

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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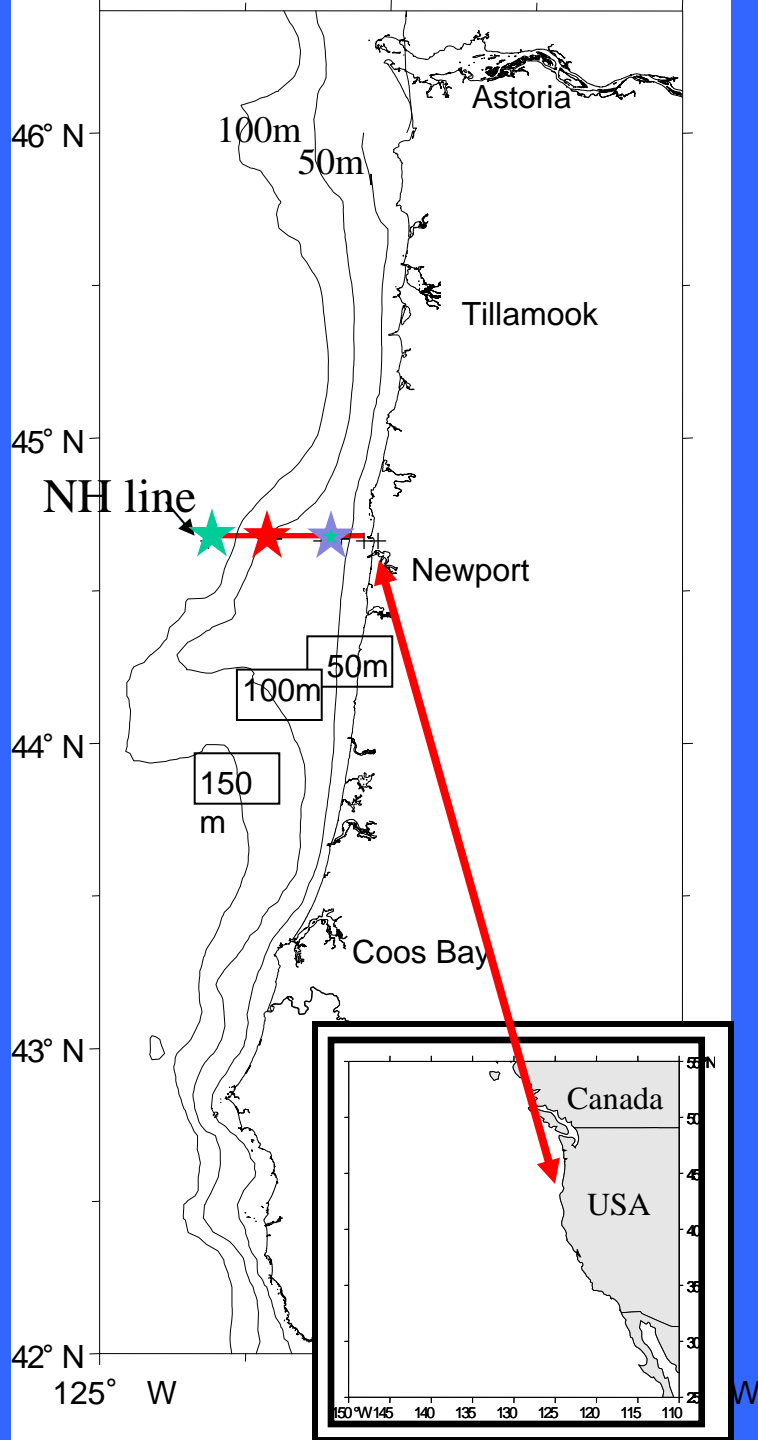


Thysanoessa spinifera

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



Station Name	Depth (m)	Km from shore	Shelf location
NH05	60	8	Inshore
NH15	90	24	Mid-shelf
NH20	296	40	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

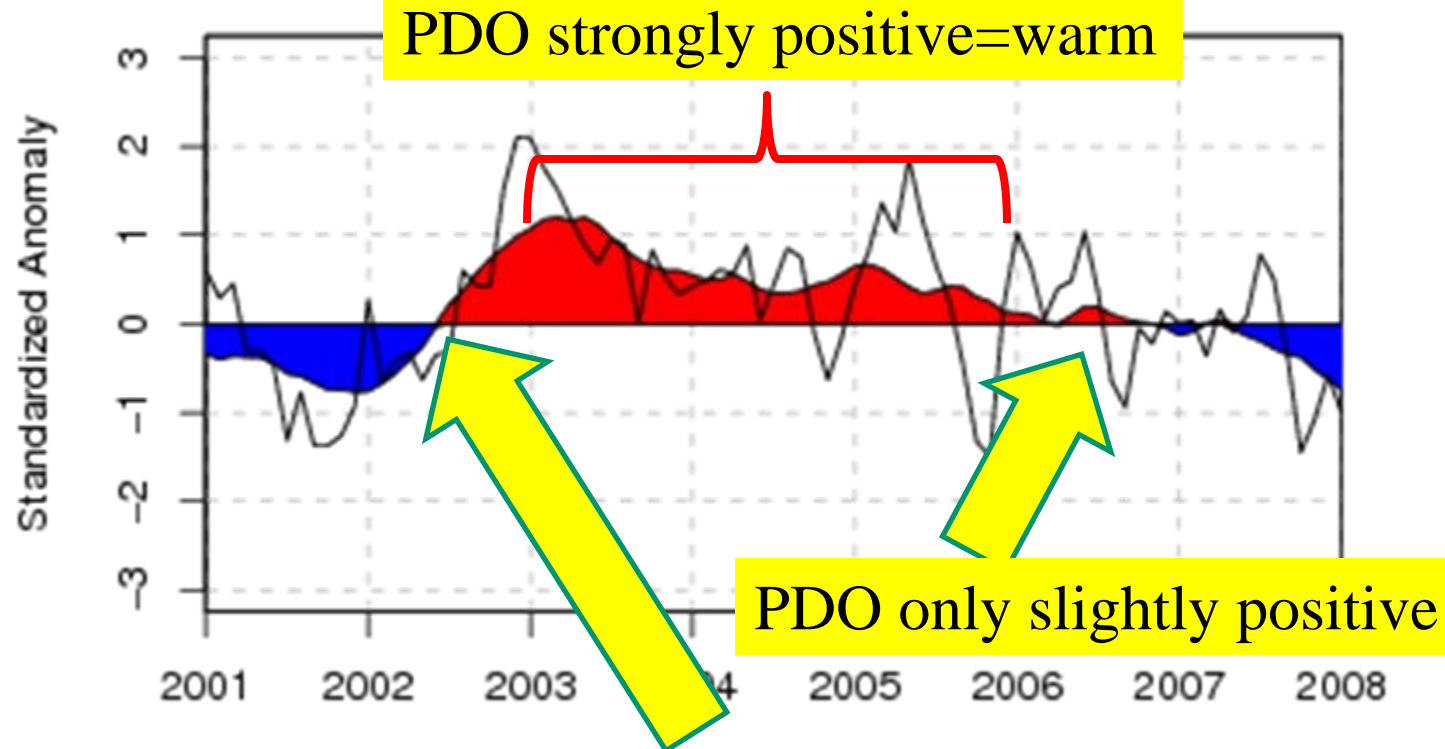


- Generally found on the shelf (<200 m depth)
- Spawn before & during upwelling, no intense period
- Prefer cooler ocean conditions

Methods

- Collected and counted lots of 1/2m vertical net and night-time bongo net samples (data presented are from 2001-2006 but project is ongoing)
- Identified all life stages of euphausiids to species (*E. pacifica* and *T. spinifera*)
- Data on early life stages of euphausiids are from 1/2m net samples - eggs, nauplii, calyptopis, and furcilia (L. Feinberg)
- Data for juvenile and adult euphausiids from nighttime bongo nets (T. Shaw)
- 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

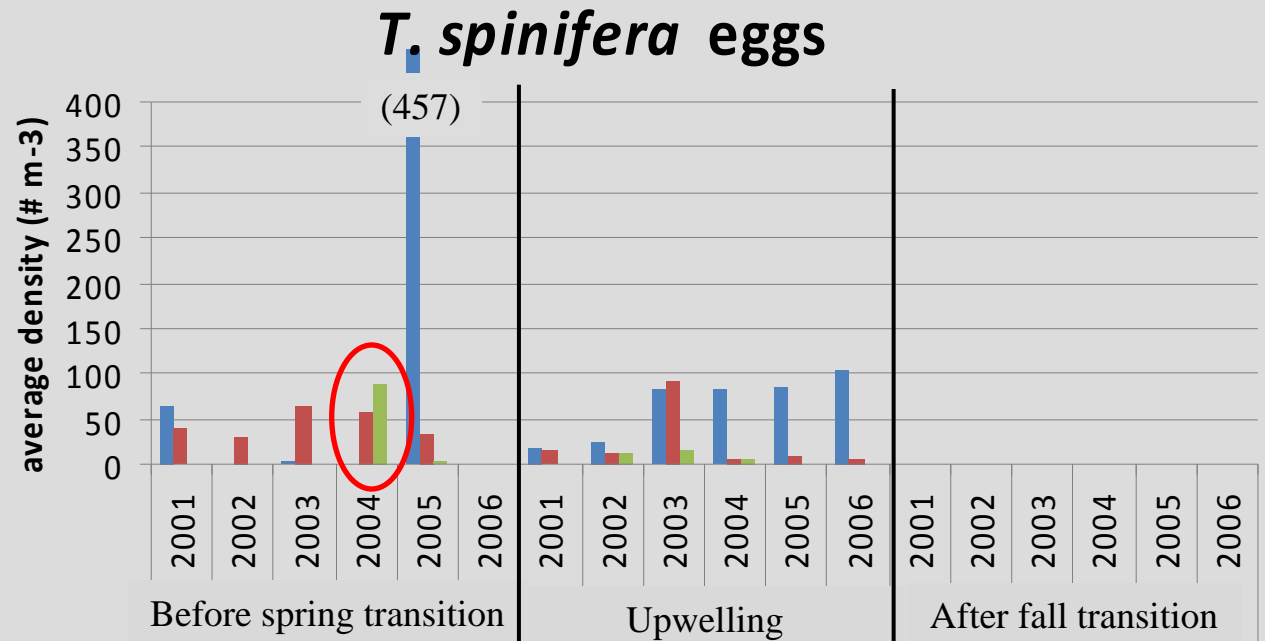
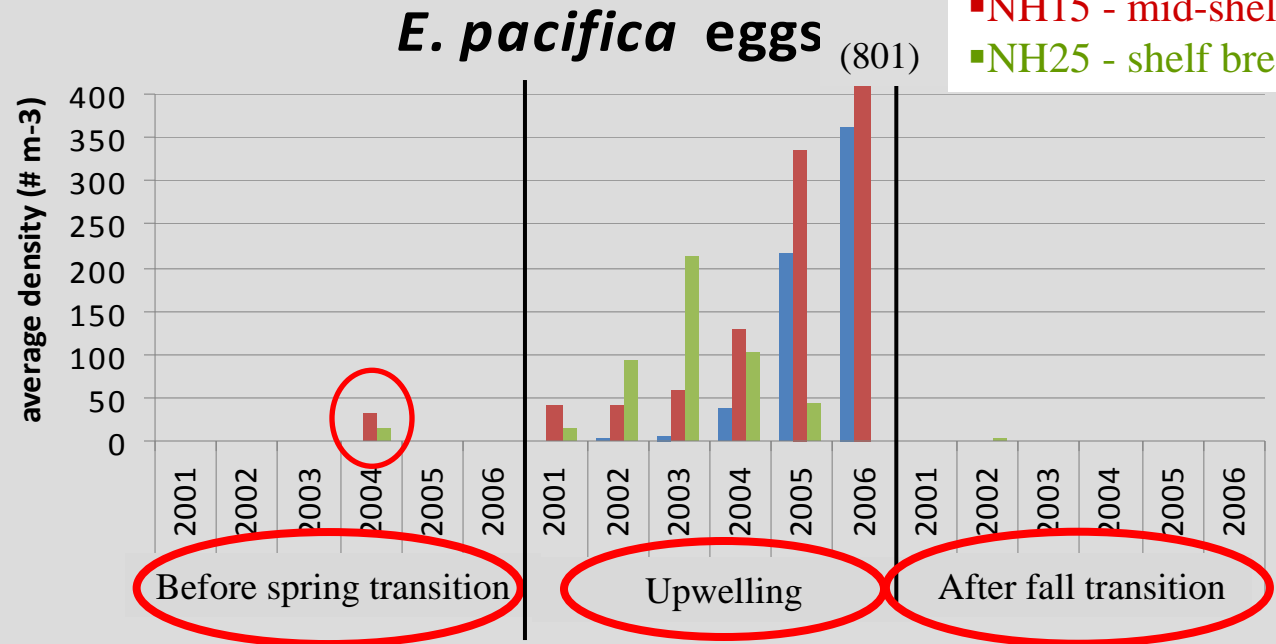
Summary of Ocean Conditions

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
- Ep and Ts eggs present at mid-shelf & shelf break in 2004

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

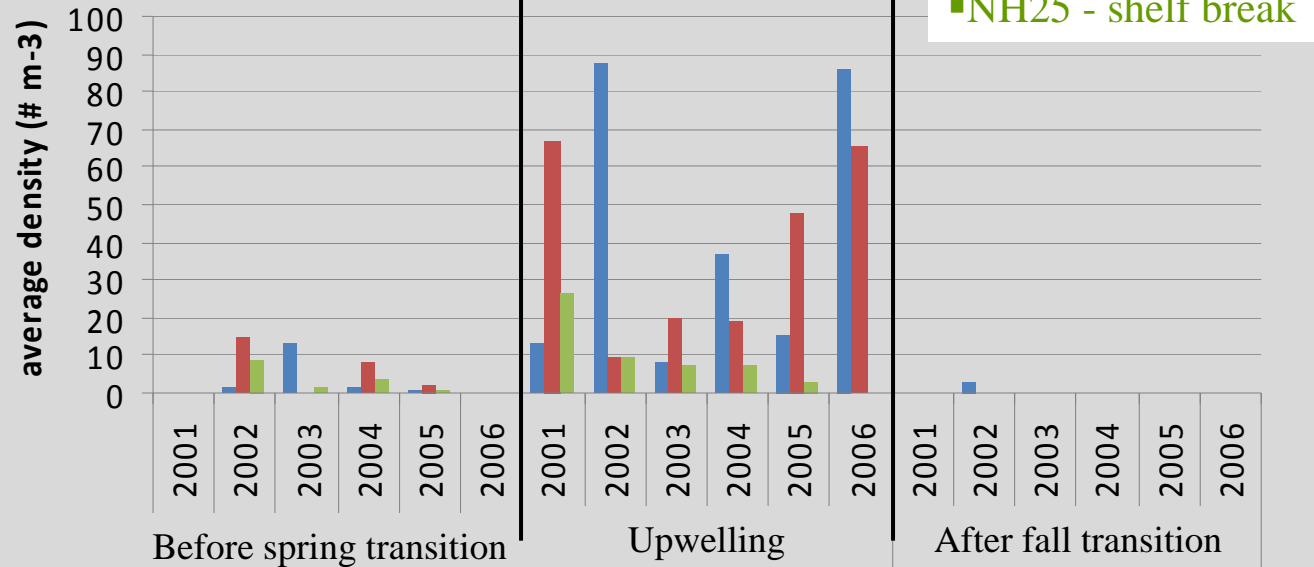


Nauplius

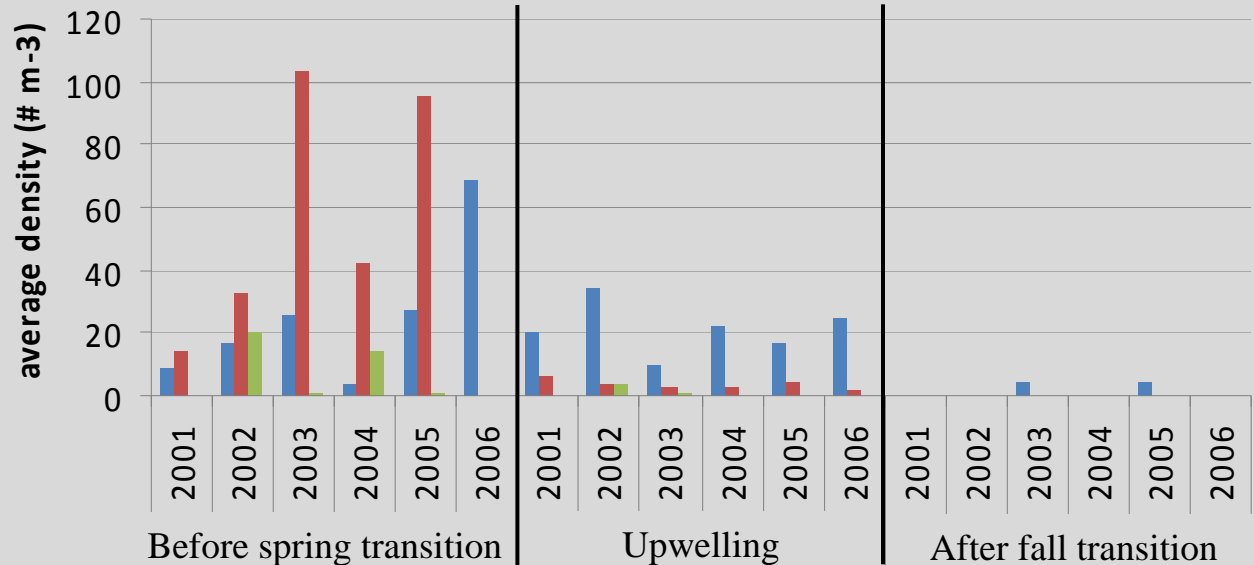
(includes metanauplius)

- 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
- Ts present at NH05 during upwelling but essentially absent from other stations

E. pacifica nauplius



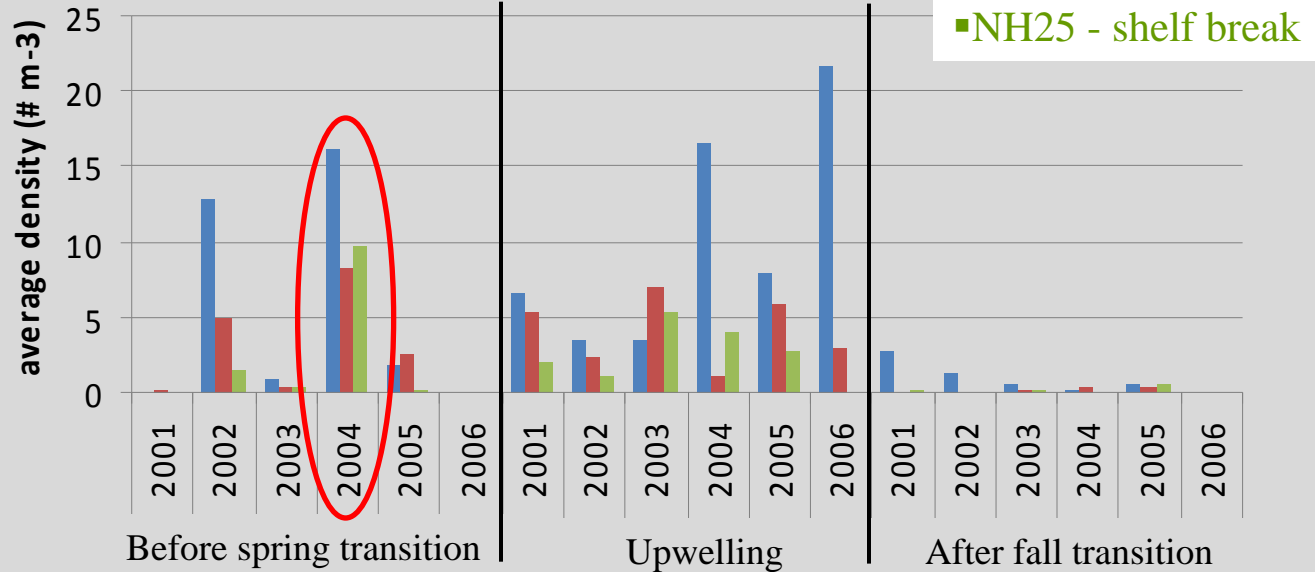
T. spinifera nauplius



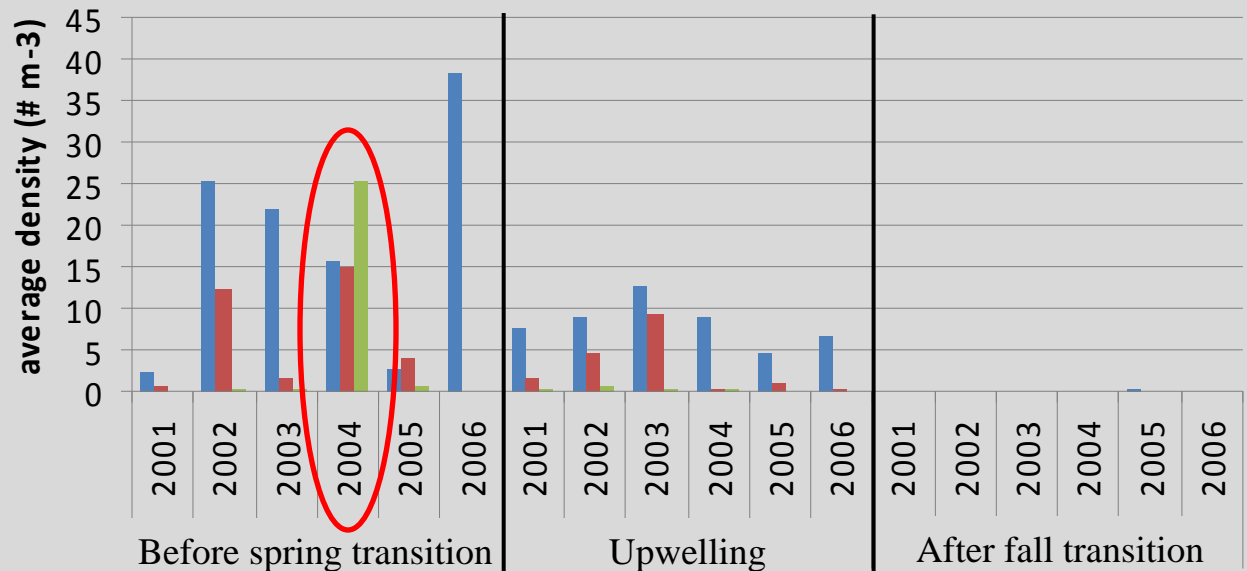
Calyptopis

- 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 before spring transition in 2004

E. pacifica calyptopis



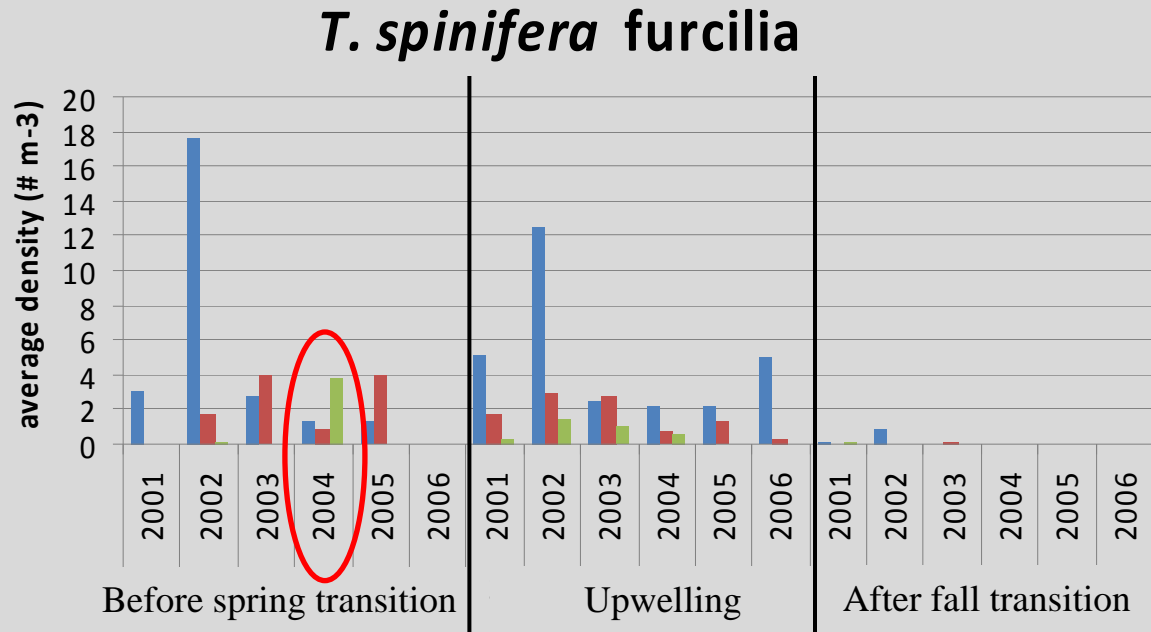
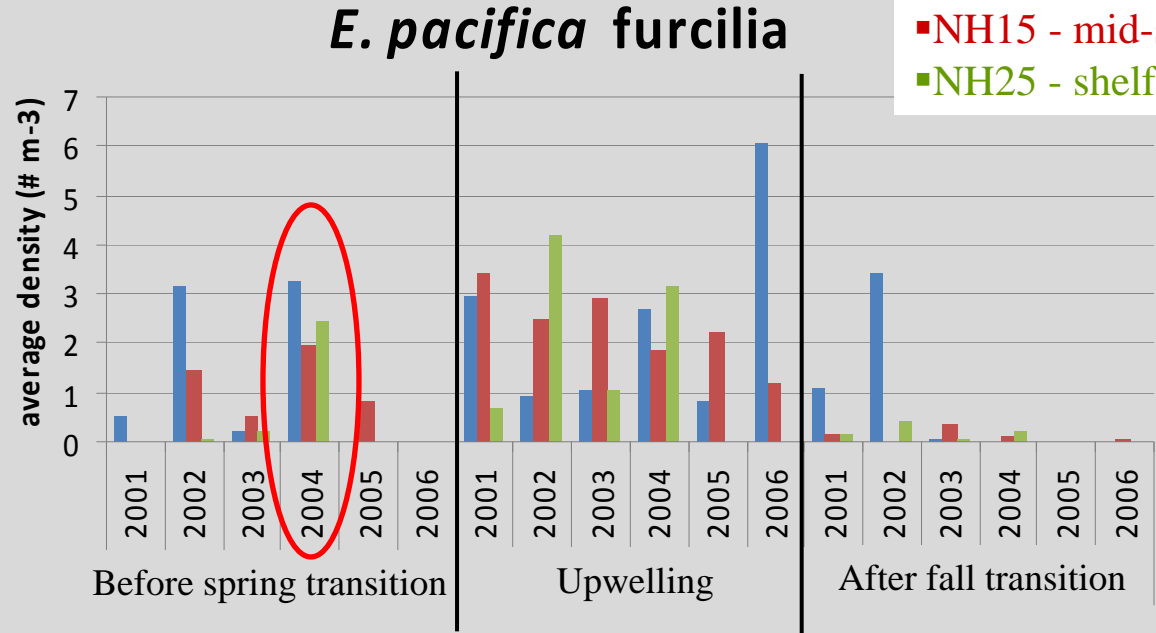
T. spinifera calyptopis



Furcilia

- Densities generally <4 for both species
- High Ts furcilia inshore in 2002: a cold year with lots of Ts spawning
- Ep & Ts present at all stations before spring transition in 2004

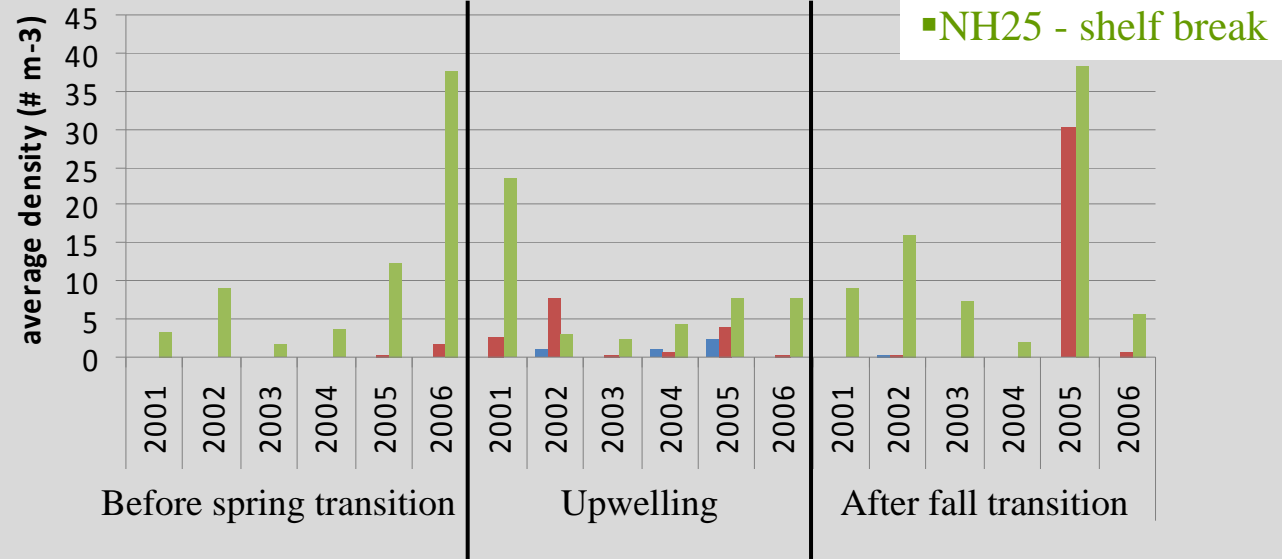
■ NH05 - inshore
■ NH15 - mid-shelf
■ NH25 - shelf break



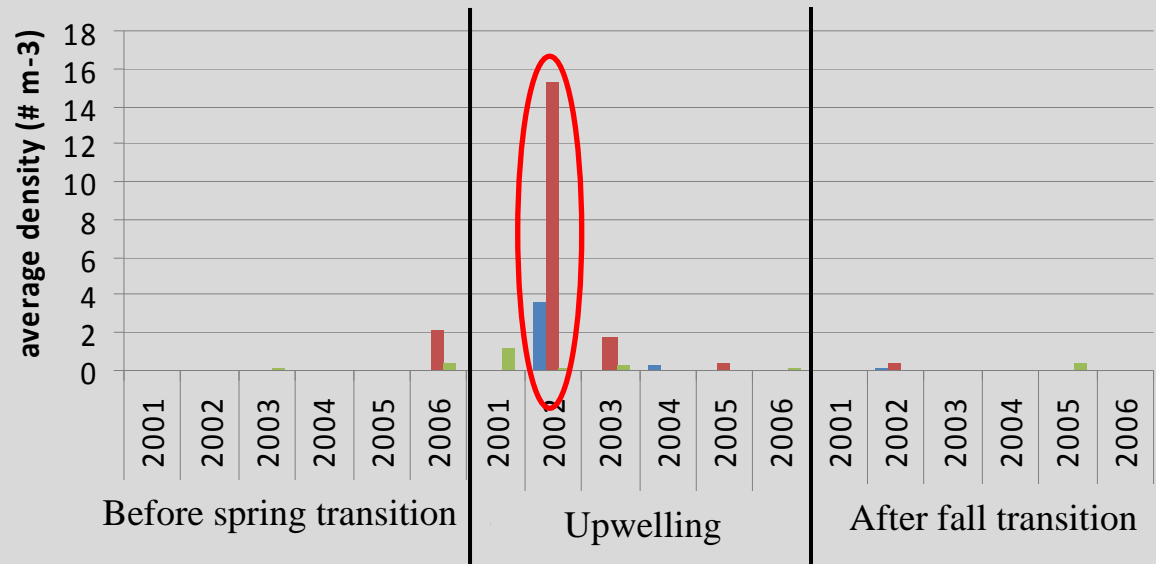
Juvenile

- Juvenile Ep clearly found offshore, densities generally lower during upwelling
- Juvenile Ts densities generally low except 2002 - high level of Ts spawning

E. pacifica juvenile



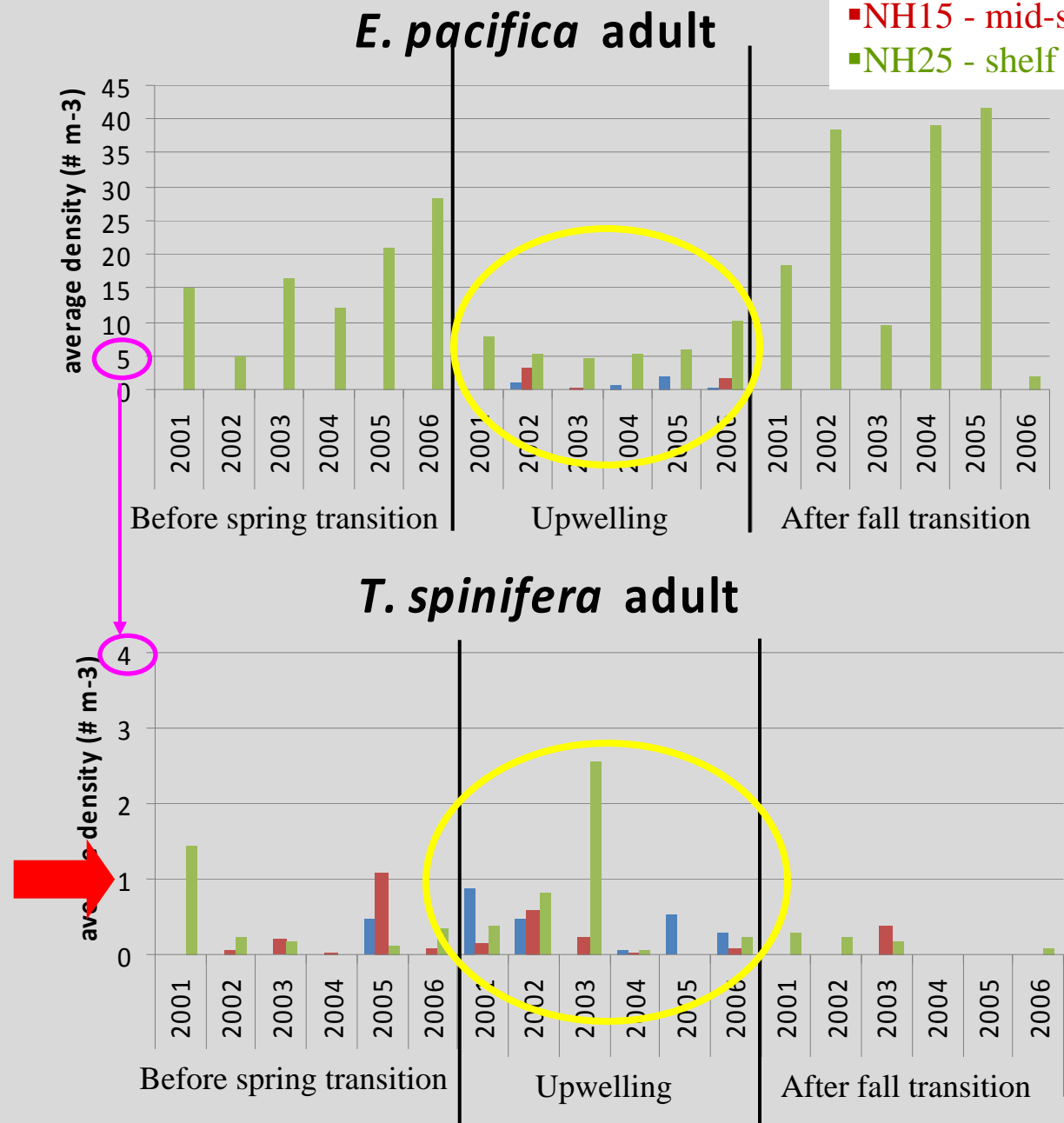
T. spinifera juvenile



Adult

- Adult Ep consistently found at offshore station (green bars)
- Interestingly, adult Ep density tended to be lower during upwelling
- Adult Ts density never very high (usually <1)
- No clear cross-shelf pattern for Ts adults

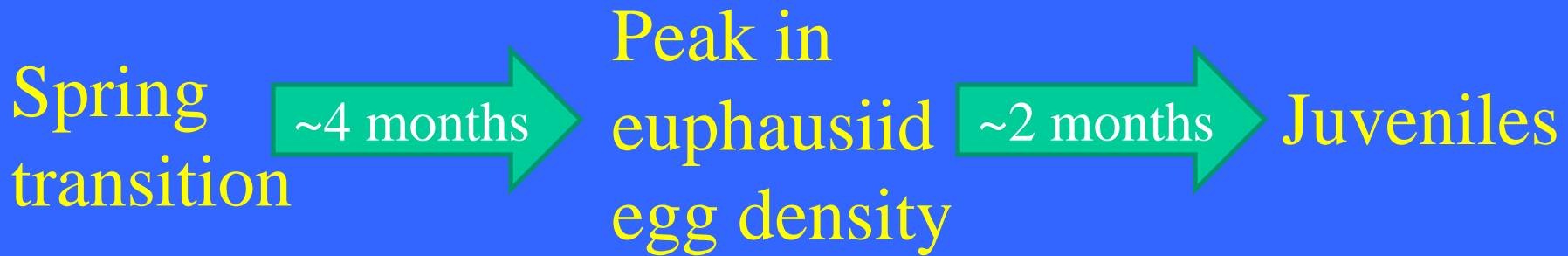
- NH05 - inshore
- NH15 - mid-shelf
- NH25 - shelf break



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

Relationship between *E. pacifica* spawning and timing of spring transition



- Consistent pattern for all six years of data regardless of PDO and upwelling conditions
- Timing of *E. pacifica* spawning tightly associated with upwelling
- Changes in the timing and/or strength of upwelling off the Oregon coast are likely to affect this pattern of euphausiid spawning

Summary

- *E. pacifica* early life stages found inshore, juveniles & adults offshore
- *T. spinifera* early life stages found inshore, densities of juveniles & adults are low and show no cross-shelf pattern
- No striking 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
- Cross-shelf distribution of both species prior to the spring transition in 2004 suggests that something unusual took place prior to the official start of the upwelling period

Acknowledgements

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- Current and former members of the Peterson lab at Hatfield Marine Science Center in Newport, Oregon



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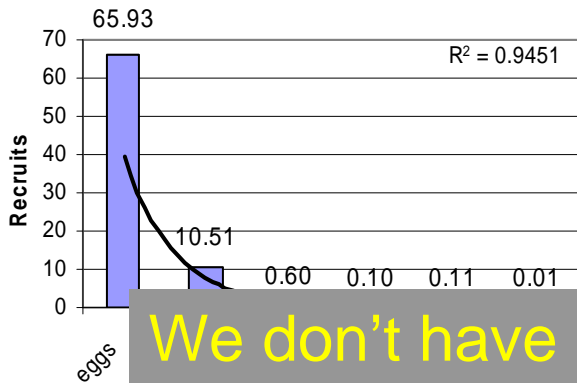
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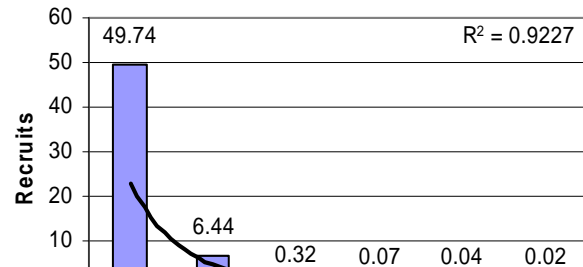
- Everything you always wanted to know about working with live euphausiids!
- Available on the PICES website! (www.pices.int) under the “Projects” heading

Survivorship Curves

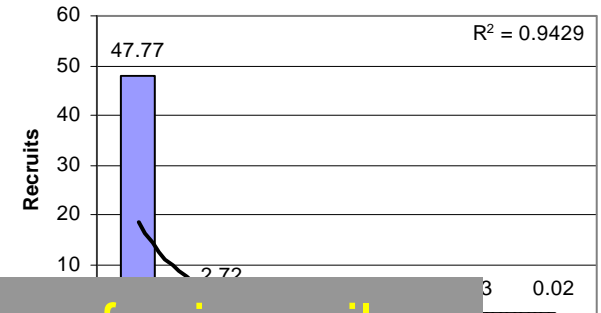
2001



2002



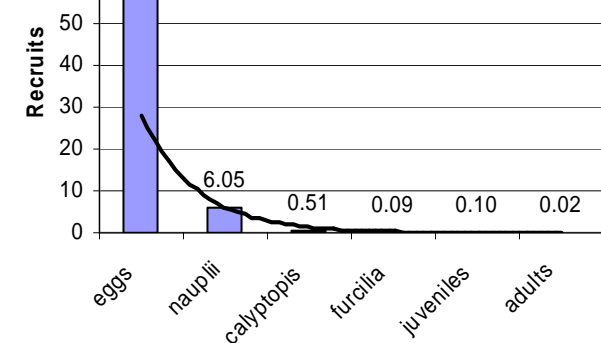
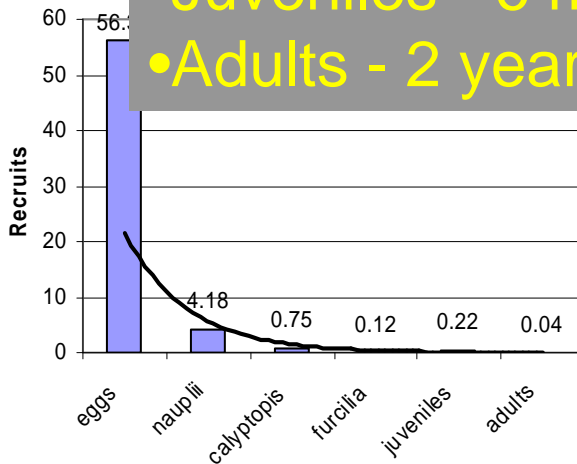
2003



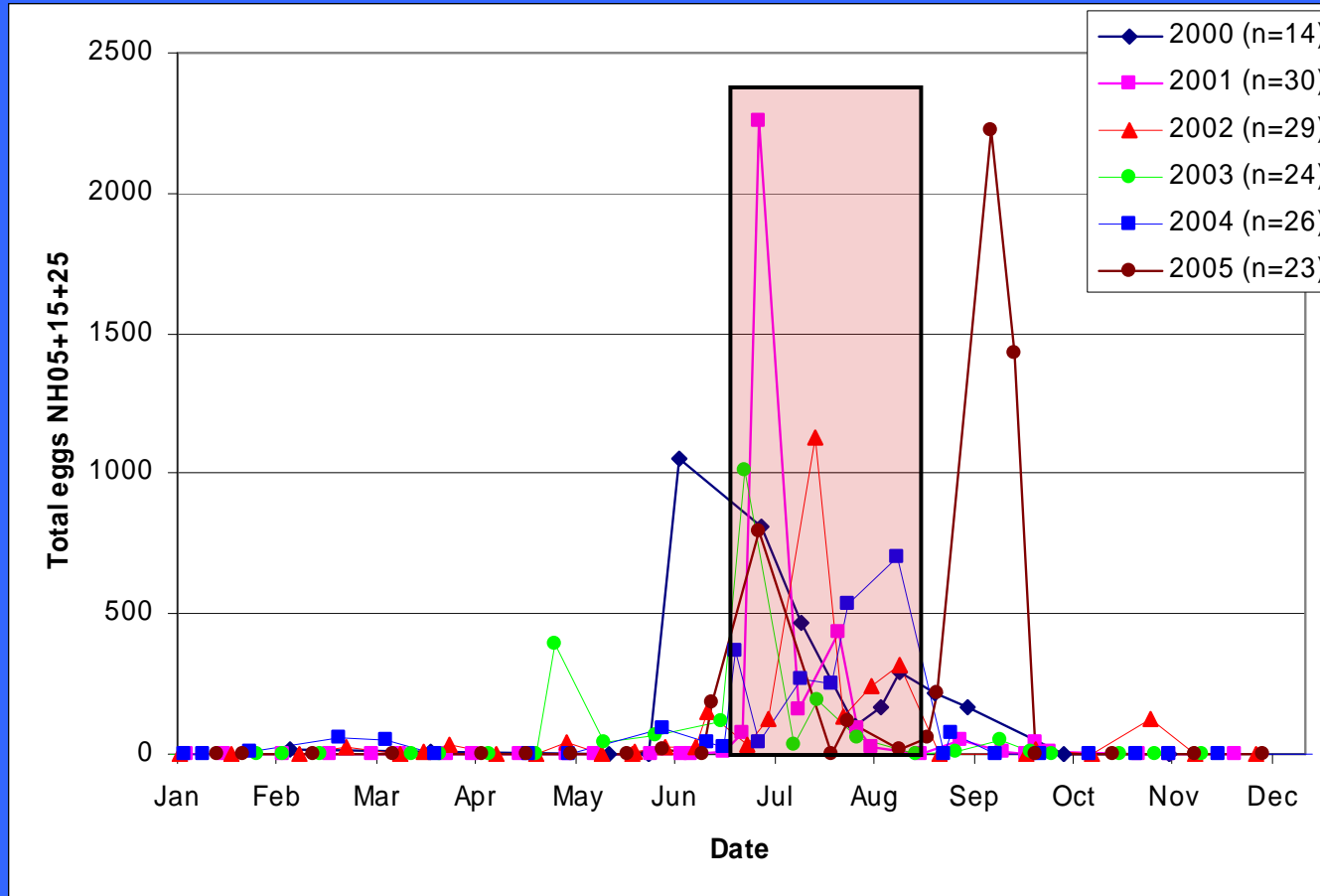
We don't have measured stage durations for juveniles and adults. The stage duration estimates that best fit these curves were:

- Juveniles - 6 months
- Adults - 2 years

2005: late upwelling, lots of eggs, few survivors



E. pacifica spawning activity



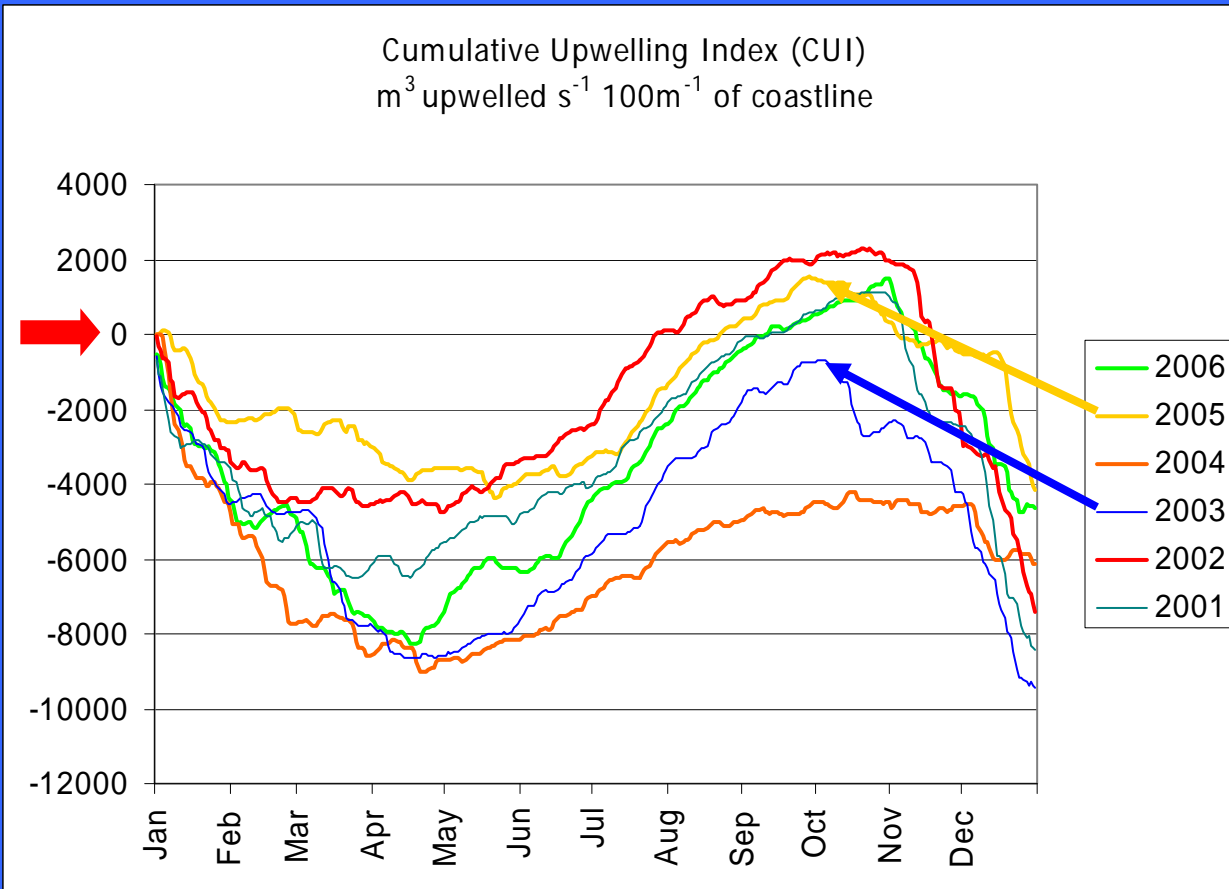
Timing of appearance of juvenile *E. pacifica* based on egg density

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