Variability in Duration and Intensity of Euphausiid Spawning off Central Oregon

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INTRODUCTION

We are tracking the population dynamics of the dominant euphausiid species (*Euphausia pacifica* and *Thysanoessa spinifera*) along with changes in physical parameters through high-frequency sampling along a transect line off Newport Oregon (Figure 1). The main strengths of this study are its frequency of sampling and its duration over several years. By studying these two dominant euphausiid species over many seasons, we hope to confirm or elaborate on some common, but poorly documented, assumptions about their population dynamics. The present study is focused on describing the seasonal and interannual variability in the spawning of these euphausiids. We also discuss the egg data in relation to chlorophyll and temperature data in order to begin to understand the cues and processes which result in large peaks of egg density in our samples.

Figure 1. Map of Oregon, Washington and British Colombia Coast. # indicates station

Half meter plankton net

METHODS

1996-2001 Field Sampling:

- Daytime sampling (at least biweekly) March-September (monthly October-February) 1-15 miles off Newport, OR (44° 40'N)
- Sampling to 25 miles off Newport starting 2001
- Vertical 0.5m plankton tows (202 um mesh) and CTDs to within 1m of bottom
- Surface water samples for Chlorophyll a and nutrients
- Secchi depths

Sample Analysis:

- Euphausiids staged, counted and speciated down to nauplius from stations 5 miles (NH05, 60m) and 15 miles (NH15, 90m) off the coast. Figure 1
- Chlorophyll analyzed fluorometrically

RESULTS

Variability in Spawning:

Our data show that the presence of euphausiid eggs off Oregon is highly variable seasonally, annually and spatially.

Table 1:

- Percent of tows per year at each station with less than 1 egg m^{-3}
  - Range: 39-75%
- Mean Density(#/m^3)
  - NH05 Range 1.1 - 206 eggs m^{-3}
  - NH15 Range: 34.7 - 254.1 eggs m^{-3}
- Date of First Big Spawning Event
  - NH05: late summer in 1997 and 1998, 1999-01 spring , especially in 2001
  - NH15: always spring, especially early in 2001

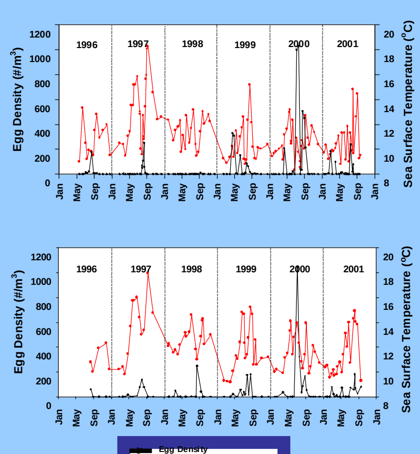
	NH05					NH15				
Year	# of tows	% < 1 m^3	Mean density (non-zero)	First Big Spawning Event	Mean SST (May-Sept)	# of tows	% < 1 m^3	Mean density (non-zero)	First Big Spawning Event	Mean SST (May-Sept)
1996	14	57	30.3	---	10.6	5	---	---	---	10.4
1997	26	65	32.6	July 29	13.7	12	42	63.9	April 25	14.9
1998	24	75	1.1	Sept. 10	11.2	15	67	34.7	March 18	13.1
1999	23	39	110.6	April 19	10.7	18	39	78.2	April 19	12.5
2000	26	65	206.4	April 12	10.7	20	35	254.1	March 29	12.2
2001	22	55	55.2	Feb. 28	10.9	20	45	75.8	Feb. 28	12.5

Table 1. Summary of NH05 and NH15 Euphausiid Egg Data. **%<1m^{-3}** : Percent of tows with fewer than 1 egg/m^3. **First Big Spawning Event** : first tow of the year when egg density exceeded 10/m^3. **SST**: sea surface temperature (°C).

Figures 2 & 3

Shows the variability summarized in Table 1. We can see clearly:

- Infrequency of peaks in eggs
- Not many eggs in winter
- Spawning season mainly March-September
- El Niño: almost no eggs at NH05
- Spring peaks : always at NH15, only at NH05 since 1999
- 1999 onward: continuing egg peaks through spawning season
- 2000: OUTSANDING year at both stations
- Peaks of egg density appear to follow cold water events



Figures 2 & 3. Plots showing cycles of sea surface temperature (°C) and egg density (#/m^3) for 1996-2001. Figure 2 (top) is NH05. Figure 3 (bottom) is NH15.

Eggs in Relation to Water Temperature:

Figure 4 shows that at station NH05 apparent peaks in egg density occur not only following cooler surface temperatures, but in association with upwelling events.

- 1997-98 El Niño shows up very clearly.
- Upwelling events appear to be strongest in 1999 and 2000 with 9° water reaching the surface several times.
- 1999 and 2000 were also the two years with highest egg peaks and mean densities at NH05.

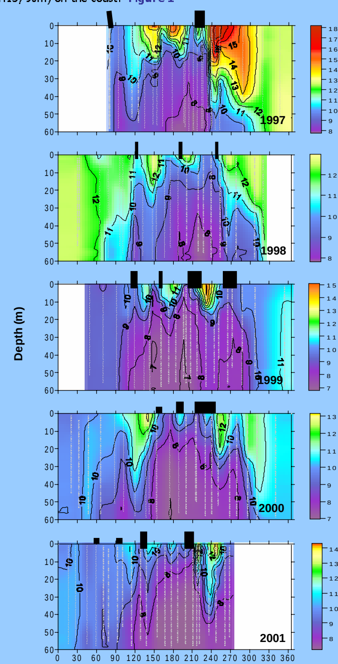


Figure 4. Contoured temperature (°C) depth profiles for NH05. Grey lines indicate actual data points. Black bars above profiles correspond to largest egg peaks from each year .

Despite a strong connection to cold water and upwelling indicated in earlier figures, Figure 5 does not show a strong correlation between surface water temperature and egg density. This lack of correlation is likely due in part to the use of discrete rather than continuous temperature data.

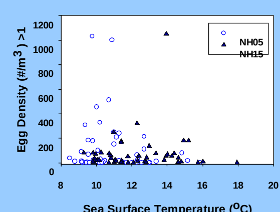


Figure 5. Sea surface temperature versus egg density (densities greater than 1m^{-3}). All years combined.

Eggs in Relation to Surface Chlorophyll a :

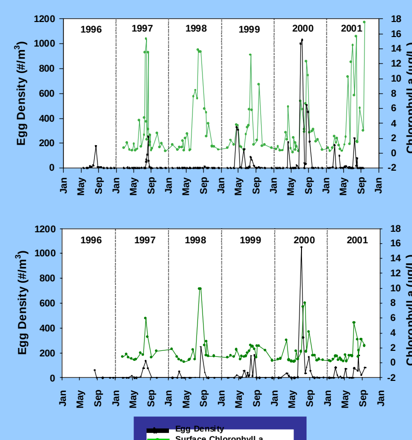
For the years in which we have data (1997-01) we found marked differences among years in both concentration and correspondence between phytoplankton blooms and peaks in egg density. The following is a summary of the data found in Figures 6 & 7.

NH05

- 1996: Sampling began in May, and no chlorophyll data available.
- 1997: Late July-mid August bloom, peak in eggs 2 weeks later
- 1998: Large bloom from mid June-mid September, no large egg peaks
- 1999: Small April bloom-large peak in egg production; no bloom in June-large peak in eggs. Big July bloom-small peak in egg density
- 2000: Blooms in April, July and August, with huge response in egg density for July and August.
- 2001: Large blooms in June, late July, and late September. The only large bloom with a corresponding egg peak was in late July. Egg peak in late February, but only a small bloom apparent.

NH15

- Small bloom in spring-all years
- Larger bloom in July-August all years
- Peaks in egg density only correspond to blooms in 1997, 1998 and perhaps 2000.
- 1999, 2001: Additional small peaks in egg density in June, no large phytoplankton blooms



Figures 6 & 7. Plots showing cycles of sea surface chlorophyll a (µg/L) and egg density #/m^3) for 1996-2001. Figure 6 (top) is NH05. Figure 7 (bottom) is NH15.

Figure 8. A scatter plot of chlorophyll vs. egg density shows that there is no strong correlation at either station.

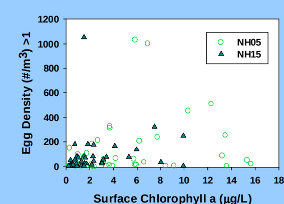


Figure 8. Total surface chlorophyll a versus egg density (densities greater than 1m^{-3}). All years combined.

CONCLUSIONS

- Spawning of euphausiids off the central Oregon coast is typically strongest in late July-early September, with minor peaks in March-April at NH15 and at NH05 since 1999.
- Bursts in euphausiid egg production do not necessarily result from phytoplankton blooms.
- Largest peaks in egg density tend to follow upwelling events.
- Densities of euphausiid eggs were extraordinarily high during the 2000 season. This corresponds with what looks to be the coldest year with the strongest upwelling season.
- It appears that the presence of eggs on the Oregon shelf is dictated more by water transport than by food availability.

FUTURE DIRECTIONS

- Use nauplii data to associate specific egg peaks with euphausiid species.
- Calculate possible distances traveled by eggs or nauplii based on development times and advection rates.
- Compare egg data to available buoy wind or surface temperature data.
- Determine whether other euphausiids ever spawn at NH05.

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