Fisheries and Oceans / Pêches et Océans
Maritimes Region

DFO Science
Stock Status Report G3-03(2000)

Chemical and Biological Oceanographic Conditions in 1998 and 1999 – Maritimes Region

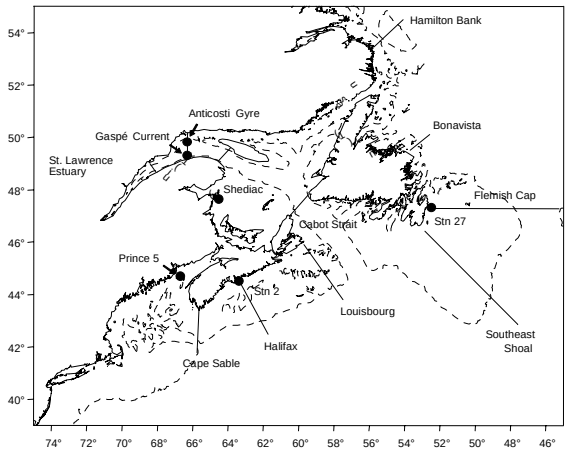
Background

The Atlantic Zonal Monitoring Program (AZMP) was implemented in 1998 with the aim of: (1) increasing DFO's capacity to understand, describe, and forecast the state of the marine ecosystem and (2) quantifying the changes in ocean physical, chemical and biological properties and the predator-prey relationships of marine resources. A critical element in the observational program of AZMP is an annual assessment of the distribution and variability of nutrients and the plankton they support.

A description of the distribution in time and space of nutrients dissolved in seawater (nitrate, silicate, phosphate, oxygen) provides important information on the water-mass movements and on the locations, timing and magnitude of biological production cycles. A description of the distribution of phytoplankton and zooplankton provides important information on the organisms forming the base of the marine foodweb. An understanding of the production cycles of plankton is an essential part of an ecosystems approach to fisheries management.

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, groundfish surveys) in each region (Laurentian, Maritimes, Newfoundland) sampled at a frequency of bi-weekly to once annually. The sampling design provides for basic information on the natural variability in physical, chemical and biological properties of the Northwest Atlantic continental shelf. Groundfish surveys and cross-shelf sections provide detailed geographic information but are limited in their seasonal coverage. Critically placed fixed stations complement the geography-based sampling by providing more detailed information on temporal (seasonal) changes in ecosystem properties.

Atlantic Zonal Monitoring Program (AZMP)
Sections and Fixed Stations



Summary

- Bottom water nutrient concentrations were lower in 1998 than in 1999 (and lower than the long-term mean conditions) and consistent with hydrographic evidence of a significant incursion of Labrador Slope Water onto the shelf in 1998. No influence of the Labrador Slope Water was evident on surface nutrient concentrations.

- Nutrient cycles at the three AZMP fixed stations in 1999 showed similar seasonal patterns; surface concentrations decreased in spring following winter maximum concentrations, remained low in summer and increased again in fall. The seasonal patterns did not differ appreciably from historical trends.

- Phytoplankton biomass (chlorophyll concentration) was variable but concentrations were generally higher in spring than in fall in 1998 and 1999. Bi-weekly sampling at the AZMP fixed stations in 1999 suggested that "blooms" of phytoplankton occurred in the spring,

summer and fall, with the timing differing somewhat at each location. Satellite ocean colour data indicated that the spring and fall phytoplankton blooms occurred earlier in 1999 than in 1998. Concentrations overall, were not notably different from long-term mean conditions where historical data exists (e.g. the central Scotian Shelf).

- Zooplankton biomass was highly variable and no geographic or seasonal patterns in distribution were apparent. Peak biomass levels were observed in summer at the three AZMP fixed stations.

- There was no evidence that the 1998 Labrador Slope Water incursion affected the distribution or quantity of plankton on the Scotian Shelf.

Introduction

The biological cycle of plankton is largely under the control of physical processes. Specifically, light and a source of nutrient salts (e.g. nitrate, phosphate, silicate) are required for the growth of marine microscopic plants (phytoplankton). The phytoplankton constitute the base of the marine foodweb and are the primary food source for the animal component of the plankton, zooplankton. Both phytoplankton and zooplankton, in turn, are food for larval fish and invertebrates and influence their survival rate.

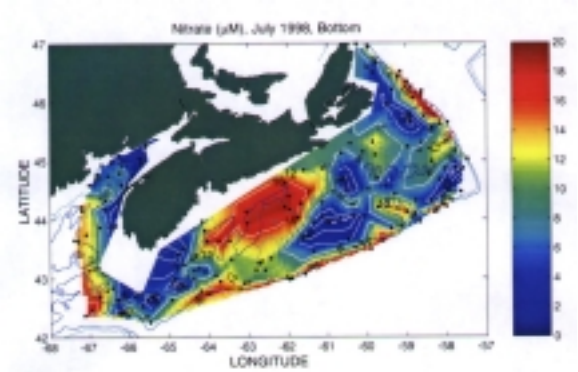
Thus, a description of the cycle of nutrients on the continental shelf will aid in understanding and predicting the spatial and temporal variability in plankton populations. An understanding of plankton cycles will, in turn, aid in assessing the health of the marine ecosystem and its capacity to sustain harvestable fisheries.

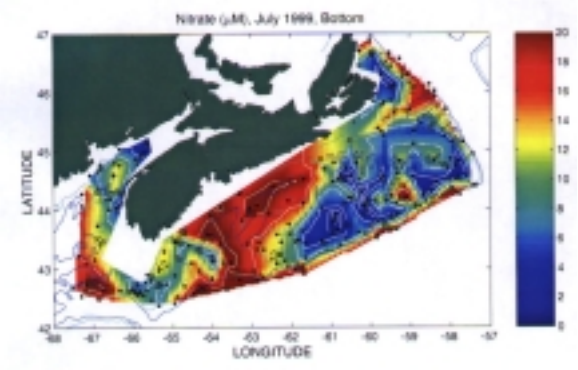
Summer and Fall Groundfish Surveys

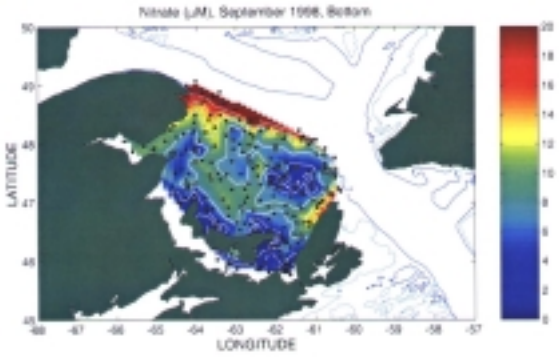
At each of ~200 (summer, Scotian Shelf and eastern Gulf of Maine) and ~175 (fall, Southern Gulf) stations occupied during the annual groundfish surveys, surface and bottom water samples were collected for nutrients in 1998 and 1999; chlorophyll was added in 1999. At selected stations in 1999 (~32 on the Scotian Shelf and ~14 in the Southern Gulf) vertical net hauls (bottom to surface) were taken for zooplankton. Zooplankton processing of these samples is not yet completed.

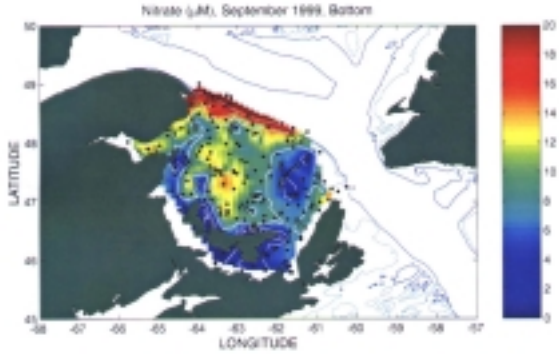
Scotian Shelf/Gulf of Maine

Surface nutrient concentrations were uniformly low over the entire shelf and eastern Gulf of Maine (not shown) in both 1998 and 1999 as a result of consumption by phytoplankton. Bottom water nutrient concentrations were higher than surface concentrations and differed significantly between the two years. Differences were most pronounced on the central shelf. Concentrations in the high nutrient central shelf region were generally lower and their geographical extent more confined in 1998 than in 1999. This feature is consistent with evidence from hydrographic data of a major intrusion of Labrador Slope Water onto the shelf in 1998; Labrador Slope Water is low in nitrate and high in oxygen relative to the Warm Slope Water that dominated in 1999. Chlorophyll levels in 1999 were variable and no distinct distribution pattern was observed except for an indication of somewhat higher levels at stations in the eastern Gulf of Maine (not shown).









Southern Gulf of St. Lawrence

Surface nutrient levels were uniformly low in 1998 and 1999. Bottom water concentrations were elevated relative to surface concentrations and similar for two years although there was an indication of slightly higher concentrations of nitrate in the central Gulf in 1999. Chlorophyll "hot spots" were observed in 1999 in the Shediac Valley region, in the eastern Northumberland Strait and in the eastern Gulf off the coast of Cape Breton (not shown).

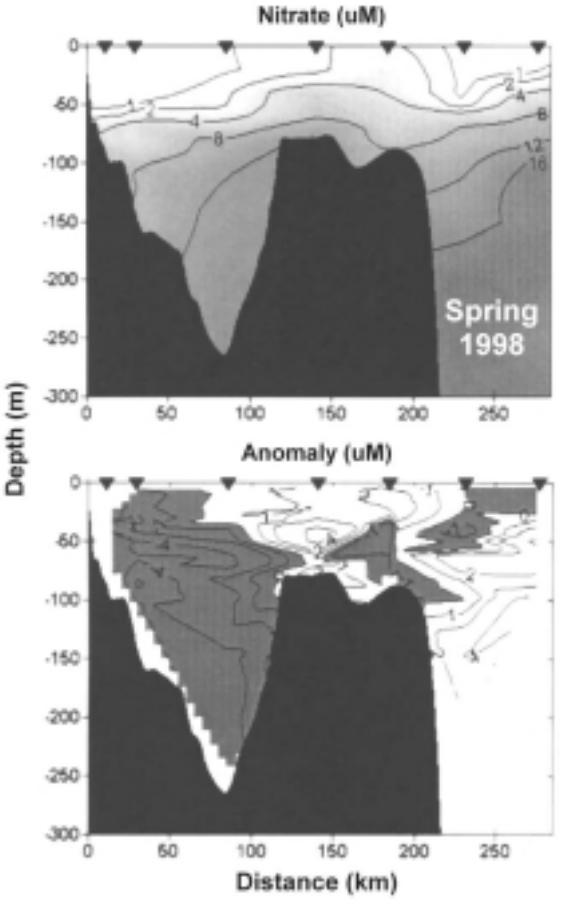
Spring and Fall Sections

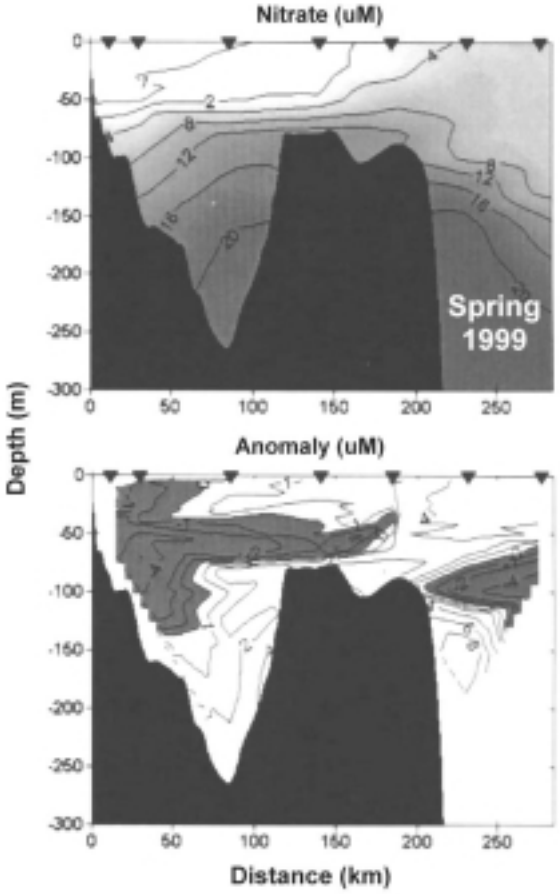
Samples were collected for nutrients, chlorophyll and zooplankton at stations along four primary sections crossing the Scotian Shelf (Cape Sable Section, Halifax Section, Louisbourg Section) and Cabot Strait (Cabot Section). Sections were occupied during the spring (April) and fall (October-November) of 1998 and 1999.

Nutrients

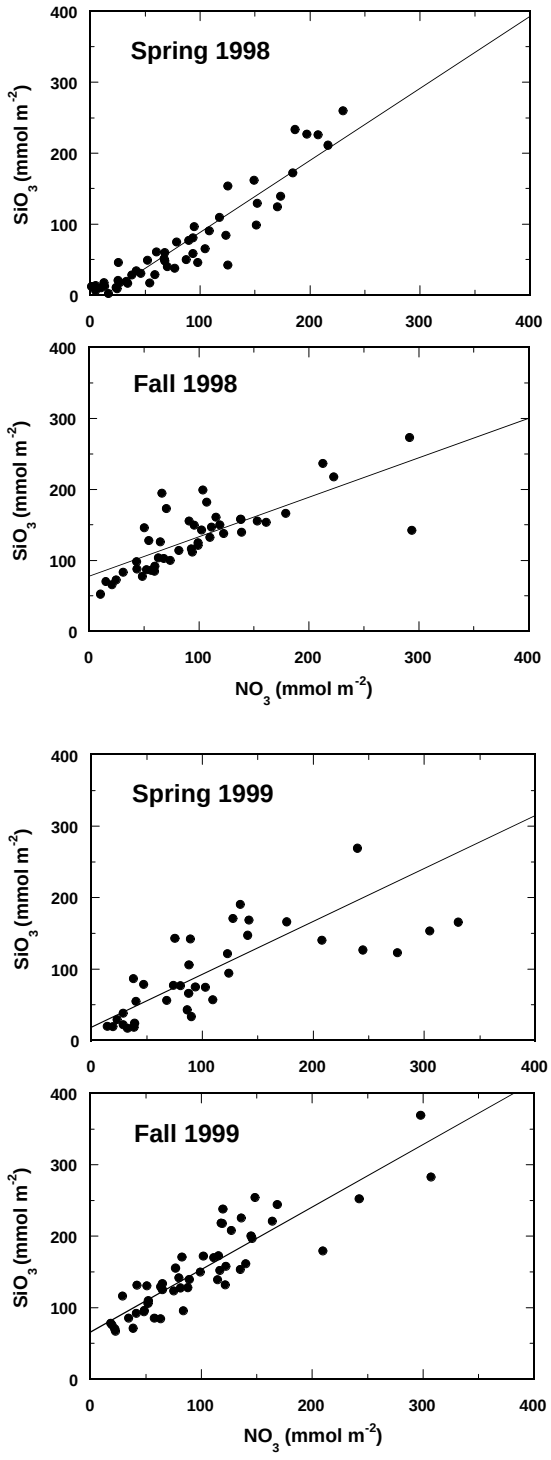
Nutrient distributions were generally similar along all lines, i.e. concentrations were low in near surface waters (<50 m) in spring and fall and increased with depth. Deep water concentrations, particularly along the Halifax Section, were significantly lower in 1998 than 1999. This difference was clearly evident when nutrient distributions were compared with the long-term mean concentrations as anomaly fields. The large negative anomalies (grey areas in anomaly

plots) were seen in Emerald Basin in 1998 in spring. This was consistent with observations from the summer groundfish survey showing the incursion of low-nutrient Labrador Slope Water onto the central shelf. Conditions reverted to near normal by spring 1999. No affect of the Labrador Slope Water was apparent in surface nutrient concentrations.





A comparison of the concentrations of nitrate and silicate in near surface waters (0-50 m) showed that both nitrate and silicate were reduced to low levels in spring whereas in the fall, a significant quantity of silicate remained in the water after nitrate was exhausted. Nitrate is consumed by all forms of phytoplankton whereas silicate is used exclusively by diatoms, often a preferred food of zooplankton and invertebrate larvae. The nitrate-silicate plots suggested that diatoms were an important component of the phytoplankton community in spring and less so in fall in both 1998 and 1999.

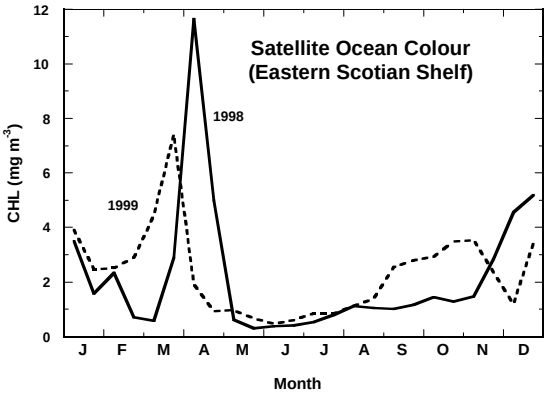


Phytoplankton

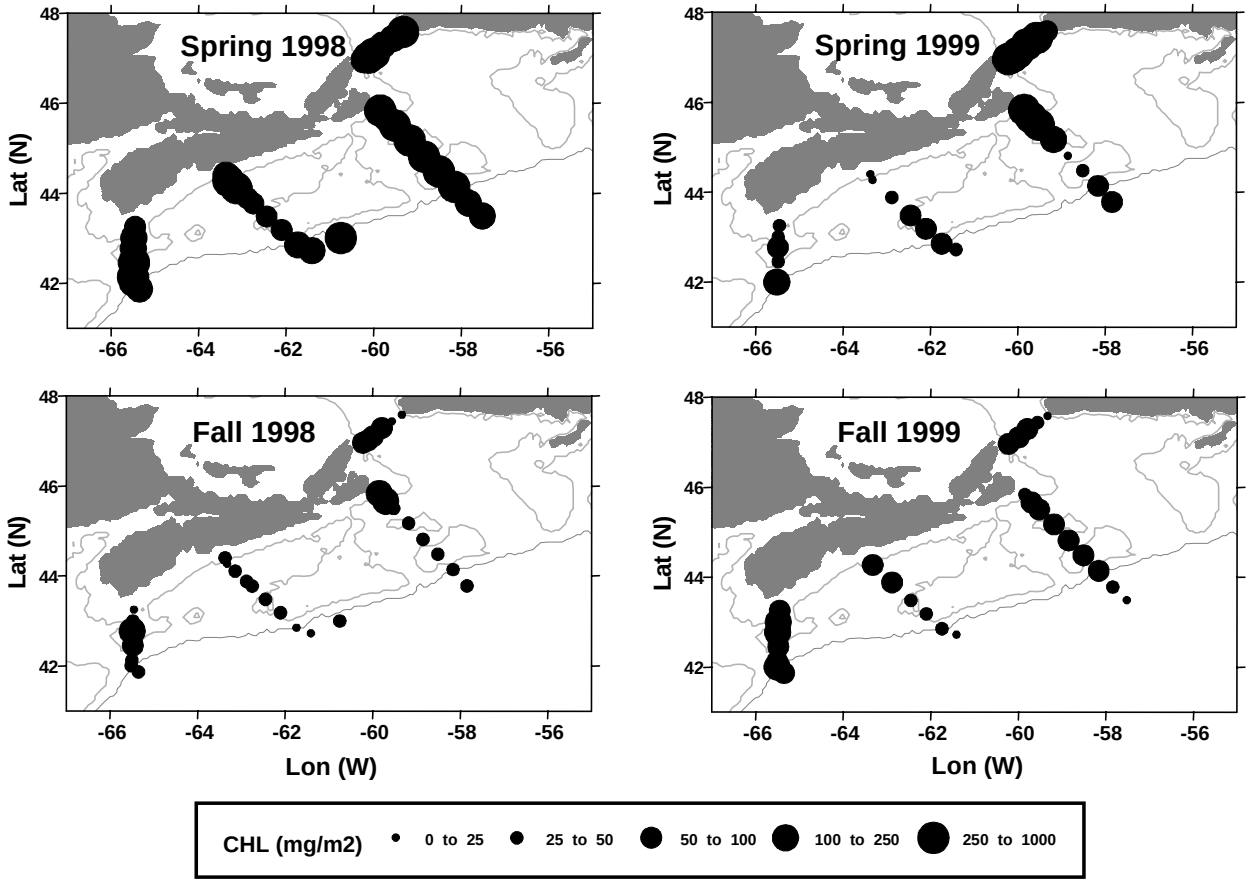
Phytoplankton biomass levels (chlorophyll concentration) were higher in spring than in fall along all sections in 1998 and 1999. Springtime concentrations shelf-wide were somewhat higher in 1998 than in 1999, particularly on the western shelf, indicating that overall levels in 1998 were higher than in 1999 or that the timing of the spring bloom differed between the two years.

In fall, highest concentrations were observed along the Cape Sable Section and on the eastern shelf and Cabot Strait. Chlorophyll levels in 1998 were similar to the long-term mean. Thus, the Labrador Slope Water incursion did not appear to have influenced the distribution and quantity of phytoplankton on the shelf.

Satellite remote-sensing of ocean colour suggested that the 1999 spring and fall blooms occurred earlier in the Maritimes Region than in 1998. This was particularly evident on the eastern Scotian Shelf.

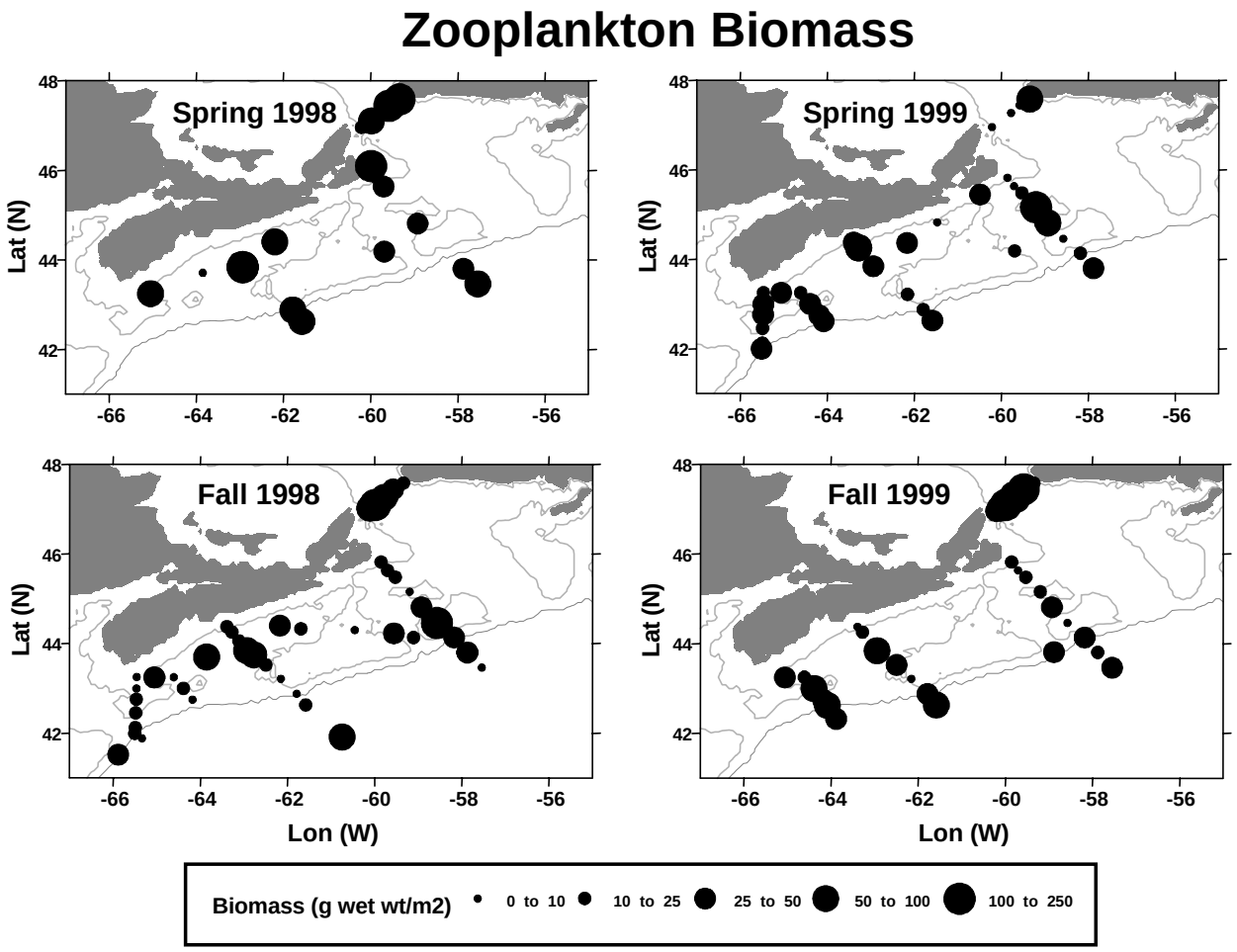


Phytoplankton Biomass



Zooplankton

Zooplankton biomass distribution on the shelf was highly variable both geographically and with season; no clear patterns were evident although biomass appeared to be persistently high in Cabot Strait in spring and fall. Levels in 1998 and 1999 were similar to the long-term means. There was no evidence of an effect of the 1998 Labrador Slope Water incursion on zooplankton distribution or biomass level.



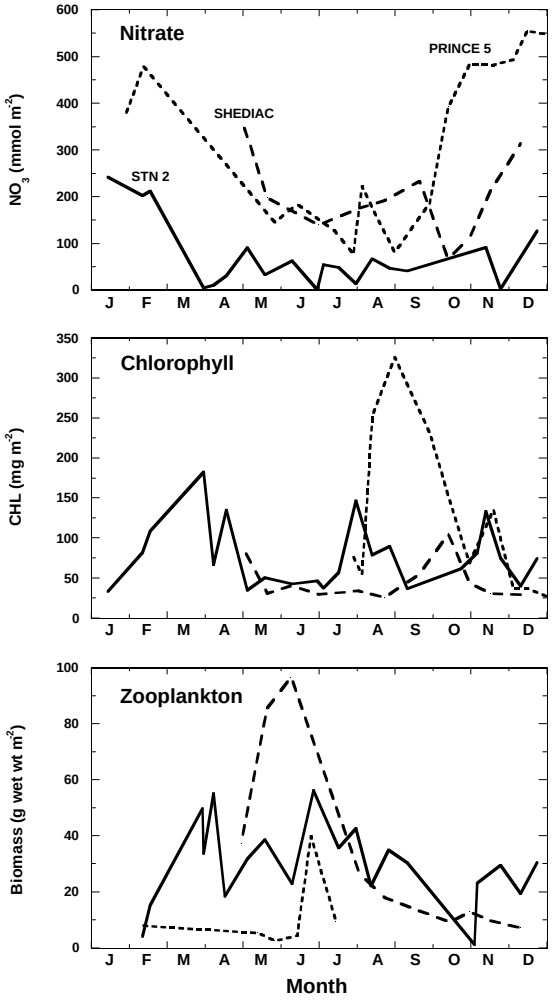
Fixed Stations

Samples were collected on a bi-weekly to monthly basis for nutrients, chlorophyll and zooplankton at three fixed stations; Prince 5 (at the mouth of the Bay of Fundy), Halifax Section Station 2 (20 nmi off Halifax Harbour) and Shediac Valley (northwestern Magdalen Shallows). Sampling did not begin until 1999 and a complete annual dataset is only available for Station 2.

Nutrient concentrations in near surface waters (upper 50 m) followed a similar seasonal pattern at all three locations; concentrations were high in late fall/winter and low in spring/summer due to biological consumption. Typically, concentrations were higher at Prince 5 and Shediac than at Station 2. Concentration were not significantly different from long-term mean concentrations where they exist, i.e. the Scotian Shelf and Bay of Fundy.

Three distinct phytoplankton "blooms" were observed at Station 2: early spring, late summer and late fall. Biomass maxima were also observed in the fall at Shediac and Prince 5, the latter being particularly strong and substantially higher than levels recorded at the other fixed stations. Concentration were not significantly different from historical mean values where they exist, i.e. Halifax Station 2 data compared with long-term data from the central Scotian Shelf.

Zooplankton biomass peaked in summer at each of the fixed stations, however, the seasonal pattern at Station 2 was not as distinct as observed at the other stations. Biomass levels were highest at Shediac and lowest at Prince 5.



Conclusions

Seasonal patterns and regional differences were observed in chemical and biological variables in the Maritimes Region in 1998 and 1999. Noteworthy among the differences between years was the lower concentration of nutrients in deep waters in 1998 associated with the incursion of Labrador Slope Water onto the Scotian Shelf. Differences observed in the hydrographic and chemical conditions between the two years were not as apparent in biological properties but this may be partially a result of the high inherent spatial and temporal variability in phytoplankton and zooplankton populations.

A more synoptic view of the Northwest Atlantic phytoplankton derived from the satellite-based ocean colour showed that the major spring and fall phytoplankton blooms was earlier in 1999 than in 1998.

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