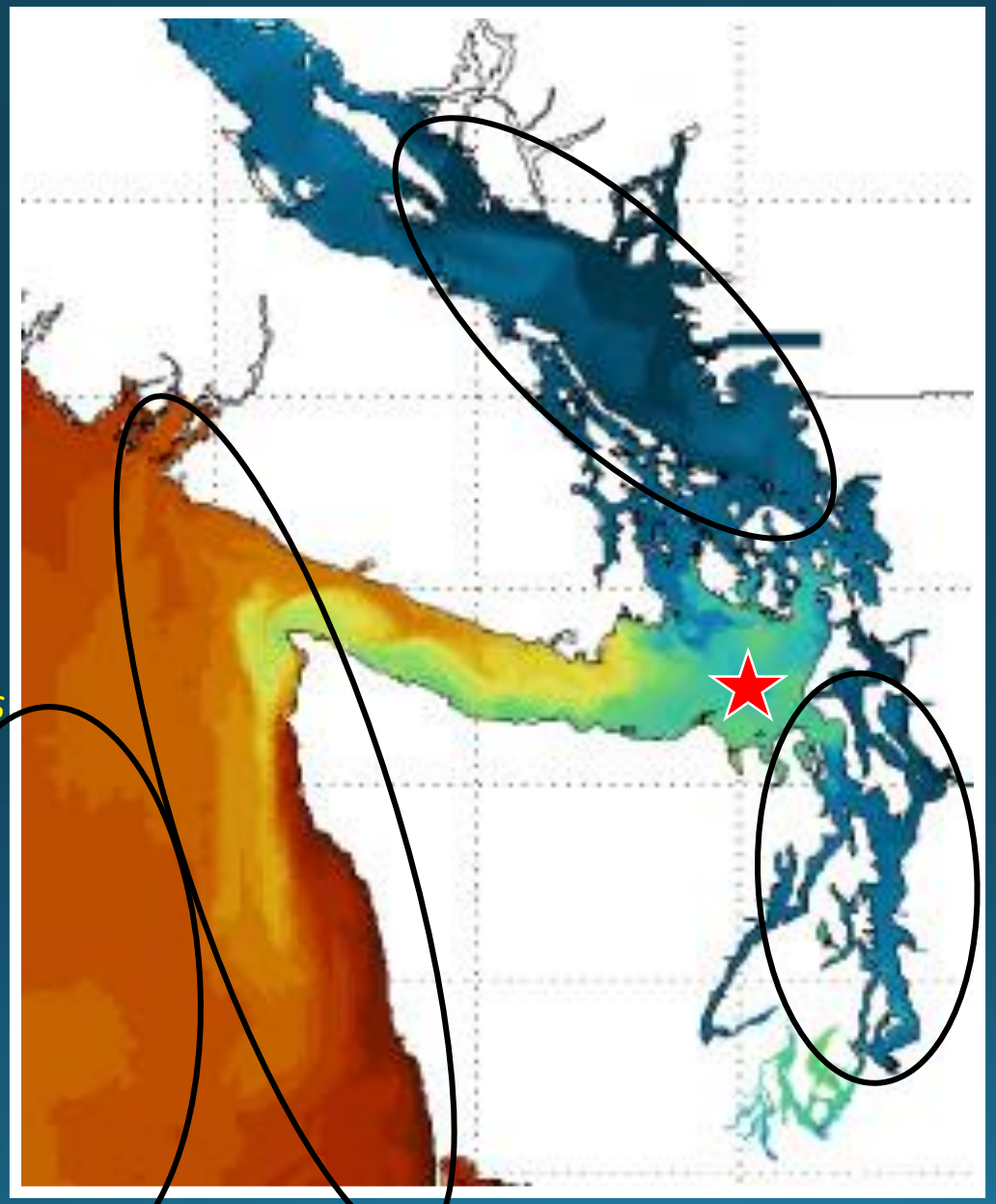
# Indicator species

**Cold-water, upwelling-associated species assemblage**

*Calanus marshallae*
*Acartia longiremis*
*Pseudocalanus mimus*

**Offshore, warm-water oceanic species assemblage**

*Clausocalanus spp.*
*Ctenocalanus vanus*
*Mesocalanus tenuicornis*



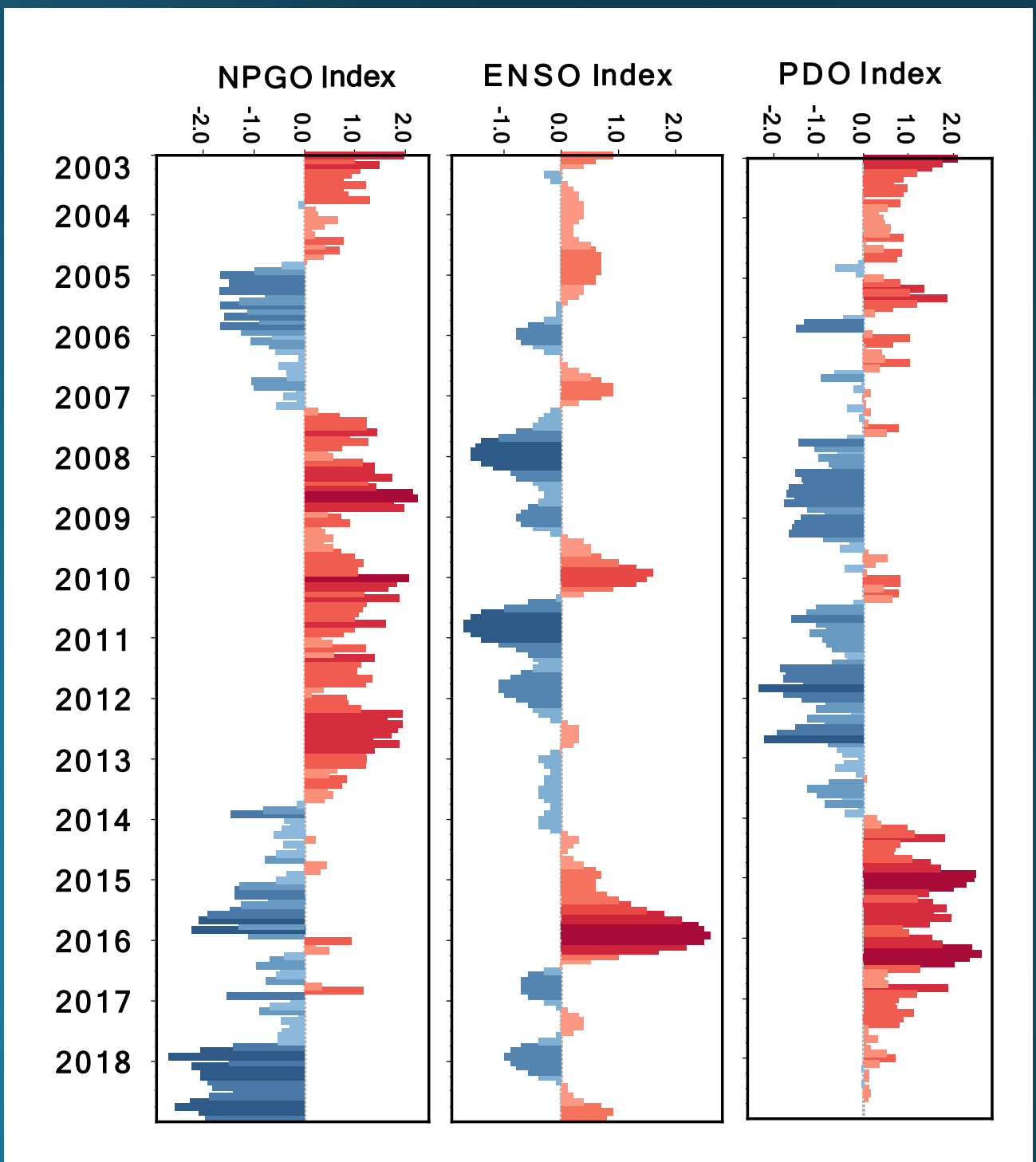
MacCready: MOSSEA Model

**Strait of Georgia species assemblage**

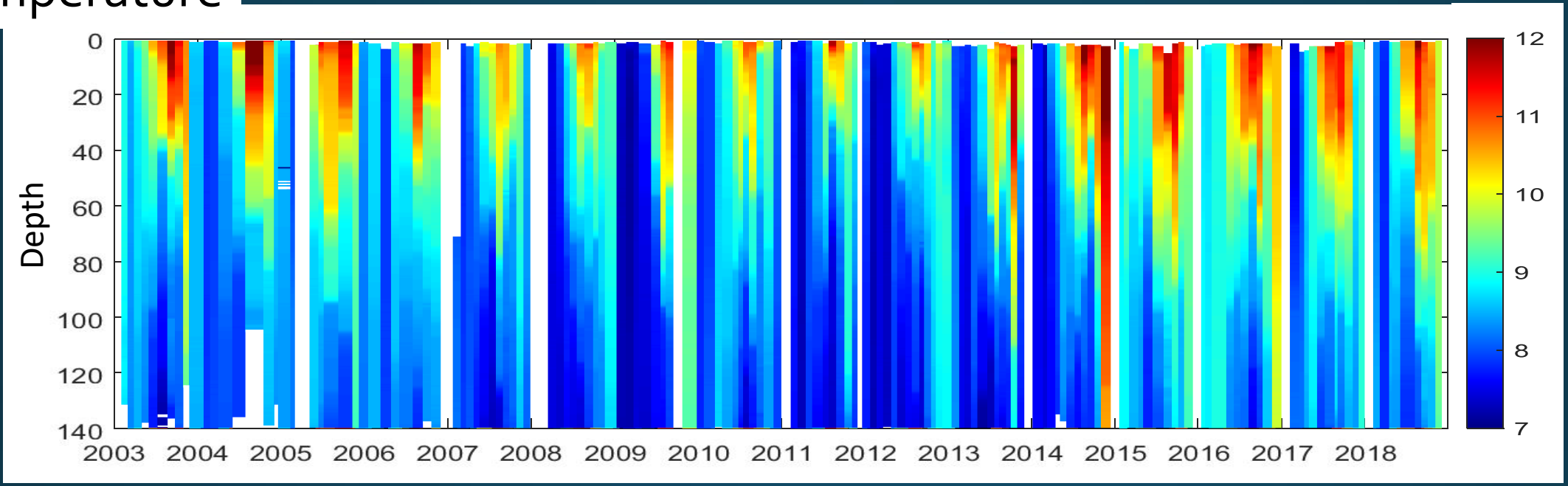
*Pseudocalanus minutus*

**Puget Sound species assemblage**

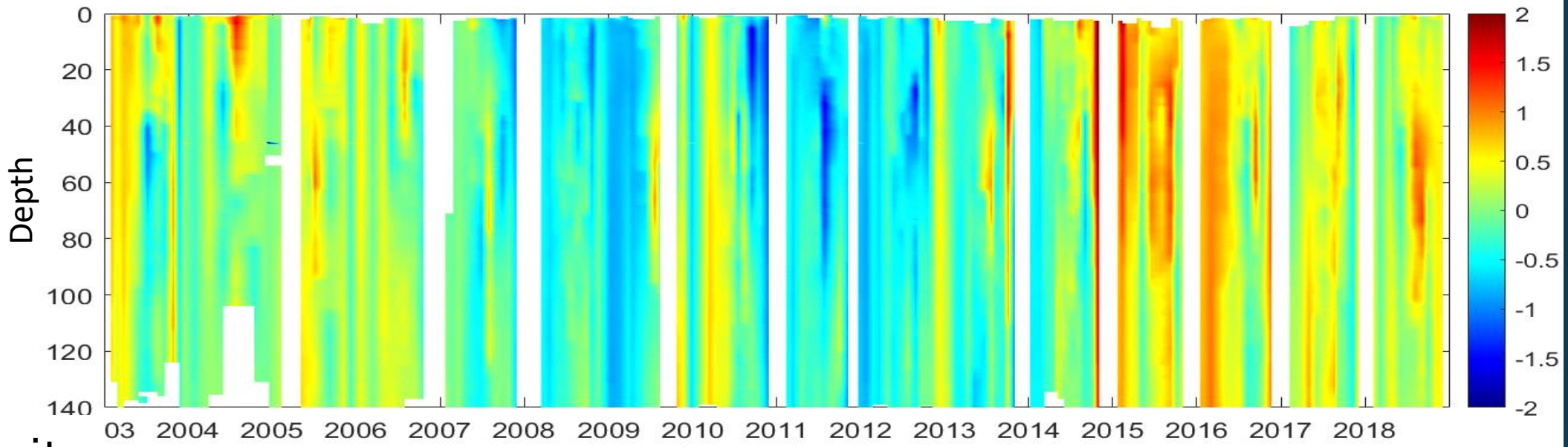
*Ditrichocorycaeus anglicus*


NPGO Index
ENSO Index
PDO Index
-2.0
-1.0
0.0
1.0
2.0
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018

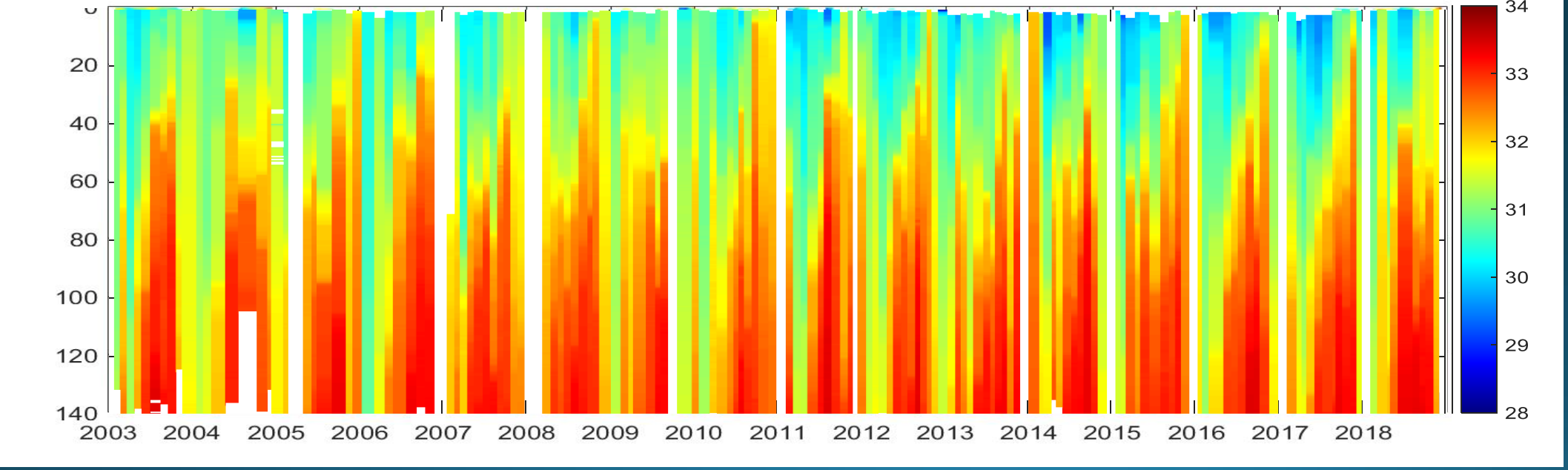
# Temperature

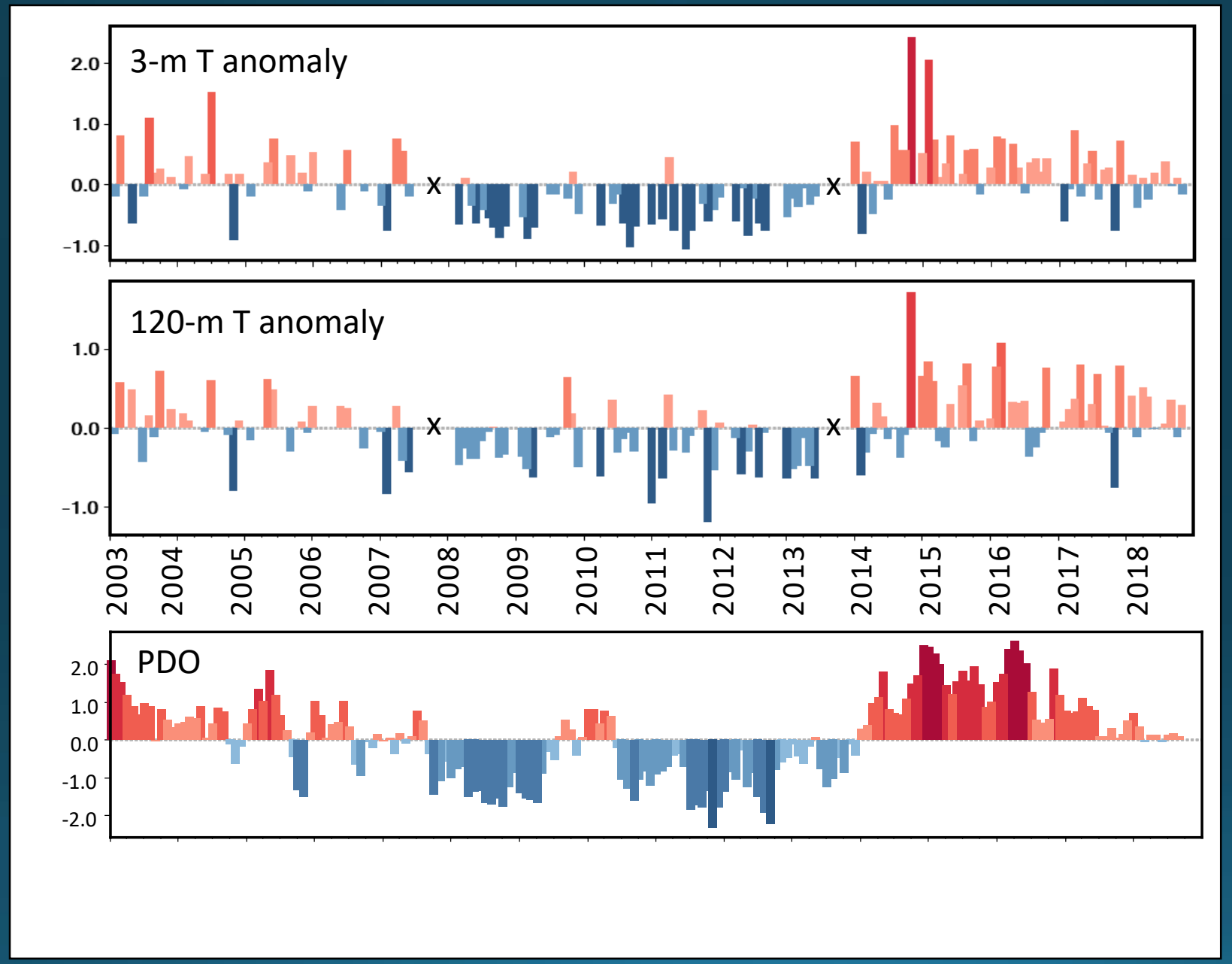


# Temperature



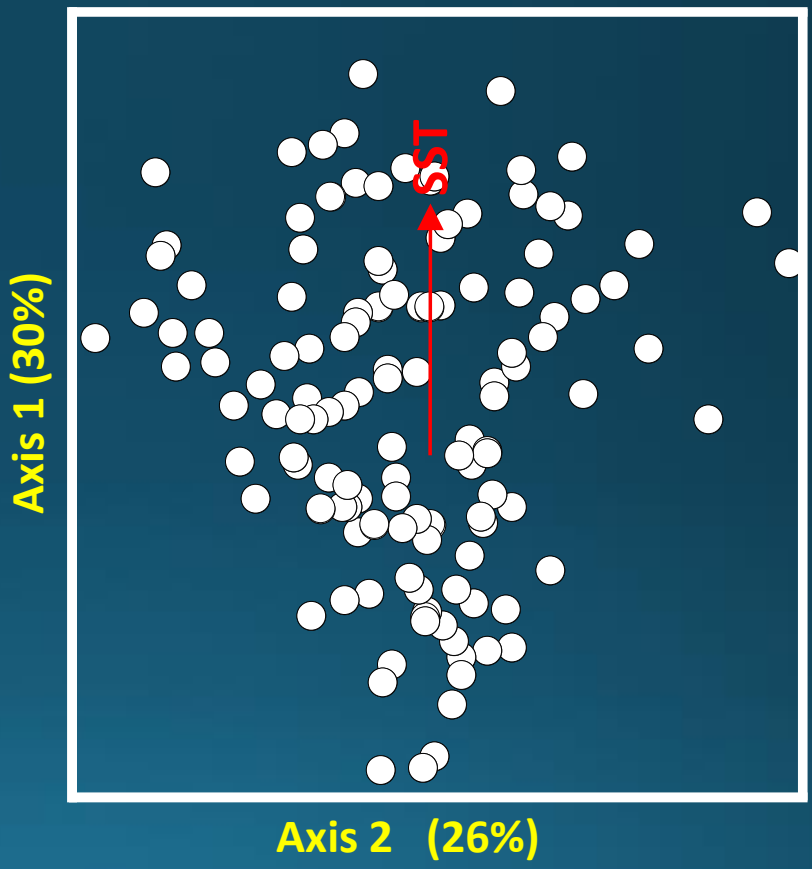

# Salinity



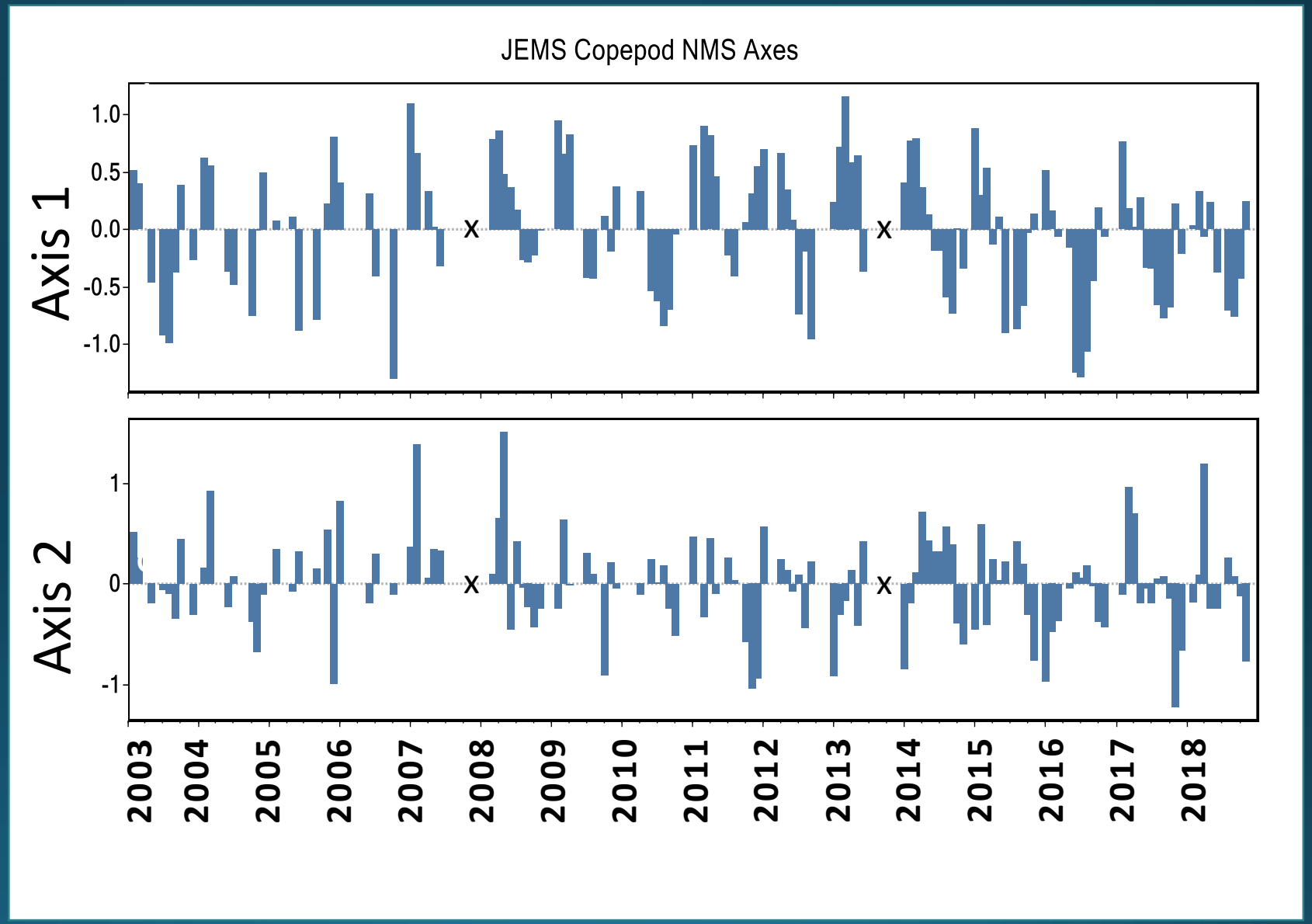

3-m T anomaly
2.0
1.0
0.0
-1.0
x
x
120-m T anomaly
1.0
0.0
-1.0
x
x
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
PDO
2.0
1.0
0.0
-1.0
-2.0

# **Zooplankton data Analysis:** Non-Metric Multidimensional Scaling (NMS) Ordination of copepod species composition

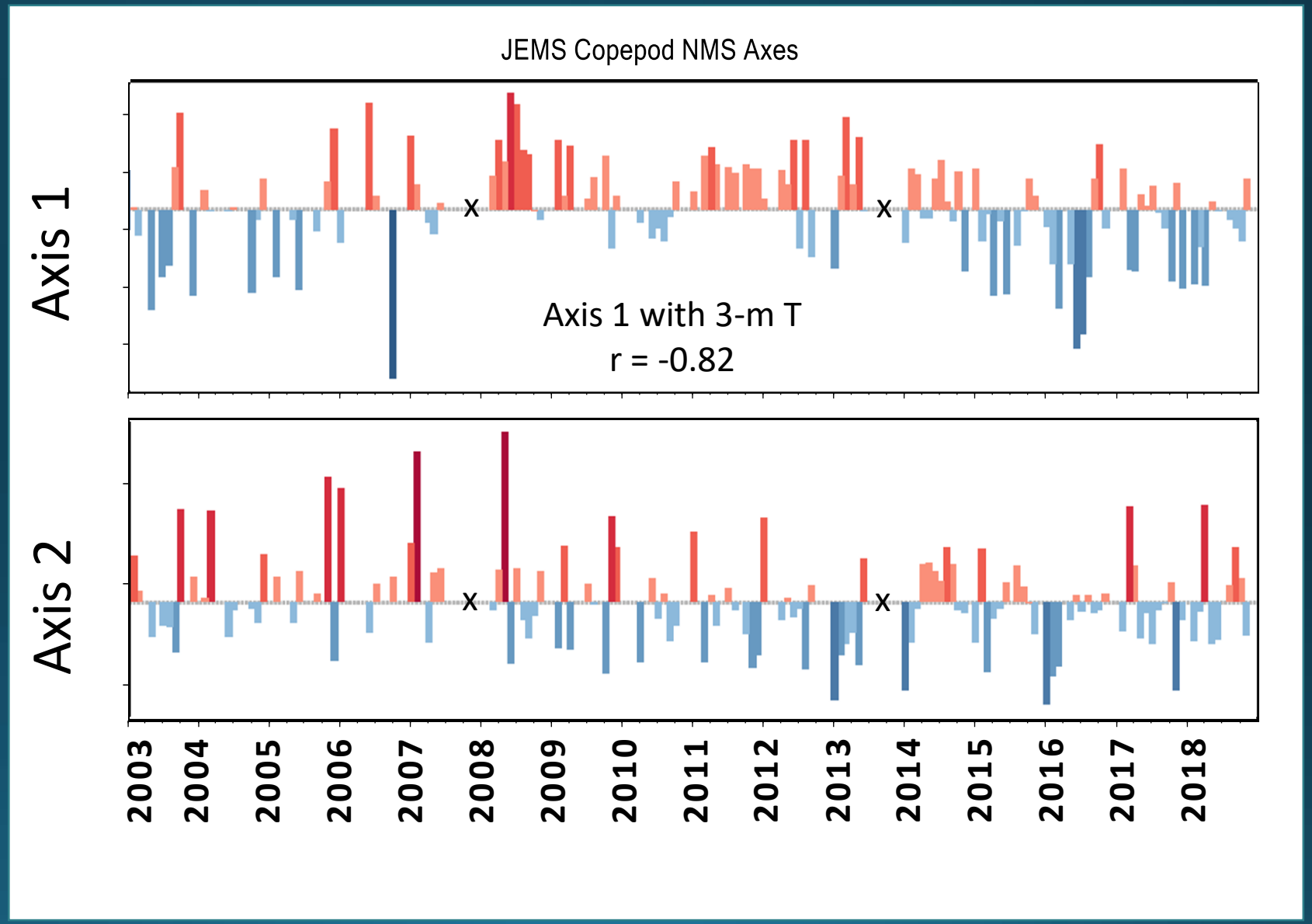
- **Copepod species abundances**
- **Relativized to species proportion in each sample**
- **Axis 1 rotated to SST**

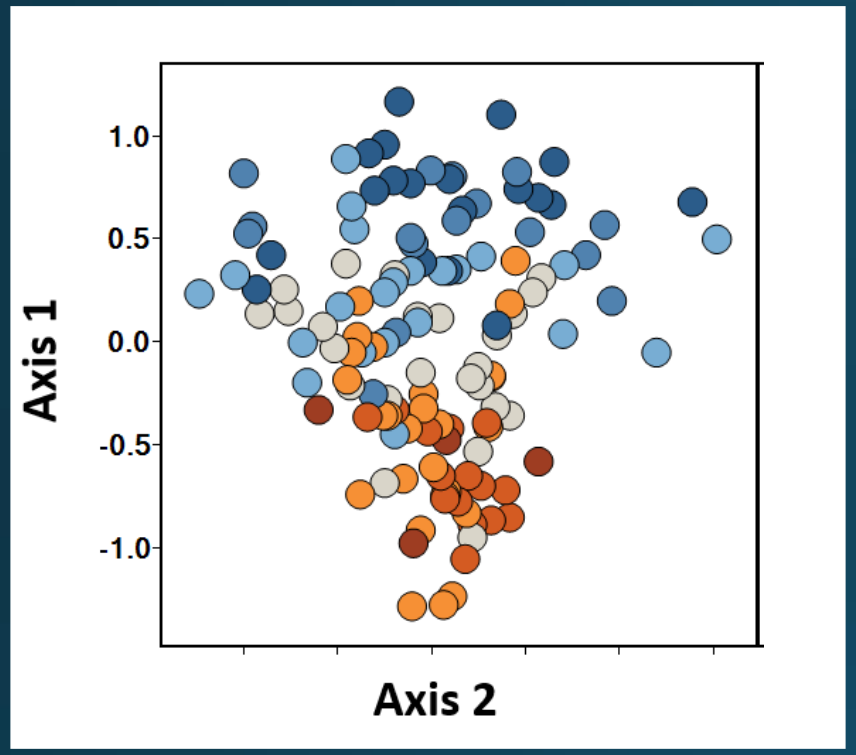


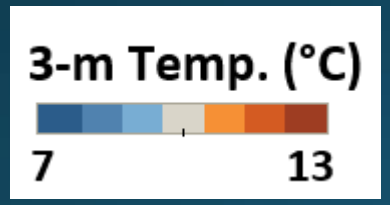
Axes time series:

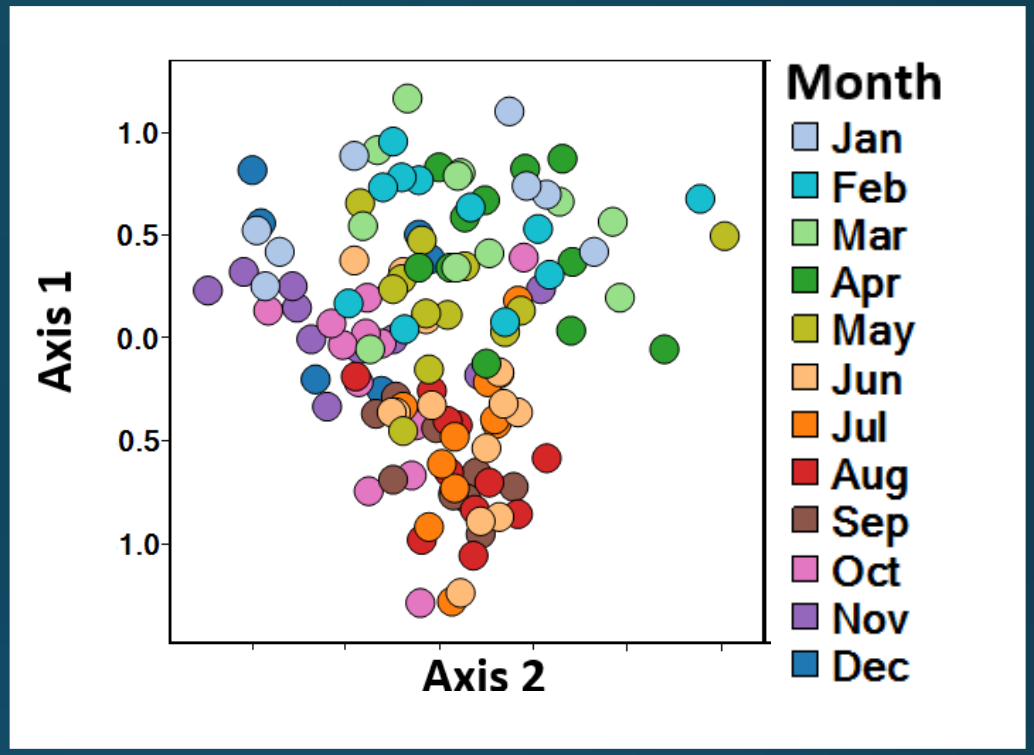


Anomalies,
Seasonal cycles
removed





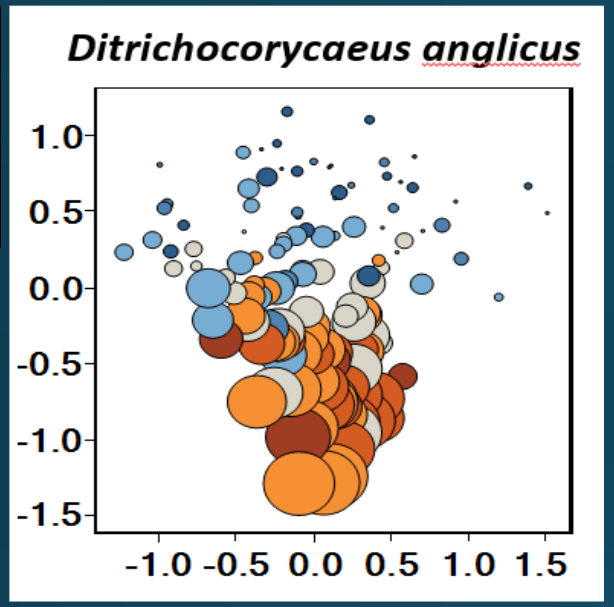

- Strong seasonal cycle
- Interannual anomalies

What species are primary drivers of community changes?

What controls their temporal variability?

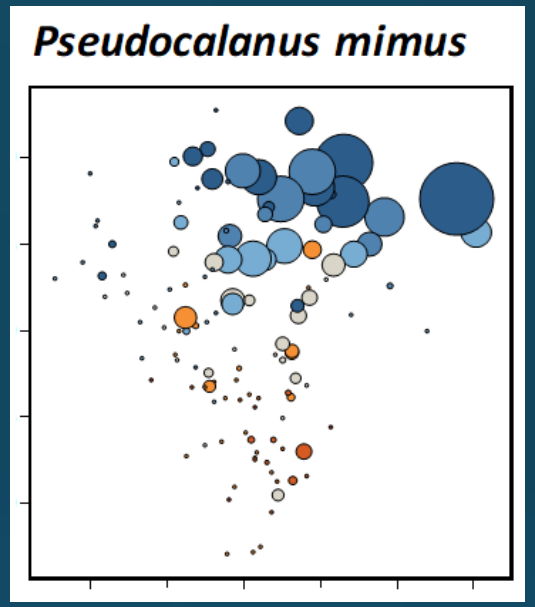
# Strongest species correlations with Axis 1:

Puget Sound indicator



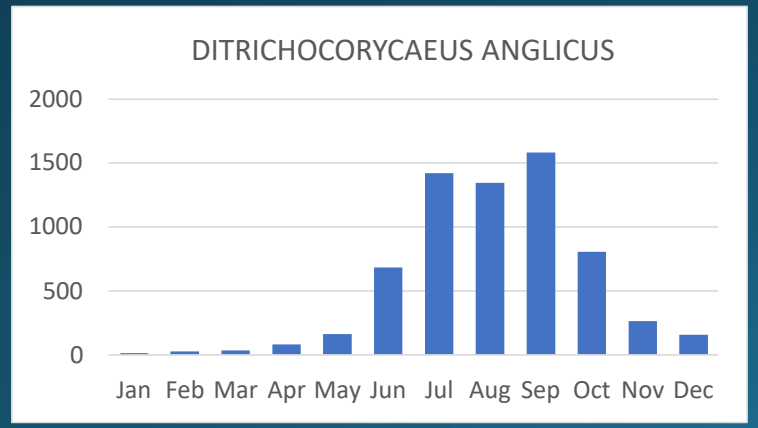

r = -0.93

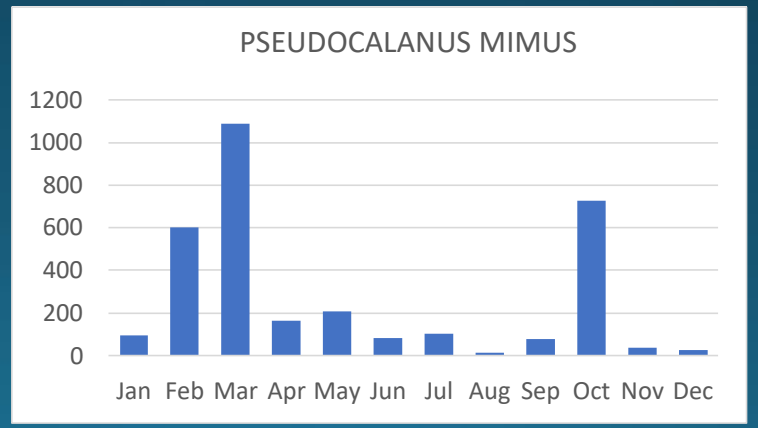
Upwelling indicator




r = 0.51

Average seasonal cycles (#/m$^3$):



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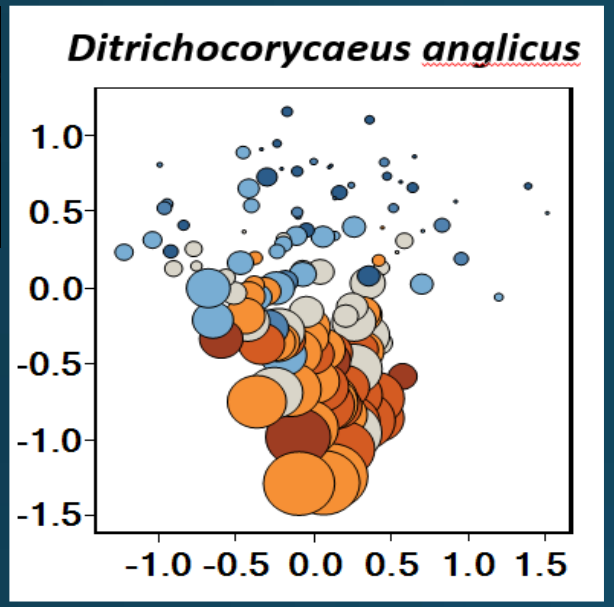
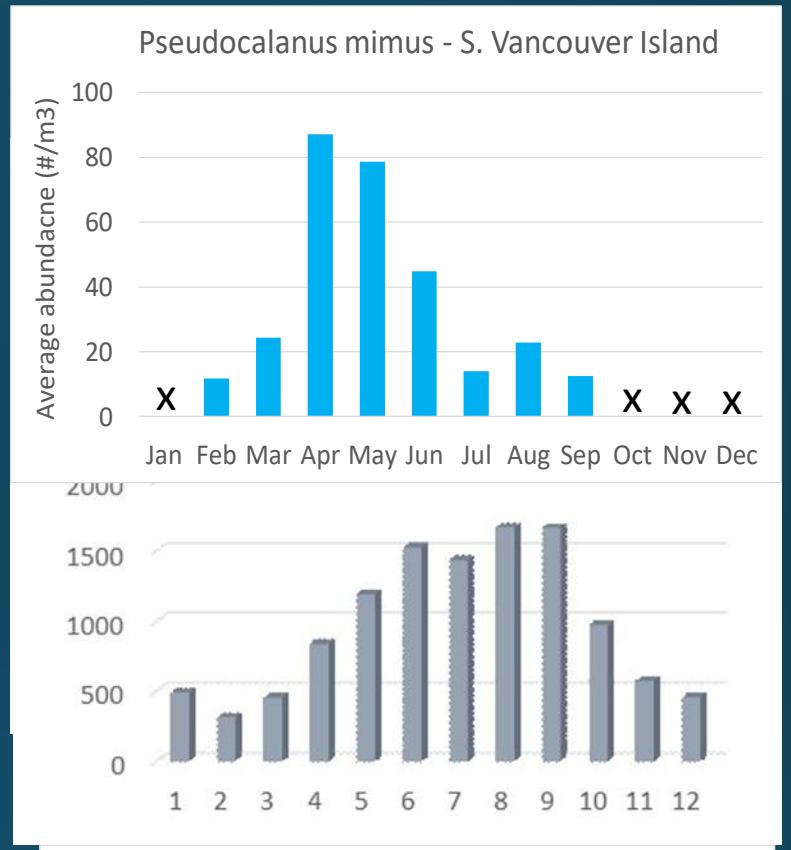
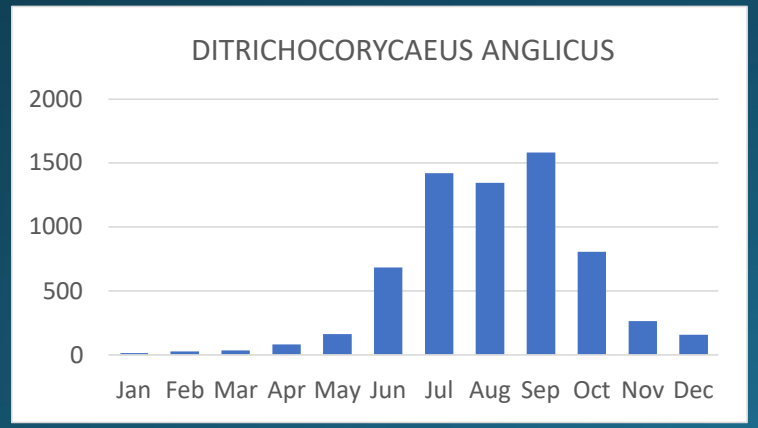
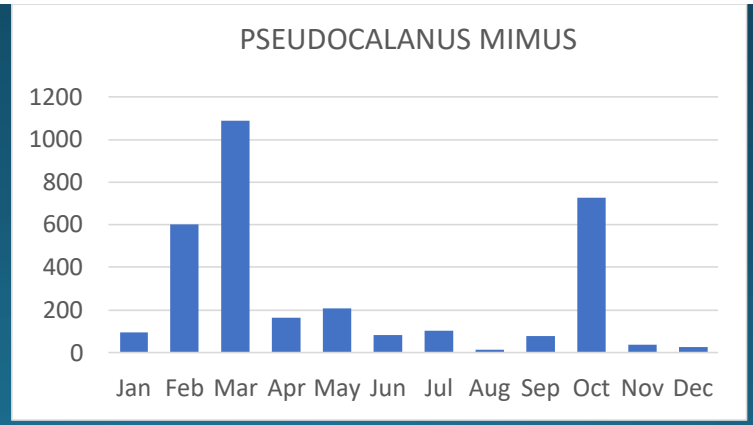



r = -0.93




Average seasonal cycles (#/m³):



# LiveOcean ROMS model – P. MacCready and the UW Coastal Modeling Group

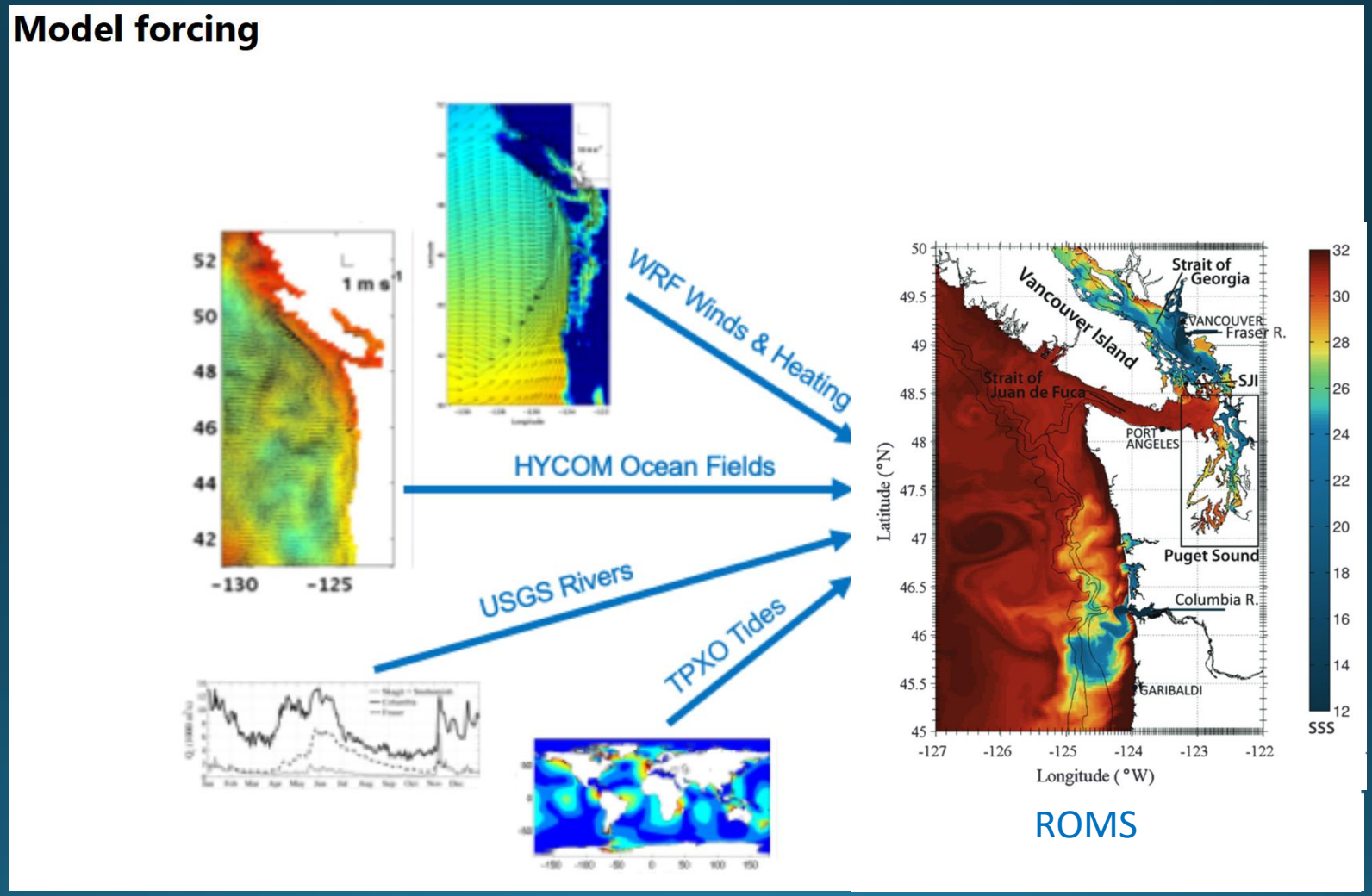
"Cascadia 1" - 2013-2018 hindcasts

1500 m (in Salish Sea) to 4500 m (ocean) horizontal resolution

40 vertical terrain-following layers

Nested in HYCOM

Tides, rivers, winds, heating



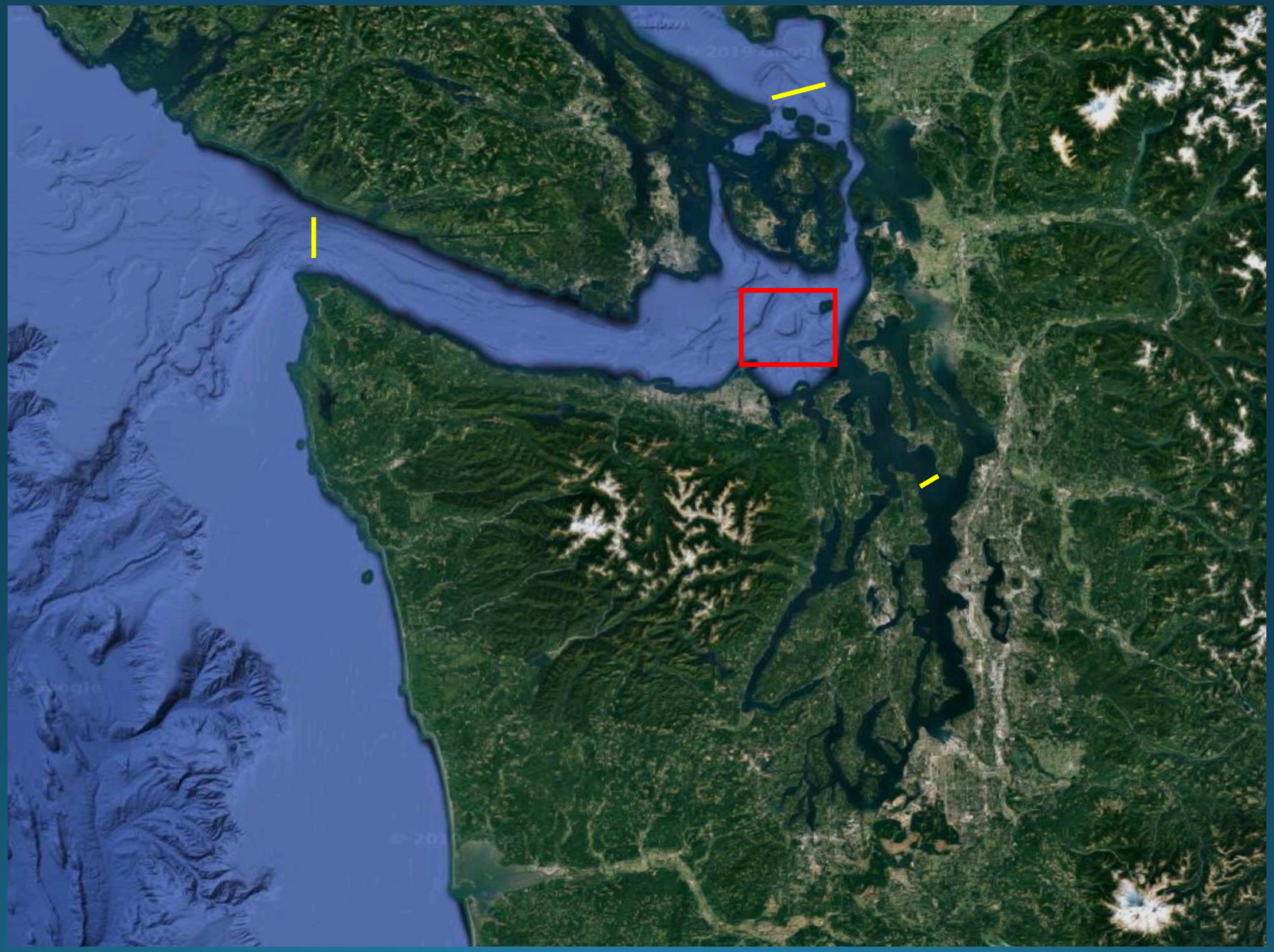
Particle releases from 3 boundaries

Tested 3 approx. depth ranges (surface-trapped, mid, deep)

Released monthly, advected 30 days

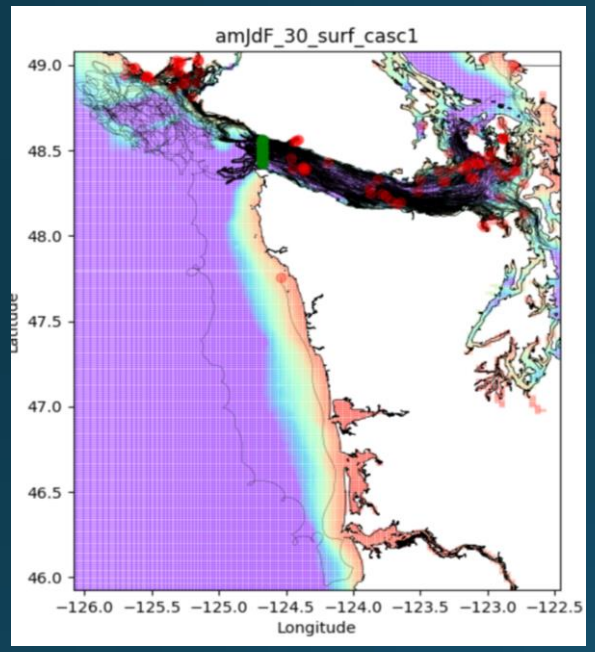
Neutrally buoyant – tracked in 3D

Data = proportion of particles that entered domain from each release

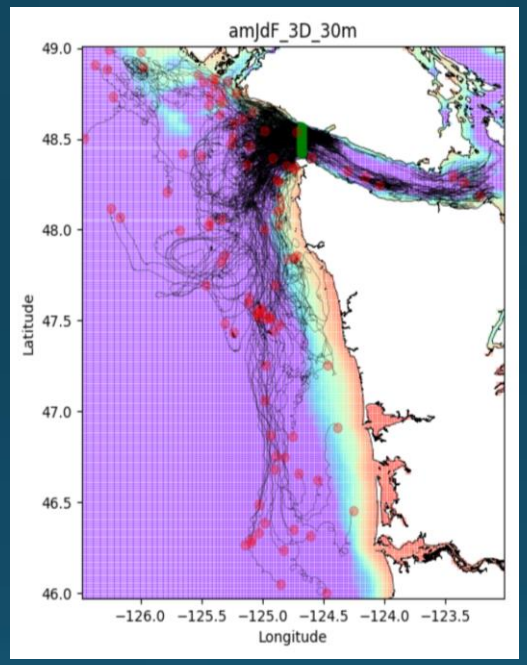


# Example particle trajectories: Feb 2013 – Strait of Juan de Fuca releases

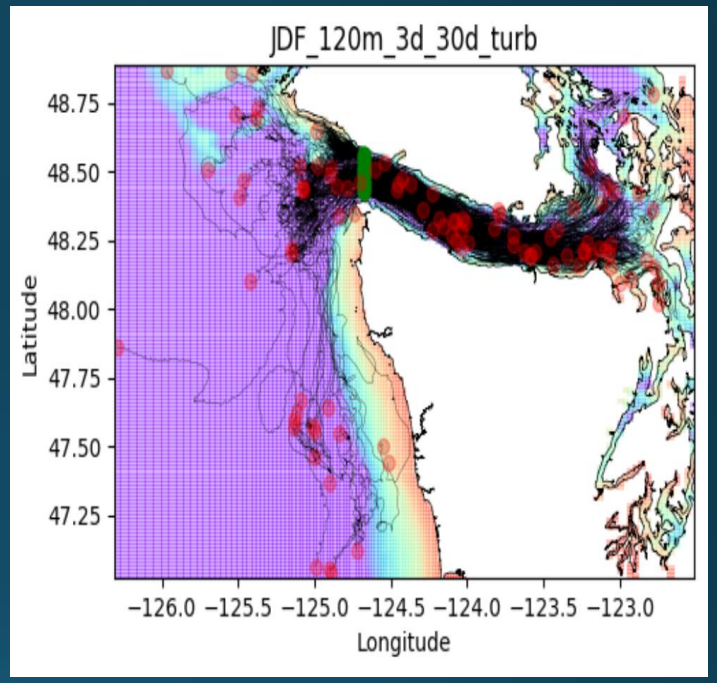
**Surface trapped**

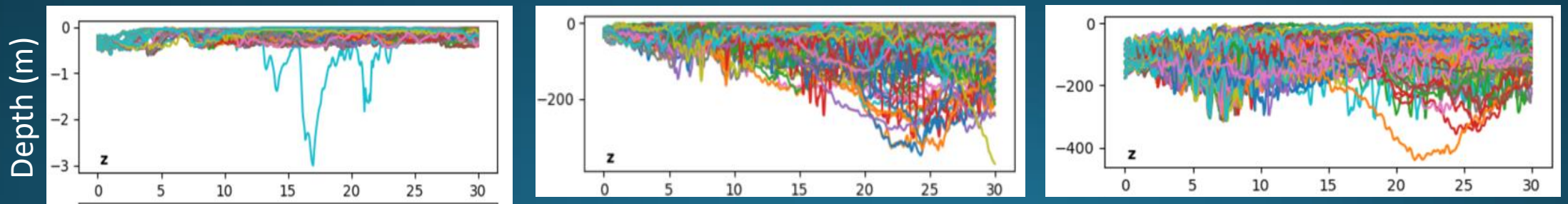



**~30-50 m**

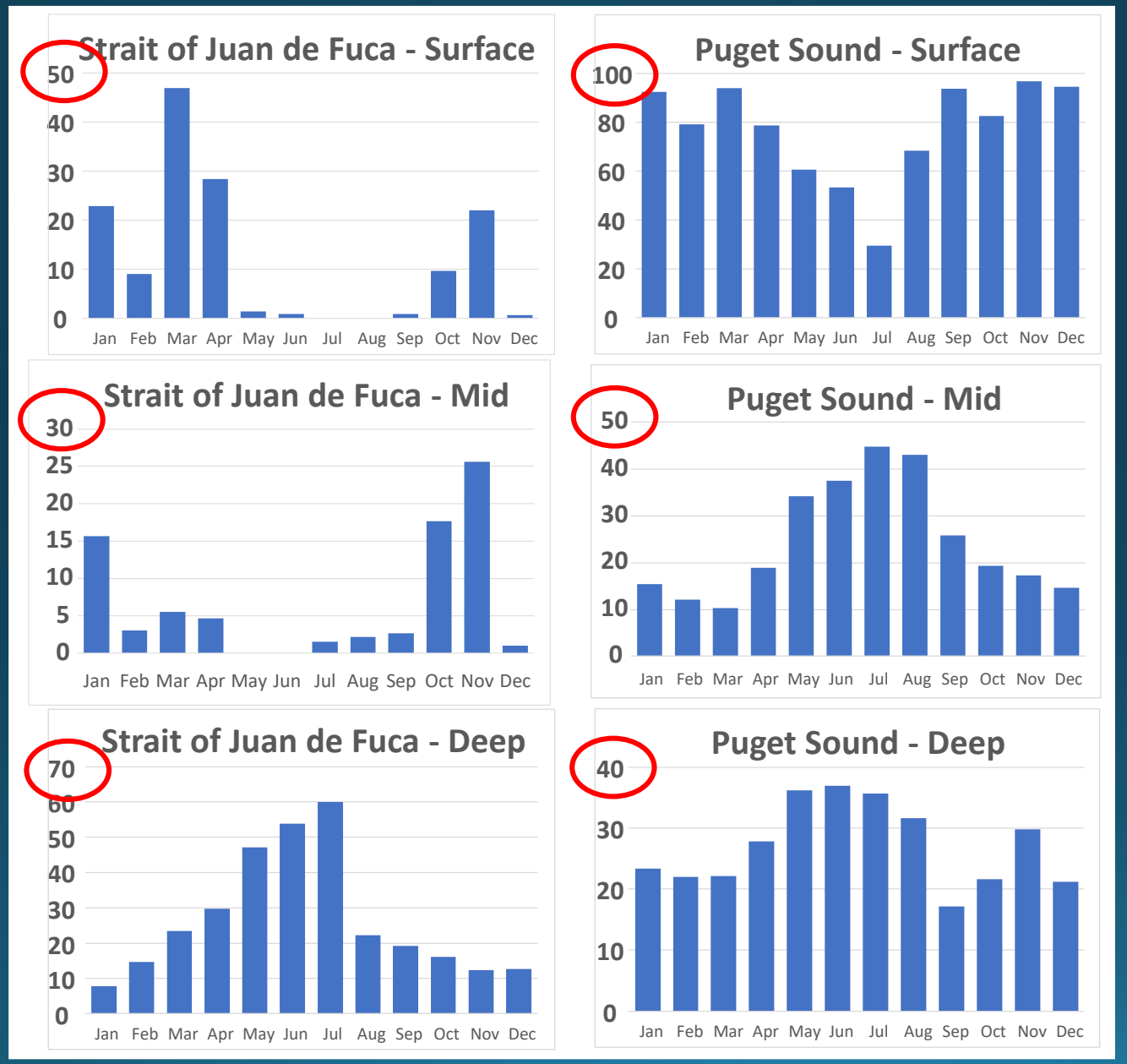



**~100-150 m**



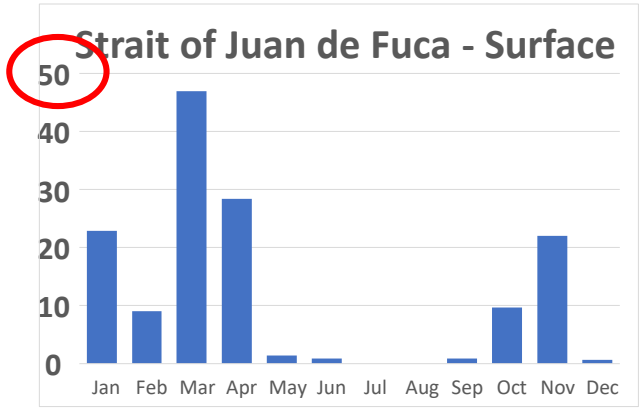



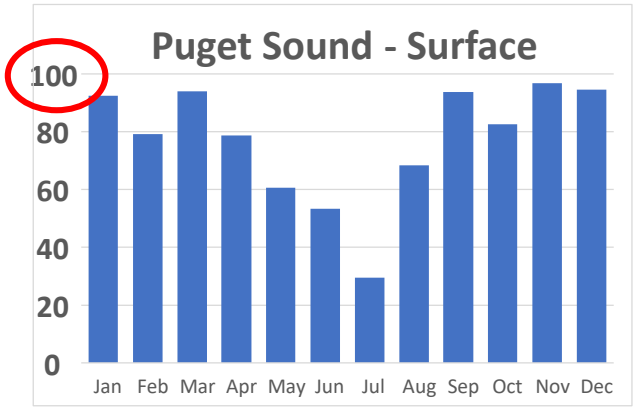
# Seasonal cycles of particle trajectories

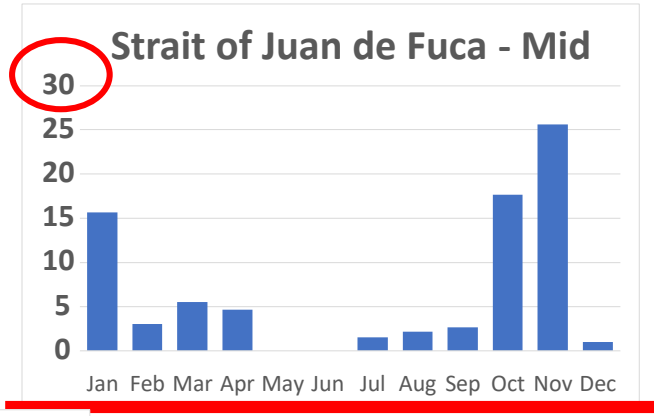


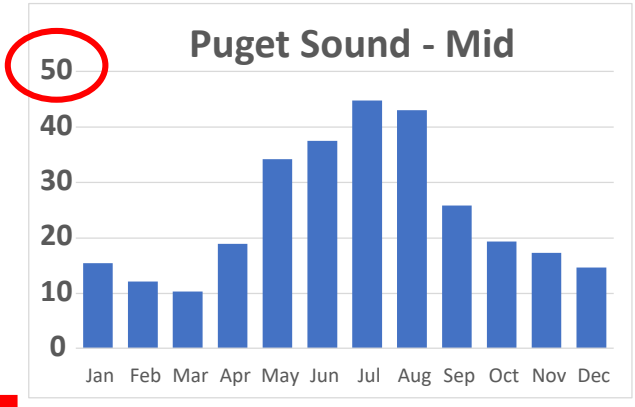
# Seasonal cycles of particle trajectories

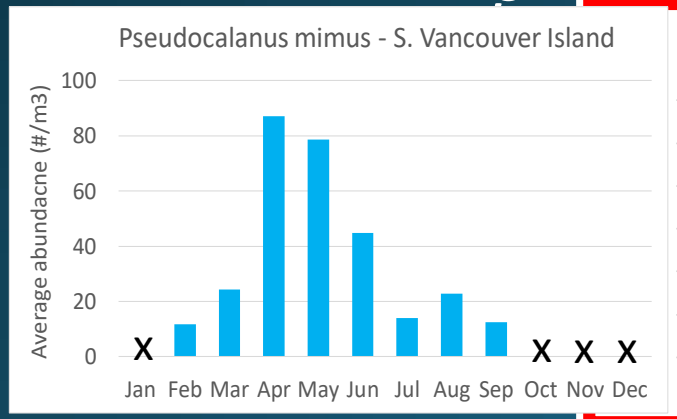
eleased that reached the domain

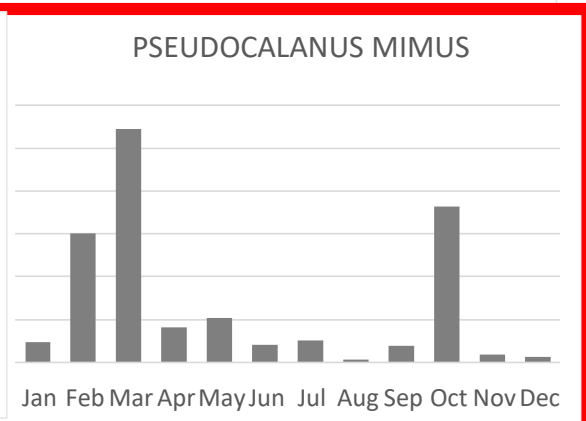


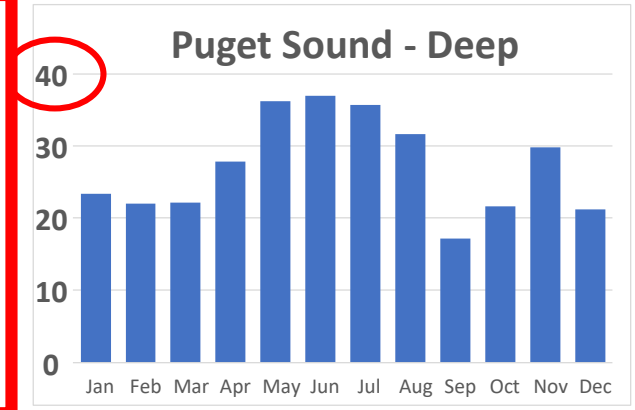



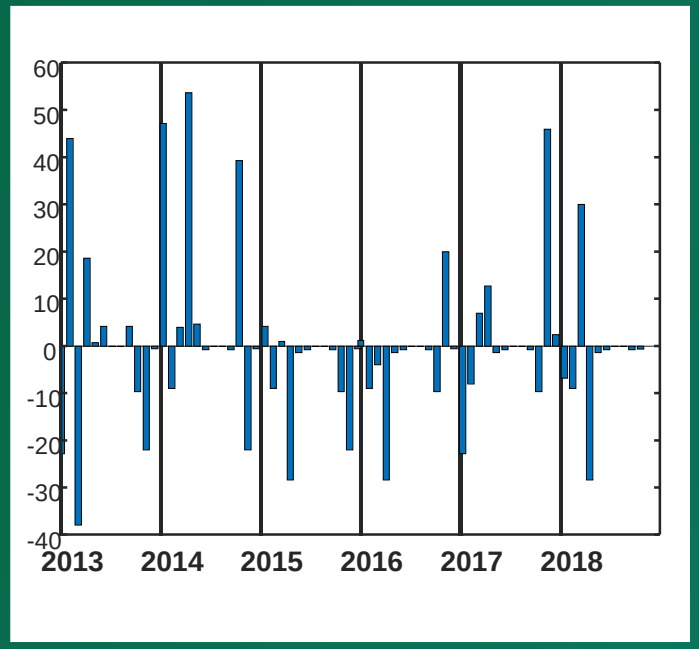



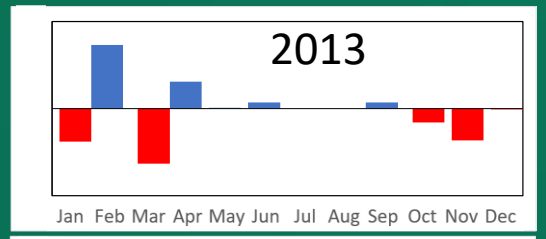



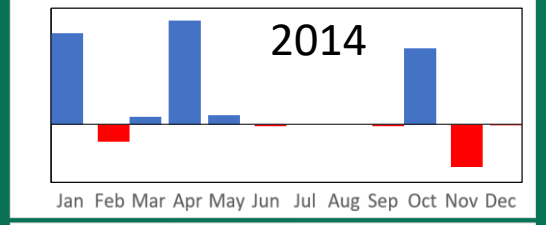



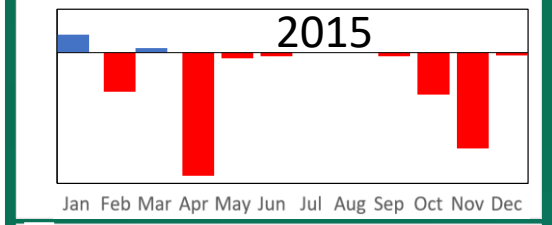



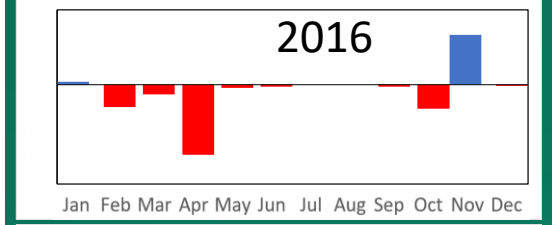
## Strait of Juan de Fuca surface particle anomalies

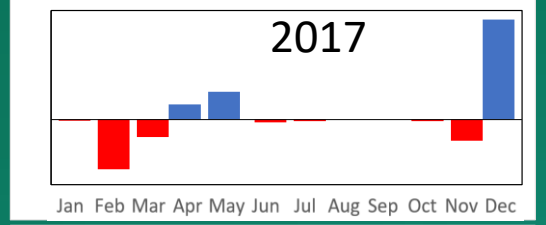


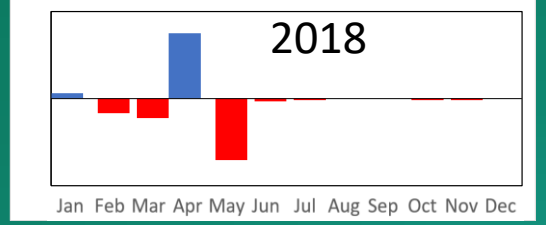



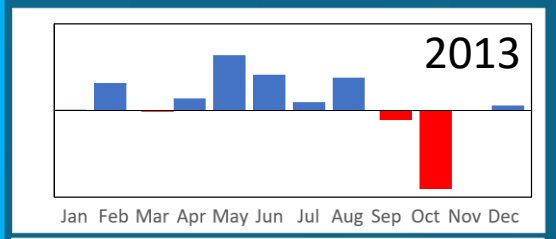



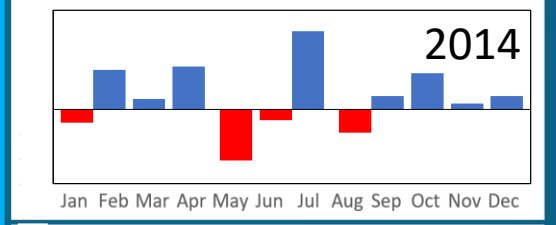



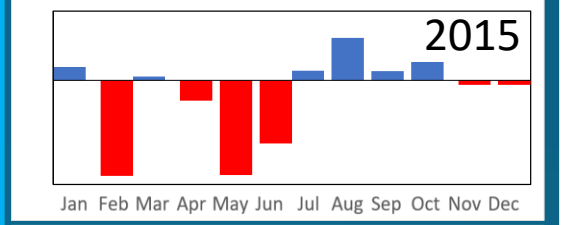



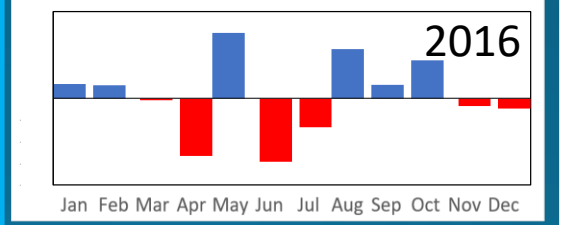



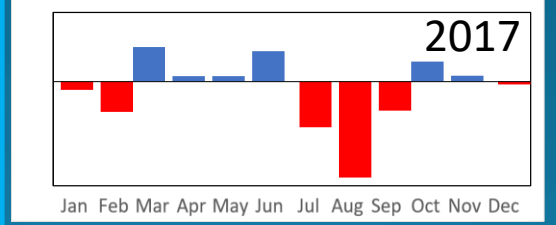



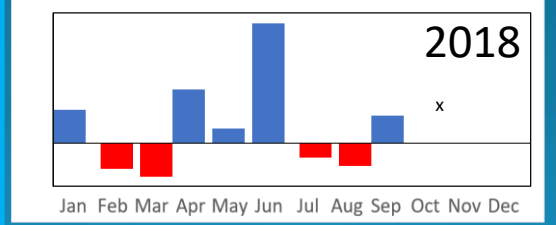



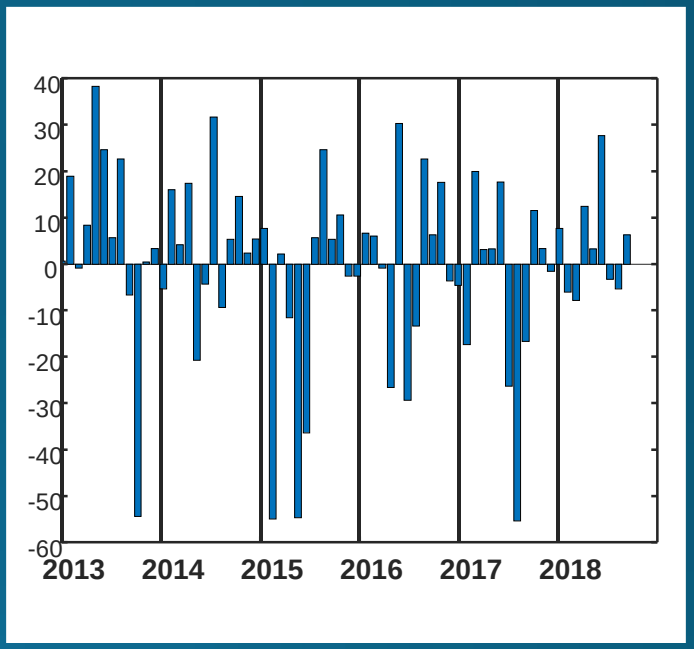




## Puget Sound surface particle anomalies



# Conclusions

Zooplankton community shows interannual variability correlated with climate indices.

Coastal versus inland indicator species show contrasting seasonality

Ocean-estuary advection is important, likely in combination with life history patterns.

# Thank you!

University of Washington
WA Dept of Ecology
The Salish Sea Marine Survival Project (SSMSP)
NOAA and the Tulalip Tribe
Captain and crew of the R/V Zoea
Moira Galbraith