

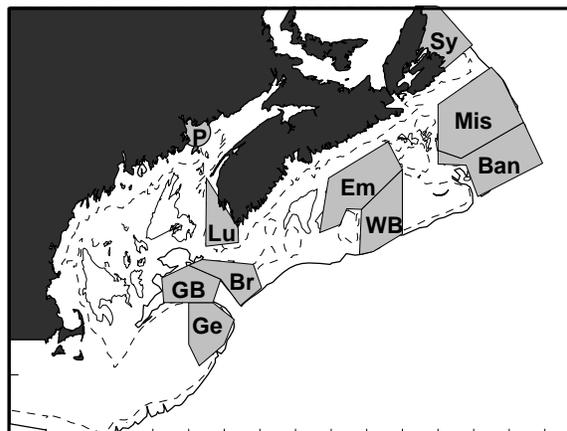
## State of the Ocean: Scotian Shelf, Bay of Fundy and Gulf of Maine

### 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 process oriented 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. The data collected during the groundfish and pelagic resource surveys are also maintained in a regional groundfish data base that is cross-linked with the biological data collected at each survey station.*



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

### Mean Conditions

Temperature and salinity conditions within the Scotia Shelf, Bay of Fundy and Gulf of Maine Region 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. The 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 200m. 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.

**Available from:** Maritimes Regional Advisory Process, Department of Fisheries and Oceans, P.O. Box 1006, Stn. B105, Dartmouth, N.S. Canada B2Y 4A2. Telephone: 902-426-8487. E.Mail: [d\\_geddes@bionet.bio.dfo.ca](mailto:d_geddes@bionet.bio.dfo.ca)

In the winter, the water column in deep regions of the Scotian Shelf such as Emerald Basin consists of two layers. The upper layer (100 to 150 m) contains cold, low salinity water and sits above a bottom layer of warm, salty water. The latter originates in the offshore slope region and enters the Shelf through deep channels or gullies. In summer, there are three layers. Seasonal heating forms a thin (30-40 m) warm upper layer. The winter-cooled waters form a cold intermediate layer (CIL) and the warm bottom layer remains unchanged. This vertical structure varies over the shelf. The warm offshore waters do not penetrate the eastern Scotian Shelf and hence the CIL extends to the bottom in many places. On the banks shallower than 150 m, there is also no warm bottom layer. In those areas of strong tidal currents, the waters, even in summer, are vertically well-mixed.

Despite these seasonal differences, the horizontal pattern of temperature and salinity is generally the same throughout the year. The temperatures and salinities 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 at 50 m, the long-term composite distribution of temperatures (not shown) ranges from 0-3°C over the eastern Scotian Shelf, 3-7°C over much of the central shelf and 7-9°C over the western Scotian Shelf, eastern Gulf of Maine and Bay of Fundy.

The corresponding composite distribution of near-bottom temperatures (not shown) show similar ranges to that at 50 m except over the central shelf where the range increased to 3-9°C, the higher temperatures being caused by the intrusion of the warm offshore waters. Temperatures along the southern and eastern edges of the Scotian Shelf range from 3-5°C, due to the deep offshore slope waters and the deep waters within the Laurentian Channel. A

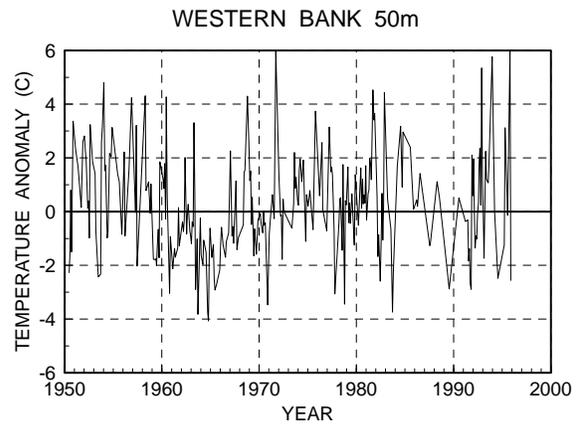
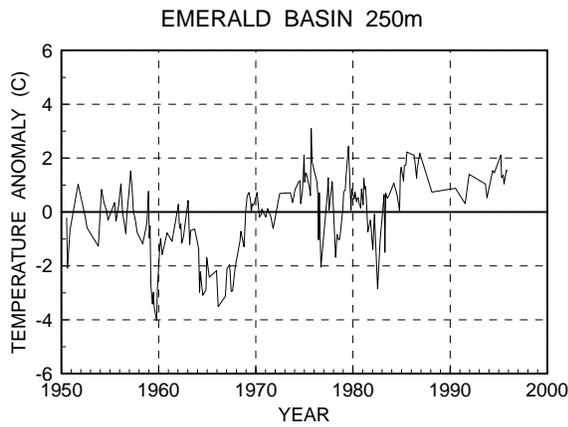
relatively cold tongue of water is evident in the near-bottom temperatures off Shelburne.

### *Time Trends*

Long-term coastal sea surface temperatures are available at Halifax and St. Andrews. The only long-term hydrographic offshore monitoring station 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 in the zonal data base. The representative trends plotted below for 50 m are 45-55 m averages while the 250 m trends are 240-260 m averages.

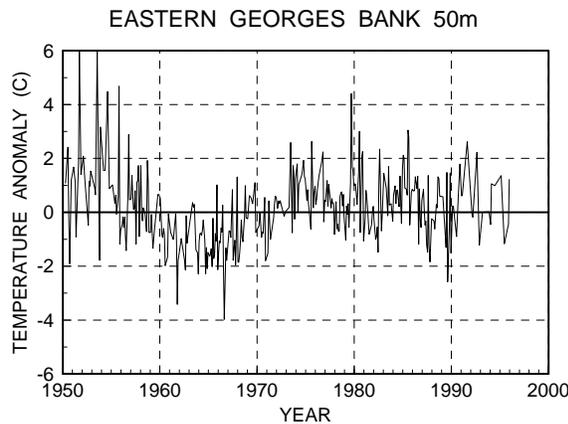
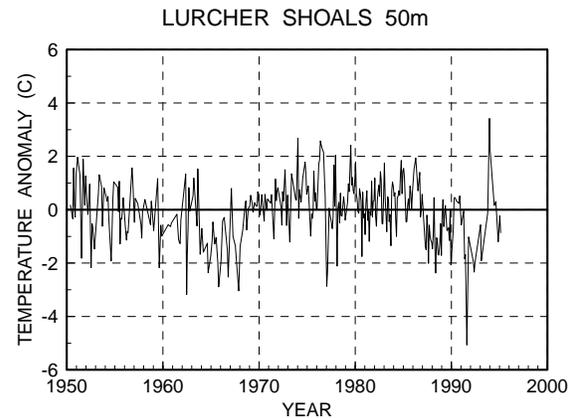
In order to detect time trends in temperature, the seasonal cycle is removed by calculating deviations (anomalies) of temperatures from the long-term (1961-90) monthly means for each area. With the exception of the Prince 5 series, the data from most areas are very sparse in the 1990s and especially prior to 1950.

In general, the series are characterized by short period fluctuations, indicated by spikes in the time series, superimposed on long period (10-30 years) trends with amplitudes of 1-2°C. While the spikes often represent “noise” due in large part to limited amounts of data and most often show little similarity from area to area, the long-period trends are highly significant, showing strong similarity over most of the Scotian Shelf and the Gulf of Maine.

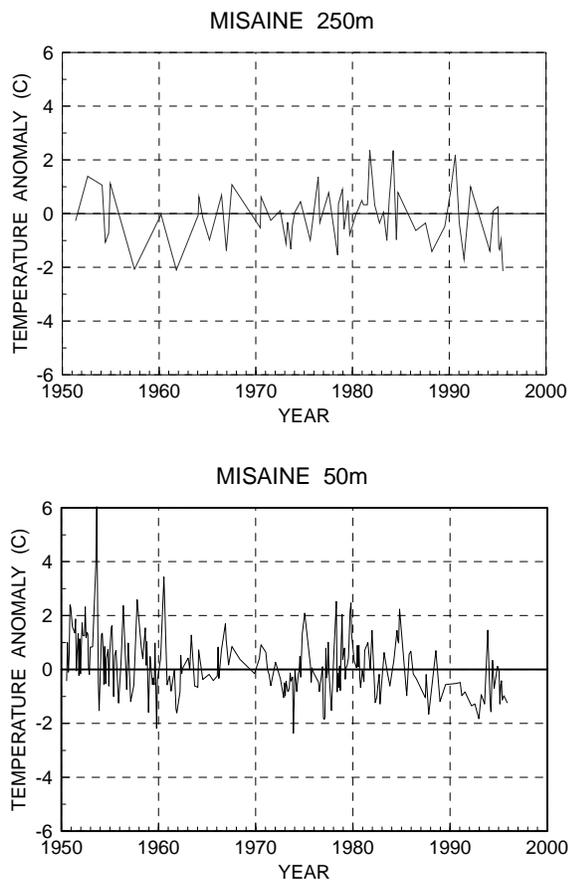


The temperature pattern in Emerald Basin (area Em on the chart at the beginning of the State-of-the-Ocean report) is representative of the long-period trends in the deep waters throughout the central and western shelf. Temperatures were near or above average in the 1950s and declined to below average in the 1960s. The lowest temperatures occurred during 1965-67. Temperatures rose rapidly to above normal by the early 1970s and since then have generally remained warmer-than-average. In the shallow waters, the temperature trends were similar to those in the deep waters until the mid-1980s. Temperatures on the offshore banks (Georges and Western) declined during the late 1980s and early 1990s to levels comparable to those in the cold period of the 1960s but increased during recent years to oscillate about normal.

Temperatures on Lurcher Shoals also declined throughout the late 1980s and early 1990s and although temperatures have been warming in recent years, they have remained below average, with the exception of a warm anomaly in 1994.



In intermediate and deep waters of the eastern shelf, as exemplified by the Misaine area, the amplitude of the long period temperature trend is smaller than on the rest of the shelf (order 1°C). The low temperature anomalies during the 1960s occurred a few years before those in the central and western shelf (1960-63) and were not as cold. From the mid-1960s to the early 1980s temperatures at Misaine oscillated near or above average. In the mid-1980s temperatures fell to below average and throughout most of the water column have generally remained colder-than-normal for the past decade.



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

Temperature trends over the eastern inshore areas (e.g. Sydney Bight) and offshore banks (e.g. Banquereau) are not shown but are similar to those in the Misaine area, with the exception of a few warm anomalies in the mid 1990s.

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), western (4X), central (4W) and eastern (4Vs) Scotian Shelf areas.

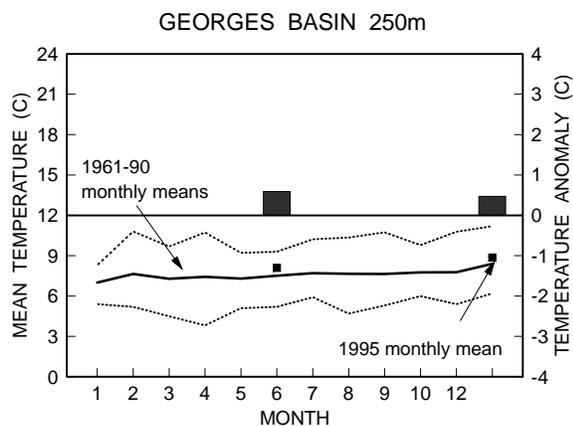
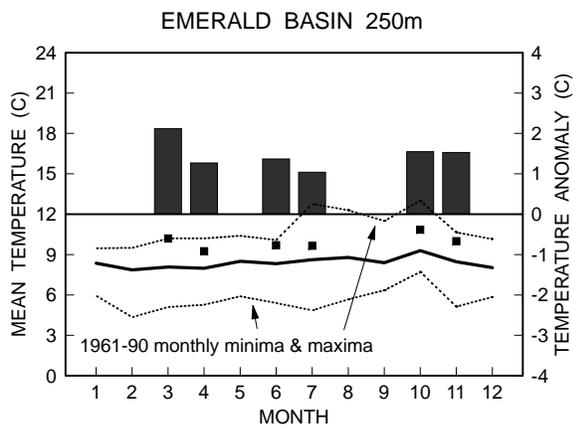
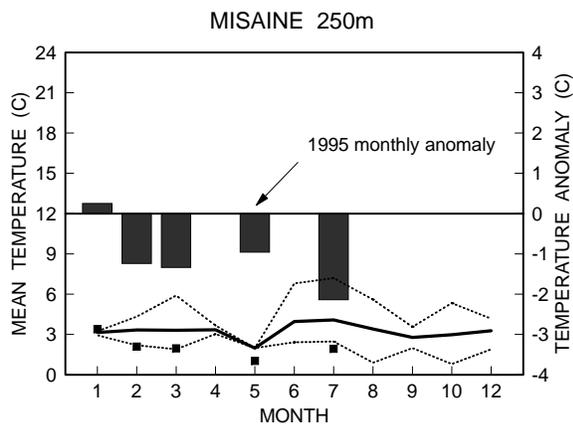
### *Conditions in 1995*

The above normal air temperatures in 1994 continued throughout much of 1995 (January-March, June-August, October), but unlike 1994, the 1995 warm months were interspersed with colder than normal months (April, May, September).

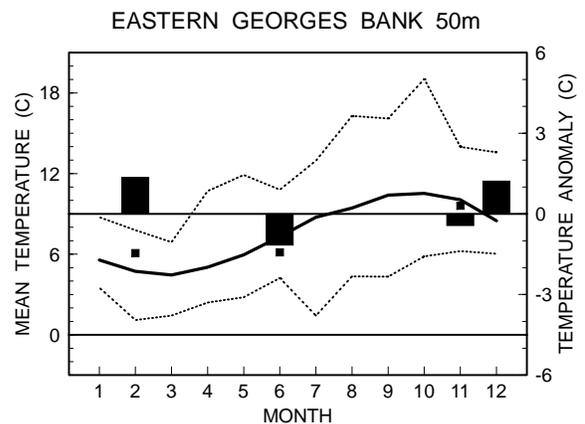
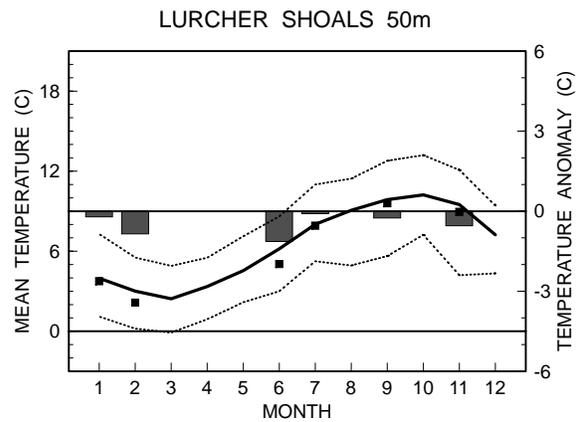
The amount of sea ice that reached the Scotian Shelf was near normal in 1995, although its areal extent was less than in 1994. The ice arrived later than normal, except off eastern Cape Breton where the ice arrived one week early, and stayed longer than normal, particularly in the coastal Cape Breton area where anomalous northeasterly winds in March kept the ice close to shore.

As in previous years the ocean temperature conditions in 1995 depended upon location and depth. The 1995 monthly mean sea-surface temperatures (SSTs) were, for the most part, below normal in Halifax Harbour and above normal at St. Andrews. Only two months (Sept., Oct.) had above average temperatures at Halifax whereas all months were near or above average at St. Andrews.

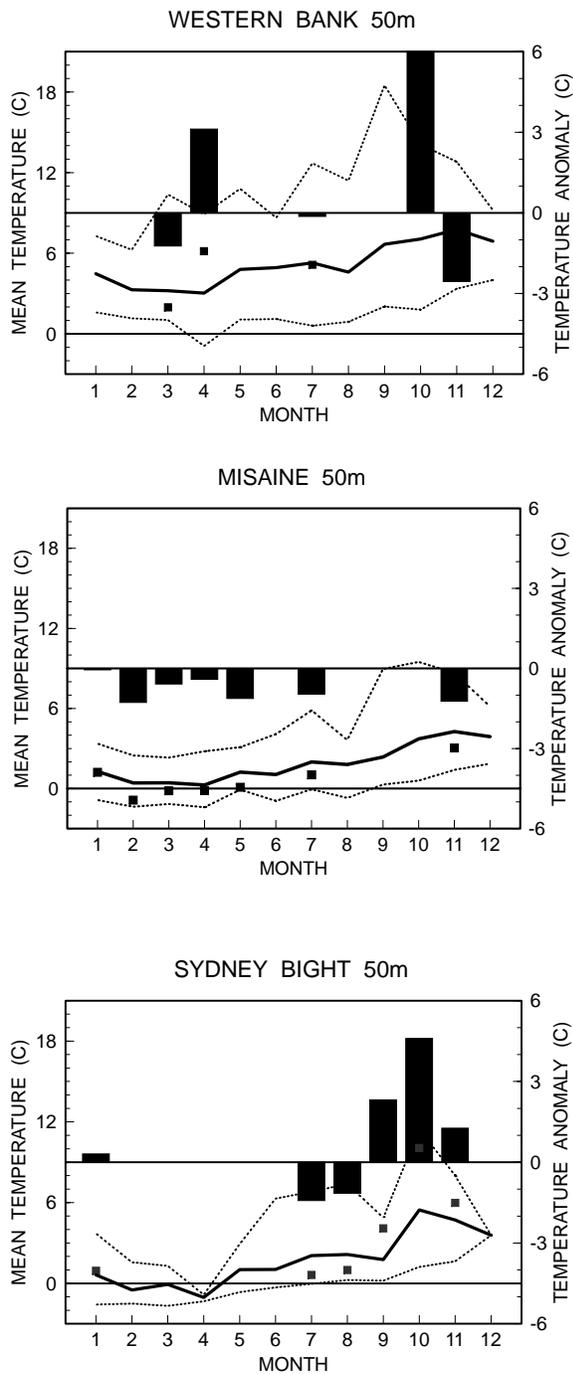
In 1995, the near bottom waters in the deep basins on the Scotian Shelf and in the Gulf of Maine, such as Emerald Basin and Georges Basin, continued to be warmer-than-normal. Deep waters in Cabot Strait fell from above normal to near normal while over the eastern Scotian Shelf they were colder-than-normal. The warmer-than-normal temperatures are due to the influence of warm slope water whereas the colder-than-normal temperatures are influenced by the cold intermediate layer.



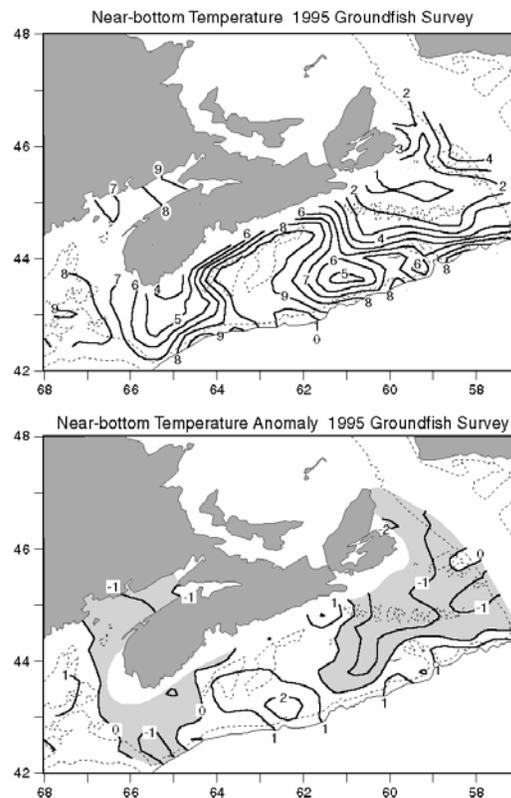
due to the influence of warm offshore waters. On Georges and Browns banks temperatures at 100m were below normal in the summer but above normal in the fall. Temperatures on Western Bank varied throughout the year with some months being above normal and others below normal. The temperatures were above normal in the Bay of Fundy throughout most of the year. These spatial and temporal differences reflect varying degrees of influence of the cold intermediate layer and slope waters.



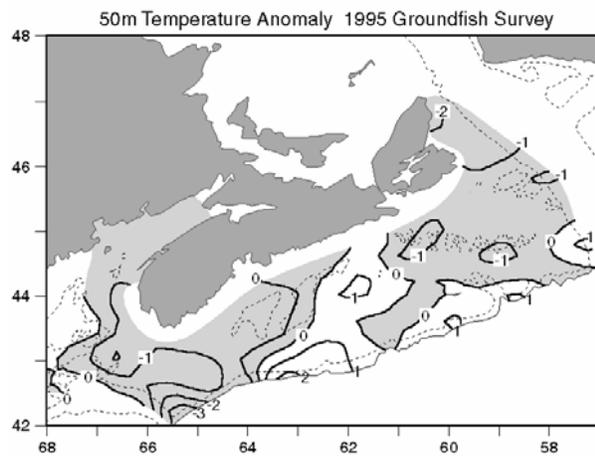
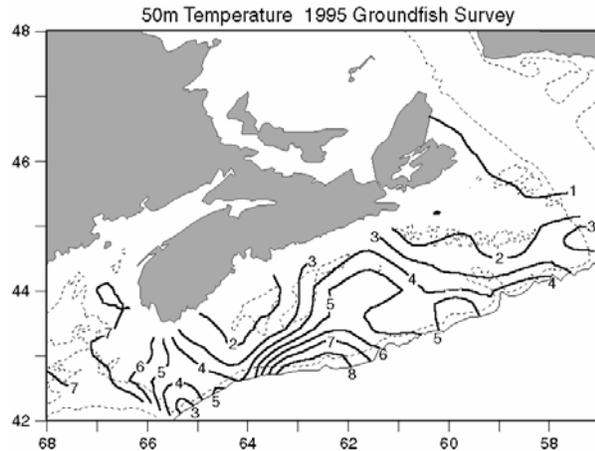
The temperatures at shallower depths also varied with location. The temperatures at 50m over Sydney Bight, Misaine Bank and Lurcher Shoals were below normal throughout much of the year whereas temperatures were above normal on Banquereau Bank. The latter are



but these are confounded by interannual variation in the timing of the surveys. During the summer survey near bottom temperatures were less than 2°C over most of the eastern Scotian Shelf, resulting in below normal values. Colder-than-average temperatures were also observed over the western Scotian Shelf and in the Bay of Fundy whereas warmer-than-normal temperatures were found over the central Scotian Shelf and the central Gulf of Maine. Although the relatively cold water continued to be found over much of the eastern Scotian Shelf, the number of summer survey stations with temperatures less than 0°C continued to decrease. The temperature anomalies at 50 m show a similar pattern to the near-bottom waters.



The temperature conditions during the 1995 groundfish research surveys reflected the above patterns. The temperatures for 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



Ken Drinkwater  
 Bedford Institute of Oceanography  
 P.O. Box 1006  
 Dartmouth, Nova Scotia  
 B2Y 4A2

TEL: (902) 426-2650  
 FAX: (902) 426-7827  
 EMAIL: k\_drinkwater@bionet.  
 bio.dfo.ca

### References

Drinkwater, K.F., R.G. Pettipas, and W.M. Petrie. 1996. Physical oceanographic conditions on the Scotia-Shelf and in the Gulf of Maine during 1995. DFO Atl. Fish. Res. Doc. 96/18.

Drinkwater, K.F., R.G. Pettipas, and W.M. Petrie. 1996. Overview of meteorological and sea ice conditions off eastern Canada in 1995. DFO Atl. Fish. Res. Doc. 96/19.

Page, F.H., R. Losier, and J. McRuer. 1996. Overview of near-bottom water temperature and salinity conditions observed during the groundfish research vessel surveys conducted within the Scotia-Fundy Region, NAFO areas 4VWX and 5Z in 1995. DFO Atl. Fish. Res. Doc. 96/20.

### For More Information

#### Contact:

Fred Page  
 St. Andrews Biological Station  
 St. Andrews, New Brunswick  
 E0G 2X0

TEL: (506) 529-8854  
 FAX: (506) 529-4274  
 EMAIL: f\_page@bionet.bio.dfo.ca

or