FRONTS & FISH: Interannual Differences in Frontal Structure and Effects on Pollock and Prey

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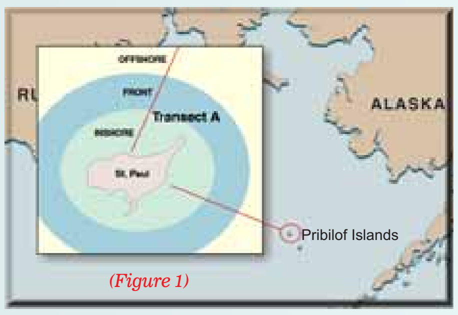
Introduction

Oceanic fronts can affect the distribution and productivity of planktonic organisms in many coastal systems. Early life stages of many marine fish may concentrate in these fronts and benefit from the enhanced feeding conditions. The research described here is part of a study of distribution, growth, and survival of age-0 walleye pollock (*Theragra chalcogramma*) in the Bering Sea. Juvenile walleye pollock are a nodal species in the food web and a major prey of many higher trophic level carnivores. The Pribilof Islands region is a location where intensive predation occurs due to large numbers of seabird and marine mammal rearing sites located there. Previous surveys of the large-scale shelf distribution of juvenile pollock indicate that high abundances occur around these islands. This suggests that the benefits of occupying this habitat outweigh the disadvantages of increased predation risk. The strong interaction of tides and topography produces highly productive frontal regions that completely surround the islands.



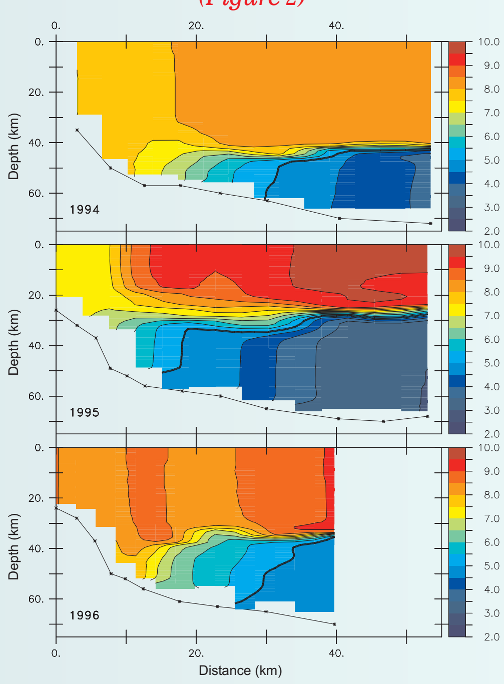
(Figure 1)

Methods

Figure 1: During September of 1994 through 1996, sampling was conducted on Transect A. CTD casts were made from surface to bottom to determine frontal structure and samples were collected for nutrients and chlorophyll. Net sampling for zooplankton and nekton was clustered inshore, within, and offshore of the frontal region. The primary zooplankton sampling gear was a $1\ m^2$ MOCNESS containing nine nets for depth-stratified sampling. Larger age-0 pollock and other nekton were collected using a $100\ m^2$ anchovy trawl with 3 mm mesh in the codend. Age of juvenile pollock was determined by otolith analysis. Stomach contents were examined from each habitat to characterize the diets.

Results

(Figure 2)



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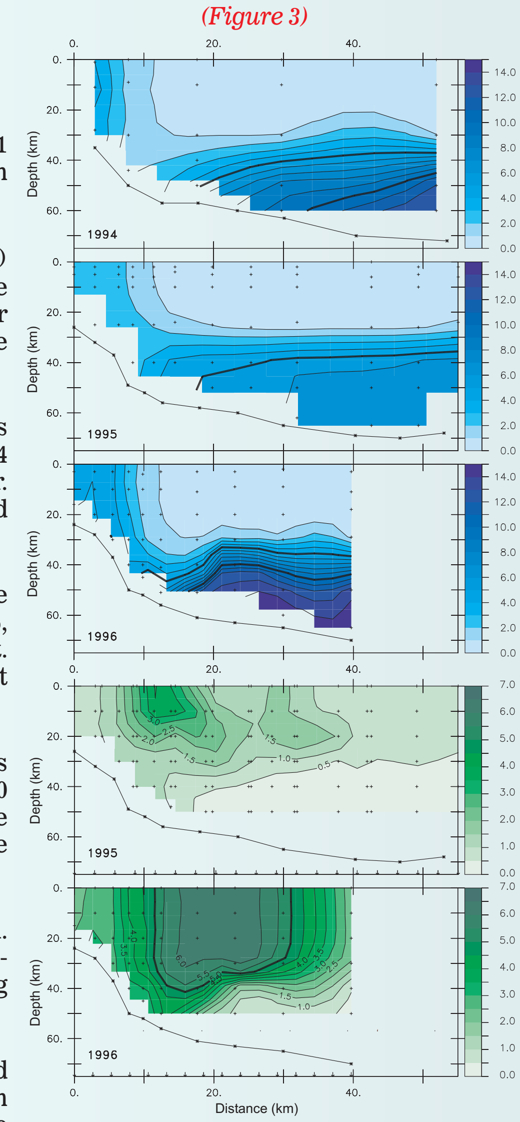


- *Physical Oceanography*

Figure 2: Comparison of temperature sections on Transect A during 19 September 1994, 10-11 September 1995, and 11-12 September. The upper mixed layer was much shallower in 1995 than in 1994 and 1996 and the thermocline was stronger.

- *Nutrients and Chlorophyll*

Figure 3: Distribution of nitrogenous nutrients ($\mu M\ NO_2$ and NO_3 combined) and chlorophyll-a ($\mu g/l$) (no data available for 1994) concentrations along Transect A. Nutrients were > 1 μM below the thermocline in the stratified waters and throughout the water column in the transition and inner front area. Maximum chlorophyll concentrations were found in surface waters. Moderate chlorophyll concentrations were measured at the thermocline.

- *Zooplankton*

Figure 4: Displacement volumes by habitat and year for zooplankton collected in MOCNESS tows integrated over the water column. Mesh size is 505 μm in 1994 and 1995 and 333 μm in 1996. In 1994 and 1995, the highest volumes found offshore and volumes at the front and inshore were much lower. The high volume in offshore samples was due mainly to high abundances of copepods. The front had the highest volumes in 1996, but this may be due in part to using a smaller mesh size that year.

- *Pollock Density and Size*

Figure 5: Density and size distribution of age-0 pollock by year and habitat. Pollock densities were higher at the front in 1994 and 1996, but showed slightly higher densities inshore of the front in 1995, although the differences were not significant. The lowest densities were found offshore of the front. In 1994, pollock were significantly larger in the offshore habitat than in the inshore and front habitats. There were no significant size differences among the habitats in 1995 and 1996.

- *Growth*

Figure 6: Growth curves for age-0 pollock showing size at age for collections from different positions relative to the front. Length at age was slightly higher overall in 1995 than in 1994 for fish over 100 days old, suggesting a higher growth rate. A trend of increasing fish size from inshore to offshore was apparent in 1994. In 1995, a slight increase in size at age was apparent for the fish offshore relative to those at the front.

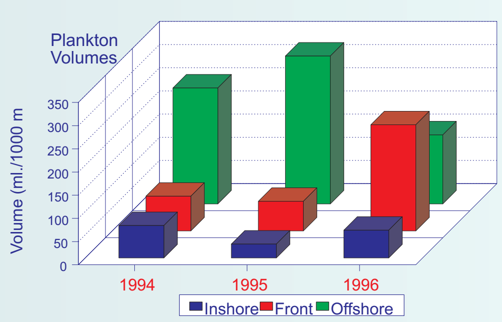
- *Feeding*

Figure 7: Stomach contents of age-0 pollock by year and location with respect to the frontal region. Diet composition was variable among years and areas but copepods, euphausiids, fish (smaller age-0 pollock), and chaetognaths were major prey. No interannual or habitat differences in feeding intensity were observed.

- *Condition Factor*

Figure 8: Comparison of the mean (± 1 standard deviation) condition factor (W/L^3) for each year and habitat and the overall means for each year (dashed lines). Year was not significant but the location with respect to the front was significantly related to body condition; pollock offshore were found to have a higher condition index than those at or inshore of the front.

(Figure 4)



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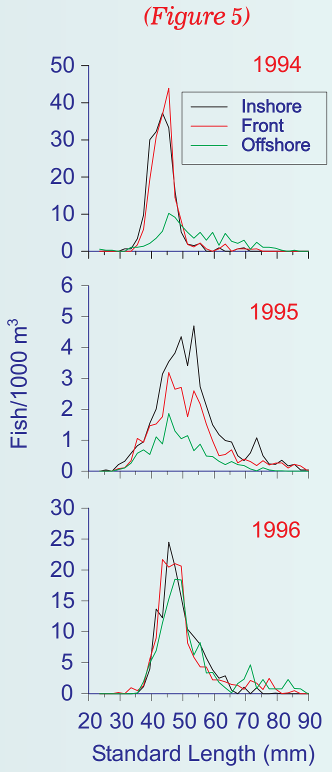
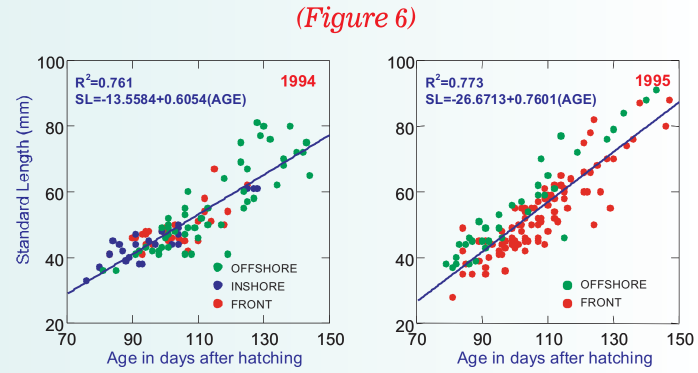


Conclusions

- Highest densities of pollock found at the front or inshore, but the food densities were highest offshore.
- An apparent increase in size and age from inshore to offshore was observed in 1994.
- Diets highly variable but copepods and euphausiids were the main prey at front.
- Condition of juveniles was significantly higher offshore than in other regions.

(Figure 6)



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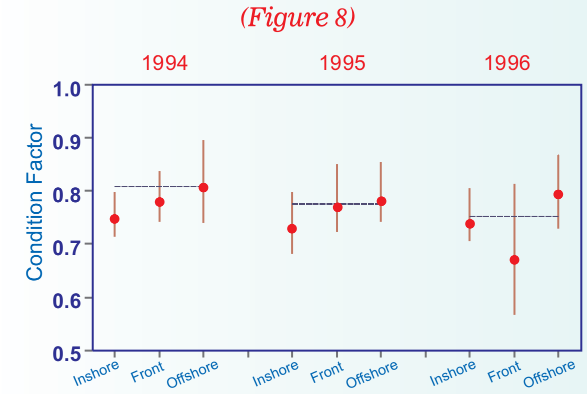

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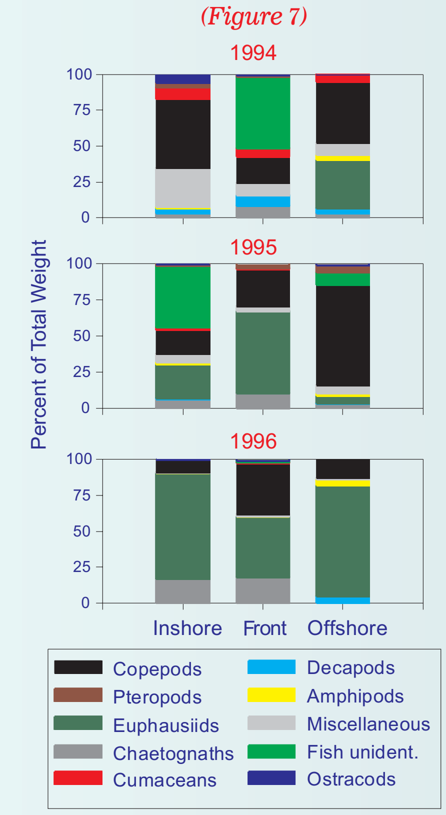

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