

Population dynamics of the euphausiids
Euphausia pacifica and *Thysanoessa spinifera*
off Newport, OR, USA in relation to
environmental conditions



Euphausia pacifica

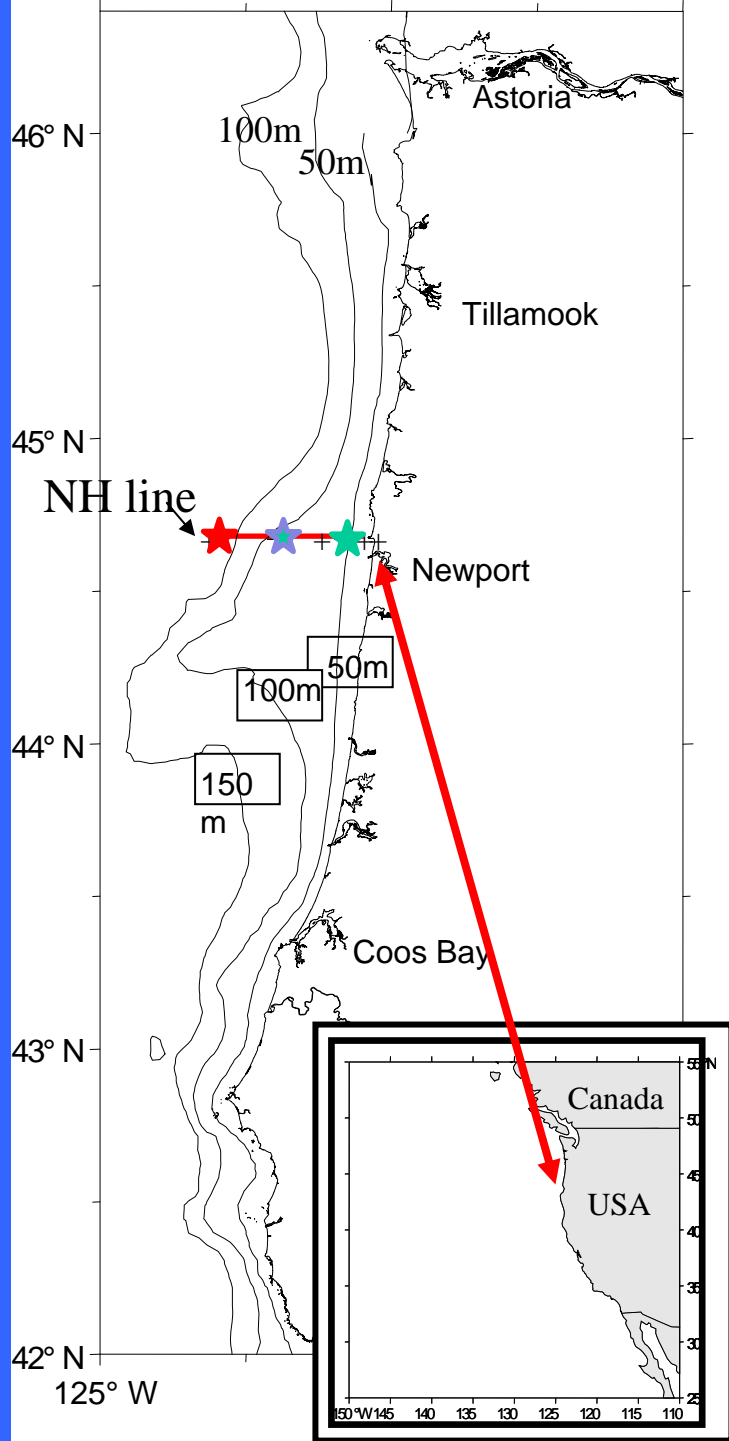
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Thysanoessa spinifera

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

Time series off Newport, OR (NH line)



- Sampled twice per month for zooplankton by the Peterson lab since 1996
- Sampling for adult euphausiids using night bongo tows starting in 2001
- Sampling stations:
 - ★ NH05 (60m) - inshore
 - ★ NH15 (90m) – mid-shelf
 - ★ NH25 (296m) – shelf break

Target Species



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

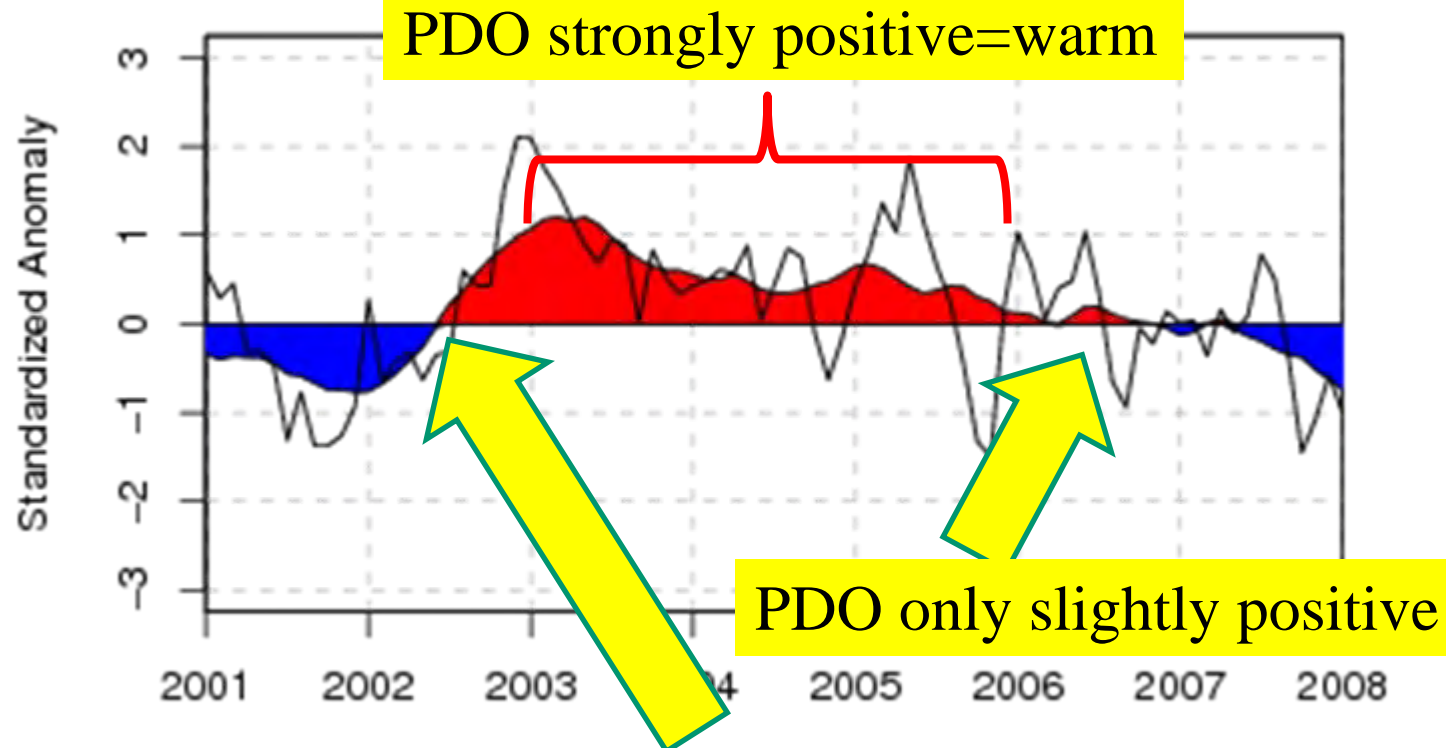


- Generally found on the shelf (<200 m depth)
- Spawn before & during upwelling, no intense period
- Prefer cooler ocean conditions

Methods

- Collected lots of net samples (data presented are from 2001-2006 but project is ongoing)
- Counted and identified to species euphausiid eggs, nauplii, calyptopis, and furcilia from 1/2m vertical net samples, measured furcilia
- Counted and measured juvenile and adult euphausiids (*E. pacifica* (Ep) and *T. spinifera* (Ts)) from nighttime bongo nets
- PDO & local buoy 46050 for temperature data
- Dates of spring and fall transitions from Logerwell et al. 2003 & http://www.cbr.washington.edu/data/trans_data.html

Pacific Decadal Oscillation (PDO)



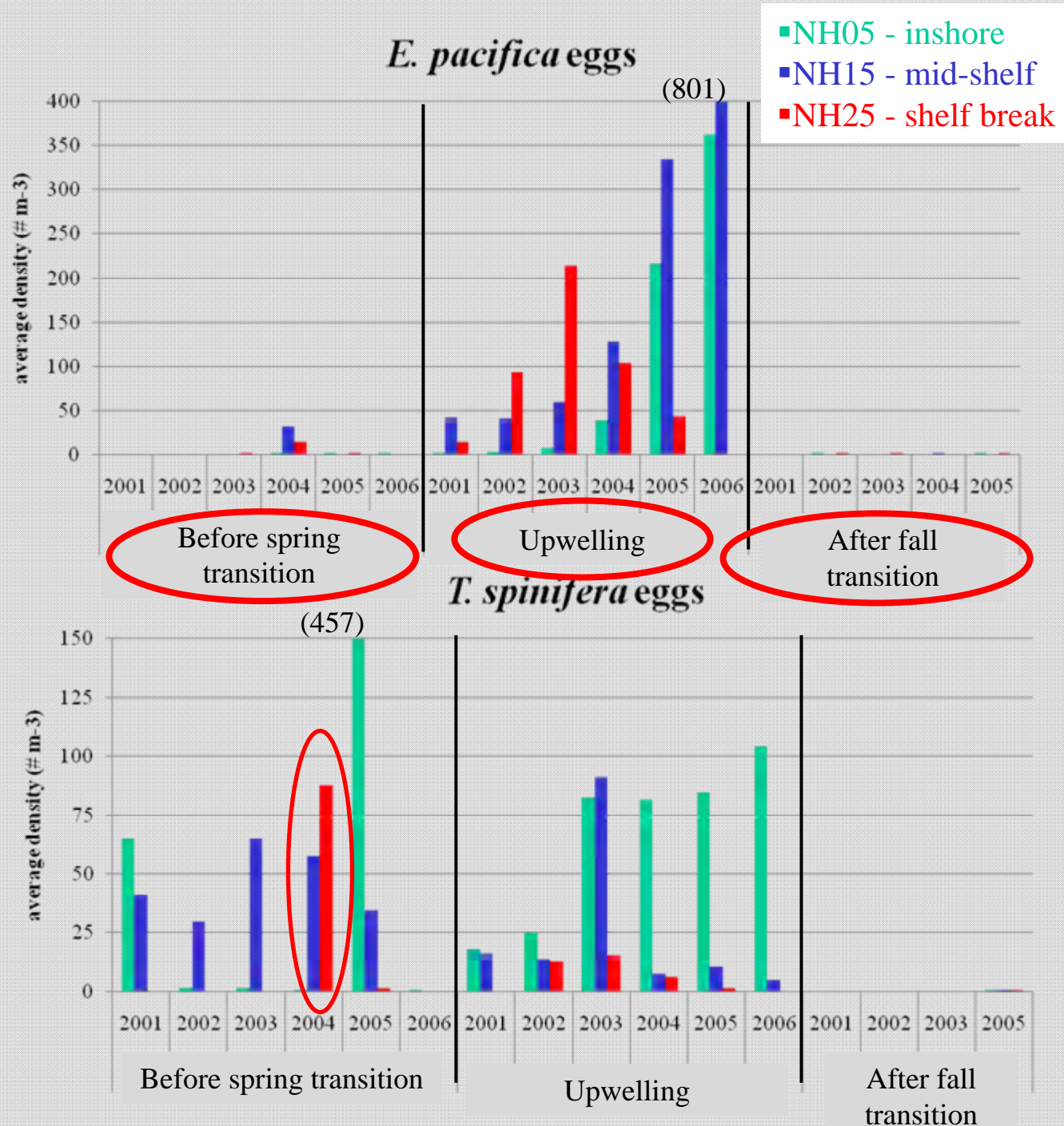
Note: local SST off Newport, OR lags behind the PDO so while the PDO was warming in 2002 the ocean in our study area was still cold

Summary of Ocean Conditions

Year	Spring transition (ST)	Fall transition (FT)	Duration of upwelling (mo)	Ocean temp.
2001	2-Mar	12-Nov	8.5	Cool
2002	21-Mar	6-Nov	7.7	Cool
2003	22-Apr	15-Oct	5.9	Warm
2004	20-Apr	7-Nov	6.7	Warm
2005	25-May	29-Sep	4.2	Warm
2006	22-Apr	31-Oct	6.4	Warm

Eggs

- Ep eggs clearly have a strong association with upwelling
- Ts eggs present at similar densities before and during upwelling
- Ts in 2004 high at mid-shelf & shelf break, absent after fall transition

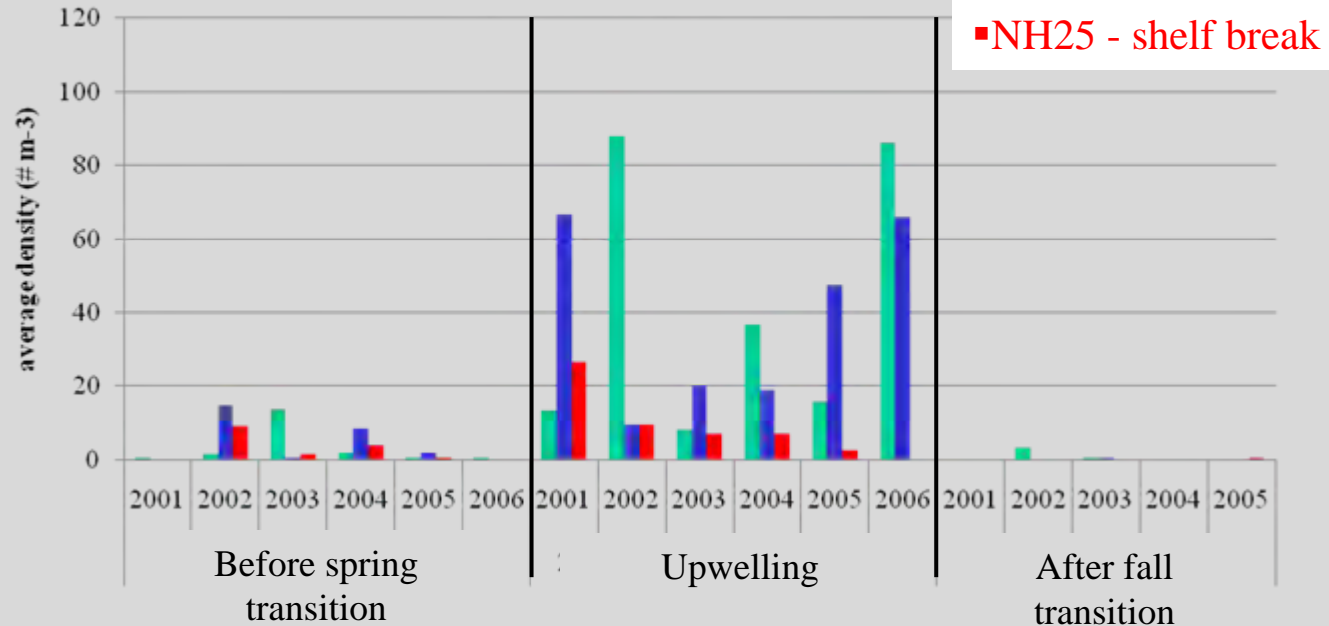


Nauplius

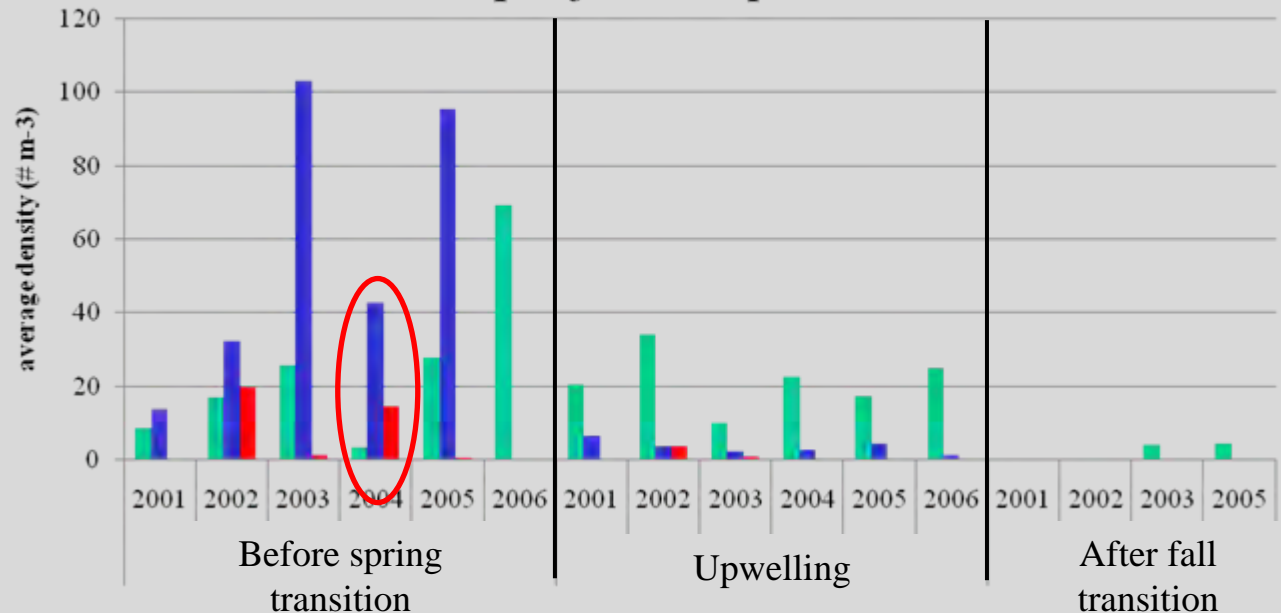
(includes metanauplius)

- Not surprisingly, patterns similar to eggs since hatching time ~36h
- Ep nauplii also strong assn w/upwelling, high densities typically at NH05 & NH15
- Ts nauplii highest densities before upwelling season; 2004 still present NH15 & 25
- Ts present at NH05 during upwelling but essentially absent from other stations

E. pacifica nauplius



T. spinifera nauplius

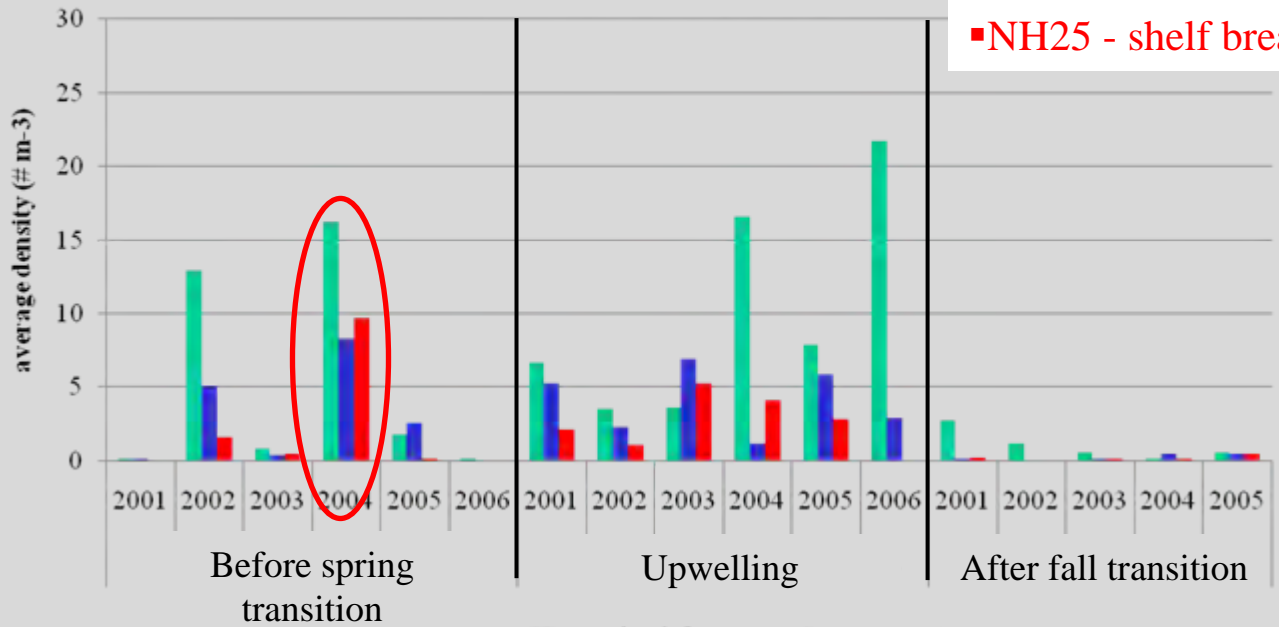


Calyptopis

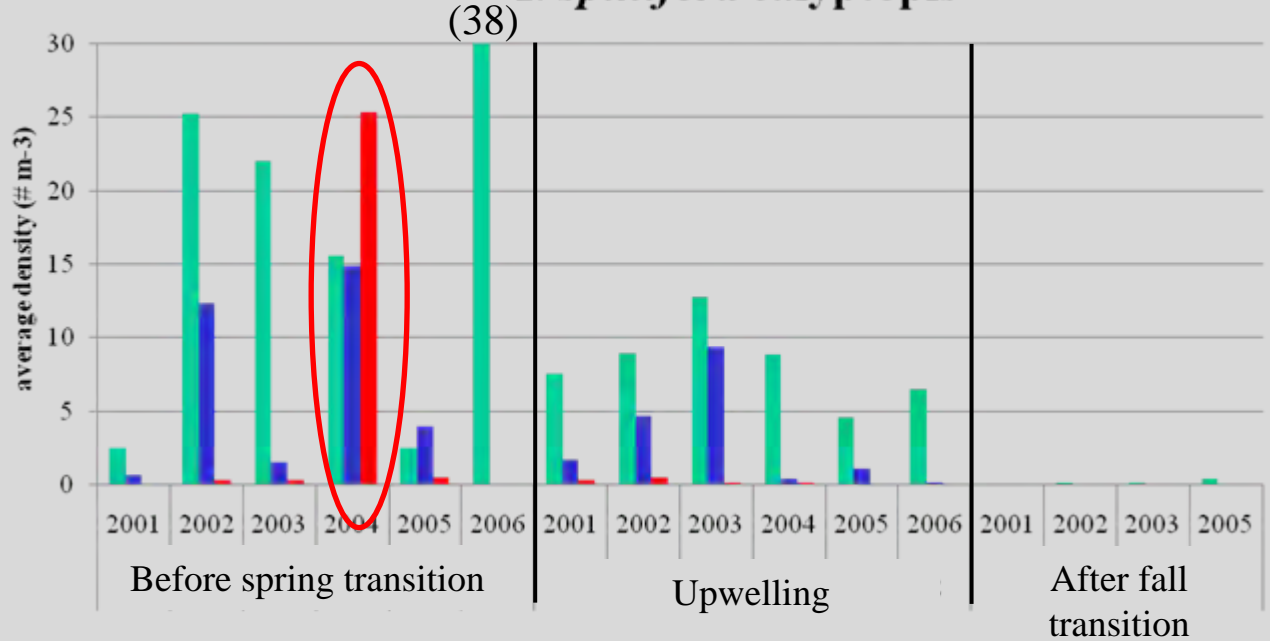
- Ep still strongly associated w/upwelling, but some high values prior to spring transition
- Ts values highest before upwelling
- Ts consistently found at NH05 during upwelling
- Ep & Ts at all stations in 2004

E. pacifica calyptopis

■ NH05 - inshore
■ NH15 - mid-shelf
■ NH25 - shelf break



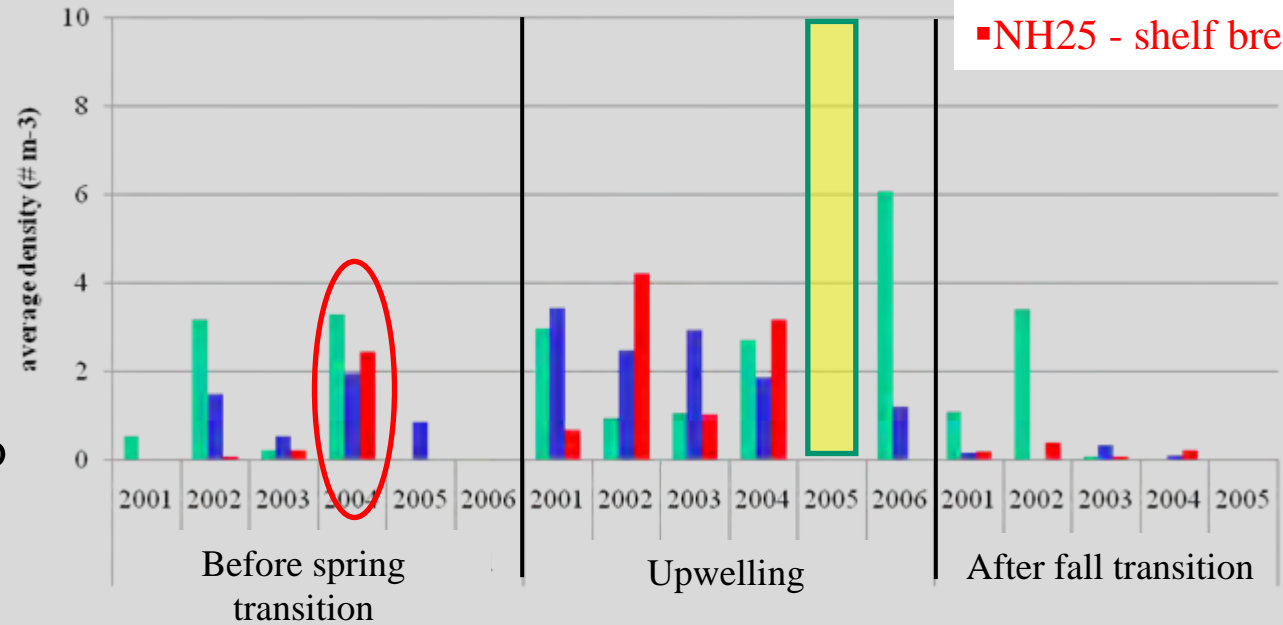
T. spinifera calyptopis



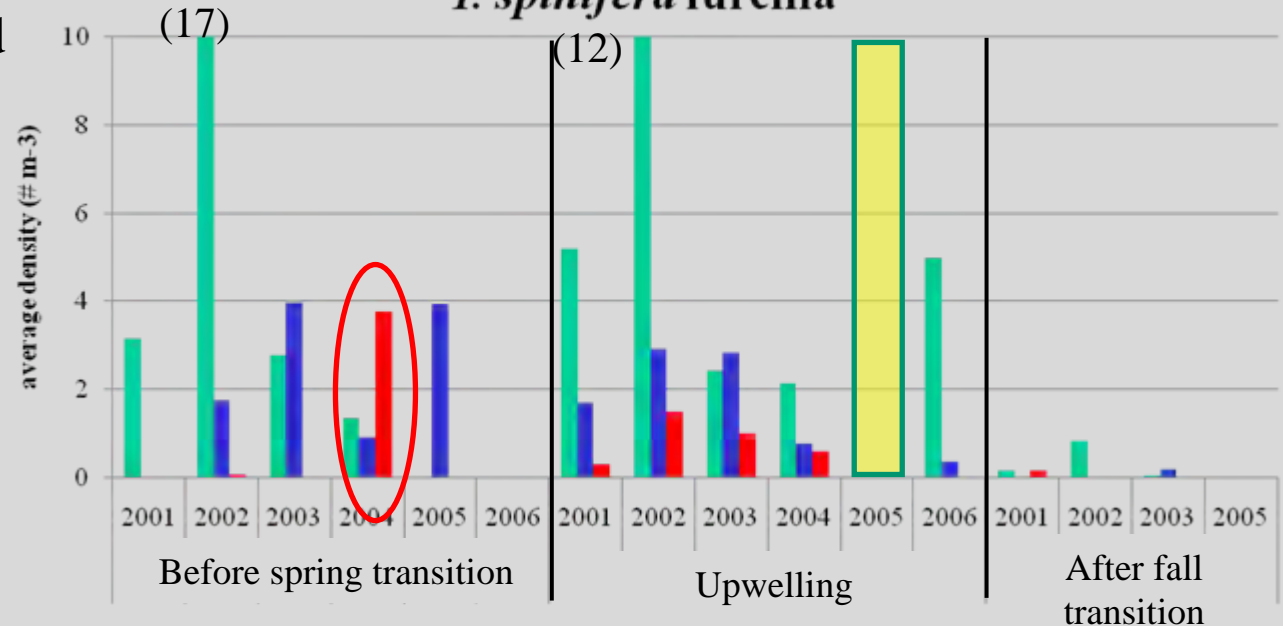
Furcilia

- Densities generally <4 for both species
- No furcilia during upwelling in 2005 for either spp. (late start to upwelling & short season)
- High Ts furcilia inshore in 2002: a cold year with lots of Ts spawning
- Ep & Ts abundant at all stations before spring transitions

E. pacifica furcilia



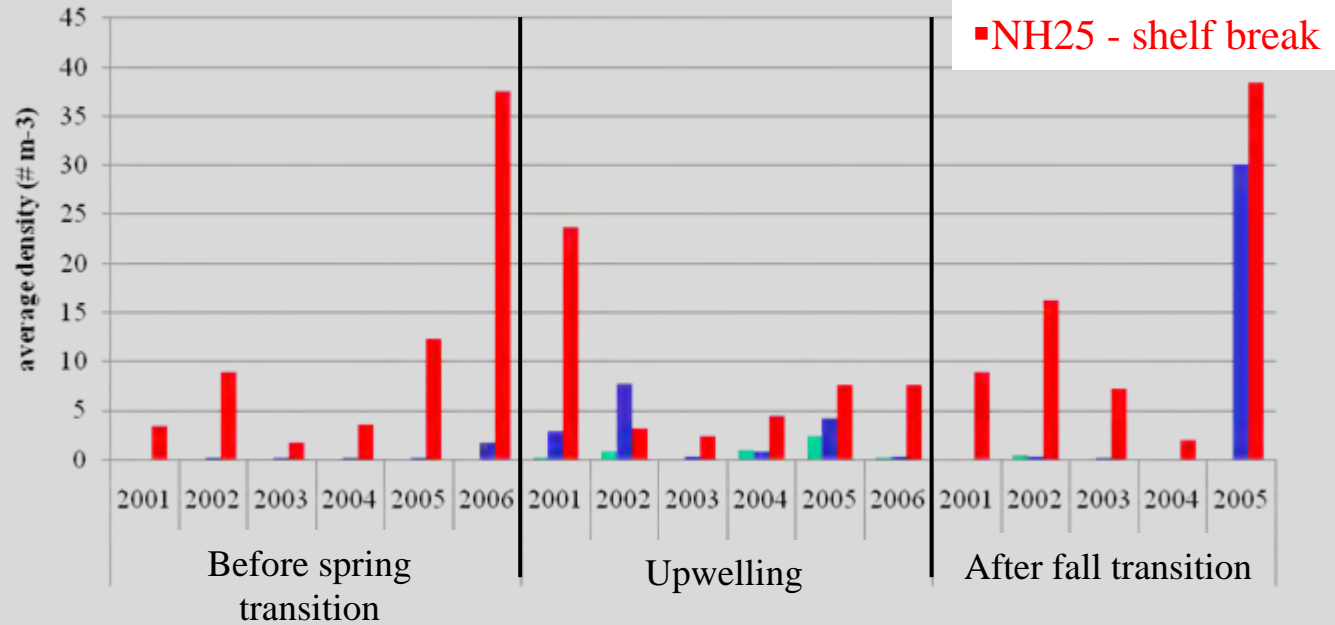
T. spinifera furcilia



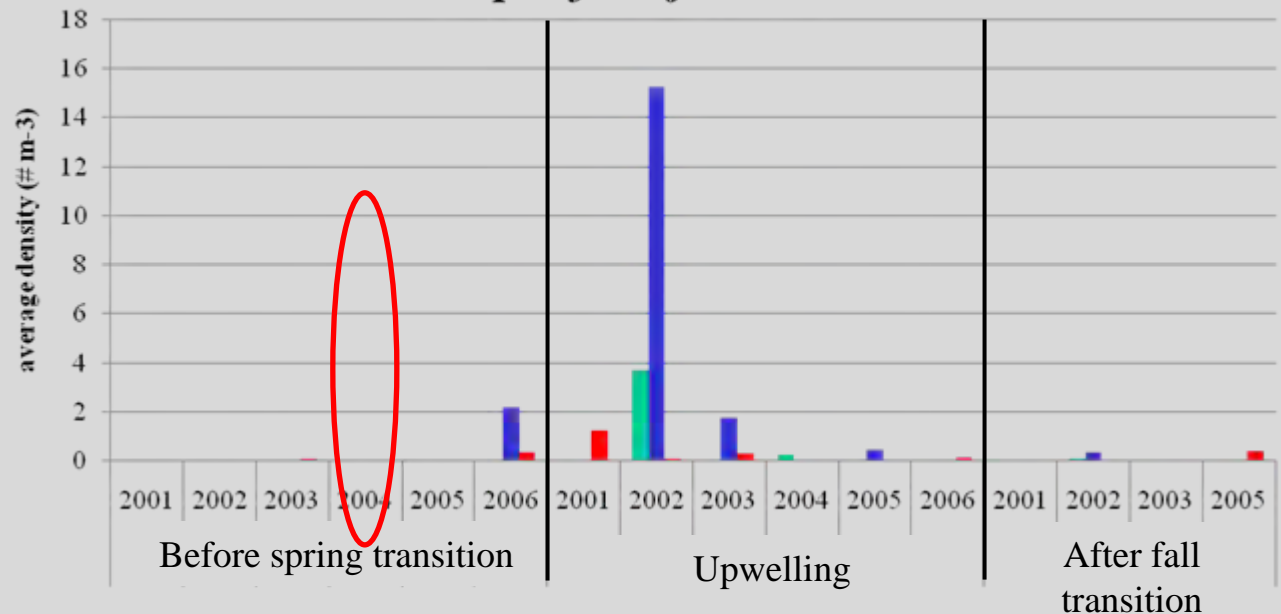
Juvenile

- Juvenile Ep clearly found offshore, densities generally lower during upwelling
- Lots of juveniles in 2005 after fall transition even though no furcilia
- Juvenile Ts densities generally low except 2002 - high level of Ts spawning
- Ts juveniles absent in 2004

E. pacifica juvenile



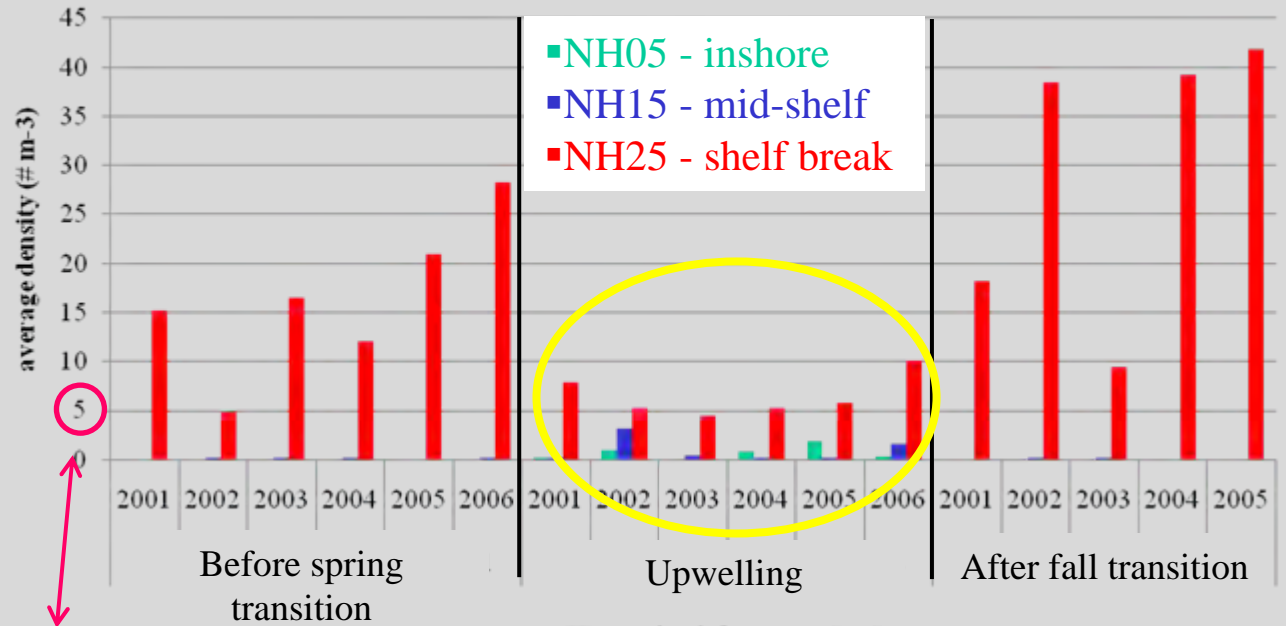
T. spinifera juvenile



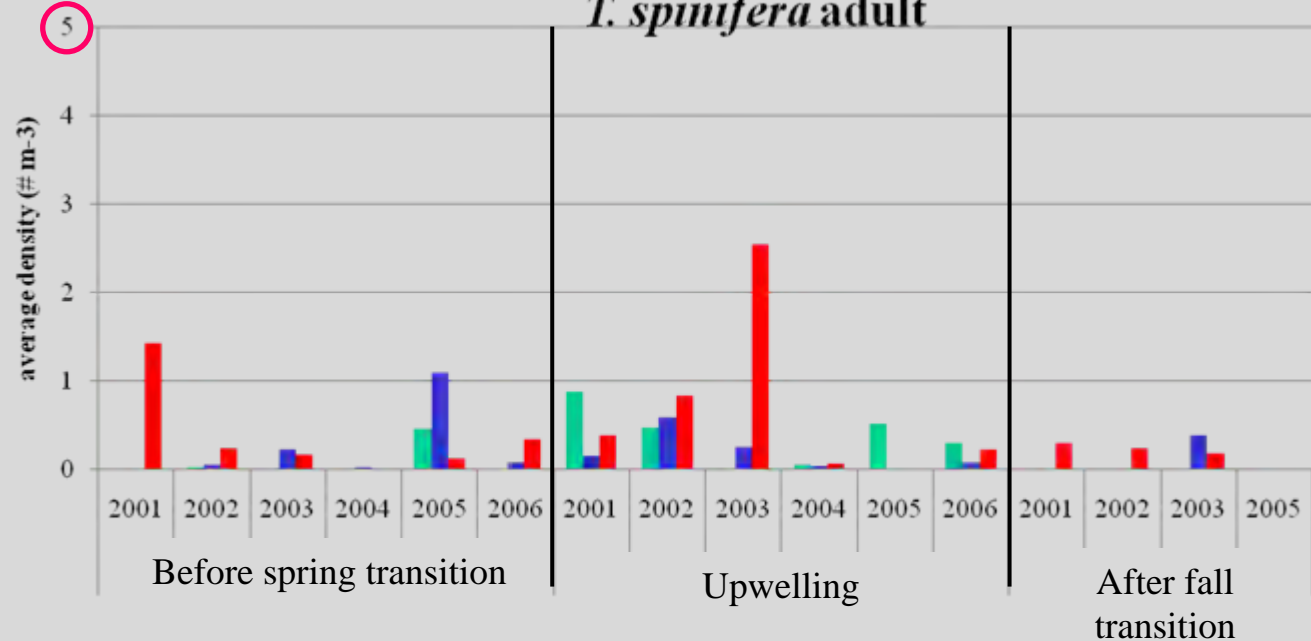
Adult

- Adult *Ep* consistently found at offshore station
- Interestingly, adult *Ep* density consistently lowest during upwelling
- Adult *Ts* density never very high (usually <1)
- No clear cross-shelf pattern for *Ts* adults

E. pacifica adult



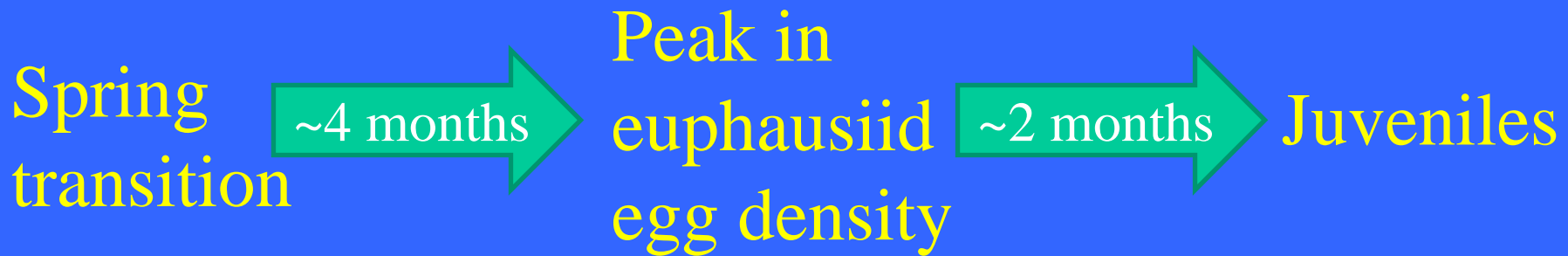
T. spinifera adult



Preliminary Results

- Cross-shelf distribution of life stages
 - *E. pacifica* : early life stages found inshore; juveniles & adults predominantly offshore
 - *T. spinifera*: eggs-furcilia consistently found inshore & mid-shelf; juvenile & adult densities low and show no clear cross-shelf pattern
- Seasonal patterns
 - *E. pacifica* eggs clearly associated with upwelling
 - *T. spinifera* start spawning prior to the spring transition
 - Early stages of *T. spinifera* common at mid-shelf & shelf break in 2004 but completely absent after fall transition
- Effect of cool & warm ocean conditions on these two euphausiid species not clear from this preliminary look at the data

Understanding ecosystem



- Consistent pattern for all six years of data regardless of PDO and upwelling conditions
- Timing of *E. pacifica* spawning tightly associated with upwelling
- Poor recruitment in 2005 (no furcilia) when upwelling started a month later than normal
- Changes in upwelling off the Oregon coast are likely to affect this pattern of euphausiid spawning

Summary & Future Plans

- Cross-shelf distribution patterns similar by species among years regardless of ocean conditions
 - *E. pacifica* early life stages inshore, juveniles & adults offshore
 - *T. spinifera* early life stages inshore, juveniles & adults low densities & no clear cross-shelf distribution patterns
- No obvious differences in abundance of euphausiids in relation to cold & warm years – temperature range during this study period may not have been high enough to show a strong effect
- Analyze these data using more specific characterizations of environmental conditions; it appears that something interesting was happening in 2004 before the spring transition

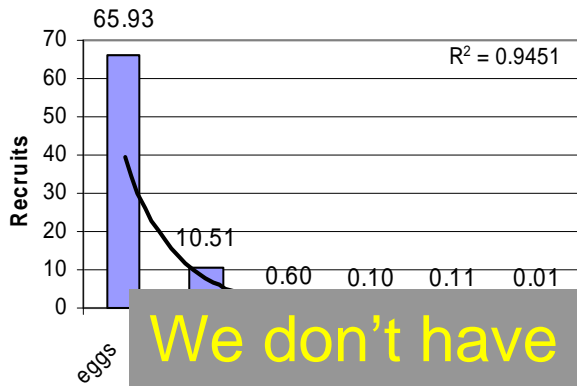
Acknowledgements

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- Current and former members of the Peterson lab at Hatfield Marine Science Center in Newport, Oregon
- Partial travel support provided by National Science Foundation

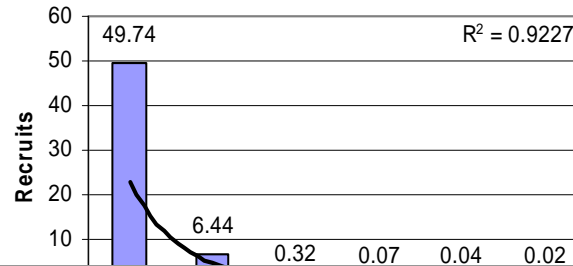


Survivorship Curves

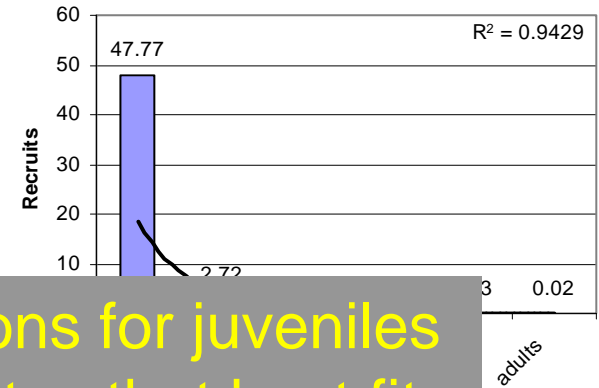
2001



2002



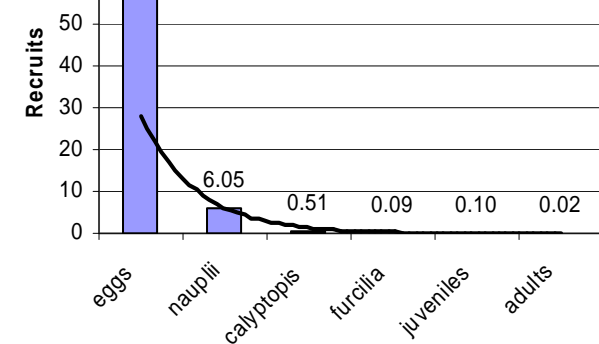
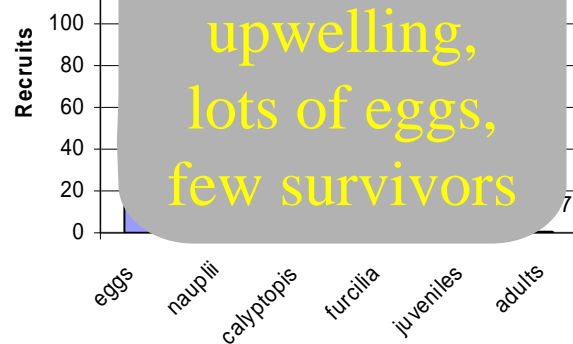
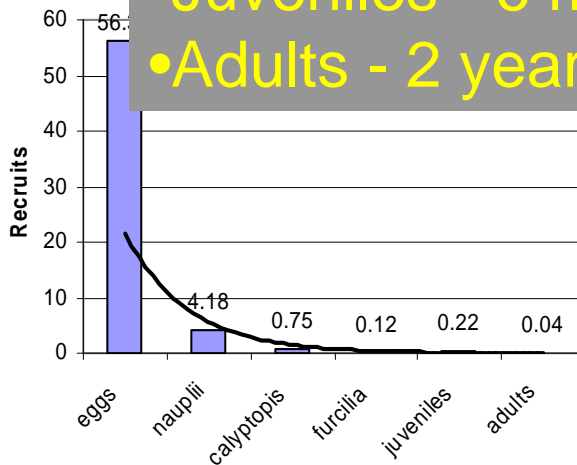
2003



We don't have measured stage durations for juveniles and adults. The stage duration estimates that best fit these curves were:

- Juveniles - 6 months
- Adults - 2 years

2005: late upwelling, lots of eggs, few survivors



Euphausiid Live Work Protocol

Protocols for Measuring Molting Rate and Egg Production of Live Euphausiids



Courtesy of the Peterson Lab at Hatfield Marine Science
Center, Newport, Oregon, USA

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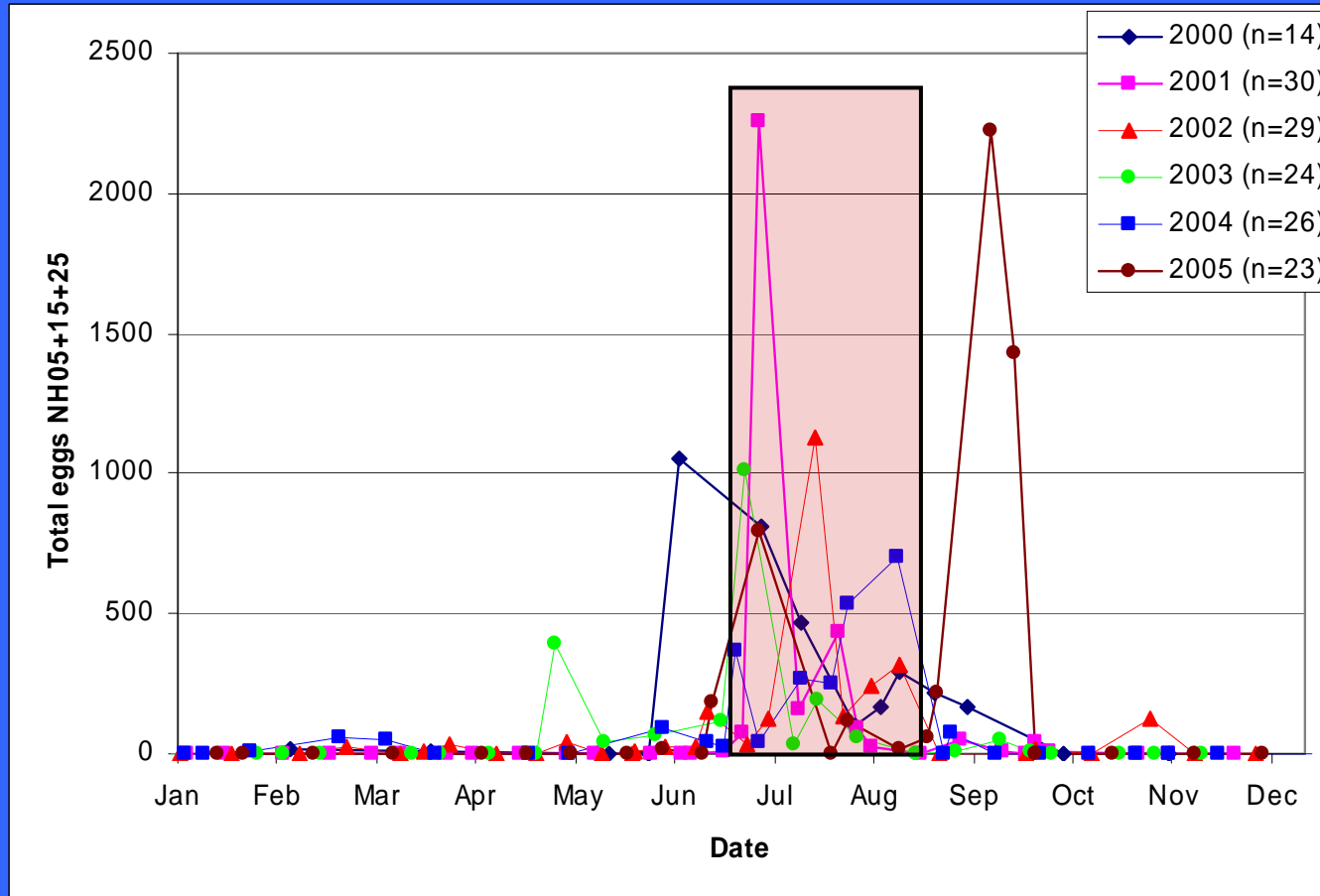
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- Everything you always wanted to know about working with live euphausiids!
- Available on the PICES website! (www.pices.int) under the “Projects” heading

E. pacifica spawning activity



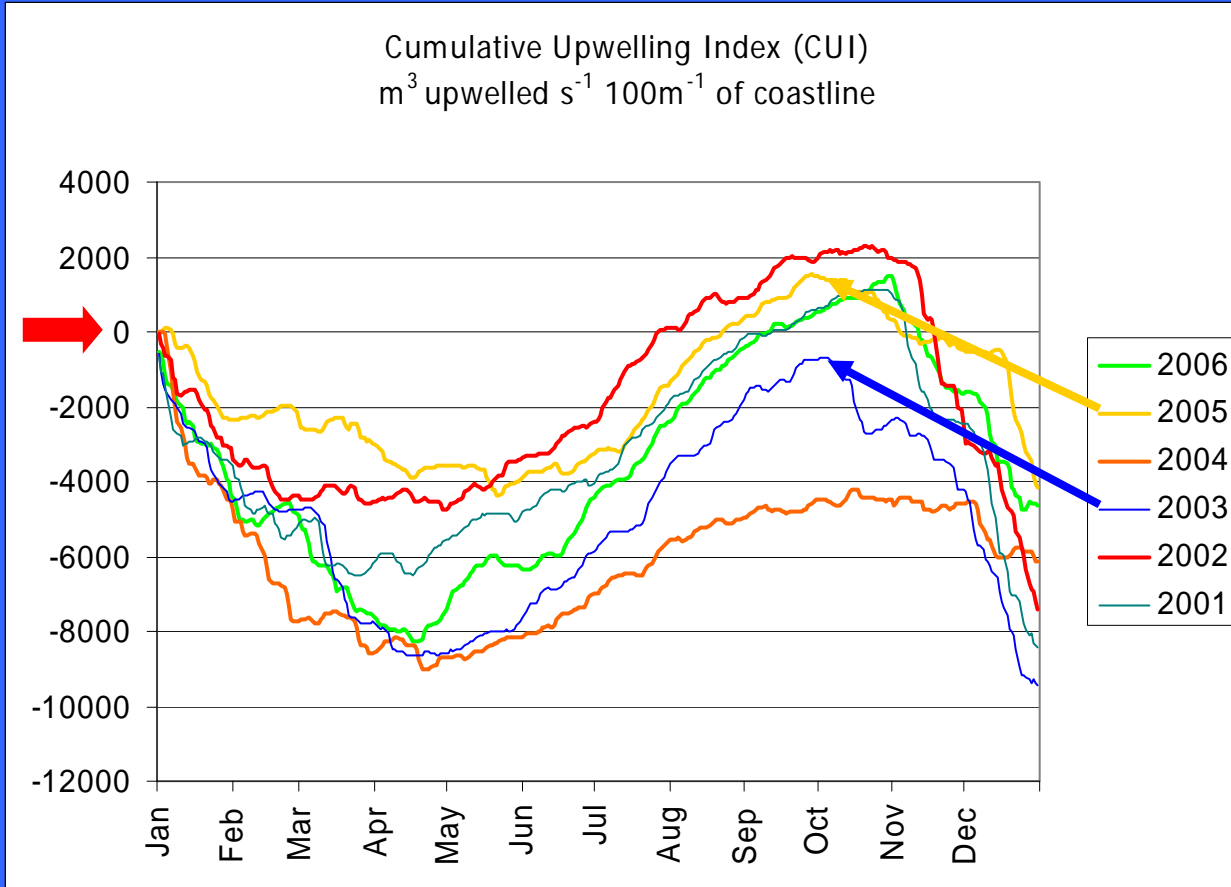
Timing of appearance of juvenile *E. pacifica* based on egg density

Year	Date of egg peak	Date size mode appeared	Months btwn dates	Size mode
2001	18-Jul	7-Nov	3.7	9.14
2001	18-Jul	27-Nov	4.4	5.13
2002	23-Jul	15-Oct	2.8	6.45
2002	1-Nov	6-Feb	3.2	6.95
2003	3-Jul	5-Sep	2.1	4.98
2004	17-Aug	28-Oct	2.4	7.95
2005	21-Sep	15-Nov	1.8	4.55
2006	22-Aug	20-Oct	2.0	5.75

Test of this idea limited by sampling intervals. Longer intervals tend to have a higher size mode, consistent with the animals having had more time to grow.

Cumulative Upwelling Index

2001-2006



- CUI positive during upwelling season 2001, 2002, 2005, 2006
- Shortest upwelling seasons 2003 (5.9 mo.), and 2005 (4.2 mo.).
- Average 6.7 months of upwelling

Seasonal comparison

- Two seasons in the ocean off the Oregon coast – upwelling and downwelling
- Seasons defined by timing of spring and fall transitions based on several environmental conditions (Logerwell et al. 2003)
- Median spring transition date (=upwelling) **April 18** (range March 2 - May 25)
- Median fall transition date (=downwelling) **Oct. 27** (range Sept. 13 - Nov. 17)
- Data in the stage-specific graphs use transition dates specific to each year