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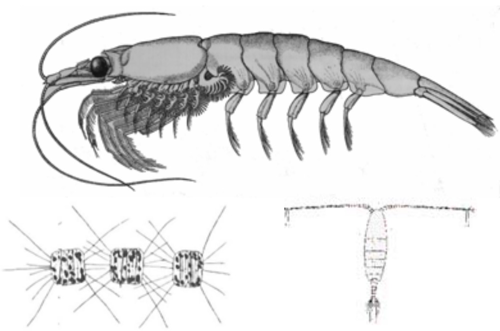
Newfoundland and Labrador Region **Ecosystem Status Report 2004/007**



2003 State of the Ocean: Chemical and Biological Oceanographic Conditions in the Newfoundland Region

Background

The Atlantic Zone Monitoring Program (AZMP) was implemented in 1998 with the aim of increasing DFO's capacity to understand, describe, and forecast the state of the marine ecosystem and to quantify the changes in the ocean's physical, chemical and biological properties. A critical element of the AZMP involves an observation program aimed at assessing the variability in nutrients, phytoplankton and zooplankton.

The AZMP derives its information on the state of the marine ecosystem from data collected at a network of sampling locations (fixed point stations, cross-shelf sections, and groundfish surveys) in each region (Quebec, Gulf, Maritimes, Newfoundland) sampled at a frequency of bi-weekly to once annually.

A description of the seasonal patterns in the distribution of phytoplankton (microscopic plants) and zooplankton (microscopic animals) provides important information about organisms that form the base of the marine foodweb. An understanding of the production cycles of plankton, and their interannual variability, is an essential part of an ecosystem approach to fisheries management.

Summary

- Silicate inventories in the surface layer (top 50 m of the water column) at Station 27 appeared to show an increase relative to the 2000-02 average.
- Near bottom nutrient concentrations at Station 27 continued their decline since 2000, with levels approximately 20-25% lower than the 2000-02 average, but this pattern did not appear to prevail across the Newfoundland Shelf.
- There was no evidence of a fall bloom at Station 27 based on water collections, but large scale satellite observations and the fall oceanographic survey indicate that a fall bloom occurs almost every year throughout much of the region.
- The timing of the spring bloom was delayed by approximately two weeks relative to the long term average, although the duration was similar to the long term average.

- In 2003 the numerical abundance of most phytoplankton groups was lower than in previous years, following a trend which started in 2000.

- Phytoplankton biomass at Station 27 was consistent with the observations made during three oceanographic surveys (April-May, July, December) which showed generally lower (20-50%) phytoplankton concentrations across much of the Newfoundland Shelf and Grand Banks in 2003 compared to 2000-2002.

- The abundance of the copepodite stage of small and large copepod species was generally comparable to previous years.

- The development and production of the dominant copepod species was similar to 2001 but delayed by approximately one month relative to other observations since 1999.

- The relative abundance and occurrence of copepod species normally found in colder waters appear to have increased while the relative abundance of one important warm water species has returned to levels observed in 1999, a reversal of the trend that had been evident since that time.

Introduction

Phytoplankton are microscopic plants that form the base of the aquatic food web, occupying a position similar to that of plants on land. There is a wide variation in the size of phytoplankton, with the largest species being members of a group called diatoms while smaller species are members of a group called flagellates. They use light to produce organic matter from nutrients dissolved in marine waters. The growth rate at which new organic matter is produced depends on temperature and the abundance of light and nutrients. The phytoplankton constitute the primary food source of the animal component of the plankton, zooplankton. In most marine waters, phytoplankton undergo a spring-summer explosion in abundance called a bloom.

The dominant zooplankton in Newfoundland waters are copepods. They represent the critical link between phytoplankton and larger organisms. Young copepods (nauplii) are the principal prey of young fish while the older stages (copepodites) are eaten by larger fish, such as juvenile and adult capelin.

A description of the cycle of nutrients on the continental shelf aids in understanding and predicting the variability of plankton populations in space and time. An understanding of the plankton cycles will, in turn, aid in assessing the health of the marine ecosystem and its capacity to sustain fisheries.

Nutrient concentrations and phytoplankton biomass

During 2003, the seasonal cycle of nitrate (a source of nitrogen) and silicate (a source of silica which is critical for some dominant species of phytoplankton) showed the typical pattern of depletion in surface waters following the spring phytoplankton bloom. The onset of the spring phytoplankton bloom occurred about two weeks later relative to the long term average, although the duration (~30-40 days) was similar to the long term average (Figure 1). This may have been due to stronger mixing of the water column during winter and early spring relative to 2002. However in contrast to 2002, the depth to which high densities of phytoplankton occurred during the spring was shallower. During the remainder of the year, the cycle and abundance of phytoplankton was similar to that previously observed.

Following the spring bloom, there were small amounts of phytoplankton below the surface which persisted throughout the summer and fall. This is in contrast with observations in 1999 when the levels of phytoplankton below the surface showed substantial changes in abundance throughout the summer and fall, reaching concentrations that were

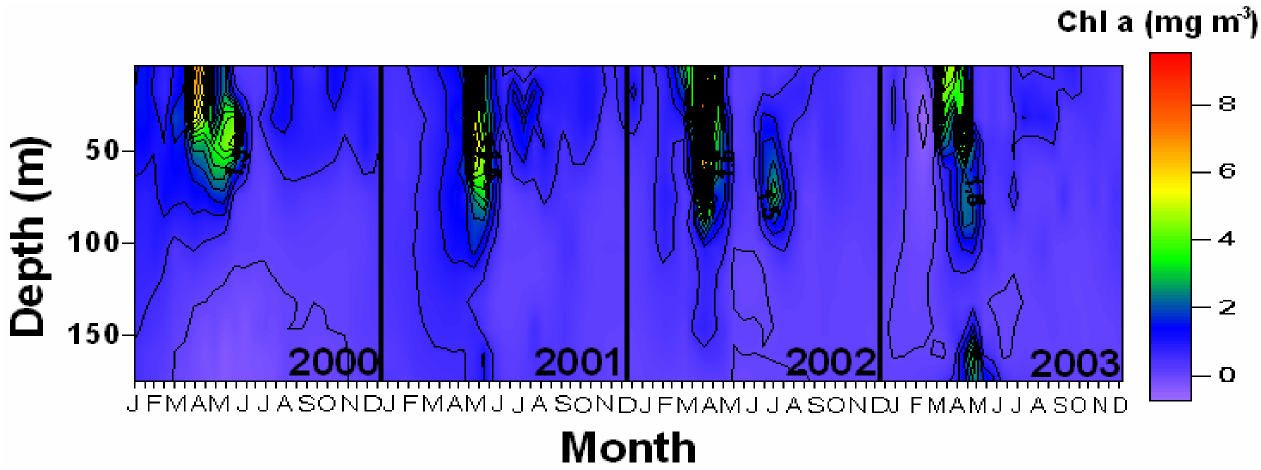


Figure 1: Seasonal vertical distribution of phytoplankton at Station 27 for 2000-2003.

approximately 2-3 times higher than what was observed in 2000-2002. Furthermore, we have not detected a fall phytoplankton bloom at Station 27 since 2000, although satellite derived observations of surface concentrations of phytoplankton across a broader area of the Avalon Channel and other regions of the Shelf indicate an increase in abundance when mixing of the water column increases in the fall.

Nutrient concentrations near the bottom, which provides a measure of the amount of material that will be available once the fall and winter mixing of the water column takes place, continued their decline since 2000 at the fixed station near St. John's (Figure 2). On the other hand, silicate inventories in the surface layer at Station 27 appeared to show an increase relative to the 2000-02 average. The most notable relative change was in the concentration of nitrate, an essential element in the growth of all phytoplankton species. Near bottom nutrient concentrations at Station 27 continued their decline since 2000, with levels approximately 20-25% lower than the 2000-02 average, but this pattern did not appear to prevail across the Newfoundland Shelf (Figure 3).

Nutrient concentrations in the surface layer (top 50m) in 2003 along the sections were generally higher during the spring, summer and fall compared to those of 2000-2002 with the greatest changes occurring on the Grand Banks and off Bonavista, particularly nitrates (Figure 3).

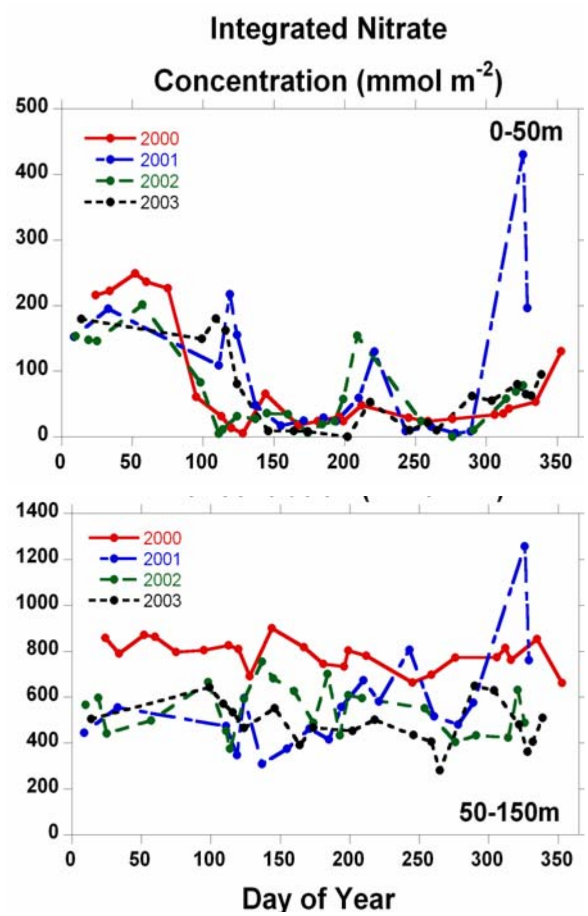


Figure 2: Integrated abundance of nitrate in the upper (0-50m, top) and deep (50-150m, bottom) of the water column at Station 27 from 2000 to 2003.

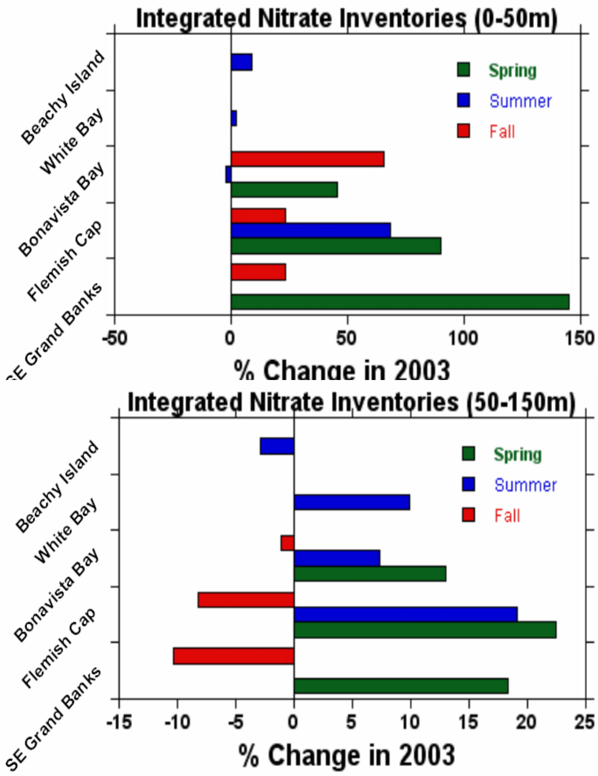


Figure 3: Relative change in nitrate levels integrated over 0-50 m and 50-150 m at Station 27 relative to the average from 2000-2003.

Seasonal fluctuations in phytoplankton biomass in the Newfoundland region are dominated by changes in the abundance of diatoms. Information from 1999 to 2003 shows that the spring phytoplankton bloom is a time of the year diatoms dominate during the spring while in the fall it is primarily flagellates and dinoflagellates which dominate. In 2003 the numerical abundance of most phytoplankton groups was lower than in previous years, following a trend which started in 2000. This was also apparent during the regional oceanographic surveys. Although this did not appear to affect the overall biomass of phytoplankton available to zooplankton, the lower numbers may affect other elements of the pelagic ecosystem on the Newfoundland Shelf.

The pattern in phytoplankton biomass at Station 27 was consistent with the observations made during three oceanographic surveys (April-May, July, November) which showed generally lower (20-50%) phytoplankton concentrations across much of the Newfoundland Shelf and Grand Banks in 2003 compared to 2000-2002. Phytoplankton concentrations tend to be higher along the Labrador coast relative to the Newfoundland Shelf during the summer, the only time when this region is sampled. However, the difference is largely caused by differences in the timing of the seasonal cycle in phytoplankton growth, with the seasonal warming being delayed as one moves from south to north.

Satellite-derived estimates of surface chlorophyll

Biological conditions derived from ocean colour data collected by satellite can be found at the Bedford Institute of Oceanography Ocean Sciences Division website (http://www.mar.dfo-mpo.gc.ca /science/ocean/ias/seawifs_1.html).

Although these data do not provide information on vertical structure of phytoplankton in the water column, they do provide highly resolved (~1.5km) data on their geographic distribution in surface waters. The data are provided as composite images over two week intervals for the northwest Atlantic.

The seasonal cycle of phytoplankton throughout most Newfoundland waters is characterized by two peaks, one in the spring (April-May) and another smaller peak in the late fall or early winter (October-January). The satellite information is generally consistent with observations from Station 27 and from transects across the Shelf. The timing of peak concentrations of surface chlorophyll concentrations in 2003 was slightly later than normal on the southern part of the Newfoundland Shelf. In offshore and northern regions, where the influence of the Labrador Current is more important, the onset of the spring bloom remained later than was observed in the late 1990s.

Zooplankton abundance

In 2003, the overall abundance of zooplankton was similar to levels observed in the previous year, although numbers were higher in the fall of 2002 due to an increase in the abundance of two species of small copepods (*Oithona* sp. and *Pseudocalanus* sp.). The overall species composition was generally similar to that encountered in previous years. The abundance and occurrence of copepod species normally associated with cold (*Calanus glacialis, Calanus hyperboreus*, and *Microcalanus* sp.) and warm waters (*Temora longicornis*), which had shown a gradual shift toward cold water species since 1999 shifted back toward warm water species in 2003 (Figure 4).

Zooplankton abundance shows a distinct seasonal cycle, with a gradual increase throughout the year until late fall when there is a substantial decrease following a reduction in phytoplankton production. This seasonal pattern reflects the increased production of copepod nauplii and copepodites as well as larvaceans (the organisms associated with the occurrence of slub) and blackberries (pelagic gastropods).

Species of small copepods (*Pseudocalanus* sp., *Oithona* sp., *Centropages* sp., *Acartia* sp.) dominate in the spring and fall whereas larger species of the genus *Calanus* (*C. finmarchicus*, *C. glacialis*, *C. hyperboreus*) reach similar levels of numerical abundance by early to mid-summer. In 2003, large copepods were slightly less abundant than in the previous year.

As with the phytoplankton bloom, the onset of production of *Calanus finmarchicus* appeared to be delayed slightly relative to previous year. The production of nauplii, the youngest developmental stages of copepods, was generally 30-50% lower than levels observed in previous years. Furthermore, the occurrence of later stages, known as copepodites, also appeared to peak about one month later than was observed in 2002 (Figure 5).

The general distribution of copepod species across the Newfoundland Shelf was consistent with previous observations. In the spring, overall copepod abundance appears to be relatively uniform across the Shelf. However, during summer months, species show a greater degree of spatial structure in their distributions. Small species of copepods are found across the Shelf but their greatest abundances are in coastal areas and on top of the Grand Banks. Similarly, large species of copepods, dominated by *C. finmarchicus*, occur over the entire shelf but their greatest numbers are generally associated with the inshore and offshore branches of the Labrador Current where large numbers of mature and immature animals are found. In the summer of 2003, the abundance of most groups of zooplankton appeared to be higher along the Labrador Shelf than was observed in previous years.

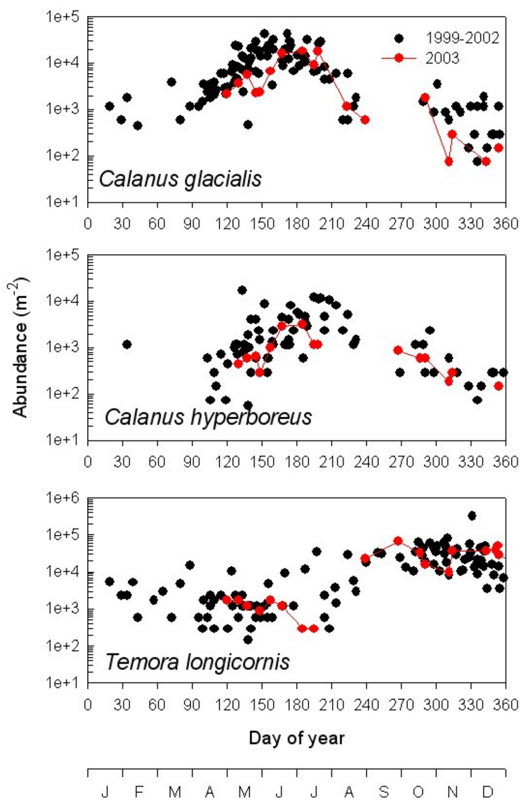


Figure 4: Seasonal abundance of two cold water and one warm water species of copepods contrasting 2003 (red symbols) with previous observations from 1999-2002 (black symbols).

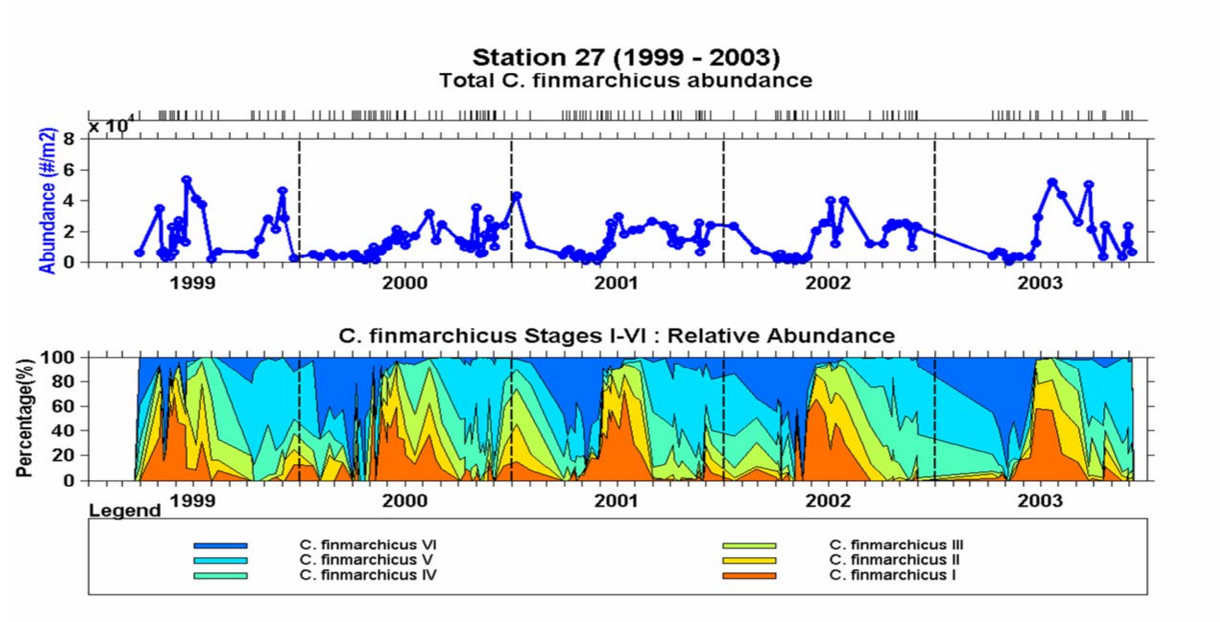


Figure 5: Seasonal abundance and relative stage distribution of copepodites of C. finmarchicus at Station 27 for 1999 to 2002. The youngest stages are indicated as CI and the oldest stages (C VI) represent the adults capable of reproduction.

Continuous Plankton Recorder

The Continuous Plankton Recorder (CPR) collections along the line from Iceland to St. John's, which crosses the northern edge of the Grand Banks, have been ongoing between the years 1959-1986 and 1991-present. The collections show that during the period after 1991, the abundance of all stages of *Calanus finmarchicus* as well as that of total euphausiids, a shrimp-like animal, has been lower than during the earlier period, whereas the color index, a measure of phytoplankton abundance, has been substantially higher. Although there have been fluctuations in the abundance of these organisms on the Grand Banks since 1991, the only clear trend is that the euphausiids have been decreasing.

References

Pepin, P. and G. Maillet. 2002. Biological and Chemical Oceanographic conditions on the Newfoundland Shelf during 2001 with comparisons with earlier observations. DFO Can. Sci. Adv. Sec. Res. Doc. 2002/052, 60 p.

Pepin, P. G. Maillet, S. Fraser and D. Lane. 2004. Biological and Chemical Oceanographic conditions on the Newfoundland Shelf during 2003. DFO Can. Sci. Adv. Sec. Res. Doc. 2004/033, 56 p.

Therriault, J.-C., and 11 co-authors. 1998. Proposal for a Northwest Atlantic Zonal Monitoring Program. Can. Tech. Rep. Hydrogr. Ocean Sci. 194, 57 pp.

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