

An overview of the ecology and population dynamics of *Euphausia pacifica* around the Pacific Rim

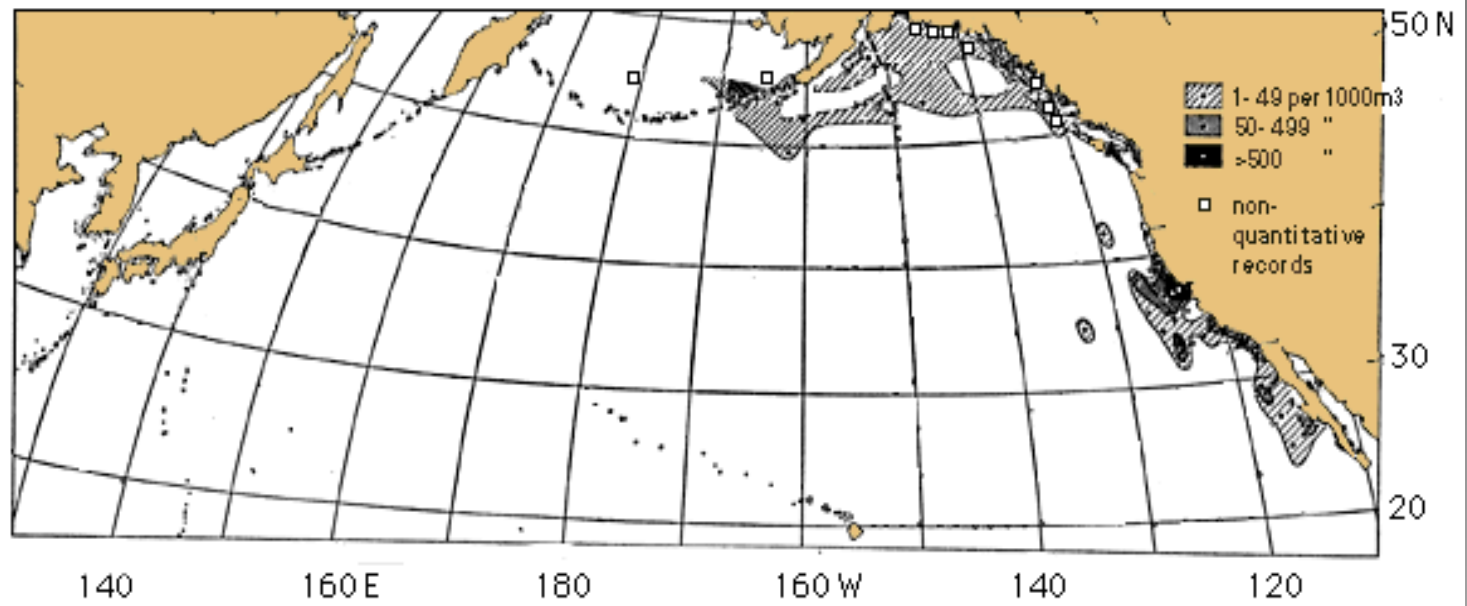
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NOAA Fisheries
Newport OR
WG 23

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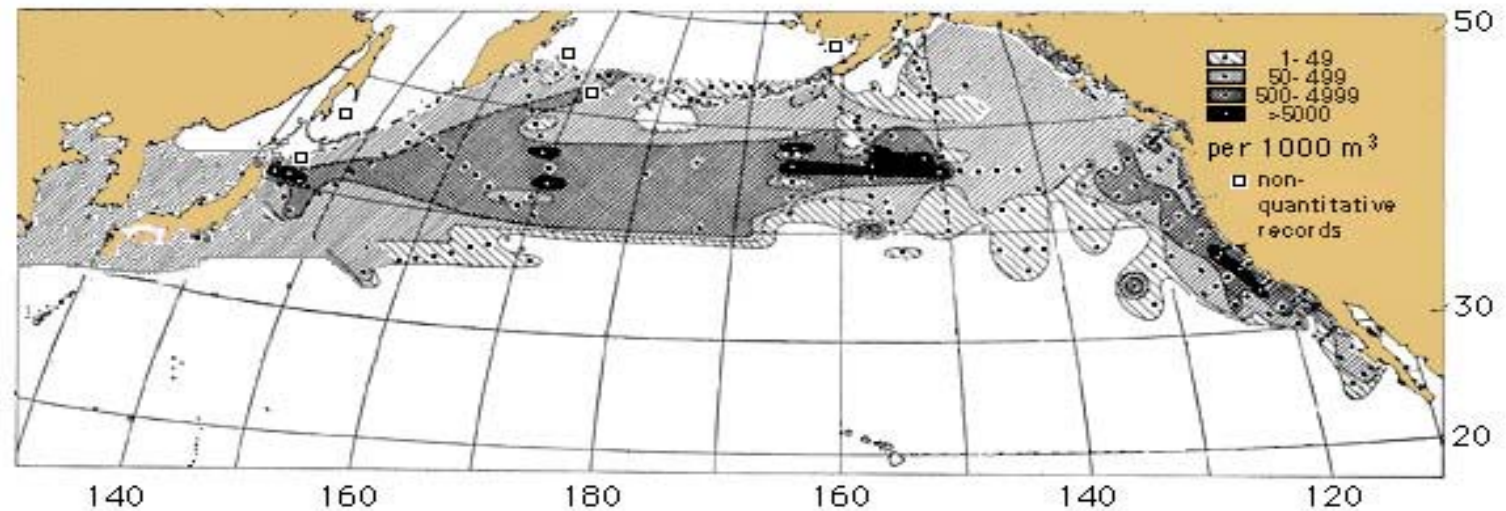
“Comparative ecology
of the euphausiids
Euphausia pacifica
and *Thysanoessa* spp
in coastal and
oceanic waters
around the Pacific
Rim”




Thysanoessa spinifera



Euphausia pacifica



 *Euphausia pacifica*

after Brinton 1962, Hong 1969
(updated by Peterson 2004)

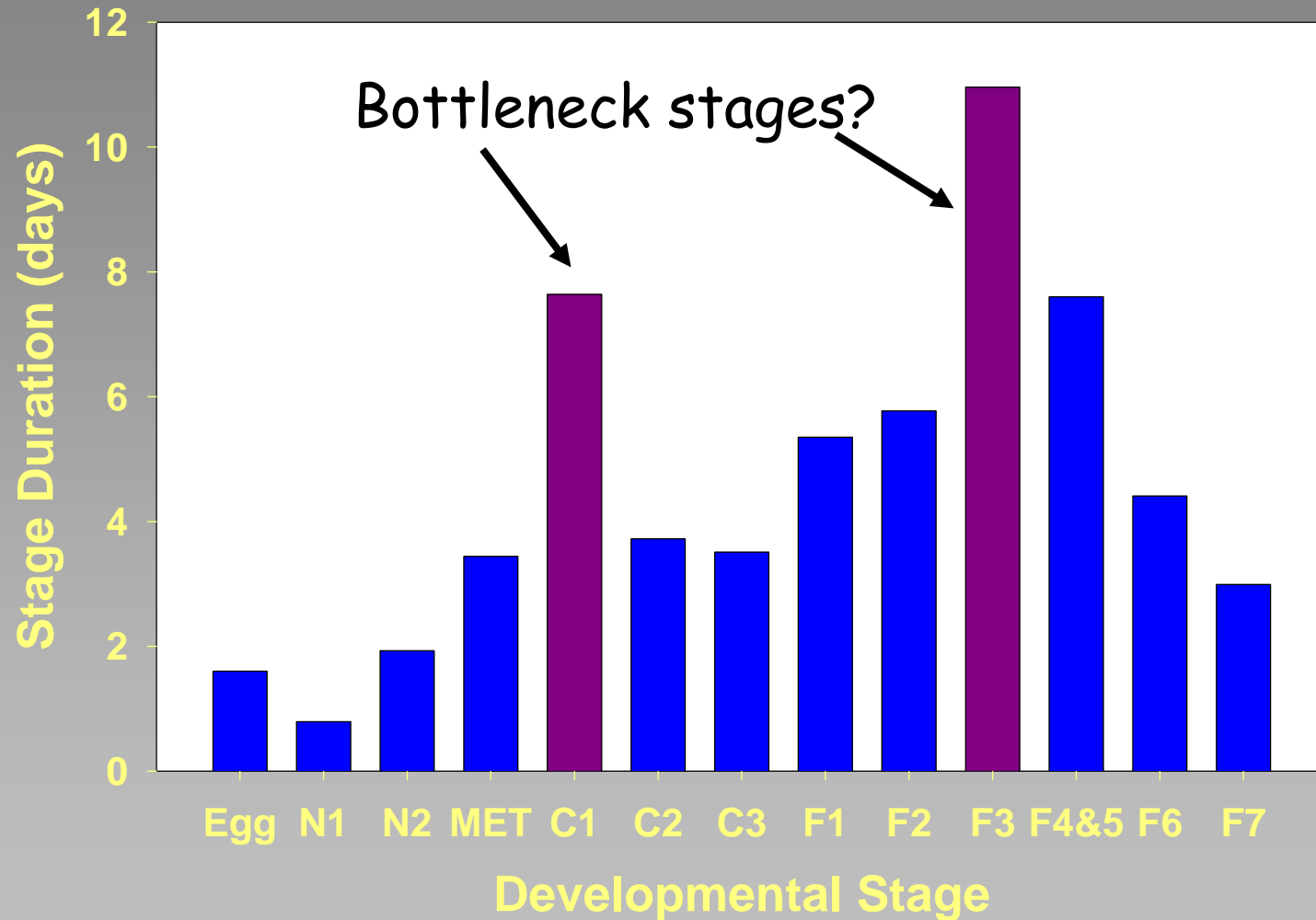
First meeting yesterday

- Reports from each nation
- Ongoing research
- Future plans
- Areas of collaboration
- Gaps in our understanding

State specific development times

- Raised animals in lab from eggs; fed mixture of four foods (Rhodomonas, Thal. pseudonana, Ditylum, Heterocapsa and Oxyrrhis).
- Animals checked daily. Once individuals reached furcilia each was kept in it's own glass palace.
- Maintained individuals through adults for two years (which upon reaching adulthood, females laid eggs).
- Juveniles → adults; sacrificed 10 animals each two months for Ju and Harvey (GLOBEC) to measure lipofuscein (ageing pigment in the eyes).

Larval Stage Durations



C1 is first feeding stage; F3 is when swimming legs develop.

Juveniles and Adults

- Reached F7 in 60 days
- Reach adult (at 12 mm) within ~ 4 months
- The most fecund adults are ~ 20 mm or about 12 months of age

Growth: measured in 3 ways



❖ Cohort Analysis

- ❖ Repeated sampling of a field population over regular intervals

❖ Instantaneous Growth Rate (IGR)

- ❖ Incubations of individual animals to determine inter-molt period (IMP) and molt increment (mm) in 24 h incubations

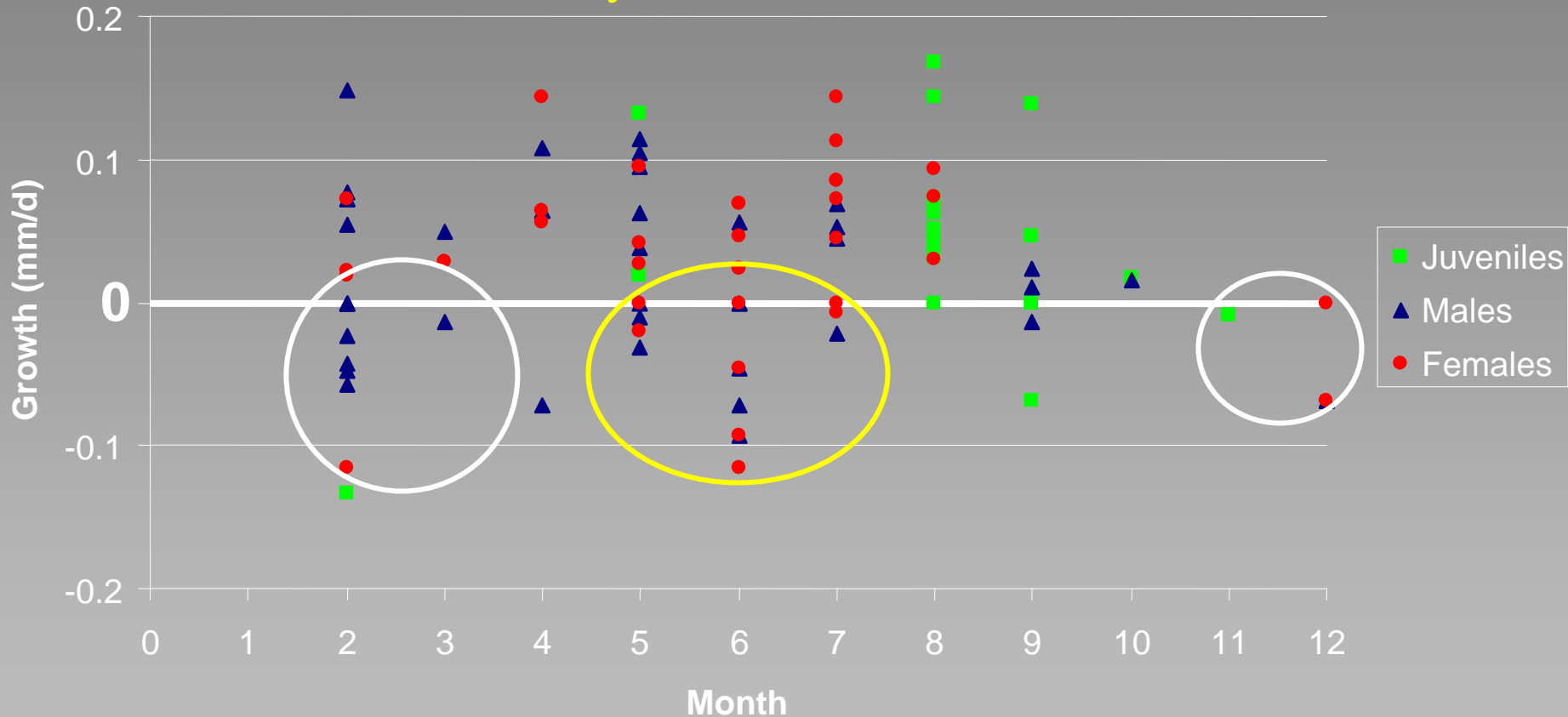
❖ Observation of Laboratory Reared Animals

- ❖ Follow growth of animals for extended periods in the laboratory by measuring molts

Growth: Results

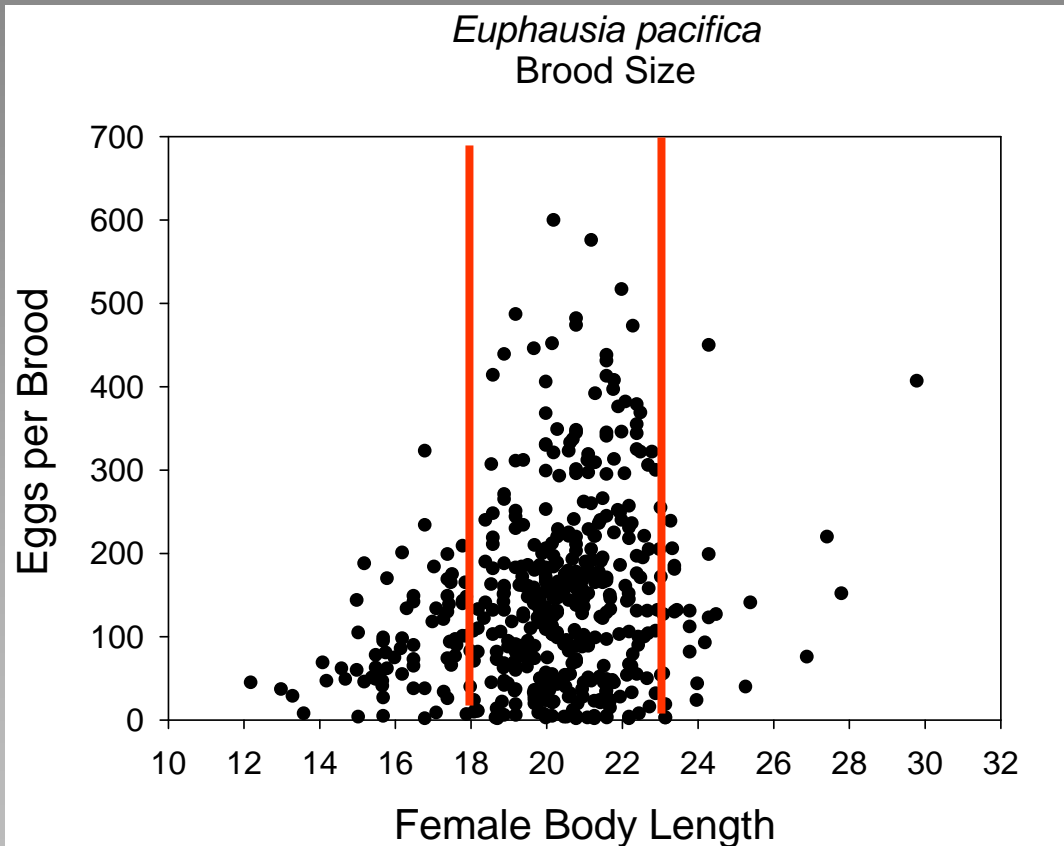
- Moults ~ every week.
- Growth rapid in spring.
- Adult growth slow in summer (due to reproduction)
- Growth increases in autumn
- Little-to-no growth in winter - in fact, animals shrink in winter!
- Growth in field cohorts = growth of animals in 48 h incubations = growth of animals grown in the laboratory from egg to adult. Order of 0.05 to 0.1 mm day⁻¹ = 1.5 to 3.0 mm per month.

Euphausia pacifica: Growth in 48 h molting experiments



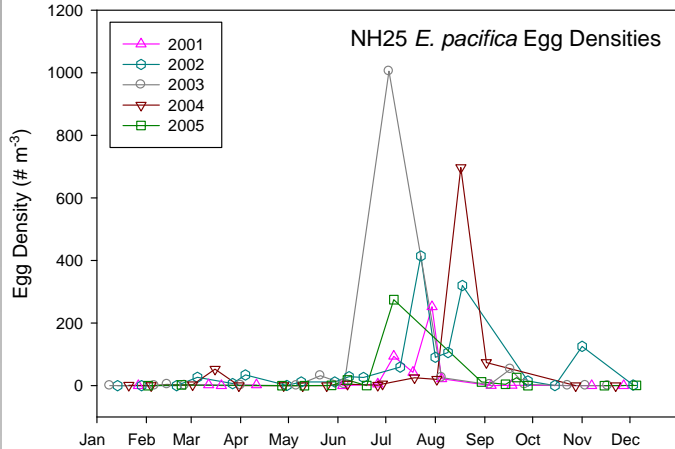
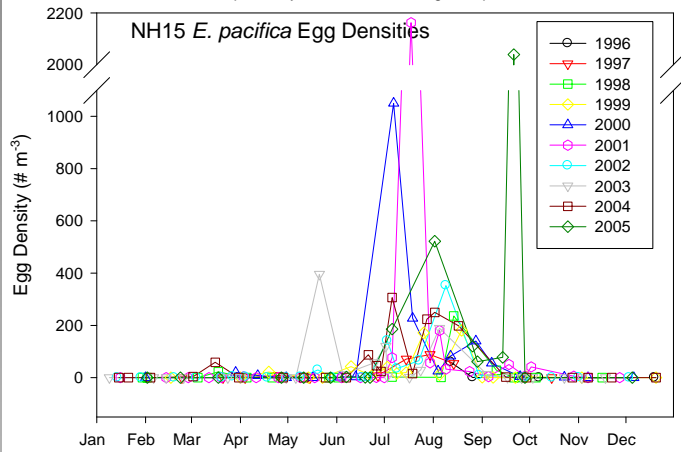
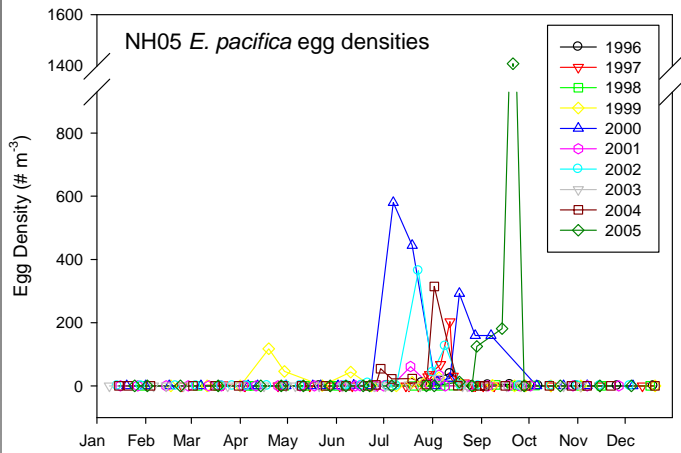
- Males shrink in winter; females seldom shrink
- Females shrink in summer → maximize reproductive effort by putting all available energy + lipid into eggs

Reproduction: brood size

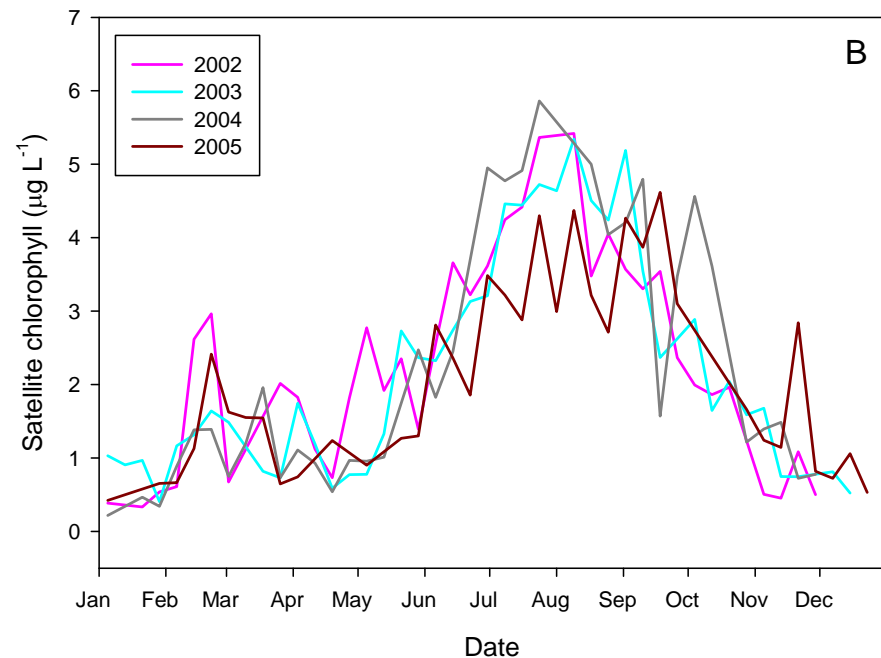
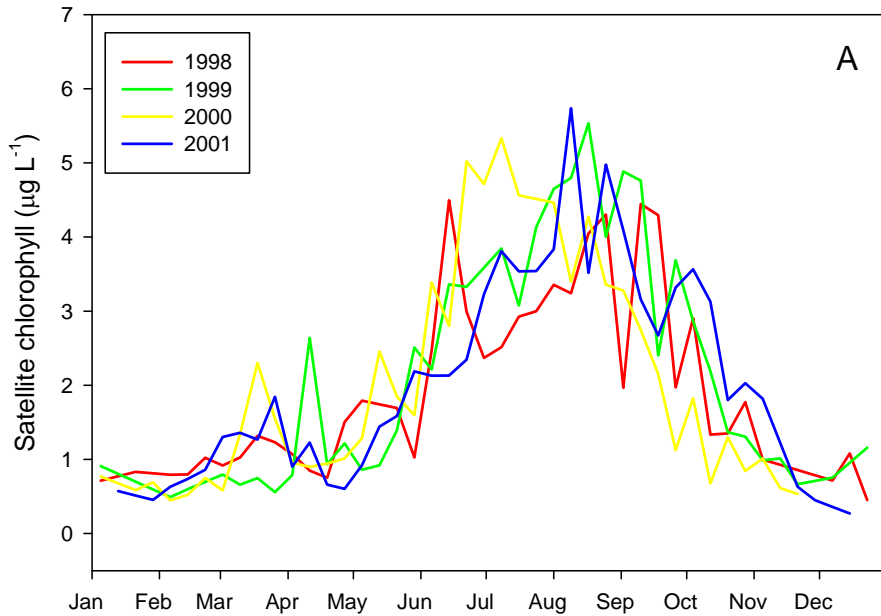


- $N = \sim 1200$ females
- First reproduction for adult females of 12 mm total length (age = \sim four months)
- Largest broods in 18-23 mm females; peak in brood size at 20 mm body length (age = one year)
- Produce a brood \sim once per week

Euphausia pacifica eggs, Newport Line:



- Most abundant at NH 15. Peaks can occur between late January-September.
- Often see peaks at NH 05 and shelf break
- Seldom see peaks in winter
- Conclusion: this species is mostly a summer spawner, that can occupy both shelf and slope waters



- Winter spawning dependent entirely on the appearance of a bloom in February
- Blooms seen in 2002-2005 (but not earlier in the time series) and *T. spin* spawned in Feb of those years.
- The winter bloom establishes the cohort that recruits as an adult that summer, thus availability of this species to predators (hake, seabirds, whales) depends on weather in winter, a new twist to the match-mismatch & phenology problem.

Comparison of *E. pacifica* egg production by females from Santa Barbara & Oregon

- Incubated 12 ripe females from Santa Barbara
 - 6 females produced multiple broods
 - Females examined daily from April – December, 2003 for a total of 9 months to look at daily variations
- Incubated 27 ripe females from Heceta Bank
 - 14 females produced multiple broods
 - Examined daily; experiment lasted from July – December, 2003

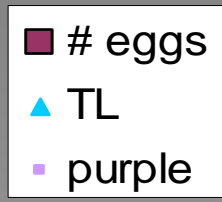
Key results

- The average number of eggs produced was the same for both populations:
 - 102 eggs per batch for Oregon females
 - 116 eggs per batch for Santa Barbara females
- Females are capable of laying eggs for months on end (at least for 9 months!) with outputs of 6000-8000 eggs.
- When producing eggs at high rates, females invest so much energy that they experience negative growth (that is, they become smaller).

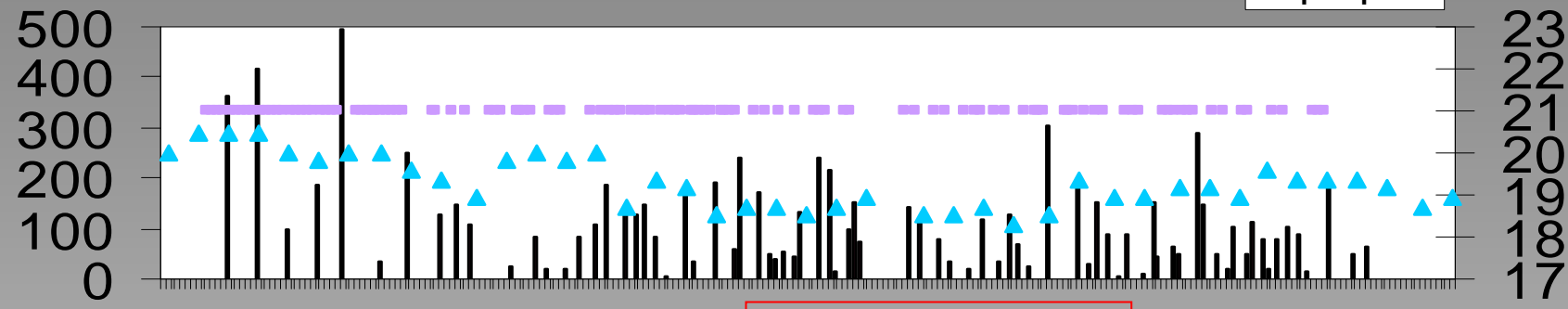
Variability in Spawning Patterns Santa Barbara

 A

8,597 eggs!

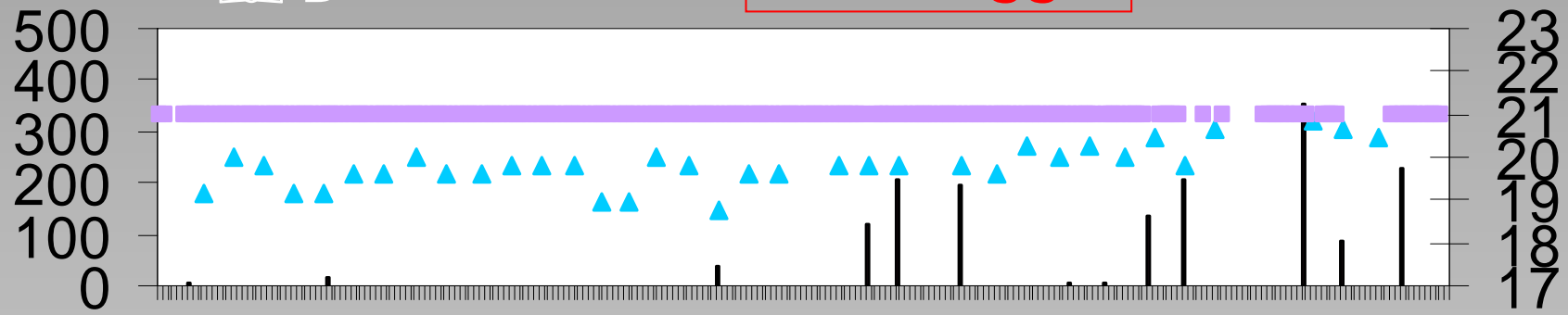


Eggs



 B

1,600 eggs!

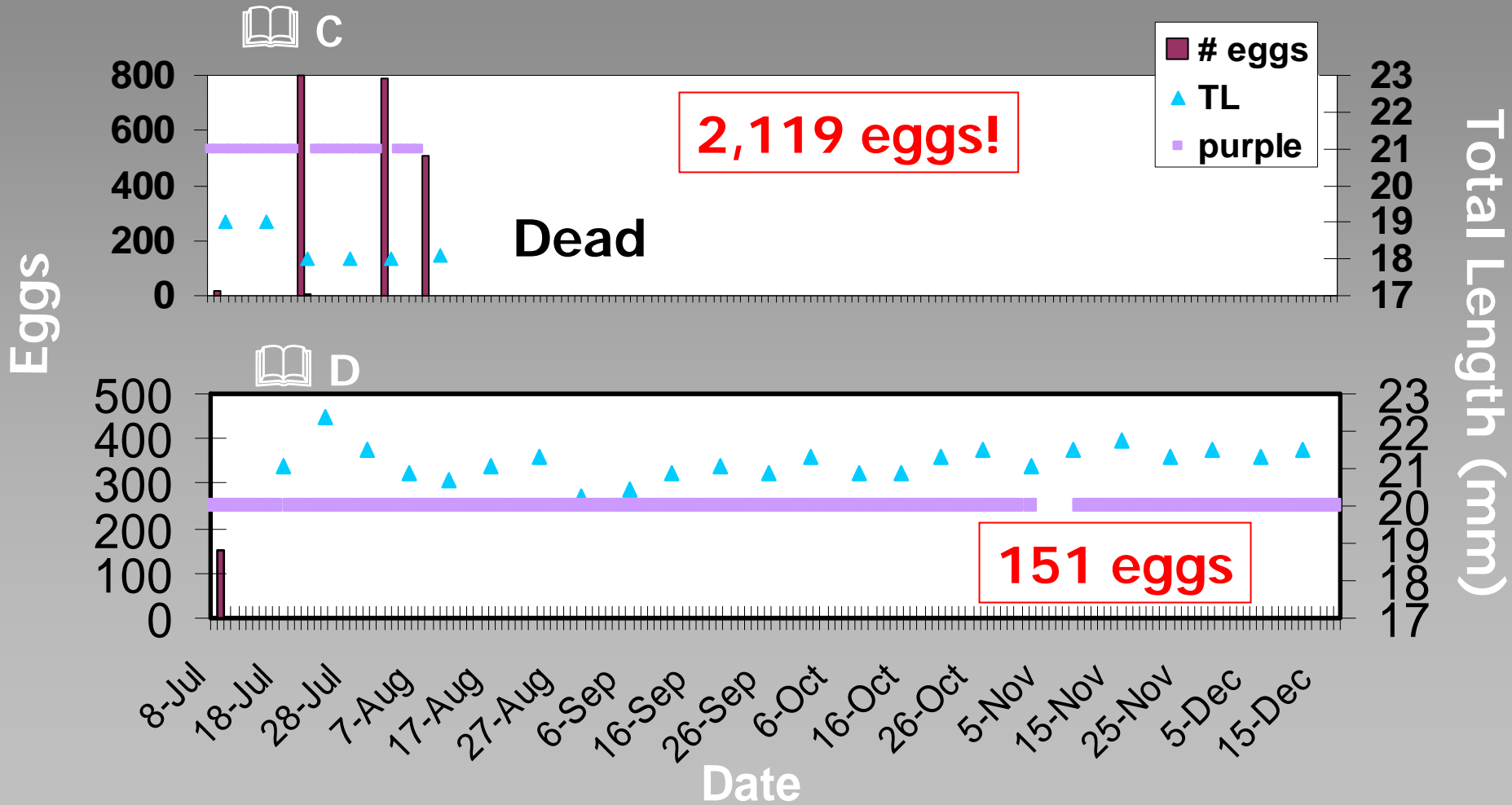


Total Length (mm)

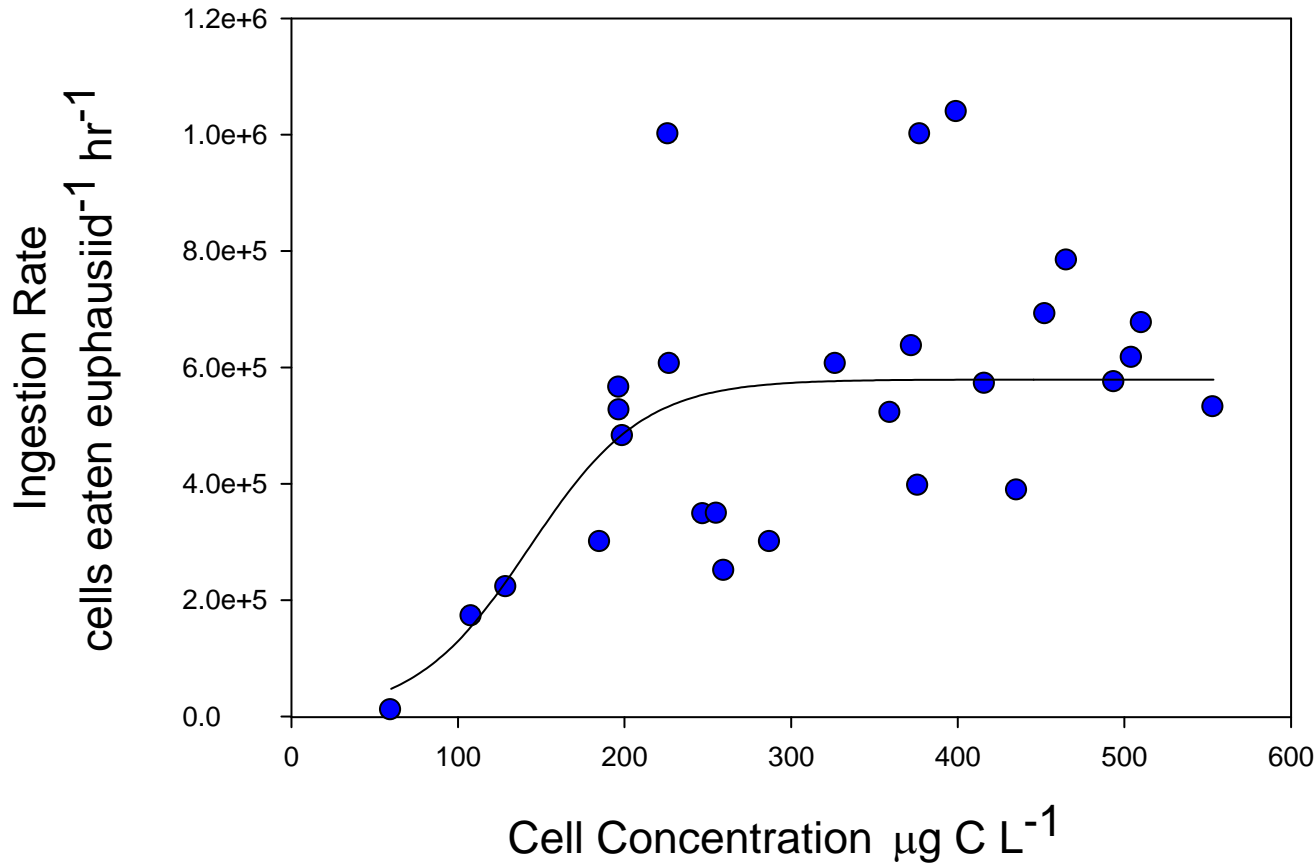
2-Apr 16-Apr 30-Apr 14-May 28-May 11-Jun 25-Jun 9-Jul 23-Jul 6-Aug 20-Aug 3-Sep 17-Sep 1-Oct 15-Oct 29-Oct 12-Nov 26-Nov 10-Dec

Date

Variability in Spawning Patterns Heceta Bank



Ingestion Rates, *E. pacifica*,
feeding on *Rhodomonas*:
3-parameter sigmoid model
 $p = 0.012$; $R^2 = 0.24$



Grazing

- *E. pacifica* feeding on *Rhodomonas*
- Lots of variability
- Can feed on particles as small as 4 µm

Ability to feed on a wide-spectrum of cells may explain why this species is pan-Pacific and able to survive and prosper in a stunning variety of ecosystems