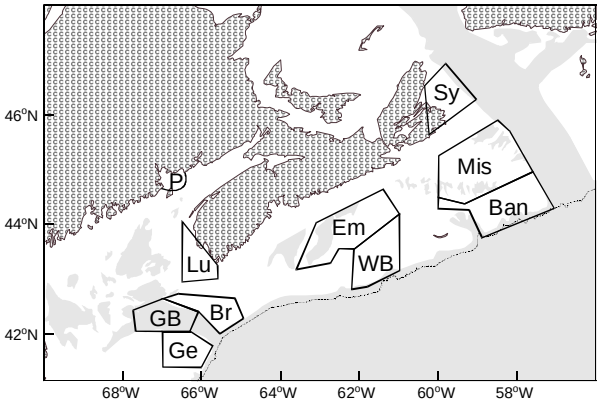
Fisheries and Oceans / Pêches et Océans
Maritimes Region

DFO Science
Stock Status Report G3-01(1998)

1997 State of the Ocean: Scotian Shelf, Bay of Fundy and Gulf of Maine



Sy -Sydney Bight
Mis-Misaine Bank
Ban-Banquereau
Em -Emerald Basin
WB-Western Bank
P - Prince 5
Lu - Lurcher Shoals
Br - Browns Bank
GB - Georges Basin
Ge - Georges Bank

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 (mainly water temperature and salinity) are therefore measured during research vessel resource surveys. Additional hydrographic, meteorological and sea ice data are obtained from a variety of sources, including standard monitoring stations, 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) data base. A working copy is maintained in a zonal data base at the Bedford Institute of Oceanography.

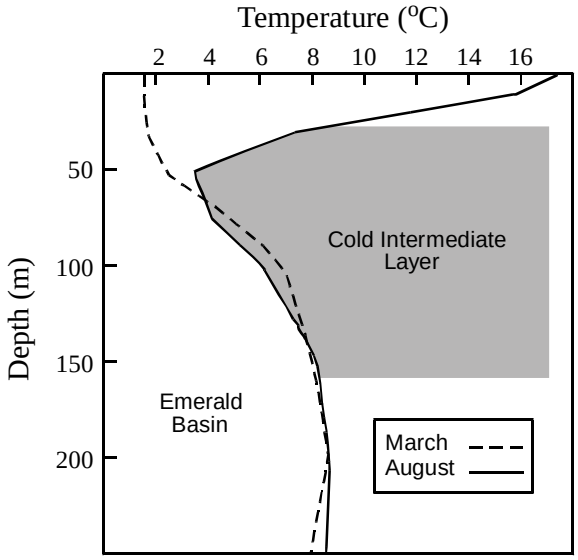
Mean Conditions

Temperature and salinity conditions within the Scotian Shelf, Bay of Fundy and Gulf of Maine vary spatially due to complex bottom topography, transport from upstream sources such as the Gulf of St. Lawrence, and exchange with the adjacent, offshore slope waters. Water properties are also characterized by large seasonal cycles, depth differences and horizontal east-west and inshore-offshore gradients.

The seasonal temperature range of the waters over the Scotian Shelf decreases with depth. At the surface, the range is about 16°C but there is little or no seasonal change at depths greater than approximately 150 to 200 m. In the shallow regions of the Gulf of Maine, such as Lurcher Shoals, the Bay of Fundy and Georges Bank, the seasonal cycle shows much less change with depth due to vertical mixing by the strong tidal currents.

Canada

In the winter, the water column in deep regions of the Scotian Shelf consists of two layers separated by a transition zone as is shown in the plot below of the variation in temperature with depth in Emerald Basin.



The upper layer is mixed by the winter winds and contains cold, low salinity water. The bottom layer has relatively warm and salty water. The latter originates from the offshore slope region and enters the Shelf through deep channels or gullies. In summer, seasonal heating forms a thin (30-40 m) warm upper layer. The winter-cooled waters form a cold intermediate layer (CIL; 40-150 m) and the warm bottom layer remains unchanged. Variations in this vertical structure occurs over the shelf. The warm offshore waters do not penetrate onto the eastern Scotian Shelf and hence waters typical of the CIL (temperatures less than 5°C) extend to the bottom. Throughout the Scotian Shelf where depths are shallower than 150 m, there is no warm bottom layer. In areas of strong tidal currents, the waters even in summer are vertically well mixed.

Temperatures and salinities generally increase from east to west and from inshore to offshore due to the influences of the warmer, more saline offshore waters and the outflow of the fresher water from the Gulf of St. Lawrence. For example, in the summer within the CIL, the 50 m temperatures typically range from 0-3°C over the eastern Scotian Shelf, 3-8°C over much of the central shelf and 6-9°C over the western Scotian Shelf, eastern Gulf of Maine and Bay of Fundy. The one exception to the general trend in horizontal distributions is the surface temperatures in summer, when they increase from west to east due to the warm surface outflow from the Gulf of St. Lawrence.

The near-bottom temperatures display similar ranges to that at 50 m except over the central shelf where the range increases to 3-9°C, the higher temperatures being caused by the intrusion of the warm offshore waters.

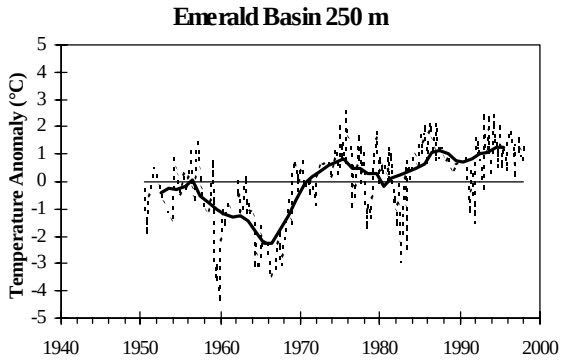
Long-Term Time Trends

Year-to-year changes in the water temperatures on the Scotian Shelf and in the Gulf of Maine are among the most variable in the North Atlantic Ocean. Information on ocean climate variability is derived from several sources. Long-term coastal sea surface temperatures are available at Halifax and St. Andrews. The only long-term hydrographic offshore monitoring site within the region is Prince 5 (P), located at the mouth of the Bay of Fundy, however, temperature time series have been constructed for other areas from data collected during fisheries surveys and oceanographic studies.

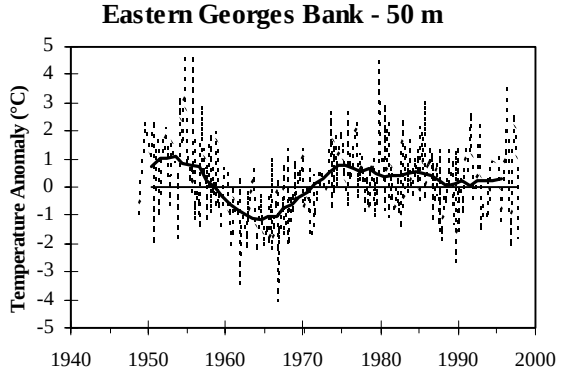
In order to detect time trends in temperature, the seasonal cycle is removed by calculating deviations (anomalies) of temperatures from the long-term (1961-90) monthly means for each area. Inter-annual variability is also expressed as anomalies. With the exception of the Prince 5 series, the data from most areas are very sparse prior to 1950.

In general, the temperature records are characterized by short period spikes,

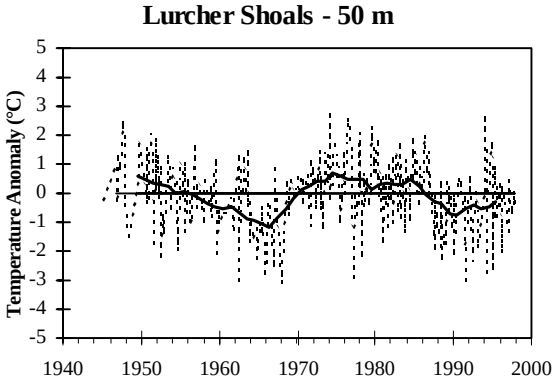
superimposed on long period (10-30 year) trends with amplitudes of 1-2°C. While the spikes often represent "noise" due in large part to limited amounts of data and usually show little similarity from area to area, the long-period trends show strong similarity over much of the Scotian Shelf and the Gulf of Maine.



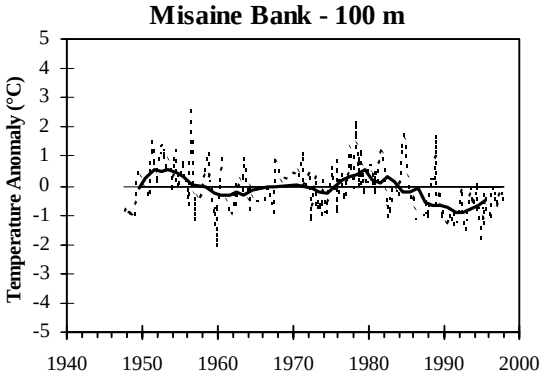
The temperature pattern in Emerald Basin (area Em on the chart at the beginning of this report) is representative of the long-period trends in the deep waters throughout the central and western shelf and in the Gulf of Maine. Temperatures were near or above average in the 1950s and declined to below average in the 1960s. The extended period with the lowest temperatures occurred during the mid-1960s. Temperatures rose rapidly in the late 1960s and since the 1970s have generally remained warmer-than-average.



In shallower waters over the shelf, temperature trends were similar to those in the deep waters until the mid-1980s. Temperatures on eastern Georges Bank (Ge), which are representative of the offshore banks including Browns and Western (areas Br and WB, respectively), tended to be above average through most of the 1970s and 1980s but declined slightly in the late 1980s and since then have oscillated about normal.



Temperatures in the shallow inshore areas of southwest Nova Scotia (Lurcher Shoals; area Lu) show a clear decline from the mid-1980s to the early 1990s, reaching levels comparable to those in the cold period of the 1960s. Although temperatures have been warming in recent years, they have generally remained below average.



In intermediate and deep waters of the eastern shelf, as exemplified by Misaine Bank (area Mis), the amplitude of the long-period temperature trend is smaller (order 1°C) than for the rest of the shelf. For example, the low temperature anomalies during the 1960s were not as cold as elsewhere on the Scotian Shelf such as in Emerald Basin or over Lurcher Shoals. From the late-1960s to the mid-1970s temperatures at Misaine oscillated near or above average. They rose above normal

around 1980 but by the mid-1980s, temperatures fell sharply and, throughout most of the water column, have generally remained colder-than-normal for the past decade. Temperature trends over the eastern inshore areas (e.g. Sydney Bight, area Sy) and offshore banks (e.g. Banquereau, area Ban) are similar to those in the Misaine area.

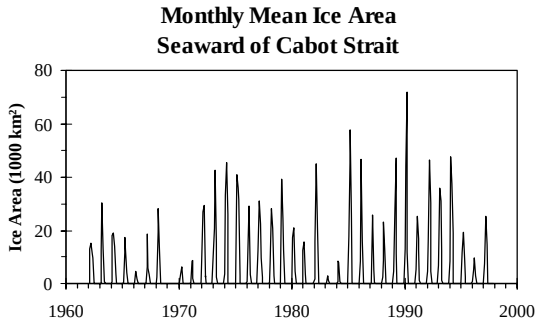
In the deep waters of Cabot Strait, temperatures were coldest during the 1960s but have been above or near average in recent years.

The general temperature trends described above are reflected in the time series of the summer research vessel stratified mean near-bottom temperatures for the Bay of Fundy (4X) as well as the western (4X), central (4W) and eastern (4Vs) Scotian Shelf.

Conditions in 1997

Annual mean air temperatures over the Scotian Shelf, Bay of Fundy and the Gulf of Maine during 1997 were slightly below normal and decreased relative to 1996. Seasonally, air temperatures were warmer-than-normal during the winter but were cool for the remainder of the year.

The amount of sea ice that reached the Scotian Shelf was below normal in 1997 but greater than in 1996. Although there was less ice than average, its duration was longer-than-normal by 2-4 weeks, due principally to a later-than-normal departure.



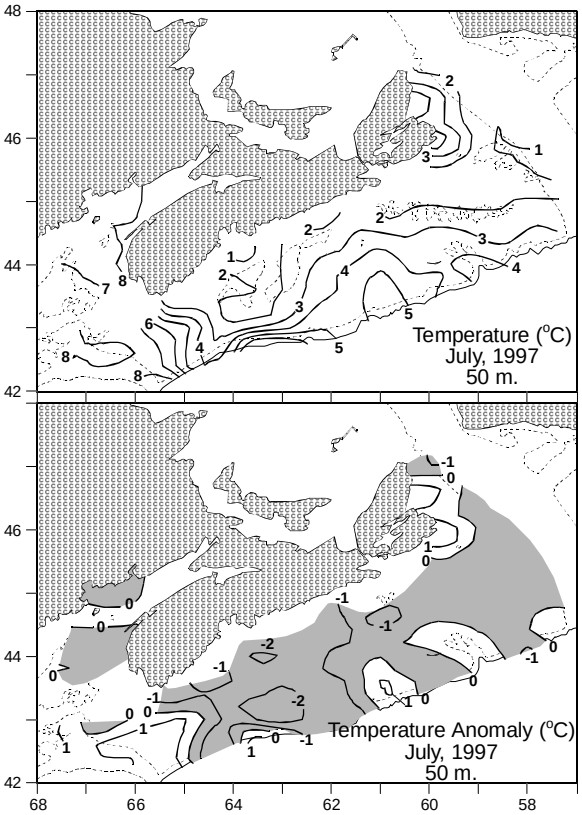
As in previous years, the ocean temperature conditions in 1997 depended upon location and depth. Monthly mean coastal sea surface temperatures in the Gulf of Maine and the Bay of Fundy revealed warm conditions in contrast to the colder-than-normal waters that predominated at Halifax. This pattern has persisted since mid-1994. At Prince 5, monthly mean temperatures were predominantly warmer-than-normal during the winter and early spring as well as during the autumn. Summer temperatures were relatively cold. Salinity anomalies at Prince 5 rose sharply from the record low values of 1996 but remained below normal. Low salinities at Prince 5 over the past few years mirror salinity changes in the deep waters of the Gulf of Maine.

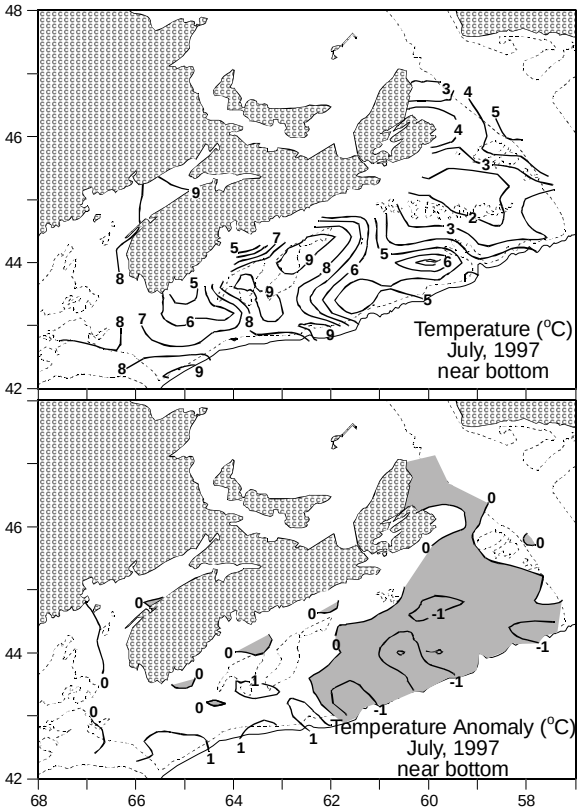
Although the temperature of the bottom waters over the northeastern Scotian Shelf, along the Atlantic coast of Nova Scotia and off southwestern Nova Scotia have been increasing slightly over the past two years, they continued to remain below normal. These colder-than-normal temperatures have persisted since the mid-1980s. This is in contrast to the deep waters in Emerald Basin on the central Scotian Shelf which have been warmer-than-normal during this time, including in 1997. This is related to the presence of warm offshore water at the continental slope which is intermittently transported into Emerald Basin by cross-shelf exchange processes through connecting gullies and channels.

In the central Gulf of Maine such as in Georges Basin (area GB), temperatures also remained well above normal. The conditions in the Gulf of Maine are believed to have been initiated by an influx of warm slope water through the Northeast Channel in late 1993. During the autumn of 1997, very cold waters of Labrador Current origin were observed along the continental slope of the Scotian Shelf at depths of 100 to 300 m as far south as Emerald Basin. They replaced warm Slope water that has occupied this region over most of the past 30 years. By December there was evidence that these cold waters were beginning to penetrate into Emerald Basin so that it appears that the warm conditions in the deep regions of the Basin are coming to an end. In the Laurentian Channel to the east of the Scotian Shelf, deep (200-300 m) waters at Cabot Strait were slightly above their long-term mean value, and near last year's temperatures. These were both below the maximum recorded in 1993 of 1°C above normal.

The temperatures at shallower depths also varied with location. Within the Cold Intermediate Layer at 50 to 100 m over Sydney Bight, Misaine Bank and Lurcher Shoals, temperatures were below normal throughout much of 1997. Colder-than-normal temperatures were also observed at these depths over Emerald Basin, which is in contrast to 1996.

The temperature conditions during the 1997 groundfish research surveys reflected the above patterns. The temperatures from the 4VW and 5Z spring and 4VWX summer surveys were all within the historical ranges observed during the surveys. The temperatures during the spring surveys were near or above the survey means. On Georges Bank, the 5Z spring survey recorded the lowest salinities in the survey series.





During the summer survey, near-bottom temperatures were less than 2°C over a large portion of the northeastern Scotian Shelf, resulting in below normal temperatures. Colder-than-average temperatures in 1997 were also observed over the Western and Banquereau whereas warmer-than-normal temperatures were found over the central and western Scotian Shelf and in the Bay of Fundy. Temperatures in the cooler-than-normal areas, did however, warm slightly relative to the 1996 survey whereas the warmer areas cooled. The temperature anomalies at 50 and 100 m show a similar pattern to the near-bottom waters.

For more Information

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