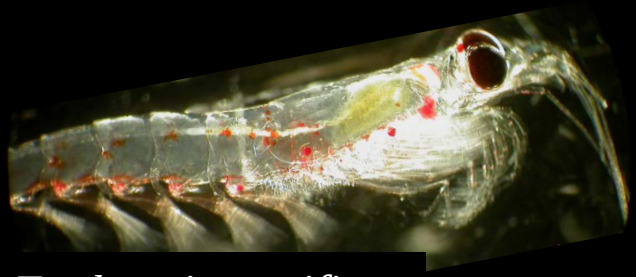
# The euphausiids *Euphausia pacifica* and *Thysanoessa spinifera* in the coastal upwelling zone off the Oregon Coast, USA



*Euphausia pacifica*

*Thysanoessa spinifera*

**C. Tracy Shaw, Leah R. Feinberg, Jennifer Fisher, and William T. Peterson**

The euph…*ca* and
*T*…
coastal upw…ast, USA

The Euphausiids
vs
The Warm Blob

*Euphausia pacifica*

*Thysanoessa spinifera*

**C. Tracy Shaw, Leah R. Feinberg, Jennifer Fisher, and William T. Peterson**

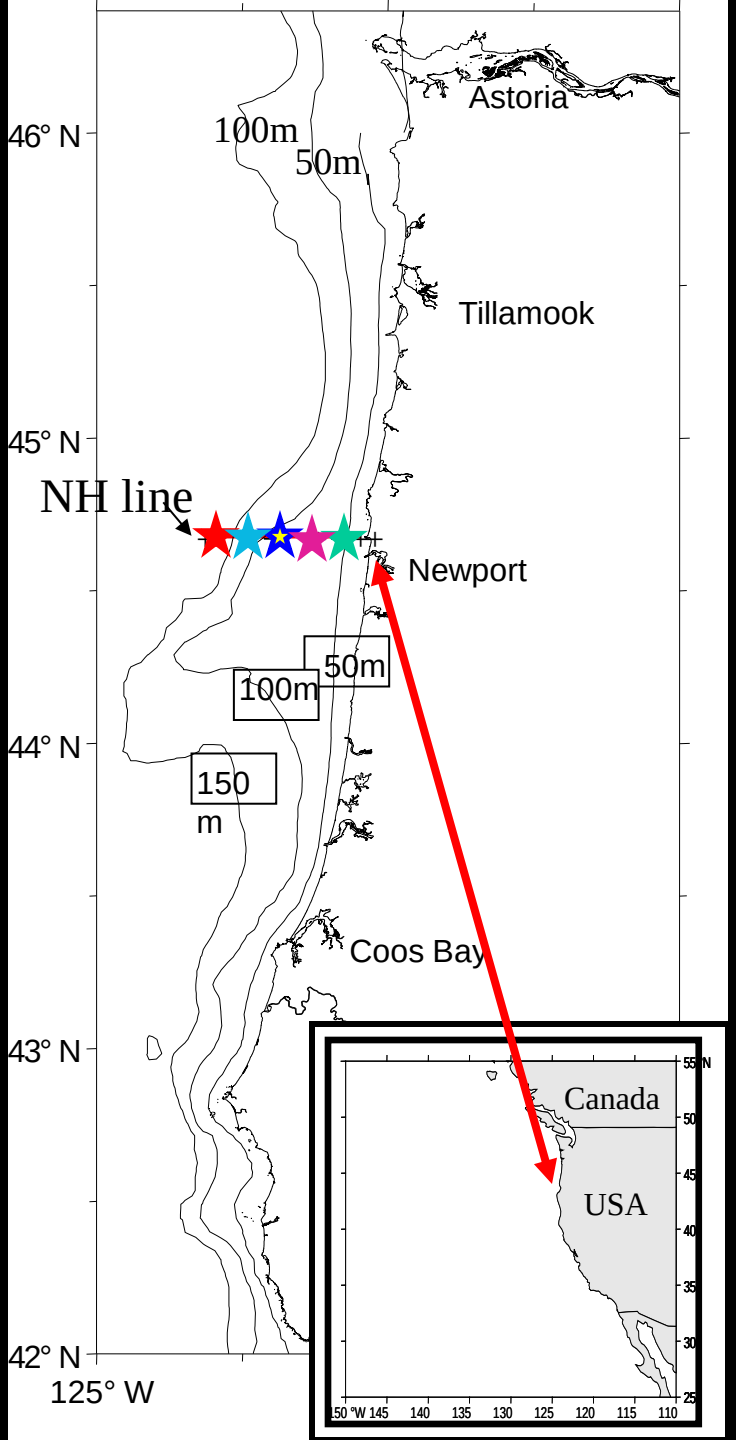
# Target Species

*Euphausia pacifica*

- Generally found at and beyond the shelf break (>200 m depth)
- Intense period of spawning during summer upwelling season
- Present in cool & warm ocean conditions

*Thysanoessa spinifera*

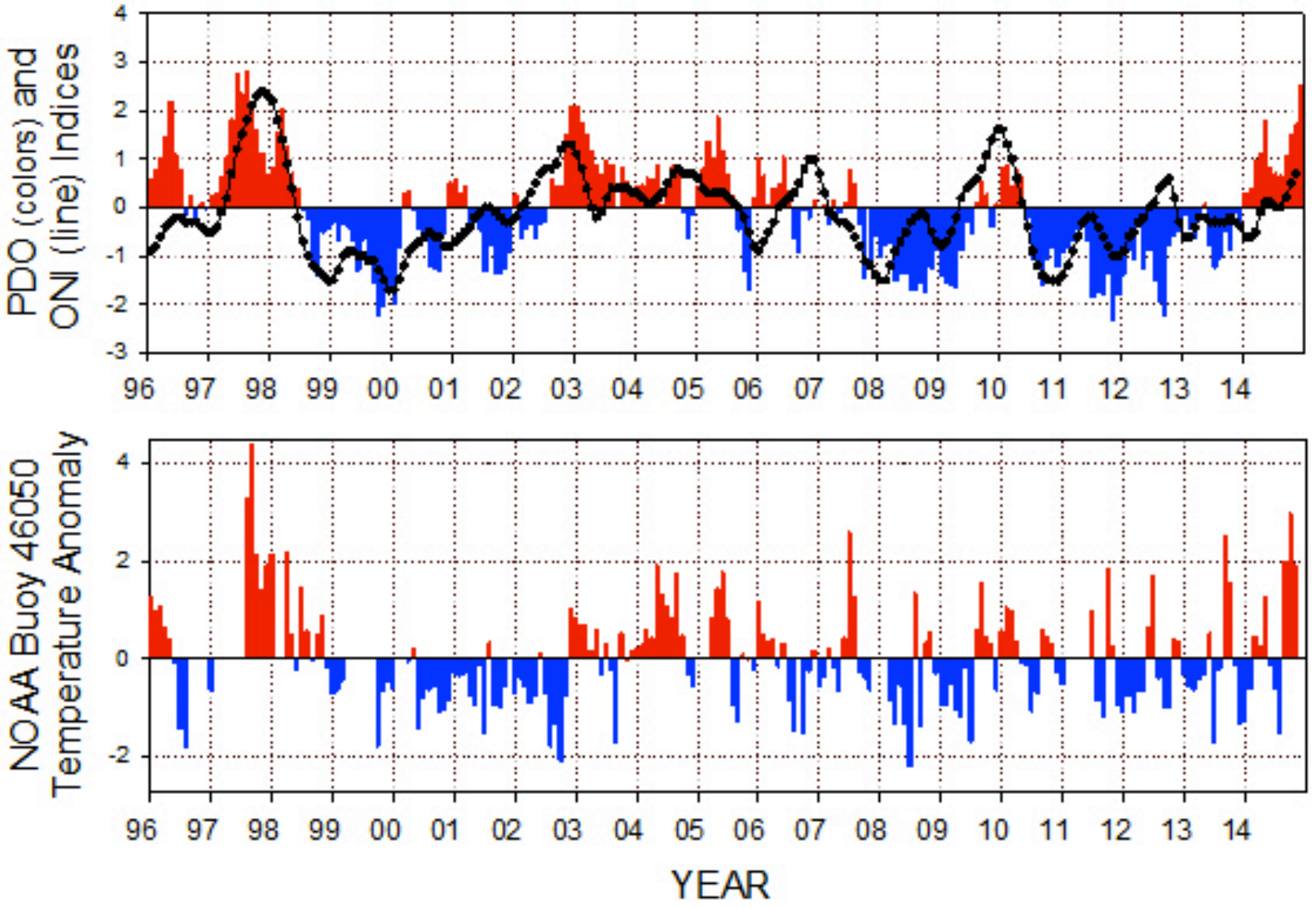
- Generally found on the shelf (<200 m depth)
- Spawn before & during upwelling, no intense period
- Prefer cooler ocean conditions




# Time series off Newport, OR (NH line)

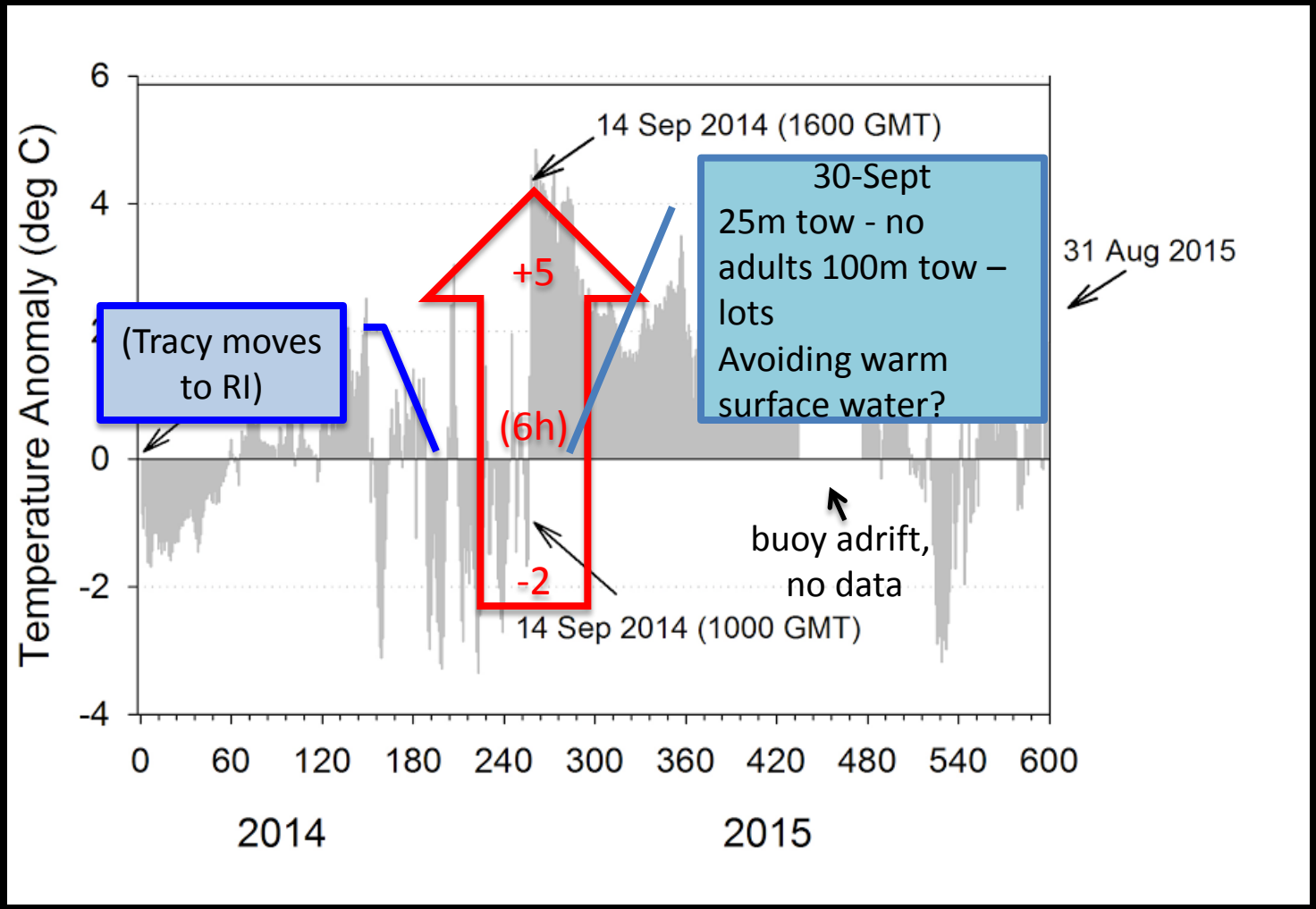
- Sampled twice per month 1996-2013; ~monthly 2014-present
- Night bongo net samples for adult euphausiids from 2001- present (15 years so far)
- Data for this presentation:
  - 1998-1999, 2001-2013
  - no 2014
  - 2015 (Jan-July)
- Station distance offshore & depth
  - NH05 – 8 km, depth 60m
  - NH10 – 16 km, depth 80m
  - NH15 – 25 km, depth 90m
  - NH20 – 32 km, depth 140m
  - NH25 – 40 km, depth 296m
- ☺

# Ocean Temperature 1996-2015



# SST Anomaly at NOAA Buoy 46050

## Jan. 2014-Aug. 2015



El Niño

Cold water on shelf

Late upwelling

Warm blob

| Year | Spring transition (ST) | Fall transition (FT) | Upwelling (months) | Cold water copepods (months) | PDO phase |
|---|---|---|---|---|---|
| 1998 | El Niño | | | | Warm |
| 2001 | 1-May | 7-Oct | 5.3 | 7.7 | Cool |
| 2002 | 17-Apr | 4-Nov | 6.7 | 6.6 | Cool |
| 2003 | 20-Apr | 26-Sep | 5.3 | 4 | Warm |
| 2004 | 21-Apr | 21-Aug | 4.1 | 5.2 | Warm |
| 2005 | 22-May | 29-Sep | 4.3 | 1.1 | Warm |
| 2006 | 20-Apr | 31-Oct | 6.5 | 4.1 | Warm |
| 2007 | 27-Apr | 28-Sep | 5.1 | 9.5 | Cool |
| 2008 | 29-Apr | 15-Sep | 4.6 | 7.9 | Cool |
| 2009 | 14-May | 11-Oct | 5.0 | 9 | Cool |
| 2010 | 10-Jun | 14-Sep | 3.2 | 5.3 | Cool |
| 2011 | 16-Apr | 11-Sep | 4.9 | 6.3 | Cool |
| 2012 | 4-May | 7-Oct | 5.2 | 5.8 | Cool |
| 2013 | 7-Apr | 22-Aug | 4.6 | 5.9 | Cool |
| 2014 | 10-May | 20-Sep | 4.4 | 3.5 | Warm |
| 2015 | 11-Apr | 1-Oct | 5.8 | NA | Warm |

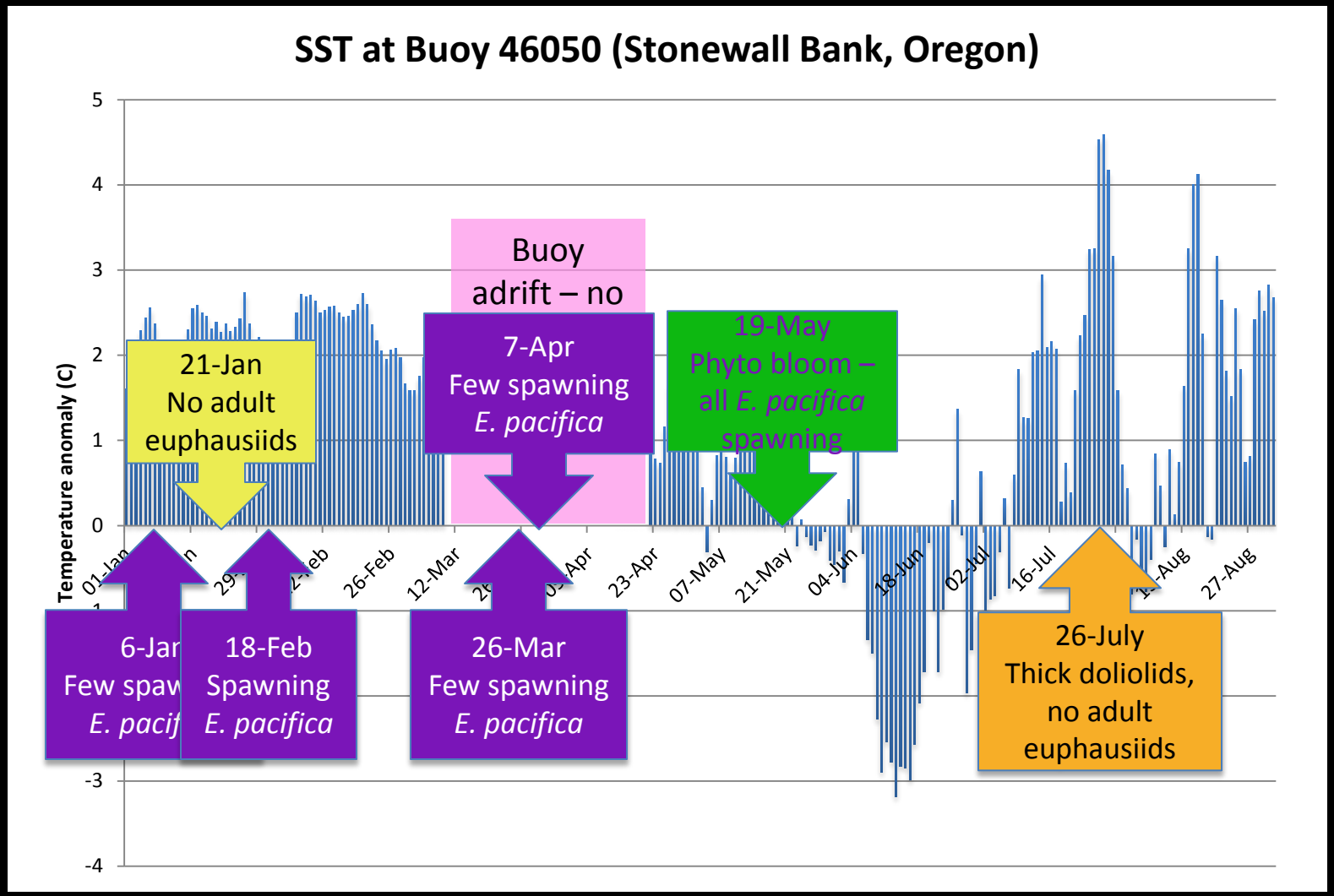
2015 comparison:
Duration of upwelling similar to other years
No biological transition

(www.damp.coas.oregonstate.edu/windstress/allyears.html)

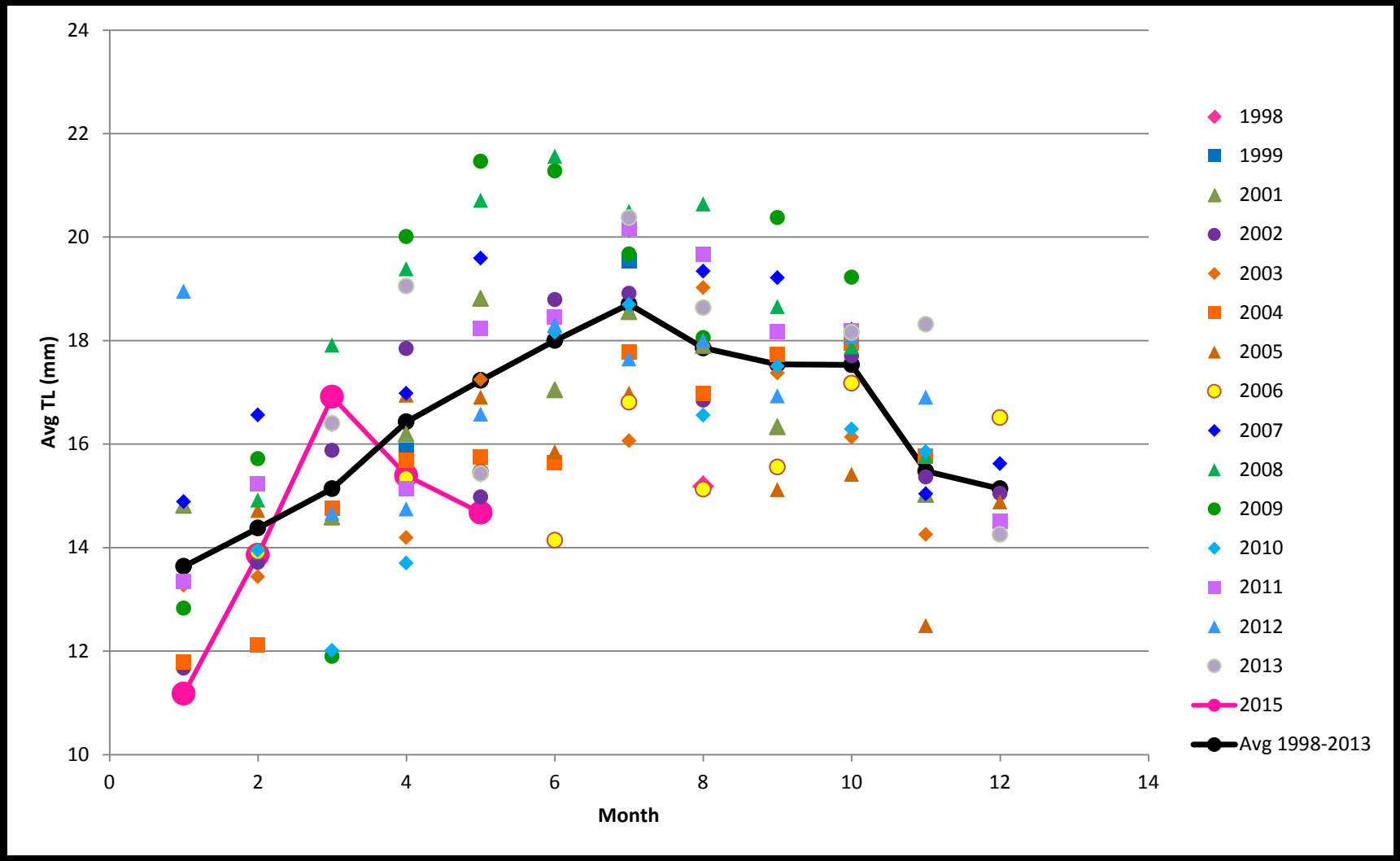
# Warm blob & euphausiids

- Will there be any euphausiids?
- Rare or new species of euphausiids?
  - Many “warm blob” copepod species rare or never before seen in our study area
- Will euphausiid densities decrease?
- Will they be spawning?
- Will they be smaller in length?
- Change in biomass?
- Changes in cross-shelf distribution?

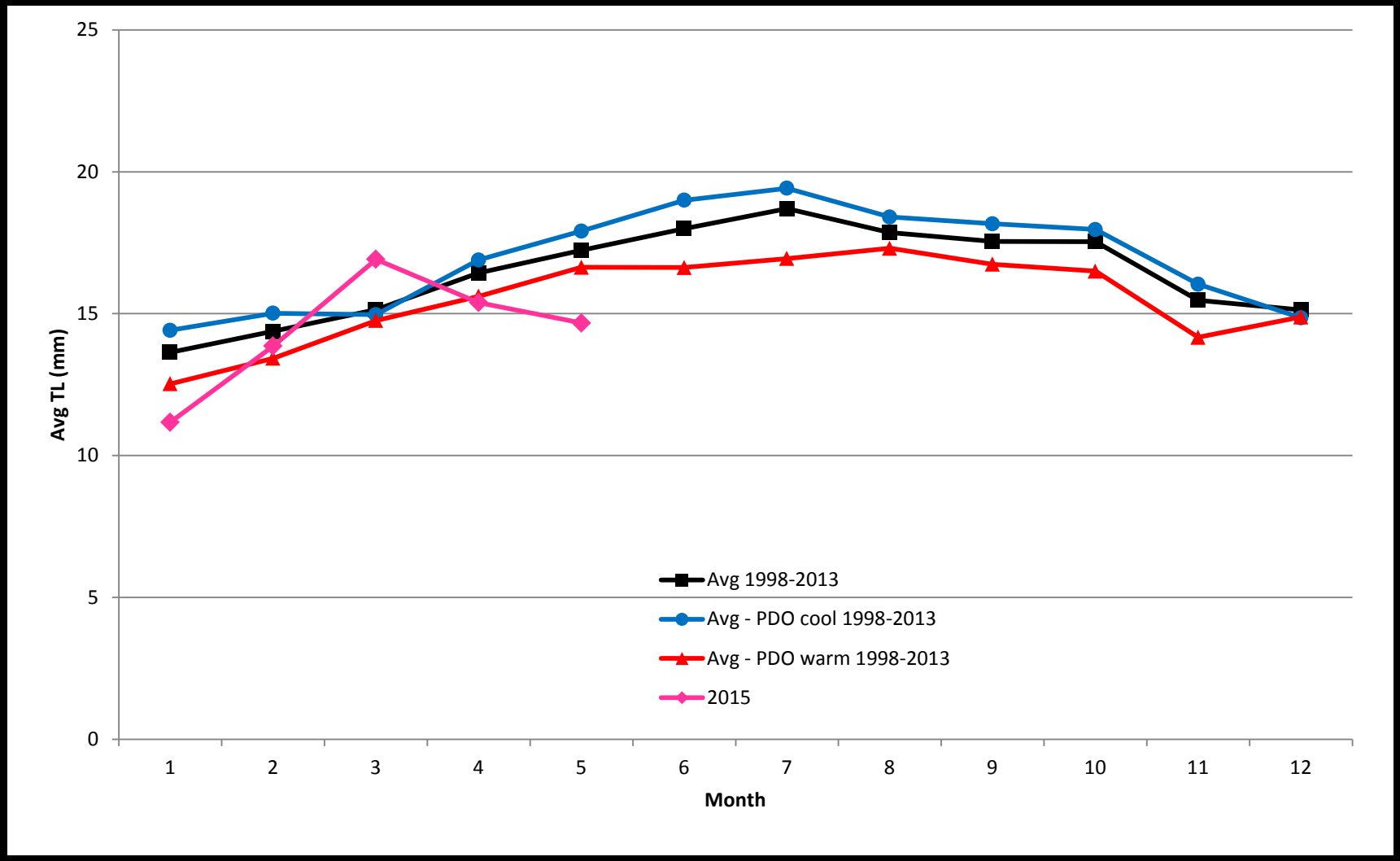
# 2015 SST & Krill Data



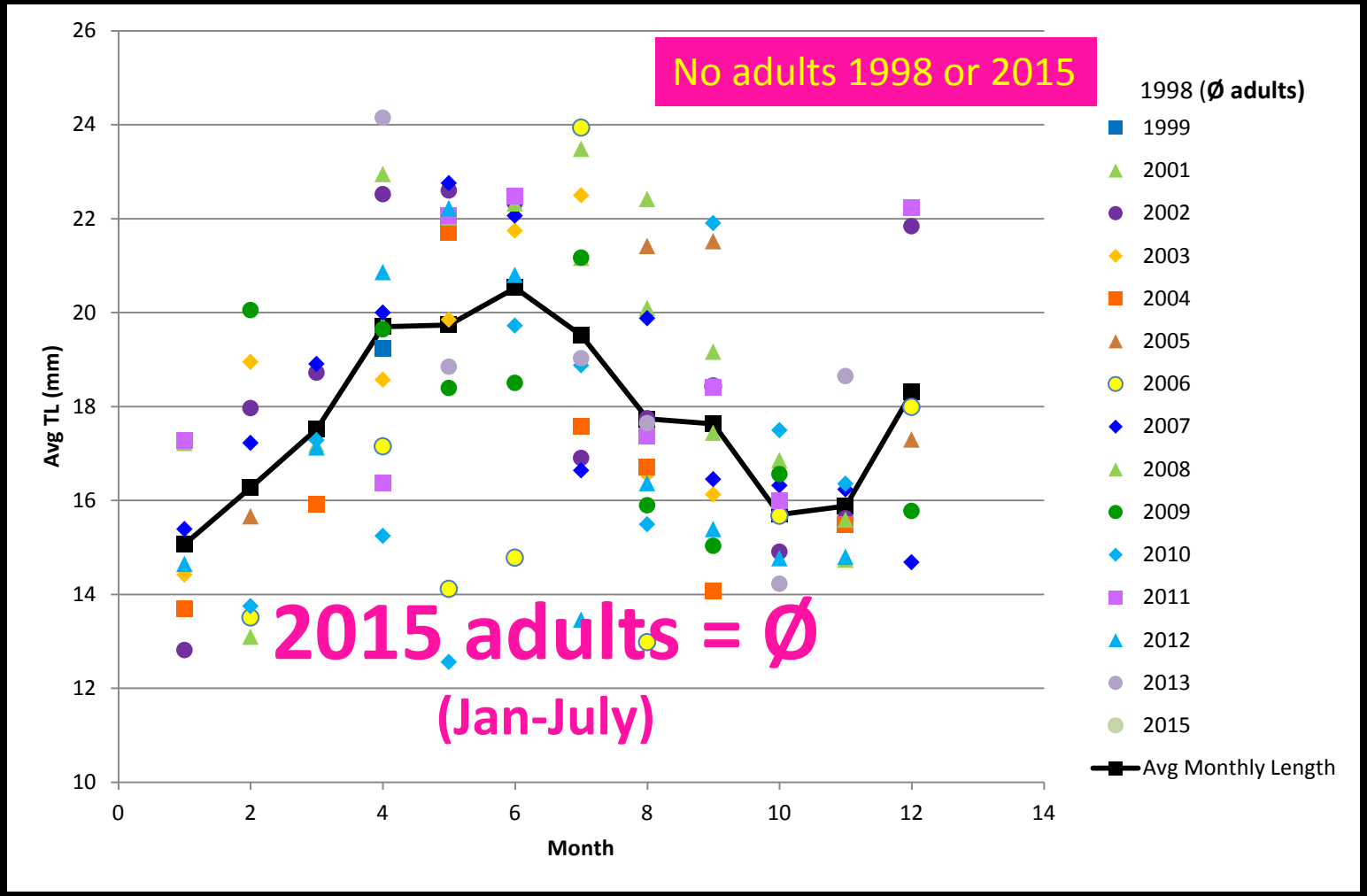
# *E. pacifica* adults



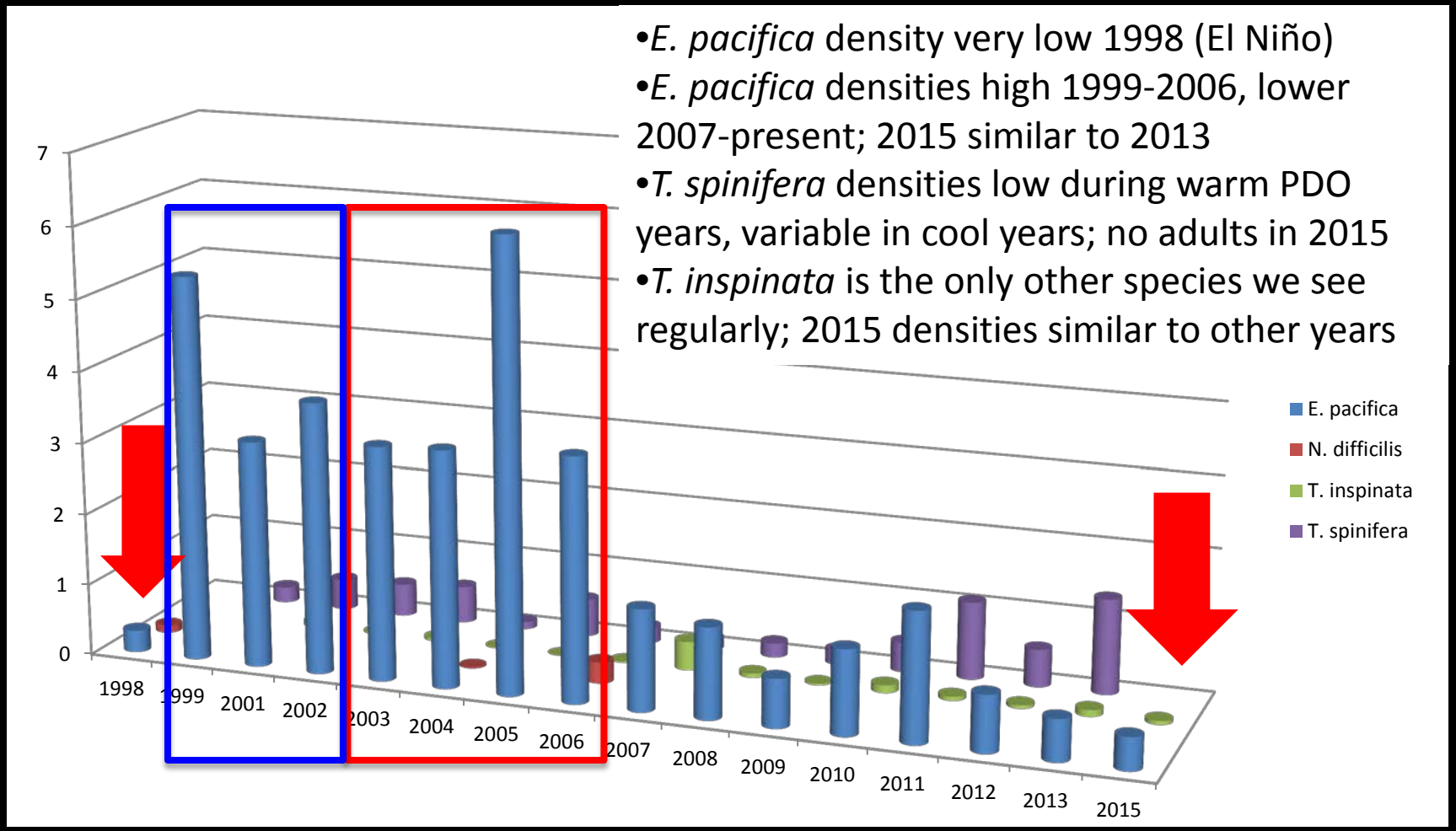
# *E. pacifica* adults



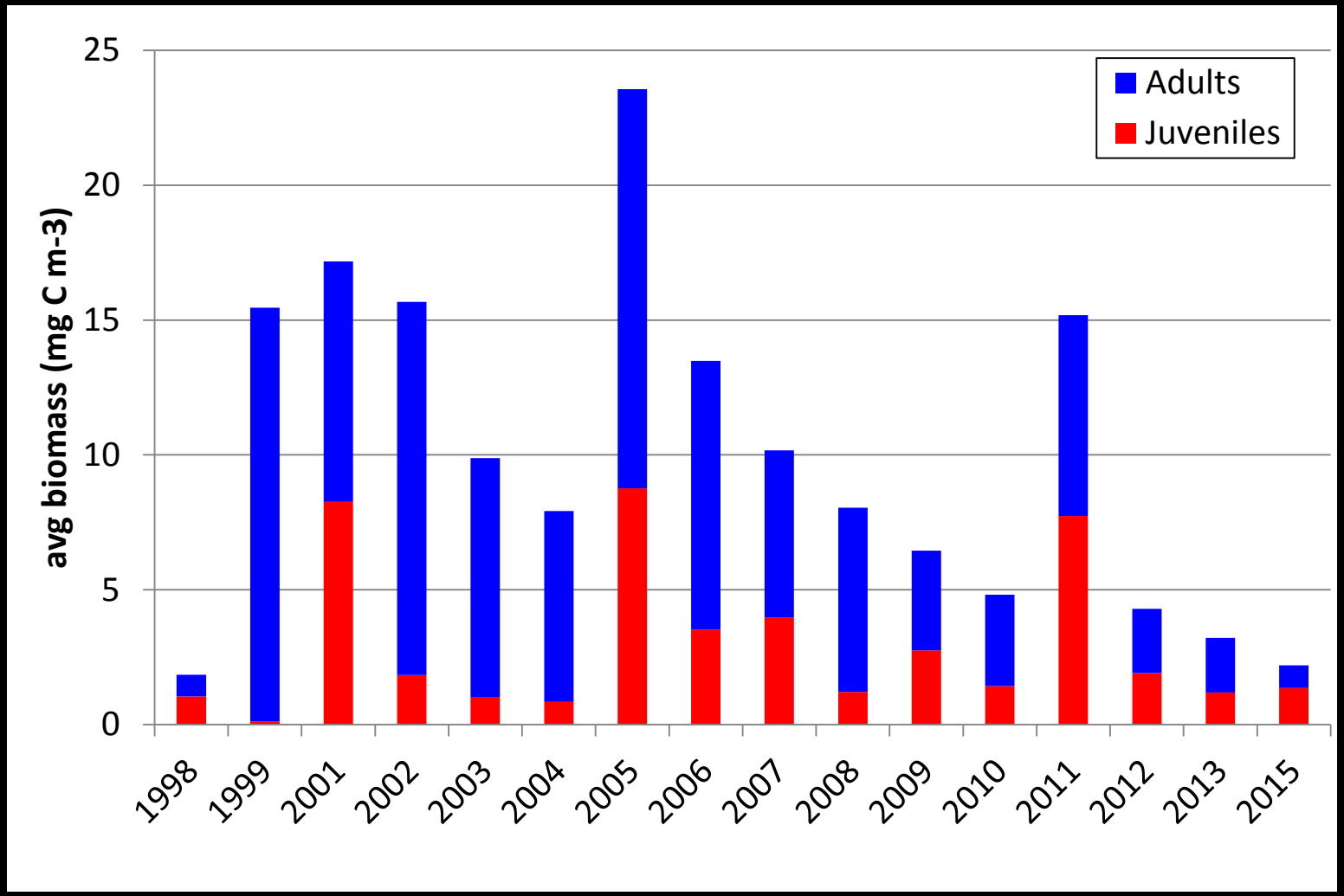
# *T. spinifera* adults



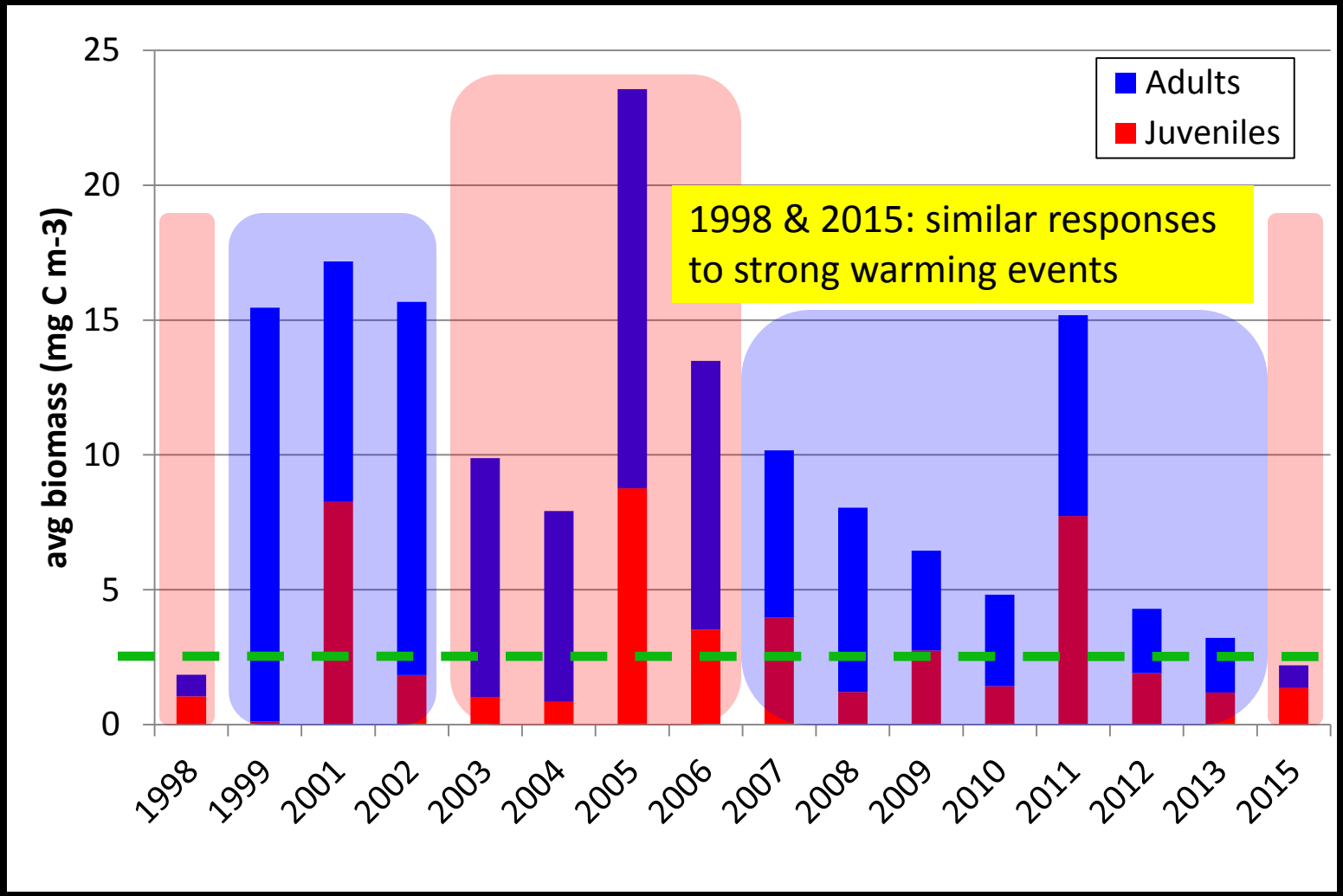
# Density & Species Composition (adults)



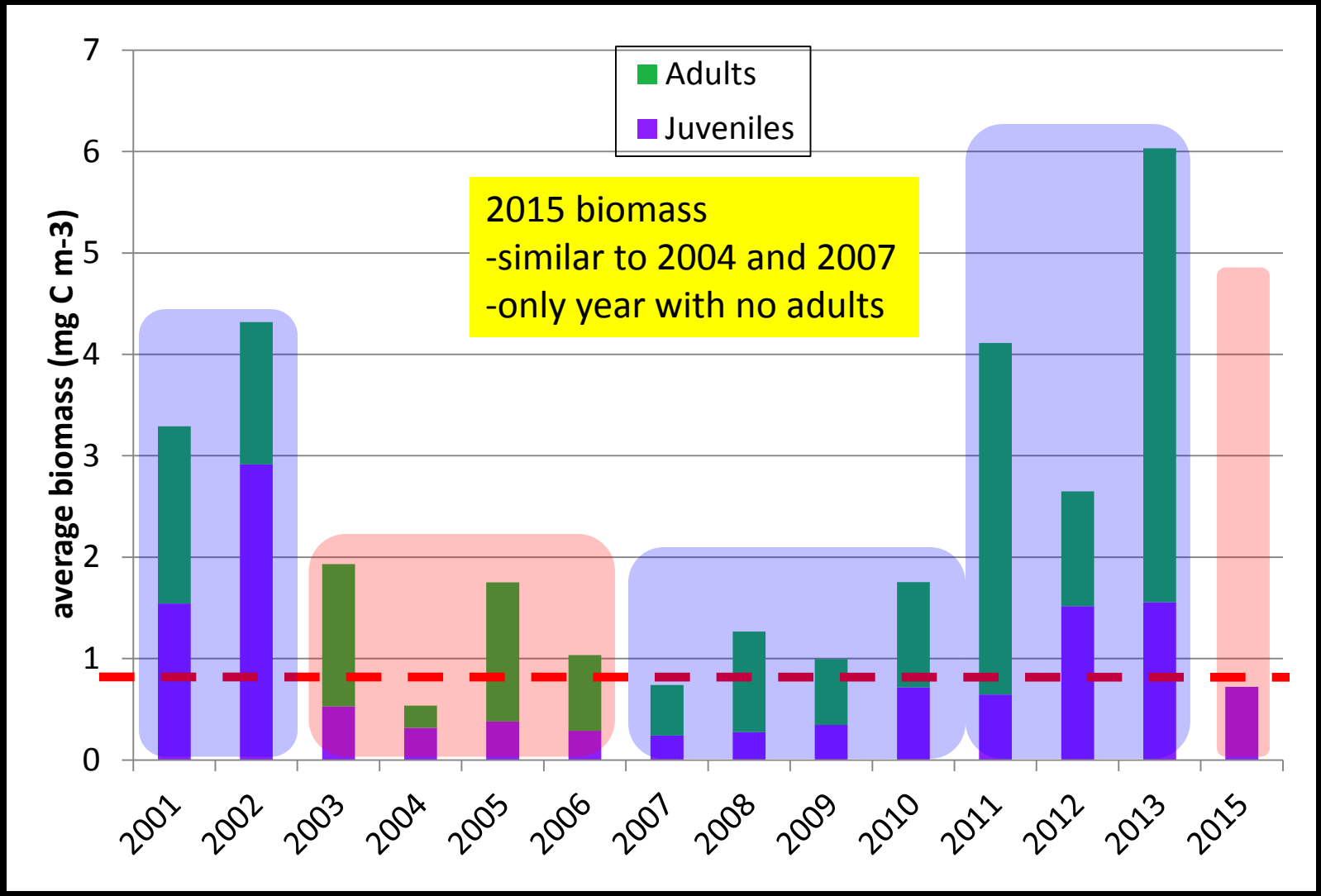
# *E. pacifica* biomass



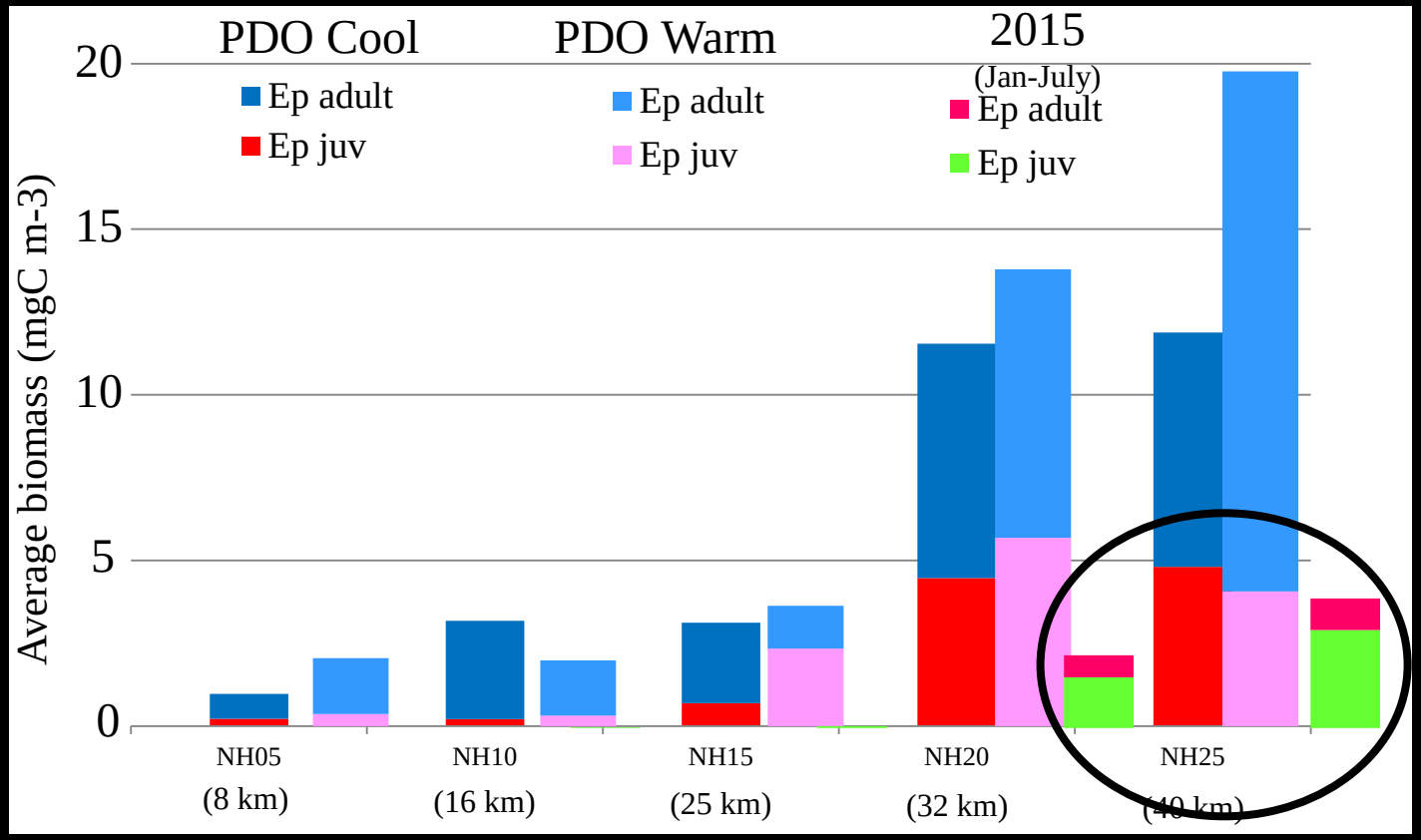
# *E. pacifica* biomass



# *T. spinifera* biomass



# *E. pacifica* cross-shelf biomass cool vs. warm PDO + 2015

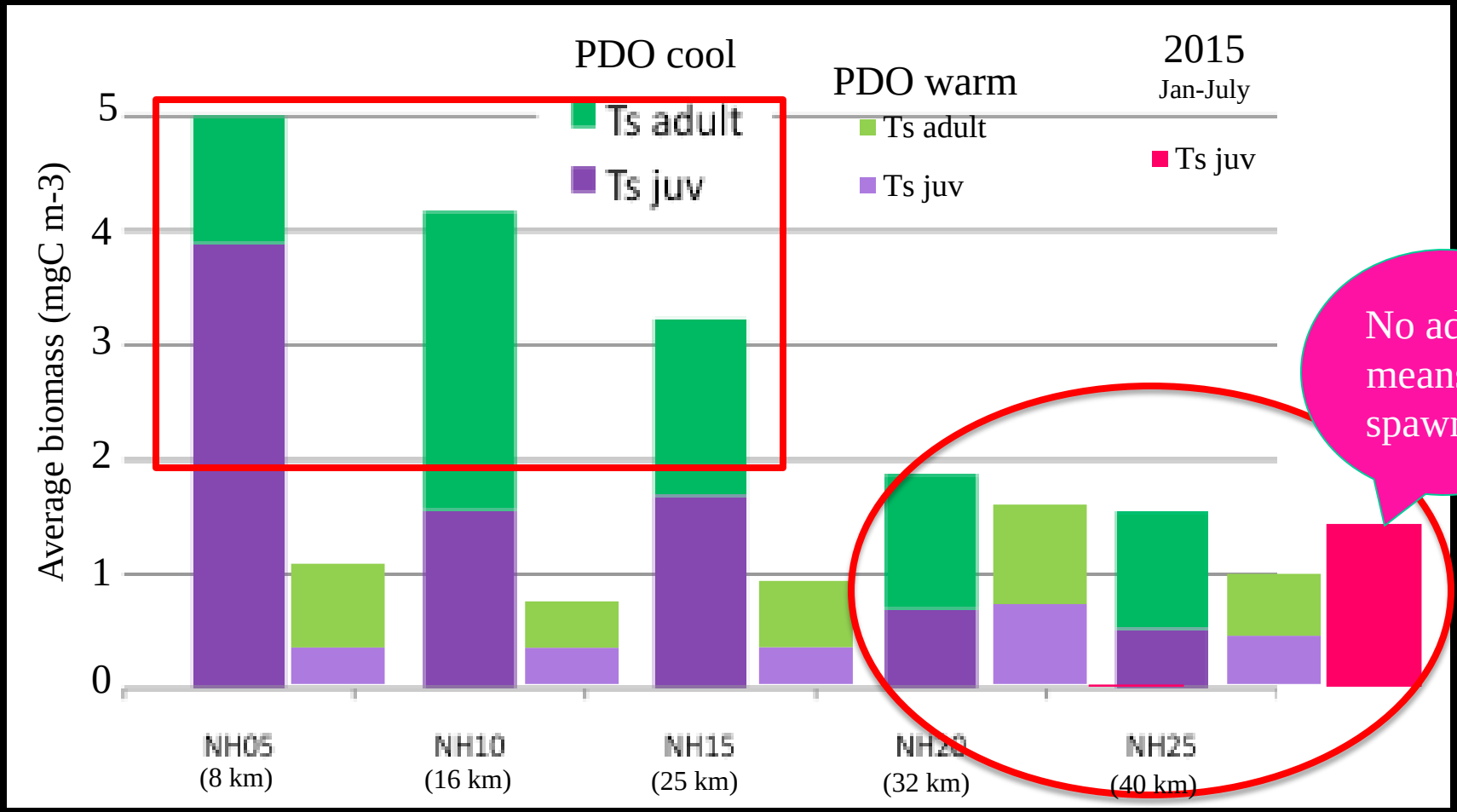



Cross-shelf pattern for 2001-2013 similar for cool & warm PDO

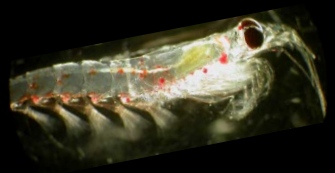
*E. pacifica* might even like a little warming

Drastically lower biomass in 2015 suggests that they would **not** like a lot of warming

# *T. spinifera* cross-shelf biomass cool vs. warm PDO + 2015




- Biomass offshore essentially the same for cool and warm PDO
- 2015 similar offshore biomass, but only juveniles and only from one sample (July)
- Biomass inshore higher during cool conditions (max of 5 mgC $m^{-3}$ = 5 large adults)

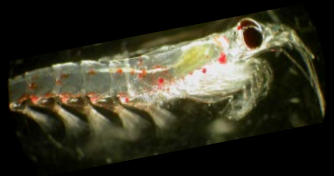


# Warm blob answers?

- *Euphausia pacifica*
  - Present?
  - Spawning?
  - Smaller lengths?
  - Lower density?
  - Lower biomass?
  - Cross-shelf?
    - No *E. pacifica* biomass inshore, offshore biomass much lower than other years

Yes

- *Thysanoessa spinifera*
  - Adults absent Jan-July
  - Cross-shelf
    - No biomass inshore where it is usually highest; offshore biomass similar to other years but juveniles only
- Rare or new species of euphausiids? No



# Implications

- Euphausiids off the Oregon Coast are adapted to cooler ocean conditions
  - *E. pacifica* does well with warm or cool PDO but not with more extreme temperatures; response to 2015 similar to 1998
  - *T. spinifera* adults completely absent during warm conditions in 2015, also absent during 1998 El Niño
- Potential effects of warming on spawning and abundance
  - Spawning may be reduced in warm conditions due to fewer adults, smaller adults, lack of phytoplankton blooms, increase in gelatinous zooplankton
  - Both species have a lifespan of about two years. Warm conditions lasting two or more years in a row could result in reduced euphausiid abundance (migration and reduced reproduction).
  - Reduced euphausiid abundance may impact higher trophic levels, including commercial fish and seabirds
- How would we interpret data from 2015 if we didn't have this long-term time series data set for context?

# Acknowledgements


- Research vessels:*Elakha*, *Wecoma*, *Atlantis*, *Frosti*, *Miller Freeman*, *McArthur II*, *New Horizon*, *Shimada*
- Funding sources:NOAA/NWFSC, ONR/NOPP, NSF/CoOP/COAST, NOAA-GLOBEC, NSF/CoOP/RISE, NOAA-SAIP
- My boss at the University of Rhode Island (Dr. Brad Seibel) for sending me to this meeting to talk about data that has nothing to do with my current job
- My former boss (Bill Peterson) just for being Bill


# Euphausiid Live Work Protocol

Protocols for Measuring Molting Rate and Egg Production o Live Euphausiids

Courtesy of the Peterson Lab at Hatfield Marine Science Center, Newport, Oregon, USA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Celebrating 10 years on the PICES website! (2005-2015)

- Everything you always wanted to know about working with live euphausiids!

Available on the PICES website! (www.pices.int) under the "Projects" heading