Research vessel CCGS Teleost

Environmental Conditions in the Newfoundland Region during 2000

Background

The physical oceanographic environment influences the yield (growth, reproduction, survival), and behaviour (distribution catchability, availability) of marine organisms as well as the operations of the fishing industry. Changes in this environment may contribute directly to variations in resource yield, reproductive potential, catchability, year-class size (recruitment) and spawning biomass as well as influencing the perception of the resource status and the efficiency and profitability of the industry.

Physical oceanographic conditions are therefore measured during research vessel resource surveys and regularly at fixed sites as part of the ***Atlantic Zonal Monitoring Program (AZMP)****. Additional hydrographic, meteorological and sea ice data are obtained from a variety of sources, research studies, ships-of-opportunity, fishing vessels, and remote sensing (satellites).*

All of the hydrographic data are edited and archived in Canada's national Marine Environmental Data Service (MEDS) database. A working copy is maintained in a zonal database at the Northwest Atlantic Fisheries Centre in St. John's Newfoundland.

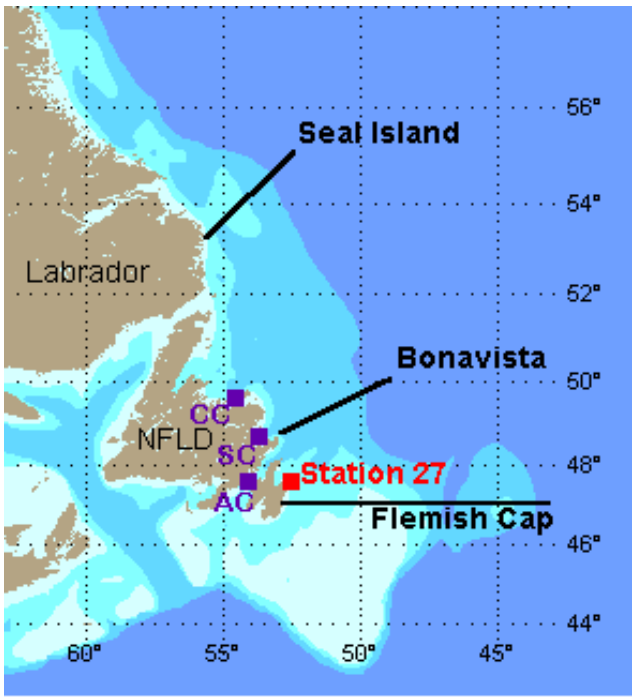

Fig. 1. Location Map showing the positions of standard transects and fixed oceanographic monitoring sites in the Newfoundland Region.

Summary

- Annual air temperatures were up to 1°C above normal during 2000 from Cartwright Labrador to St. John's in southern Newfoundland.
- The Newfoundland Shelf sea ice extent increased compared to 1999 but was still below normal. The sea ice duration was shorter than normal, similar to 1999.
- The annual surface water temperature off St. John's was about 1/2°C above normal during 2000.
- Annual bottom temperatures at Station 27 off St. John's were about 1/3°C above normal.

- Salinities off St. John's were fresher than normal during winter and spring and near normal during the remainder of the year of the year.

- The volume of sub-zero °C water on the Newfoundland and southern Labrador Shelves during 2000 was below normal in the south and slightly above normal in northern regions.

- Bottom temperatures in Newfoundland waters during 2000 were up to 1°C above the long-term average over many areas, but generally cooler than 1999 values.

- The percentage area of sub-zero°C water covering the banks in the Newfoundland Region during 2000 increased slightly over 1999 values in most areas.

- In general, ocean temperatures during 2000 cooled relative to 1999 but continued above normal in most areas.

Introduction

The ocean environment on the Newfoundland Shelf is influenced by several factors including the Labrador Current, cross-shelf mixing with warmer continental slope water, bottom topography, variations in solar heat input, ice cover and storm forced mixing. The resulting water mass on the shelf is characterised by large annual cycles with strong horizontal and vertical temperature and salinity changes. These changes in water properties are monitored extensively by fisheries assessment and oceanographic research surveys throughout the year (Fig. 1). Some of these observations are expressed as differences from their mean or anomalies. Where possible, the long-term means are standardised to a base period from 1961-1990.

Conditions in 2000

Newfoundland and Labrador air temperatures were mostly above normal during 2000 (Fig 2a).

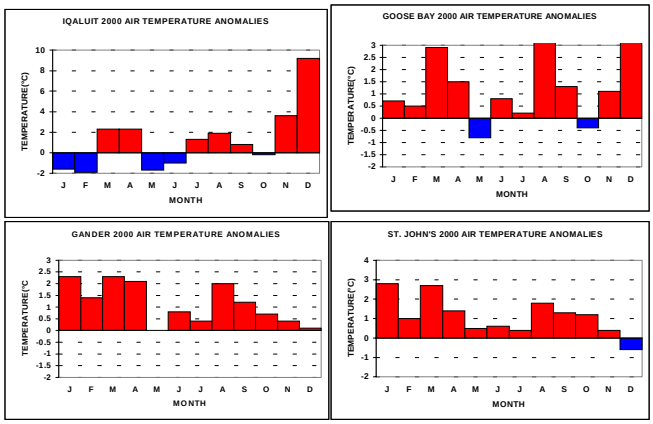

Fig 2a. Departures from normal mean air temperatures at four sites in the northwest Atlantic for 2000.

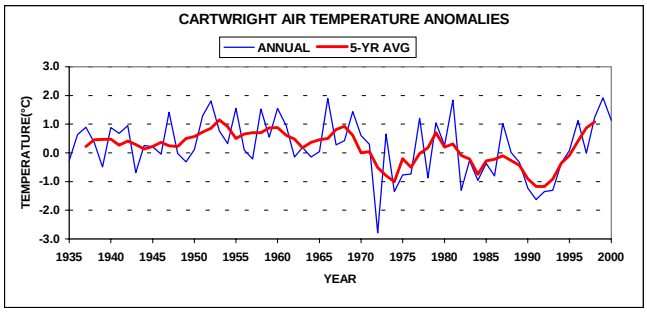

Fig. 2b. Departures from normal mean air temperature (blue line) and the 5-year means at Cartwright on the Labrador Coast (red line).

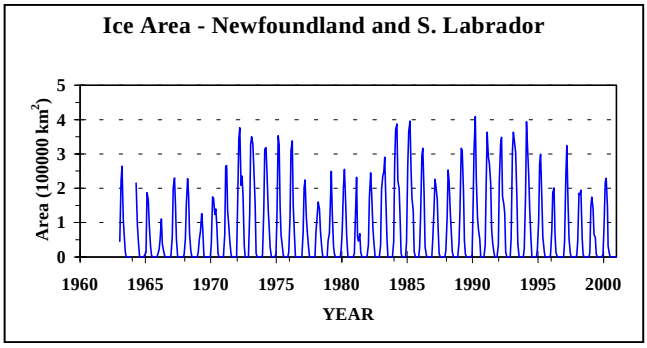

Fig. 3. Time series of sea-ice areas off Newfoundland and southern Labrador.

The air temperature time series at Cartwright (Fig. 2b) since the 1960s show large variations,

superimposed on a general downward trend up to the early 1990s. During 1999 record highs were recorded at St. John's with temperatures 1.9°C above normal, a 126-year record and at Cartwright 1.9°C above normal, a 65-year record. Air temperatures during 2000 decreased slightly over 1999 values, but remained above normal by 1°C in many areas. The peak extent of sea ice area on the Newfoundland and southern Labrador Shelves during 2000 decreased over 1999 but was still only about ½ the peak extent of the heavy ice years of the early 1990s (Fig. 3).

Station 27 Temperature and Salinity

Near surface temperatures at Station 27 which is located in the inshore branch of the Labrador

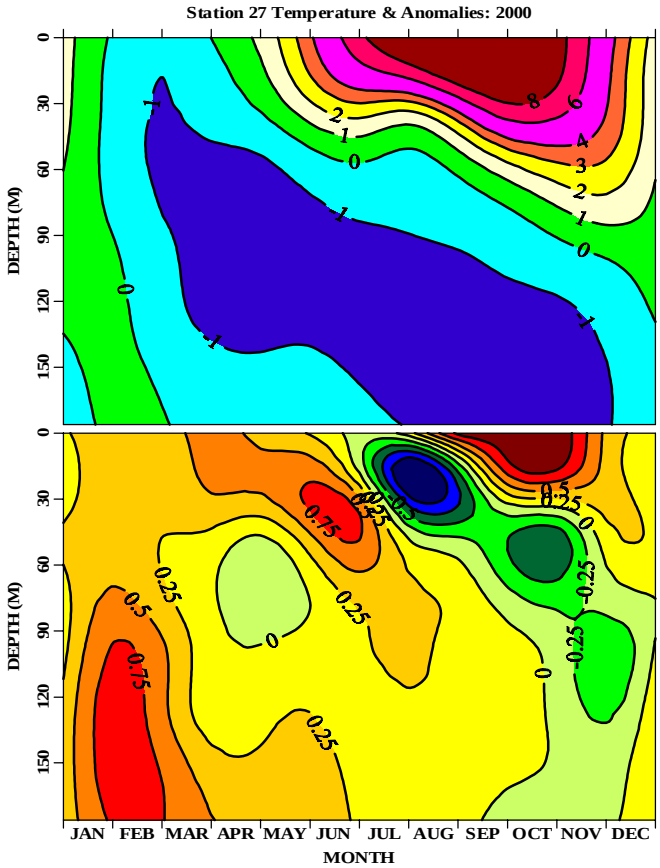

Fig. 4. Monthly temperature (top) and their departures from normal (bottom) at Station 27 as a function of depth for 2000.

Current (Fig. 1), were near constant at about 0°C from late January to early April and from approximately 0-1°C throughout the year near the bottom at about 175-m depth. By early May near

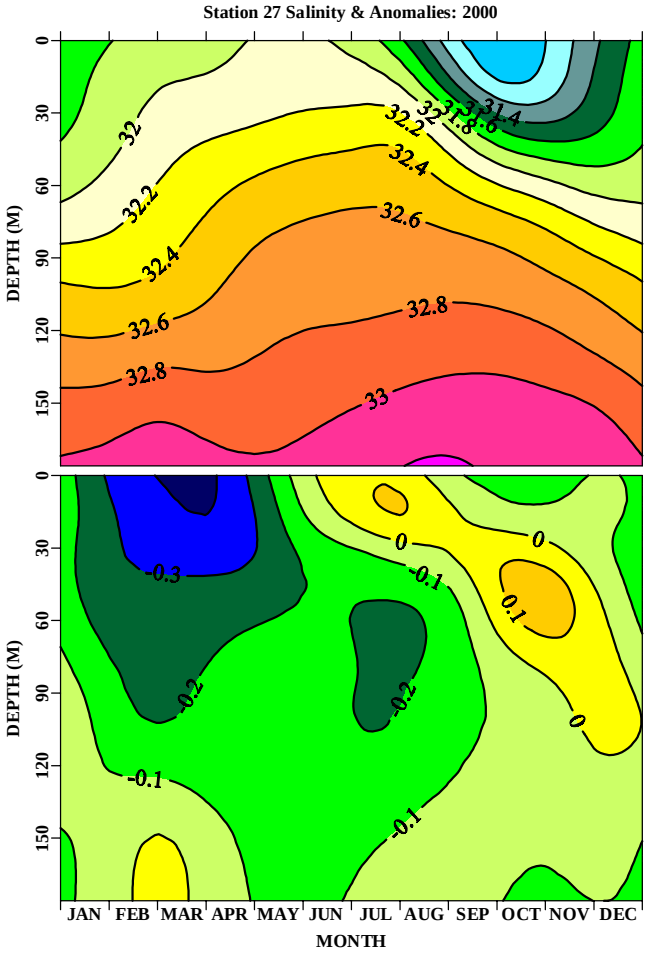

Fig. 5. Monthly salinity (top) and their departures from normal (bottom) at Station 27 as a function of depth for 2000.

temperatures had warmed to 3°C and to above 14°C by August, after which the fall cooling commenced. These values ranged from 1/4° to 3/4°C above normal for the winter months over most of the water column. By mid-summer a cold sub-surface anomaly developed that penetrated to near bottom depths by the end of the year. Fall temperatures were generally above normal in the upper water column and below normal below 50-m depth (Fig. 4). Surface salinities (Fig. 5) reached a maximum of >32 by late April and decreased to a minimum of <31 by

late September, these values were below the long term mean by up to 0.4. Below 50-m depth, salinities generally ranged from 32.2 to 33.25. Except for the near surface positive anomaly during the summer, salinities were generally below normal throughout the year.

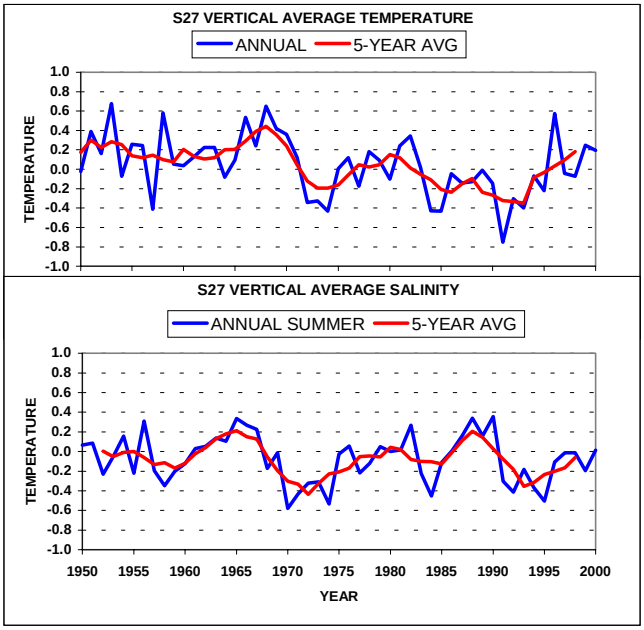

Fig. 6. Departures from normal depth averaged (0-176 m) Station 27 temperature and upper layer (0-50 m) averaged summer (July-Sept) salinity. The red lines are the 5-year means.

The station 27 depth-averaged annual temperature (which is proportional to the heat content of the water column) (Fig. 6) shows large fluctuations at near decadal time scales, with cold periods during the early 1970s, mid 1980s and early 1990s. During the time period from 1950 to the late 1960s the heat content of the water column was generally above the long-term mean. Recently the heat content of the water column varied from a record low in 1991, to a near record high during 1996 and was above the long-term mean in 1999 and 2000. The depth-averaged (0-50 m) summer (July-September) salinity anomalies (Fig. 6) show similar behaviour to the heat content, with fresher than normal periods generally corresponding to colder than normal conditions. During 1995 summer salinities started to increase and were near normal during 1996 to 1998, slightly below normal in 1999 and near normal in 2000.

Temperature Trends on St Pierre Bank, Hamilton Bank and on Flemish Cap

The time series of near bottom temperature anomalies from 1950 to 2000 on St. Pierre Bank are shown in Fig. 7. The temperature trends are

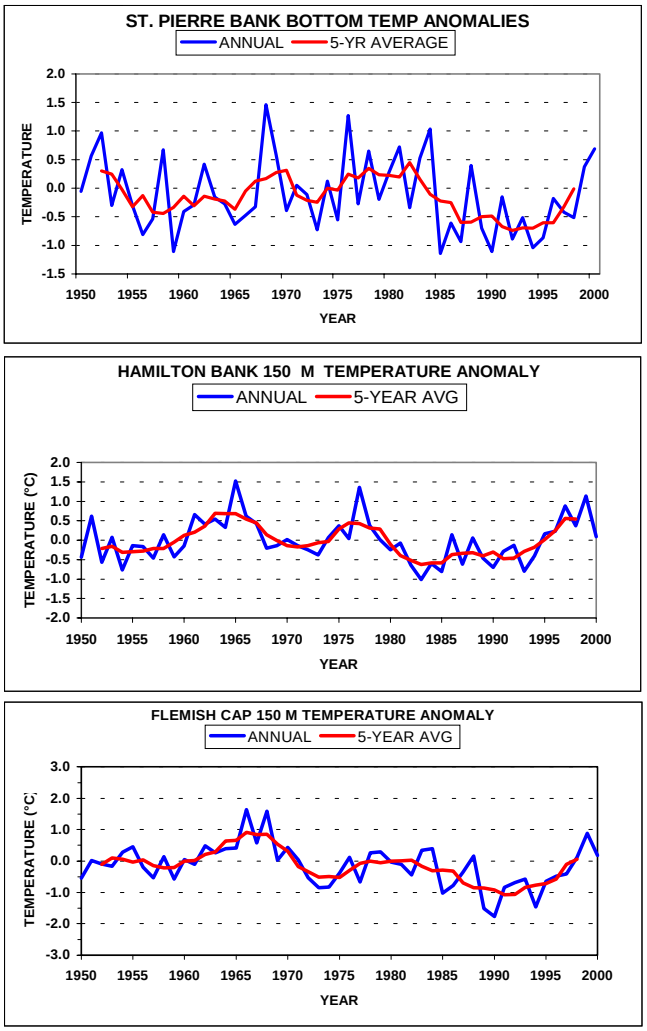

Fig. 7. Departures from normal annual near bottom temperatures on St. Pierre Bank, Hamilton Bank and on the Flemish Cap. The red lines are the 5-year means.

characterised by large annual variations greater than 1°C above and below normal. During the cold period beginning around 1984 temperatures

near bottom on St. Pierre Bank decreased by up to 1°C and continued below normal until about 1997. From 1993 to 1999 temperatures warmed over the top 20-m of the water column but remained well below average near bottom at 75-100 m depth until at least 1996. Around 1998 temperature began to moderate and were above normal during 1999 and 2000. On Hamilton Bank (Fig. 7) near bottom temperatures were below normal throughout most of the 1980 and into the early 1990s. By the mid-1990s however temperatures increased to above normal conditions. Bottom temperatures during 2000 decreased from the high values of 1999 to near normal values. Bottom temperatures on the Flemish Cap (Fig. 7) show similar trends as on the Newfoundland Shelf with values during 2000 at about normal, again a decrease from 1999 values.

Inshore Temperature Time Series

Temperature time series from long-term monitoring sites at Comfort Cove in Notre Dame Bay, Stock Cove in Bonavista Bay and at Arnold's Cove Placentia Bay (Fig. 1) at 10-m depth for 1999 and 2000 are displayed in Fig. 8. Temperatures at Comfort Cove were above normal during the spring and summer months during both 1999 and 2000 and near normal during the remaining months. At Stock Cove temperatures were above normal for most of 1999, except August, October and November. During 2000 they were above normal for all available months with maximum anomalies occurring during the summer. The above normal temperatures at Arnold's Cove during 1999 continued into 2000 with temperatures reaching up to 3°C above normal in July. Data were not available for the late fall month's at all three sites.

The Newfoundland Shelf Cold Intermediate Layer (CIL)

A common feature of the temperature structure on the Newfoundland Continental Shelf is the layer of cold sub-zero °C water, commonly referred to as the Cold Intermediate Layer or CIL. This winter cooled water remains trapped between the seasonally heated surface layer and warmer continental slope near bottom water during the summer and early fall months. Along

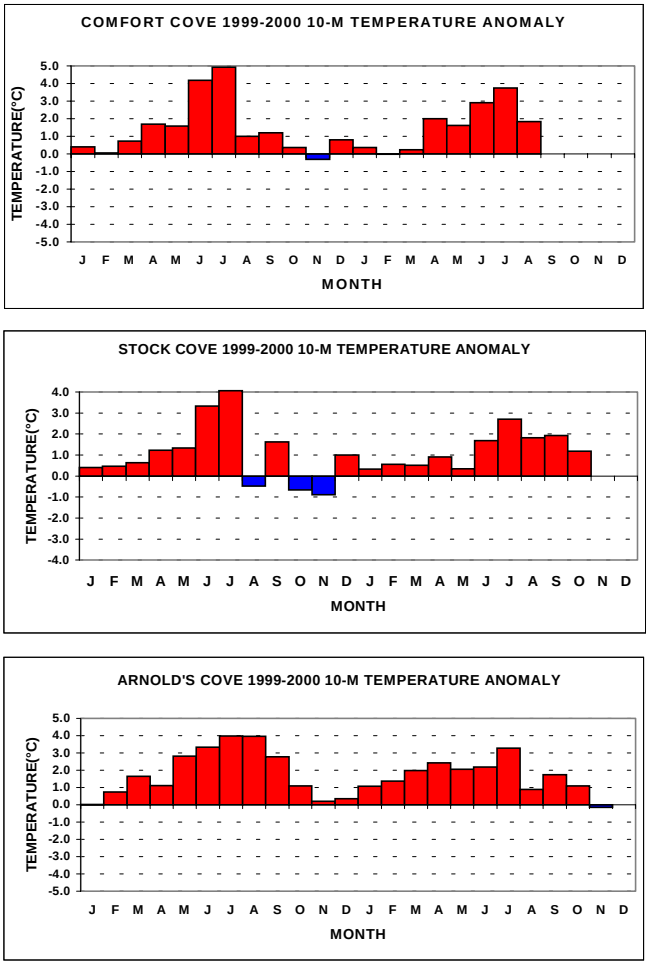

Fig. 8. Departures from normal monthly temperatures at 10 m depth during 1999 and 2000 at Comfort Cove, Notre Dame Bay, Stock Cove, Bonavista Bay and for Arnold's Cove, Placentia Bay (locations shown in Fig. 1).

the Bonavista transect during the summer of 2000 this cold layer extended offshore to about 220 km, with a maximum vertical extent of about 200 m corresponding to a cross-sectional area of about 27 km^2, which was about normal. The annual values of the summer a CIL area for the Seal Island, Bonavista and Flemish Cap transects are displayed in Fig. 9. The position of the

transects are shown in Fig. 1. Low values of CIL areas correspond to warm oceanographic conditions. During the summer of 1999 the CIL area off Bonavista was about 25% below normal compared to 5% below normal in 1998 and 28% below normal in 1997. The CIL area along the Seal Island transect was slightly above normal during 2000 compared to about 49% below normal during 1999, 15% in 1998 and 38% during 1997. During the cold years from 1990 to 1994 the CIL was above normal reaching a peak of more than 60% in 1991. During 2000 on the Grand Bank along the Flemish Cap transect the CIL was similar to 1999 at approximately 15% below normal compared to about normal in 1998.

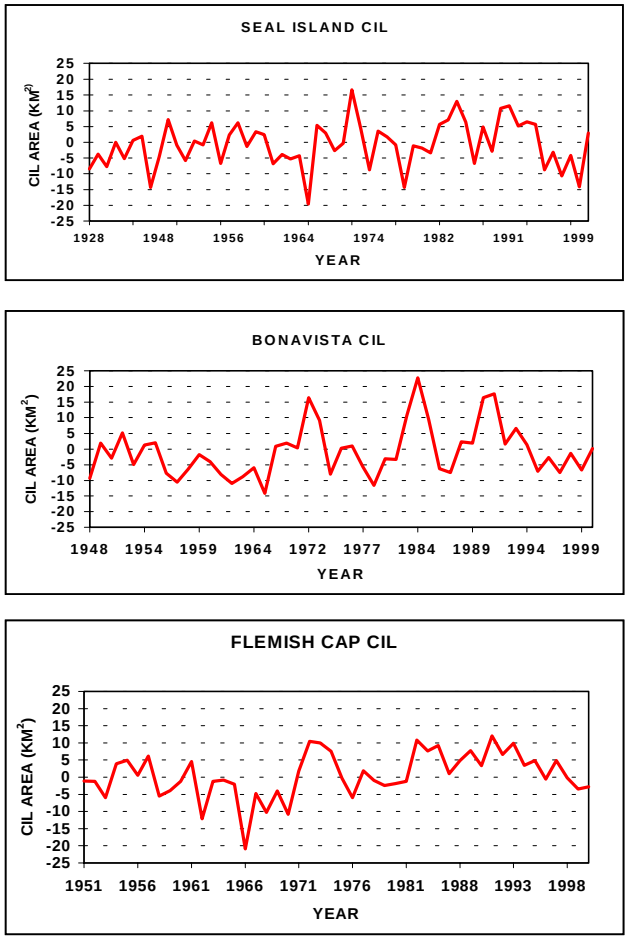

Fig.9. Annual summer CIL area anomalies along the standard transects across the Newfoundland Shelf shown in Fig. 1.

Bottom Temperatures

Spring

Bottom temperature anomalies on the Grand Bank during the spring of 2000 are displayed in Fig. 10. During 2000 sub-zero °C was restricted to a small area in the Avalon Channel and above normal conditions persisted over the entire northern Grand Bank with temperatures ¼ to 1/2°C above average. Over the central and southern areas of the Grand Bank bottom temperatures ranged from 1-2°C above the long-

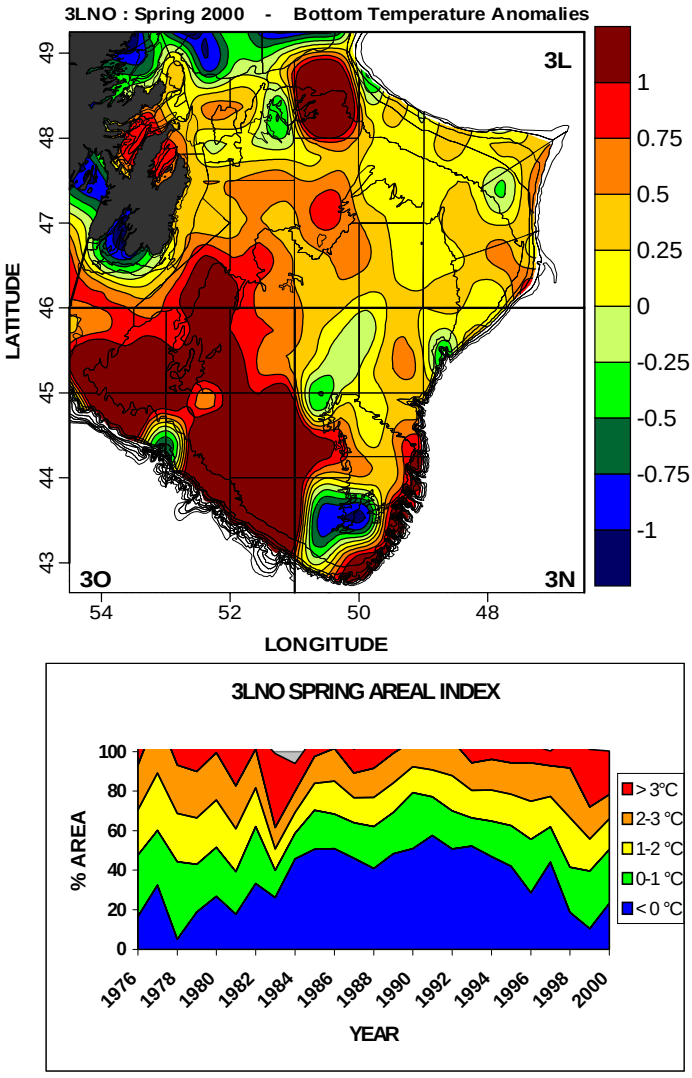

Fig. 10. Bottom temperature anomalies (in °C) for the spring of 2000 for NAFO Divisions 3LNO and the percentage area of the bottom covered by water in various temperature bins.

term mean. The areal extent of bottom water in different temperature bins shows a significant decrease in the extent of sub-zero ^{o}C water with a corresponding increase in the extent of water above 1^{o}C during the spring of 1998 and 1999 compared to 1997. During the spring of 2000 however, the extent of sub-zero ^{o}C water increased over 1999 values (Fig. 10). Bottom temperature anomalies during the spring of 2000 in NAFO Subdivisions 3Ps and 3Pn are shown in Fig. 11. Except for Hermitage Channel, bottom temperatures were above average over most areas with values up to 1^{o}C above normal in many areas.

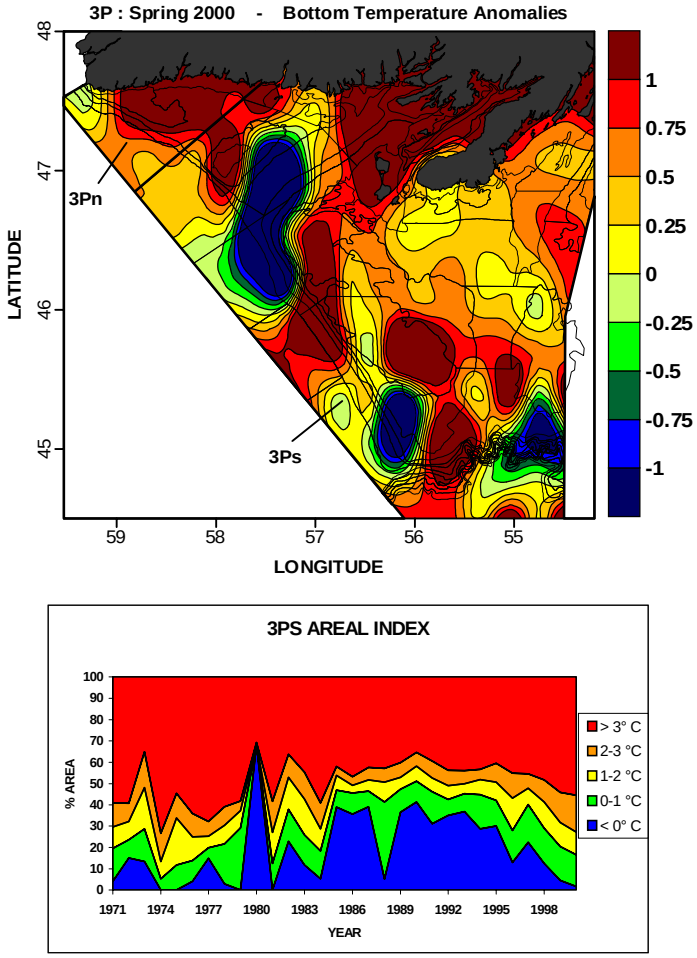

Fig. 11. Bottom temperature anomalies (in °C) for the spring of 2000 for NAFO Subdivisions 3Pn and 3Ps and the percentage area of the bottom covered by water in various temperature bins.

The areal extent of sub-zero ^{o}C bottom water in this region increased significantly in the mid-1980s but decreased to very low values beginning in 1998 which continued into 1999 and 2000 (Fig. 11). The extent of bottom water with temperatures above 1^{o}C was about 60% of the total area during 1995 and this increased to 70% in 1999 and to 85% during the spring of 2000 (Fig. 11). In general, temperature conditions in this region are highly variable but it appears that the cold trend on St. Pierre Bank has moderated during 1998 to 2000.

Autumn

Bottom temperature anomalies for the fall of 2000 in NAFO Divisions 2J, 3K and 3LNO are shown in Figs. 12 to 14. Bottom temperatures were up to 1^{o}C above normal on the major banks in Divisions 2J and 3K with normal values along the shelf edge. During the fall of 2000 in Divisions 3LNO above normal bottom temperatures were confined mainly to the outer edges of the banks with values up to 1^{o}C above normal. A large area of the central banks had below normal values with temperatures up to 1^{o}C below normal. In general, temperatures in Division 3LNO decreased over spring values and were down significantly over 1999 values. During the fall of 2000 the area of sub-zero ^{o}C water covering the bottom in Divisions 2J and 3K decreased to near 0% (Figs 12 and 13, bottom panels). In Divisions 3LNO the area of sub-zero ^{o}C increased over 1999 values to near 40% in 2000 (Fig. 14). The areal extent of bottom water with temperatures above 1^{o}C increased significantly during the fall of 1999 reaching about 80% of the total area on all major banks in the region. During 2000 this area decreased in all areas, with the largest decrease in Divisions 3LNO during the fall.

In general ocean temperatures in the Newfoundland Region during the period of 1996 to 2000 were above their long-term mean in almost all areas but showed a slight decrease during 2000 over 1999 values.

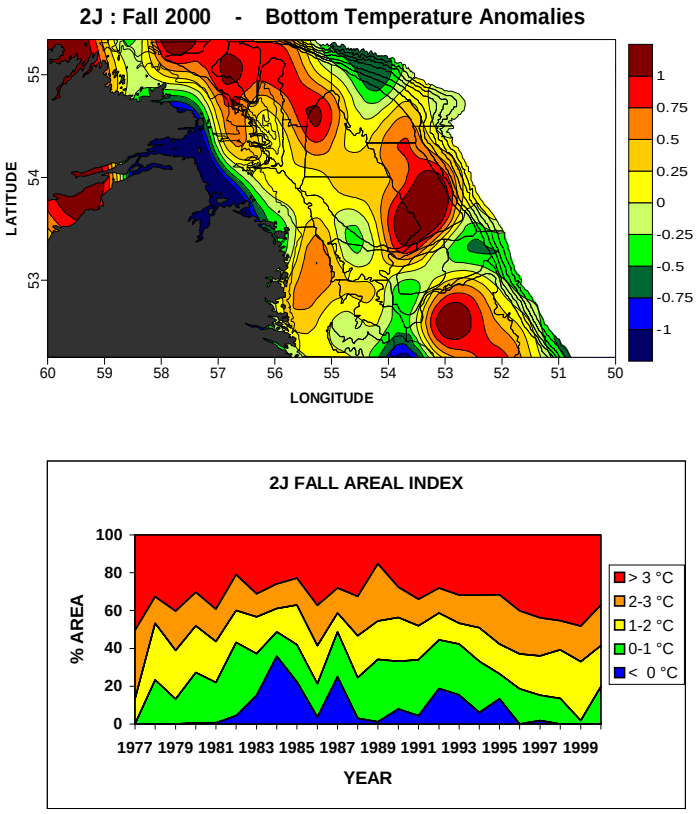

Fig. 12. Bottom temperature anomalies (in °C) for the fall of 2000 for NAFO Division 2J and the percentage area of the bottom covered by water in various temperature bins.

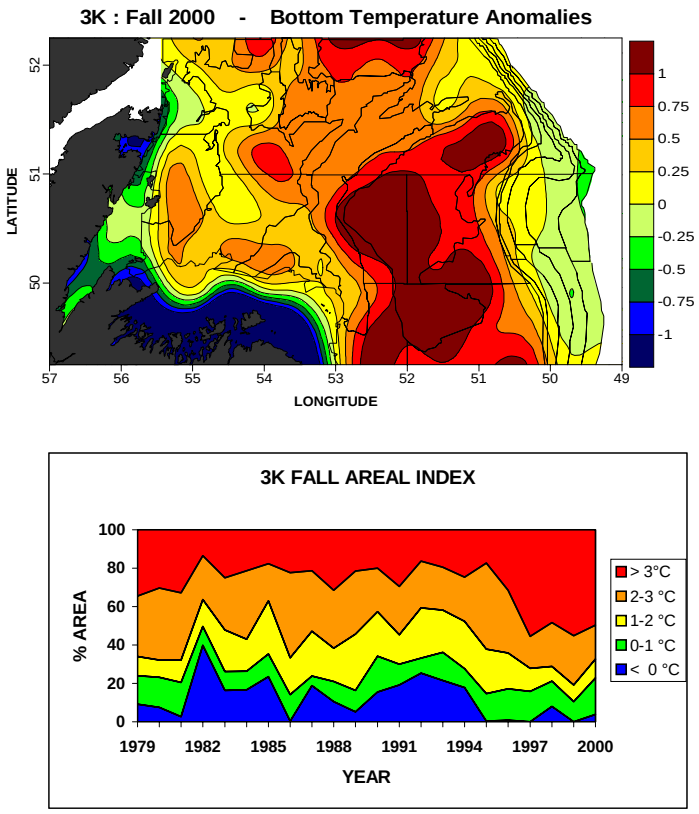

Fig. 13. Bottom temperature anomalies (in °C) for the fall of 2000 for NAFO Division 3K and the percentage area of the bottom covered by water in various temperature bins.

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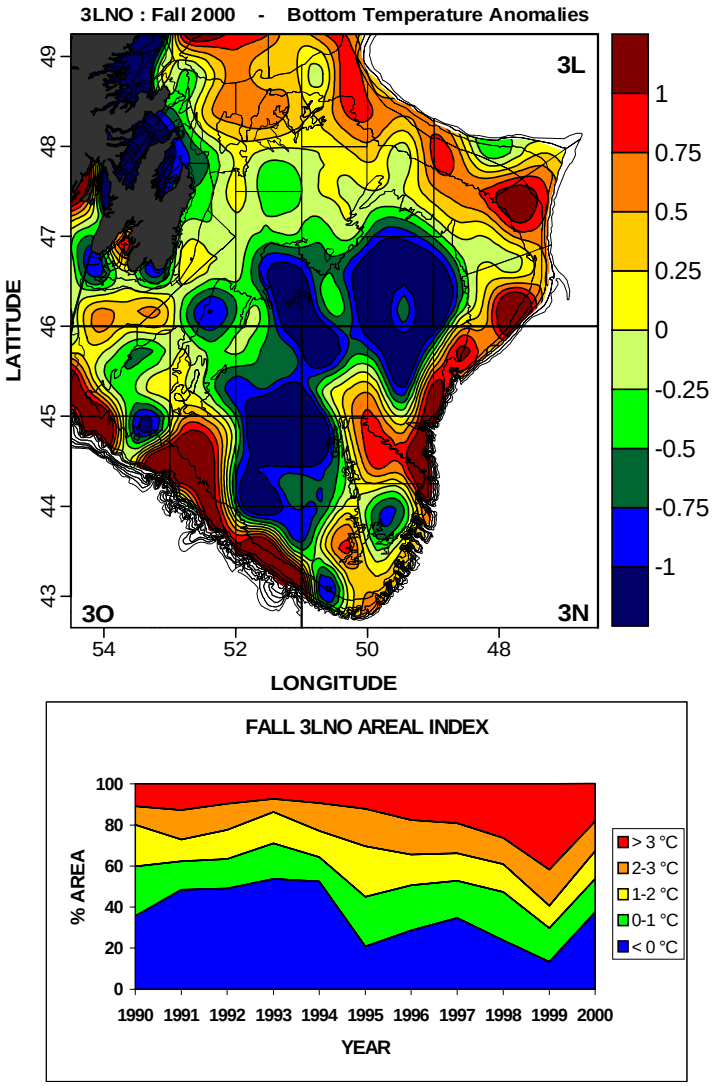

Fig. 14. Bottom temperature anomalies (in °C) for the fall of 2000 for NAFO Divisions 3LNO and the percentage area of the bottom covered by water in various temperature bins.

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