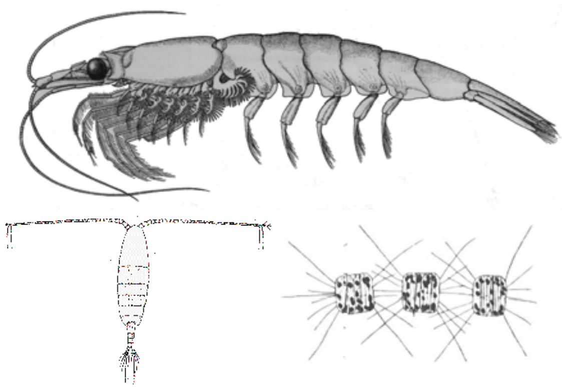

Chemical and Biological Oceanographic Conditions 2000 – Newfoundland Region

Background

The Altantic 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 physical, chemical and biological properties (Therriault et al. 1998). 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 (Laurentian, 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

- Nutrient concentrations in the surface layer (top 50m) in 2000 were similar to those of 1999.
- There was a distinct north-to-south gradient in the depth and seasonal pattern of nutrient depletion during the spring and summer.
- Near bottom nutrient concentrations on the Newfoundland Shelf off Bonavista, in the Avalon Channel and on the continental slope were higher during the Fall of 2000 than in the Spring. There was no evidence of such an increase in 1999.
- The seasonal cycle in phytoplankton biomass in 2000 was less variable than in 1999.
- There was no evidence of a fall bloom on the shelf or Grand Banks, in contrast to 1999 when there was a notable increase in phytoplankton biomass on the Southeast Shoal.

- Satellite observations of sea surface phytoplankton concentrations indicated the seasonal production cycle across most of the Newfoundland Shelf and Grand Banks was similar in 1999 and 2000 with the possible exception that the timing of the bloom was slightly earlier in the former, possibly due to differences in the timing of ice melt.
- Zooplankton abundance was relatively uniform across the entire shelf in both the spring and the summer.
- The abundance of the copepodite stage of small copepod species was slightly higher in 2000 than in 1999 but there was no notable change in the abundance of young stages.
- The abundance of the copepodite stages of large copepod species which makes up the bulk of the zooplankton biomass, was similar in 1999 and 2000. However, the abundance of their offspring was about twice that observed in 1999.

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. They use light to synthesize organic matter from nutrients dissolved in marine waters. The 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.

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 will aid 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 harvestable fisheries.

Nutrient concentrations and phytoplankton biomass

In most marine waters, phytoplankton undergo a spring-summer explosion in population abundance called a bloom. During 2000, 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 (Fig.1). However in contrast to 1999, the depth to which depletion occurred was shallower and the replenishment normally observed in the fall, following the strong mixing of surface and deep waters, had yet to be observed by mid-December.

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, were similar to 1999 at the start of 2000. However, as the seasons progressed from spring toward the fall, there was a notable increase in the levels of nitrate and silicate in bottom waters below 150m (Fig.2). As a result, areas where the Labrador current is prominent, such as the Avalon Channel, Flemish Pass and other regions along the continental slope, showed higher nutrient levels by the end of the year whereas shallower areas, such as the Grand Banks, had yet to show such an increase.

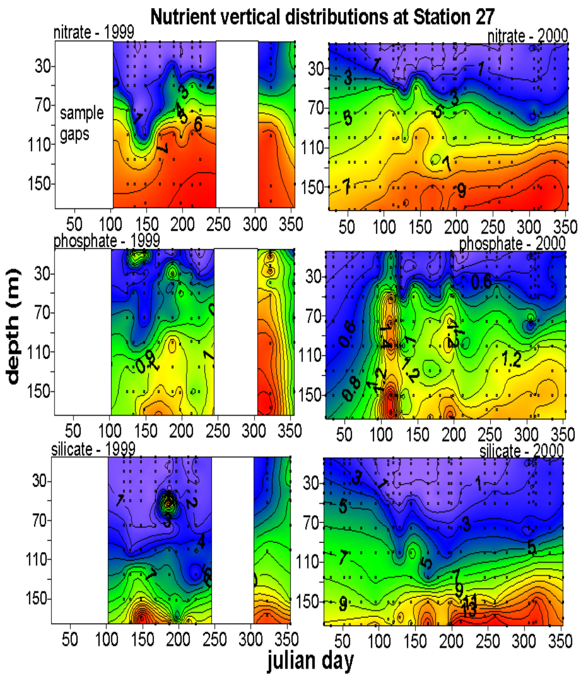

Figure 1. Vertical distribution of nitrate (top), phosphate (middle) and silicate (bottom) at Station 27 during 1999 (left) and 2000 (right).

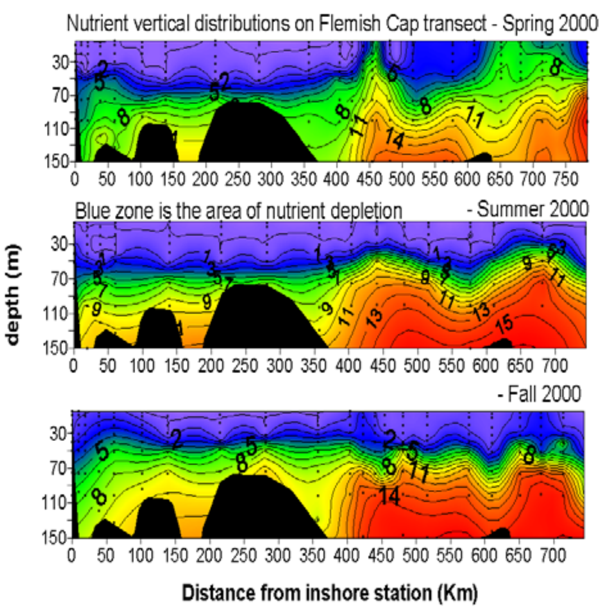

Figure 2. Vertical distribution of nitrate along the Flemish Cap transect in the spring, summer and fall of 2000.

Seasonal fluctuations in phytoplankton biomass in the Newfoundland region are dominated by changes in the abundance of diatoms. Information from 1999 and 2000 shows that the spring phytoplankton bloom is a time of the year when the abundance of diatoms peaks, and that when there is a small bloom of phytoplankton in the fall, the group which shows the most substantial increase in abundance again consists principally of diatoms.

The seasonal cycle in phytoplankton biomass at Station 27 showed a large peak concentration in the upper 60m of the water column in April (Fig.3). Following that, 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 approximately 2-3 times higher than what was observed in 2000. Furthermore, there was no fall bloom in 2000, whereas there was a notable bloom on the Southeast Shoal in 1999.

The pattern in phytoplankton biomass at Station 27 was consistent with the observations made during three oceangraphic cruises (April-May, July-August, November) which showed slightly lower phytoplankton concentrations across much of the Newfoundland Shelf and Grand Banks in 2000 compared to 1999. The exception to this occurred along the continental slope, in the strongest part of the Labrador current, where phytoplankton concentrations are generally high relative to those found on the shelf. This is largely a result of differences in the availability of nutrients.

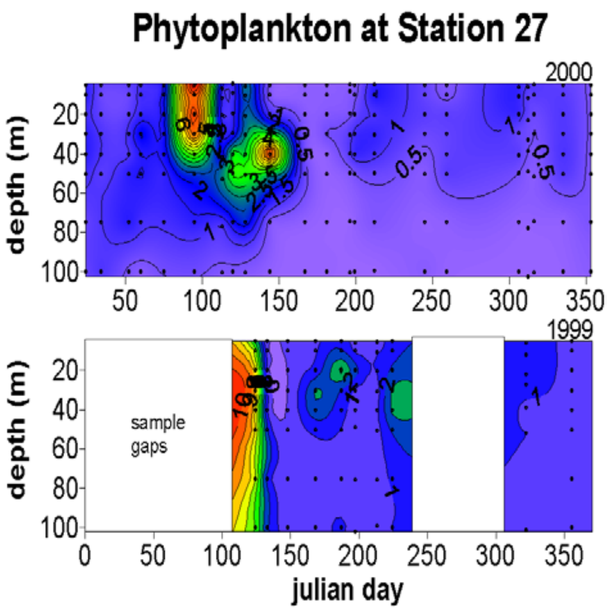

Figure 3. Seasonal vertical distribution of phytoplankton at Station 27 during 1999 (bottom) and 2000 (top).

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 (~1km) 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. Peak concentrations of surface chlorophyll concentrations are similar in 1999 and 2000. The spring phytoplankton bloom is shorter and earlier in coastal areas than it is in the offshore waters associated with the Labrador current. The spring phytoplankton bloom was slightly later in 2000 relative to 1999, possibly due to differences in the timing of ice melt.

Zooplankton abundance

In 2000, the overall abundance of zooplankton was slightly greater than was observed in the previous year, and close to the overall maximum abundance levels encountered since collections started in 1996. The overall species composition was similar to that encountered in previous years.

Zooplankton abundance shows a distinct seasonal cycle, with a large increase following the spring phytoplankton bloom (Fig.4). This reflects the increased production of copepod nauplii as well as larvaceans (the organisms associated with the occurrence of slub) and pelagic gastropods (species of *Lamicina* often referred to as blackberries). Species of small copepods (*Pseudocalanus* sp., *Oithona* sp., *Centropages* sp., *Acartia* sp.) dominate in the spring whereas larger species of the genus *Calanus* (*C. finmarchicus*, *C. glacialis*, *C. hyperboreus*) reach similar levels of numerical abundance by mid-summer. In 2000, small copepods were slightly more abundant than in the previous year.

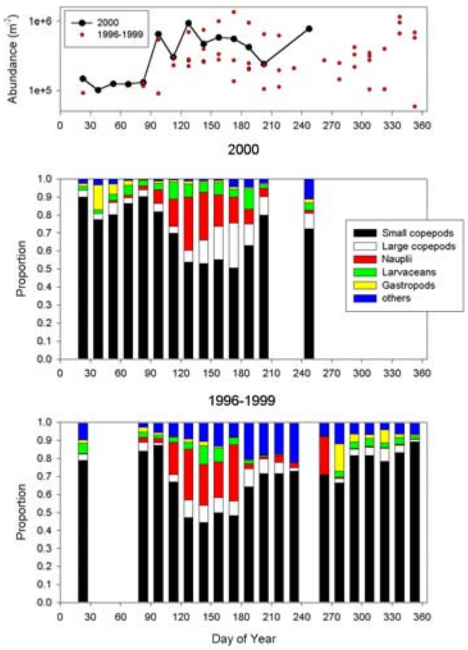

Figure 4. Abundance (top) and relative composition (middle) of zooplankton caught at Station 27 in 2000. The relative composition for the period 1996-1999 is shown for reference (bottom).

The most notable feature of the zooplankton community in 2000 was the relatively high abundance of nauplii from the large species of copepods (probably a combination of *C. finmarchicus* and *C. glacialis*) (Fig.5). Observations at Station 27 were consistently near the highest levels recorded since 1996 and the overall summer abundance of nauplii from large copepods in 2000 across the Newfoundland Shelf was approximately twice that observed during 1999. Where both adults and nauplii co-occurred, the average number of nauplii per adult was 2-3 times higher in 2000 relative to 1999.

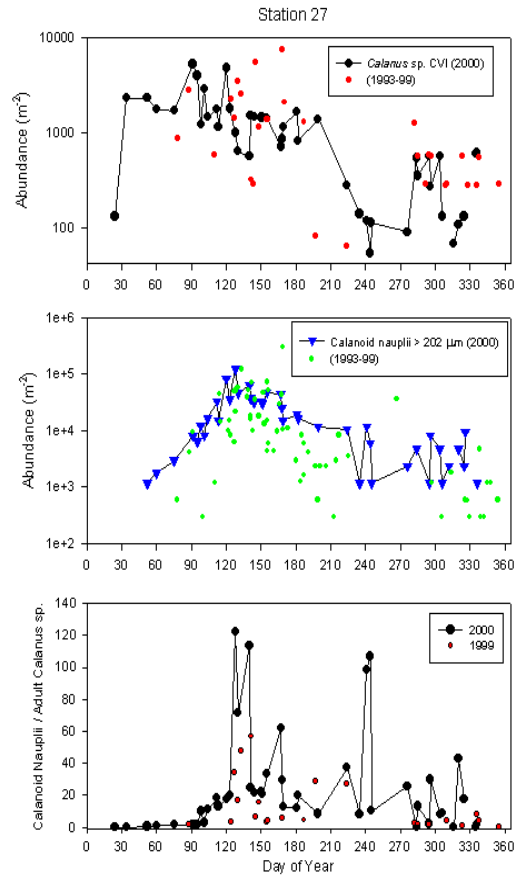

Figure 5. Abundance of adult Calanus sp. copepods (top) and nauplii (middle) from Station 27 during 2000. The relative abundance of offspring and adults is shown to be higher in 2000 than in the previous year (bottom). Data from previous years is shown in each panel to provide a reference perspective.

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.

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, has 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. However since 1997, the abundance of *C. finmarchicus* appears to have been increasing (Sameoto 2001), which is consistent with the observations from the samples collected along the standard oceanographic transects.

Conclusions

Seasonal patterns and regional differences were observed in chemical and biological variables in the Newfoundland region in 2000 relative to 1999. Although the satellite view of phytoplankton levels indicated that the two years were similar, subsurface concentrations were substantially lower and less variable through the summer and fall of 2000 than they were in 1999. Furthermore, there was no evidence of a fall bloom in 2000 whereas there was at least local evidence of a bloom in 1999 (e.g. Southeast Shoal).

Overall zooplankton abundance was slightly higher in 2000 relative to the previous year. Much of that increase could be attributed to two numerically dominant species of small copepods but which make up only a small proportion of the overall biomass. Large species of copepods, which make up the bulk of the zooplankton biomass, were at levels similar to those observed in 1999. There was a notable increase in the abundance of young produced by large species of copepods. This indicates that there may have been increased secondary production or enhanced survival but it is still unclear whether these changes are associated with fluctuations in the physical or biological components of the Newfoundland Shelf ecosystem.

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