

NEP-CCS Progress Report 2004

This report summarizes two separate, but related projects:

A COMPARISON OF THE EFFECTS OF COASTAL UPWELLING ON THE POPULATION DYNAMICS AND VITAL RATES OF THE EUPHAUSIIDS *Euphausia pacifica* AND *Thysanoessa spinifera* IN THE NORTHERN CALIFORNIA CURRENT, NORTH AND SOUTH OF CAPE BLANCO, OR

LONG-TERM CHANGES IN HYDROGRAPHY AND ZOOPLANKTON IN NORTHERN CALIFORNIA CURRENT WATERS OFF THE OREGON COAST

PRINCIPAL INVESTIGATORS: Dr. William T. Peterson
Northwest Fisheries Science Center
2030 South Marine Science Drive
Newport, Oregon 97365 USA
E-mail: bill.peterson@noaa.gov

PROJECT SUMMARY

I. Key Objectives and Goals of the Euphausiid Population Dynamics project

(i) determine the seasonal cycles of abundance of the two euphausiid species in relation to interannual variations in circulation, hydrography and upwelling (and spring transition);

- Abundance
- Spawning
- Recruitment variability

(ii) determine the seasonal, interannual and spatial variations in egg production rates, cohort development, and recruitment as a function of upwelling and phytoplankton blooms;

- Brood size from incubations
- Long term measurement of brood size over the course of several months
- Inter brood periods; ovary ripeness
- Length of spawning season
- Brood size vs. chlorophyll
- Brood size vs. female size
- Number of eggs per spawning event

(iii) examine the seasonal, interannual and spatial variations in mortality rates and production as a means to develop a better understanding of euphausiid population dynamics; and

- Egg mortality (assuming vertical life table)
- NH 25, NH 15 and NH 5 separately
- Lab mortality

DT Experiment in general
Alternate developmental pathways
Lab cohort vs. field cohort
Cohorts identified through changes in length-frequency
Cohorts identified through changes in abundance of life history stages
Lipofuscein calibration
Recruitment calculated as abundance/DT
Molting rates used to estimate growth rates (in length); compare to other studies
Production = gB
Production as ($P = W/D*N$)
Ontogenetic differences in vertical distribution; vertical migration.

(iv) determine overwintering strategies and the role of seasonal reversals in circulation and the spring transition in redistributing euphausiids in shelf and slope waters.

Adults available year around. Abundances decline during winter?
Molting rates show that animals shrink in length during winter

II. List of Papers

Published Work

Batchelder, H. P., J. A. Barth, P. M. Kosro, P. T. Strub, R. D. Brodeur, W. T. Peterson, C. T. Tynan, M. D. Ohman, L. W. Botsford, T. M. Powell, F. B. Schwing, D. G. Ainley, D. L. Mackas, B. M. Hickey, and S. R. Ramp (2002). The GLOBEC Northeast Pacific California Current System Program, *Oceanography*, 15 (2), 36-47.

Feinberg, L. R. and W. T. Peterson (2003) Variability in duration and intensity of euphausiid spawning off central Oregon, 1996-2001. *Prog. Oceanog.*, 57, 363-379.

Gómez-Gutiérrez, J. (2002) Hatching mechanism and delayed hatching of the eggs of three broadcast euphausiid species under laboratory conditions. *J. Plankton Res.* 24 (12), 1265-1276.

Gómez-Gutiérrez, J. A. de Robertis, W. Peterson and R. Brodeur. 2003. Mass mortality of krill caused by parasitoid ciliate. *Science* 131:339

Irigoién, X. and 16 others including W. Peterson. 2002. Copepod hatching success in marine ecosystems with high diatom concentrations. *Nature* 419:387-389 (including cover photo).

Keister, J.E. and W.T. Peterson. Zonal and seasonal variations in zooplankton community structure off the central Oregon coast, 1998-2000. *Prog. Oceanogr.* 57:341-361.

Mackas, D. L., W.T. Peterson and J.E. Zamon. 2004. Comparison of interannual biomass anomalies of zooplankton communities along the continental margin of British Columbia and Oregon. *Deep-Sea Res.* 51:876-896

Peterson, W. T. and D. L. Mackas (2001). Shifts in zooplankton abundance and species composition off central Oregon and southwestern British Columbia, PICES Press, 9(2), 28- 31, 2001

Peterson, W.T. and J.E. Keister. 2002. The effect of a large cape on distribution patterns of coastal and oceanic copepods off Oregon and northern California during the 1998-1999 El Niño-La Niña. Prog. Oceanogr. 53:389-411

Peterson, W.T., J. Keister and L. Feinberg. 2002. The effects of the 1997-99 El Niño/La Niña events on hydrography and zooplankton off the central Oregon coast. Prog. Oceanogr. 54:381-398

Peterson, W. T. and J. E. Keister (2003) Interannual variability in copepod community composition at a coastal station in the northern California Current: a multivariate approach. Deep Sea Res. 50:2499-2517

Peterson, W. T. and F. B Schwing (2003) A new climate regime in northeast Pacific ecosystems. Geophys. Res. Lett., 30 (17), 1896, C1-C4.

In Press or accepted

Feinberg, L. R., C. T. Shaw and W. T. Peterson. Larval development of *Euphausia pacifica* in the laboratory. J. Plankton Res (accepted after minor revision)

Gómez-Gutiérrez, J., W.T. Peterson and C.B. Miller. Cross-shelf life-stage segregation and community structure of the euphausiids off central Oregon (1970-1972). Deep-Sea Res. (in press)

Hirst A.G., Peterson W.T., Rothery P. Errors in estimates of juvenile copepod growth rates are widespread: problems with the Moulting Rate method. Mar. Ecol. Prog. Ser. (in press)

Keister, J.E., T. B. Johnson, C. A. Morgan, and W. T. Peterson. Biological indicators of the timing and direction of warm-water advection during the 1997/98 El Niño off the central Oregon coast, USA. Mar. Ecol. Prog. Ser. in press

Ressler, P. H., Brodeur, R. D. Peterson, W. T., Pierce, S. D., Vance, P. M., Roestad, A. R. and J. A. Barth. 2004. The spatial distribution of euphausiid aggregations in the northern California Current during August 2000. Deep Sea Res. (in press)

Sutor, M., T.J. Cowles, and W.T. Peterson. Acoustic Observations of Finescale Zooplankton Distributions in the Oregon Upwelling Region. Deep-Sea Res. (in press).

Oral and Poster Presentation

We have made at least 42 oral and poster presentations of GLOBEC-funded research at regional (e.g., EPOC; Annual Juv. Salmonid Conference), national (e.g., AGU, ASLO) and international

(e.g., PICES, GLOBEC) since 1999.

Other Relevant Publications

Peterson, W.T. 2001. Patterns in stage duration and development among marine and freshwater calanoid and cyclopoid copepods: a review of rules, physiological constraints, and evolutionary significance. *Hydrobiologia* 453/454:91-105.

Peterson, W.T., J.Gomez-Guitterez and C.A. Morgan. 2002. Cross-shelf variation in calanoid copepod production during summer 1996 off the Oregon coast, USA. *Mar. Biol.* 141:353-365

Morgan, C.A., W.T.Peterson and R.L.Emmett. 2003. Onshore-offshore variations in copepod community structure off the Oregon coast during the summer upwelling season. *Mar. Ecol. Prog. Ser.* 249:223-236

Lamb, J. and W. Peterson. Ecological zonation of zooplankton in the COAST study region off central Oregon in June and August 2001. *J. Geophys. Res.* (in press).

Sutor, M., T.J.Cowles, W. Peterson and J. Lamb. Comparison of acoustic and net sampling to determine patterns of zooplankton biomass and taxonomic groups. *J. Geophys. Res.* (in press).

Tynan, C.T. , D. P. DeMaster, and W. T. Peterson. 2002. Endangered right whales on the southeast Bering Sea shelf. *Science* 294:1894

III. On line status of data and data products

Much of our zooplankton data is available in the GLOBEC data base. This includes taxonomic counts from samples processed (a subset of the total only) from the vertical plankton tows (VPT data from 1997-2001; 2002- not in yet), MOCNESS tows (pre-2003 only; later data not in yet) and (I think) the MOCNESS-Acoustics tows.

All CTD data from Elakha cruises have been placed in the NWFSC GLOBEC data base (not yet on the more broadly accessible GLOBEC NEP server). CTD data from Sacajawea cruises (1997-2000) are available in the COAS CTD database.

In addition, all CTD, and most nutrient and chlorophyll data which we collected during the four mesoscale cruises is available in the GLOBEC data base. Nutrient and chlorophyll data from May 2000 (NH0005) are not online as the Rosette on the CTD was flaky, tripping intermittently and irregularly, and some detective work is still required to decipher what depths bottles (and nuts and chl) came from.

None of the euphausiid rate measurements have been placed into the GLOBEC data base.

IV. Papers realistically expected by June 2005.

In Preparation

Feinberg, L.R. , C.T. Shaw and W.T. Peterson. A comparison of fecundity of *Euphausia pacifica* from the California Current (Oregon and Southern California)– laboratory evidence for multiple broods.

Feinberg, L.R. and W. Peterson. Seasonal and interannual variations in duration and intensity of euphausiid spawning season in the Oregon upwelling zone.

Hooff, R., and W. Peterson. Unusual increases in copepod biodiversity in the coastal upwelling zone of the Northeast Pacific.

Gómez-Gutiérrez, J., Feinberg, L. R., Shaw, C. T. and W. T. Peterson. Interannual and geographical variability of the brood size of the euphausiids *Euphausia pacifica* and *Thysanoessa spinifera* along the Oregon coast (1999-2003). Mar. Ecol. Prog. Ser.

Gómez-Gutiérrez, J., Feinberg, L. R., Shaw, C. T. and W. T. Peterson. Fecundity of *Euphausia pacifica* along the Oregon coast: A comparison of laboratory and field estimations.

Peterson, W. and R. Hooff. Relationships between the Pacific Decadal Oscillation, biomass of boreal copepod species and salmon survival in the northern California Current: the potential role of lipids in controlling salmon survival.

Shaw C. T., Feinberg, L. R., and W. T. Peterson. Variability in developmental pathways of individual larval *Euphausia pacifica*

Vance, M. and W. Peterson. Ontogenic and diel migration of larval, juvenile and adult *Euphausia pacifica* in the Oregon upwelling zone.