Cross-shelf transport of zooplankton and population processes in California Current off Oregon Coast

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Introduction

The study is based on the survey conducted on June 1-17th 2002 as a part of GLOBEC NEP Program. The objectives are

1) measure the zooplankton abundance and distribution corresponding to mesoscale physical field;
2) observe the seasonal variation of physical and zooplankton fields in the California Current System (CCS) off Oregon coast;
3) understand the transport and entrapment processes of zooplankton in CCS off Oregon coast;
4) estimate the zooplankton population dynamic rates.

1. Instrument

Optical Plankton Counter (OPC) (Focal Technology)
3431 size classes, 0.25-14mm (ESD), 50cm² aperture

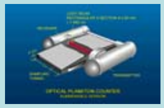


Figure 1 Optical Plankton Counter

2. Survey

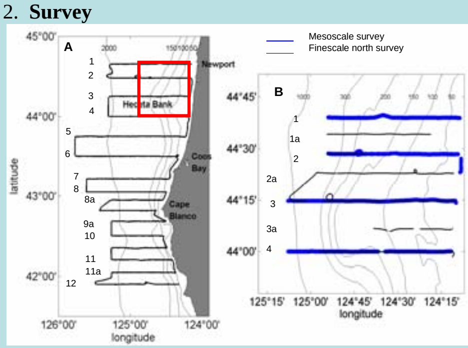


Figure 2

(A) The survey region with the contoured bathymetry. The OPC survey transects included mesoscale transect 1-7 and the south finescale transect 8-12 during June 1-15 2002 (plotted in bold lines). The box highlighted the Heceta Bank area with the repeated measurements. (B) The enlarged box indicated the shiptrack of mesoscale survey (blue line), and finescale survey (black line). The time difference between the two surveys is approximate 7 days.

3. Horizontal distribution

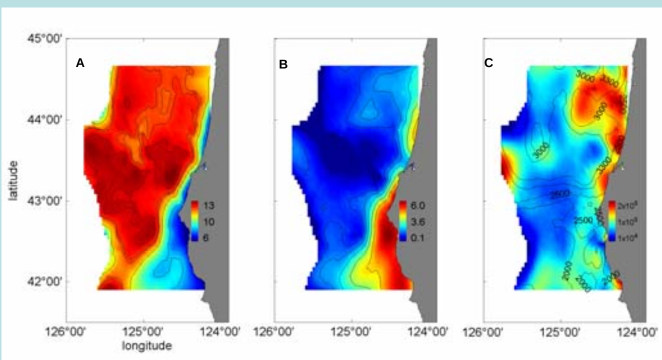
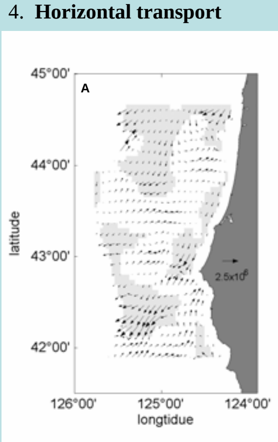
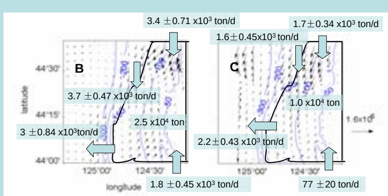


Figure 3 (A) Temperature (°C), (B) *chl* (μg l⁻¹), (C) zooplankton biomass (μgC m⁻³) (color) and zooplankton abundance (# m⁻³) (contour) at 5 m

4. Horizontal transport





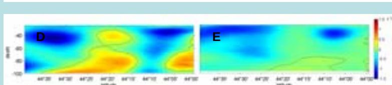


Figure 4 (A) Depth integrated biomass transport (μ g C m⁻¹ s⁻¹) in the upper 150 m. The shadow area indicates the westward offshore transport; (B) Depth integrated (0-100m) biomass transport (μ gCm⁻¹s⁻¹) in mesoscale survey; The net transport was calculated in the north, south and west boundary of the enclosed area. The arrows indicate the net transport direction. (C) Depth integrated (0-100m) biomass transport in finescale survey. (D) Westward transport along the west boundary (150m isobath) in mesoscale survey (the positive is eastward inshore transport, the negative is westward offshore transport). (E) West ward transport along the west boundary in finescale survey.

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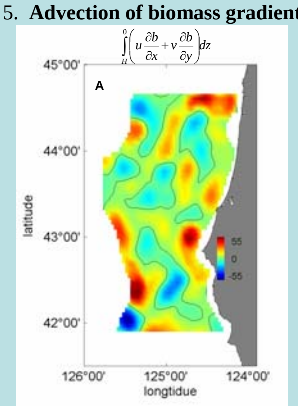
5. Advection of biomass gradients and deep zoopankton maxima



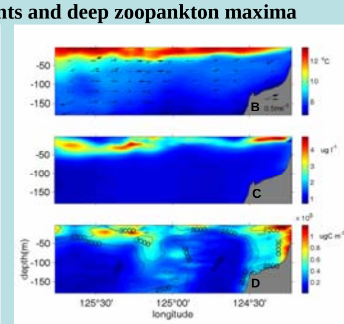


Figure 5 (A) Depth integrated (0-150 m) total advection of zooplankton biomass gradient (μ g C m⁻² s⁻¹). (B) Temperature (°C) with current (m s⁻¹); (C) *chl* (μ g l⁻¹); (D) zooplankton biomass (μ g C m⁻³) with contoured abundance (# m⁻³) in mesoscale transect line 5.

6. Residence time and population propagation

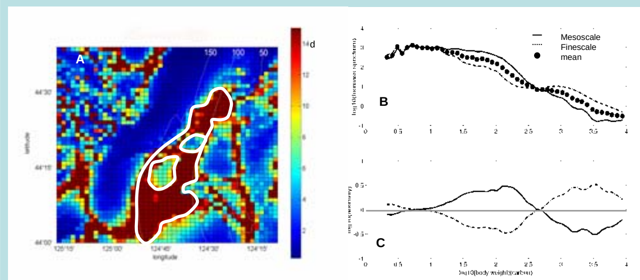


Figure 6 (A) The time scale of biomass gradient transport. The time scale is defined as $\frac{\int b\,dz}{\int\left(u\frac{\partial b}{\partial x}+v\frac{\partial b}{\partial y}\right)dz}$ .The enclosed long residence time area (over 14 days) is highlighted with the bold white line. (B) The biomass spectrum within the long residence time area in mesoscale survey (bold line), finescale survey (dash line), and seasonal mean of the two surveys (dot). (C) The biomass spectrum anomaly of mesoscale survey (bold line), and north finescale survey (dash line) with respect to the mean.

7. Spatial variation in size structures

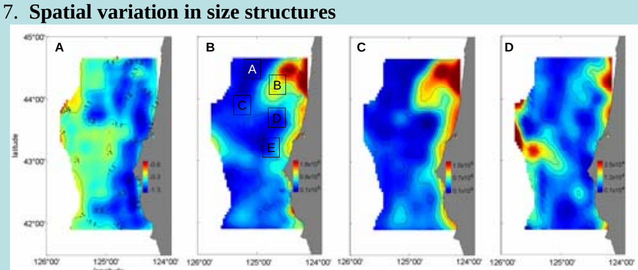


Figure 7 (A) The estimated slope of biomass spectrum in mesoscale survey. (B) Depth averaged biomass in mesoscale survey. (C) The biomass distribution of small (<300 μ gC) and (D) big (>300 μ gC) sizes in mesoscale survey.

8 biomass spectrum in selected locations

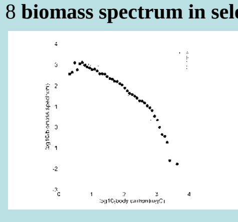


Figure 8 The size structure vs. biomass spectrum at area A, B, C, D, E. The locations of the areas are indicated in figure 6

9. Diel vertical migration

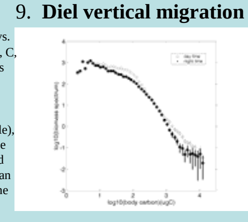


Figure 9 The mean biomass spectrum measured by OPC during the day-time (open circle), and night-time (solid dot) in the mesoscale survey. The thin and bold vertical bars cross the mean biomass spectrum values are the 95% confidence levels

Summary

- There is strong correlation between upwelling areas and zooplankton biomass maxima (Figure 3).
- The circulation produces a net influx at approximately 23% of the daily biomass standing stock in coastal upwelling areas (Figure 4).
- The offshore transport of high zooplankton biomass occurred off Heceta Bank and Cape Blanco associated with the offshore jet (Figure 4).
- The zooplankton biomass gradient advection led to a paired convergence and divergence area on both sides of an offshore-jet, which corresponds to the deep zooplankton maximum (Figure 5).
- The time scale of the biomass gradient transport was calculated at Heceta Bank (Figure 6).
- The propagation of biomass spectrum peak was observed within long resident time areas between two repeat surveys (Figure 6).
- The *diel* migration is insignificant in survey (Figure 9).