

State of Phytoplankton, Zooplankton and Krill on the Scotian Shelf in 1997

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.

Temperature can have a large influence on the community structure and production of zooplankton and can cause large seasonal, yearly and multi-year changes in zooplankton population size. Zooplankton are sampled with a variety of nets, multifrequency acoustics and optical instruments over the Nova Scotian Shelf twice a year. These data are used to monitor long-term changes in the levels of zooplankton species.

Summary

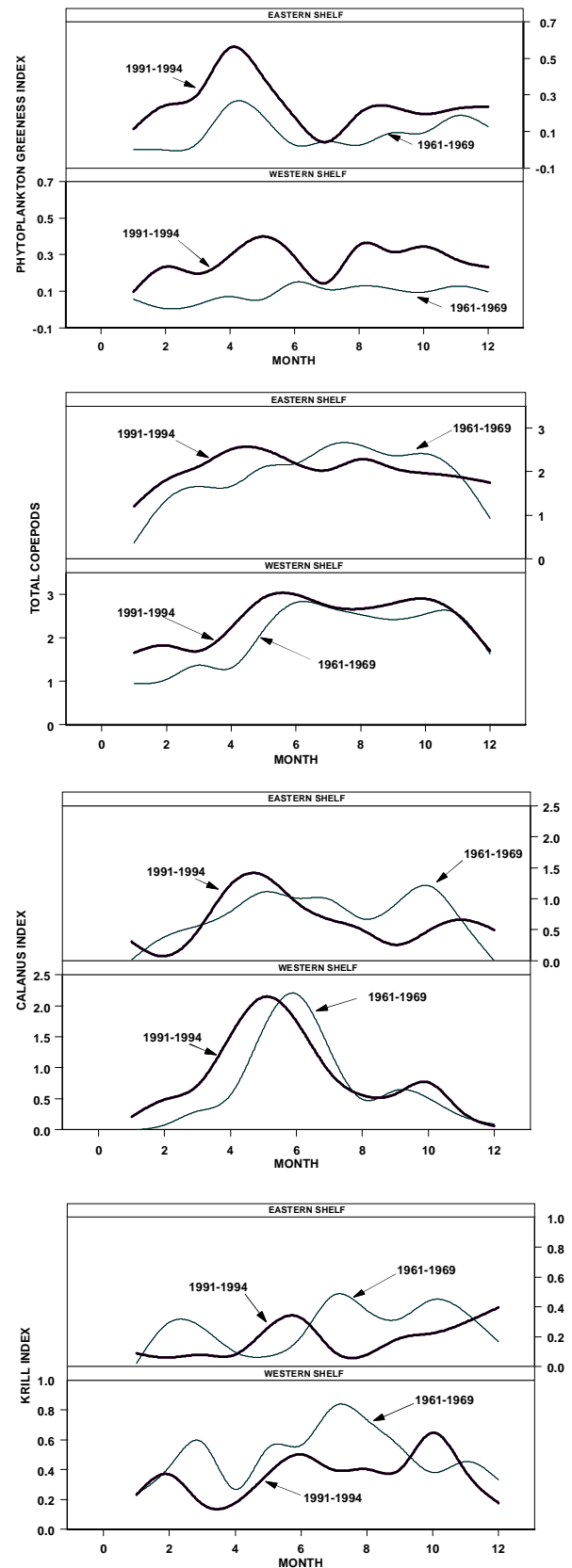
- Continuous Plankton Recorder (CPR) plankton indices on the eastern and western halves of the Shelf showed that phytoplankton and copepod blooms started earlier in the year between 1991 - 1994 compared to 1961 - 1969.
- The CPR data showed *Calanus* and total copepod spring abundance peaks occurred about a month earlier in 1991 - 1994 compared to 1961 - 1969.
- The CPR krill index was significantly lower between 1991 - 1994 than between 1961 - 1969 suggesting the population was higher in the 1960s.
- Net samples of zooplankton showed similar levels of zooplankton biomass on the Louisbourg and Halifax transects.
- The water temperature on the eastern Shelf was significantly colder than the water on the western shelf, which resulted in higher concentrations of arctic copepods on eastern Shelf.
- The acoustic index for krill showed the concentrations of krill only slightly below the long-term mean.
- The over-wintering population of the copepod *C. finmarchicus* in Emerald Basin was at historical low levels.

Continuous Plankton Recorder

The Continuous Plankton Recorder (CPR) is an instrument that collects phytoplankton and zooplankton on a long continuous ribbon of silk while towed from commercial ships. The position on the silk corresponds to location of the different sampling stations. Historical CPR data were analyzed to detect differences in the seasonality of indices of phytoplankton and zooplankton abundance for different years on the Scotian Shelf. All CPR data, from 1961 to 1994, were grouped into two time periods, 1961 to 1969 (a period when the bottom temperature of the central Shelf was colder than normal) and 1991 to 1994 (a period when the central Shelf bottom temperatures were warmer than normal and the eastern Shelf bottom temperatures were colder than normal). The data were also subdivided into eastern and western Shelf areas. The dividing longitude for east and west was $-62^{\circ}00'$ W. The indices are measures of numbers of plankton collected in a single CPR sample. They do not represent absolute concentrations of organisms, but only represent relative changes in concentrations.

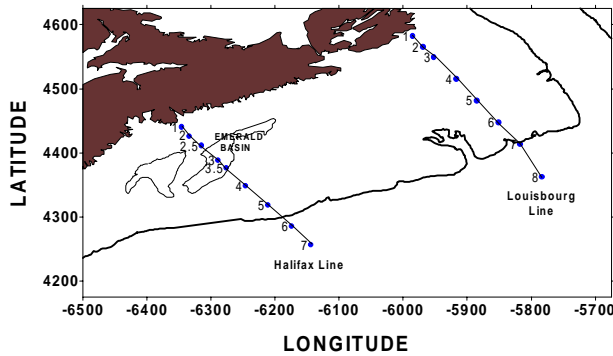
The phytoplankton greenness index (a measure of the amount of chlorophyll on the silk), the *Calanus* index and the Total copepod index were all significantly higher in the early months of the year between 1991 and 1994 than during 1961 - 1969. The phytoplankton greenness index increased earlier in the year between 1991 and 1994 in both Shelf areas as did the total copepod index. The *Calanus* index increased earlier in the year only in the eastern Shelf area. The total copepods and *Calanus* indices peaked about a month earlier between 1991 - 1994. The krill index was significantly lower in both Shelf areas in the 1991 - 1994 period.

Plankton Indices



Halifax and Louisbourg Transects

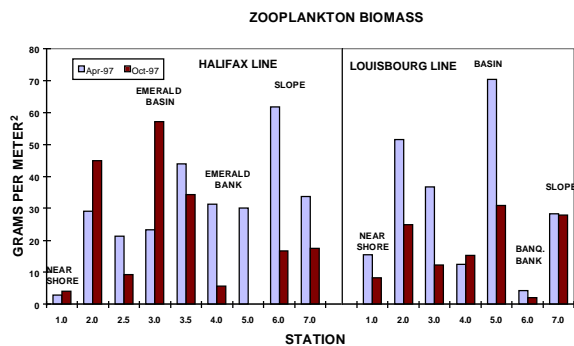
The Halifax and Louisbourg transects were sampled during the spring and fall in 1997 using conventional plankton nets and multifrequency acoustics (Sameoto and Herman 1990).



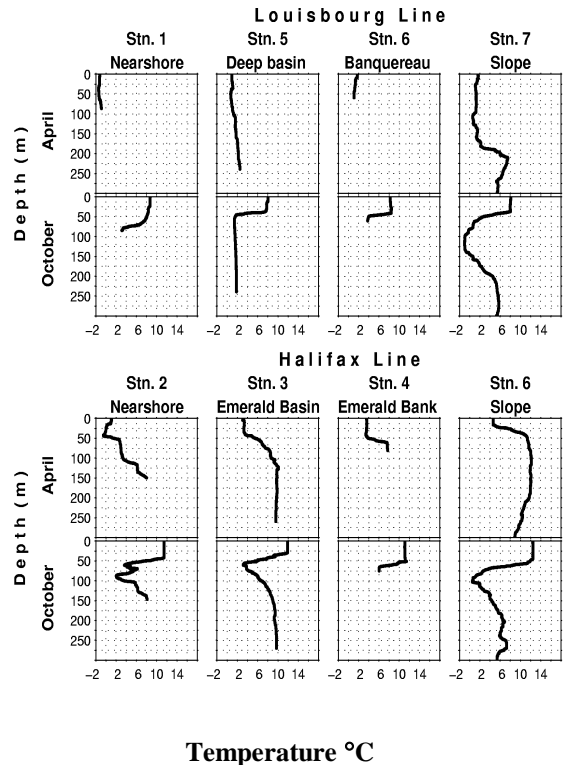
**Halifax and Louisbourg Transect
Temperatures and Copepod
Concentrations**

The eastern Shelf area has generally colder midwater and bottom temperatures than the western Shelf. The differences in temperature in the two areas influence not only the growth rate of zooplankton, but also the species composition of the zooplankton community; as an example, the eastern Shelf has a higher percentage of arctic copepods than the western Shelf. The cold water masses that affect the eastern Shelf also periodically affect the western Shelf, and for this reason the temperature is monitored on the Louisbourg and Halifax transects. These two transects are considered representative of the eastern and western Shelf.

**Zooplankton Biomass on Halifax and
Louisbourg Transects**



In 1997, zooplankton biomass on the Halifax transect was much lower than in 1996. This resulted in no significant differences in the total zooplankton biomass between the Halifax and the Louisbourg transects during the spring or fall in 1997. This was in contrast to 1996 when the Halifax Transect had a higher biomass than the Louisbourg Transect.



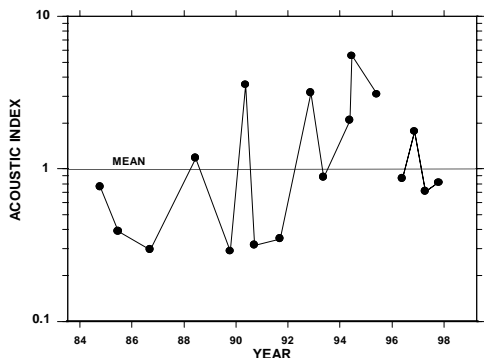
Temperature profiles are shown for selected stations on the two transects for comparison. During April and October 1997 the temperature profiles had colder values on the Louisbourg Transect at all depths and

these were similar to profiles taken in 1996. The October temperature profiles showed an unusual cold water mass on the edge of the slope extending from the Louisbourg Transect westward past the Halifax Transect. This cold fresh water was believed to be primarily Labrador Current water. It flooded onto the Shelf and into the basins during the winter causing a large drop in temperature below 100m. In April, 1998, the temperature below 100m in Emerald Basin had dropped to about 6° C from 10° C in October, 1997.

Acoustic Index

Acoustic data are good indicators of changes in krill abundance both across the shelf and between different months of the year. High daytime levels of the krill acoustic index were detected during April in the region of Emerald Basin extending from a depth of 100m to the bottom. These data suggested a large population of krill on the shelf. There was little evidence of significant numbers of pelagic fish larvae and / or juveniles. The krill acoustic index on the Louisbourg transect indicated a biomass about 5 times lower than that on the Halifax transect.

Krill Trends in Emerald Basin 1984-1997



Acoustic data collected over the last decade in Emerald Basin has shown a close relationship between the acoustic index (volume backscattering at 200 kHz) and krill concentrations. The 200 kHz data provided

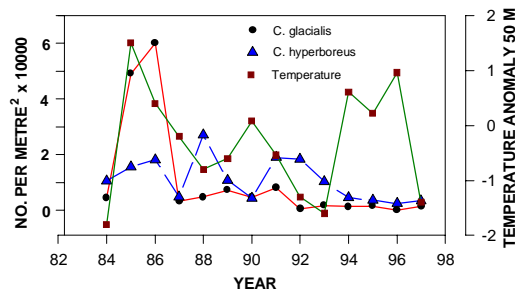
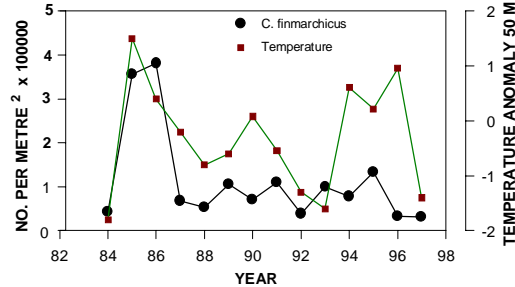
an accurate estimate of the krill concentrations.

The acoustic index showed the level of krill in Emerald Basin to be slightly below the long-term mean value.

An error due to faulty equipment was found in the 1995 acoustic data. These acoustic levels were too low and subsequently have been corrected in the Acoustic Index figure in this report.

Calanus finmarchicus in Emerald Basin

The copepod, *Calanus 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 1997 population of *C. finmarchicus* was at the same very low level seen in the fall of 1996. *C. glacialis* and *C. hyperboreus* (both

Arctic species) had very low concentrations in the Basin in 1997. The temperature anomaly at 50 m in June and the numbers of *C. finmarchicus* appeared to be related in the years 1984 to 93, showing that as the temperature decreased there was generally a decrease in the size of the *C. finmarchicus* population. However, since 1993 the relationship between temperature and population size has been poor. There was no relationship between temperature anomaly and the abundance of *C. hyperboreus* or *C. glacialis*.

Conclusions

The eastern shelf has been influenced by abnormally cold bottom temperatures in recent years and it is possible that this cold water has affected the size of the krill population in the region. Long-term time series data show that the levels of krill in the eastern region were lower in the 1990s than in the period between 1961 to 1975 when bottom temperatures were warmer.

The Emerald Basin *Calanus finmarchicus* data indicated that since 1987 the population levels have been stable but much lower than in 1985 and 1986. Zooplankton samples and the acoustic index showed there was a gradual increase in both krill and fish populations in the Basin between 1984 and 1996. The affect of the influx of cold Labrador water onto the Shelf during the winter on the community structure of zooplankton and krill is uncertain but evidence of change will be closely monitored in 1998.

Outlook

The zooplankton population, measured by the size of the *C. finmarchicus* population in Emerald Basin, is at a historical low level. It is postulated that if the bottom temperatures

on the eastern shelf remain cold (i.e. in the range of 1° C) *C. finmarchicus* populations and possibly krill populations will remain low in the eastern region. Krill populations on the western half of the shelf are near their long-term mean. The recent flood of cold Labrador water onto the western shelf may cause zooplankton community structure changes in 1998.

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