# The distribution of zooplankton, nutrients, chlorophyll, fish and seabirds relative to the major water masses and current regimes on the shelf of the northern Gulf of Alaska during 1998 and 1999 (GLOBEC Long-Term Observation Program)


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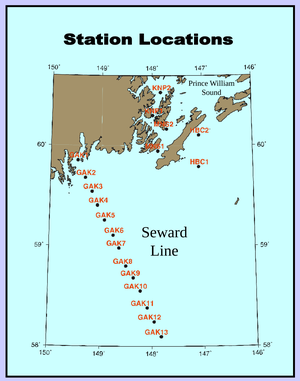
## Introduction:

Each year millions of salmon smolts are released into Prince William Sound from natural spawning streams and hatcheries. Despite the intensive enhancement programs, the year class strength of the returning salmon is highly variable, resulting in large annual fluctuations in the fishery. Much of the year-class mortality is thought to occur in the nursery areas in Prince William Sound and during migrations along the shelf to foraging areas in the Alaska Gyre. Prince William Sound and the adjacent Gulf of Alaska also sustain fisheries on a variety of other taxa, including pollock, herring, halibut, black cod, shrimp and crab. Although the region supports a substantial commercial fishery, very little is known of the scale, timing or mechanisms driving the annual fluctuations in year-class strength of the major fin and shell fish populations. The GLOBEC program seeks to identify, quantify and model the physical and ecological factors impacting year-classes.

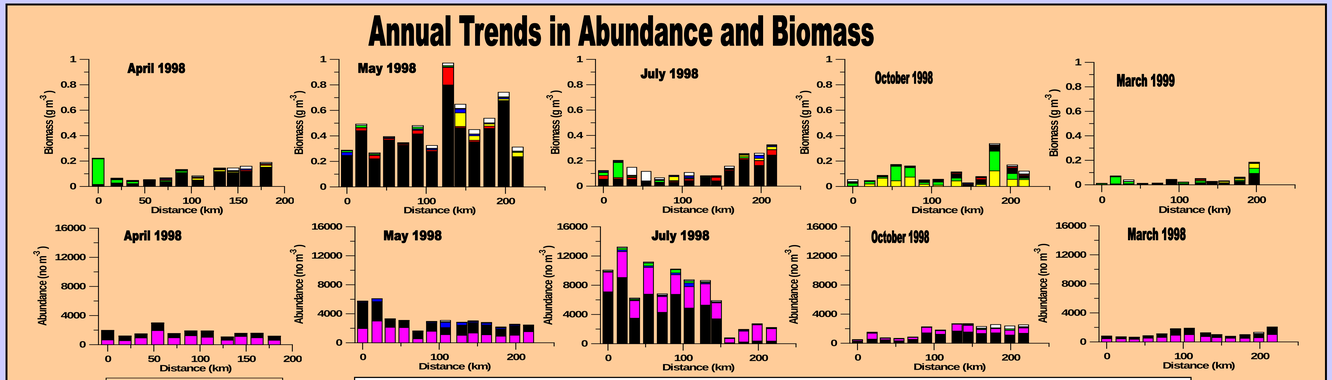
Year-class strength of any given population can vary on scales of years to decades. Therefore, identification of the mechanisms influencing recruitment and the time scales over which they operate requires long term observations. Such long-term observations are critical to developing, testing and reparameterizing the numerical models which are being developed to analyze, simulate and predict climate-related influences on fisheries populations. This poster illustrates some of the initial results of the long-term observation program currently under way in the northern Gulf of Alaska.

## Methods

1) Stations were taken along the Seward line (Station Figure, GAK 1-13). Supplemental samples were taken in Prince William Sound. Triangles on contour plots (upper axes) indicate station locations.
2) Methods for physical oceanographic, nutrient and fish data are presented in their respective posters.
3) Micronekton were collected with a 1-m MOCNESS with 0.5 mm mesh towed double obliquely from 100 m to surface. Samples were collected at 20 m depth intervals.
4) Zooplankton were collected with a 25 cm CalVET net with 0.15 mm mesh towed vertically from 100 m to the surface.
5) Acoustic data were collected with an HTI multi-frequency echosounder at 43, 120, 200 and 420 kHz.

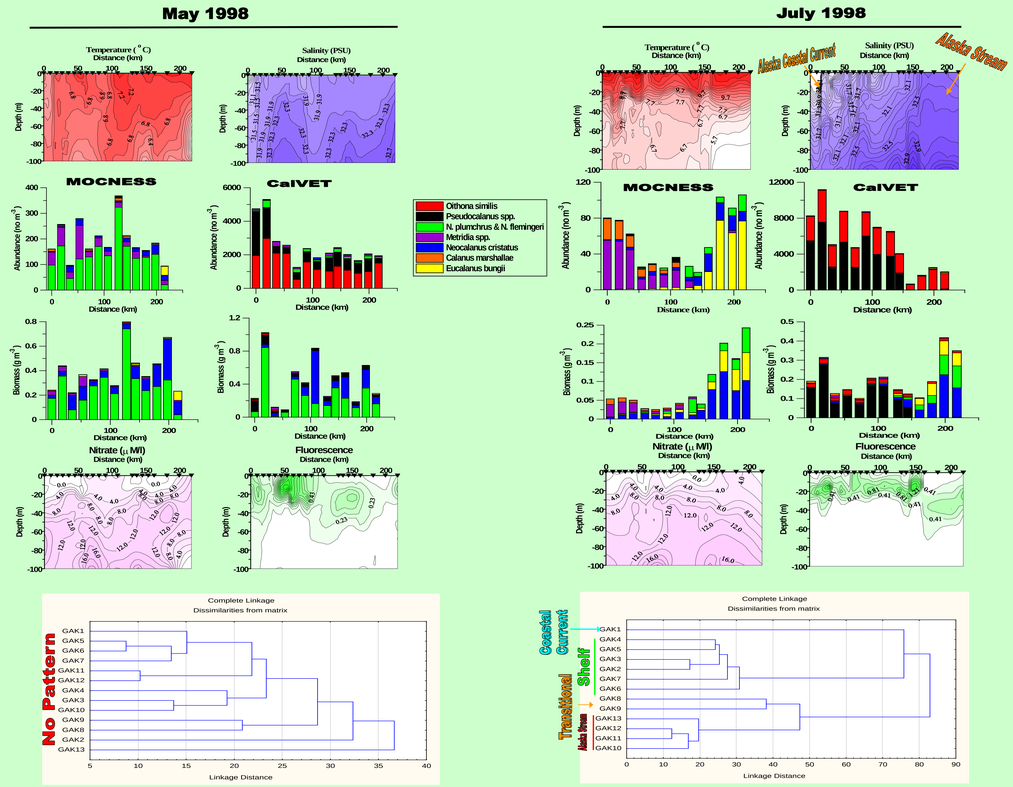



## Annual Trends in Abundance and Biomass




Average abundance and biomass of major taxonomic groups in the upper 100 m. Upper row MOCNESS, lower row CalVETs.
1) Biomass in April through July was dominated by calanoid copepods, primarily ***Neocalanus***.
2) Euphausiid tended to occur in the inner stations from April through July.
3) Abundance was dominated all year by small calanoids and cyclopoids, in particular ***Pseudocalanus*** spp. and ***Oithona similis***.
4) Abundance in 1998 peaked in July.
5) Abundance and biomass patterns are similar to those recorded in Prince William Sound.

## Community Composition and Water Mass Distribution





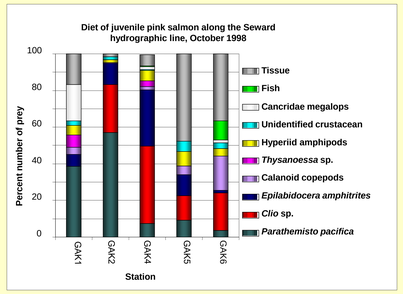


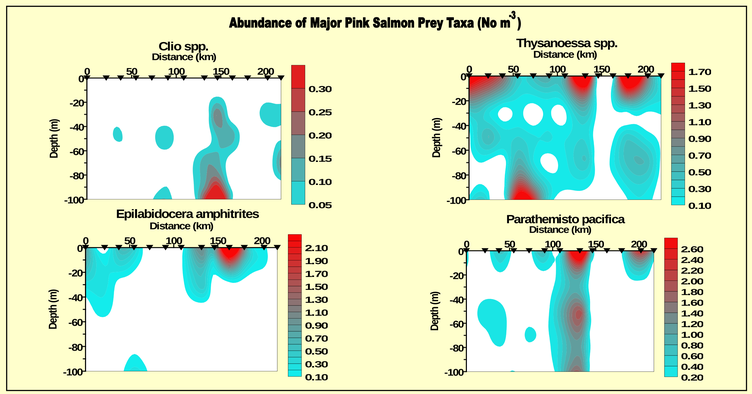


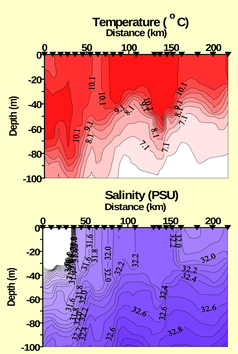

Distribution of major water mass types, calanoid copepod abundance and biomass, nitrate nitrogen and fluorescence along the Seward Line, May and July 1998.
1) Three water mass types present: oceanic Alaska Stream, brackish Alaska Coastal Current near shore, an intermediate shelf regime between.
2) Shelf regime occupied the upper 20 m of most of the line in May. Note the 31.2 psu isoline present clear out to the end of the transect.
3) A distinct front separated oceanic from shelf water in July. Note the salinity front at km 150 along the Seward Line.
4) Cluster analysis divided the July zooplankton assemblage into distinct species groups. Oceanic copepods (***Neocalanus cristatus***, ***N. plumchrus***, ***N. flemingeri***, ***Eucalanus bungii***) predominated on the outer shelf. Neretic species (***Pseudocalanus*** spp. and ***Calanus. marshallae***) dominated on the shelf. Distinct species groups were not observed in May. Oceanic species were spread across the entire shelf. Although the small copepods dominated the abundance, the biomass was dominated by the large ***Neocalanus*** species.
5) Doming of isotherms and isohalines in May suggest the presence of an eddy between km 50 amd km 100. Elevated nitrate and fluorescence at the surface indicate elevated production associated with the eddy. The eddy was absent in July. Elevated nitrate occurred near the surface in the oceanic regime.

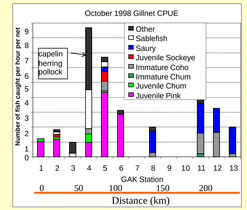
## Fish Distribution and Diets (October 1998)

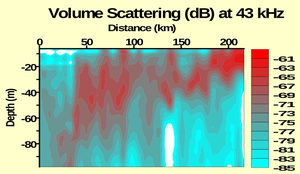
1) Pink salmon were caught on the inner part of the line. Highest catches occurred on the outer edge of the Coastal Current (km 50 and 100).
2) Major dietary items of pink salmon included ***E. amphitrites***, ***Clio*** sp. and ***P. pacifica***. ***Thysanoessa inermis*** and ***T. spinifera*** are large prey items which may contribute substantially to the overall diet.
3) Pink salmon prey densities in the net tows were quite low compared to the abundance of other zooplankton taxa. These fish are apparently very selective.
4) Highest catches of Pacific saury and coho salmon occurred on the outer end of the line, in or near Alaska Stream waters.
5) Acoustic data indicate that fish targets were concentrated in warmer waters above the pycnocline. The deeper distribution of fish targets on the inner part of the line coincided with a deepening of the pycnocline. Fish targets were largely absent from the brackish Alaska Stream water.



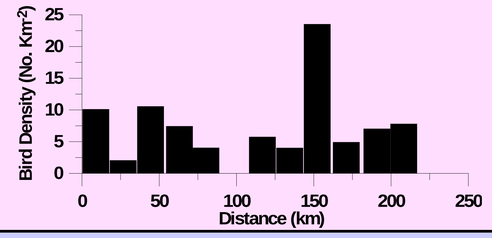



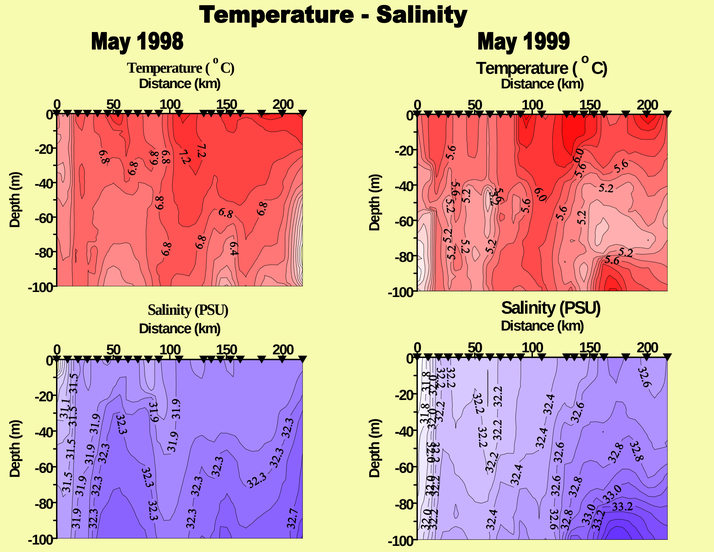
## Seabird Counts (October 1997)

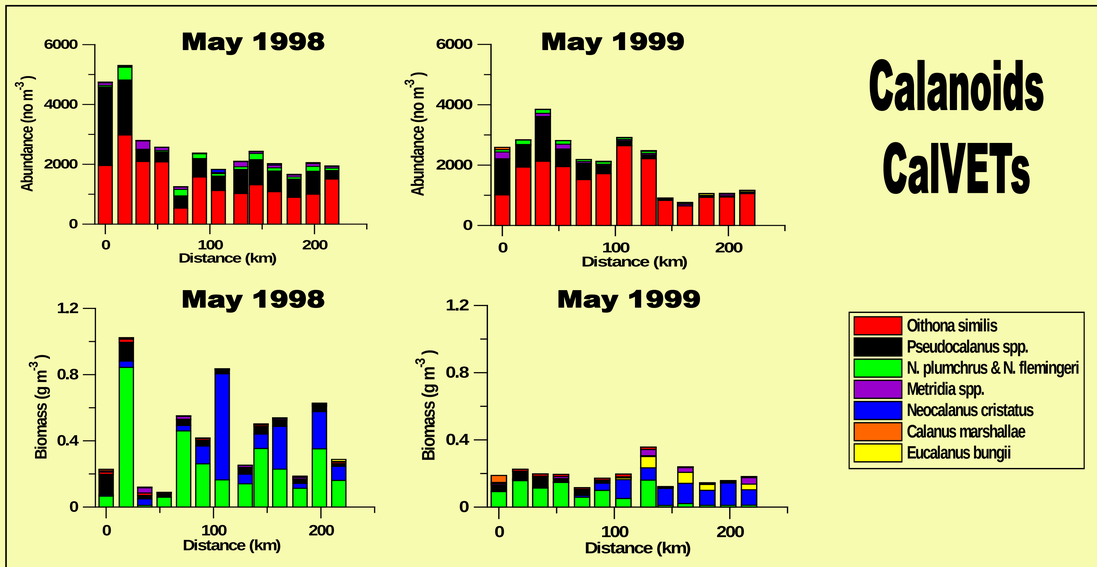
During many of the cruises seabird were counted from the bridge of the vessel while transiting between stations on the Seward Line. This plot shows an example of the cross-shelf distribution of seabirds during October 1997. The pulse of birds within the ACC and inshore of the frontal boundary (inside km 20) consisted primarily of surface-feeding Northern Fulmars and diving White-winged Scoters; most of the density consisted of one flock of scoters. The concentration of birds between km 25 and 75 occurred in the frontal zone separating the Alaska Coastal Current from shelf water and consisted primarily of deep-diving Common Murres and secondarily of surface-feeding Northern Fulmars. Fisheries data from October 1998 suggest that several species of fishes concentrate in this region at this time of the year. The third concentration of birds occurred between km 100 and 160, and consisted of a congregation of surface-feeding Fork-tailed Storm-Petrels (and secondarily Northern Fulmars) in the vicinity of the shelf-break front, where they presumably were feeding in microscale convergences and divergences. A smaller number of these two species also occurred between km 175 and 225.



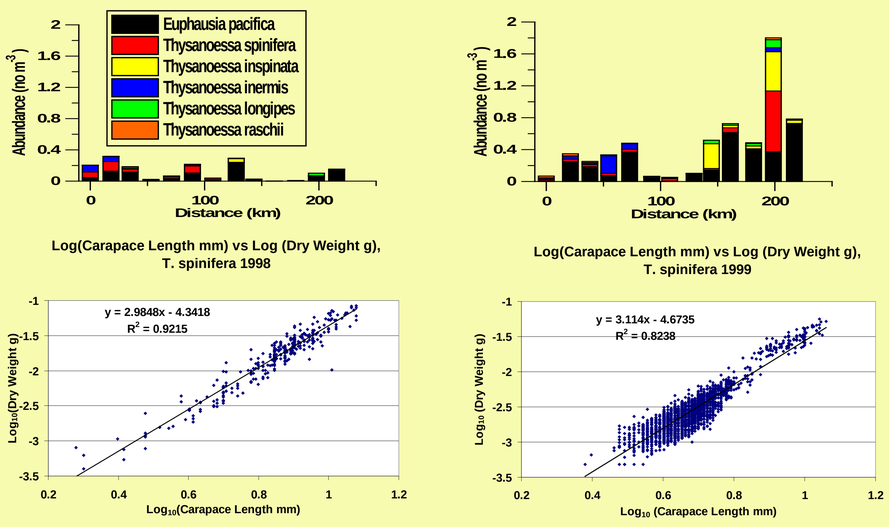

# Interannual Differences: Preliminary Indication

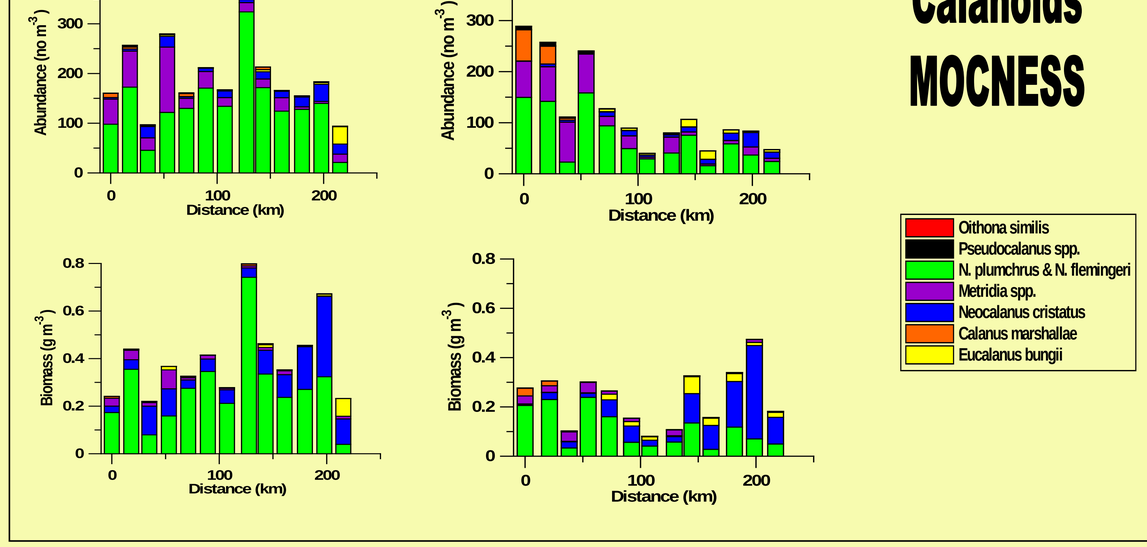
### Temperature - Salinity




### Euphausiids MOCNESS




1) Salinities above the pycnocline were substantially higher in May 1999 than in May 1998. Temperatures were lower in 1999 relative to 1998.
2) Substantial intrusion of oceanic water was observed over the shelf in May 1999. Note the decline in salinity in the upper 20 m between km 150 and km 75.
3) ***Neocalanus*** biomass in CalVET samples was significantly higher in 1998 than in 1999 over much of the Seward Line.
4) ***Neocalanus plumchrus*** and ***N. flemingeri*** biomass in MOCNESS samples was higher in May 1998. Lower ***Neocalanus*** biomass was observed in the oceanic regime in 1999.
5) Euphausiid abundance was higher in May 1999 than in May 1998, particularly in the oceanic regime.
6) Euphausiid dry weight biomass per unit carapace length was higher in 1999 samples.
7) Processing of the 1999 zooplankton samples is ongoing. Final evaluation of any differences between years will be made when the lab work and data analyses are completed.

## Conclusions:

1) The northern Gulf of Alaska zooplankton assemblage consists of two major communities: a shelf community dominated by ***Pseudocalanus*** spp. and an oceanic community dominated by ***Neocalanus*** spp. and ***Eucalanus bungii***.
2) Zooplankton biomass peaks in May or June and is dominated by the large oceanic copepods. Populations peak in June or July and are dominated by the smaller species (***Pseudocalanus*** and ***Oithona***).
3) When distinct zooplankton communities occur along the Seward Line, they are separated by a salinity front dividing the oceanic regime from the shelf community.
4) The northern Gulf of Alaska shelf is a very dynamic system. Rapid cross-shelf and along-shelf flow can modify the abundance, distribution and species composition of the major zooplankton taxa in periods of days to weeks. When the front dividing the oceanic and shelf regime is absent, the zooplankton can be dominated by shelf or oceanic taxa, depending on the origins of the water mass occupying the shelf. Preliminary satellite data suggest that mesoscale eddies may strongly influence shelf circulation (Okkonen, personal communication) and consequently, zooplankton abundance, species composition and distribution.
5) Pink salmon are distributed primarily along the inner shelf. The prey taxa are minor constituents of the zooplankton samples, suggesting high prey selectivity. Acoustic data indicate the presence of major subsurface fish targets. Target identification and verification will be essential to evaluating the effect of these fish on the zooplankton community (Process studies).
6) The long-term observation program is just beginning. As this data set grows, the accumulating information will permit us to identify the magnitude, scale and period of changes in the physical regime and associated zooplankton community.
7) Given the dynamic nature of the northern Gulf of Alaska shelf environment, mesoscale studies will be critical to evaluating the observed changes in the physical regime and the zooplankton community observed by the long-term observation program.