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Review of Selected Oceanographic Conditions During 1985 in NAFO Division 4VWX

by

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Abstract

Selected oceanographic conditions, including temperature, salinity, and the frequency of eddy activity, are reviewed for spring, summer, and fall of 1985 from NAFO Divisions 4VWX. Mean seasonal conditions were calculated from Marine Fish Division (Scotia-Fundy Region) surveys, and compared with the long-term averages. Eddy activity along the edge of the Scotian Shelf was common throughout the year, while temperatures and salinities were near normal. The exception was the eastern Scotian Shelf in summer, where bottom temperatures were 1-2 °C below their historical average. Monthly sea surface temperatures at St. Andrews were also close to their historical averages.

Résumé

Certains paramètres océanographiques, y compris la température, la salinité et la fréquence des tourbillons, sont revus pour le printemps, l'été et l'automne 1985 dans les divisions 4VWX de l'OPANO. Les moyennes saisonnières ont été calculées à partir des relevés de la Division des poissons marins (région Scotia-Fundy) et comparées aux moyennes à long terme. Les tourbillons ont été fréquents pendant toute l'année le long de la bordure du plateau Scotian, tandis que les températures et les salinités ont été presque normales. On note une exception pour la partie est du plateau Scotian en été, où les températures de fond ont été de 1 à 2°C inférieures à leur normale historique. Les températures mensuelles de la surface de la mer à St. Andrews ont aussi été voisines de leurs moyennes historiques.

Introduction

This paper reviews selected oceanographic conditions, principally temperature and salinity, concurrent with the annual stock assessment process. It is intended to provide an environmental context within which the results of research surveys, commercial catch data, and resulting annual stock assessments may be interpreted, particularly regarding the potential effect of environment on distribution and availability of fish to gear. The area surveyed is restricted to NAFO Divisions 4VWX: the Scotian Shelf, eastern Gulf of Maine, and the Bay of Fundy. For a more complete survey of oceanographic conditions in the whole of the NAFO area, see the reviews by Trites and Drinkwater (e.g. Trites 1982; Trites and Drinkwater 1983, 1984, 1985; Drinkwater and Trites 1986).

A general overview of oceanographic conditions during 1985 is presented first, examining seasonal warming characteristics and warm-core eddy activity at the edge of the shelf. This is followed by a discussion of conditions during spring, summer, and fall as determined by Marine Fish Division seasonal research surveys. Monthly mean sea surface temperatures measured at St. Andrews are then presented to indicate the general seasonal cycle of temperature, and how 1985 compared to normal conditions.

Overview of 1985

Sea surface temperatures and oceanographic events during 1985 in NAFO Divisions 4VWX are summarized from the monthly State-of-the-Ocean report in the Weekly Briefing Sheet, produced by the Bedford Institute of Oceanography. These analyses primarily concern sea surface temperature, since data are obtained from ships of opportunity and the U.S. National Environmental Satellite Service.

Sea surface temperatures were somewhat warmer than normal on the western Scotian Shelf and the Bay of Fundy in January, with the rate of seasonal cooling progressing normally. Minimum surface temperatures were reached by February and early March throughout the region, with the usual gradient of warmer water offshore and towards the south western Scotian Shelf. Rapid warming occurred in April, although the eastern Scotian Shelf was cooler than normal. Summer surface temperatures were about normal, including the usual appearance of cool water near the coast of Nova Scotia in July due to upwelling. Rapid cooling occurred in October, with temperatures in November and December also about normal.

The presence of warm-core eddies off the Scotian Shelf may affect fish distributions on the shelf, by modification of temperature and salinity conditions, or affect recruitment, by entrainment of shelf water off the shelf (e.g. Wroblewski and Cheney 1984). As determined from satellite sea surface temperature charts, eddy activity affecting the waters of the Scotian Shelf appeared to be the rule rather than the exception in 1985. Such eddies occurred in most months, apparently either entraining shelf water into the slope region, or creating a highly convoluted shelf-slope front. In general at least two, and at times up to four, eddies per month appeared to influence the shelf water, most commonly off the southwestern

Scotian Shelf and Georges Bank areas. The most complicated pattern occurred in June (4 eddies), which then tapered off to relatively light activity during early winter (Nov.-Dec.).

Seasonal Conditions

Temperature and salinity conditions in Divisions 4VWX are presented for spring and summer 1985 from regular Marine Fish Division (Scotia-Fundy Region) groundfish research surveys. Temperature and salinity for fall off southwest Nova Scotia and in the Bay of Fundy are presented from data collected on the annual Marine Fish Division larval herring survey.

Data from the groundfish surveys are presented as surface and bottom temperature and bottom salinity means and normals by stratum, and as distribution plots and anomalies. The anomalies are calculated as the difference between the 1985 value and the historical (1910-82) mean value for that parameter, area, month, and depth. Areas used for these anomaly calculations are indicated in Fig. 3b; data on historical mean values was kindly provided by R. Trites and K. Drinkwater (MEL, Bedford Institute of Oceanography, Dartmouth, N. S.). It should be noted, however, that the stations sampled during 1985 were not distributed randomly with respect to the anomaly polygons. The larval herring survey uses a regular station grid, therefore mean temperature and salinity at each station over the period 1960-1983 were calculated and used to determine the 1985 anomalies for fall in the Bay of Fundy.

Spring

The spring groundfish survey was conducted by the ALFRED NEEDLER (Cruise N041) from 28 February to 7 March 1985; its coverage was restricted to the central and western Scotian Shelf. Surface temperatures were coolest over the Scotian Gulf, and warmer to the west except on top of the shallow banks, e.g. Browns Bank was about 1°C while surrounding waters were 3-5°C. Bottom temperatures (Fig. 1) were warm in the deep water of the Scotian Gulf, Northeast Channel, and along the shelf edge, but were cooler on the shallow banks. Most areas were somewhat above their normal seasonal temperatures except for LaHave Bank, which was slightly below normal, in general agreement with the overview of sea surface temperatures presented in the previous section.

Summer

The 1985 summer groundfish survey was conducted by the ALFRED NEEDLER (Cruise N048 and N049) from 4-25 July. Surface temperatures (Fig. 2) indicated cool water on Banquereau Bank and eastern Scotian Shelf, with gradual warming to the southwest, which was distorted in part by cool water near the coast resulting from summer upwelling. Temperatures were generally cooler (about 2°C) than those measured during the 1984 summer survey. Bottom temperatures (Fig. 3a) also indicated cool water on the eastern Scotian Shelf, and particularly cold north of Banquereau Bank. Bottom temperature anomalies (Fig. 3b) demonstrate the waters of the eastern shelf were colder than normal, while those in the Scotian Gulf were up to 2°C above the historical average.

Table 1 and Table 2 compare 1985 summer bottom temperature and salinity as means by stratum (Fig. 4) with the normal value by stratum as measured on MFD summer surveys from 1970-84. The pattern is similar to Fig. 3, with strata on the eastern Scotian Shelf in 1985 being cooler than normal over the 1970-84 period, particularly in deeper water along the shelf edge (stratum 51). The fact that this stratum also had water fresher than normal (Table 2) suggests the cold intermediate water layer may have been unusually thicker or located deeper than normal in this area. It is known that temperatures of Labrador Current water off St. John's, Newfoundland in 1985, were among the coldest on record (S. Akenhead, Northwest Fisheries Center, St. John's, Nfld., pers. comm.) and it is possible this contributed to the cold intermediate layer and therefore below normal bottom temperatures of the eastern Scotian Shelf in 1985. The other stratum with particularly cool temperatures was stratum 90, off southwest Nova Scotia.

Fall

Temperature and salinity data from southwest Nova Scotia and the Bay of Fundy during fall were recorded on E.E. PRINCE cruise 329, from 22 October to 13 November 1985. Surface temperatures (Fig. 5a) were generally 10$\pm$1°C, except east of Cape Sable, where they were higher. Surface temperature anomalies (Fig. 5b) indicate these were near the historical mean, with somewhat cooler water in the central Bay of Fundy, and warmer at the head of the bay and east of Grand Manan Island. Bottom temperatures (Fig. 6a) were also generally about 10°C, and tended to follow the bathymetry, being cooler in the deep water at the mouth of the bay, and warmer in shallow water at its head. Bottom temperature anomalies (Fig. 6b) indicated these temperatures were 0-1°C above the historical average. Bottom salinity decreased gradually from $>$34 o/oo in deep water at the mouth to $<$33 o/oo at the head of the bay.

St. Andrews Temperatures

Monthly mean sea surface temperatures calculated from twice daily measurements taken at the St. Andrews wharf indicated conditions near the long-term average, as tabulated for the period 1921-1967 in Lauzier and Hull (1969) (Fig. 7). Reconstruction of the wharf during the fall prevented subsequent temperatures from being recorded.

Conclusions

In conclusion, therefore, temperature and salinity conditions during spring and summer on the Scotian Shelf and Bay of Fundy, and during fall in the Bay of Fundy in 1985, were near their long-term historical averages. The exception was the eastern Scotian Shelf, which was sampled during the MFD summer survey only. Bottom temperatures during summer in this region were 1-2°C below their historical averages, and particularly colder than normal in deep water along the edges of Banquereau Bank (strata 45, 49-51). It is suggested this may have been caused by thickening of the cold intermediate water layer, possibly resulting from the record low temperature water of the Labrador Current. Monthly mean sea surface temperatures calculated from daily measurements at St. Andrews, N.B., were also close to their historical normals, which was consistent with reports for the western

Scotian Shelf from ships of opportunity. Weekly satellite images of sea surface temperature suggest eddy activity along the edge of the Scotian Shelf was common in 1985, with potentially strong effects on entrainment of shelf water into the slope water region. Analysis of the impact of these features is beyond the scale of the present report.

Acknowledgments

We wish to sincerely thank K. Drinkwater for permission to use the information in the monthly State-of-the Ocean report, and R. Trites and K. Drinkwater for permission to use their analyses of historical mean temperature and salinity conditions on the Scotian Shelf. The assistance of the Fisheries Ecology Section of MFD in providing temperatures and salinities measured during their larval herring survey is also appreciated.

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Wroblewski, J. S., and J. Cheney. 1984. Ichthyoplankton associated with a warm core ring off the Scotian Shelf. Can. J. Fish. Aquat. Sci. 41: 294-303.

Table 1. Comparison of Scotian Shelf 1985 bottom temperatures (means by stratum) with historical 'normals' for period 1970-84. Data from MFD summer research vessel surveys; Z-score indicates the number of standard deviations the 1985 mean is from the normal value: (1985 mean - normal)/(normal standard deviation).

Stratum	1985 temperature (°C)			1970-84 temperature (°C)			Z-score
	Mean	Std. Dev.	n	Normal	Std. Dev.	n	
40	5.6	0.5	4	5.1	1.0	30	0.5
41	3.8	1.8	5	3.3	1.1	30	0.5
42	1.0	1.1	3	3.2	3.3	26	-0.7
43	0.6	0.1	4	1.8	0.9	51	-1.3
44	1.6	0.9	4	2.4	1.0	52	-0.8
45	2.2	1.3	5	3.6	1.3	51	-1.1
46	6.4	0.6	4	5.7	0.9	35	0.8
47	3.7	1.6	4	3.7	1.8	55	0.0
48	2.1	0.8	4	2.9	0.9	54	-0.9
49	0.4	0.6	2	4.3	2.5	27	-1.6
50	2.1	2.4	3	5.5	2.3	36	-1.5
51	1.3	0.3	2	7.4	1.3	25	-4.7
52	6.8	1.5	2	5.9	1.1	28	0.8
53	10.2	0.5	3	7.7	1.3	43	1.9
54	9.5	2.6	3	6.3	2.8	40	1.1
55	6.3	1.4	7	5.8	2.3	101	0.2
56	4.6	2.3	6	5.3	2.1	81	-0.3
57	5.8	0.8	2	4.7	1.6	30	0.7
58	6.0	5.8	3	4.1	2.0	43	1.0
59	2.9	1.1	6	3.4	2.1	46	-0.2
60	9.7	0.2	4	8.3	1.3	28	1.1
61	10.4	1.1	4	9.0	1.1	34	1.3
62	4.7	5.2	2	7.9	1.7	63	-1.9
63	9.2	1.6	4	6.8	2.1	31	1.1
64	-	-	-	5.8	2.3	70	-
65	8.7	2.6	5	8.4	1.8	75	0.2
66	-	-	-	8.3	1.5	39	-
70	8.9	1.9	5	7.5	2.0	32	0.7
71	8.2	5.9	3	9.1	0.5	29	-1.8
72	5.0	4.0	3	8.2	2.5	31	-1.3
73	3.9	1.5	4	4.8	3.1	30	-0.3
74	3.4	0.4	4	4.0	1.3	30	-0.5
75	5.2	5.4	2	4.5	1.0	32	0.7
76	4.1	4.7	2	6.1	1.2	32	-1.7
77	8.9	1.4	2	6.7	1.7	31	1.3
78	9.5	1.6	3	8.7	1.4	41	0.8
80	5.0	1.6	4	7.0	1.6	59	-1.3
81	7.5	2.1	5	7.7	2.2	60	-0.1
82	7.0	3.3	3	8.0	1.1	34	-0.9
83	-	-	-	7.6	0.6	29	-
84	8.0	1.8	5	7.8	1.2	43	0.2
85	6.8	4.1	5	7.4	1.0	43	-0.6
90	5.7	2.9	6	8.2	1.0	38	-2.5
91	7.1	0.1	3	7.0	0.6	45	0.2
92	7.0	0.5	3	7.2	0.8	48	-0.3
93	7.3	0.3	3	7.7	1.1	41	-0.4
94	8.6	0.4	2	9.6	0.9	29	-1.1
95	8.0	0.1	2	9.0	1.2	30	-0.8

Table 2. Comparison of Scotian Shelf 1985 bottom salinity (means by stratum) with historical 'normals' for the period 1970-84. Data from MFD summer research surveys

Stratum	1985 salinity (o/oo)			1970-84 salinity (o/oo)		
	Mean	Std. Dev.	n	Normal	Std. Dev.	n
40	33.80	1.93	4	34.11	1.36	31
41	33.90	0.73	5	33.42	0.50	31
42	32.17	0.23	3	31.79	0.62	26
43	32.22	0.13	4	32.44	0.35	51
44	33.00	0.42	4	32.96	0.39	51
45	33.02	0.55	5	33.31	0.70	51
46	34.72	0.10	4	34.37	0.71	36
47	32.02	0.17	4	32.12	0.34	55
48	32.60	0.36	4	32.46	0.31	54
49	32.90	0.28	2	33.50	0.64	27
50	33.20	0.40	3	33.78	0.70	36
51	32.80	0.28	2	34.78	0.25	24
52	34.75	0.21	2	34.37	0.79	28
53	35.10	0.10	3	34.89	0.21	43
54	34.33	0.51	3	33.89	0.82	40
55	32.41	0.61	7	32.48	0.52	100
56	32.50	0.49	6	32.65	0.62	81
57	33.90	0.28	2	33.57	0.66	30
58	32.00	0.72	3	32.08	0.47	43
59	32.93	0.35	6	33.08	0.60	47
60	34.62	0.41	4	34.31	0.83	28
61	35.12	0.10	4	34.86	0.17	34
62	34.55	0.50	2	34.17	0.78	64
63	34.05	0.61	4	33.67	0.39	31
64	-	-	-	33.15	0.72	69
65	34.16	1.40	5	34.39	0.69	76
66	-	-	-	35.01	0.26	40
70	33.74	0.98	5	34.23	0.72	32
71	34.52	0.95	4	34.81	0.34	29
72	33.07	1.74	3	34.18	0.96	30
73	32.55	0.82	4	32.72	0.80	30
74	31.90	0.74	4	32.64	0.48	30
75	31.35	0.71	2	32.58	0.48	32
76	32.55	1.91	2	33.46	0.58	32
77	34.35	0.50	2	33.49	0.94	31
78	35.20	0.10	3	34.91	0.71	41
80	32.70	0.70	4	33.09	0.59	59
81	33.74	0.86	5	33.69	0.88	60
82	35.00	0.00	2	34.83	0.47	34
83	-	-	-	34.63	0.76	29
84	34.40	0.54	6	34.36	0.39	43
85	34.04	0.65	5	33.78	0.55	43
90	32.37	0.43	6	32.49	0.31	38
91	33.33	0.06	3	33.07	0.52	45
92	32.90	0.42	2	33.09	0.67	48
93	32.23	0.06	3	32.09	0.32	41
94	31.65	0.21	2	31.44	0.41	30
95	32.20	0.28	2	31.88	0.40	30

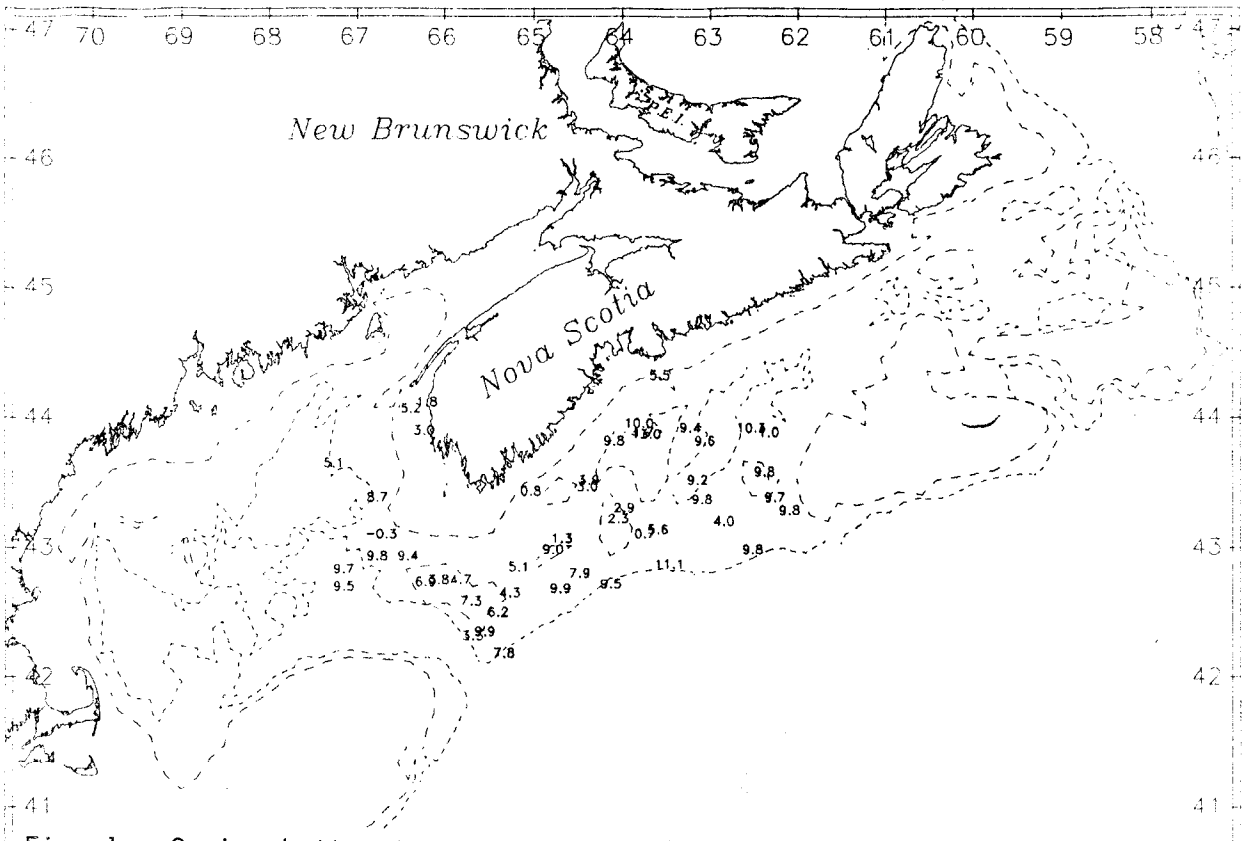


Fig. 1. Spring bottom temperatures on the western Scotian Shelf as measured by Alfred Needler Cruise N041, 28 February to 7 March 1985. Temperatures in °C; long-dashed line represents 50-fathom contour; short-dashed line, 100-fathom contour.

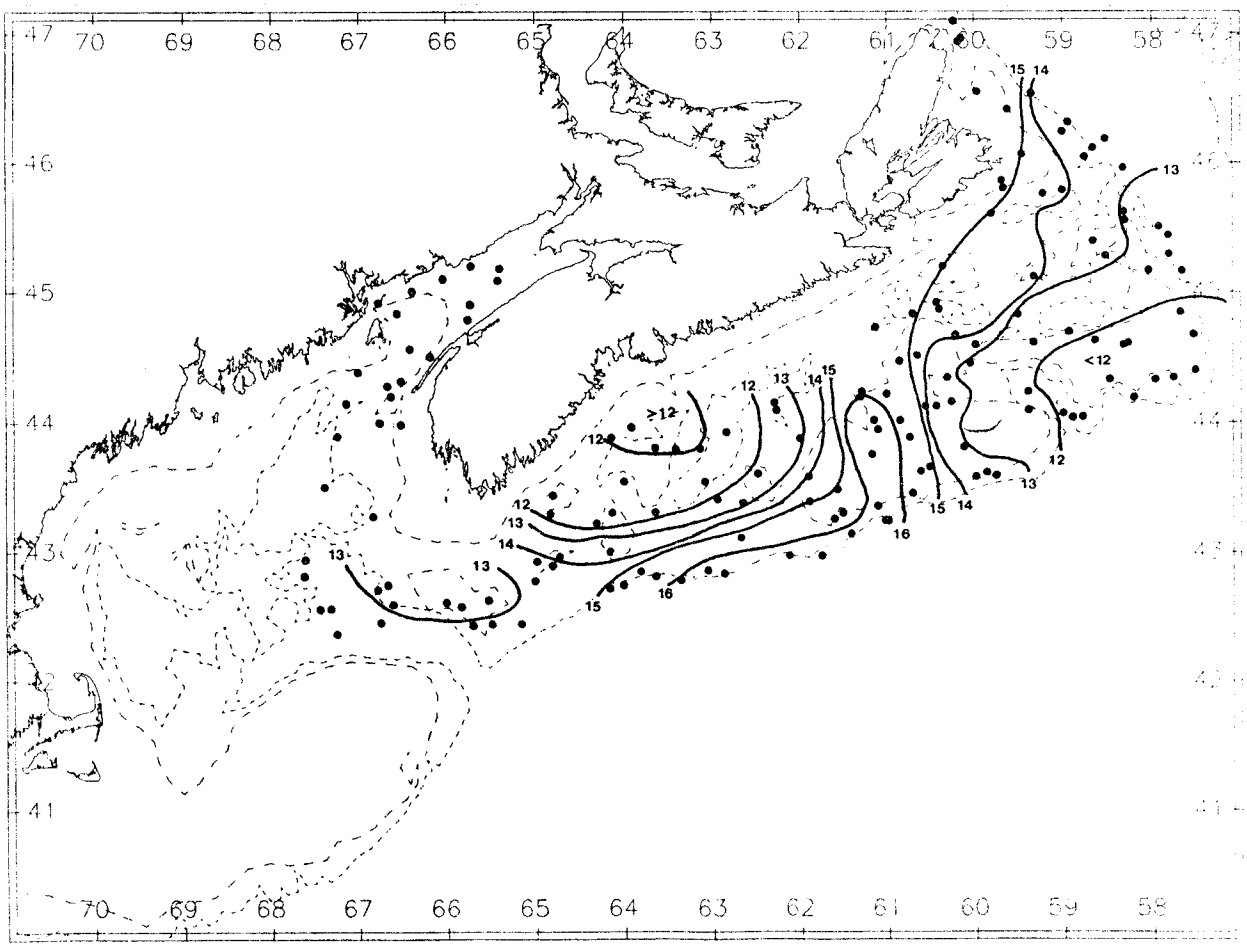


Fig. 2. Summer surface temperatures measured on Needler Cruises N048/N049, 4-25 July 1985. Temperatures in °C; bottom contours are 50 fm (long-dashed) and 100 fm (short-dashed lines).

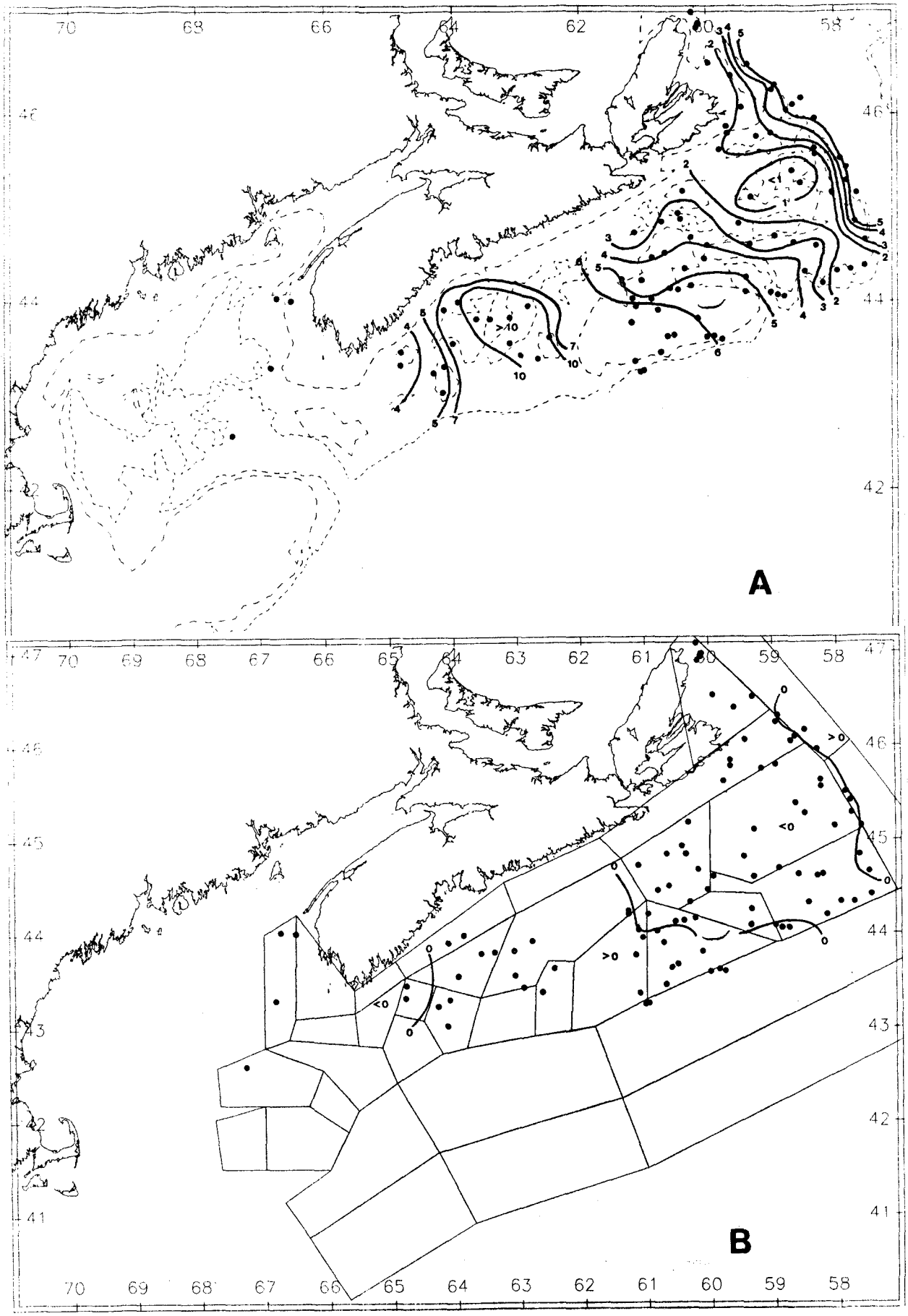


Fig. 3. A) Summer bottom temperatures from Needler Cruises N048/N049, 4-25 July 1985. Temperatures in °C; bottom contours are 50 fm (long-dashed) and 100 fm (short-dashed lines).
B) Summer bottom temperature anomalies, calculated as difference of 1985 temperature from historical normal for the appropriate polygon.

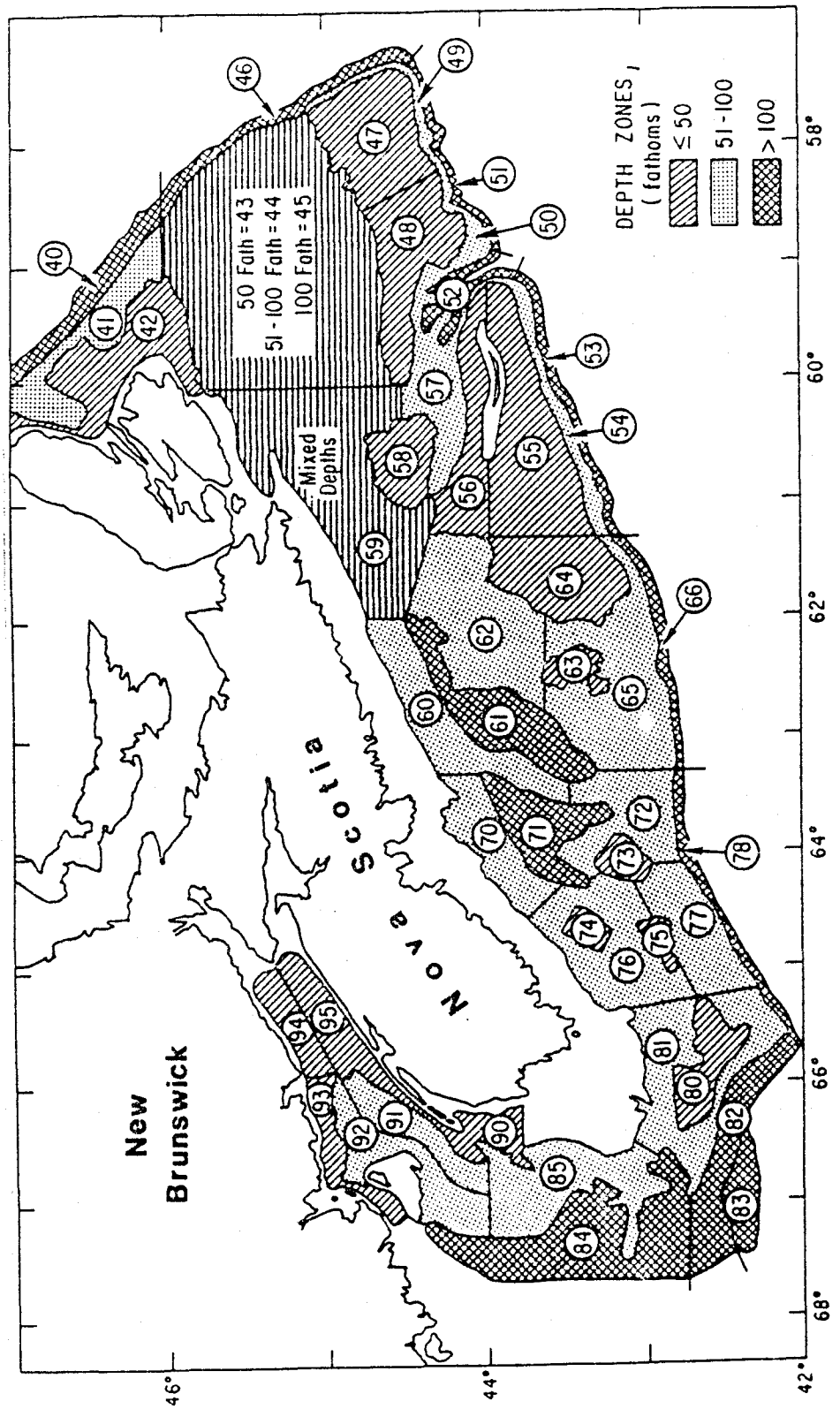
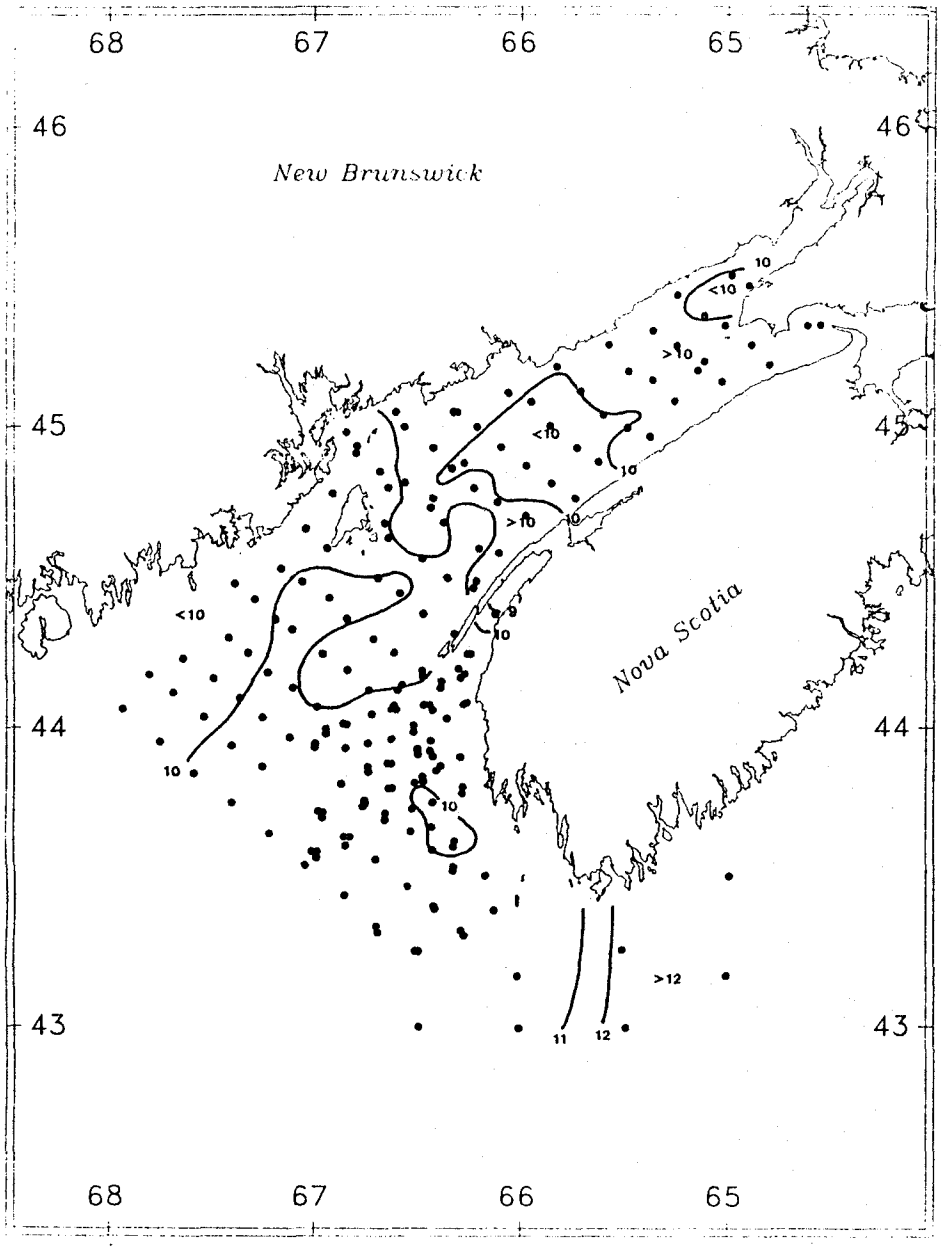


Fig. 4. Standard Marine Fish Division (Scotia-Fundy) depth-stratification scheme.



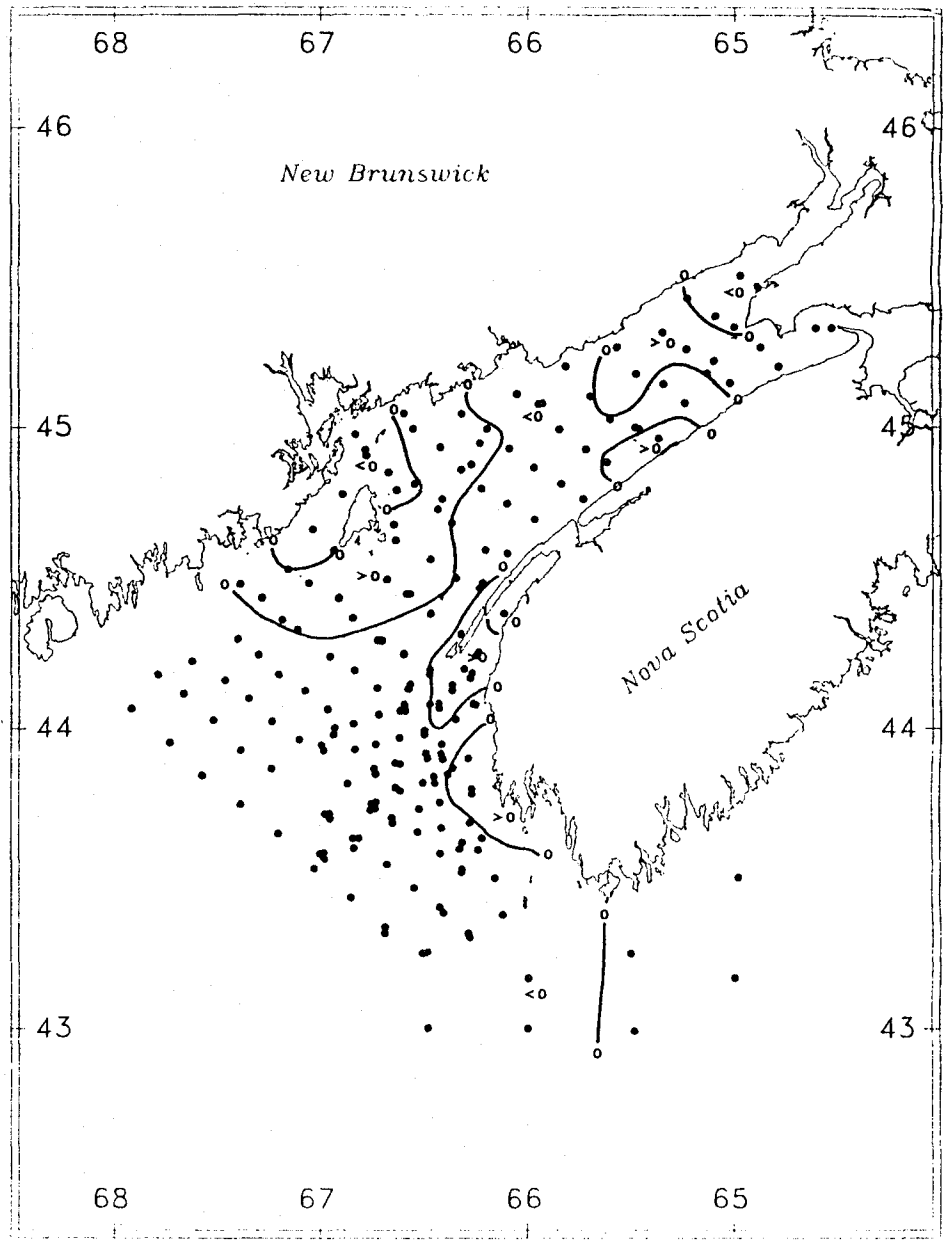


Fig. 5. A) Fall surface temperatures for Bay of Fundy-southwestern Scotian Shelf from E.E. Prince Cruise P329, 22 October to 13 November 1985. Temperatures in °C.
B) Fall Bay of Fundy surface temperature anomalies, calculated as the difference between the 1985 temperature at a station and the mean temperature at that station over the period 1960-1983.

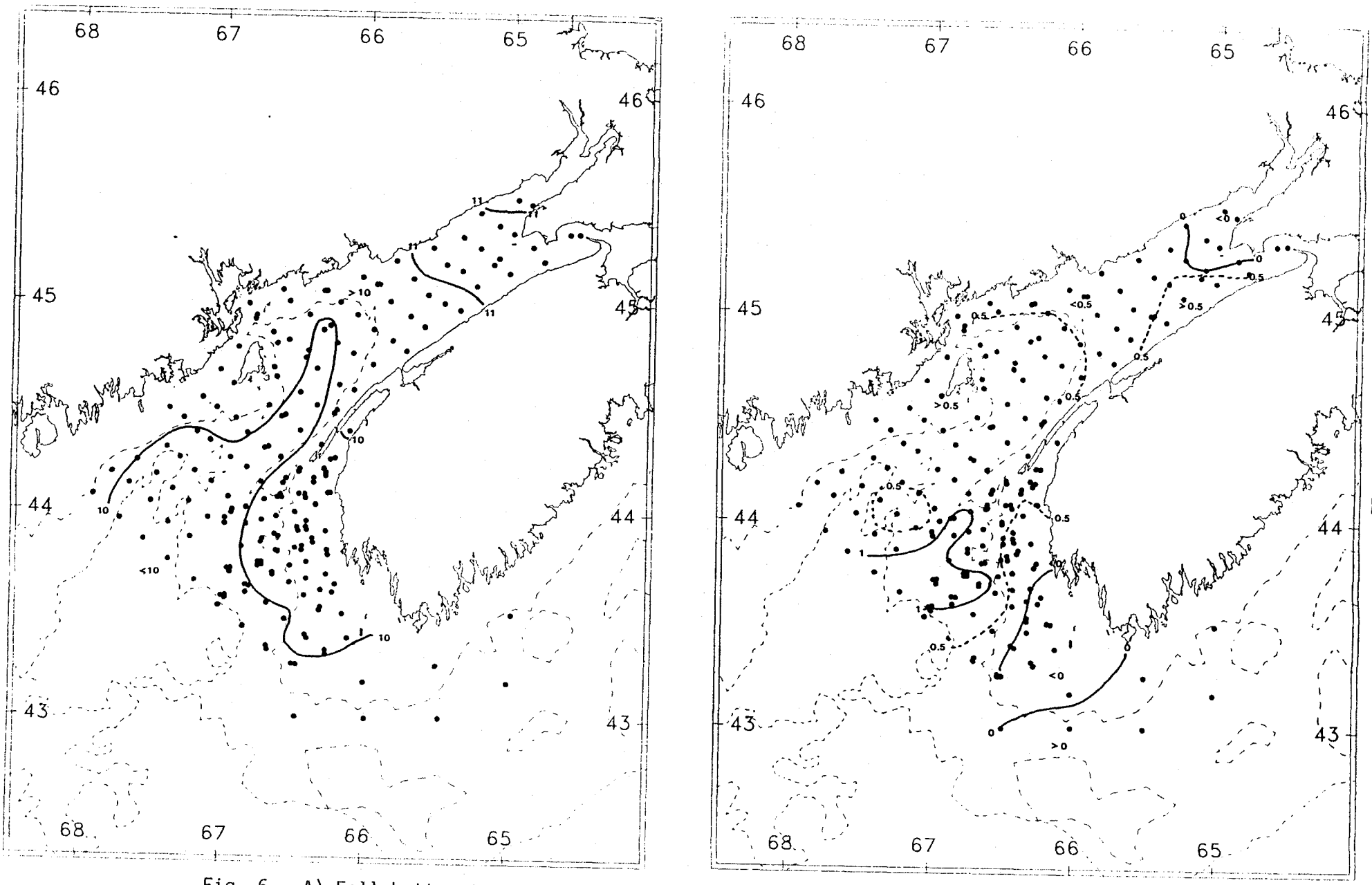


Fig. 6. A) Fall bottom temperatures from Bay of Fundy Prince Cruise P329, 22 October to 13 November 1985. Temperatures in °C; bottom contours are 50 fm (long-dash) and 100 fm (short-dashed lines).
B) Fall bottom temperature anomalies, from Cruise P329. Anomalies calculated as for Fig. 5B.

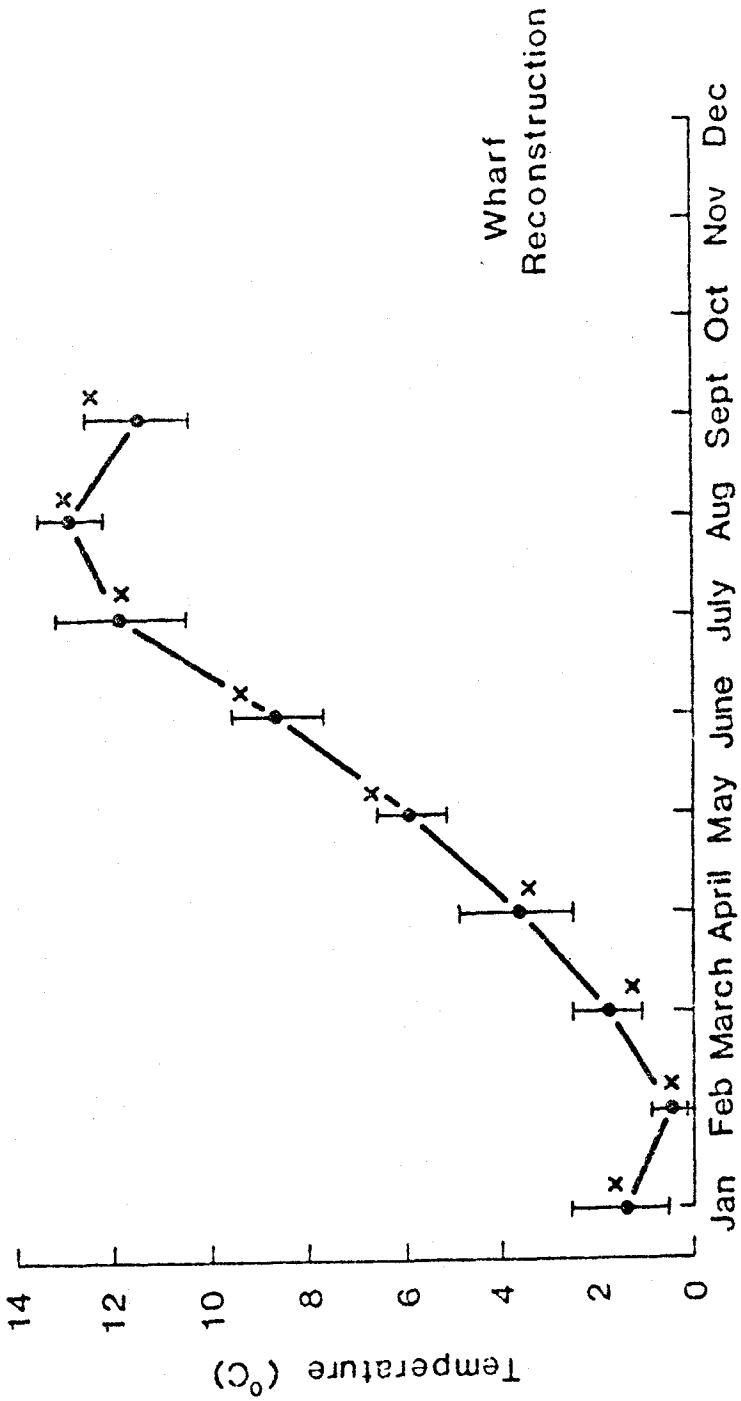


Fig. 7. Monthly mean ±1 standard deviation sea surface temperatures calculated from twice daily measurements at the St. Andrews, N.B. wharf in 1985. No data are available for November and December due to wharf reconstruction. Crosses represent 1921-1967 mean temperatures from Lauzier and Hull (1969).