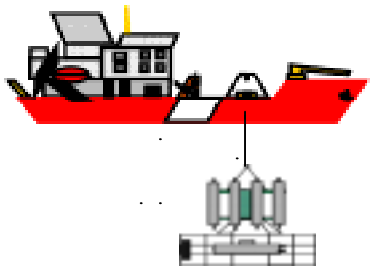


Oceanographic Conditions in the Newfoundland Region during 1997

Summary

Temperatures recorded off St. John's Harbour at Station 27 during 1997 were above normal during the winter months, below normal throughout the spring and summer in upper layer and near normal throughout the year from about 100 m to the bottom. The summer upper layer salinities were normal, the first time since 1990. Temperatures on St. Pierre Bank warmed during 1996, but decreased again to below normal values in 1997. During the summer of 1997 the area of sub-zero ^{o}C cold intermediate layer (CIL) water off Bonavista and Hamilton Bank was below normal continuing a trend established in 1995. Across the Grand Bank the CIL was above normal compared to near normal conditions in 1996. Bottom temperatures on Hamilton Bank and the Grand Bank during the fall of 1996 increased significantly over previous years and were up to 0.5 ^{o}C above normal over many areas. During the fall of 1997 bottom temperatures were still above normal over many areas, particularly on the offshore portion of the Northeast Newfoundland Shelf, while bottom temperatures on St. Pierre Bank continued below normal. In general, during 1997 oceanographic conditions were above normal over many areas, the exception being the coastal regions in the upper water column where temperatures were colder than normal during late spring and early summer.

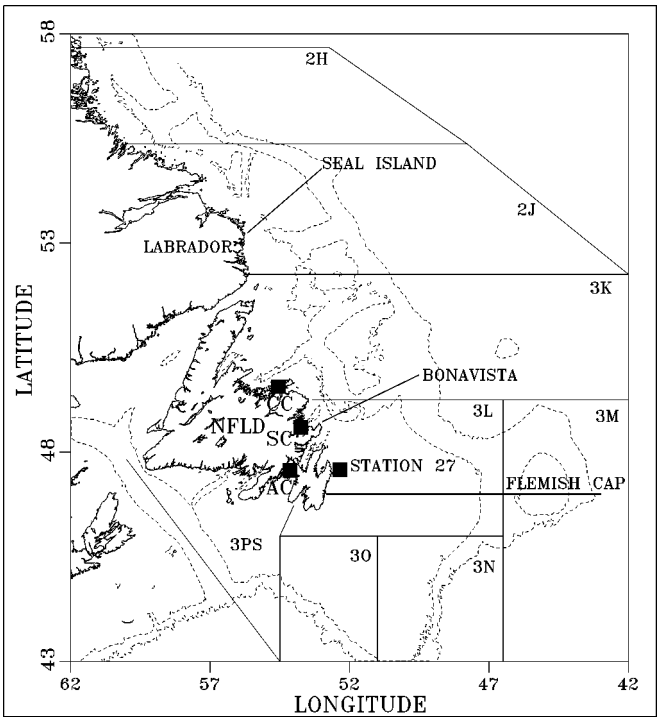


Fig. 1. Map of the Newfoundland Region showing the position of standard transects, long-term-temperature monitoring sites (CC, SC, AC) and Station 27. Depth contours are 300 and 1000 m.

INTRODUCTION

The ocean environment on the Newfoundland Shelf is influenced by the Labrador Current, cross-shelf exchange with warmer continental slope water and bottom topography. Superimposed are large seasonal and interannual variations in solar heat input, ice cover and storm forced mixing. The resulting water mass on the shelf is characterized by large annual cycles with strong horizontal and vertical temperature and salinity gradients. Water properties are monitored extensively by fisheries assessment and oceanographic research surveys throughout the year (Fig. 1). The resulting measurements are expressed as differences from their mean (anomalies). The

long-term means are standardized to a base period from 1961-1990 in accordance with the convention of the World Meteorological Organization.

Conditions in 1997

Air temperatures at Cartwright on the Labrador Coast show a decline from the higher values of 1996 but are still higher than the low values of the early 1990s (Fig. 2). The air temperature time series since the 1960s show extreme variations, superimposed on a general downward trend. The time series of ice area on the Newfoundland and Southern Labrador shelves show that the peak extent during 1997 increased over 1996 values but was below the heavy ice years of the early 1990s (Fig. 3).

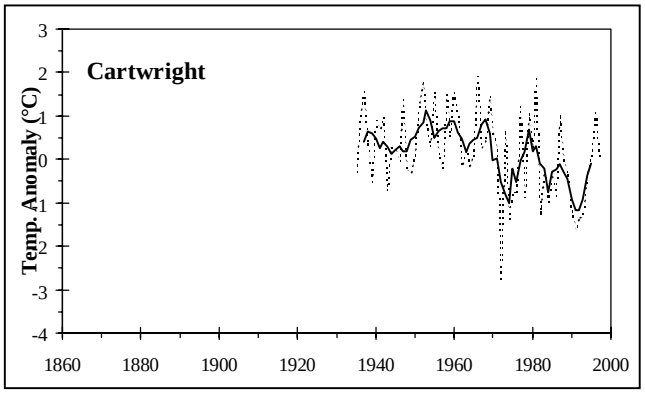


Fig. 2. Departures from normal mean air temperature (dashed line) and the 5 year means at Cartwright on the Labrador Coast.

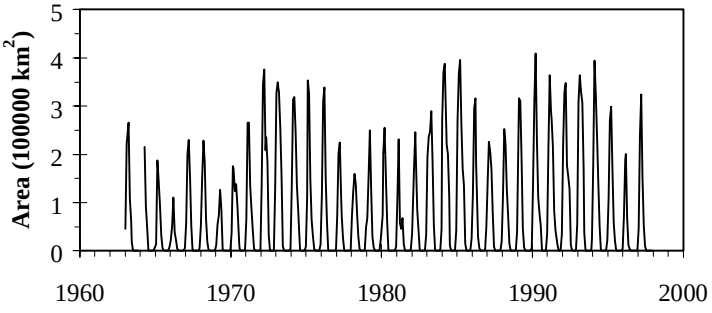


Fig. 3. Time series of ice areas off Newfoundland and southern Labrador.

Station 27 Temperature and Salinity

The temperature time series at Station 27 (Fig. 1) located in the inshore branch of the Labrador Current, shows upper layer temperatures near constant at about 0 °C from January to early April and from 0 °C to -1 °C throughout the year

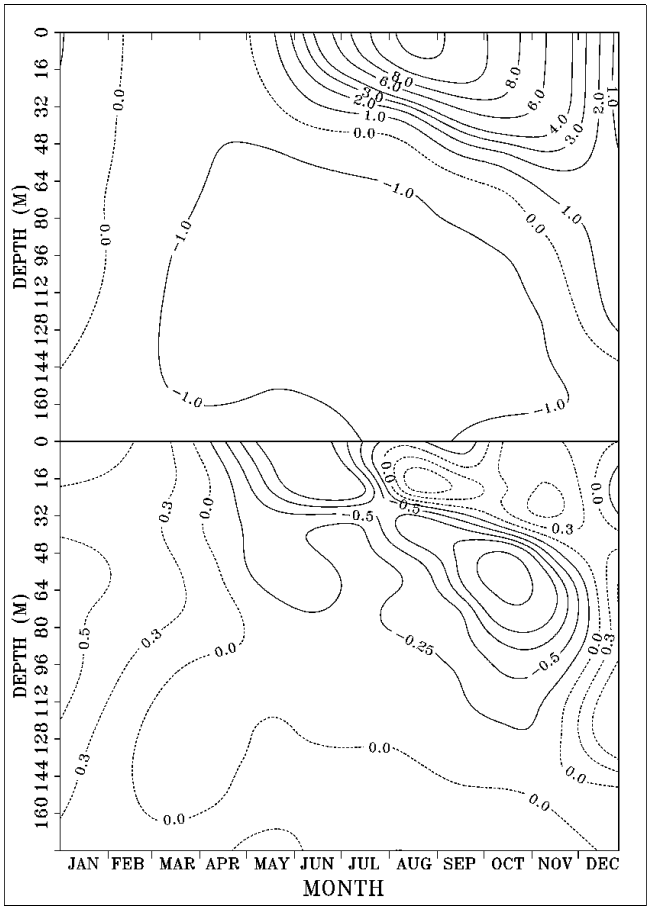


Fig. 4. Monthly temperature (top) and their departures from normal (bottom) at Station 27 as a function of depth for 1997.

near the bottom. By early May the upper layer temperature had warmed to 2 °C and to above 12 °C by August at the surface, after which the fall cooling commenced. These temperatures ranged from 0 to 0.5 °C above normal for the winter months over most of the water column. By mid-April surface temperature fell below normal by about 0.5 °C and to about 1 °C below normal by mid May. These colder than normal

temperatures penetrated deeper into the water column reaching 100 m depth by October. Fall temperatures in the upper layer were about normal. Bottom temperatures throughout the year were near normal (Fig. 4).

Upper layer salinities (Fig. 5) reached a maximum of 32.2 in mid February and decreased

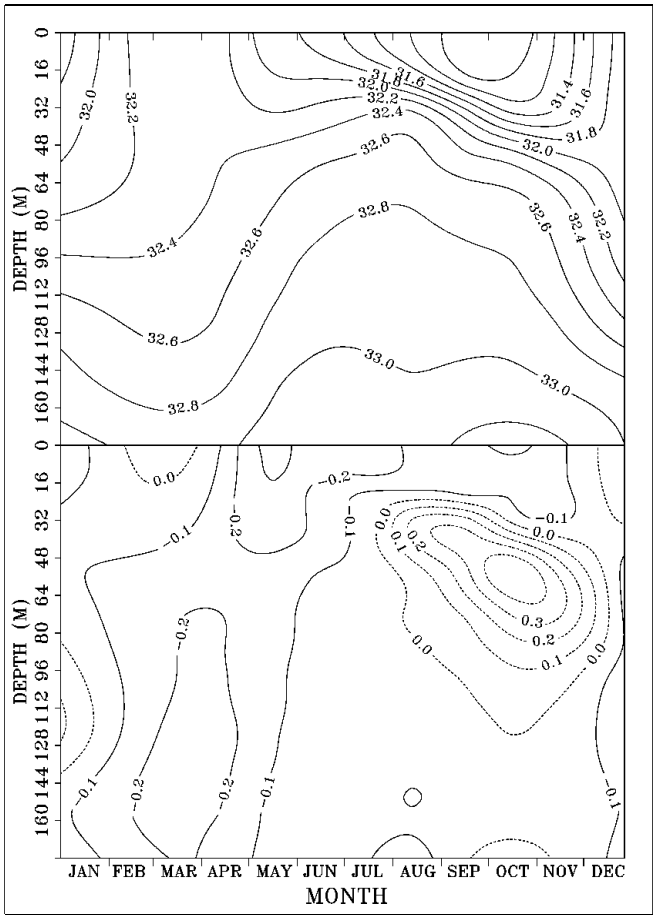


Fig. 5. Monthly salinity (top) and their departures from normal (bottom) at Station 27 as a function of depth for 1997.

to a minimum of 31 by September, these values were slightly below the long term mean. In deeper water, salinities generally ranged from 32.4 to 33, except for a positive anomaly (up to 0.5) centered at about 50 m depth during fall, these values were generally near to slightly below normal throughout the year.

The station 27 depth averaged annual temperature (which is proportional to the heat content of the water column) time series (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. The heat content of the water column reached a record low in 1991, has since recovered to a near record high value during 1996 and was near the long-term mean in 1997. The upper water column (0 to 50 m) depth averaged summer (July-September) salinities (expressed as difference from normal) (Fig. 6) shows similar behaviour as the heat content time series with longer, less saltier than normal periods corresponding to the colder than normal conditions. During 1993 summer salinities started returning to more normal values but decreased again by the summer of 1995 to near record lows but increased again in 1996 and returned to near normal values in 1997.

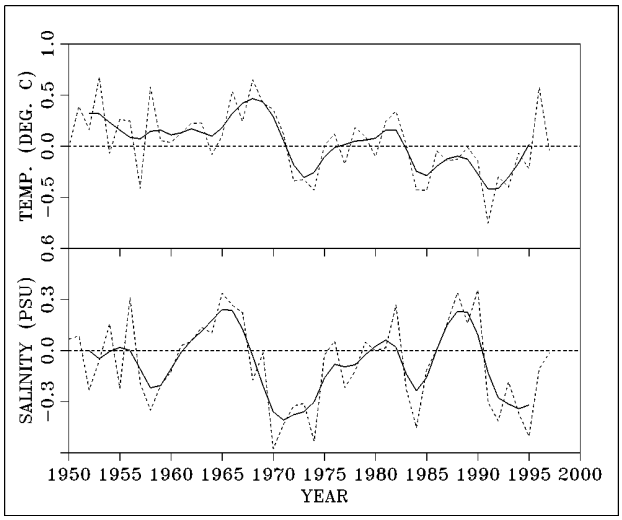


Fig. 6. Departures from normal depth averaged (0-176 m) Station 27 temperature and upper layer (0 to 50 m) averaged summer (July-Sept) salinity. The heavy lines are the three-year running means or averages.

St. Pierre Bank (Division 3Ps)

The time series of temperature anomalies from 1950 to 1997 on St. Pierre Bank within 100 m depth are shown in Fig. 7 at standard depths of 0, 20, 50 and 75 m. This record was smoothed to suppress the monthly variations, which are

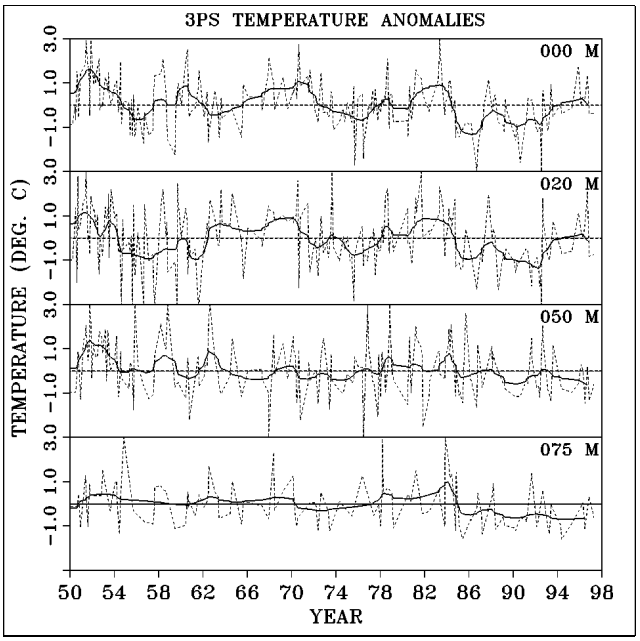


Fig. 7. Departures from normal monthly temperature at standard depths on St. Pierre Bank in subdivision 3Ps. The heavy line represents the long-term trends.

also shown as the dashed lines in the figure. The temperature trends are characterized by large variations greater than 1 ^{o}C above and below normal with periods between 5 to 10 years. During the cold period beginning around 1984 temperatures decreased by up to 2 ^{o}C in the upper water column and by 1 ^{o}C in the lower water column and continued below normal until about 1990. Since 1991 temperatures have warmed over the top 50 m of the water column but have remained well below average at 75 m depth. During 1992 to 1996 the temperature varied above and below normal in the top 20 m of the water column, but remained mostly below normal near bottom (Colbourne 1996). During mid 1996 however, conditions appear to be moderating but decreased again during 1997.

Inshore Temperature Time Series

Temperature time series from monitoring sites in Notre Dame Bay (CC), Bonavista Bay (SC) and Placentia Bay (AC) (Fig. 1) at 10 m depth for the time period 1990 to 1997 show temperatures up to 4 to 6 ^{o}C below normal during 1991 and

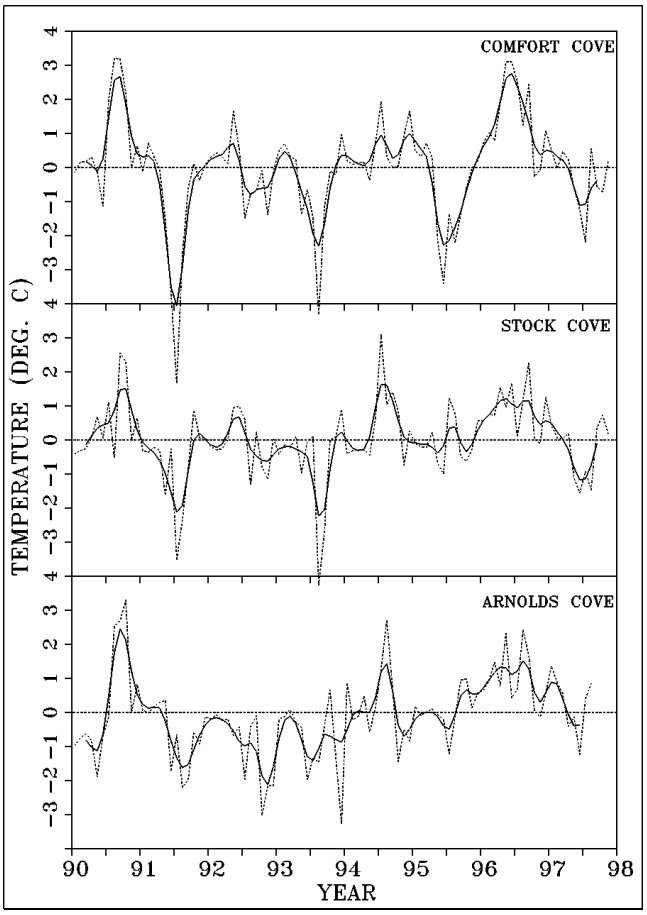


Fig. 8. Departures from normal monthly temperatures at 10 m depth for Comfort Cove (CC in Fig. 1), Notre Dame Bay, Stock Cove (SC), Bonavista Bay and for Arnold's Cove (AC), Placentia Bay.

and 1993 in the summer months in Notre Dame and Bonavista Bays and up to 2 ^{o}C below average in Placentia Bay. During 1994 temperatures were from 1 to 3 ^{o}C above normal during the summer months and from 1 to 3 ^{o}C above normal throughout most of 1996 at all 3 sites. By mid 1997 temperatures were below normal at all three sites but recovered to near normal values late in 1997.

THE NF SHELF COLD INTERMEDIATE LAYER (CIL)

As is well known, the temperature structure on the Newfoundland Continental Shelf is dominated by a layer of cold water, commonly referred to as the Cold Intermediate Layer or CIL (Petrie et al. 1988), trapped between the seasonally heated surface layer and warmer continental slope water near the bottom. Along the Bonavista transect during the summer of 1997 this cold layer extended offshore to about 180 km, with a maximum thickness of about 220 m corresponding to an area of about 19 km^2, compared to the 1961-90 average of 27 km^2.

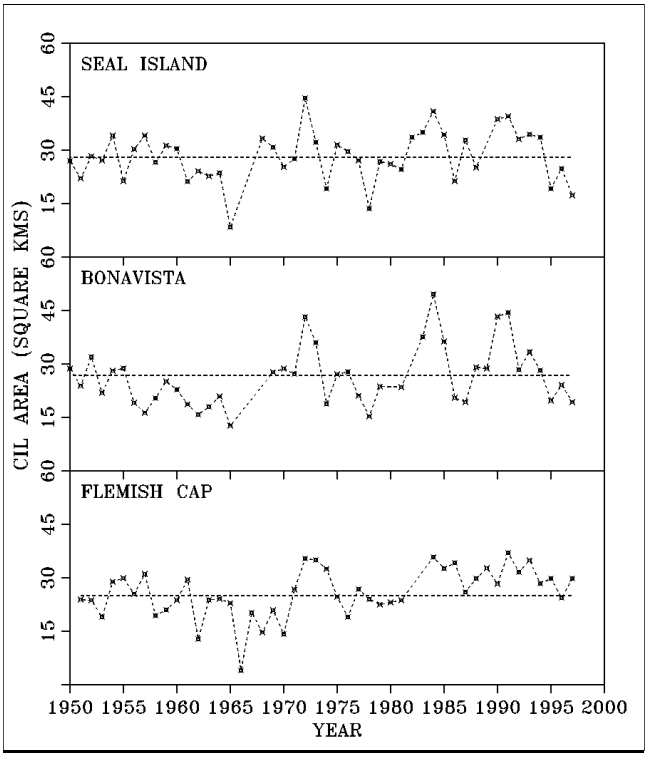


Fig.9. Time series of CIL area along the standard transects across the Newfoundlanf Shelf shown in Fig. 1.

Figure 9 shows a time series of the CIL area for the Seal Island, Bonavista and Flemish Cap transects, the positions of which are shown in Fig 1. During the summer of 1997 the CIL area off Bonavista was about 28 % below normal compared to 10 % below normal in 1996 and 30 % below normal in 1995. The CIL area along the Seal Island transect was also below normal by about 38 % during 1997, 12 % in 1996 and 32 % during 1995. From 1990 to 1994 the CIL was above normal reaching a peak of more than 60 % in 1991. On the Grand Bank along the Flemish Cap transect the CIL was about 20 % above normal compared too slightly below normal conditions during the summer of 1996 (24 km^2 versus an average of 25 km^2). In general, the total amount of sub-zero ^{o}C water on the Newfoundland Shelf, except on the Grand Bank, is continuing a below normal trend established in 1995.

BOTTOM TEMPERATURES

The 1997 and the average (1961-90) fall bottom temperature maps for the 2J3KLNO area are shown in Figs. 10 and 11 (temperature contours are -1, -0.5, 0, 1, 2, 3 and 3.5 ^{o}C, depth contours are 300 and 1000 m). The average bottom temperature over most of the Northeast Newfoundland shelf (2J3K) ranges from less than 0 ^{o}C inshore, to above 3 ^{o}C offshore at the edge of the continental shelf. The average temperature over most of the Grand Bank varies from -0.5 ^{o}C to 0 ^{o}C over the central and northern areas, 0 to 3 °C over south-eastern regions and to

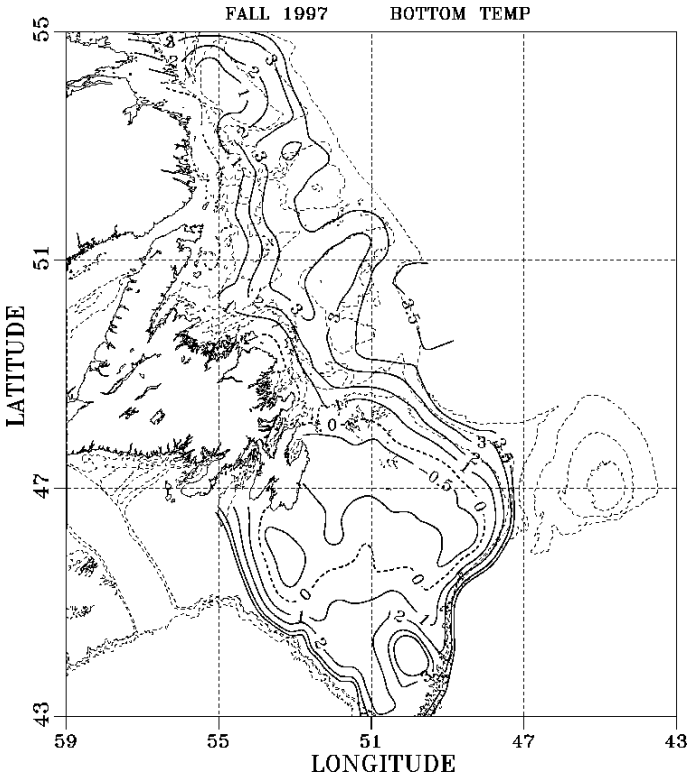


Fig. 10. Bottom temperature map of the Newfoundland Shelf Region for the fall of 1997.

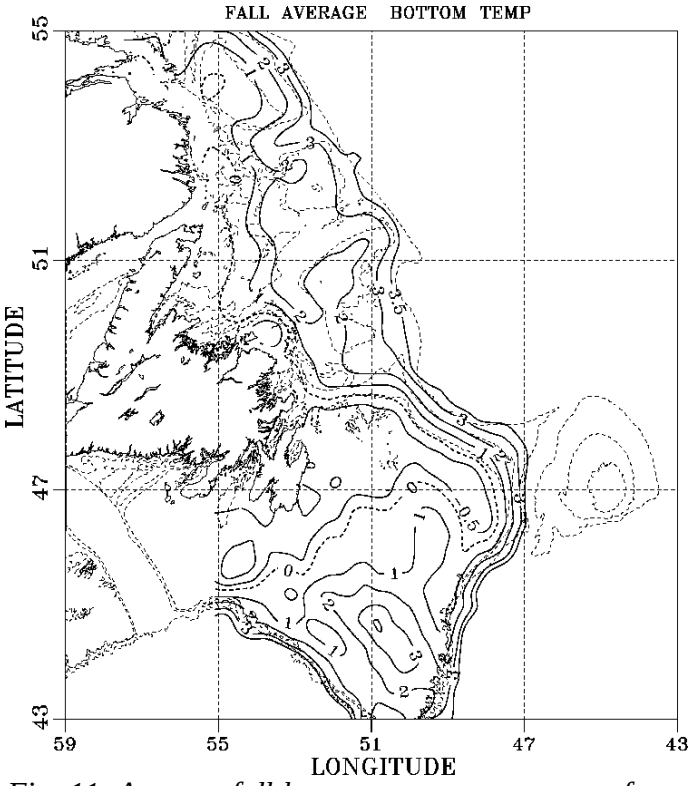
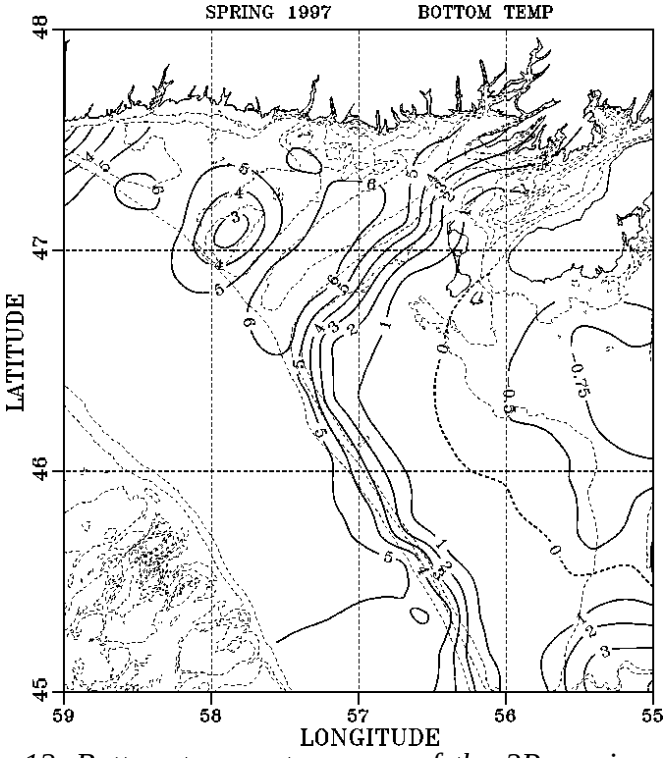


Fig. 11. Average fall bottom temperature map of the Newfoundland Shelf Region.

above 3 ^{o}C at the edge of the continental shelf. In general, bottom temperatures are nearly uniform at constant depth over most of the Northeast Newfoundland Shelf. The percentage area of water less than -0.5 ^{o}C over the Grand Bank and Northeast shelf from 1990 to 1994 was much larger than the 1961-1990 average. In 1992 and 1993 the bottom temperatures ranged from 0.25 ^{o}C to 0.75 ^{o}C below normal over most of the Northeast Newfoundland Shelf and from 0.25 ^{o}C to 1.0 ^{o}C below normal over the Grand Bank (Colbourne 1994). During the fall of 1996 bottom temperatures warmed over most areas on the Newfoundland Shelf reaching 0.5 ^{o}C above normal in many places. During 1996 the percentage area of water less than -0.5 ^{o}C on the Grand Bank was below average with a complete absence of sub-zero ^{o}C water on the Northeast Newfoundland Shelf from the Northern Grand Bank to Nain Bank. Bottom temperatures during the fall of 1997 were still above normal over many areas, particularly on the offshore portion of the Northeast Newfoundland Shelf (Fig. 10).

The 1961-90 average and the 1997 April bottom temperature maps for the 3Ps and 3Pn areas are shown in Figs. 12 and 13. In general, bottom temperatures are nearly uniform at constant depth around the Laurentian Channel and the Southwestern Grand Bank increasing from 2 ^{o}C at 200 m depth to 5 ^{o}C in the deeper water. The average bottom temperatures during April ranges from 5 ^{o}C in the Laurentian, Burgeo and Hermitage Channels to about 3 ^{o}C to 4 ^{o}C on Rose Blanche Bank and on Burgeo Bank and from 0 ^{o}C on the eastern side of St. Pierre Bank to 2 to 3 ^{o}C on the western side. During April 1996 temperatures were about average over Burgeo Bank and Hermitage Channel and along the western side of St. Pierre Bank, however on



12. Bottom temperature map of the 3Ps region during spring of 1997.

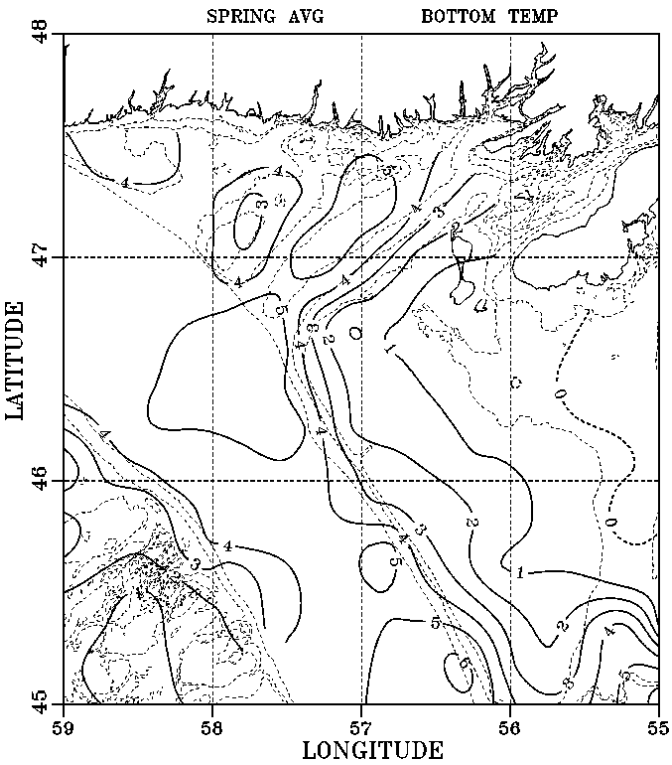


Fig. 13. Average spring bottom temperature map of the 3Ps region.

St. Pierre Bank temperatures were still slightly below average, but an increase over 1995 values, particularly on the eastern side of the bank (Colbourne 1996). During the spring of 1997 deep water temperatures appear to be above normal while most of St. Pierre Bank was below normal by more than 1.0 °C in the southeast. In general, temperature conditions in this region are highly variable (Fig. 7) and it appears that the cold trend on St. Pierre Bank is continuing into 1997.

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