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Description of the 1991 Oceanographic Conditions on the Northeast Continental Shelf

by

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ABSTRACT

A summary of hydrographic observations for ten surveys on the Northeast Continental Shelf during 1991 is presented. Plots of station positions, as well as surface and bottom distributions of temperature, salinity, and temperature anomaly are portrayed. The average surface and bottom temperatures and temperature anomalies have been calculated for each survey in five geographic regions over the Northeast Continental Shelf: western Gulf of Maine (GOMW), eastern Gulf of Maine (GOME), Georges Bank (GB), northern Middle Atlantic Bight (MABN) and southern Middle Atlantic Bight (MABS).

INTRODUCTION

The Northeast Fisheries Science Center (NEFSC) conducts several different surveys off the Northeast Continental Shelf each year. Bottom-trawl surveys have been conducted each fall since 1963 and each spring beginning in 1968. These surveys are used to determine the distribution and relative stock abundance of finfish and squid. Station coverage is from Cape Hatteras to the Gulf of Maine. Larval herring and sand lance surveys are part of a more recent series of cruises to monitor the changing status of Atlantic herring in the Georges Bank area. These cruises have been taking place November through February since 1988. Other special interest cruises occur throughout the year, such as marine mammal sighting surveys, scallop surveys, and summer bottom trawl surveys. Station coverage on these cruises varies.

Temperature observations from the spring and fall NEFSC bottom trawl survey program have been summarized through 1990 (Davis 1978 and 1979; and Mountain and Holzwarth 1990). In addition hydrographic conditions on the Northeast Continental Shelf observed as part of the NEFSC Marine Resources Monitoring Assessment and Prediction (MARMAP) program have also been summarized (Nickerson and Mountain 1983; Sibunka and Silverman 1984; Manning and Lierheimer 1988; Holzwarth and Manning 1989; and Manning and Holzwarth 1990).

An annual description of the hydrographic conditions on the Northeast Continental Shelf covering all four seasons of the year, has not been presented since the MARMAP program ended in January 1988.

Temperature and salinity observations from ten NEFSC surveys conducted during 1991 are summarized and presented in this report. Cruise operation summaries and station plots are presented for all cruises. Distribution plots of surface and bottom temperature, salinity, and temperature anomaly are contoured where sufficient data are available. Areal average temperatures and the corresponding temperature anomalies are also presented for the five different regions on the shelf.

DATA AND METHODS

Temperature and salinity measurements were obtained with a Seabird SBE 19 conductivity, temperature and pressure recording profiling instrument (Profiler). This instrument samples the water column two times per second. Two different methods were used for deployment of the instrument, depending upon the type of work conducted at a station. Whenever a plankton haul was done, the Profiler was placed above the bongo nets, and a double oblique tow was made. If no plankton haul was done, the Profiler was deployed vertically down and up through the water column. In both cases, the Profiler was lowered to within 10 m of the bottom or to a maximum depth of 200 m. Twice a day, a salinity sample was taken from the bottom of a vertical profile cast in order to calibrate the conductivity cell. Water samples were analyzed on shore with a Guildline Autosal salinometer. Calibration samples were not taken during the *R/V Argo Maine* 9103 survey cruise.

All raw data were averaged into 1 m increments. The data were edited, cleaned, and converted to a standard 80-column ASCII formatted cruise file.

Station distributions and horizontal contour plots of the surface and bottom temperature, salinity, and temperature anomaly were generated with Surface III contouring software on a VAX 11/785 computer. A plot which outlines the boundaries of the five regions on the Northeast Continental Shelf used in the areal averaging routine was also prepared.

Areal average temperatures and temperature anomalies were calculated with the method described in Holzwarth and Mountain (1990). The areal averages were summarized for five regions:

western and eastern Gulf of Maine, Georges Bank, and northern and southern Middle Atlantic Bight. Using the mid-date of each cruise, the areal average temperatures and temperature anomalies were plotted against Julian day.

RESULTS

A summary of each cruise is listed in Appendix 1, Cruise Summaries. The summary includes information on the type of cruise, its objectives, dates, specific information on the number of hydrographic stations, type(s) of instruments used, salinity calibration value, and notes pertaining to instrument performance and to data processing.

Table 1 lists the surface and bottom areal average temperatures and temperature anomalies that were calculated for each of the five regions. For most of the cruises areal average temperatures and anomalies could not be calculated for all regions due to limited station coverage. For several such cases a simple average (not an areal weighted mean) was determined for the observations in the region; these values are indicated by an asterisk. The standard deviations are also listed. SDV1 indicates how well the calculated anomaly represents the true regional average temperature anomaly. SDV2 is an indicator of how closely the areal average matches the anomaly at any particular location within that region (see Holzwarth and Mountain, 1990 for explanation of SDV1 and SDV2).

Station positions and distributions of surface and bottom temperature, salinity, and temperature anomaly are presented in Appendix 2, Figures 2 through 39. Temperature, salinity, and temperature anomaly distributions were not prepared for the surface and bottom of *R/V Chapman* 9103 or *R/V Argo Maine* 9103, because the distribution of the stations was such that accurate contours could not be produced by the software. Temperature anomaly distributions were not produced for *R/V Delaware* 9108, because the distance to standard MARMAP stations was too great for a reliable comparison to be made. Bottom distributions are not presented for *R/V Oregon* 9105, because on many stations the Profiler did not sample to within 10 m of the bottom (the criteria for a value to be considered a "bottom" sample).

Appendix 2, Figures 40 through 43 present the time series of surface and bottom average temperature and temperature anomaly for each region. These values are taken from Table 1.

DISCUSSION

In general, the temperature distributions and the areal averaged values indicate that the 1991 observations were characteristic of annual hydrographic conditions on the Northeast Continental Shelf. Within all regions, the annual high temperatures were observed during July and August. Lows appear during the February and March cruises.

When comparing observed temperatures to the 1977-1987 reference period, the anomalies show that 1991 was warmer than expected throughout most of the year. Spring bottom trawl observations were 2° to 3°C higher than expected in the MABS (see Figures 34 and 35). Starting in November, temperatures somewhat cooler than normal occurred over most of the region.

Scotian Shelf Water (<32.0 Practical Salinity Units (PSU)) was evident on the Northeast Peak of Georges Bank during two larval herring surveys (see Figures 4 and 34). These surveys, *R/V Delaware* 9101 and *R/V Delaware* 9111, took place during January and November, respectively.

Two events worth noting took place during the fall bottom trawl survey. The first was a layer of fresh water (<32.0 PSU) extending to the shelf edge of the MABS (see Figure 28). This was very different from conditions observed six months earlier on the spring bottom trawl survey. The second event was the occurrence of high salinities at three stations just north of Block Canyon, indicating water of Gulf Stream origin. Salinities at depths of 50 to 75 m were greater than 36.0 PSU. A warm core ring, seen in satellite imagery, was in the area at the time.

REFERENCES

Davis, C.W. 1978. Seasonal bottom-water temperature trends in the Gulf of Maine and on Georges Bank, 1967-1975. *NOAA Tech. Rep., NMFS-SSRF*-725. 17 p. Available from: National Technical Information Service; 5285 Port Royal Road, Springfield, VA; 22161.

Davis, C.W. 1979. Bottom-water temperature trends in the Middle Atlantic Bight during spring and autumn, 1964-1976. *NOAA Tech. Rep., NMFS-SSRF*-738. 13 p. Available from: National Technical Information Service; 5285 Port Royal Road, Springfield, VA; 22161.

Holzwarth, T.J. and J. Manning. 1989. Description of the 1986 oceanographic conditions of the Northeast Continental Shelf. Woods Hole,

Table 1. Areal average surface and bottom temperature and temperature anomaly for the NEFSC 1991 cruises in the five regions of the northeast continental shelf shown in Figure 1. "#Obs", the number of observations included in each average; "Temp", the areal average temperature; "Anomaly", the areal average temperature anomaly; "SDV1", the standard deviation associated with the average temperature anomaly; "SDV2", the standard deviation of the individual anomalies from which the average anomaly was derived.

	Surface					Bottom				
JD	#Obs	Temp (°C)	Anomaly	SDV1	SDV2	#Obs	Temp (°C)	Anomaly	SDV1	SDV2
					Gulf of Maine West					
9	10*	6.52	0.20	0.45	0.49	10*	6.64	0.49	0.41	0.44
45	10*	4.78	0.51	0.45	0.64	10*	5.20	0.92	0.41	0.73
69	26	5.00	0.67	0.21	0.74	25	5.50	0.49	0.21	0.64
207	37*	15.52	0.69	0.20	1.63	37*	6.19	0.01	0.17	0.53
276	43	12.38	0.07	0.18	0.66	43	7.31	0.10	0.19	1.23
314	11*	10.32	0.18	0.43	0.54	11*	9.10	0.97	0.41	0.54
343	7*	8.34	0.09	0.52	0.16	7*	8.01	0.35	0.37	0.37
					Gulf of Maine East					
69	18	4.11	-0.46	0.25	0.98	17	6.02	0.07	0.33	0.95
207	3*	14.13	2.11	0.64	3.00	2*	7.40	0.35	0.68	0.34
276	30	12.41	-0.05	0.20	0.55	26	9.39	0.41	0.24	1.29
314	11*	10.39	-0.89	0.27	0.43	10*	9.01	-1.35	0.27	0.48
343	8*	8.41	-0.41	0.34	0.30	7*	8.29	-0.36	0.35	0.86
					Georges Bank					
9	73	7.19	0.18	0.16	0.89	66	7.62	0.01	0.23	0.86
45	69	5.68	0.68	0.17	0.71	63	5.80	0.30	0.23	1.04
69	43	5.37	0.68	0.21	0.79	41	5.48	0.41	0.28	0.93
222	36	17.07	1.08	0.23	2.75					
276	52	15.78	0.56	0.21	1.32	43	12.61	0.12	0.30	1.87
280	25*	15.35	0.61	0.19	0.40	24*	12.53	-0.02	0.20	1.73
314	63	11.41	-0.80	0.19	0.67	62	11.24	-0.66	0.22	0.93
343	73	9.30	-0.19	0.17	0.48	67	9.34	-0.52	0.25	0.74
					Middle Atlantic Bight North					
9	23*	8.05	0.74	0.32	1.04	21*	7.96	0.59	0.35	1.23
45	46*	6.08	1.21	0.23	0.91	42*	6.45	1.16	0.25	1.45
69	53	6.14	1.67	0.32	0.58	50	5.94	1.55	0.23	1.66
178	4*	16.83	-0.29	1.08	0.39	2*	9.15	-0.95	1.37	0.33
222	18*	22.32	2.13	0.34	1.30					
276	58	19.72	1.62	0.32	1.40	53	14.20	0.83	0.22	2.03
314	20*	12.42	-0.84	0.33	1.07	19*	12.47	-0.58	0.38	1.77
343	26*	9.97	-0.20	0.30	1.08	24*	10.08	-0.40	0.33	1.56
					Middle Atlantic Bight South					
69	79	8.56	2.74	0.25	1.92	73	8.93	3.18	0.32	2.16
178	2*	21.55	2.10	1.64	2.97					
222	43*	24.27	0.34	0.26	1.15					
276	80	22.80	1.01	0.28	0.98	74	13.75	-0.36	0.34	3.10

* A true areal average could not be calculated due to poor station coverage and that the average values listed were derived from a simple average of the observations that were within the region.

MA: Northeast Fisheries Center. Center Reference Document 89-03. Available from: Information Services Section, NMFS/Northeast Fisheries Science Center, Woods Hole, MA; 02543

Holzwarth, T.J. and D. Mountain. 1990. Surface and bottom temperature distributions from the Northeast Fisheries Center spring and fall bottom trawl survey program, 1963-1987. Woods Hole, MA: Northeast Fisheries Center. *Center Reference Document* 90-03. Available from: Information Services Section, NMFS/ Northeast Fisheries Science Center, Woods Hole, MA; 02543

Manning, J.P. and T.J. Holzwarth. 1990. Description of oceanographic conditions of the Northeast Continental Shelf: 1977-1985. Woods Hole, MA: Northeast Fisheries Center. *Center Reference Document* 90-04. Available from: Information Services Section, NMFS/ Northeast Fisheries Science Center, Woods Hole, MA; 02543

Manning, J.P. and L.J. Lierheimer. 1988. Description of the 1987 oceanographic conditions of the Northeast Continental Shelf. Woods Hole, MA: Northeast Fisheries Center. *Center Reference Document* 88-01. Available from: Information Services Section, NMFS/ Northeast Fisheries Science Center, Woods Hole, MA; 02543

Nickerson, S.R. and D.G. Mountain. 1983. Surface and bottom temperature and bottom salinity distributions on the continental shelf, Cape Hatteras to Cape Sable from MARMAP cruises, 1977-1982. Woods Hole, MA: Northeast Fisheries Center. *Center Reference Document* 83-09. Available from: Information Services Section, NMFS/Northeast Fisheries Science Center, Woods Hole, MA; 02543

Sibunka, J.D. and M.J. Silverman. 1984. MARMAP surveys of the continental shelf from Cape Hatteras, North Carolina to Cape Sable, Nova Scotia (1977-1984): Atlas No. 1 summary of operations. *NOAA Technical Memorandum NMFS-F/NEC*-33. Available from: Information Services Section, NMFS/ Northeast Fisheries Science Center, Woods Hole, MA; 02543.

Appendix 1

Cruise Summaries

Cruise information and hydrographic work completed

CRUISE SUMMARY

Delaware II
Cruise DEL9101
Larval Herring/Sand Lance Study

Dates: January 3-16, 1991
Sea days: 13
Instrument(s): Profiler 360

Cruise objectives: To monitor the changing status of Atlantic herring in the Georges Bank area and the recruitment of sand lance larvae. Principally (1) determine larval distribution, abundance, and production, (2) index spawning biomass, and (3) provide systematic collections of herring larvae for age and growth estimates.

Total # of stations:	130
# Vertical CTD/Profiler casts:	34
# Double Oblique Profiler casts:	130
# XBT drops:	0
# salinity samples:	34
Salt correction:	+0.033
	Practical Salinity Units (PSU)

Special Notes: Instrument performed well, data were internally recorded (archived) and then downloaded to the computer. The cruise was interrupted by 1 port call due to bad weather. Storm warnings were also responsible for shortening the cruise period by two days.

CRUISE SUMMARY

Delaware II
Cruise DEL9103
Larval Herring/Sand Lance Study

Dates: February 6-22, 1991
Sea days: 14
Instrument(s): Profiler 360

Cruise objectives: To monitor the changing status of Atlantic herring in the Georges Bank area and the recruitment of sand lance larvae. Principally (1) determine larval distribution, abundance and production, (2) index spawning biomass, (3) provide systematic collections of herring larvae for age and growth estimates.

Total # of stations:	149
# Vertical CTD/Profiler casts:	36
Double Oblique Profiler casts:	149
# XBT drops:	0
# salinity samples:	36
Salt correction:	+0.035 PSU

Special Notes: Instrument performed well, used in archive mode. A three-day port call was made at the Woods Hole laboratory because of adverse weather conditions. This led to the cruise being extended one day.

CRUISE SUMMARY

R/V Delaware II
Cruise DEL9105
Spring Bottom Trawl Survey

Dates: March 5-16, April 1991
Sea days: 48
Instrument(s): Profiler 360/456

Cruise objectives: To (1) determine the spring distribution and relative abundance of fish species, (2) collect biological samples for studies of age and growth relationships, fecundity, maturity, and food habits, (3) collect hydrographic and meteorological data, (4) collect ichthyoplankton and zooplankton samples, and (5) make data and sample collections for cooperative researchers and programs.

Total # of stations:	333
# Vertical CTD/Profiler casts:	206
# Double Oblique Profiler casts:	77
# XBT drops:	53
# salinity samples:	26/25
Salt correction:	+0.037 PSU/+0.023 PSU

Special Notes: There were several problems with the Profilers used. There were numerous bad scans, so raw data had to be hand-edited, slowing processing. Profiler 360 was used exclusively during the first leg (March 5 to 22) of the cruise. For the remaining two legs, both Profilers were used in an attempt to find the "bad" profiler. Both Profilers were used in "real-time" mode, recording and simultaneously downloading data to a computer via a conducting core cable. It now appears that the Profilers themselves were fine. Bad data may have been a result of radio interference or "leaks" in the connections.

CRUISE SUMMARY

R/V Chapman
Cruise CHA9103
Marine Mammal Sighting Survey

Dates: June 5 to July 16, 1991
Sea days: 31
Instrument(s): Profiler 456

Cruise objectives: To (1) investigate and determine the fine scale distribution and habitat utilization within warm core rings, canyons and the shelf edge break, (2) to conduct line-transect population surveys along the shelf edge break and out to the Gulf Stream wall, and (3) determine how the composition of marine mammal species varies spatially.

Total # of stations:	100
# Vertical CTD/Profiler casts:	48
# Double Oblique Profiler casts:	0
# XBT drops:	52
# salinity samples:	8
Salt correction:	+0.022 PSU

Special Notes: Instrument used in archived mode and generally performed well. Some hand editing was required for the raw data.

CRUISE SUMMARY

R/V Delaware II
Cruise DEL9108
Gulf of Maine Bottom Trawl Survey

Dates: July 22 - August 2, 1991
Sea days: 12
Instrument(s): 456

Cruise objectives: To (1) determine the seasonal distribution and relative abundance of fish species in the Gulf of Maine, (2) collect biological samples for studies of age and growth relationships, fecundity, maturity, and food habits, (3) collect hydrographic and meteorological data, (4) collect ichthyoplankton and zooplankton samples, and (5) study the feasibility of conducting such a routine survey.

Total # of stations:	84
# Vertical CTD/Profiler casts:	57
# Double Oblique Profiler casts:	27
# XBT drops:	0
# salinity samples:	29
Salt correction:	-0.13 PSU

Special Notes: Profiler performed well, used in real-time mode.

CRUISE SUMMARY

R/V Oregon II
Cruise ORE9105
Sea Scallop Survey

Dates: July 29 - August 23 1991
Sea days: 26
Instrument(s): Profiler 851/Profiler 853

Cruise objectives: To (1) determine the distribution and relative abundance of the sea scallop *Placoppecten magellanicus* and Iceland scallop *Chlamys islandica*, (2) collect biological samples and assessment data, (3) monitor hydrographic and meteorological conditions, and (4) make collections for other scientists .

Total # of stations:	437
# Vertical CTD/Profiler casts:	115
# Double Oblique Profiler casts:	0
# XBT drops:	7
# salinity samples:	32/17
Salt correction:	+0.007 PSU/ +0.004 PSU

Special Notes: One of the major problems with this data was that several of the casts did not go within 10 m of the bottom. The last eight stations were conducted after Hurricane Bob passed through the area. Instrument 853 was used on the first leg and 851 on the second, both were used in archive mode. Incidence of salinity spiking in dense temperature gradients was aggravated by the unusually slow lowering speed of the Profiler, which required additional editing of the data.

CRUISE SUMMARY

R/V Delaware II
Cruise DEL9110
Autumn Bottom Trawl Survey

Dates: September 9 to October 24, 1991
Sea days: 45
Instrument(s): Profiler 851/ Profiler 853

Cruise objectives: To (1) determine the autumn distribution and elative abundance of fish species, (2) collect biological samples for studies of age and growth relationships, fecundity, maturity and food habits, (3) collect hydrographic and meteorological data, (4) collect ichthyoplankton and zooplankton samples, and (5) make data and sample collections for cooperative researchers and programs.

Total # of stations:	**354**
# Vertical CTD/Profiler casts:	**236**
# Double Oblique Profiler casts:	**118**
# XBT drops:	**0**
# salinity samples:	**45/11**
Salt correction:	**-0.010 PSU/ +0.010 PSU**

Special Notes: Profiler 853 was equipped with a pump that reduced the salinity spiking problem. Both instruments used in real-time mode. A possible warm core ring was evident at the southern New England shelf edge.

CRUISE SUMMARY

R/V Argo Maine
Cruise AM9103
Marine Ecosystem Response

Dates: October 1-13, 1991
Sea days: 14
Instrument(s): Profiler 456

Cruise objectives: To conduct a survey of historic herring spawning grounds of northern Georges Bank.

Total # of stations:	136
# Vertical CTD/Profiler casts:	0
# Double Oblique Profiler casts:	52
# XBT drops:	0
# salinity samples:	51
Salt correction:	N/A

(salts were not taken for calibration purposes)

Special Notes: The instrument used in archive mode and performed well.

CRUISE SUMMARY

R/V Delaware II
Cruise DEL9111
Larval herring/Sand ance Study

Dates: November 4 - 16 1991
Sea days: 11
Instrument(s): Profiler 853

Cruise objectives: To monitor the changing status of Atlantic herring in the Georges Bank area and the recruitment of sand lance larvae. Principally (1) determine larval distribution, abundance, and production, (2) index spawning biomass, and (3) provide systematic collections of herring larvae for age and growth estimates.

Total # of stations:	126
# Vertical CTD/Profiler casts:	16
# Double Oblique Profiler casts:	126
# XBT drops:	0
# salinity samples:	16

Salt correction: no correction necessary

Special Notes: Profiler 853 was used in real-time mode with the pump installed. Instrument performed well. A three-day port call was made due to bad weather.

CRUISE SUMMARY

R/V Delaware II
Cruise DEL9113
Larval herring/Sand Lance Study

Dates: December 4 -14 1991
Sea days: 11
Instrument(s): Profiler 853/Profiler 851

Cruise objectives: To monitor the changing status of Atlantic herring in the Georges Bank area and the recruitment of sand lance larvae. Principally (1) determine larval distribution, abundance, and production, (2) index spawning biomass, and (3) provide systematic collections of herring larvae for age and growth estimates.

Total # of stations:	132
# Vertical CTD/Profiler casts:	18
# Double Oblique Profiler casts:	132
# XBT drops:	0
# salinity samples:	18
Salt correction:	0 PSU/+0.019 PSU

Special Notes: Profiler 853 with pump was used on the first six stations. Ice was discovered to be clogging the Tygon tubing on the pump. Profiler 851 was used for the remainder of the cruise. Both instruments were used in real-time mode.

Appendix 2

Figures

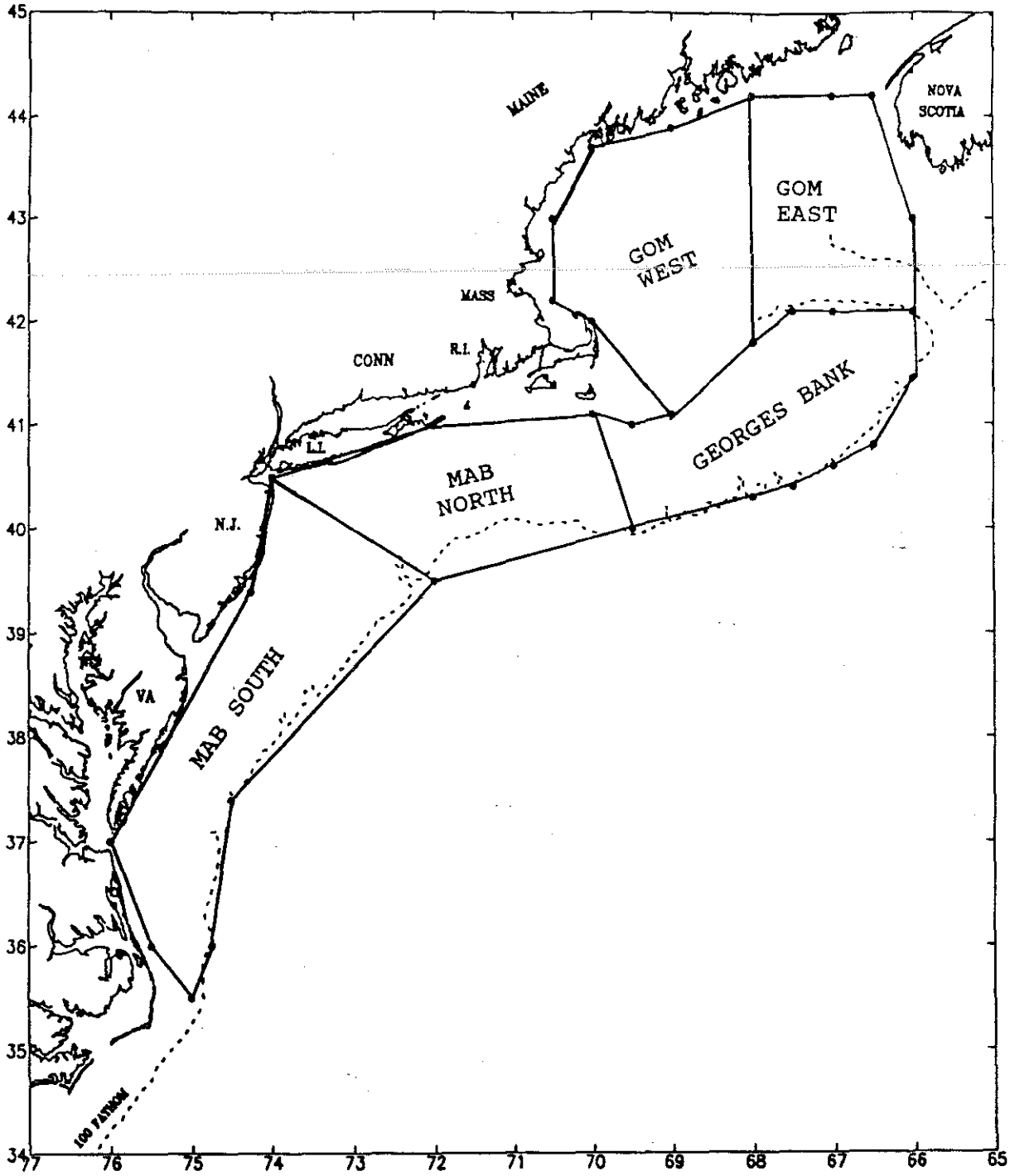

Figure 1. The region of the Northeast Continental Shelf covered by the Northeast Fisheries Science Center cruises during 1991. The boundaries of the five areas of the shelf for which average temperature and anomaly values are calculated are shown: western Gulf of Maine, eastern Gulf of Maine, Georges Bank, northern Middle Atlantic Bight, and southern Middle Atlantic Bight.

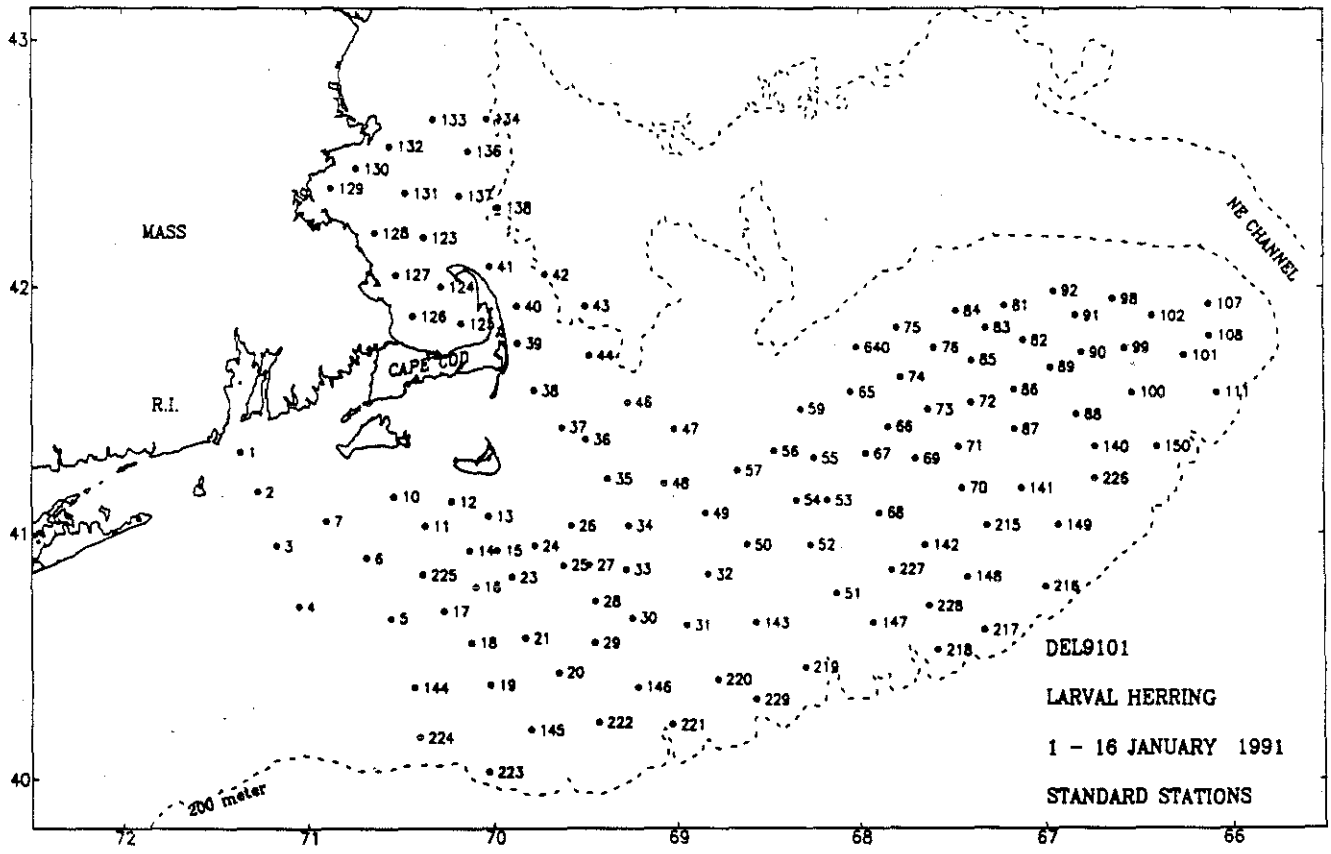

Figure 2. Hydrographic stations occupied during the Larval Herring/Sand Lance Study DEL9101.

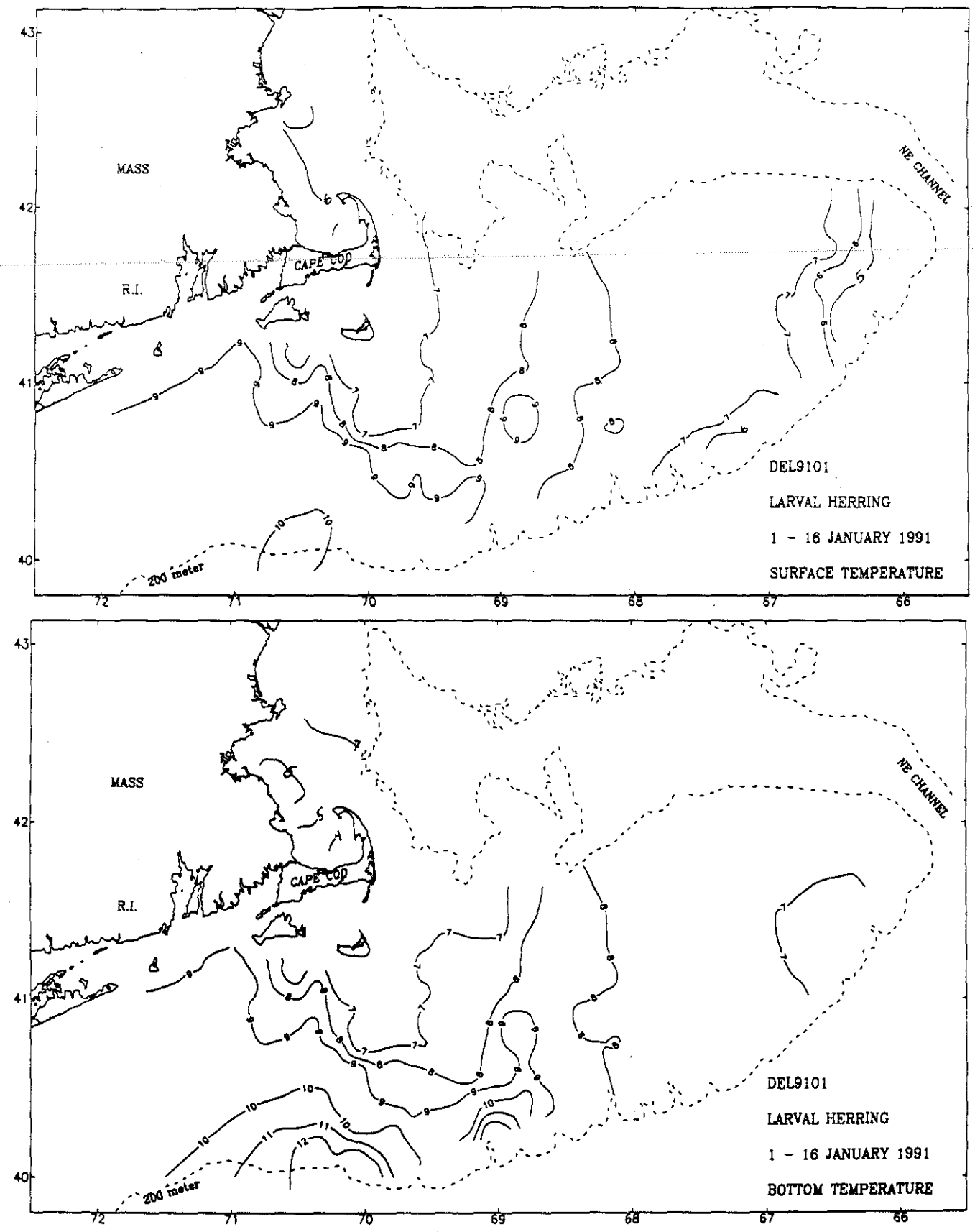

Figure 3. The surface and bottom temperature distribution for the Larval Herring/Sand Lance Study DEL9101.

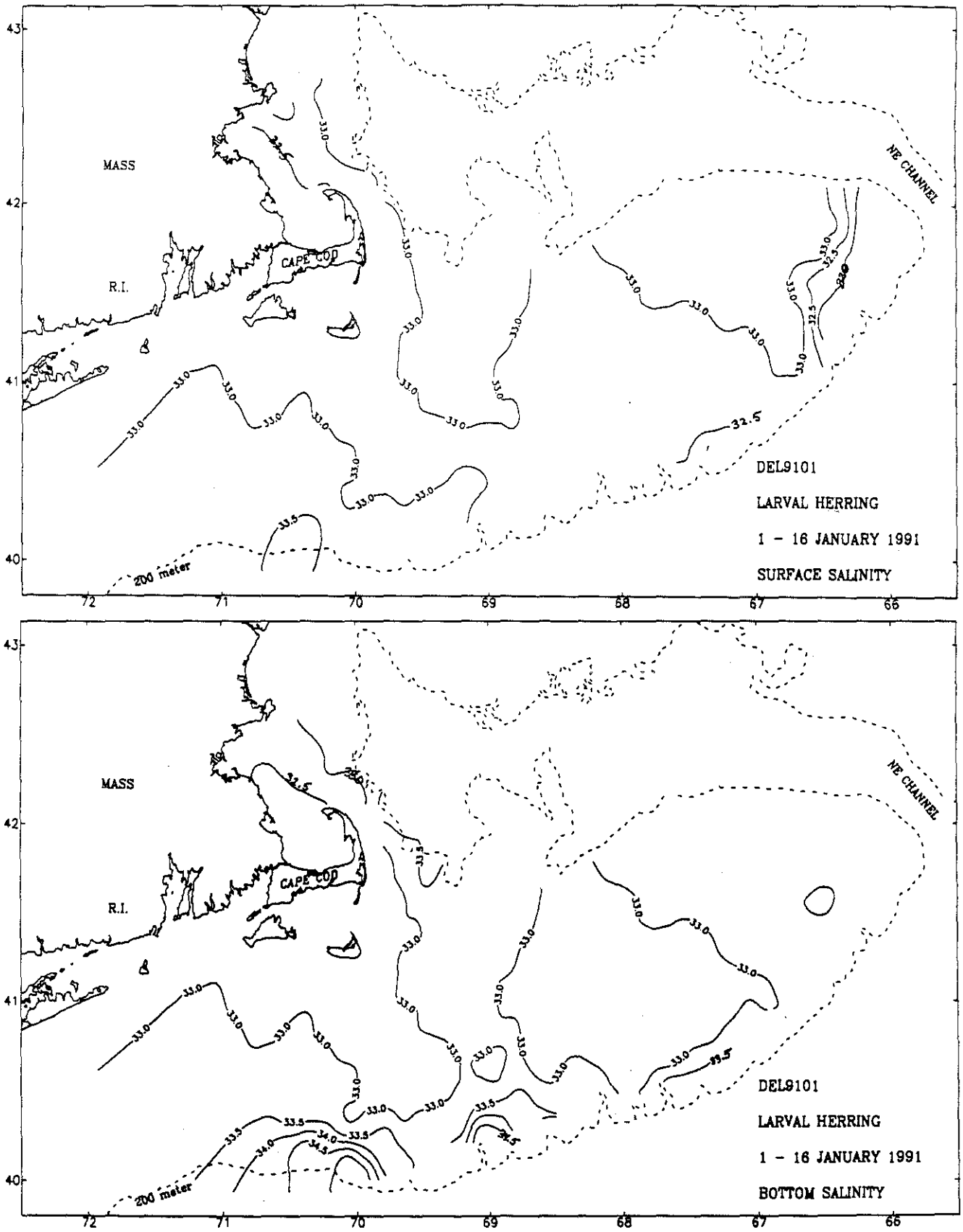

Figure 4. The surface and bottom salinity distribution for the Larval Herring/Sand Lance Study DEL9101.

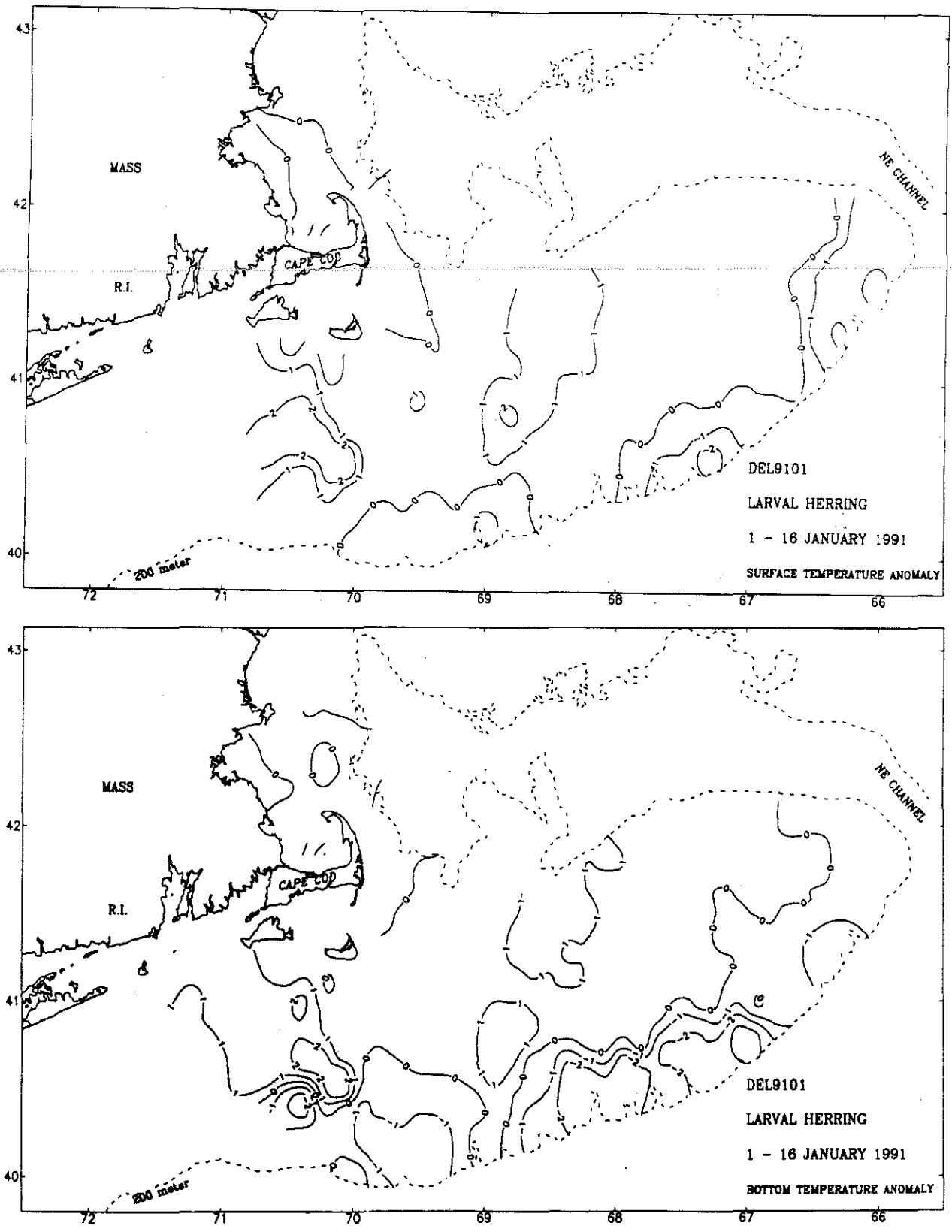

Figure 5. The surface and bottom temperature anomaly distribution for the Larval Herring/Sand Lance Study DEL9101.

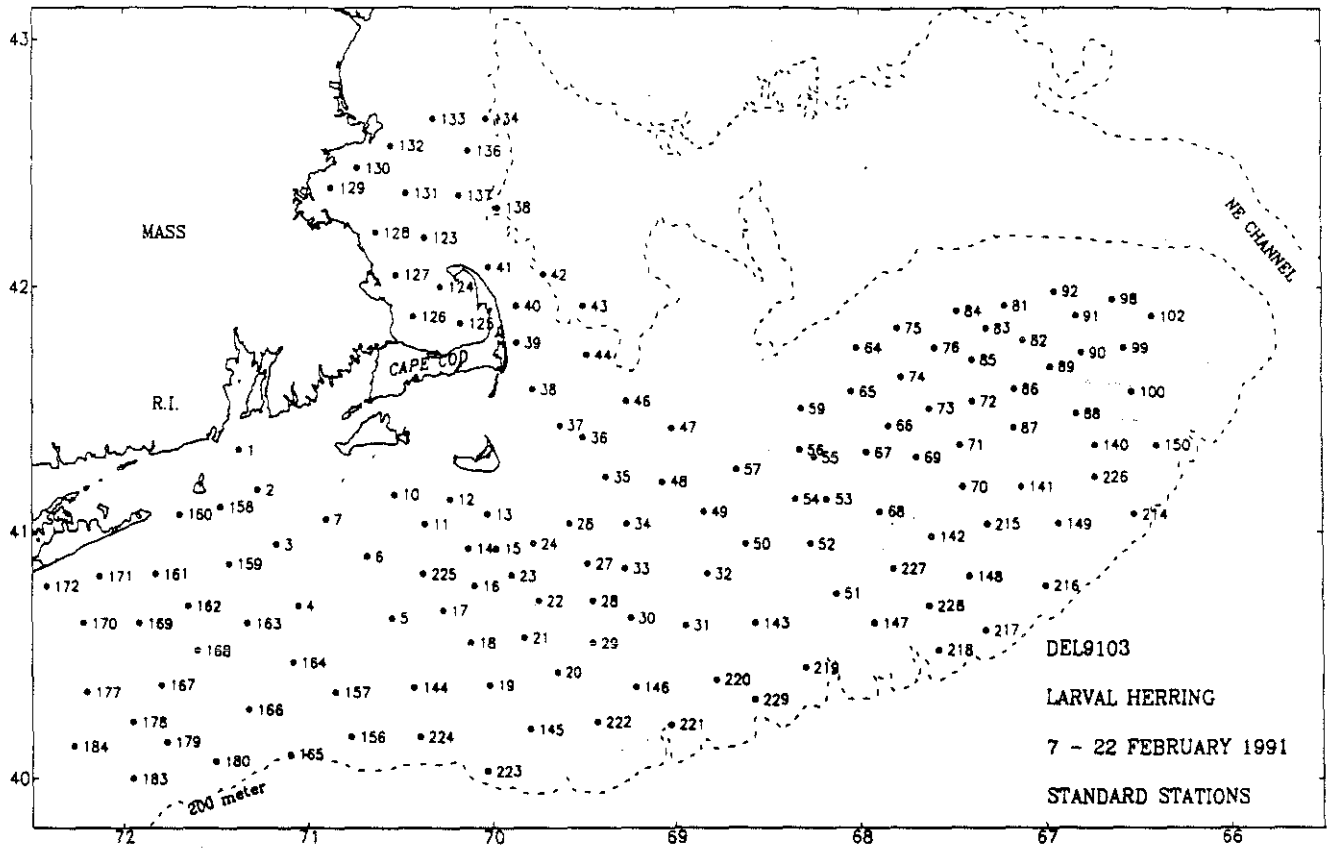

Figure 6. Hydrographic stations occupied during the Larval Herring/Sand Lance Study DEL9103.

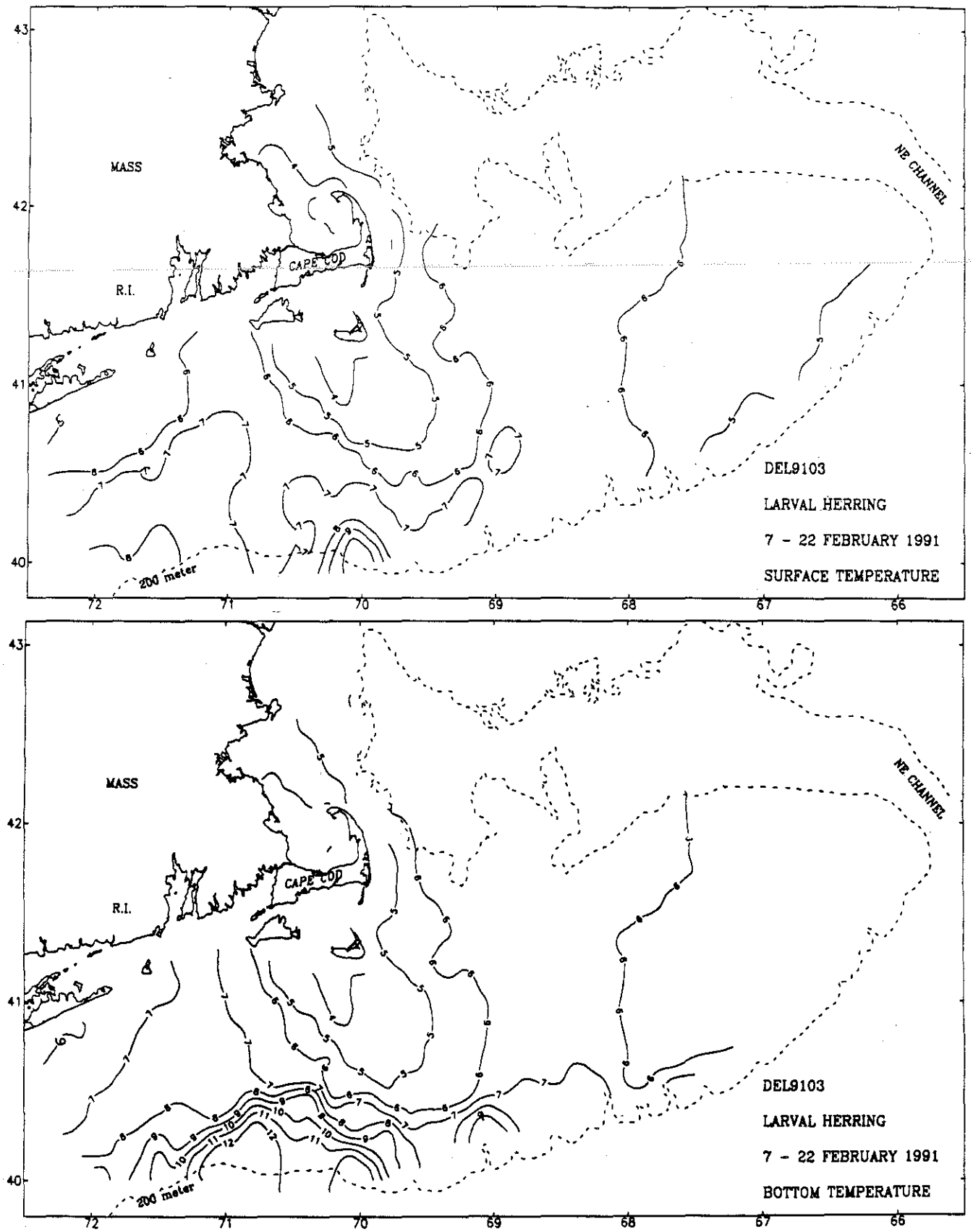

Figure 7. The surface and bottom temperature distribution for the Larval Herring/Sand Lance Study DEL9103.

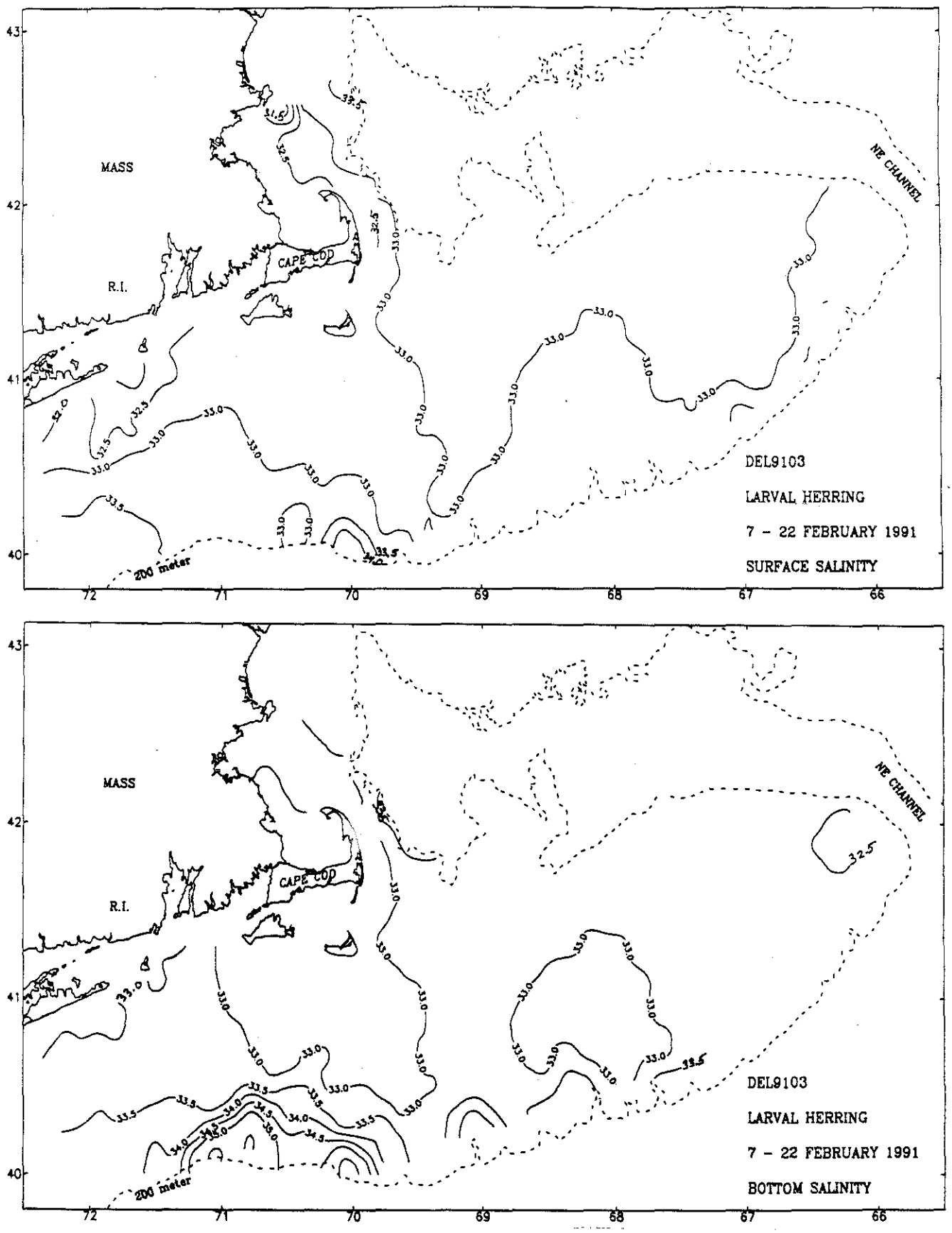

Figure 8. The surface and bottom salinity distribution for the Larval Herring/Sand Lance DEL9103.

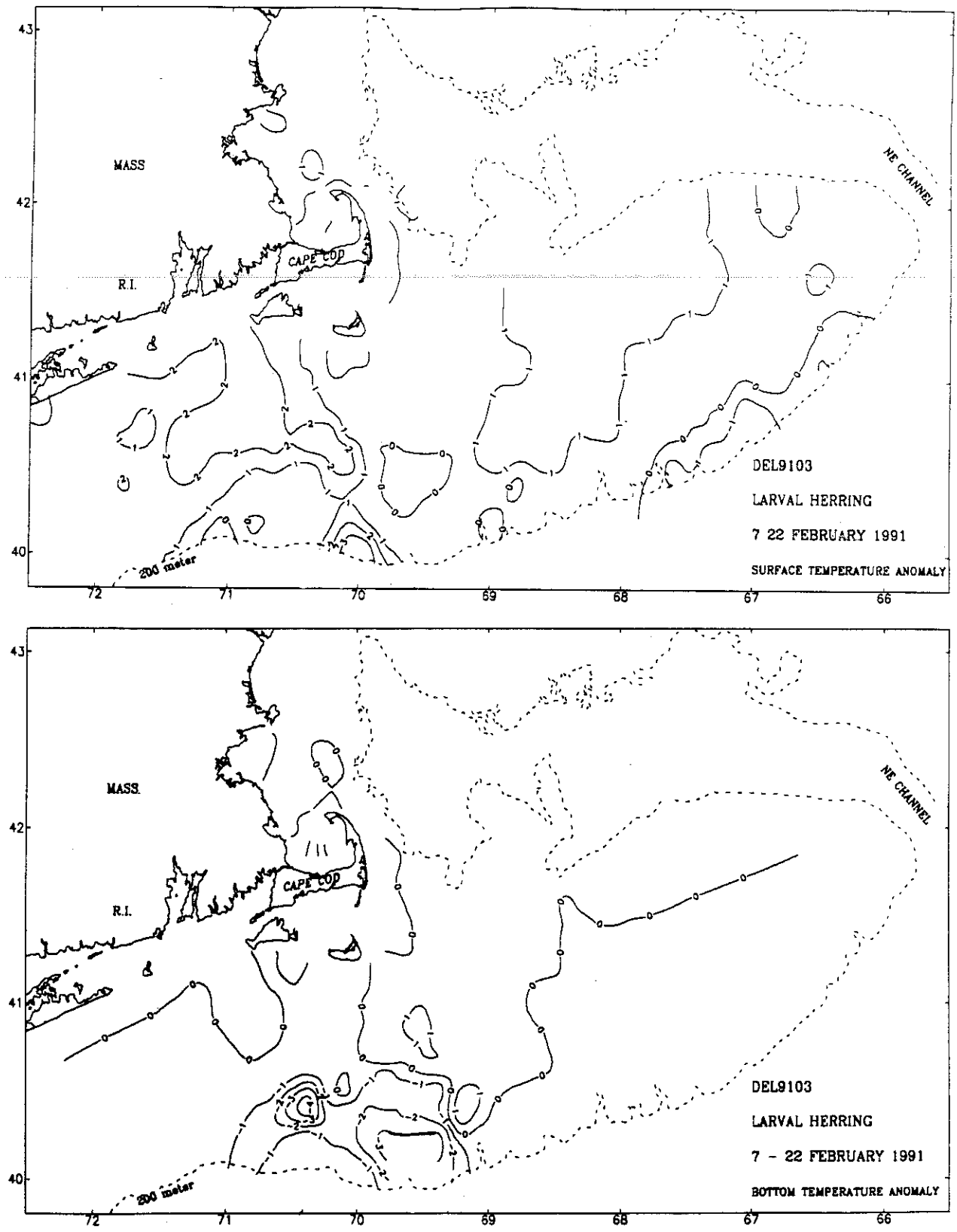

Figure 9. The surface and bottom temperature anomaly distribution for the Larval Herring/Sand Lance Study DEL9103.

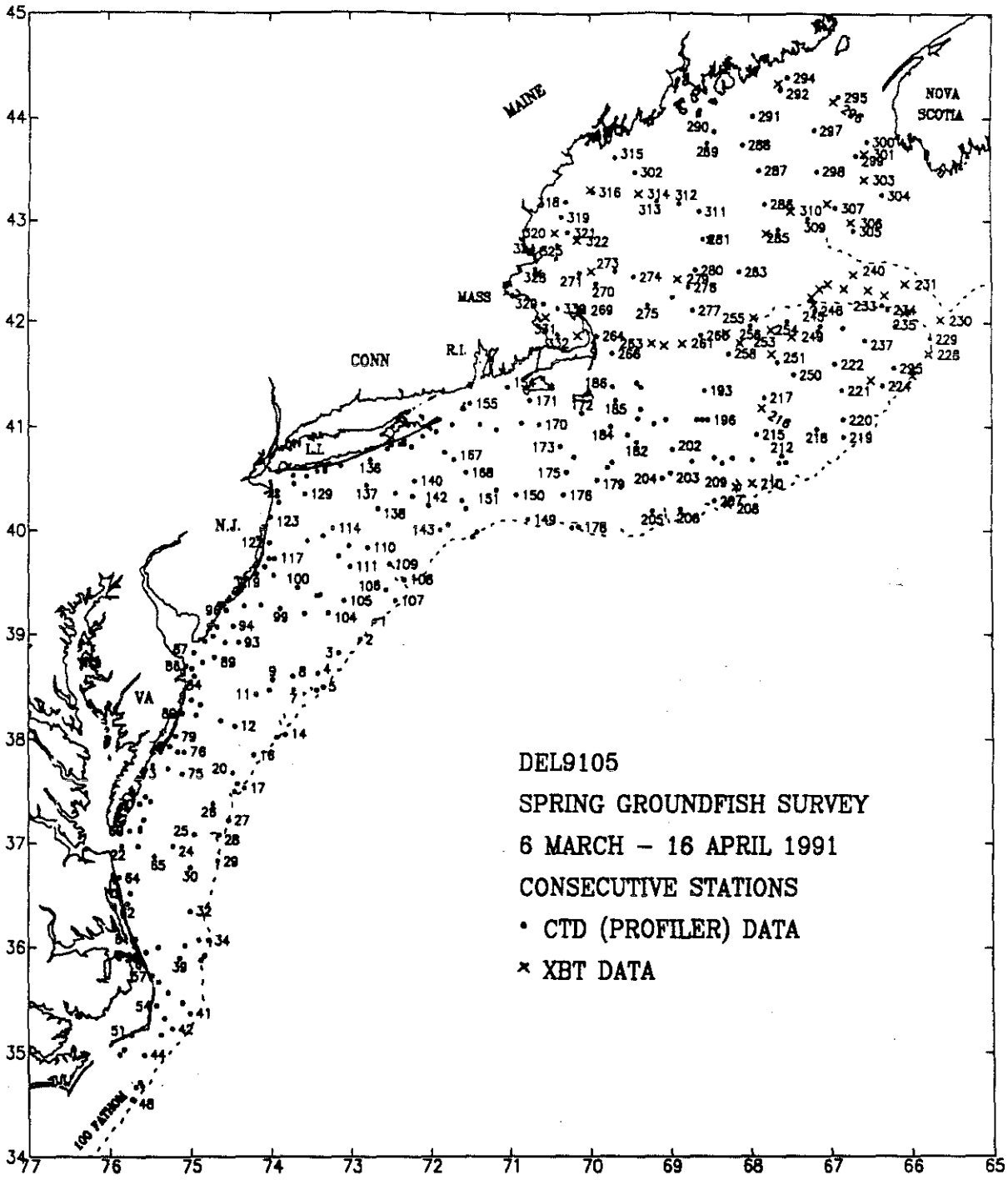

Figure 10. Hydrographic stations occupied during the spring bottom trawl survey DEL9105.

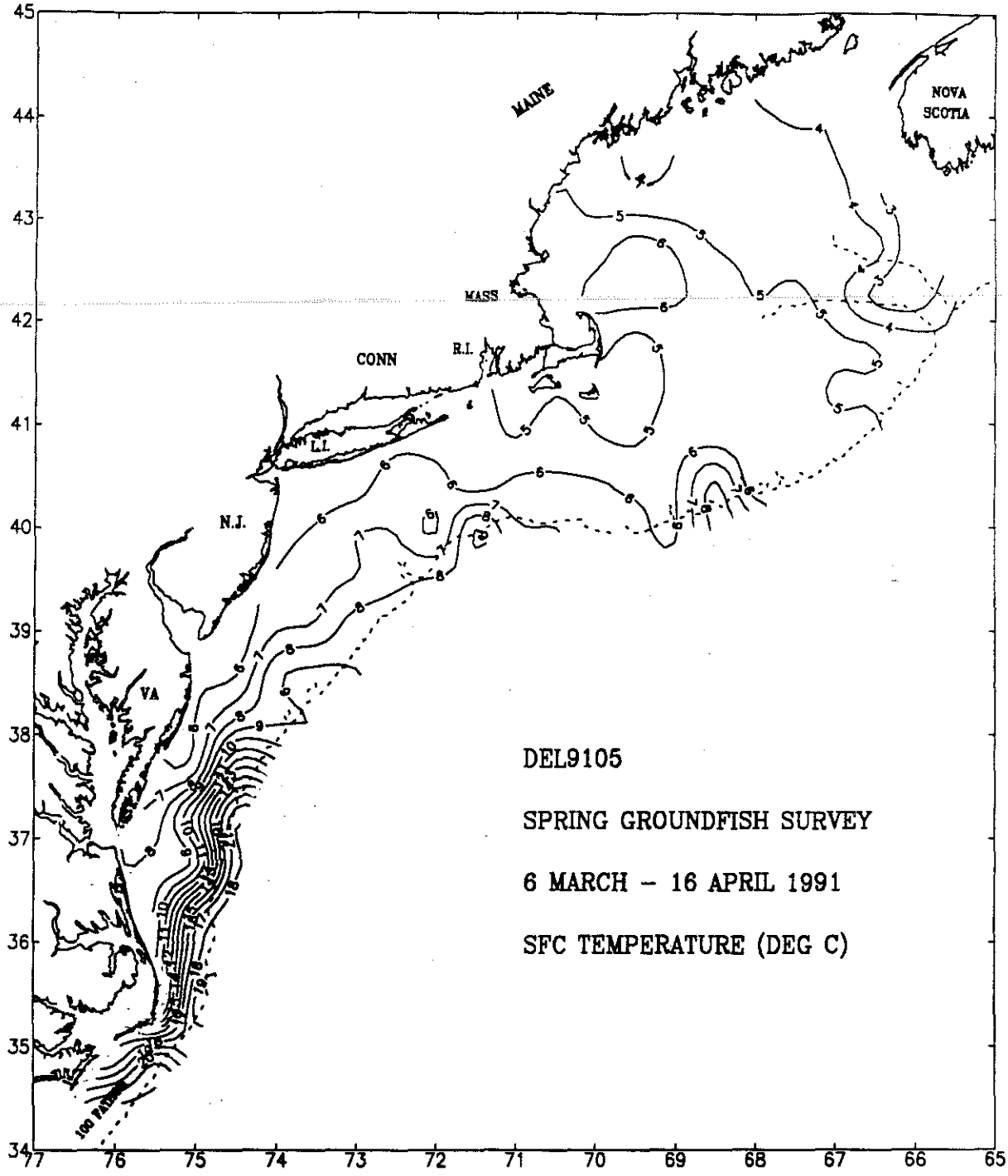

Figure 11. The surface temperature distribution for the spring bottom trawl survey DEL9105.

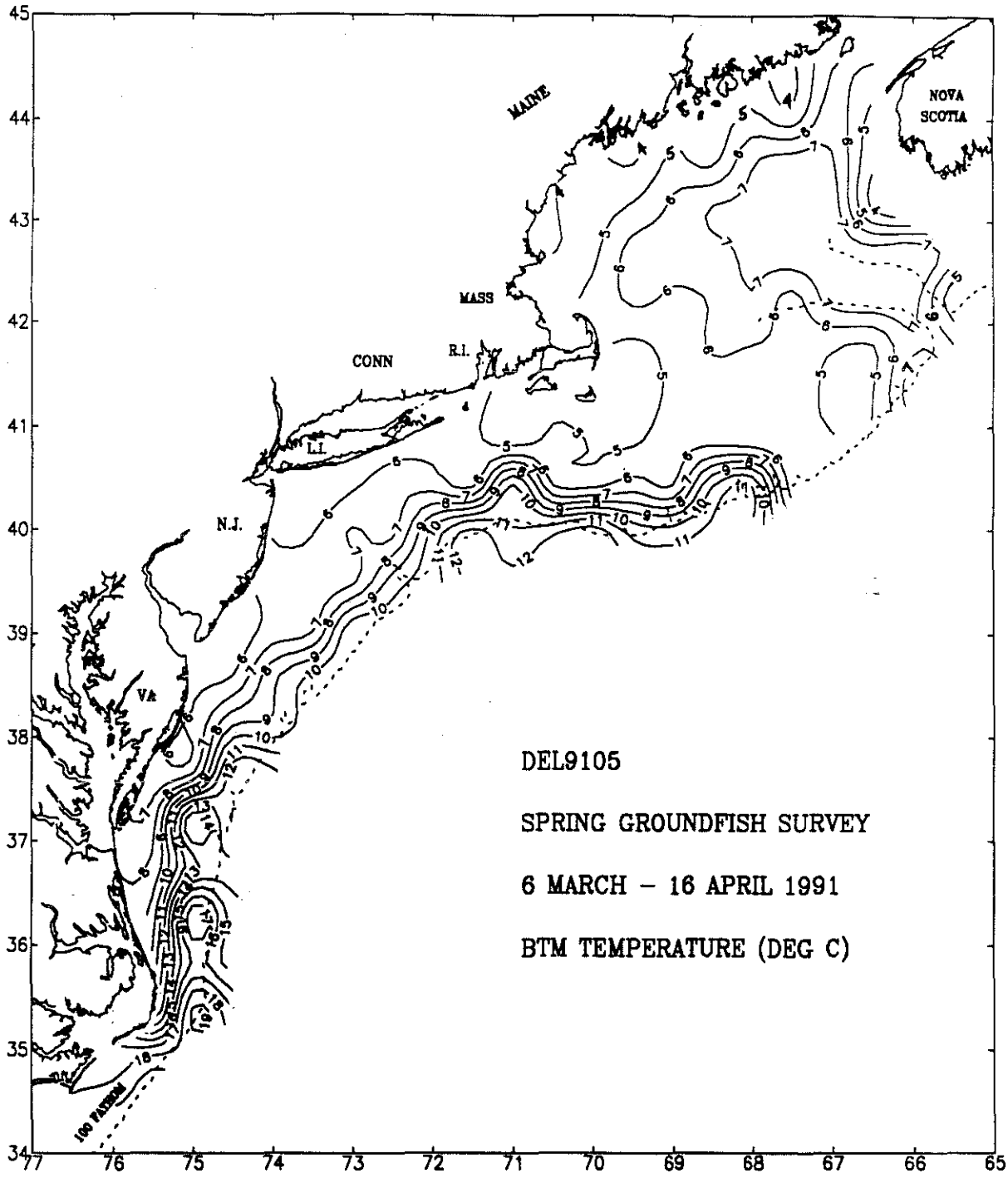

Figure 12. The bottom temperature distribution for the spring bottom trawl survey DEL9105.

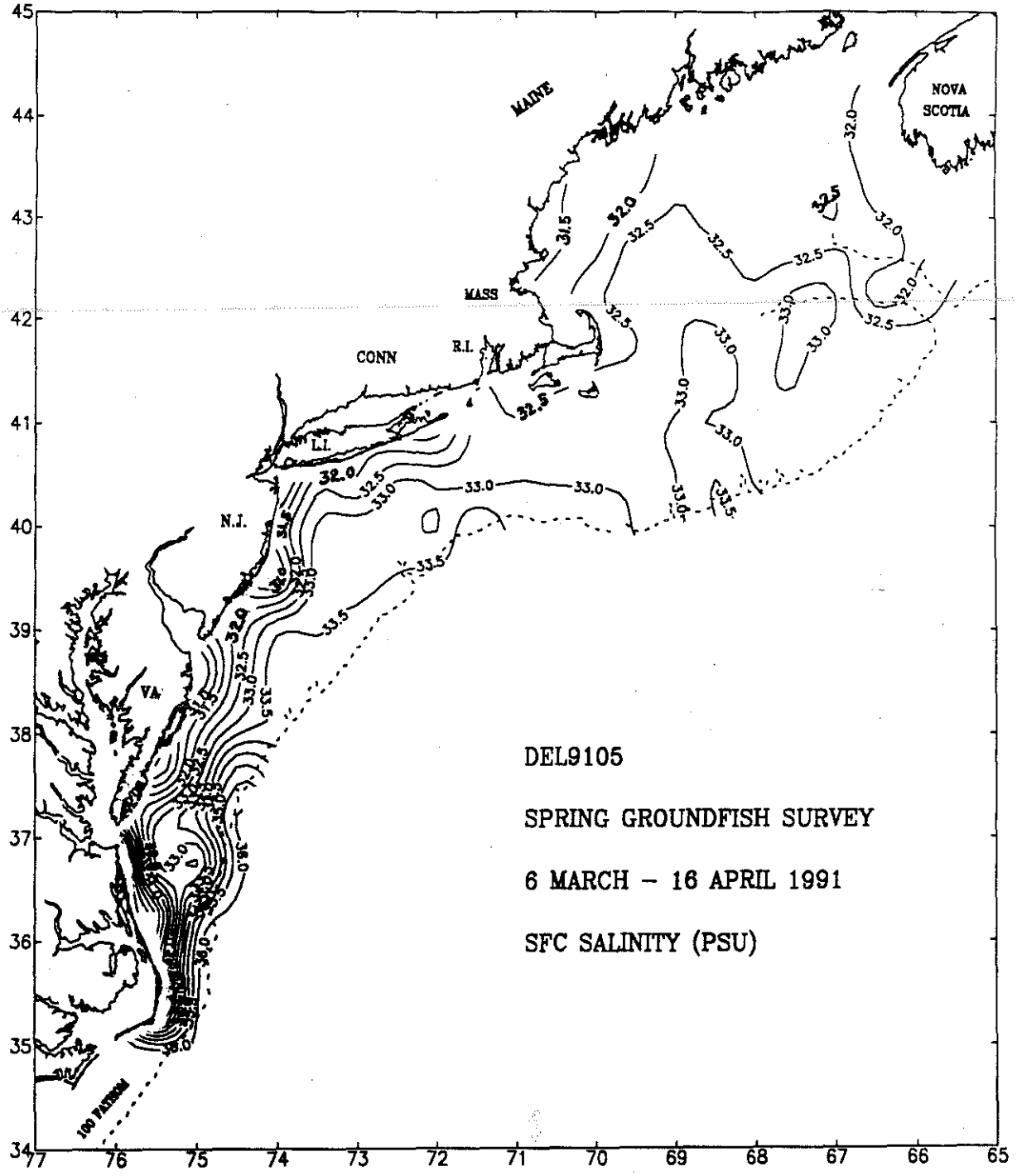

Figure 13. The surface salinity distribution for the spring bottom trawl survey DEL9105.

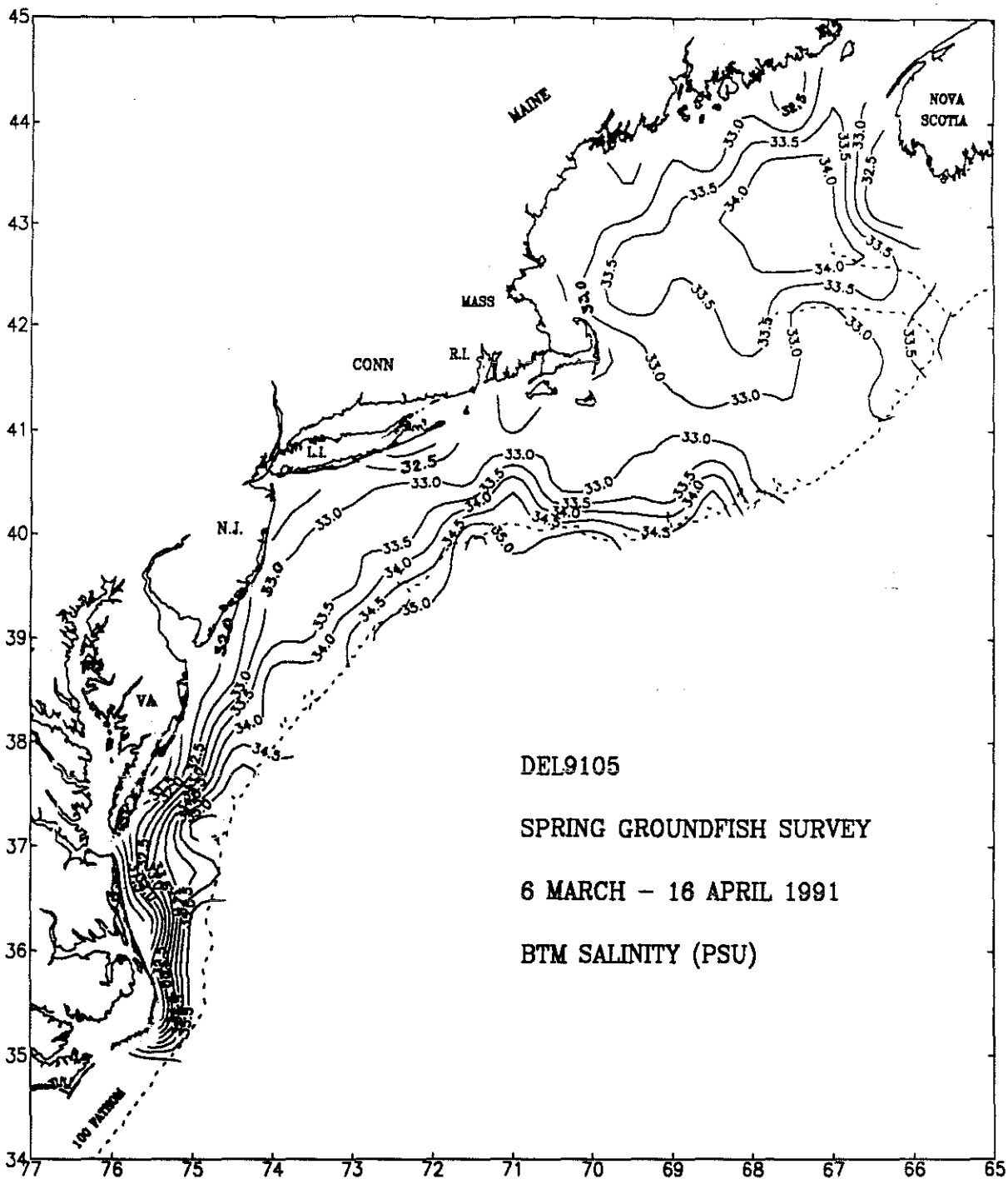

Figure 14. The bottom salinity distribution for the spring bottom trawl survey DEL9105.

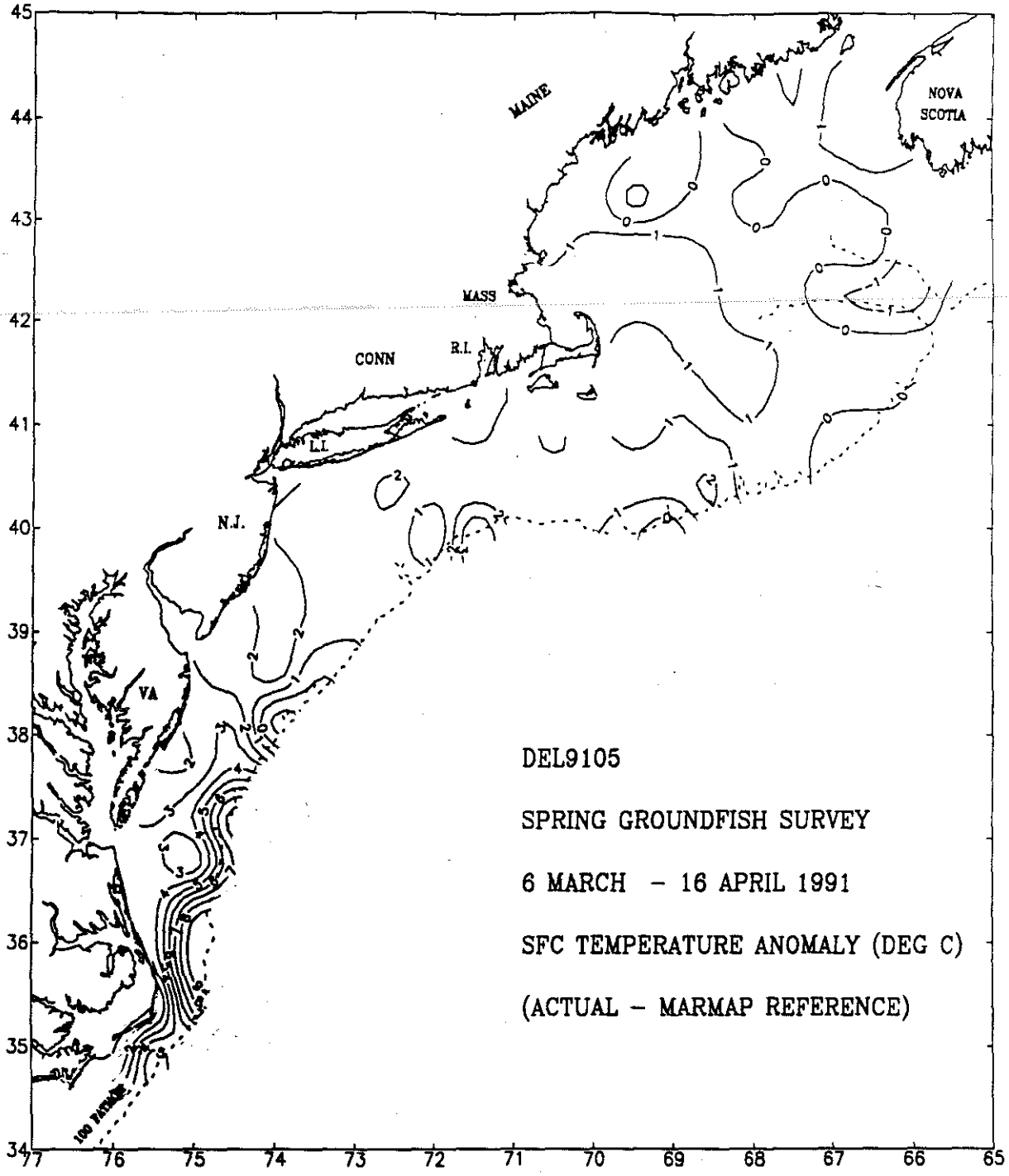

Figure 15. The surface temperature anomaly distribution for the spring bottom trawl survey DEL9105.

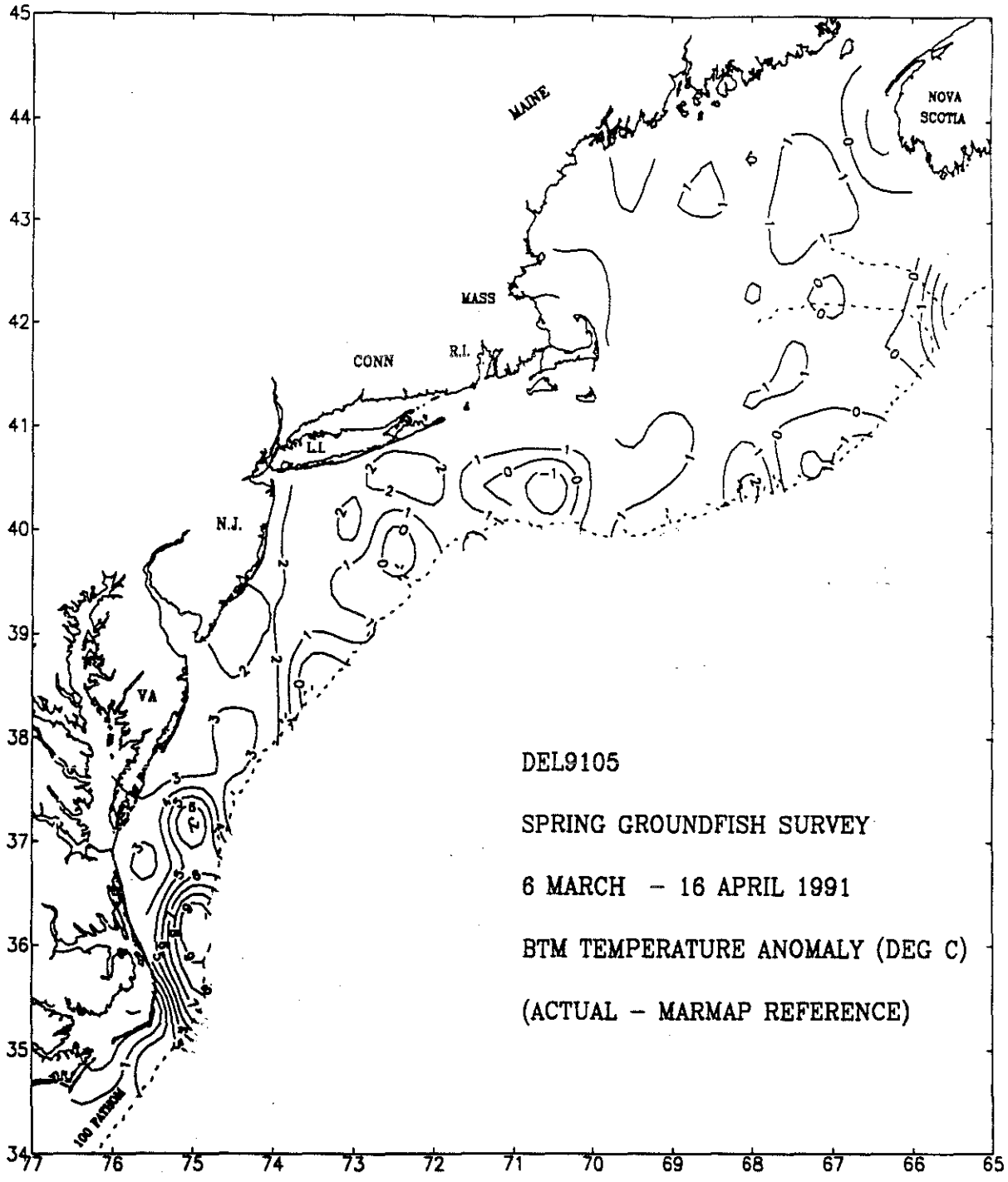

Figure 16. The bottom temperature anomaly distribution for the spring bottom trawl survey DEL9105.

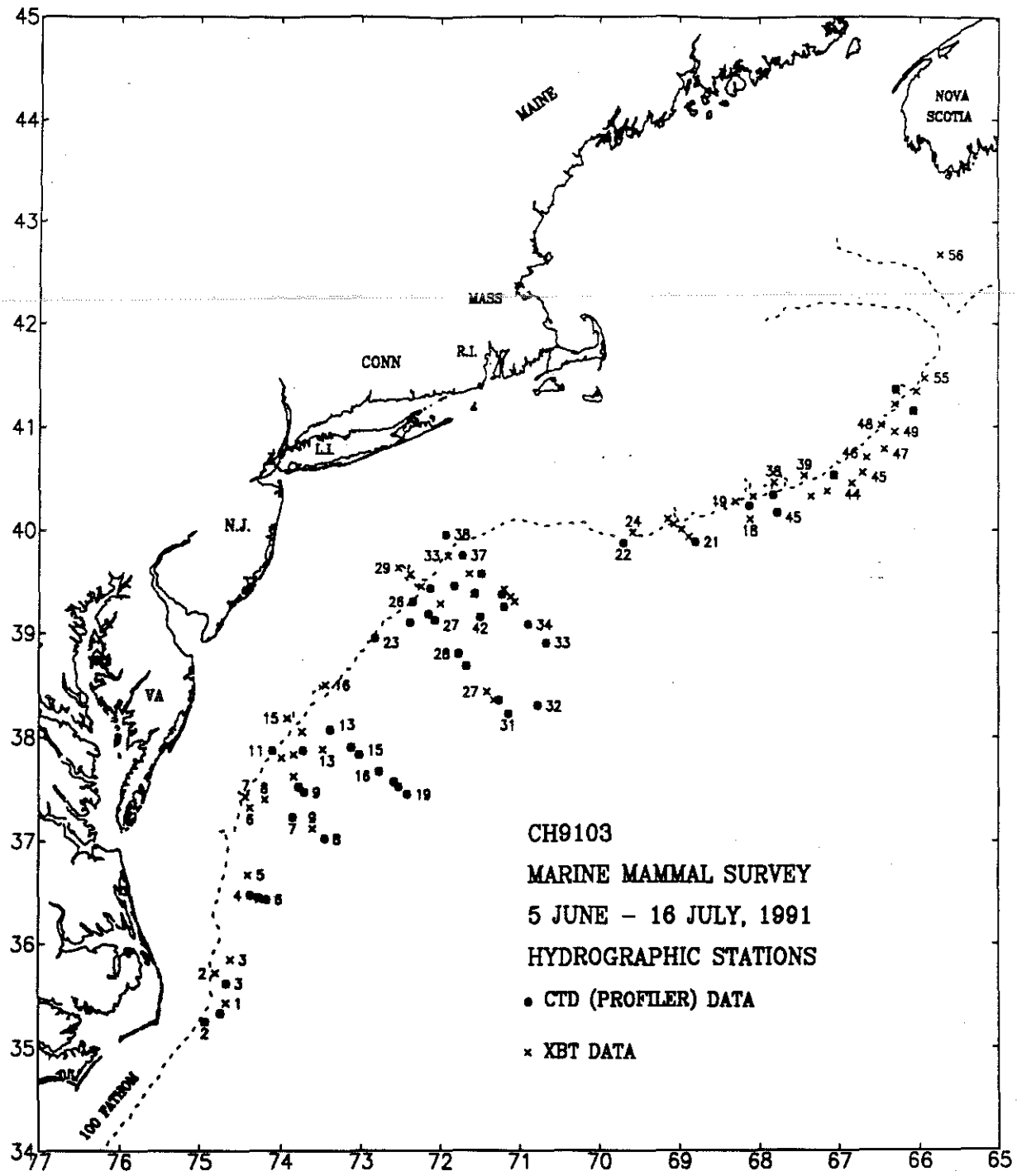

Figure 17. Hydrographic stations occupied during the marine mammal survey CH9103.

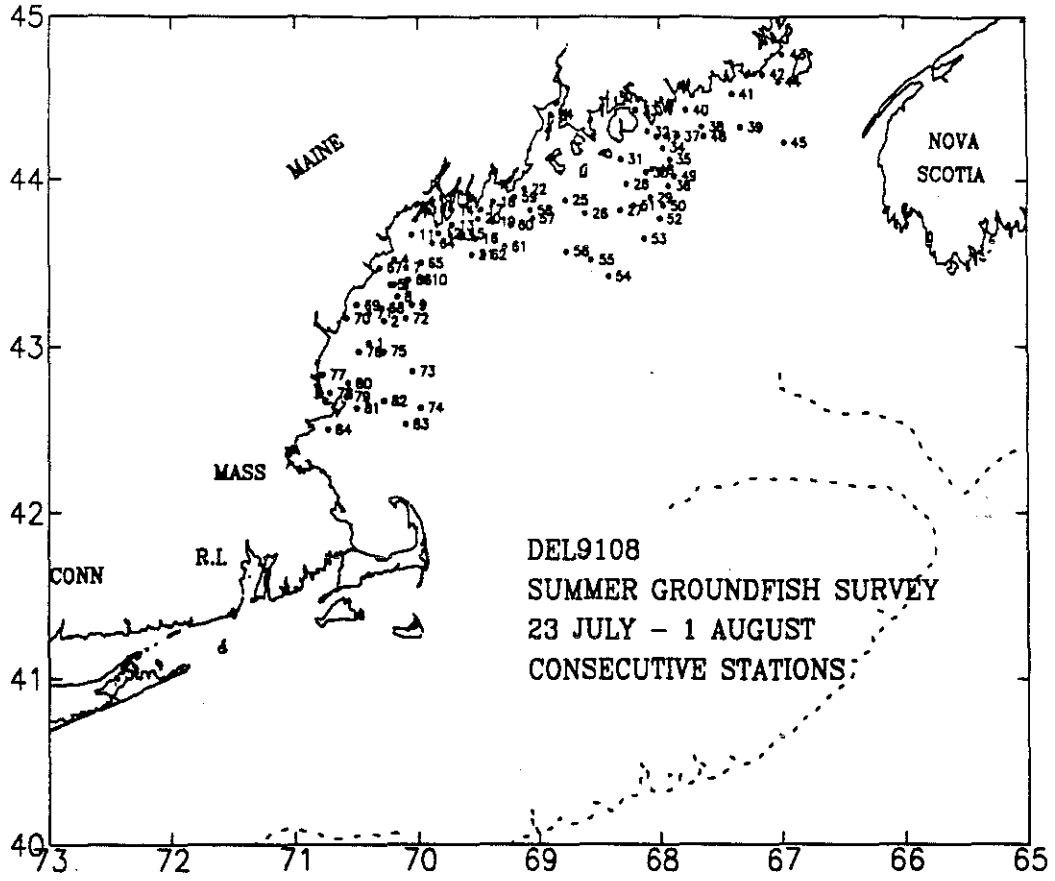

Figure 18. Hydrographic stations occupied during the Gulf of Maine bottom trawl survey DEL9108.

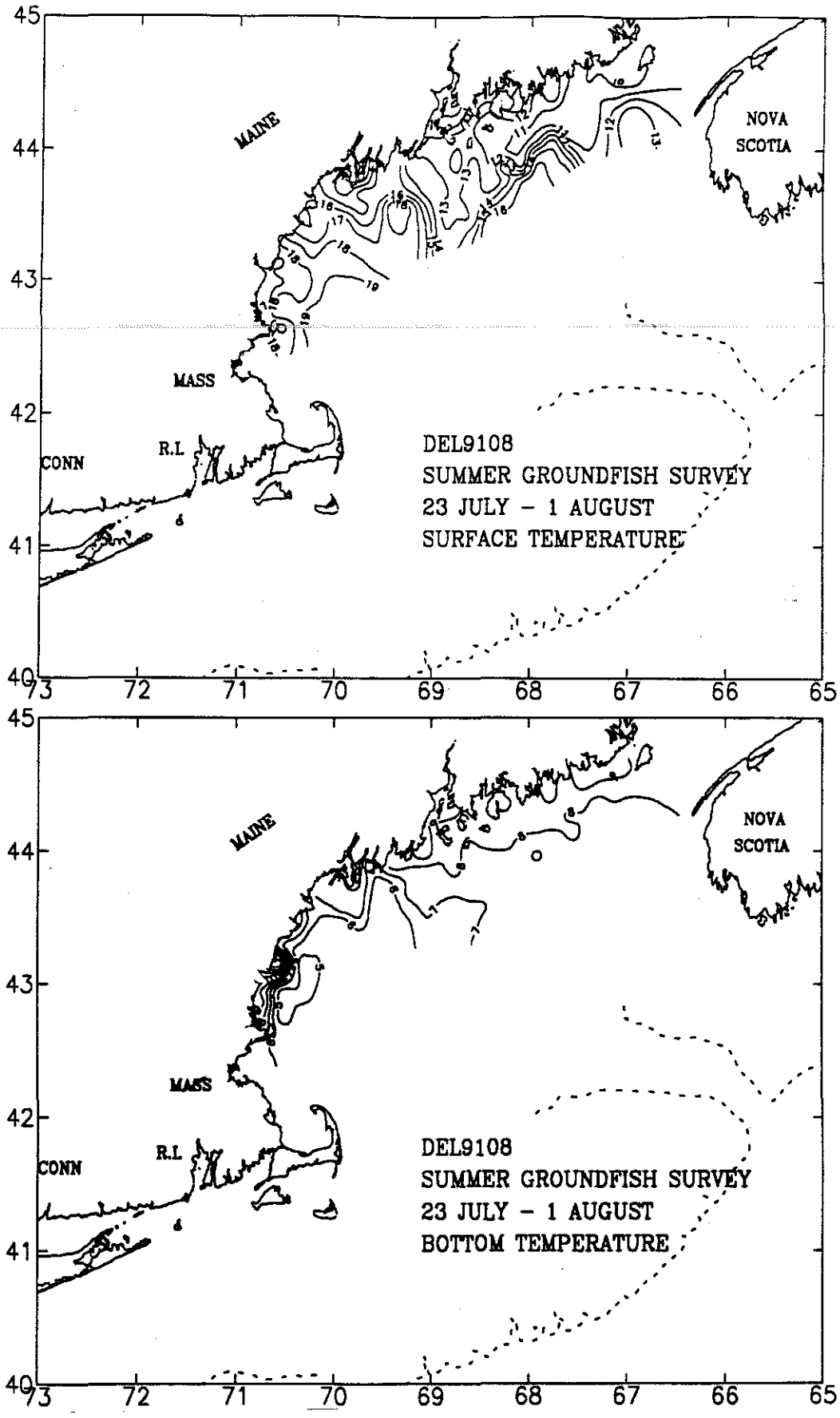

Figure 19. The surface and bottom temperature distribution for the Gulf of Maine bottom trawl survey DEL9108.

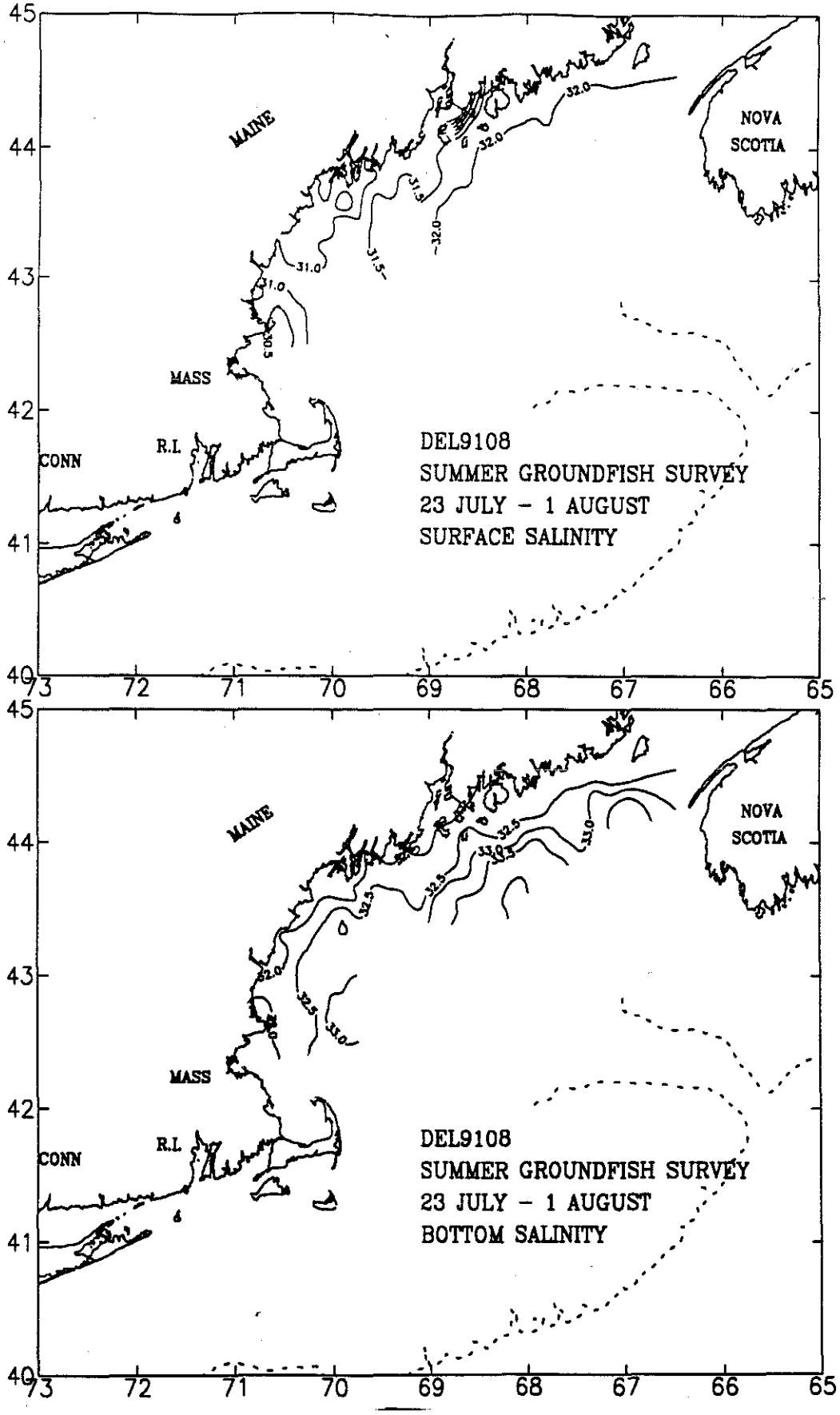

Figure 20. The surface and bottom salinity distribution for the Gulf of Maine bottom trawl survey DEL9108.

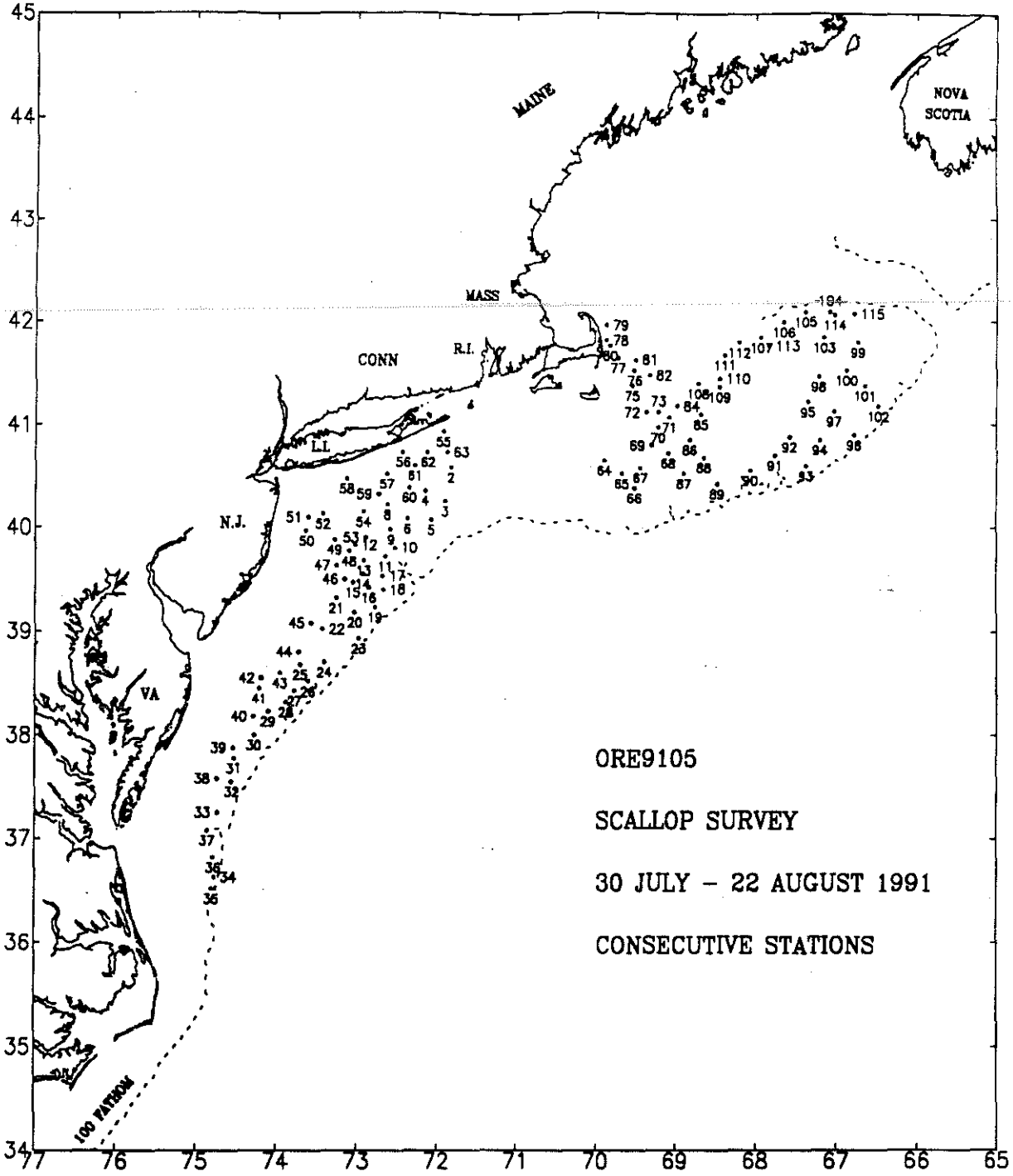

Figure 21. Hydrographic stations occupied during the scallop survey ORE9105.

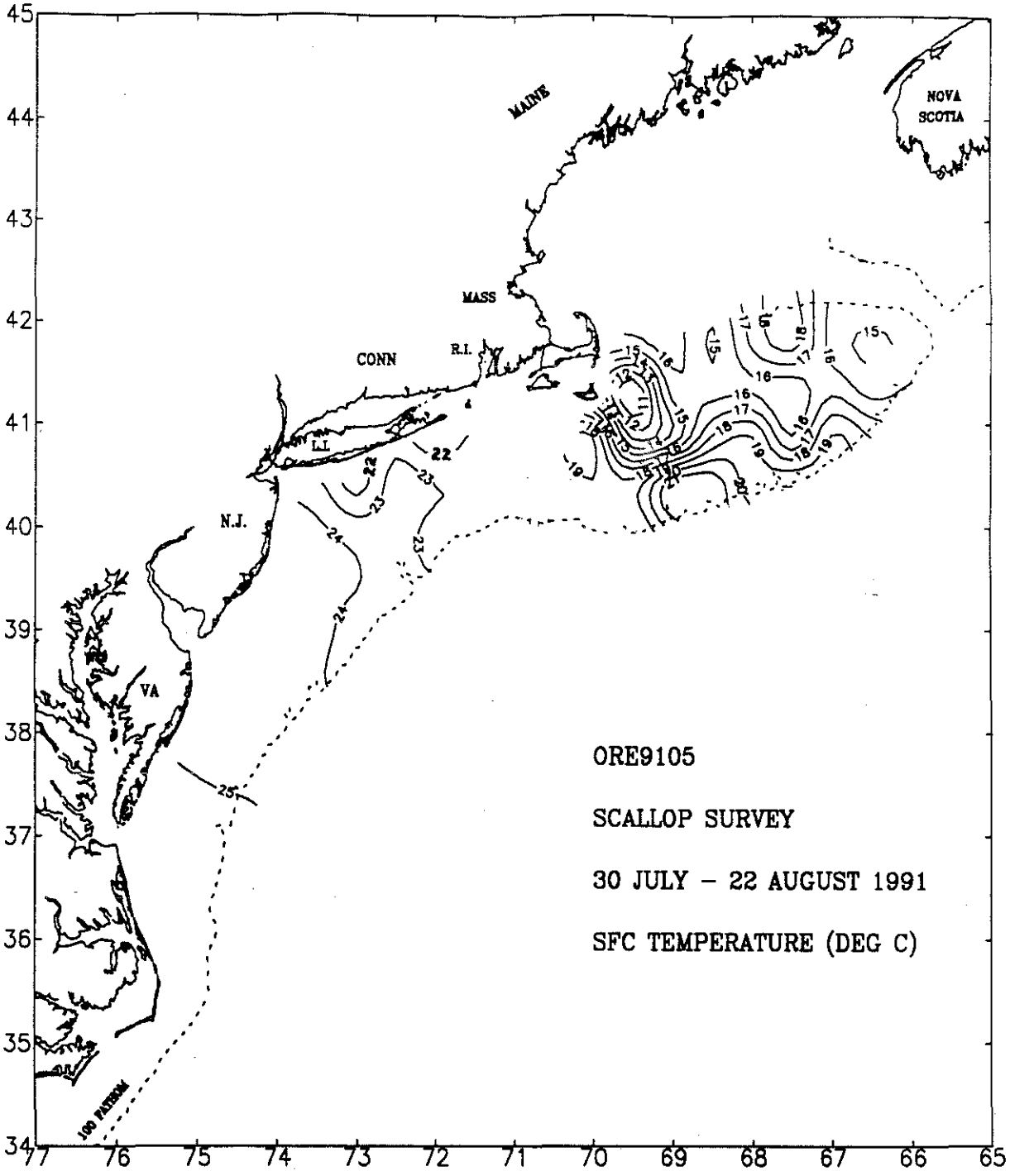

Figure 22. The surface temperature distribution for the scallop survey ORE9105.

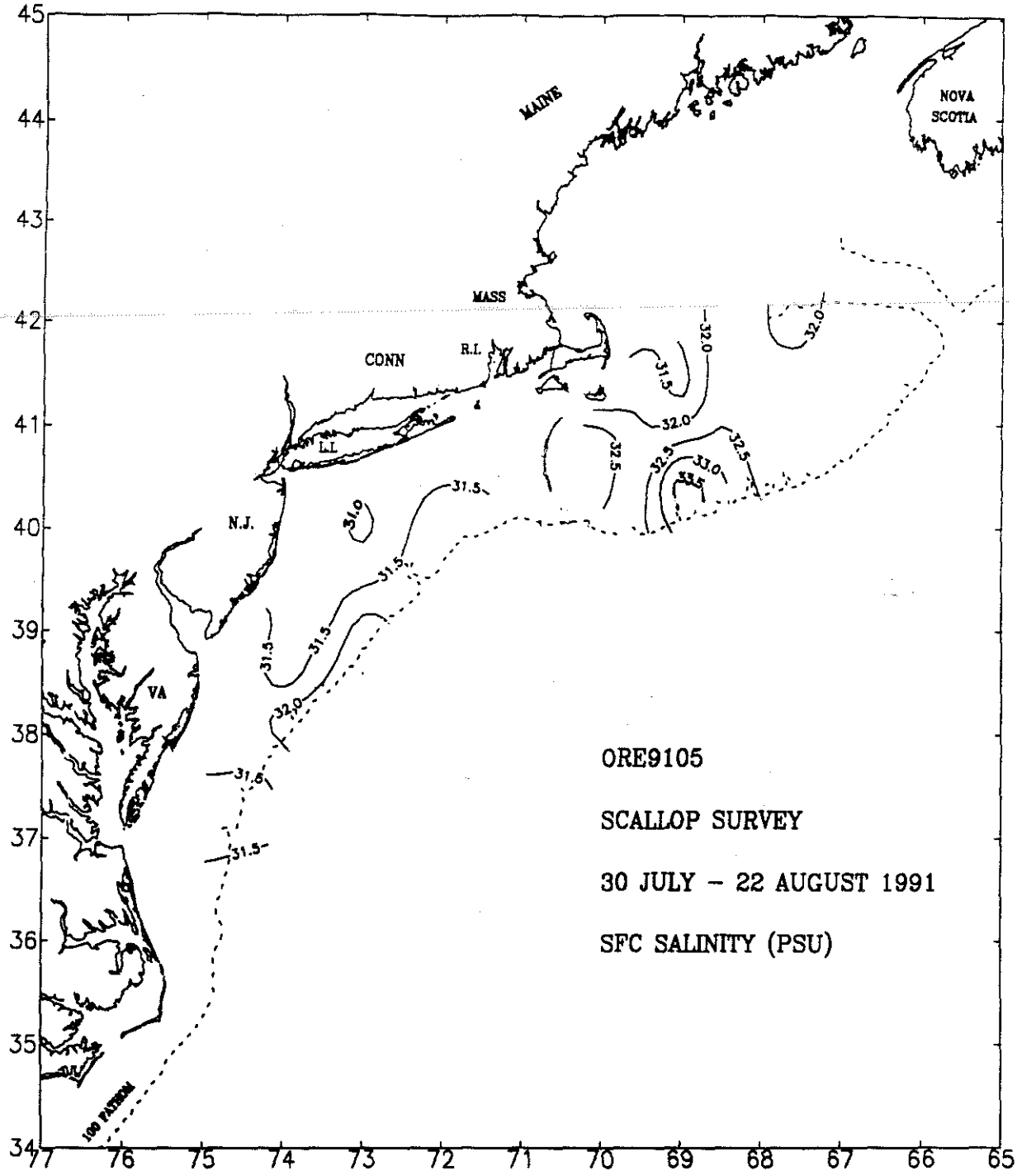

Figure 23. The surface salinity distribution for the scallop survey ORE9105.

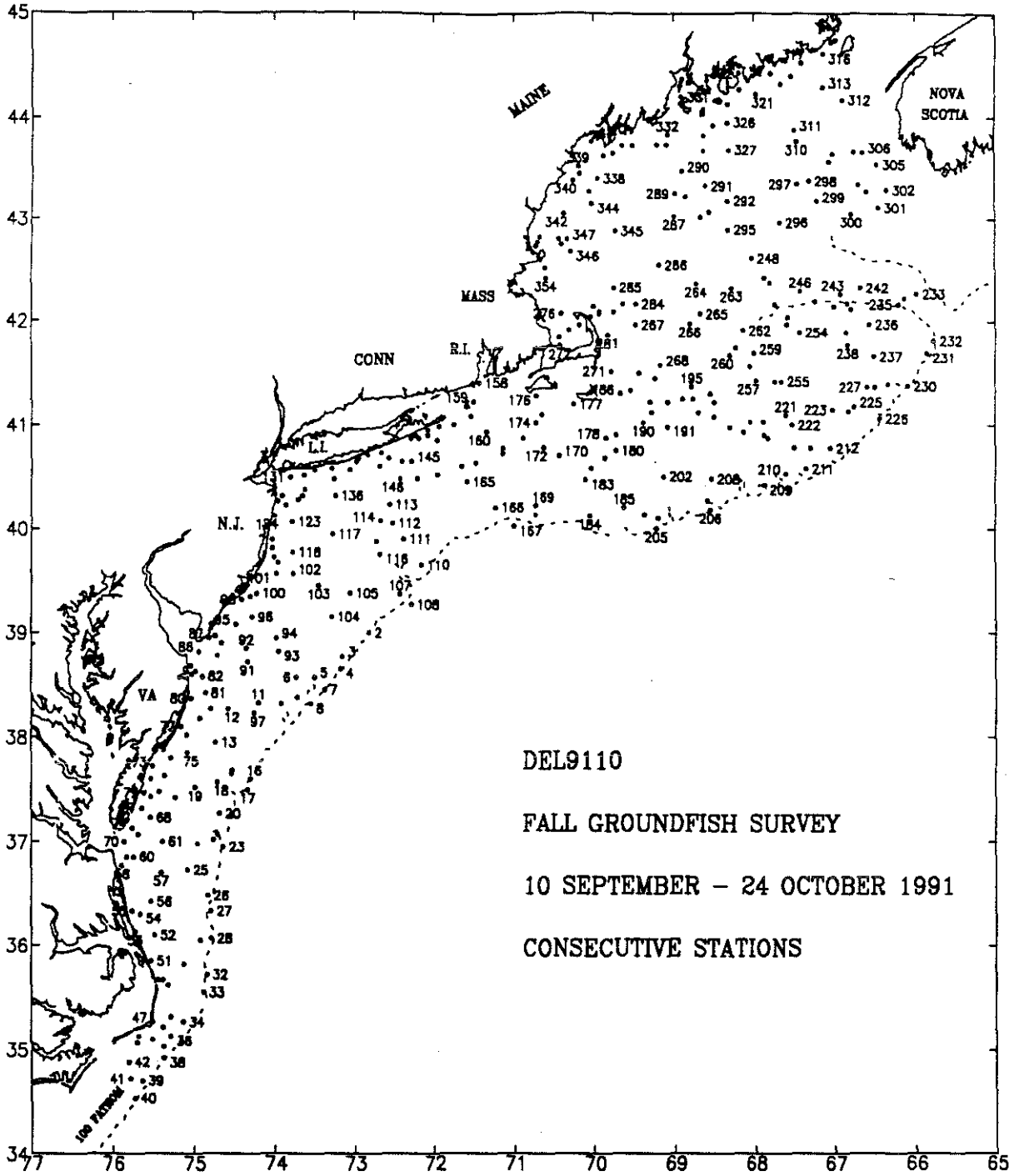

Figure 24. Hydrographic stations occupied during the fall bottom trawl survey DEL9110.

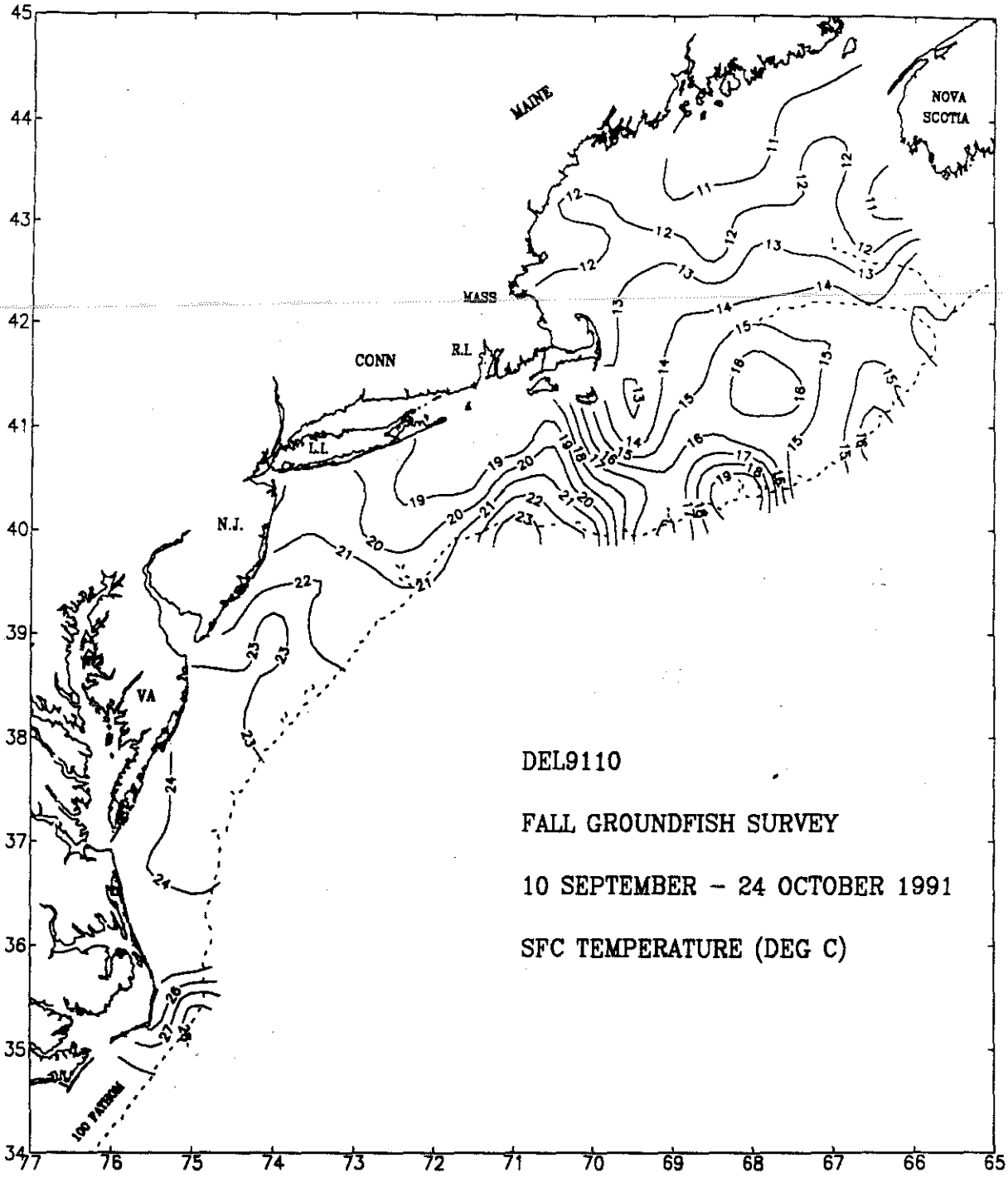

Figure 25. The surface temperature distribution for the fall bottom trawl survey DEL9110.

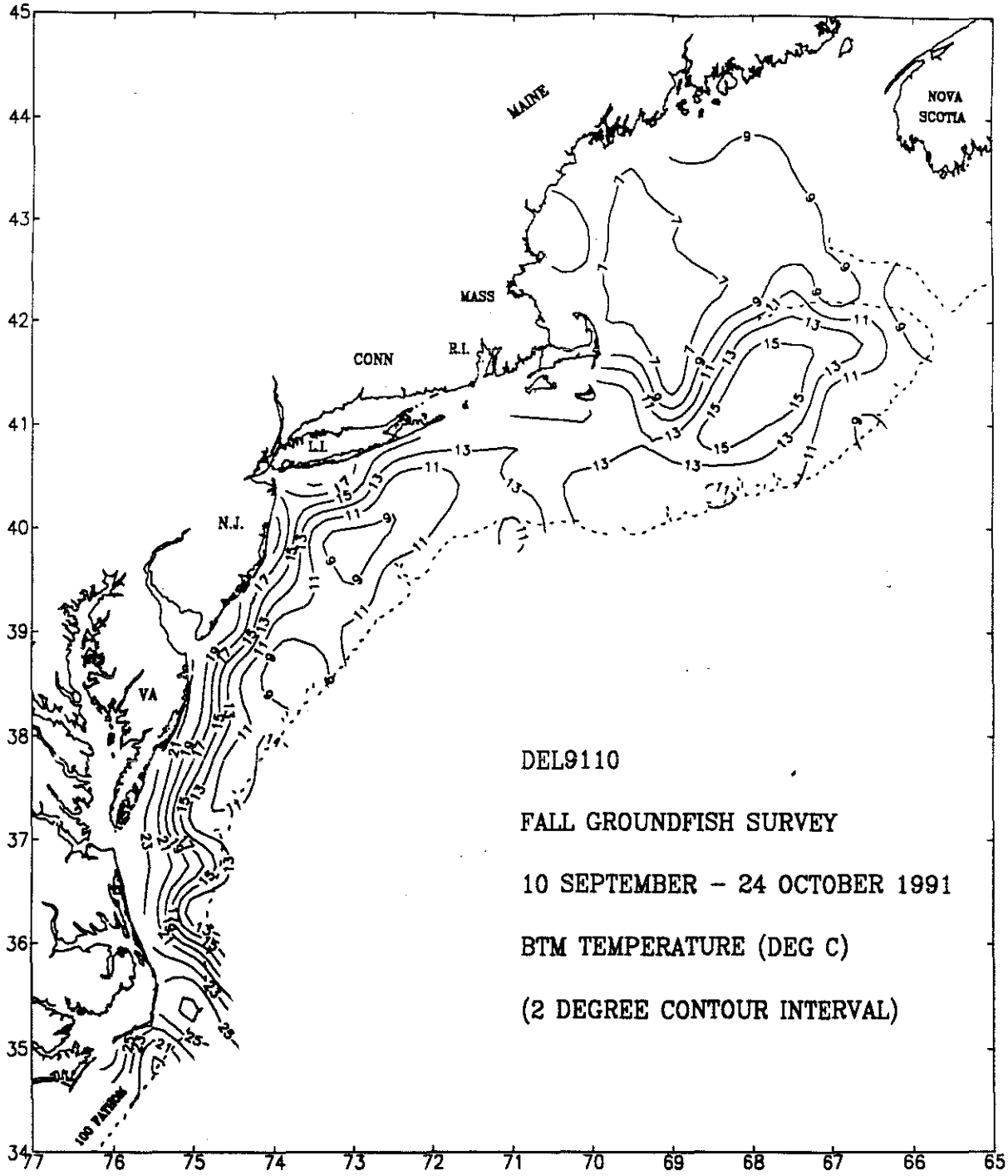

Figure 26. The bottom temperature distribution for the fall bottom trawl survey DEL9110.

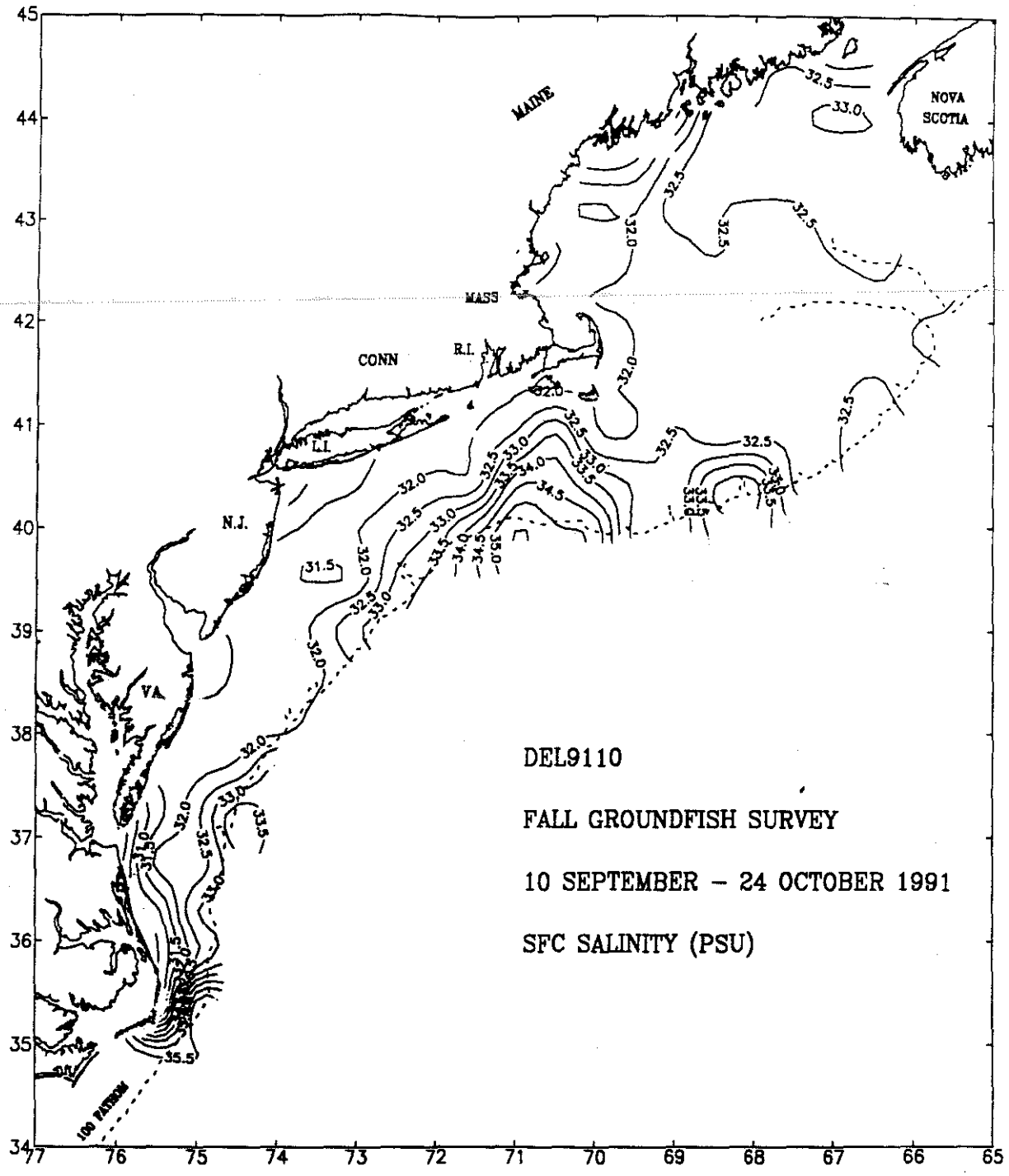

Figure 27. The surface salinity distribution for the fall bottom trawl survey DEL9110.

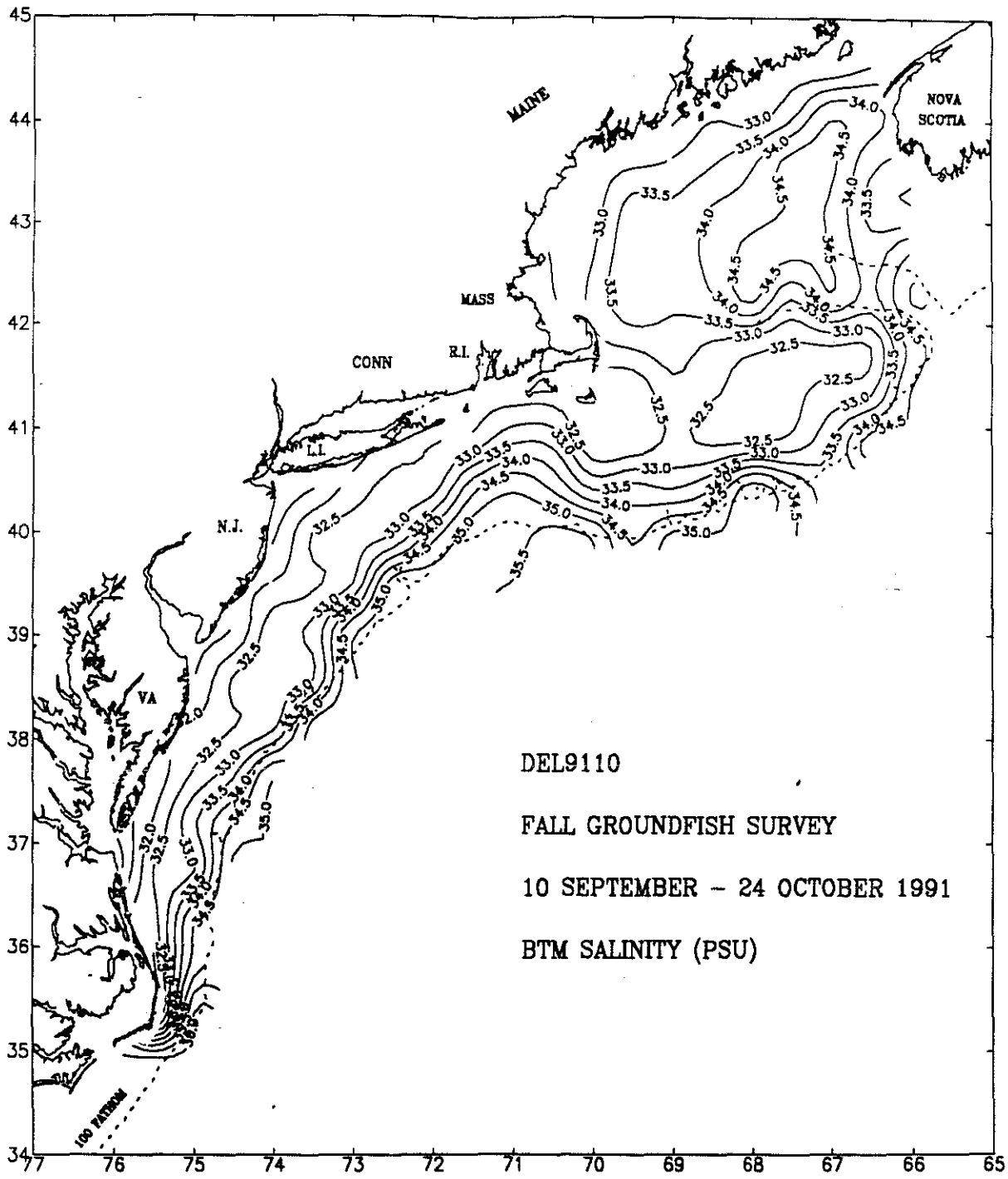

Figure 28. The bottom salinity distribution for the fall bottom trawl survey DEL9110.

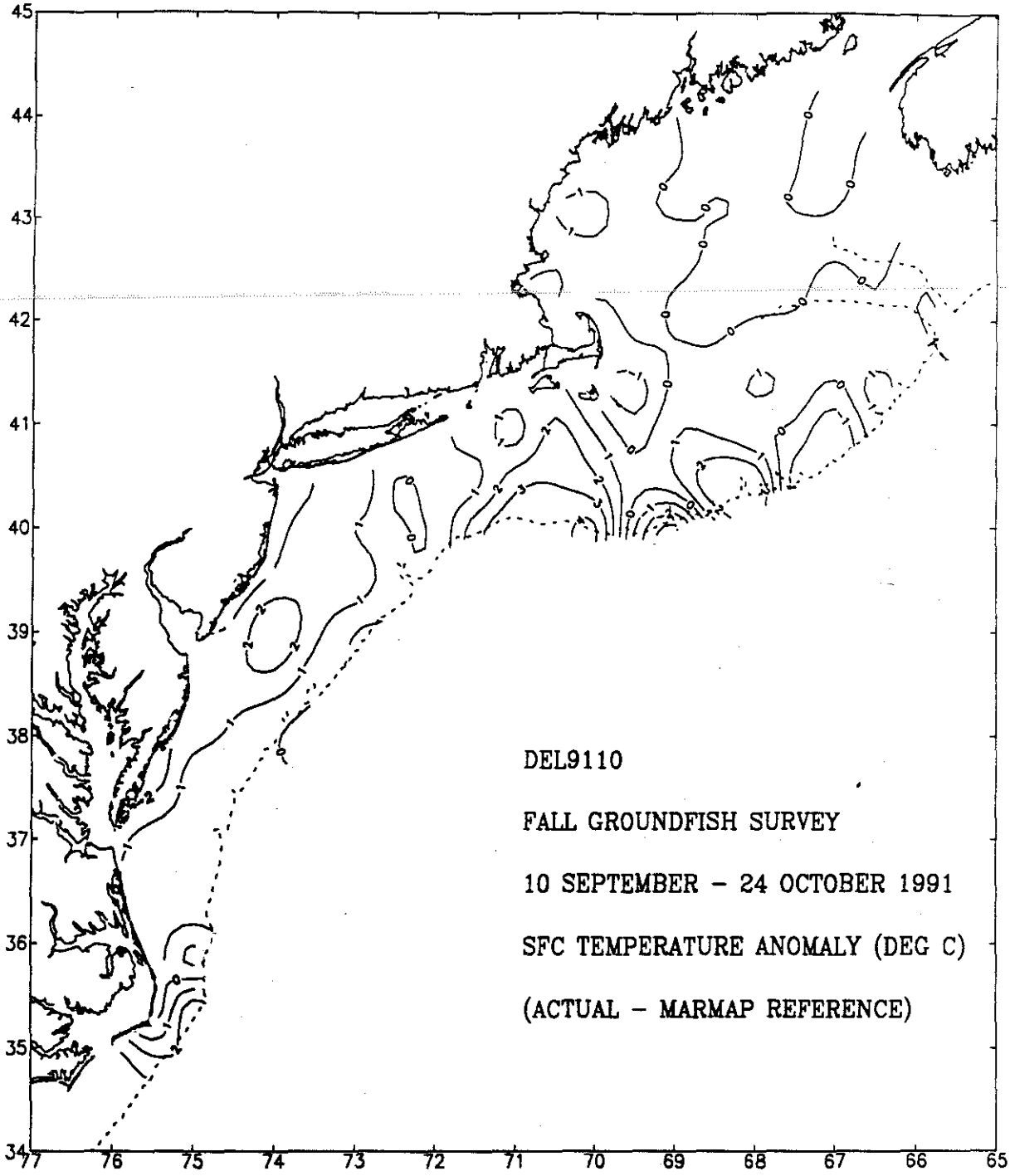

Figure 29. The surface temperature anomaly distribution for the fall bottom trawl survey DEL9110.

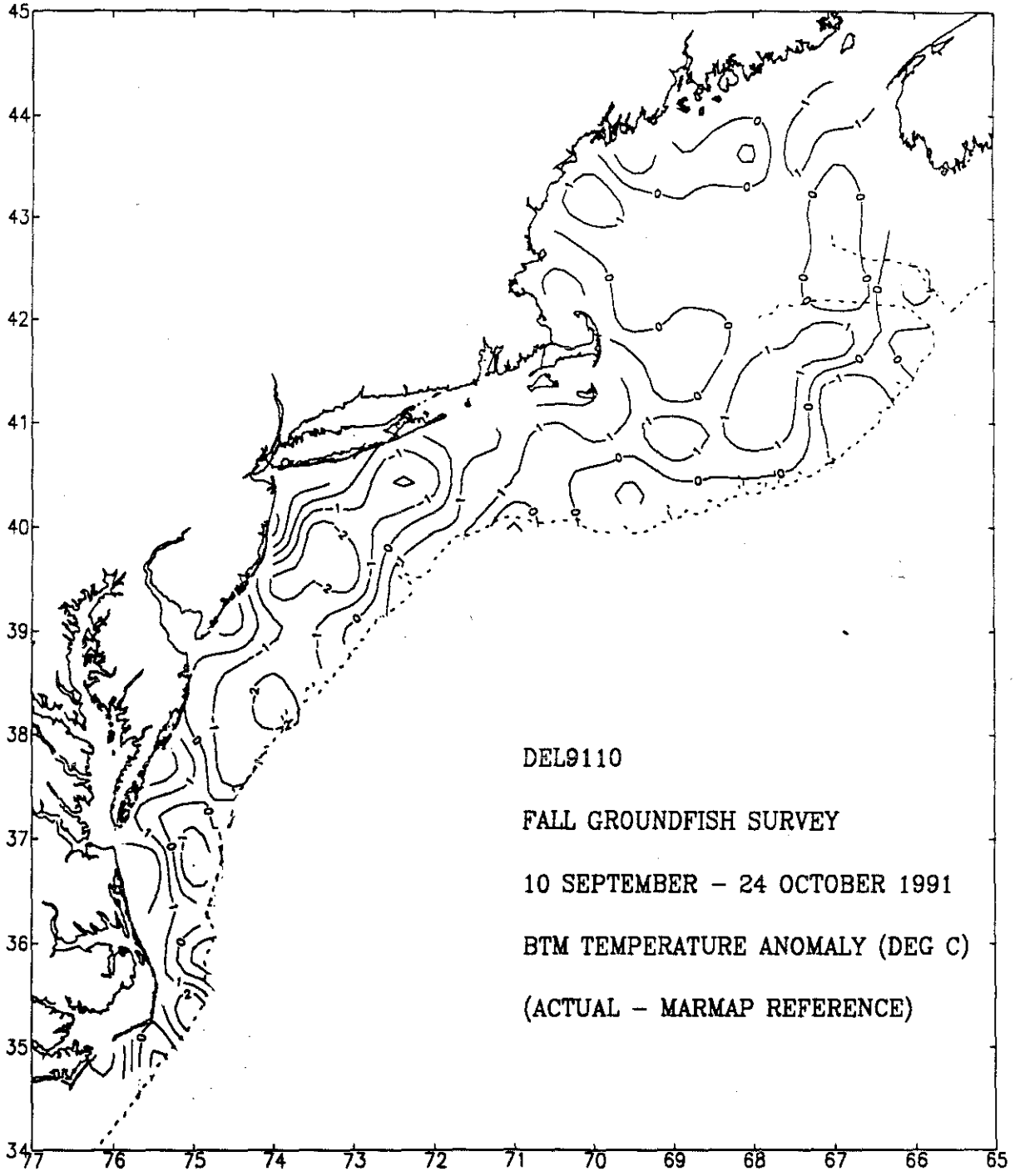

Figure 30. The bottom temperature anomaly distribution for the fall bottom trawl survey DEL9110.

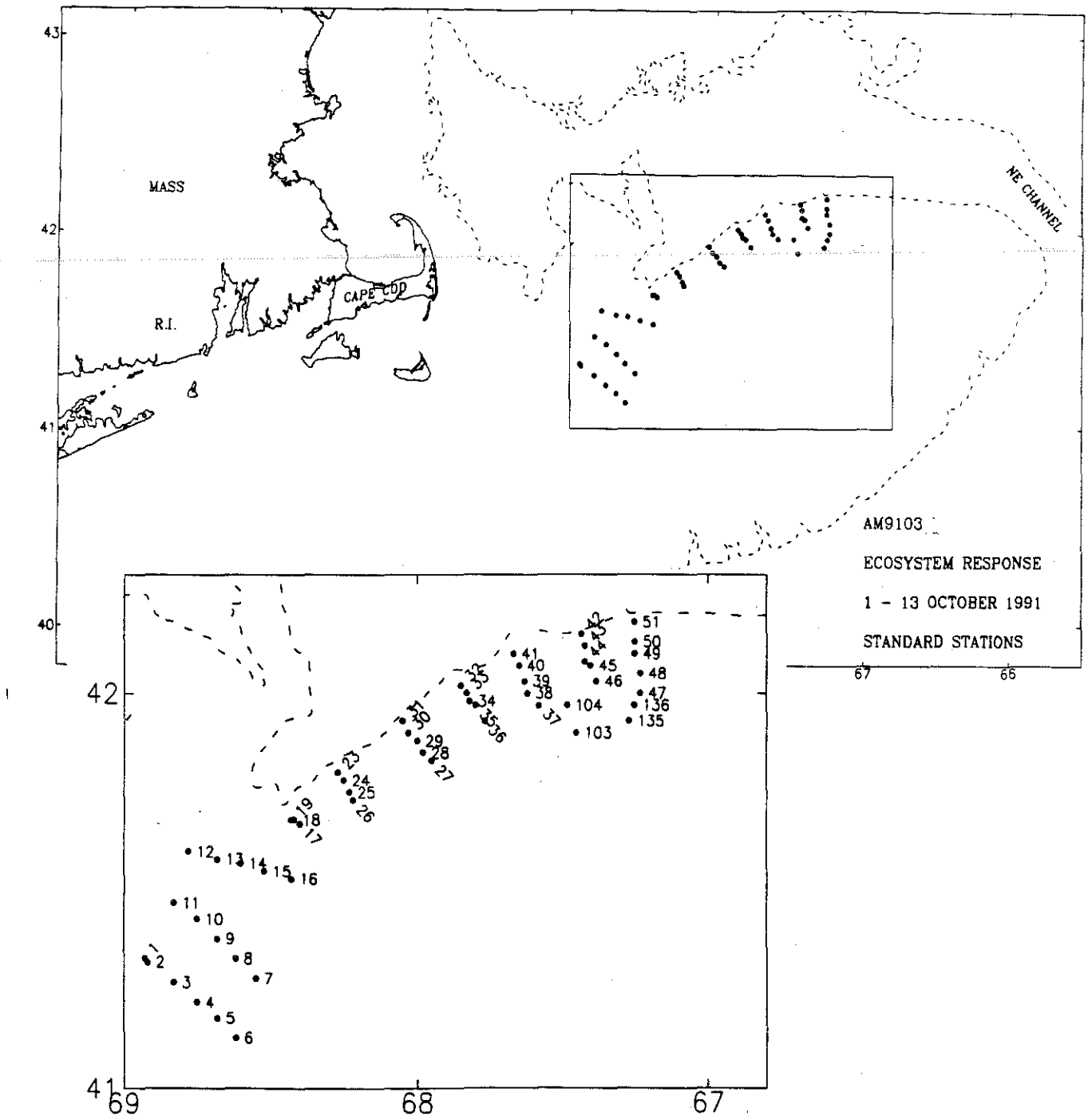

Figure 31. Hydrographic stations occupied during the Marine Ecosystem Response herring survey AM9103.

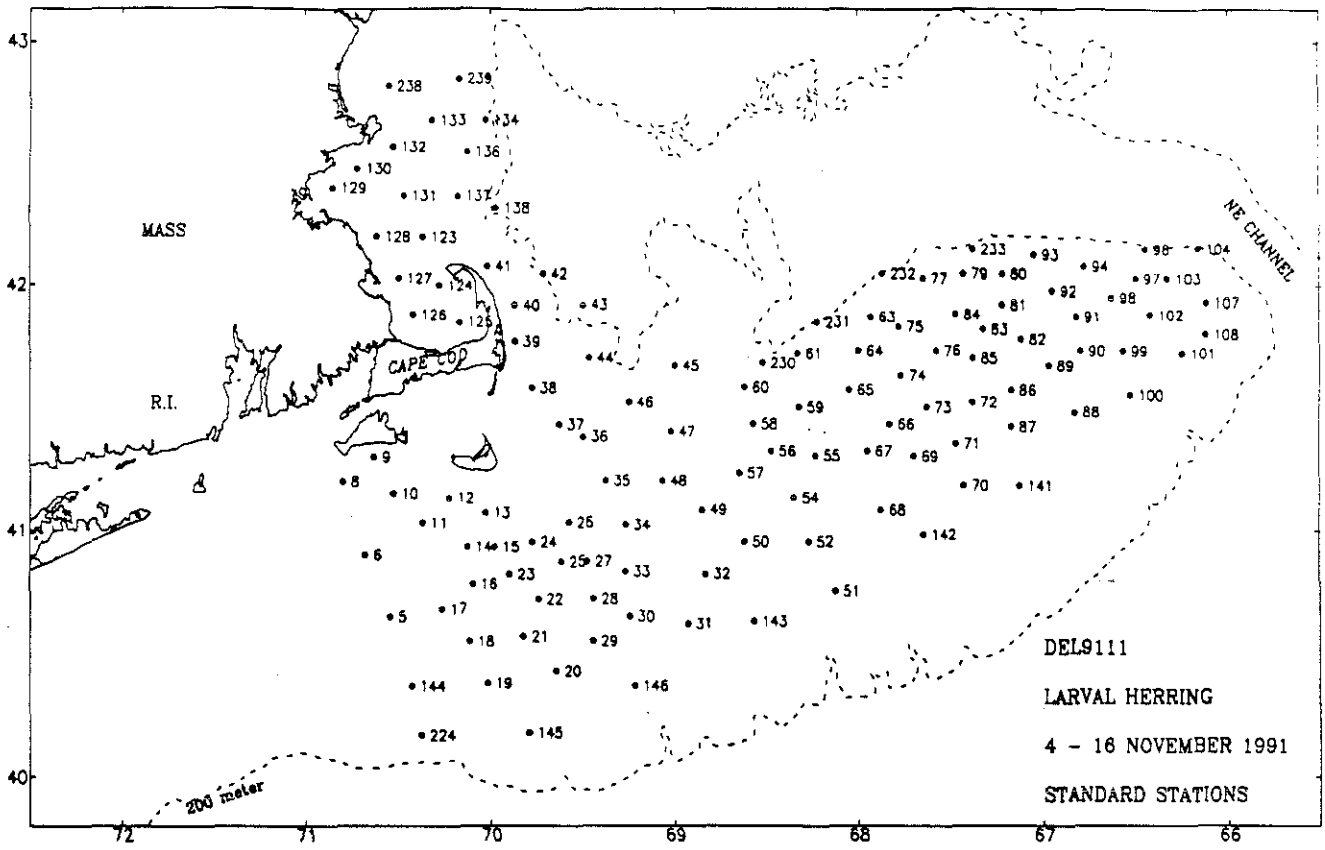

Figure 32. Hydrographic stations occupied during the Larval Herring/Sand Lance Study DEL9111.

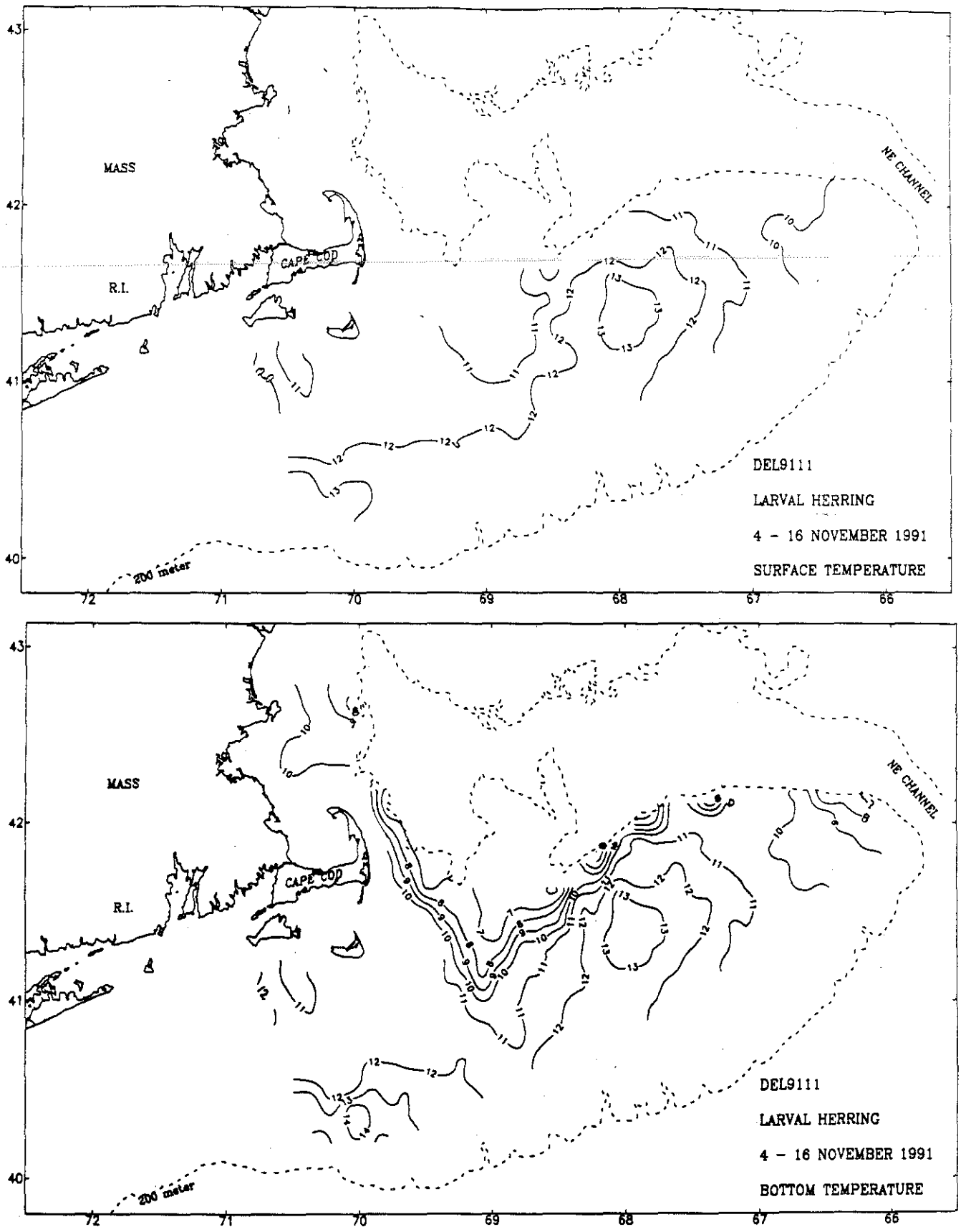

Figure 33. The surface and bottom temperature distribution for the Larval Herring/Sand Lance Study DEL9111.

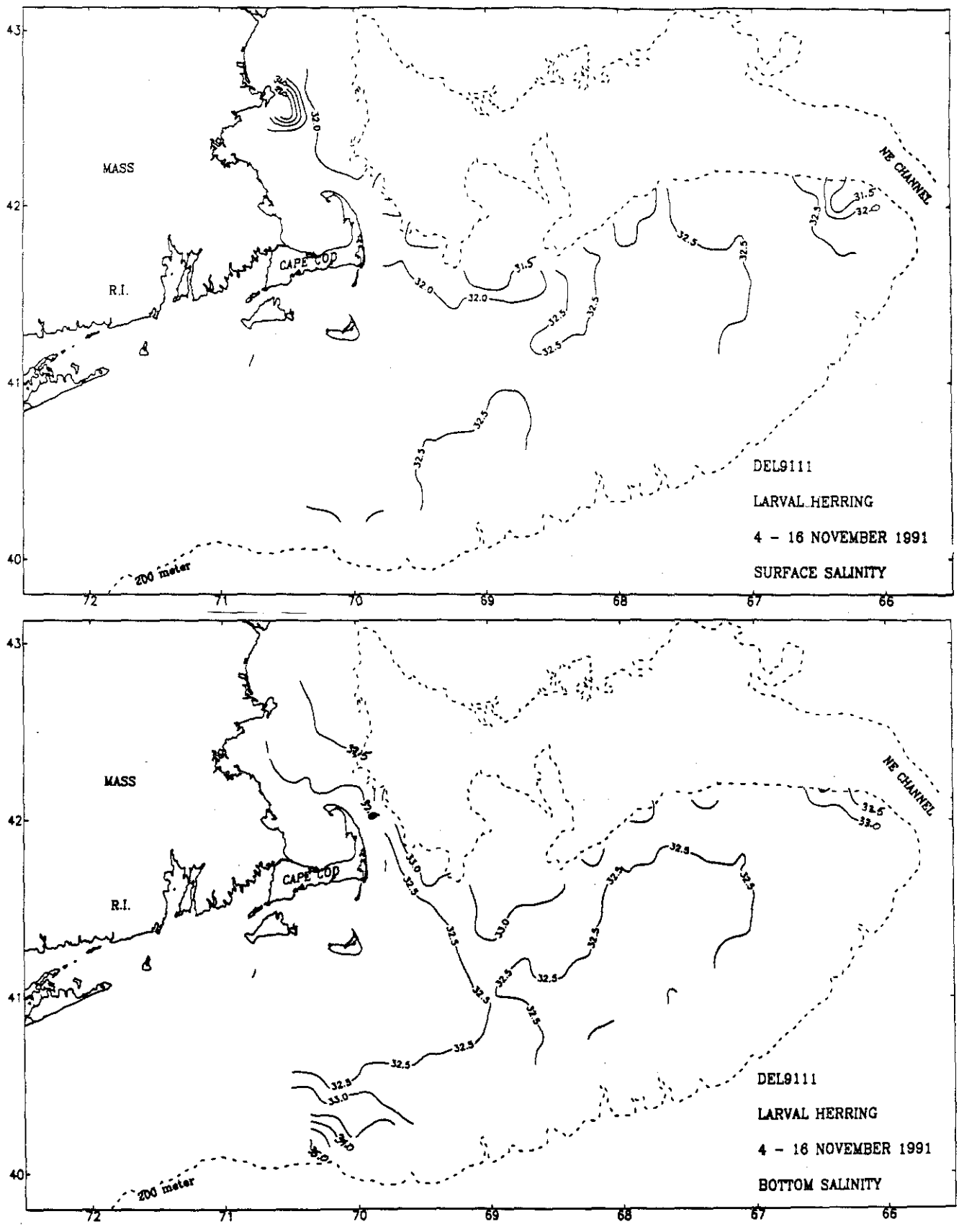

Figure 34. The surface and bottom salinity distribution for the Larval Herring/Sand Lance Study DEL9111.

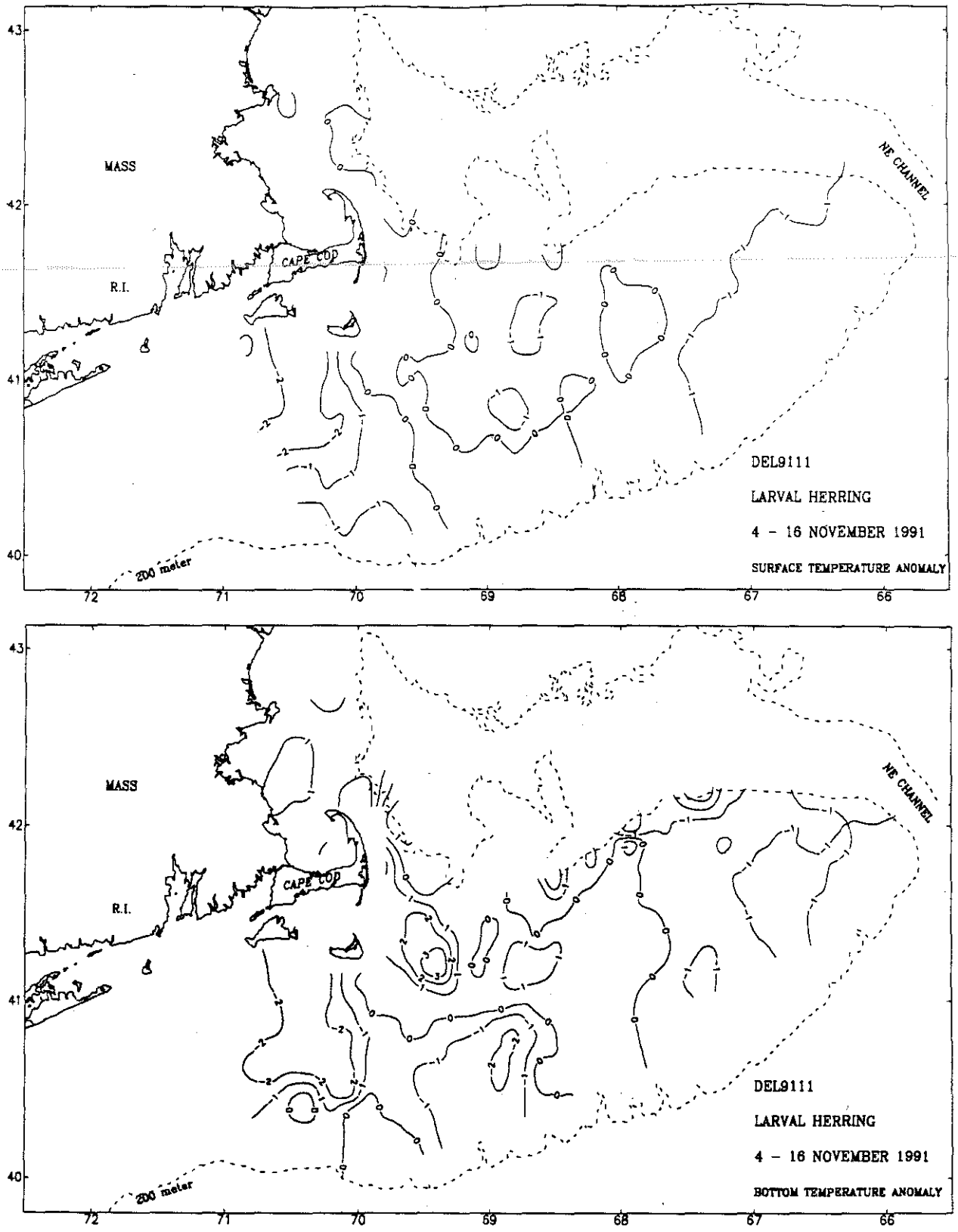

Figure 35. The surface and bottom temperature anomaly distribution for the Larval Herring/Sand Lance Study DEL9111.

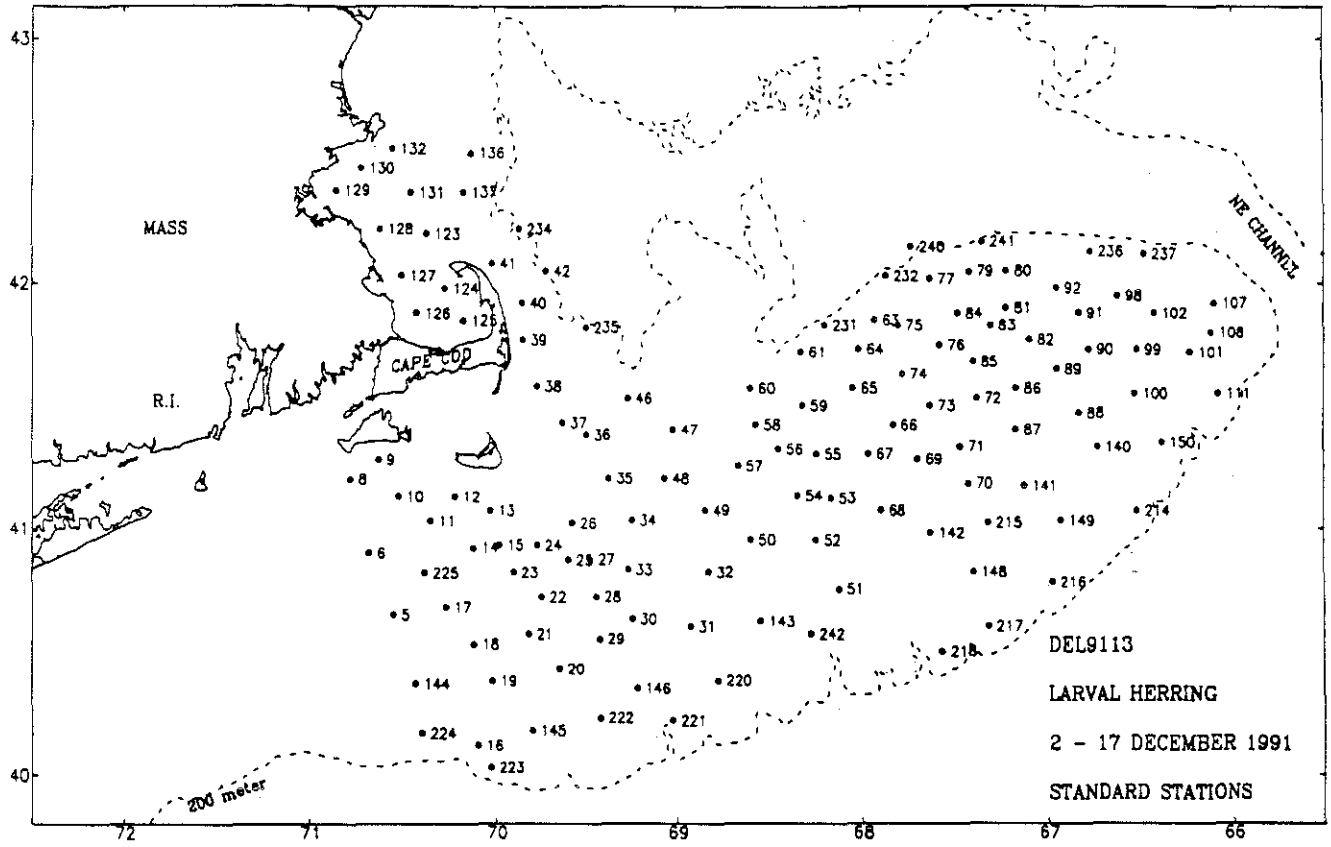

Figure 36. Hydrographic stations occupied during the Larval Herring/Sand Lance Study DEL9113.

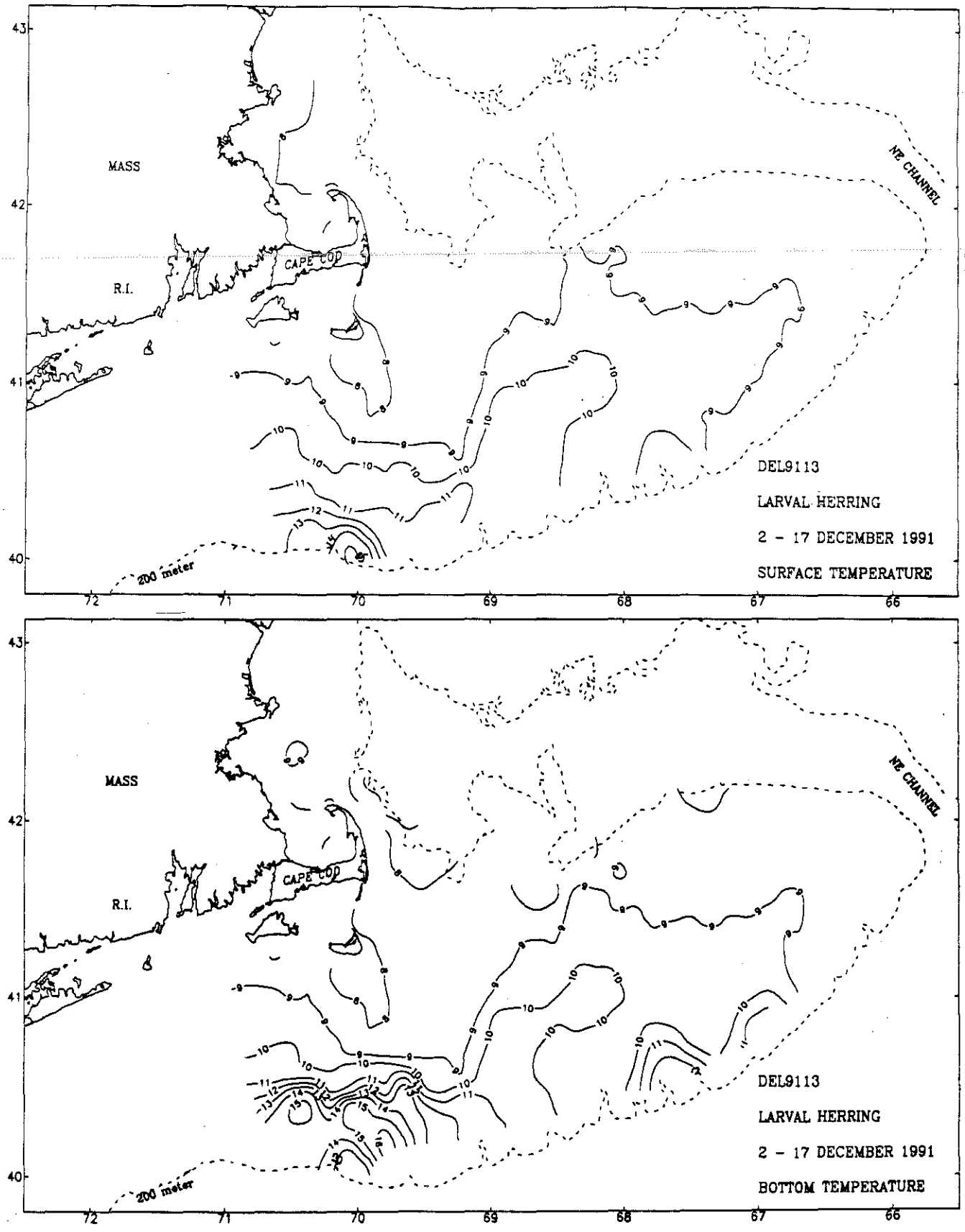

Figure 37. The surface and bottom temperature distribution for the Larval Herring/Sand Lance Study DEL9113.

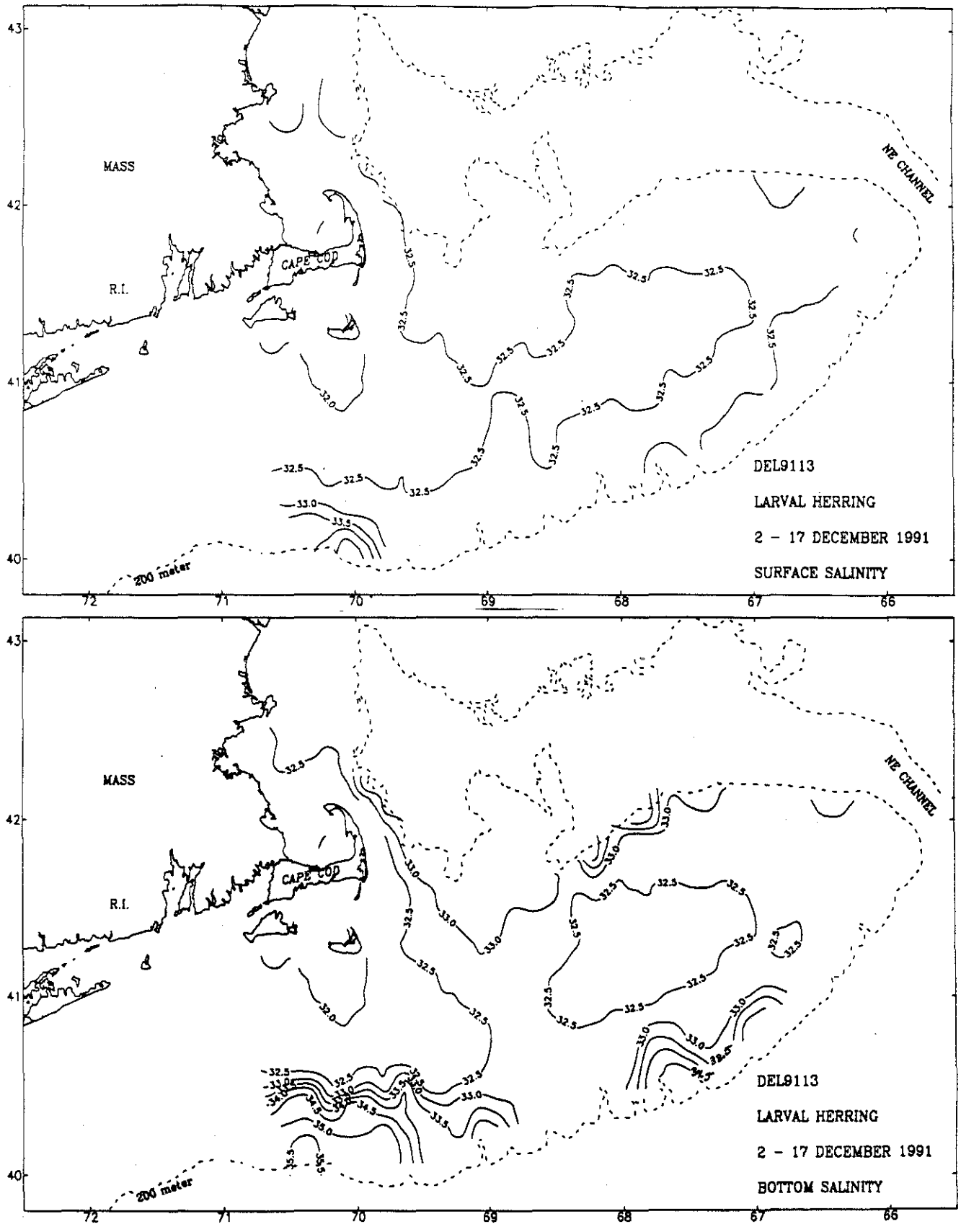

Figure 38. The surface and bottom salinity distribution for the Larval Herring/Sand Lance Study DEL9113.

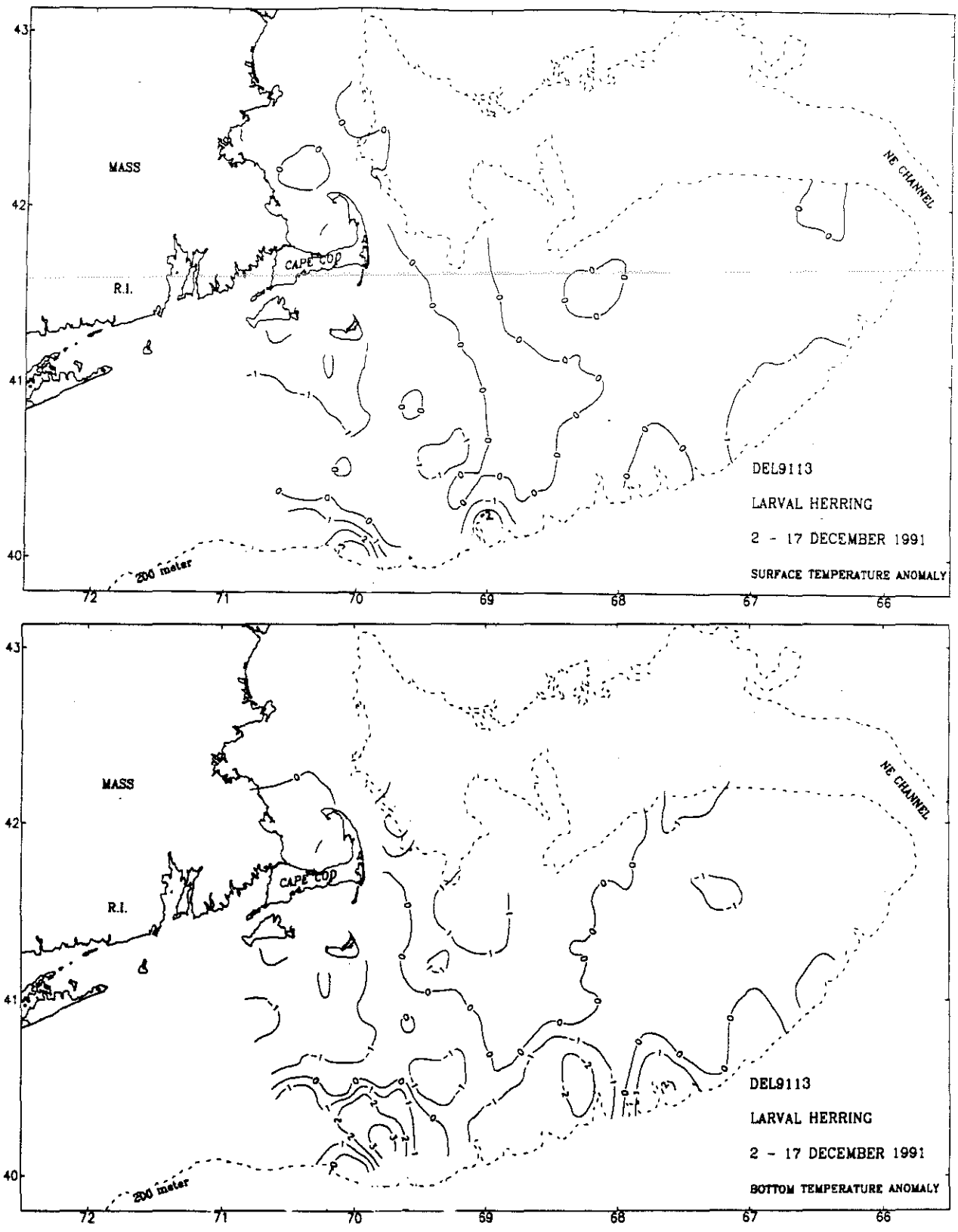

Figure 39. The surface and bottom temperature anomaly distribution for the Larval Herring/Sand Lance Study DEL9113.

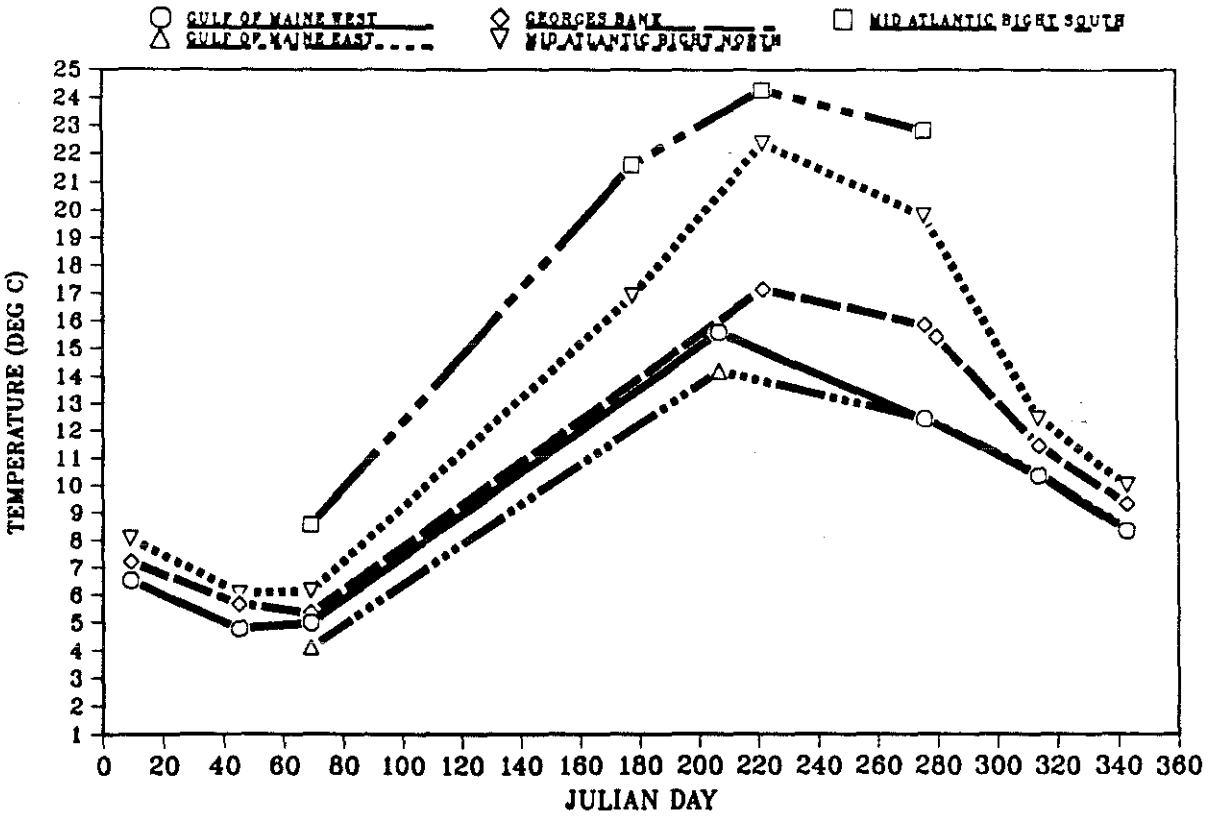

Figure 40. The 1991 areal average surface temperature values from Table 1.

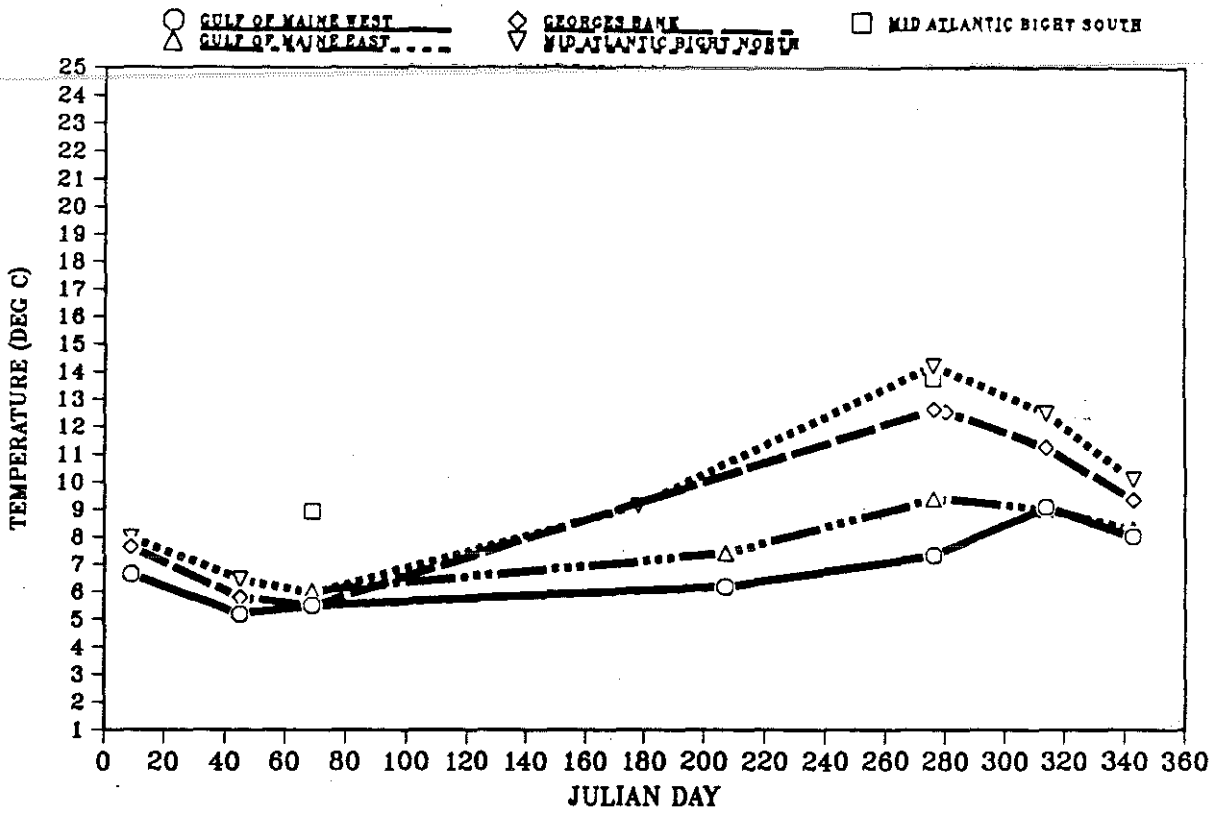

Figure 41. The 1991 areal average bottom temperature values from Table 1. There are only two data points for the Southern Middle Atlantic Bight region, so these values have simply been posted here.

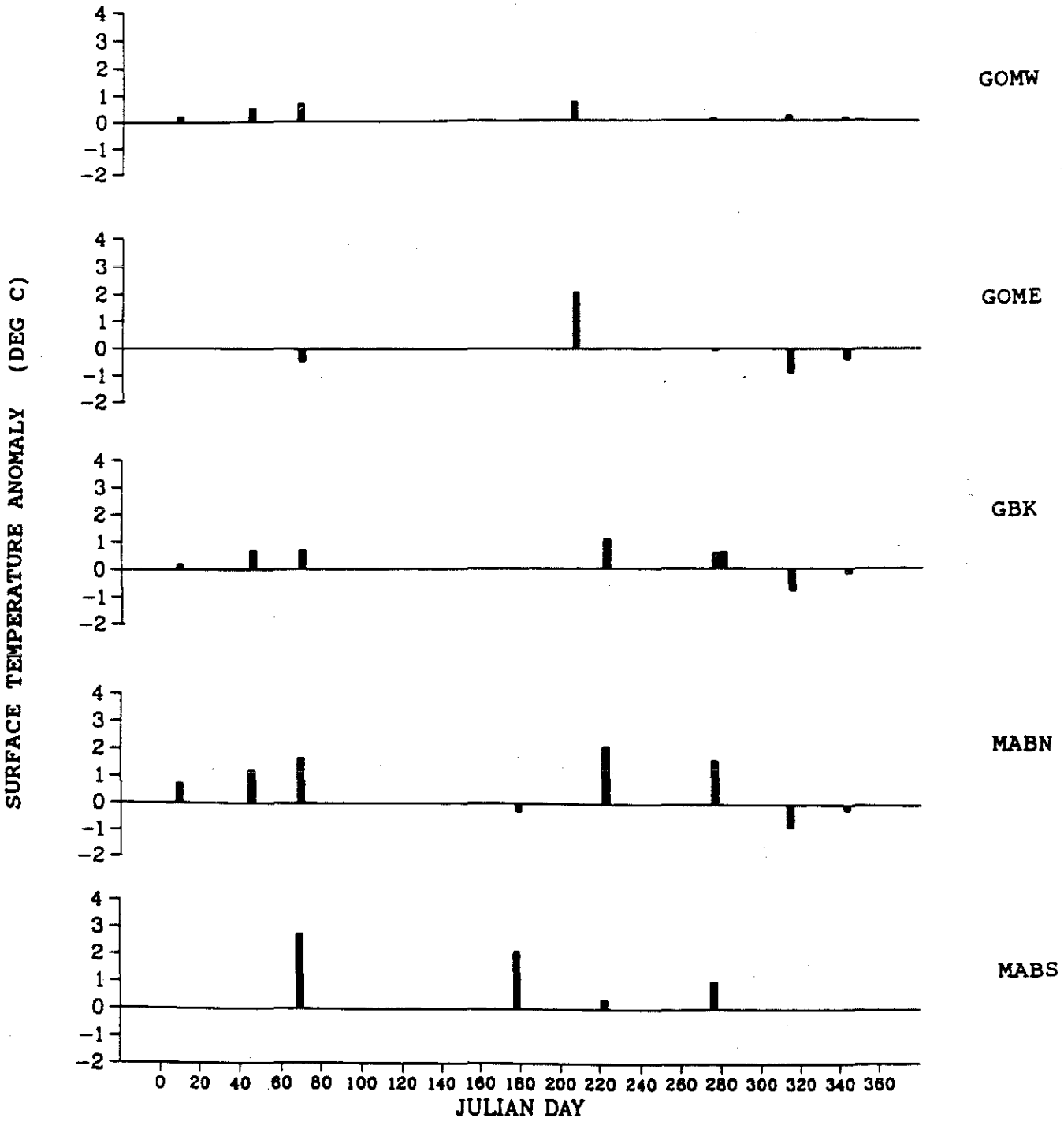

Figure 42. The 1991 areal average surface temperature anomalies, calculated in Table 1, for the five regions of the northeast continental shelf.

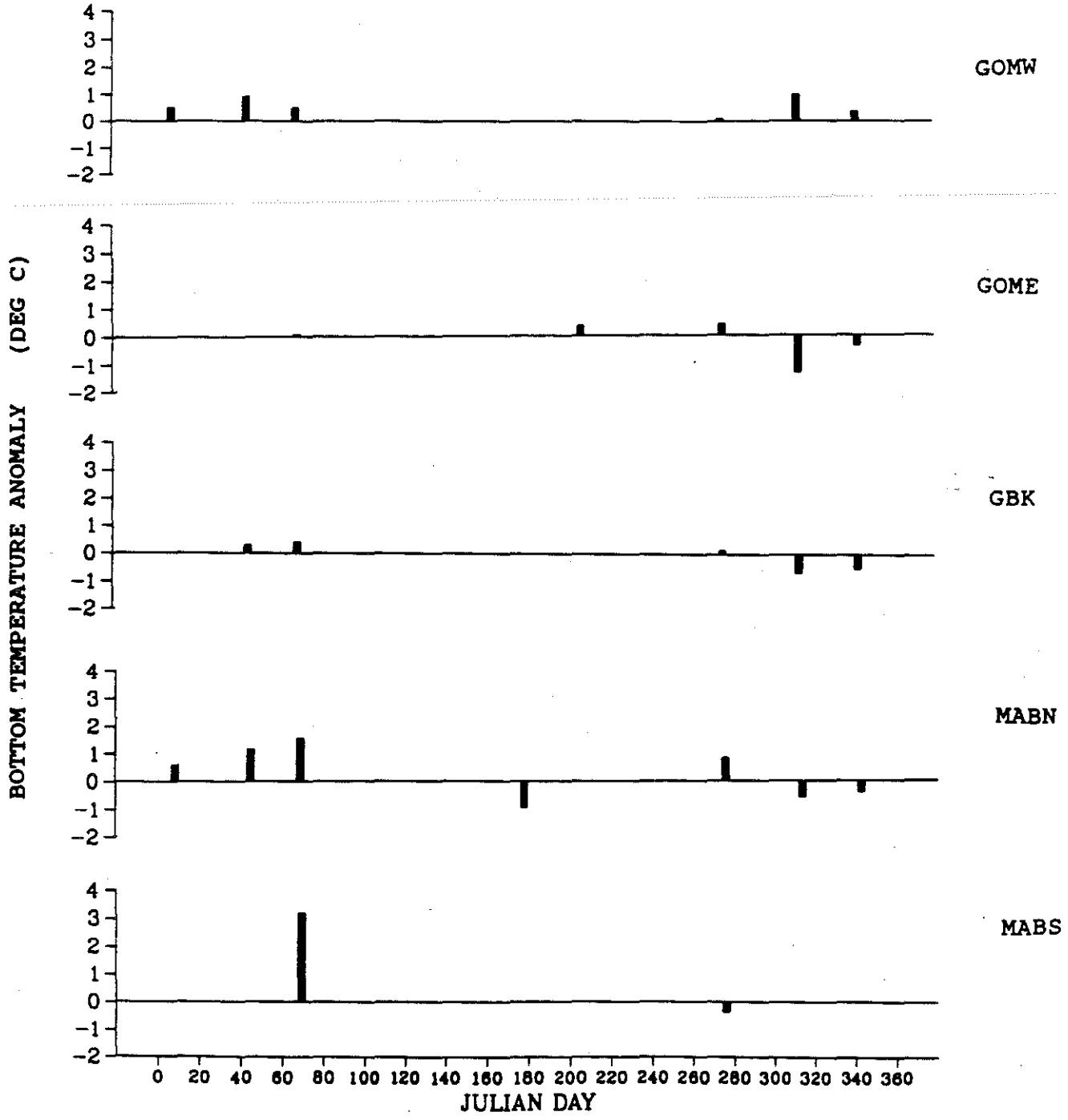

Figure 43. The 1991 areal average bottom temperature anomalies, calculated in Table 1, for the five regions of the northeast continental shelf.