Zooplankton Changes Along the Newfoundland - Georges Bank 1994 CPR Line and 1995 Halifax Line

Background

Zooplankton range in size from smaller than 1 mm (e.g. copepods) to about 4 cm (krill). They are fed on by all species of fish at some time in the fishes life cycle. There is evidence that the abundance of some species of zooplankton can influence recruitment and growth of fish such as cod, herring and capelin. The most important copepods to fish are Calanus finmarchicus and Pseudocalanus spp., and Meganyctiphanes norvegica is the most important krill species. The eggs and young of zooplankton are fed on by the youngest stages of fish and as the fish grow they feed on larger zooplankton. Many fish species also feed heavily on the adult krill.

The physical conditions, such as temperature, have a large influence on production of zooplankton. This can cause large seasonal, yearly and multi-year changes in zooplankton population size. Monthly population changes of zooplankton on the SW Grand Banks, Scotian Shelf and Georges Bank are measured by the Continuous Plankton Recording (CPR) program run by the Sir Alister Hardy Foundation for Ocean Science in Plymouth, England. Zooplankton are also sampled with a variety of nets, multifrequency acoustics and optical instruments in the area twice a year. These data are combined with CPR data to monitor long term changes in the levels of zooplankton species.

Newfoundland to Georges Bank 1994 CPR Zooplankton

The Continuous Plankton Recorder (CPR) is an instrument that collects phytoplankton and zooplankton on a long continuous ribbon of silks while towed from commercial ships. The position on the silk corresponds to location of the different sampling stations. These data were divided into three longitude sections, SW Grand Banks, Scotian Shelf and Georges Bank (Fig. 1). The phytoplankton greenness index (a measure of the amount of chlorophyll on the silk) was significantly lower in 1994 than in 1993, but it still was above the long term mean value for the three geographic sections (Fig. 2). Total copepod numbers also showed a decline in 1994 with the numbers near the long term mean on the SW Grand Banks section but below the mean on the other two sections. All species of copepods except *Calanus glacialis* (an Arctic species) on the SW Grand Banks and *Clausocalanus* spp. on the Scotian Shelf showed declines in abundance in 1994. Total copepods on the Shelf and Georges Bank had large declines in 1994 compared to 1993 abundances. Total euphausiids had a slight increase in all three regions with the numbers close to the long term mean.

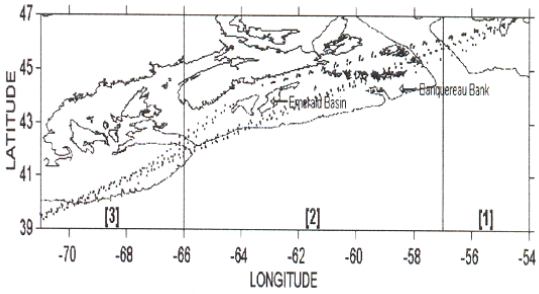

Fig. 1. Track of the CPR sampling stations in 1994 showing the three longitudinal sections SW Grand Banks (1), Scotian Shelf (2) and Georges Bank (3).

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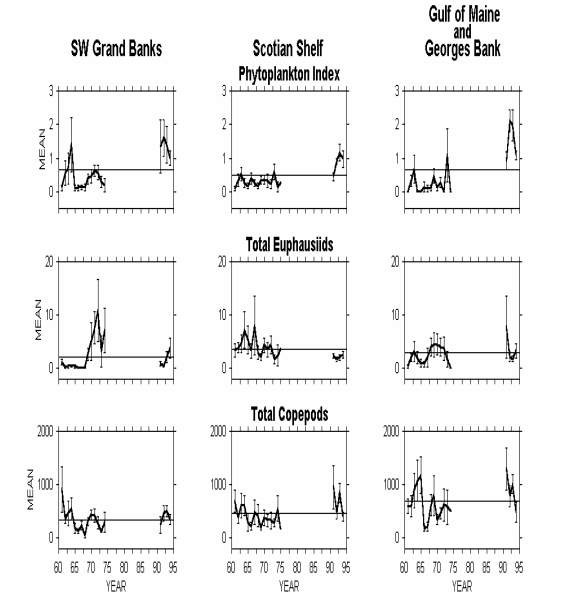

Fig. 2. The yearly averages and standard errors for various CPR plankton species groups on each of the three longitudinal sections. The horizontal line in each of the panels represents the long term mean for that taxon. There are no data between 1975 and 1990.

Halifax Line 1995

The Halifax Line was sampled during the spring, summer and fall in 1995 using conventional plankton nets,and multifrequency acoustics (Sameoto and Herman 1990).

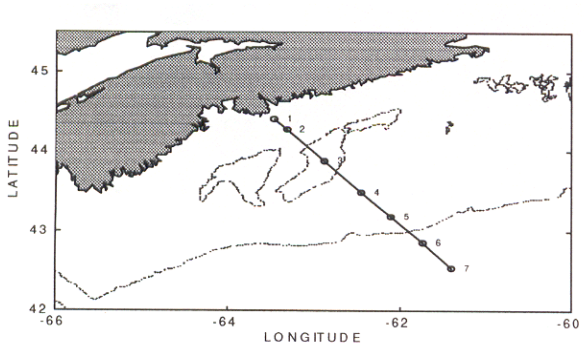

Fig. 3. Sampling stations on the Halifax line, station 3 is in Emerald Basin and station 4 on Emerald Bank.

1995 Halifax Line Temperature, Salinity and Copepod Concentrations

Temperatures of the cold intermediate layer during April 1995 were significantly warmer than they were in previous years, with no values smaller than 0°C (Fig. 3). In addition, the top 75m of water was warmer than it was in 1994. In July, the top 10m was very warm (close to 17° C) across the entire shelf and the salinity increased in the top 75 m. During October, the warm layer (~16°C) increased in thickness to about 50 m over the entire Halifax Line.

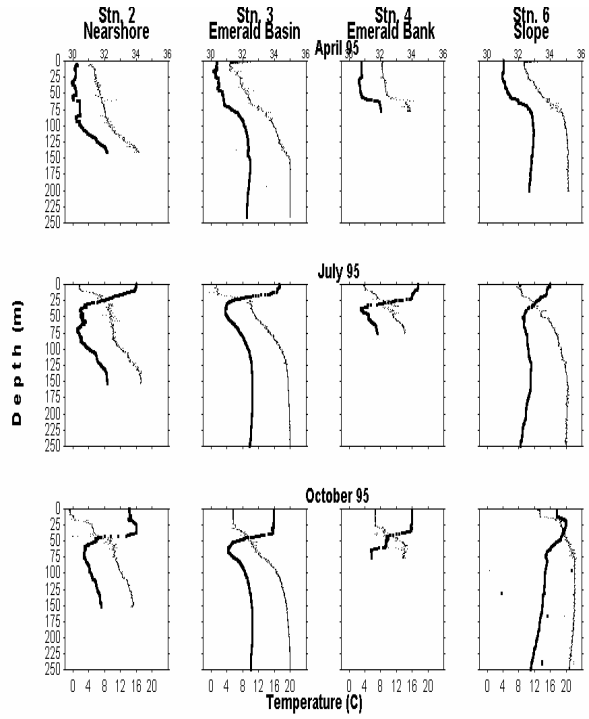

Fig. 4. Temperature (the darker solid line) and salinity profiles on selected stations on the Halifax Line during April, July and October, 1995.

Copepod concentrations in April, 1995 were very high, some of the highest ever recorded. This was the case across the entire Halifax Line extending on to the continental slope. In contrast, July copepod concentrations in the upper 50m of water were low on all stations except station 4 on Emerald Bank. In October the low concentrations on all stations may have been the result of the warm surface water on the shelf.

Acoustic Index

Acoustic data are good indicators of changes in euphausiid abundance both across the shelf and between different months of the year. High daytime levels of the krill acoustic index was detected during April in the region of Emerald Basin extending from a depth of 100m to the bottom. The levels of backscattering were as high as any we have recorded in the last 10 years. In contrast, the pelagic fish index (primarily silver hake and sandlance) was low over the Halifax Line except for a small region in the deepest region of Emerald Basin and on Emerald Bank. These data suggested a large population of euphausiids on the shelf and a low population of pelagic fish. There was little evidence of significant numbers of pelagic fish larvae and / or juveniles.

In July, the index on the Halifax Line was significantly reduced (by a factor of 16 times) from those seen in April. This reduction was due primarily to the normal die-off of euphausiids after they reproduce in June. However, it is possible that the abnormally warm water on the shelf at this time may have also adversely affected the growth of young euphausiids. The mesozooplankton (smaller than 1 cm) levels in this warm water layer were also extremely low. The October index was also abnormally low.

Euphausiid and Silver Hake trends 1984-1995

Acoustic data collected over the last decade in Emerald Basin showed a close relationship between krill and pelagic fish. The relationship between the two indices over the years 1985 to 1995 showed a significant positive correlation. Both indices showed a general increase between 1985 and 1994 followed by a significant decrease in values in 1995. These data indicated a close relationship between the fish and euphausiids in Emerald Basin. Juvenile silver hake and redfish, the two dominant pelagic species, feed primarily on euphausiids in the Basin (Waldon 1988).

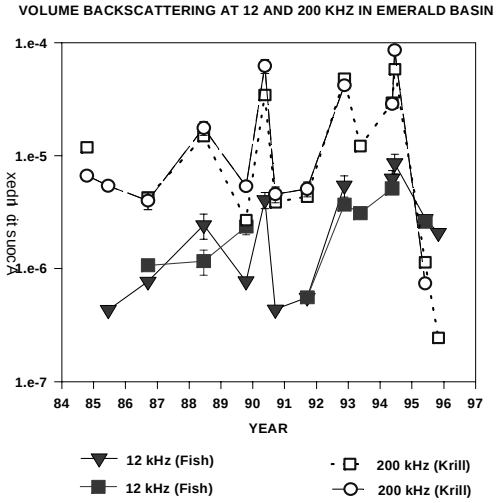

Fig. 5. Relationship between acoustic indices for pelagic fish (12 kHz) and euphausiids (200 kHz) in Emerald Basin from 1985 to 1995.

Siphonophores

Siphonophores are free swimming colonies of jelly fish, (that can be more than a metre long), and are usually associated with warm water. They are predators on zooplankton and fish larvae and can have a serious impact on populations of these animals if they exist in high concentrations. These animals were rare from 1985 to 1994 on the Scotian shelf, but were extremely abundant (~ one / m^3) in the Gulf of Maine during 1991 to 93. In October 1995 in Emerald Basin siphonphores were more abundant (1 / 10 m^3) than we have seen during the last ten years. We may be seeing a build up of their population size and this has the potential to depress the size of future copepod populations.

Calanus finmarchicus in Emerald Basin

The copepod *C. finmarchicus* accumulates in Emerald Basin during the summer and fall and remains in the deep water until the

breeding season in the late winter and early spring. It is believed that the size of the fall population of *C. finmarchicus* in the Basin in the fall is a good indicator of the size of the previous spring and summer's population on the Scotian Shelf (Sameoto and Herman 1990). The changes in the fall populations in the Basin between 1984 to 1995 are shown in Fig. 6. The 1995 population of *C. finmarchicus* increased slightly from the 1994 level. The temperature anomaly at 50 m in June and the numbers of *C. finmarchicus* appeared to be related, showing that as the temperature increased there was generally an increase in the size of *C. finmarchicus* population. *C. glacialis* and *C. hyperboreus* (both Arctic species) had low concentrations in the Basin in 1995.

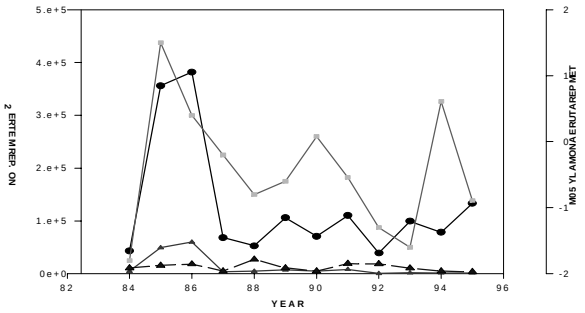

Fig. 6. Abundance of *Calanus* spp. per m^2 of water column in Emerald Basin during the fall from 1984 to 1995 plus the temperature anomaly in the Basin at 50 m during June. The circles represent *C. finmarchicus*, the small triangles *C. glacialis*, the large triangles *C. hyperboreus* and the squares the temperature anomaly.

Conclusions

The plankton greenness index decreased in 1994 but it was still above the long term mean suggesting that levels of primary production may have also been above average. The abundances of most copepod species measured by the CPR were lower in 1994 than in 1993 and many of the species had levels lower than the long term mean. The two notable exceptions were *C. glacialis* on the SW Grand Banks and *Clausocalanus* on the Scotian Shelf and Georges Bank. *C. glacialis* is an Arctic species and probably their high numbers reflect the influence of the increased Arctic water on the Bank. *Clausocalanus* is an indicator species of slope water and its high concentrations on the Shelf and Georges Bank may have been due to increased Slope water influence in these areas. These data indicated that zooplankton concentrations in 1994 were only slightly lower than average on the Scotian Shelf and average on the SW Grand Banks. The Georges Bank data series is only four years long and therefore not really long enough to calculate an accurate long term mean, however, since 1991 there has been a general decline in the level of copepod abundance on the Bank.

The Emerald Basin *Calanus finmarchicus* data indicated that since 1987 the population levels have been stable but much lower than in 1985 and 1986. Based on samples and the acoustic index there was a gradual increase in both euphausiid and fish populations in the Basin between 1984 and 1994 followed by a steep decline in their population size in 1995. The causes for these declines are not known.

Outlook

The zooplankton populations, including krill, appear to be declining from high levels seen during the last few years. Copepod levels were slightly below the long term mean on the Shelf and below the 1991 to 1993 levels on Georges Bank. It is unknown if the steep decline in krill observed in 1995 is just an aberration or the start of a long term decline in this population.

For More Information

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Sameoto, D. D. and A. W. Herman. 1990. Life cycle and distribution of *Calanus finmarchicus* in deep basins on the Nova Scotia shelf and seasonal changes in Calanus spp. Mar. Ecol. Prog. Ser. 66: 225-237.

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