

Science

Sciences

### Newfoundland Region



# 2001 State of the Ocean: Chemical and Biological Oceanographic Conditions in the 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. 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, Maritimes, Newfoundland) sampled at a frequency of biweekly 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.



Stock Status Report G2-02 (2002)

## Summary

- Nutrient concentrations in the surface layer (top 50m) at Station 27 in 2001 were lower in the spring and fall compared to those of 2000.
- Near bottom nutrient concentrations at Station 27 were 1.5-2 times lower than in 2000, although this pattern was not evident during oceanographic surveys conducted on the Newfoundland Shelf or Grand Banks.
- There was no evidence of a fall bloom on the Northeast Newfoundland 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 delayed by up to 30 days relative to conditions in 1999 and 2000. The delay on the onset of the spring bloom appeared to be greater on the Newfoundland and Labrador shelves than on the Grand banks.
- The abundance of the copepodite stage of small and large copepod species was slightly lower in 2001 than in 2000.
- The development and production of the dominant species in this group appeared to be delayed relative to 1999 and 2000.
- The abundance of naupliar stages of copepods was similar to levels observed in 1999 but the peak concentrations were approximately 50% of those observed in 2000.

## 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 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 component of the animal plankton, zooplankton. In most marine waters, phytoplankton undergo a spring-summer explosion in population 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 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

During 2001, 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. However. the onset of the spring phytoplankton bloom occurred about one month later in 2001 relative to the previous two years (Fig.1). This may have been due to a prolonged period of strong mixing of the water column during winter and early spring. However in contrast to 2000, the depth to which depletion occurred was deeper in 2001. During the remainder of the the cycle and abundance vear. of phytoplankton was similar to that observed in previous years. Nutrient concentrations in the surface layer (top 50m) at Station 27 in 2001 were lower in the spring and fall compared to those of 2000.

The seasonal cycle in phytoplankton biomass at Station 27 showed a large peak concentration in the upper 60m of the water column in May (Fig.1). However, the

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duration of this bloom was approximately 40 days shorter than in 2000. Following that, there were small amounts of phytoplankton surface which persisted below the 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 and 2001. Furthermore, there was no fall bloom in 2000 and 2001, whereas there was a notable bloom on the Southeast Shoal in 1999.



Figure 1. Seasonal vertical distribution of phytoplankton at Station 27 during 2001 (top) and 2000 (bottom).

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 generally lower in 2001 than in 2000 at the fixed station near St. John's (Fig.2). This was also apparent in the surface layer but to a lesser degree. The

notable change in the most was concentration of silicate, an essential element in the growth of diatoms. Near bottom nutrient concentrations at Station 27 were 1.5-2 times lower than in 2000, although this pattern was not evident during oceanographic surveys conducted on the Newfoundland Shelf or Grand Banks in 2001 (Fig.3).



Figure 2. Integrated abundance of silicate in the upper (0-50m, top) and deep (50-150m, bottom) of the water column at Station 27 during 2001.

Seasonal fluctuations in phytoplankton biomass in the Newfoundland region are dominated by changes in the abundance of diatoms. Information from 1999 to 2001 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. However, in 2001 numerical abundance the of small phytoplankton (those called flagellates) was lower by approximately 50% in contrast to previous years. This was also apparent

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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.





Figure 3. Vertical distribution of nitrate along the Bonavista Bay transect in the spring, summer and fall of 2001.

The pattern in phytoplankton biomass at Station was consistent with 27 the observations made during three oceanographic cruises (April-May, July-August, November) which showed similar phytoplankton concentrations across much of the Newfoundland Shelf and Grand Banks in 2001 compared 2000. to Phytoplankton concentrations tend to be higher along the Labrador coast during the summer oceanographic survey, 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-The satellite information is January). generally consistent with observations from Station 27 and from transects across the Shelf. Peak concentrations of surface chlorophyll concentrations in 2001 were similar to previous years but the onset of the spring phytoplankton bloom was clearly delayed across most of the Newfoundland and Labrador Shelves by up to 30 days relative to conditions in 1999 and 2000. The delay in the onset of the spring phytoplankton bloom was less notable on the Grand Banks and Southeast Shoal (Fig.4). However, the information collected by satellites as well as from field collections point to an increasing lateness in the onset of the bloom from 1999 to 2001.



### Bonavista Bay Section : Satellite Surface Chlorophyll Concentration

Figure 4. Sea surface chlorophyll concentration from 1998 to 2001 along the Bonavista Bay transect.

## Zooplankton abundance

the overall abundance In 2001. of zooplankton was slightly lower than was observed in the previous year, and close to the overall minimum abundance levels encountered during the fall of 2001. The overall species composition was similar to that encountered in previous years but two large copepod (Calanus groups, a finmarchicus) and a pelagic gastropod (normally referred to as blackberries), formed a greater overall proportion of the zooplankton than in the two previous years.

Zooplankton abundance shows a distinct seasonal cycle, with a large increase following the spring phytoplankton bloom. This reflects the increased production of copepod nauplii as well as larvaceans (the organisms associated with the occurrence of slub) and 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 2001, small copepods were slightly less abundant than in the previous year.

One of the most notable features of the zooplankton community in 2001 was the relatively high abundance of *Calanus finmarchicus* copepods in the winter (Fig.5). Observations at Station 27 were consistently above levels recorded during the period January-March as a result of a large cohort of young animals coming into the population from the previous fall. However, this high abundance was not followed by a substantial increase in production of young in the following summer.

As with the phytoplankton bloom, the onset of production of *Calanus finmarchicus* appeared to be delayed relative to previous years. The production of nauplii, the youngest developmental stages of copepods, was notably lower and later in 2001 relative to 2000. Furthermore, the occurrence of later stages, known as copepodites, also appeared to peak about one month later than was observed either in 1999 or 2000 (Fig.6)



Figure 5. Abundance of adult Calanus sp. copepods (top) and nauplii (bottom) from Station 27 during 2001. Balck symbols indicate abundance levels observed in 1999 and 2000. Data from previous years are shown in each panel to provide a reference perspective.

The general distribution of copepod species the Newfoundland Shelf was across 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 greatest numbers their 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 2001, abundance of most the groups of zooplankton appeared to be higher along the Labrador Shelf than observed was previously.



Figure 6. Relative stage distribution of copepodites of C. finmarchicus at Station 27 for 1999, 2000 and 2001. 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, has been ongoing between

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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 abundance of euphausiids has been decreasing.

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