Community Structure of Surface Nekton and Plankton in the Northern California Current in Relation to Oceanographic Conditions

Richard D. Brodeur, Northwest Fisheries Science Center, NOAA, Newport, OR, USA
Todd W. Miller, Cooperative Institute for Marine Resource Studies, OSU, Newport, OR, USA
Douglas C. Reese, College of Oceanic and Atmospheric Sciences, OSU, Corvallis OR, USA
Robert L. Emmett, Northwest Fisheries Science Center, NOAA, Newport, OR, USA

We conducted an analysis of how zooplankton and nekton are distributed in the Northern California Current in space and time relative to environmental factors using multivariate and geostatistical analyses. The community structure, spatial distribution patterns, and environmental relationships of neustonic plankton and near-surface nekton from June and August 2000 GLOBEC cruises were examined. Particular emphasis was placed on differences related to the regions north and south of Cape Blanco and Heceta Bank, two prominent topographic features of the study area. Crab megalopae, hyperiid amphipods, euphausiids, and chaetognaths dominated the neuston zooplankton community during both cruises (Figure 1). Nekton assemblages differed significantly between cruises with the June cruise dominated by juvenile rockfishes, rex sole, and sablefish, which were almost completely absent in August. The forage fish community in June was comprised mainly of herring and smelt whereas in August, it was mainly sardines and other southern species (Figure 1). Cluster and indicator species analysis differentiated the inshore and offshore taxa (Figure 2). Results from Nonmetric Multidimensional Scaling analysis confirmed the cross-shelf zonation of zooplankton and nekton, with sea surface temperature the most consistent environmental parameter explaining the distributions (Figures 2 and 3). Geostatistical analysis of the same data showed a marked difference in spatial and temporal distribution and abundance of neuston biomass (Figure 4). Two species of nekton, jack mackerel (*Trachurus symmetricus*) and juvenile rockfish (*Sebastes* spp.), showed concentrated aggregations over a geographic scale (Figure 5).

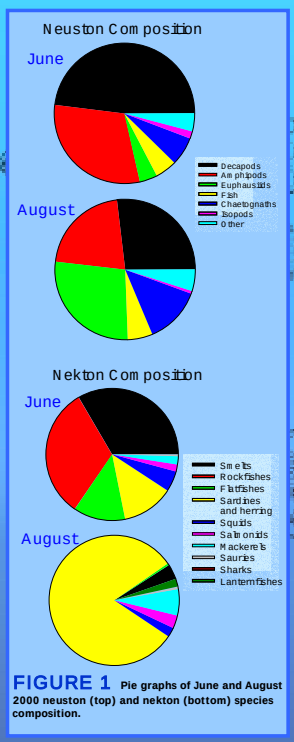

FIGURE 1 Pie graphs of June and August 2000 neuston (top) and nekton (bottom) species composition.

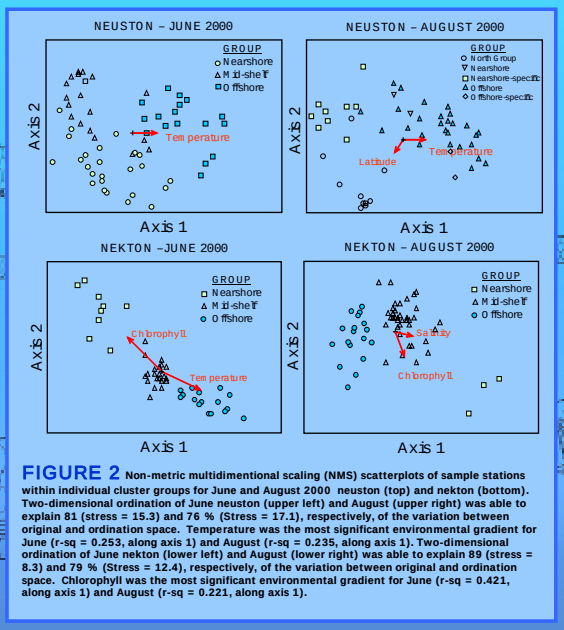

FIGURE 2 Non-metric multidimentional scaling (NMS) scatterplots of sample stations within individual cluster groups for June and August 2000 neuston (top) and nekton (bottom). Two-dimensional ordination of June neuston (upper left) and August (upper right) was able to explain 81 (stress = 15.3) and 76 % (Stress = 17.1), respectively, of the variation between original and ordination space. Temperature was the most significant environmental gradient for June (r-sq = 0.253, along axis 1) and August (r-sq = 0.235, along axis 1). Two-dimensional ordination of June nekton (lower left) and August (lower right) was able to explain 89 (stress = 8.3) and 79 % (Stress = 12.4), respectively, of the variation between original and ordination space. Chlorophyll was the most significant environmental gradient for June (r-sq = 0.421, along axis 1) and August (r-sq = 0.221, along axis 1).

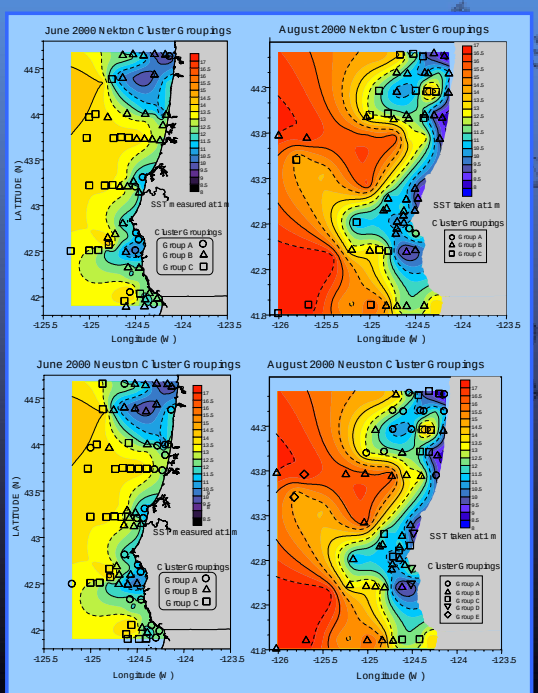

FIGURE 3 Northern California and Oregon cross-shelf distribution of nekton (top) and neuston (bottom) cluster groups from June (left) and August (right) 2000. Color gradient denotes sea surface temperature (SST, ° C). Distribution of cluster groups for both nekton and neuston resulted in on-shore (Group A) and offshore groupings (Group C in June, and D and E in August for neuston; Group C in June and August for nekton).

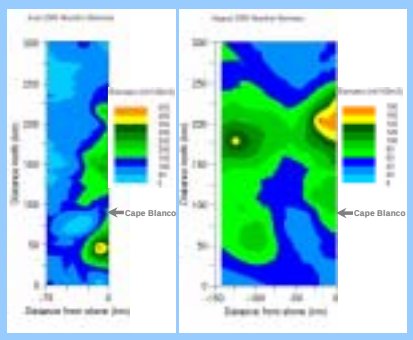

FIGURE 4 Spatial distribution of neuston biomass as determined by geostatistical analyses for June (left) and August (right). June neuston biomass was highest nearshore and south of Cape Blanco, whereas August biomass was higher offshore and north. Overall biomass was higher during June. Note: scales differ between June and August.

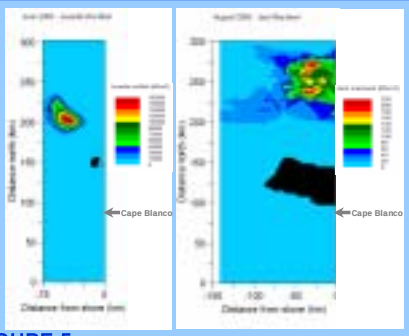

FIGURE 5 Distribution and abundance of juvenile rockfish (left) and jack mackerel (right) during the June and August, respectively, 2000 GLOBEC cruise as determined with geostatistical analyses. Black regions on the map indicates zero fish. Jack mackerel were more abundant in the northern region and closer to shore. Juvenile rockfish were highly concentrated over Heceta Bank, a significant submarine relief.

Methods

Sampling

Sampling was conducted during June and August of 2000 as part of the GLOBEC mesoscale surveys. Stations were sampled along both regular transects and also in areas of special biological interest. At each station, a CTD cast, neuston tow and pelagic trawl were made. The trawl measured 30m by 18m in mouth area with a fine mesh liner to collect juvenile fishes. All nekton were sorted at sea and identified to the lowest possible taxonomic category. All trawls were made in the surface layer for 30 minutes. Surface zooplankton tows were also made during the day with a 0.3x1.0 m neuston net towed for 10 minutes. Samples were sorted to species in the laboratory for only those taxa that exceeded 5 mm in the greatest dimension.

Analysis

We used agglomerative hierarchical cluster analysis (AHCA) to examine species and station groups. The cutoff level was determined using the multi-response permutation procedure (MRPP). Description of the primary species for each grouping was done using indicator species analysis (ISA). The statistical significance of each group was examined by Monte Carlo simulation. Ordination of the stations was done using Non-metric multidimensional scaling (NMS). Correlations of environmental variables with each axis were used to measure the relationships of these variables to species data.

We also used geostatistical analysis to examine the spatial distribution and abundance of the neuston and nekton data. Spatial analysis was performed by modeling the relationship between the variance of the distance between measurements and the distance of the corresponding points from each other. Models were then used to interpolate values for points not measured with the use of kriging. The kriging method provided estimates by performing a weighted average of the sampled values, and furthermore provided a measure of error associated with these estimates.

Results and Conclusions

Species Composition

- Neuston was dominated by decapods and amphipods during both June and August; during August, euphausiids contributed to a higher proportion of taxa collected.
- Nekton composition differed markedly between June and August. Juvenile rockfish and smelts were dominant during June, whereas sardines, herring, and mackerel were dominant during August.

Nonparametric statistics

- From AHCA and ISA, cross-shelf zonation of species composition is very apparent for both neustonic zooplankton and nekton.
- From NMS, sea surface temperature and chlorophyll were the strongest environmental parameters in explaining this relationship.

Geostatistical Analysis

- Neuston biomass differed spatially and quantitatively between June and August.
  - Biomass was higher overall during June with highest levels south of Cape Blanco.
  - Biomass distribution was more protracted during August with highest levels north of Cape Blanco.
- Juvenile rockfish were highly concentrated over Heceta Bank, a bathymetric relief along the Oregon shelf, suggesting the potential retention or aggregation of juvenile rockfish.
- Jack mackerel were generally more abundant during August and were concentrated nearshore and to the north.