Biological responses to oceanic climate variability off Oregon and Washington USA in three calanoid copepods: *Acartia tonsa*, *Calanus pacificus*, and *Paracalanus parvus*

Jesse F. Lamb[1], Bill T. Peterson[2], Cheryl A. Morgan[1], Julie E. Keister[3]

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

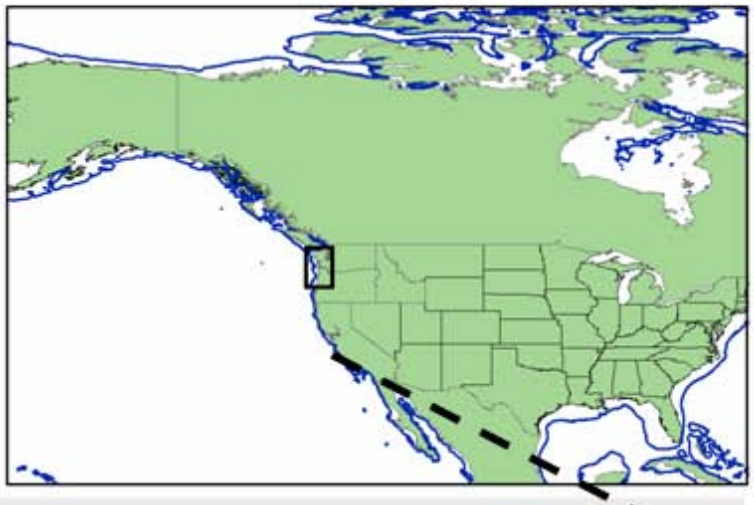
[2] Northwest Fisheries Science Center, NOAA Fisheries, Hatfield Marine Science Center, Newport, OR USA

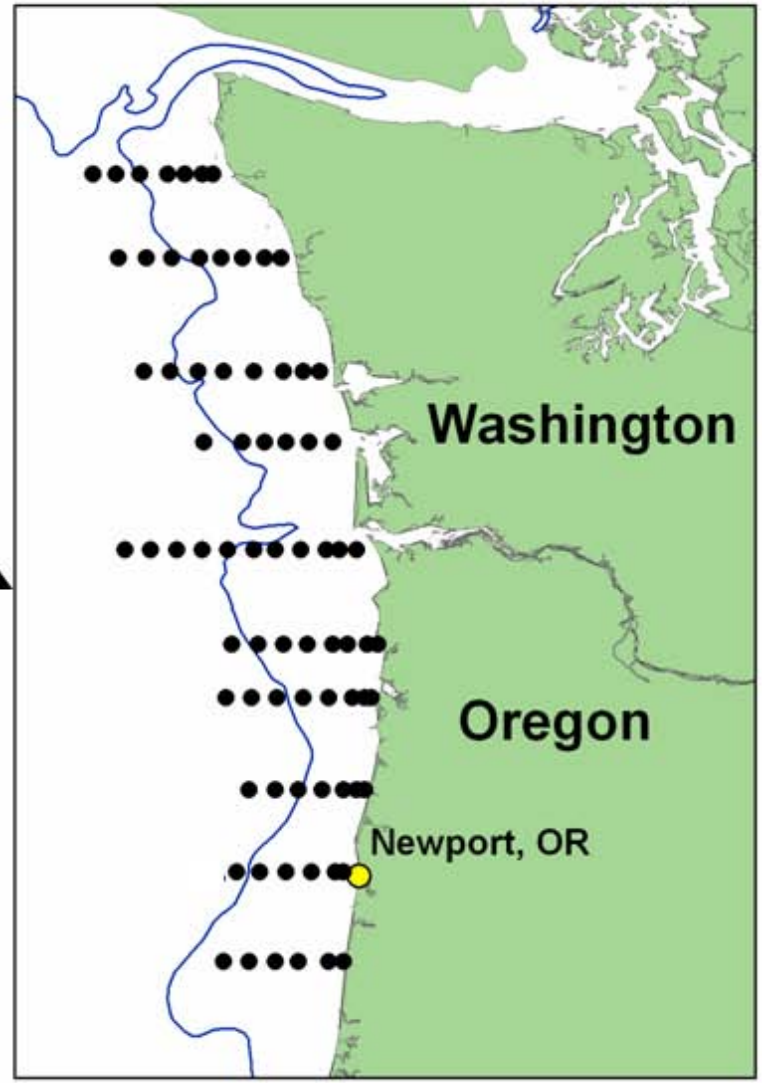
[3] College of Oceanic and Atmospheric Sciences, Oregon State University, Corvallis, OR USA

Outline

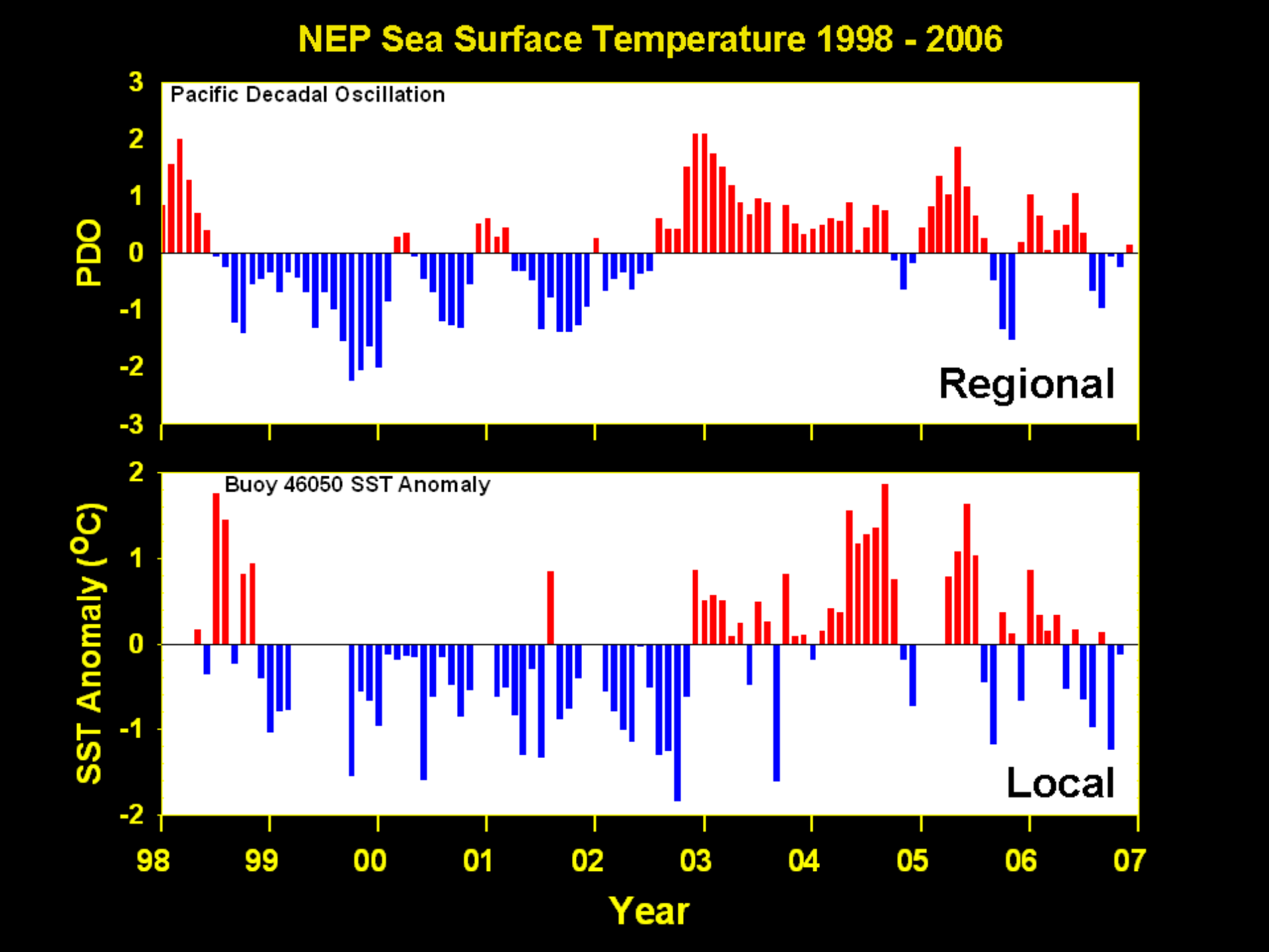
- Overview of the recent SST anomalies in the Northeast Pacific
- SST comparisons to Copepod Community structure
- Comparisons of three warm water copepod species and their relation to local changes in SST (and climate variability)
- Conclusions

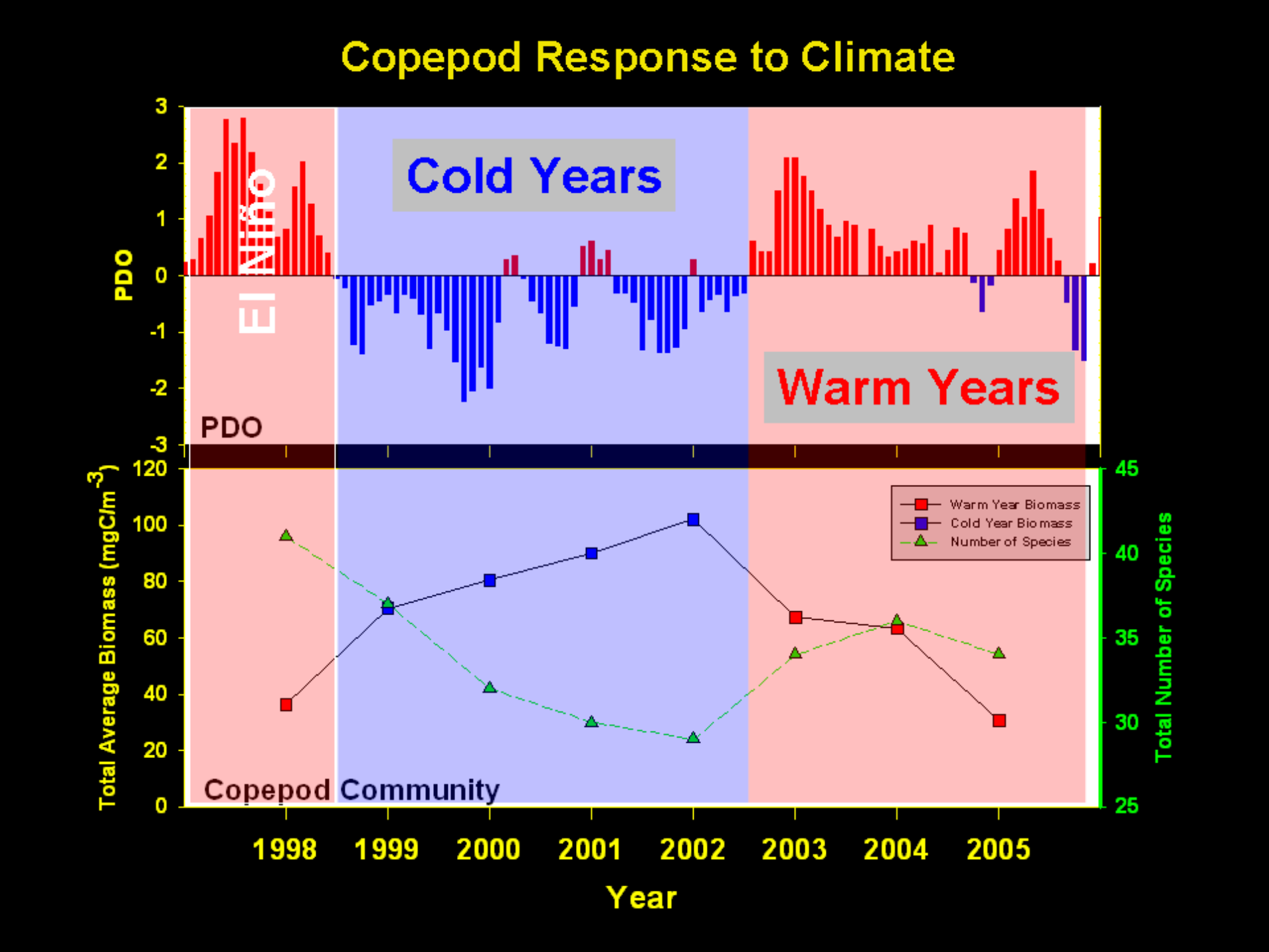
Sampling Methodology



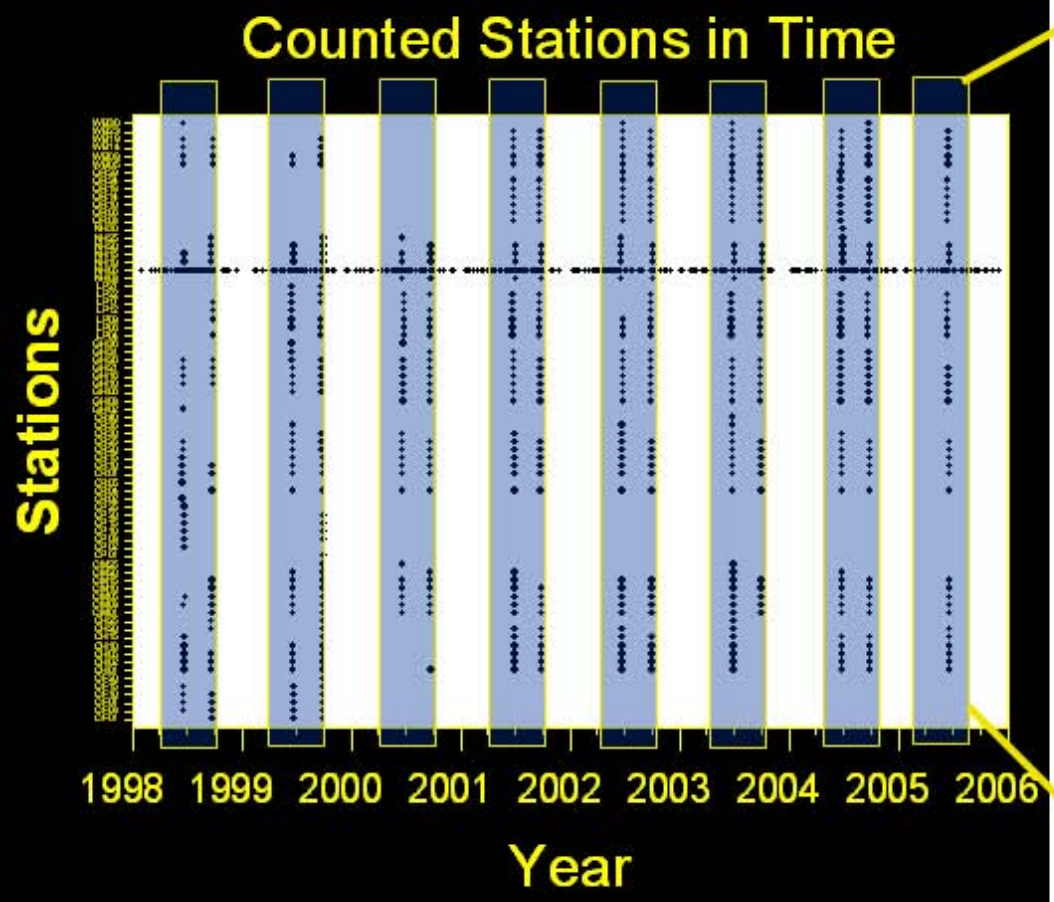


- 1/2m diameter 202 µm mesh Vertical Net Hauls from a maximum depth of 100 m to the surface
- 1998 – 2005
- 44 – 48°N Latitude,
- BPA Salmon Project: June & September sampling
- Newport Hydrographic Line Project : Biweekly, 12+ years
- 847 total samples used for analysis

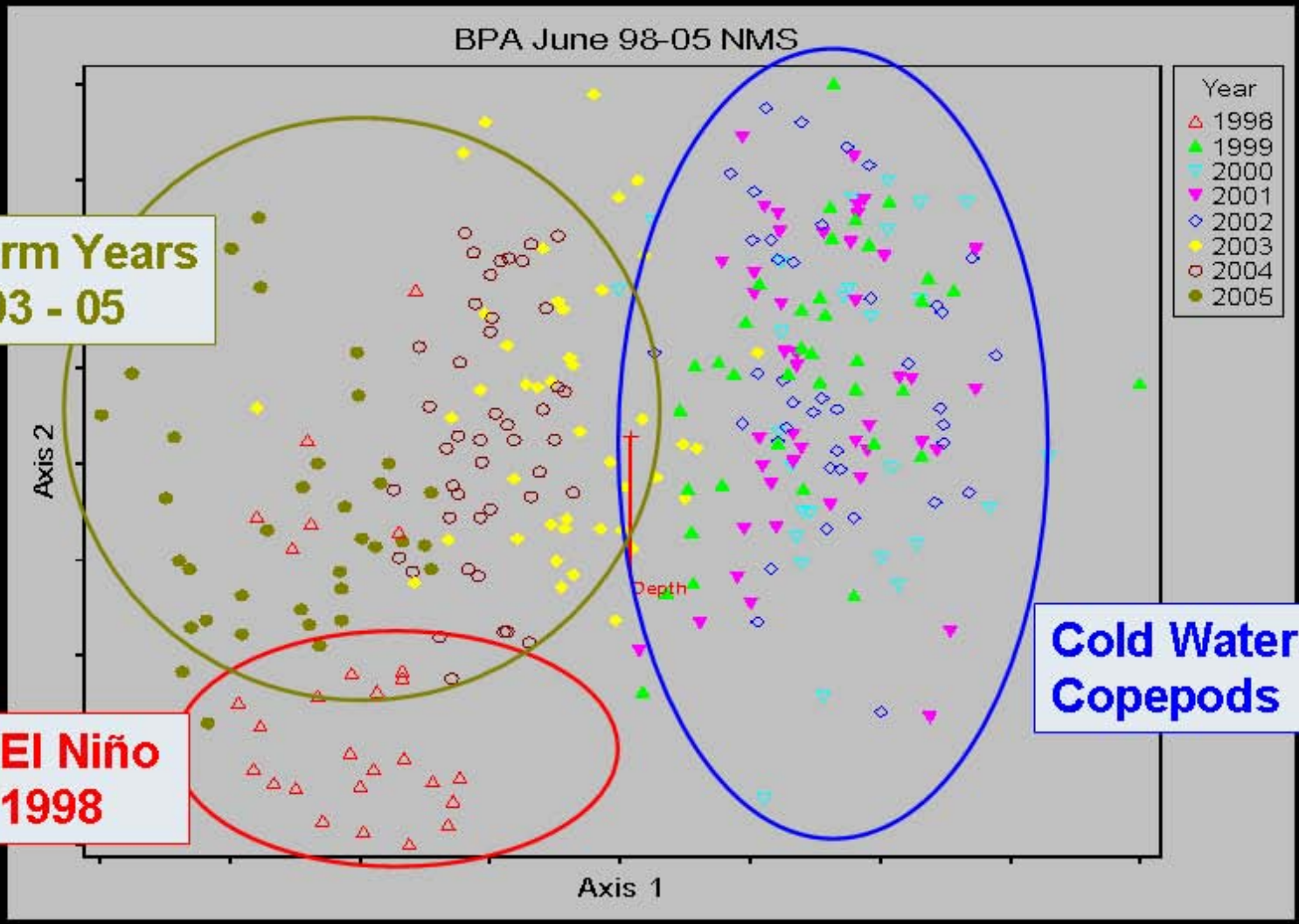

NEP Sea Surface Temperature 1998 - 2006
Pacific Decadal Oscillation
PDO
3
2
1
0
-1
-2
-3
Regional
Buoy 46050 SST Anomaly
SST Anomaly (°C)
2
1
0
-1
-2
Local
98
99
00
01
02
03
04
05
06
07
Year


Copepod Response to Climate
PDO
El Niño
Cold Years
Warm Years
PDO
Total Average Biomass (mgC/m-3)
Warm Year Biomass
Cold Year Biomass
Number of Species
Total Number of Species
Copepod Community
1998
1999
2000
2001
2002
2003
2004
2005
Year

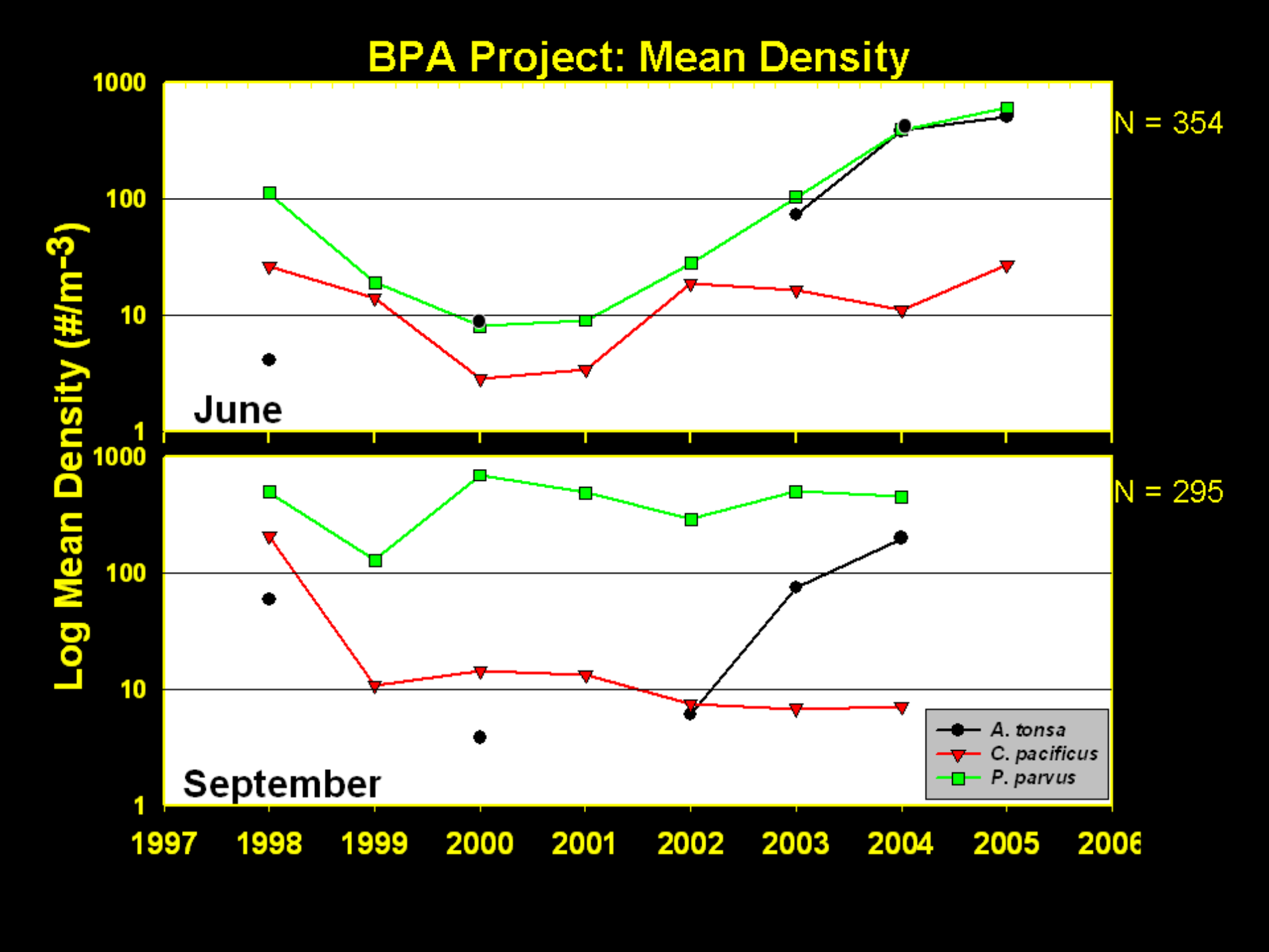
BPA Sampling – June & September



N = 298

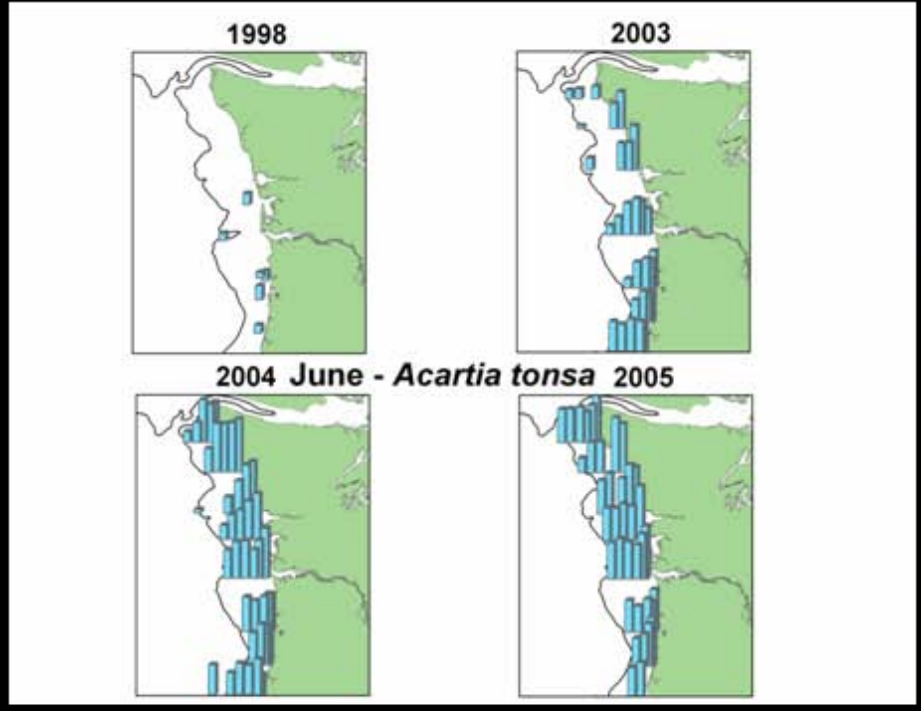


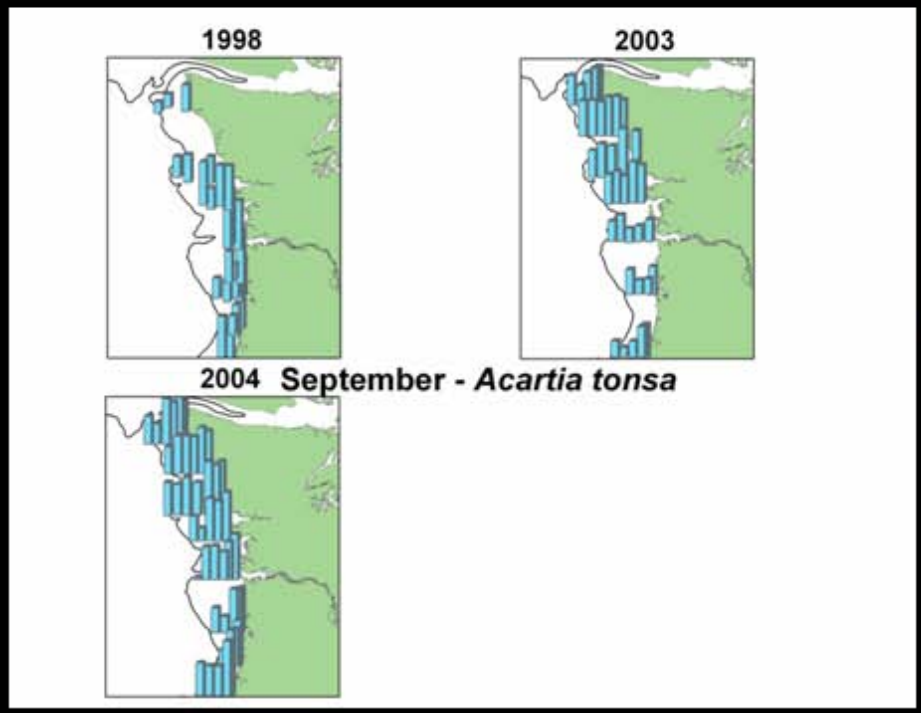
Warm Water Species	Cold Water Species
Acartia tonsa	*Acartia longiremis*
Calanus pacificus	*Calanus marshallae*
Paracalanus parvus	*Pseudocalanus spp.*


BPA Project: Mean Density
Log Mean Density (#/m-3)
1000
100
10
1
June
N = 354
September
N = 295
A. tonsa
C. pacificus
P. parvus
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006

Occurrence of *A. tonsa*, *C. pacificus*, and *P. parvus* in BPA project samples

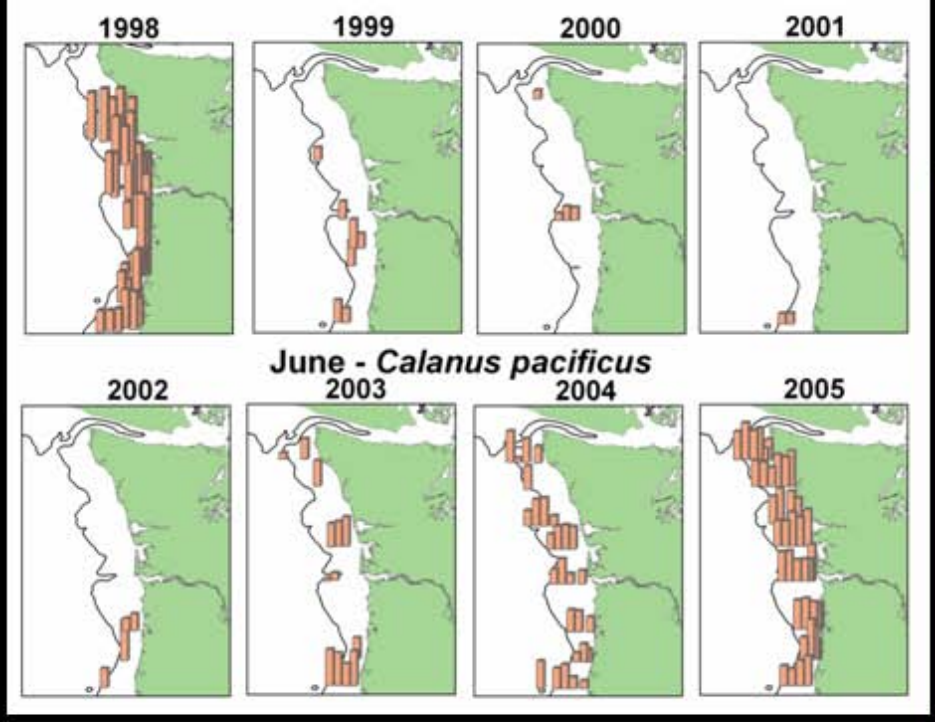
		% of Samples Containing		
Year	Samples Counted	*A. tonsa*	*C. pacificus*	*P. parvus*
1998	71	48	97	97
1999	95	0	39	71
2000	63	5	43	73
2001	92	0	22	76
2002	96	2	21	78
2003	93	78	55	98
2004	96	94	68	100
2005	43	91	98	98

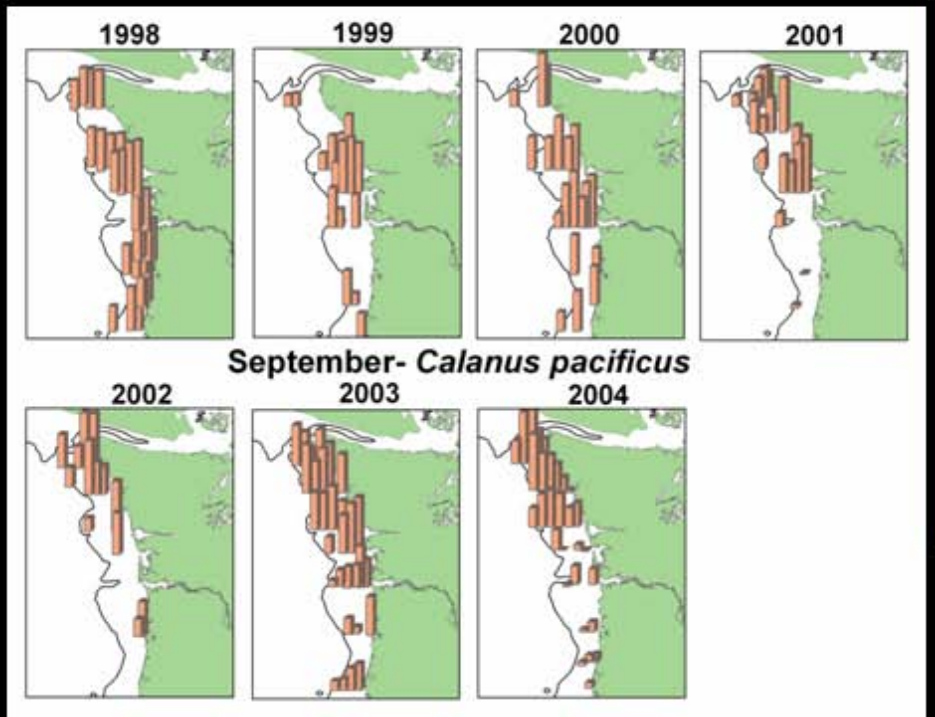




Acartia tonsa

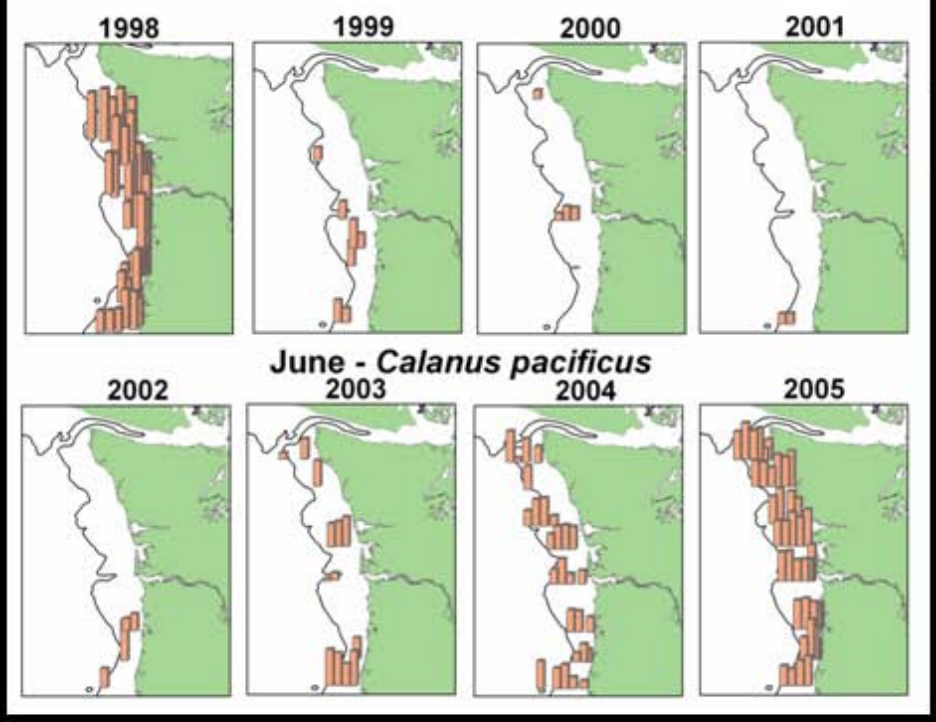
- Only present in very warm years
- Primarily inshore
- Thrived up north
- 1998 abundance lower than 2003 - 05

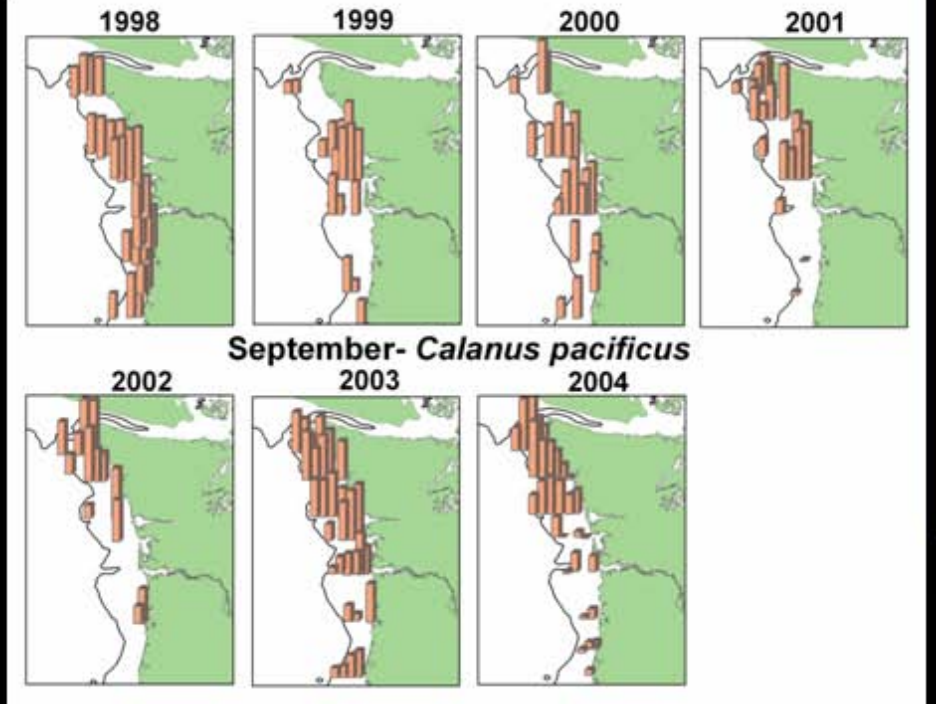




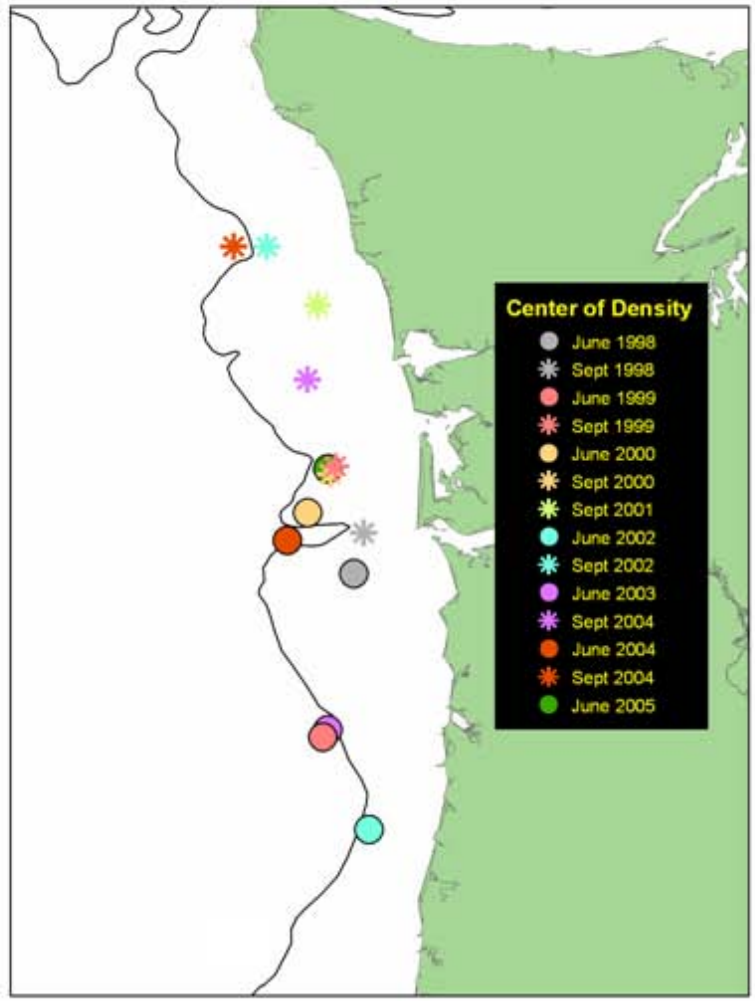
Calanus pacificus

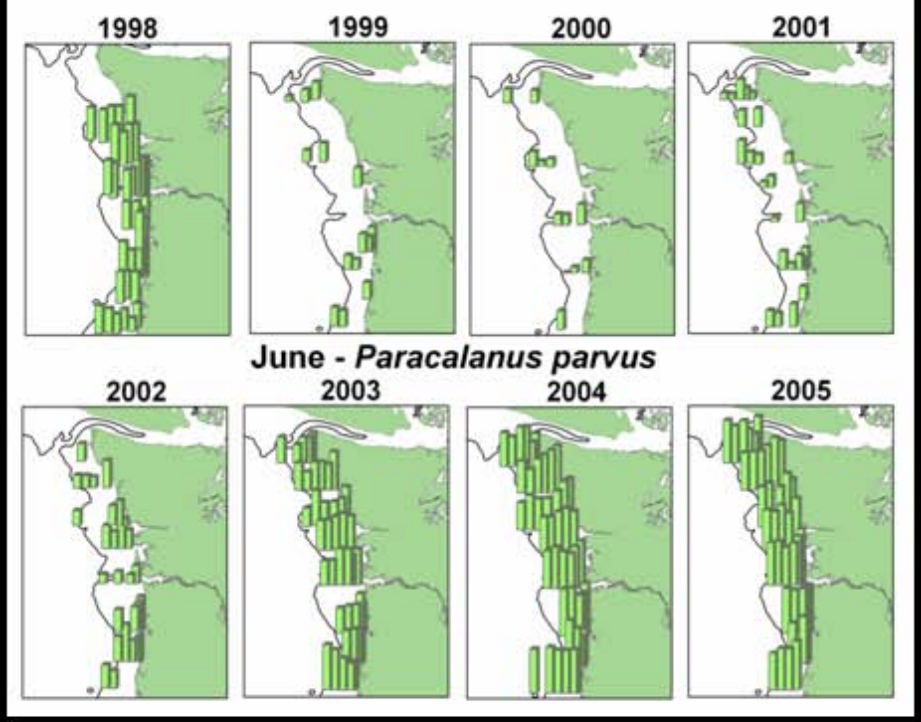
- Largest density during 1998
- Found at and beyond the shelf break during cold years
- Primarily North of CR during September
- 1998 abundance higher than 2003 - 05

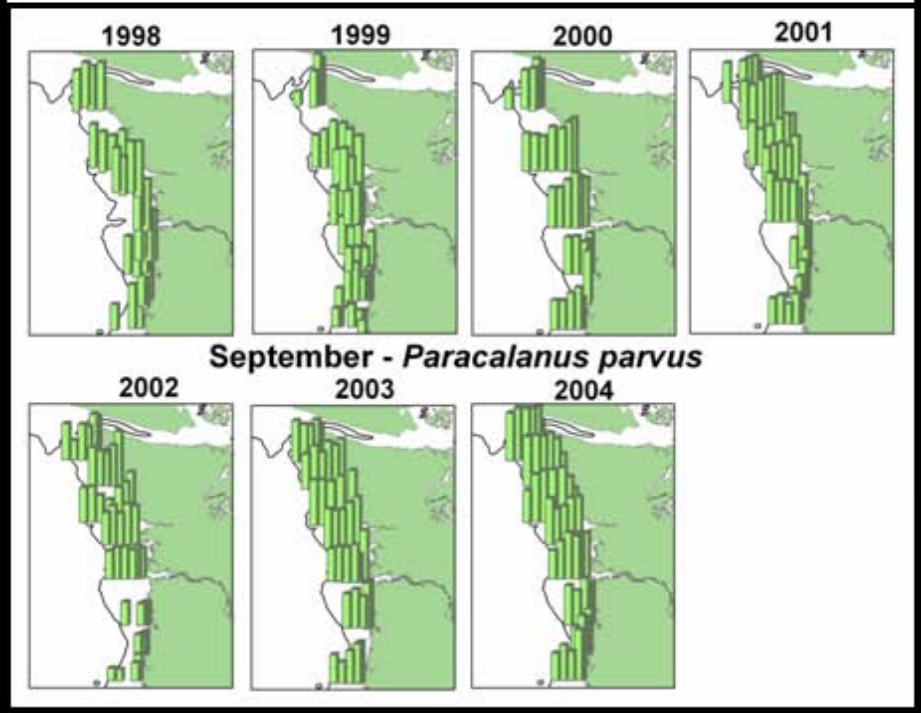




Calanus pacificus Center of Density

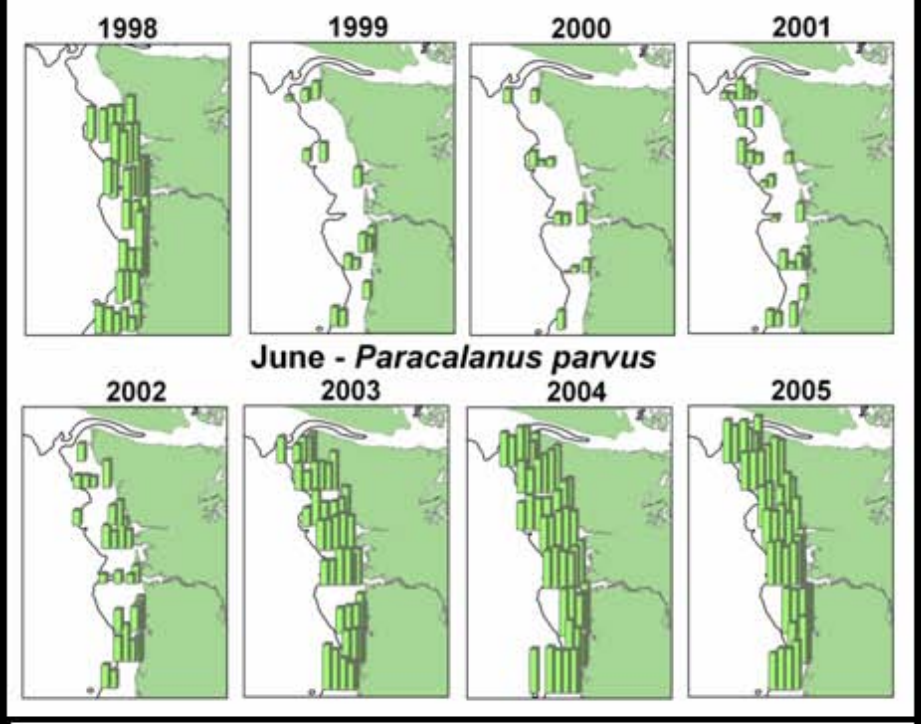


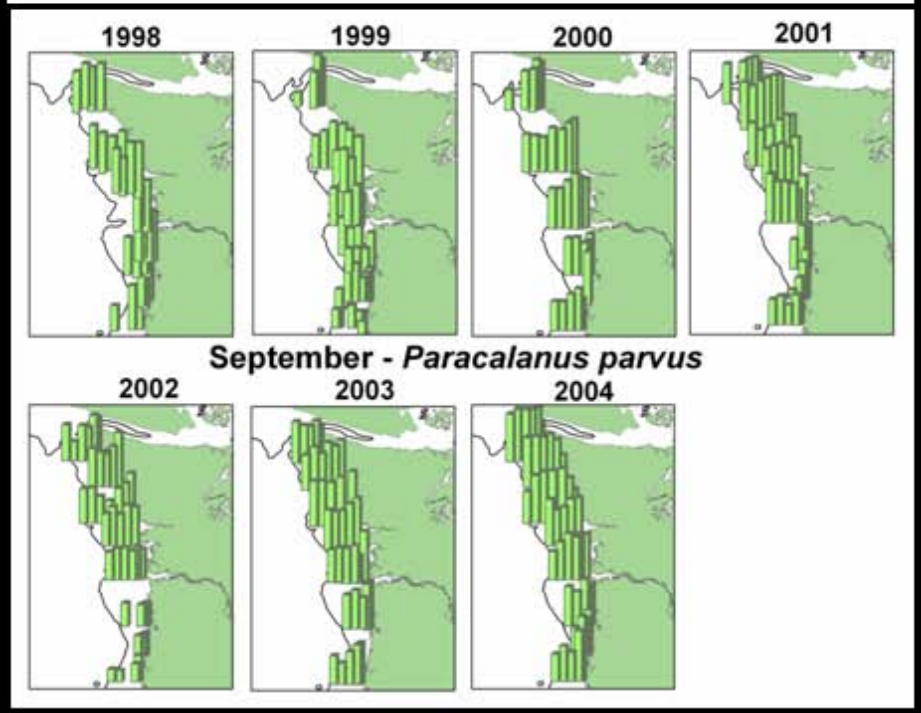


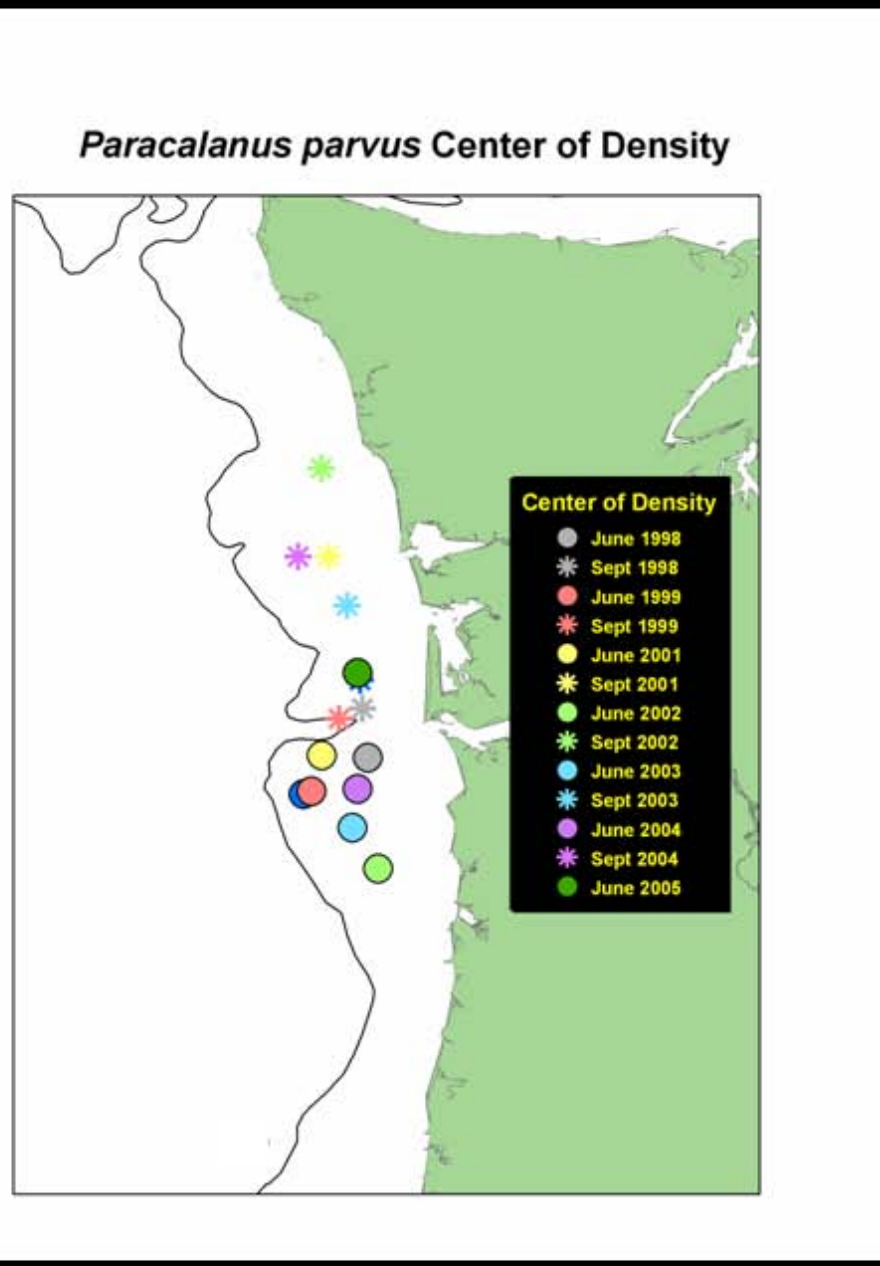


Paracalanus parvus

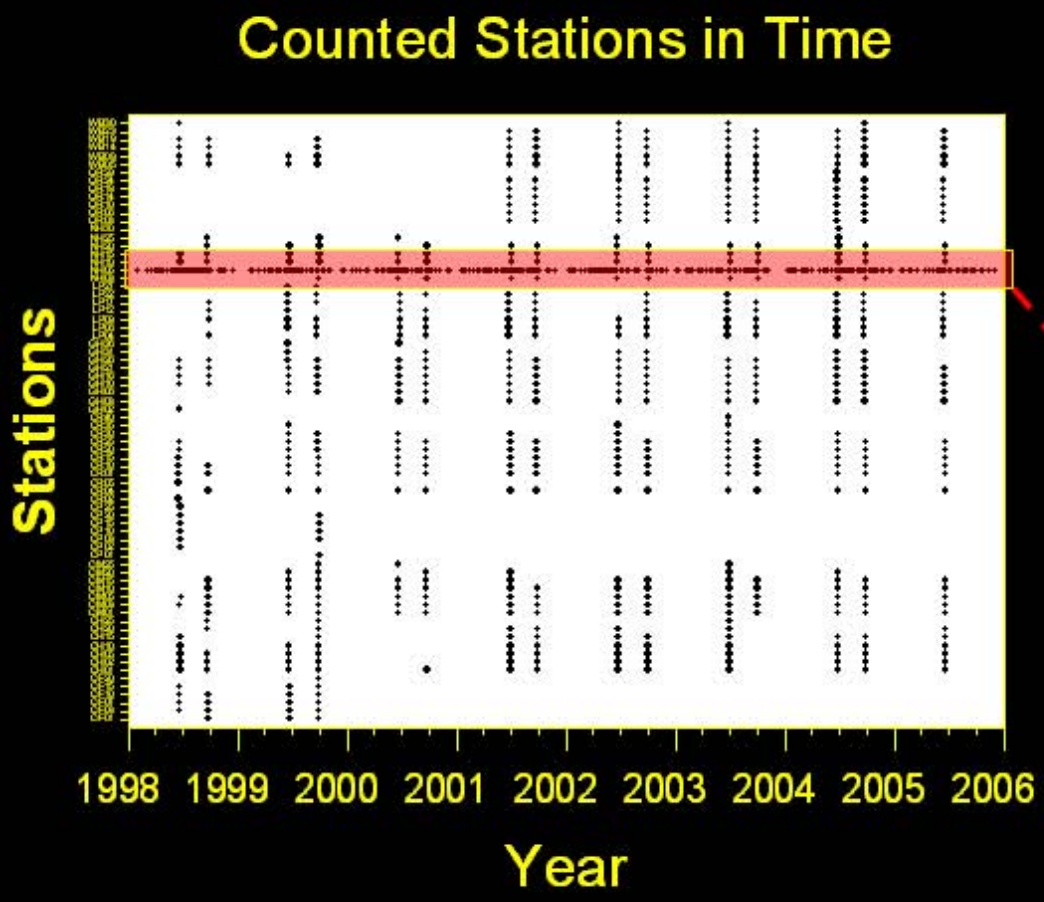
- Fairly ubiquitous through the years
- Lowest abundances during June 1999 – 2002, but still present shelf-wide
- Most abundant copepod during 2003 - 05

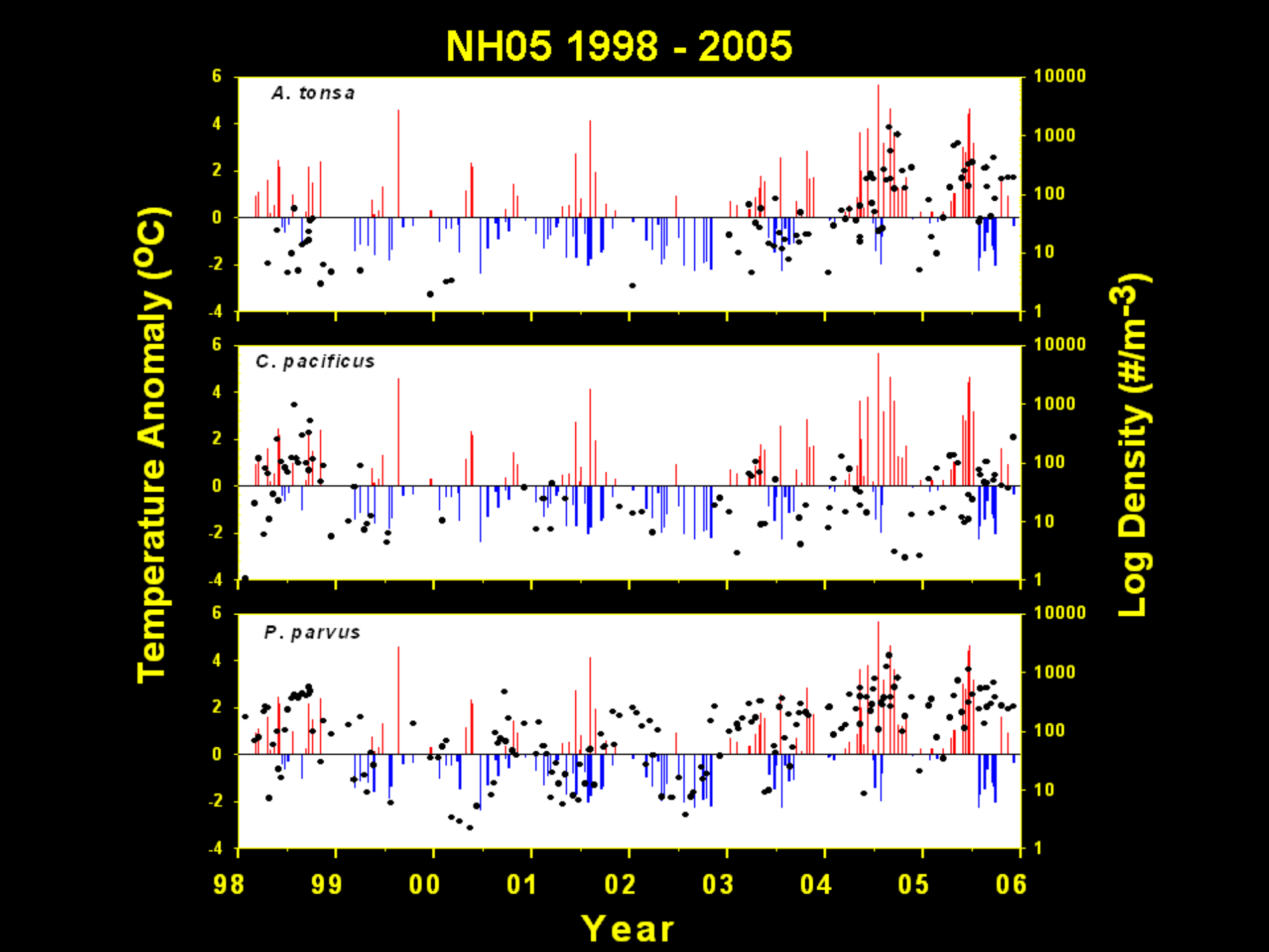

1998
1999
2000
2001
June - Paracalanus parvus
2002
2003
2004
2005

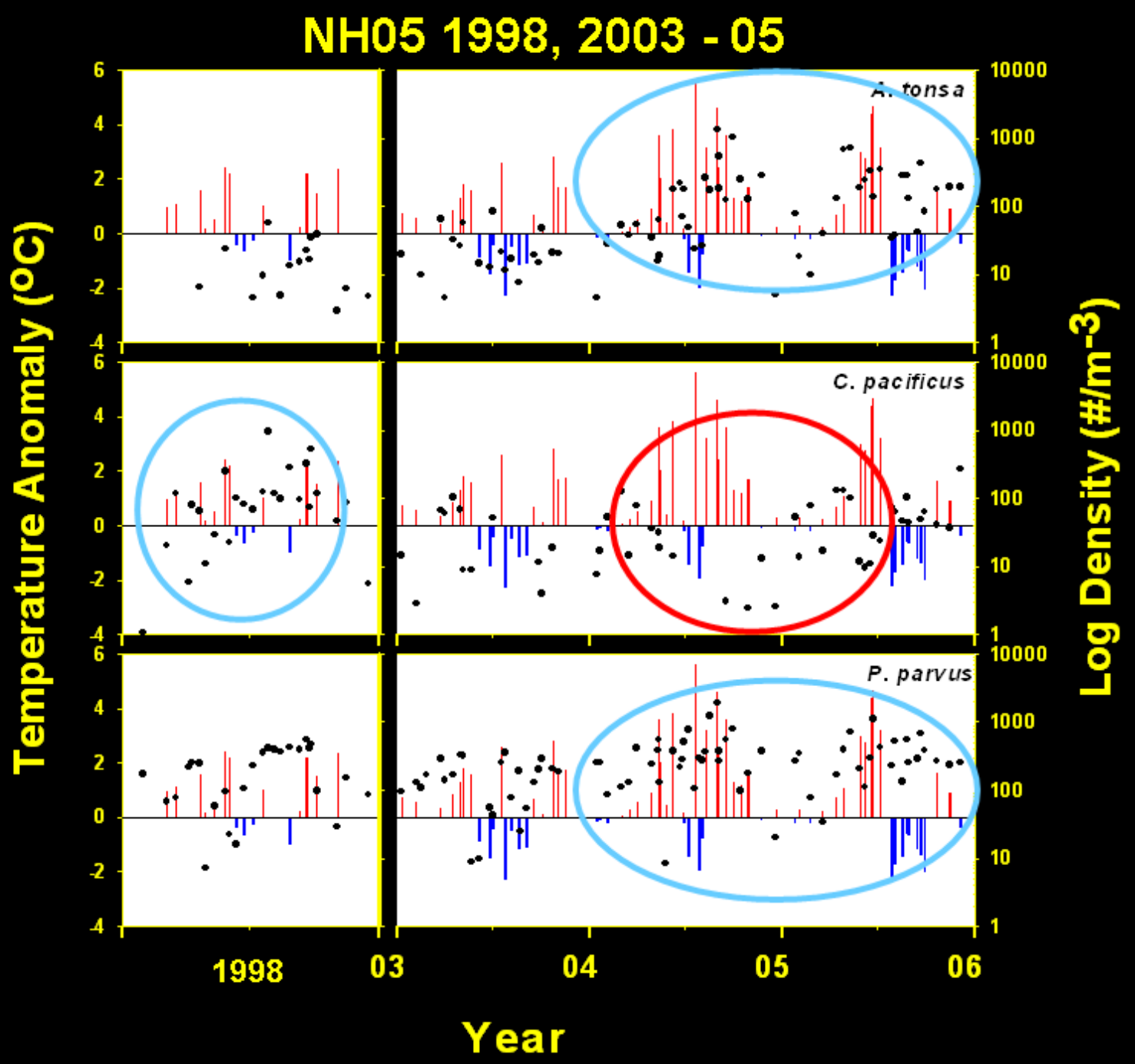

1998
1999
2000
2001
September - Paracalanus parvus
2002
2003
2004


Paracalanus parvus Center of Density
Center of Density
June 1998
Sept 1998
June 1999
Sept 1999
June 2001
Sept 2001
June 2002
Sept 2002
June 2003
Sept 2003
June 2004
Sept 2004
June 2005

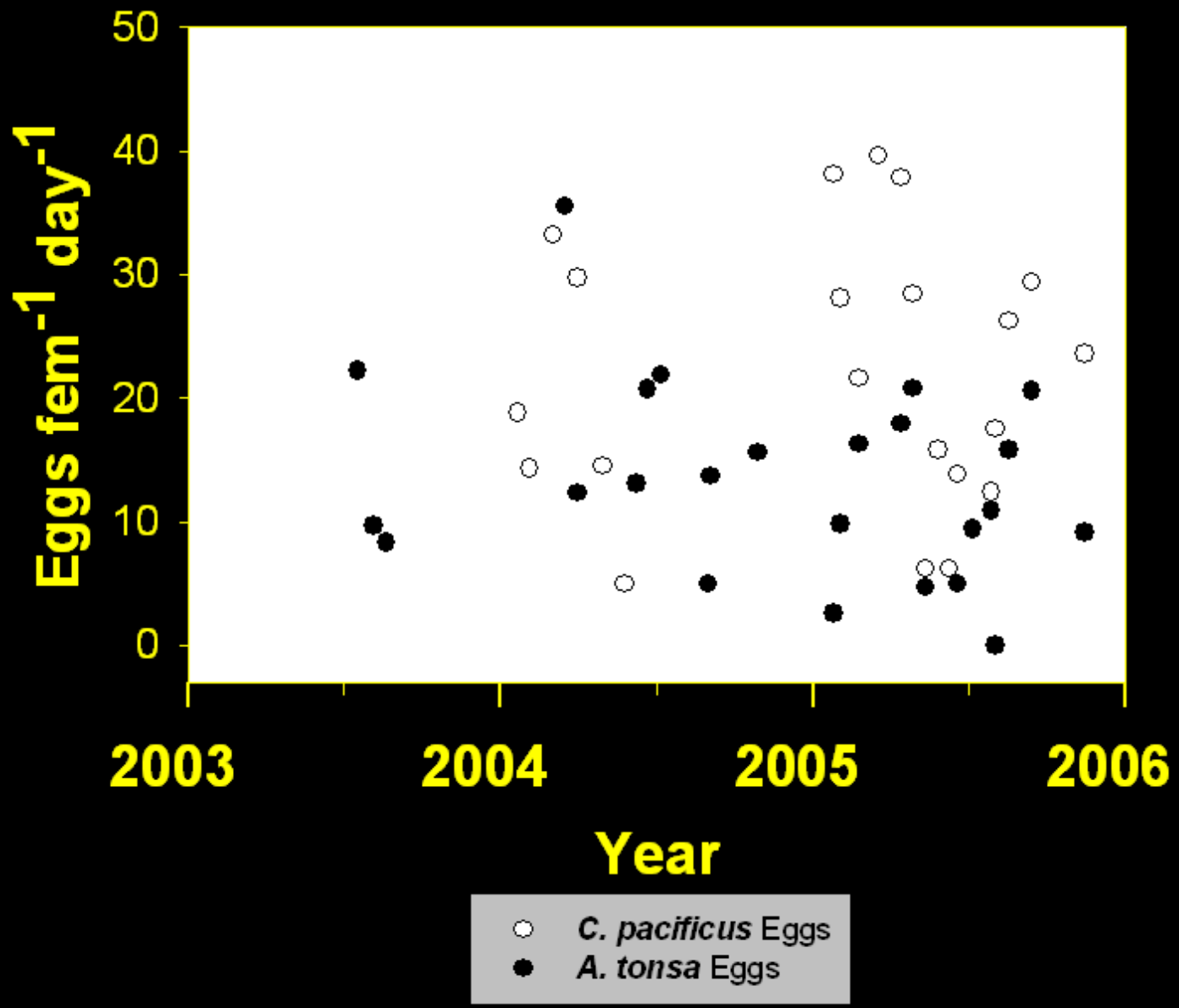
NH05 Sampling – Year Round




NH05 1998 - 2005
A. tonsa
C. pacificus
P. parvus
Temperature Anomaly (°C)
Log Density (#/m-3)
Year
98
99
00
01
02
03
04
05
06
6
4
2
0
-2
-4
10000
1000
100
10
1


NH05 1998, 2003 - 05
A. tonsa
C. pacificus
P. parvus
Temperature Anomaly (°C)
Log Density (#/m-3)
6
4
2
0
-2
-4
10000
1000
100
10
1
1998
03
04
05
06
Year

NH05 - Egg Production Experiments



Synopsis

	Individual Differences between Species
Acartia tonsa	• Large fluctuations in both presence and abundance during warm years could indicate stronger forcing from the south, or greater onshore transport of surface waters • Could be the best indicator of strong, warm water anomalous events in our system due to it's extreme sensitivity to upwelling conditions
Calanus pacificus	• Continuing presence near the shelf break during colder years could indicate a push of more oceanic/transition zone water (i.e. during El Nino, winter seasons) • Very high SST during the summer of 2004 – 05 seemed to have a negative effect on abundances
Paracalanus parvus	• Always present in both cold and warm years, yet it's largest relative abundance was in the warm years of 2003 -05, where it became the dominant copepod species

Conclusions

- Even though all three copepod species were a part of the warm water community, their differential response to the El Niño of 1998 versus the anomalously warm years of 2003 – 05 suggest different life history responses.
- The change in copepod dominance during the "warm years" (2003-2005) might be an example of how an upwelling system might be affected by a persistently warm climate.

Acknowledgements

Projects…

BPA Salmon Project
GLOBEC

People…

Leah Feinberg
Tracy Shaw
Jennifer Menkel
Hongsheng Bi

And anyone else who helped deploy, retrieve, or process plankton on our cruises!!!

Vessels…

R/V Elahka
R/V Sacajawea
F/V Frosti
F/V Predator
F/V Sea Eagle

CIMRS