Distribution of zooplankton communities relative to hydrographic features in the northern Gulf of Alaska

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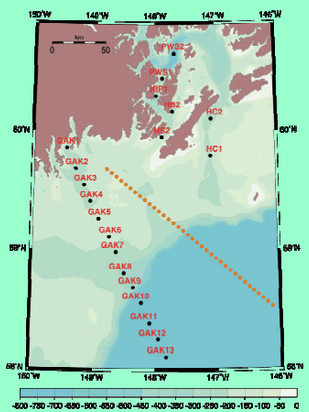
Abstract:
The cross-shelf distribution of zooplankton on the northern Gulf of Alaska shelf in May 1998, 1999 and 2000 was related to the distribution of water properties on the shelf. Conditions which promoted a distinct shelf-break front resulted in distinct zooplankton communities. Multidimensional scaling grouped stations by the species composition and developmental stages of the zooplankton taxa. When a strong front was present, distinct station groupings were observed. The dominant taxa within the groupings were related to the origin of the water mass: Alaska Stream, Shelf, Coastal Current or fjord-estuary. The water masses were identified primarily by salinity, secondarily by temperature. The cross-shelf distribution of water masses was also identified by SeaWifs images of the chlorophyll distribution. When distinct zooplankton communities were present, the satellite image revealed sharp boundaries between regions of high and low chlorophyll concentrations. The intensity of the shelf break frontal boundary was related to the position of westward propagating eddies off the shelf break. The time scale of small eddy propagation past the Seward Line (off Resurrection Bay, Alaska) was on the order of days to weeks. The timescale for large eddies propagating past the Seward Line was on the order of weeks to months.

Methods:

Large zooplankton and micronekton were collected at the 13 stations on the Seward Line and five locations in Prince William Sound. Samples were taken with a 1-m MOCNESS with 0.5 mm mesh nets. The net were fished from 100 m to the surface in 20 m increments. Samples were preserved in 10% formalin. Zooplankton were identified to the lowest taxonomic category possible. Copepods were staged. Wet weights were measured on all taxa and stages. CTD profiles were taken with a Seabird model 911 CTD system with dual conductivity and temperature sensors. Multidimensional scaling was used to group the stations by the abundance, species composition and developmental stage of the ten most abundant taxa in each net.



Map showing the location of the study site, the Seward Line stations (labeled GAK), and the Prince William Sound stations.
Orange dots show the track of the TOPEX satellite over the study area.

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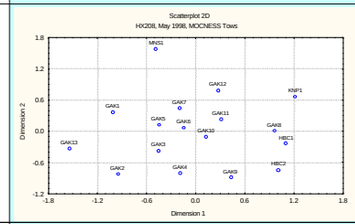
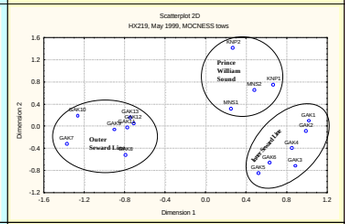
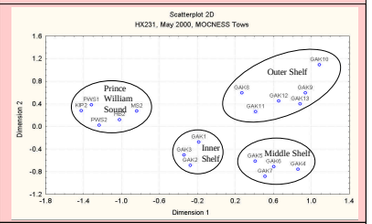
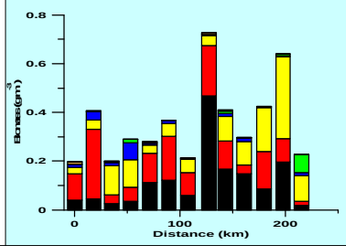
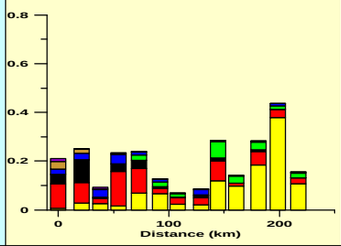
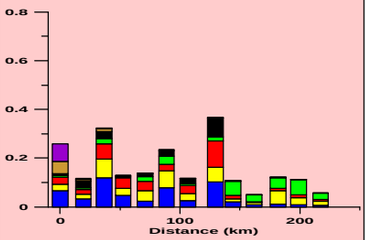
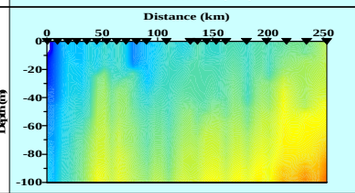
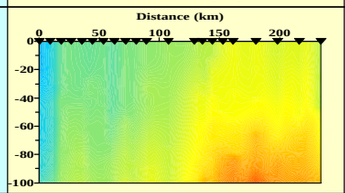
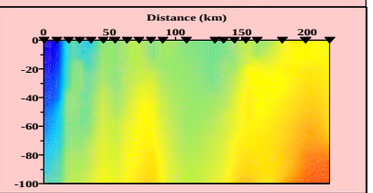
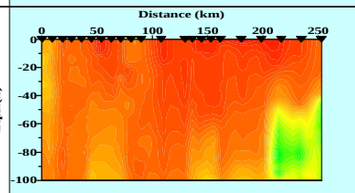
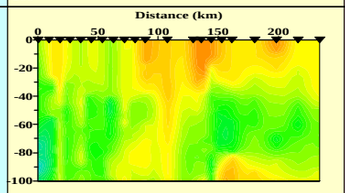
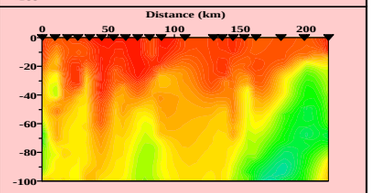
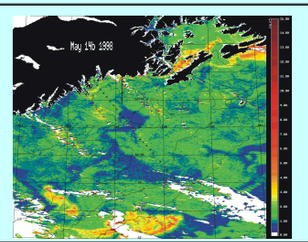
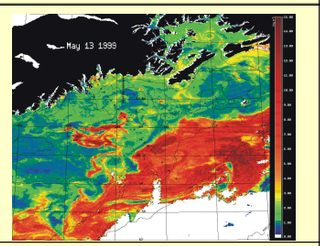
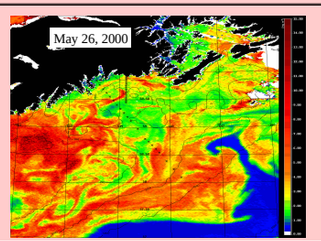
Conclusions:

1) In the presence of a well developed shelf break front, distinct zooplankton communities associated with shelf and oceanic water masses are observed on the northern Gulf of Alaska shelf. Prince William Sound has a characteristic species complex suggesting the presence of a unique zooplankton community in the deep fjords.
2) In the absence of a well developed shelf break front, the shelf and oceanic zooplankton communities become mixed across the shelf, with no distinct grouping of stations based on zooplankton species composition.
3) Satellite images of chlorophyll concentration can indicate the present of frontal regions or eddy activity. When a well developed shelf break front was present, marked differences in chlorophyll concentration were observed on either side of the front.
4) The intensity of fronts is at least partially influenced by eddies propagating westward along the shelf break. Large slow eddies with length scales of 100 km or more may influence the distribution of water mass properties on the shelf for one to several months. Superimposed on the larger eddies are small fast eddies, which may substantially alter the cross shelf distribution of water masses and their associated zooplankton assemblages on time scales of days to weeks.

	May 1998	May 1999	May 2000
1) Multidimensional scaling showing station groupings based on the 10 most abundant taxa per net. May 1998: Stations are scattered with no distinct groupings and little apparent order. May 1999: stations group into three distinct clusters with the shelf stations divided into oceanic and shelf groupings. May 2000: stations on the shelf group into a Coastal Current, shelf and oceanic community. Prince William Sound stations grouped separately.			
Taxa: *Neocalanus plumchrus*, *Neocalanus flemingeri*, *Neocalanus cristatus*, *Metridia pacifica*, *Eucalanus bungii*, *Calanus marshallae*, *Metridia okhotensis* **2) Biomass of the major calanoid species across the shelf**: The oceanic group was dominated by *E. bungii* and *N. cristatus*. The shelf group contained *M. pacifica*, *N. flemingeri* and *N. plumchrus*. The Coastal Current regime contained *C. marshallae* and *M. ochotensis*.			
3) Salinity distribution (PSU): May 1998: Low surface salinity with deep water intrusions along the entire line. May 1999: a distinct front at km 150 divides shelf from oceanic water. May 2000: Fronts at km 50 and 150 divide oceanic from shelf water and shelf water from the Coastal Current regime. The shelf break fonts indicate the presence of an eddy (see Nos. 4 and 5).			
4) Temperature distribution (oC): May 1998: Unusually warm surface water was present in the upper 100 m across the entire shelf due to El Nino effects. May 1999 and May 2000: Intrusions of cold water upward and warm water downward are associate with fronts at the shelf break. The shelf break fonts indicate the presence of an eddy (see Nos. 4 and).			
5) SeaWifs Images: The cross shelf distribution of chlorophyll from satellite images (Seward line stations indicated by black dots). May 1998: A random distribution of chlorophyll across the shelf, distinct regions of high and low chlorophyll absent. May 1999: the shelf is divided into distinct domains, oceanic high chlorophyll and shelf low chlorophyll. May 2000: a distinctive high oceanic chlorophyll regime occurred off shore. A low chlorophyll regime occurred on the shelf with streaks of high chlorophyll associated with the Coastal current. A small eddy can be seen propagating westward along the shelf break.			
6) TOPEX altimeter measurements of sea surface height anomalies (SSHA) along ground track D90 (see Station Map). The underlying bathymetry is indicated by the dotted line. SSHA troughs (crests) correspond to upwelling (downwelling) zones. SSHA profiles that slope steeply downward in the offshore direction are associated with hydrographic fronts. May 1998: The slopes of SSHA profiles were weak over the outer shelf and upper continental slope suggesting that the shelf break front was relatively weak. Weak downwelling occurred over the upper and mid-continental slope. May 1999: Steep downward-sloping SSHA profiles over the shelfbreak and upper continental shelf reflect the presence of a strong shelfbreak front. A narrow downwelling zone occurred over the outer shelf whereas a broad upwelling zone was centered over the middle of the continental slope. By mid-May a large anticyclonic eddy had arrived at ~145.5W. May 2000: A narrow upwelling zone occurred over the outer shelf with downwelling occurring near the shelf break. Relatively strong hydrographic fronts are inferred for the mid-shelf and upper continental slope