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Description of the 1993 Oceanographic Conditions on the Northeast Continental Shelf

by

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ABSTRACT

A summary of hydrographic observations for fourteen surveys on the northeast continental shelf during 1993 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 as well as temperature anomalies have been calculated for each survey in five geographic regions over the northeast continental shelf. These are: 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. Complete coverage of the shelf (Cape Hatteras to the Gulf of Maine) occurs during spring and fall bottom-trawl surveys. Larval herring surveys cover the Georges Bank area. Other special interest cruises occur throughout the year, *i.e.* marine mammal sighting surveys, shellfish surveys, and summer and winter bottom trawl surveys. Coverage of stations on these cruises varies.

The oceanographic conditions during 1991 and 1992 are described in Holzwarth-Davis and Taylor (1992 and 1993).

Temperature and salinity observations from fourteen NEFSC surveys conducted during 1993 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 measures the pressure, temperature, and conductivity of the water 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 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.

All data from the *R/V Gloria Michelle* shrimp cruise were collected with an expendable bathythermograph (XBT) probe. This data set contains temperature only.

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 prepared for each survey. Areal average temperatures and temperature anomalies were calculated using the method described in Holzwarth and Mountain (1990). The areal averages were summarized for the five regions of the northeast continental shelf shown in Figure 1: western and eastern Gulf of Maine, Georges Bank, and northern and southern Middle Atlantic Bight. The areal average temperatures and temperature anomalies were plotted against the mid-date of all observations within a region of each cruise.

RESULTS

The NEFSC cruises for which data are presented in this report are listed in Table 1. A summary of each cruise is listed in Appendix 1. 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 data processing.

Table 1. Summary of 1993 cruises

Cruise	Program	Dates	Region[1]
DEL9301	Larval Herring Study	6-21 January	MABN,GB,GOMW
DEL9303	Winter Btm. Trawl Survey	4 - 26 February	MAB,GB
ALB9304	Spring Btm. Trawl Survey	8 March - 30 April	NE Shelf
ALB9305	Bluefish Survey	13 - 14 May	MAB slope
ALB9306	Marine Ecosystem Response	17 - 28 May	GB
DEL9306	Marine Mammal Survey	14 June - 2 July	S. Georges
DEL9308	Summer Btm. Trawl Survey	20 July - 6 August	GOM
ORE9304	Sea Scallop Survey	31 July - 24 August	MAB,GB
GM9220	Shrimp Survey	2 - 13 August	GOM
AJ9301	Harbor Porpoise Survey	5 - 23 August	GOM
ALB9311	Autumn Btm. Trawl Survey	7 September - 26 October	NE Shelf
EGG9301	Harbor Porpoise Survey	9 - 19 September	GOM
DEL9312	Larval Herring Study	2 - 10 November	MABN,GB,GOMW
DEL9314	Larval Herring Study	30 November - 10 December	MABN,GB,GOMW

[1] Regional abbreviations

GB	=	Georges Bank
GOM	=	Gulf of Maine
MAB	=	Middle Atlantic Bight
MABN	=	Northern MAB
NE Shelf	=	Northeast Continental Shelf
GOMW	=	Western GOM

Table 2 lists the surface and bottom areal average temperatures and temperature anomalies that were calculated for each of the five regions. For most 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).

Figures 2 through 3 present the time series of surface and bottom average temperature and temperature anomaly for each region. These values, taken from Table 2, include only the true areal averaged data.

Station positions and distributions of surface and bottom temperature, salinity, and temperature anomaly for the different cruises are presented in Figures 4 through 67. Temperature, salinity, and temperature anomaly distributions were not prepared for the surface and bottom of *R/V Phocoena* 9301 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 Albatross* 9305, *R/V Delaware* 9306, and *R/V Abel J* 9301, because the distance to standard MARMAP stations was too great for a reliable comparison to be made. Bottom distributions were not presented for *R/V Albatross* 9305, *R/V Delaware* 9306, and *R/V Abel J* 9301, 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). The *R/V Albatross* 9305 temperature and salinity contours were prepared at the 100 m level.

No salinity samples were taken on the *R/V Gloria Michelle* 9320; consequently, no salinity plots were generated.

DISCUSSION

Overall, the distribution patterns of temperature and salinity appeared typical for the northeast continental shelf region. The majority of the regional averaged temperatures were only slightly cooler (generally 1° C or less) when compared to the 1977-1987 reference period.

Anomalous temperatures and salinities occurred during cruises at small sites (1 or 2 stations). Such localized events are not discussed here.

Table 2. Areal average surface and bottom temperature and temperature anomaly for the NEFSC 1993 cruises in the five regions of the northeast continental shelf shown in Figure 1[1]

Cruise			Surface					Bottom			
	CD	#Obs	Temp (°C)	Anomaly	SDV1	SDV2	#Obvs	Temp (°C)	Anomaly	SDV1	SDV2
Gulf of Maine West											
DEL9301	9	8[2]	5.26	-0.92	0.50	0.43	8[2]	5.96	0.00	0.36	0.55
ALB9304	111	33	4.75	-0.44	0.20	1.14	33	4.68	-0.63	0.15	0.81
DEL9308	210	53[2]	15.24	-0.74	0.17	1.66	51[2]	5.66	-0.50	0.14	1.09
GLM9320	220	42[2]	18.13	0.99	0.19	1.78	42[2]	5.36	-0.32	0.14	1.25
AJ9301	228	2[2]	15.50	-0.71	0.84	1.84	2[2]	5.55	-0.64	0.51	1.31
DEL9311	286	39	12.12	-0.53	0.18	0.68	39	7.01	-0.20	0.15	1.42
DEL9312	308	10[2]	9.75	-0.76	0.46	0.36	10[2]	7.40	-0.69	0.37	0.89
DEL9314	338	8[2]	8.69	0.34	0.50	0.36	8[2]	7.15	-0.69	0.36	1.04
Gulf of Maine East											
ALB9304	108	31	3.89	-1.12	0.20	1.18	29	6.13	-0.34	0.22	0.93
DEL9308	205	13[2]	14.58	-0.13	0.31	1.24	11[2]	7.78	0.12	0.30	1.19
ORE9304	229	8[2]	16.56	2.10	0.29	1.39	8[2]	7.53	-4.56	0.28	1.41
AJ9301	232	3[2]	14.03	0.08	0.46	1.32	3[2]	6.93	-0.45	0.51	1.46
DEL9311	290	30	11.49	-1.06	0.22	0.87	28	8.89	-0.20	0.27	1.74
DEL9312	311	12[2]	10.85	-1.03	0.26	0.25	11[2]	9.65	-1.19	0.27	1.33
DEL9314	343	5[2]	9.68	0.62	0.39	0.29	5[2]	9.02	-0.37	0.40	0.76
Georges Bank											
DEL9301	13	73	5.93	-0.92	0.16	0.64	66	6.29	-1.16	0.20	0.82
ALB9303	54	15[2]	4.43	-0.94	0.36	0.62	10[2]	5.61	-1.06	0.52	0.96
ALB9304	100	56	5.01	-0.11	0.21	1.66	50	4.81	-0.61	0.25	0.86
ALB9306	140	42[2]	7.33	-0.72	0.18	0.53	40[2]	7.02	0.12	0.23	1.45
DEL9306	170	36[2]	12.84	-0.67	0.37	2.29	9[2]	8.62	0.61	0.63	2.06
ORE9304	227	59	16.63	0.84	0.18	2.58	57	10.38	-0.86	0.21	2.10
DEL9311	278	57	15.94	0.61	0.21	1.35	49	13.45	0.57	0.22	1.78
DEL9312	311	69	12.26	-0.34	0.18	0.84	68	11.98	-0.13	0.17	1.15
DEL9314	342	72	10.15	0.31	0.17	1.03	66	10.26	0.09	0.22	0.87
MAB North											
DEL9301	15	70	6.68	-0.93	0.22	1.12	62	7.43	-0.97	0.27	1.13
ALB9303	52	38	4.16	-0.79	0.29	1.11	34	4.82	-0.94	0.33	1.22
ALB9304	89	53	4.31	-0.29	0.26	0.66	48	4.36	-1.18	0.31	1.42
ALB9305	132	2[2]	13.55	2.64	1.97	0.41					
ORE9304	211	20[2]	20.94	1.19	0.32	0.89	20[2]	8.34	-0.31	0.34	2.04
DEL9311	267	58	18.69	0.68	0.27	1.25	53	12.22	-0.14	0.33	2.49
DEL9312	306	20[2]	12.01	-0.99	0.33	1.03	19[2]	12.04	-0.85	0.37	1.27
DEL9314	336	20[2]	10.27	-0.20	0.34	0.84	18[2]	10.45	-0.54	0.39	0.93
MAB South											
DEL9301	19	12[2]	7.06	-0.50	0.48	1.50	9[2]	7.11	0.12	0.53	0.83
ALB9303	41	54[2]	6.83	0.35	0.25	1.70	49[2]	6.69	0.49	0.27	1.48
ALB9304	79	82	5.22	-0.80	0.24	1.49	76	5.36	-0.44	0.28	2.09
ALB9305	112	3[2]	9.67	-0.23	1.46	2.85					
ORE9304	217	48[2]	24.14	0.02	0.24	0.67	47[2]	8.10	0.17	0.29	1.76
DEL9311	257	81	22.94	1.06	0.26	2.13	75	12.26	-2.03	0.29	3.08

[1] "CRUISE", the code name for a cruise; "CD", the calendar mid-date of all the stations within a region for a cruise; "#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.

[2] 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.

REFERENCES

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: NOAA/NMFS/NEFSC. *Ref. Doc.* 90-03. Available from: Information Services Section, NMFS/Northeast Fisheries Science Center, Woods Hole, MA; 02543

Holzwarth-Davis, T.J. and M. H. Taylor. 1992. Description of the 1991 oceanographic conditions on the northeast continental shelf. Woods Hole, MA: NOAA/NMFS/NEFSC. *Ref. Doc.* 92-08. Available from: Information Services Section, NMFS/Northeast Fisheries Science Center, Woods Hole, MA; 02543.

Holzwarth-Davis, T.J. and M. H. Taylor. 1993. Description of the 1992 oceanographic conditions on the northeast continental shelf. Woods Hole, MA: NOAA/NMFS/NEFSC. *Ref. Doc.* 93-25. Available from: Information Services Section, NMFS/Northeast Fisheries Science Center, Woods Hole, MA; 02543.

Appendix 1

Summary of Cruise Information and Hydrographic Work Completed

CRUISE SUMMARY

Vessel: *R/V Delaware II*
Cruise: DEL9301
Program: Larval herring/Sand lance Study
Dates: January 5 - 21, 1993
Sea days: 17
Instrument(s): *Profiler* 456/*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: 177
 # Vertical CTD/*Profiler* casts: 24
 # Double Oblique *Profiler* casts: 177
 # XBT drops: 0
 # salinity samples: 24
Salt correction: +0.016 PSU

Special Notes: Instrument # 456 performed well, data were recorded in 'real-time' mode, recording and simultaneously downloading data to a computer via a conducting core cable. Instrument # 853 was used for three stations only, consecutive #'s 97, 98, and 99, no salinity correction was applied.

CRUISE SUMMARY

Vessel: *R/V Albatross IV*
Cruise: ALB9303
Program: Winter Bottom Trawl Survey
Dates: February 3 - 27, 1993
Sea days: 21
Instrument(s): *Profiler* 853

Cruise objectives: To (1) determine the winter 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: 125
 # Vertical CTD/*Profiler* casts: 58
 # Double Oblique *Profiler* casts: 19
 # XBT drops: 4
 # salinity samples: 18
Salt correction: +0.023 PSU

Special Notes: *Profiler* 853 generally performed well in the real-time mode. There were a few problems with the electrical connections at the start of the survey. No salinity data were obtained on consecutive station #'s 77-82 and 116-118 due to ice clogging the pump.

CRUISE SUMMARY

Vessel: *R/V Albatross IV*
Cruise: ALB9304
Program: Spring Bottom Trawl Survey
Dates: March 8 - April 30, 1993
Sea days: 46
Instrument(s): *Profiler* 851/*Profiler* 360

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: 329
 # Vertical CTD/*Profiler* casts: 213
 # Double Oblique *Profiler* casts: 119
 # XBT drops: 0
 # salinity samples: 11 (for #851)/ 18 (for #360)
Salt correction: +0.066PSU/ +0.044 PSU

Special Notes: Both instruments used in real-time mode. Instrument # 851 was clogged with ice near the end of the first leg. Instrument # 360 was used on the remainder of the survey.

CRUISE SUMMARY

Vessel: *R/V Albatross IV*
Cruise: ALB9305 II
Program: Larval Bluefish Distribution Study
Dates: May 6 - 13, 1993
Sea days: 9
Instrument(s): *Profiler* 360/*Profiler* 456

Cruise objectives: To (1) search for evidence of bluefish spawning via bongo sampling gear and to (2) test methods of transmitting and displaying satellite images at-sea.

Total # of stations: 54
 # Vertical CTD/*Profiler* casts: 54
 # Double Oblique *Profiler* casts: 54
 # XBT drops: 0
 # salinity samples: 3/8
Salt correction: None. Not enough reliable samples for either instument.

Special Notes: *Profiler* #360 was used on stations 1 through 13, *Profiler* #851 was used on the remainder of the stations. Both instruments were used in the real-time mode and experienced severe spiking which was caused by hydraulic fluid leaking into the slipring. Vertical *Profiler* casts only sampled the top 100 m of the water column regardless of bottom depth. Double oblique *Profiler* casts sampled just the top 15 m.

CRUISE SUMMARY

Vessel: *R/V Albatross IV*
Cruise: ALB9306
Program: Marine Ecosystem Response
Dates: May 18 - 28, 1992
Sea days: 11
Instrument(s): *Profiler* 851

Cruise objectives: To (1) acquire information on the abundance and distribution of ichthyoplankton and zooplankton on the southern flank of Georges Bank in relation to water column conditions, (2) deploy and recover two moorings for measuring physical and biological parameters at a fixed site, (3) make repeated observations of the plankton at the fixed site and within a drifting patch of water tagged by transmitting buoys, and (4) make these observations in close cooperation with the *R/V Colombus Iselin*.

Total # of stations: 47*
 # Vertical CTD/*Profiler* casts: 8
 # Double Oblique *Profiler* casts: 47
 # XBT drops: 0
 # salinity samples: 8
Salt correction: +0.019 PSU

Special Notes: *There were approximately 150 "stations" during the survey. Instrument #851 was used in real-time mode.

CRUISE SUMMARY

Vessel: *R/V Delaware*
Cruise: DEL9306
Program: Marine Mammal Sighting Survey
Dates: June 1 - July 2, 1993
Sea days: 30
Instrument(s): *Profiler* 851

Cruise objectives: To (1) investigate and determine the fine scale distribution and habitat utilization of beaked whales and pelagic delphinids within warm core rings (WCR) and the shelf edge break, (2) to determine if distribution of these species is continuous along Georges Bank shelf edge to the Scotian Shelf, (3) to determine if beaked whales are associated with a WCR, and (4) to conduct line-transect population surveys within the study area.

Total # of stations: 111
 # Vertical CTD/*Profiler* casts: 134
 # Double Oblique *Profiler* casts: 22
 # XBT drops: 0
 # salinity samples: 37
Salt correction: no correction done

Special Notes: Instrument #851 generally performed well in the realtime mode. After the slip rings failed was used in 'archived' mode (data was internally recorded and then downloaded to the computer) during the first leg. Instrument did not record clean data during the beginning and end of some casts on the first leg. The slip rings were replaced before the start of the second leg. Instrument worked fine on the second leg. The winch broke at the end of leg I and double oblique bongo tows were not possible. Salinity samples were taken for calibration purposes, however, the bottle numbers were not recorded at each station and no salinity correction could be calibrated.

CRUISE SUMMARY

Vessel: *R/V Delaware II*
Cruise: DEL9308
Program: Gulf of Maine Bottom Trawl Survey
Dates: July 20 - August 4, 1993
Sea days: 15
Instrument(s): *Profiler* 456/*Profiler* 853

Cruise objectives: To (1) determine the seasonal distribution and relative abundance of fish and invertebrate species, (2) collect biological samples for studies of age and growth relationships, fecundity, maturity, and food habits, (3) continue an evaluation of the feasibility of conducting a routine bottom trawl survey time series in nearshore waters of the Gulf of Maine, (4) collect hydrographic and meteorological data, (5) collect samples for cooperative researchers, (6) conduct gear tests, and (7) sample groundfish nursery areas in order to develop prerecruitment indices.

Total # of stations: 149
 # Vertical CTD/*Profiler* casts: 104
 # Double Oblique *Profiler* casts: 0
 # XBT drops: 0
 # salinity samples: 26/2
Salt correction: no correction necessary

Special Notes: Instrument #456 was used until problems occurred. Instrument # 853 worked for eight stations before being damaged. Both instruments were used in real-time mode. Instrument #456 was used on the remainder of the trip in the archived mode.

CRUISE SUMMARY

Vessel: *R/V Oregon II*
Cruise: ORE9304
Program: Sea Scallop Survey
Dates: July 31 - August 25, 1992
Sea days: 25
Instrument(s): *Profiler* 851

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: 446
 # Vertical CTD/*Profiler* casts: 141
 # Double Oblique *Profiler* casts: 0
 # XBT drops: 0
 # salinity samples: 36
Salt correction: none necessary

Special Notes: The instrument was used in archived mode.

CRUISE SUMMARY

Vessel: *R/V Gloria Michelle*
Cruise: GM9320
Program: Summer Gulf of Maine Shrimp Survey
Dates: August 2 - 13, 1993
Sea days: 12
Instrument(s):

Cruise objectives: To investigate the population of northern shrimp in the Gulf of Maine.

Total # of stations: 53
 # Vertical CTD/*Profiler* casts: 0
 # Double Oblique *Profiler* casts: 0
 # XBT drops: 54
 # salinity samples: 0
Salt correction: N/A

Special Notes: No CTD or *Profiler* was used on this trip.

CRUISE SUMMARY

Vessel: *R/V Abel J*
Cruise: AJ9301
Program: Harbor Porpoise Sighting Survey
Dates: August 3 - 22, 1993
Sea days:
Instrument(s): *Profiler* 360

Cruise objectives: To (1) conduct a line transect sighting survey to determine summer distribution and relative abundance of marine mammals, particularly of harbor porpoises, (2) study vessel avoidance behavior by porpoises, (3) compare porpoise detection rates between ship and aircraft platforms, (4) harbor porpoise surfacing rates in relation to proximity to ship, and (5) collect water column temperature and salinity data.

Total # of stations: 35
 # Vertical CTD/*Profiler* casts: 35
 # Double Oblique *Profiler* casts: 0
 # XBT drops: 0
 # salinity samples: 0
Salt correction: none applied

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

CRUISE SUMMARY

Vessel: *R/V Delaware II*
Cruise: ALB9311
Program: Autumn Bottom Trawl Survey
Dates: September 7 - October 27, 1993
Sea days: 48
Instrument(s): *Profiler* 851/ Profiler 853

Cruise objectives: To (1) determine the autumn 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: 339
 # Vertical CTD/*Profiler* casts: 226
 # Double Oblique *Profiler* casts: 113
 # XBT drops: 0
 # salinity samples: 11/37
Salt correction: no corrections necessary

Special Notes: Instrument #851 was used for 77 stations until it failed and was replaced with instrument #853. Both instruments were used in the real-time mode.

CRUISE SUMMARY

Vessel: *R/V Phocoena*
Cruise: EGG9301
Program: Harbor Porpoise Migration Study
Dates: September 9 - 19, 1993
Sea days: 11
Instrument(s): *Profiler* 360

Cruise objectives: To investigate the distribution of harbor porpoise and the water characteristics in the Penobscot Bay, Maine area.

Total # of stations: 40
 # Vertical CTD/Profiler casts: 40
 # Double Oblique Profiler casts: 0
 # XBT drops: 0
 # salinity samples: 0
Salt correction: no correction

Special Notes: Instrument used in archived mode and generally performed well. Instrument was hand lowered to the bottom. The R/V *Phocoena* is a 17 ft hard-bottom, inflatable boat.

CRUISE SUMMARY

Vessel: *R/V Delaware II*
Cruise: DEL9312
Program: Larval herring Study
Dates: November 2 - 10, 1993
Sea days: 9
Instrument(s): *Profiler* 1447/*Profiler* 1468

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: 15
 # Double Oblique *Profiler* casts: 132
 # XBT drops: 0
 # salinity samples: 5/10
Salt correction: 0.0/+0.012 PSU

Special Notes: Both instruments were used in real-time mode. Instrument #1447 was used for the first 37 stations. The survey was completed with instrument # 1468.

CRUISE SUMMARY

Vessel: *R/V Delaware II*
Cruise: DEL9314
Program: Larval herring/Sand lance Study
Dates: November 30 - December 10, 1993
Sea days: 11
Instrument(s): *Profiler* 1447

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: 134
 # Vertical CTD/*Profiler* casts: 16
 # Double Oblique *Profiler* casts: 134
 # XBT drops: 0
 # salinity samples: 16
Salt correction: no correction

Special Notes: Instrument performed well in the real-time mode.

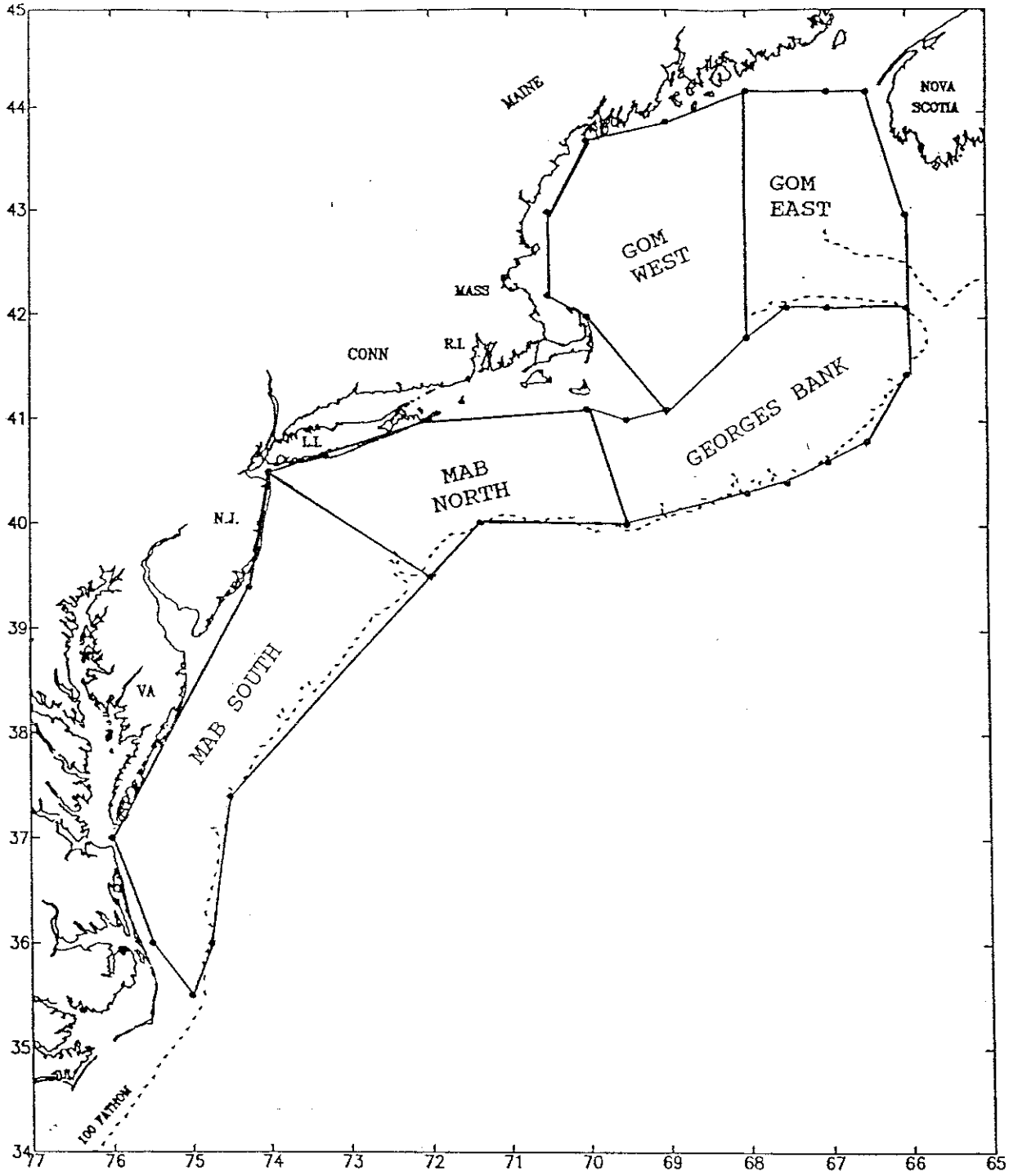


Figure 1. The regions of the northeast continental shelf covered by the Northeast Fisheries Science Center cruises during 1993. The boundaries of the five areas of the shelf for which average temperature and anomaly values are calculated are shown: western Gulf of Maine, eastern Gulf of Maine, Georges Bank, northern Middle Atlantic Bight, and southern Middle Atlantic Bight.

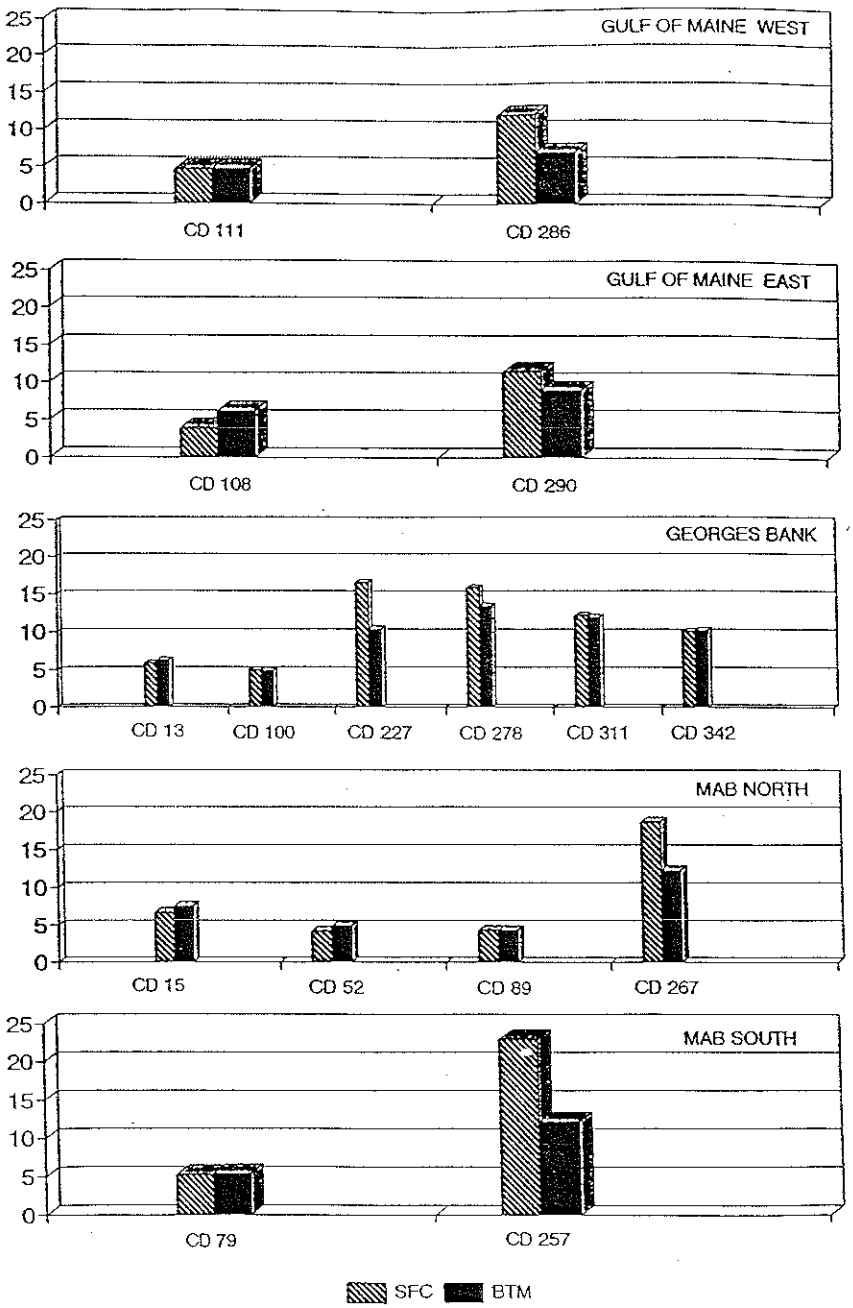


Figure 2. The 1993 areal average surface and bottom temperature values from Table 2. They are presented by the mean calendar day (CD) of the observations within a particular region during a cruise. Averages marked with an asterisk in Table 2 are not included here because they do not represent a "true" areal average and may be biased by the location of stations within a region.

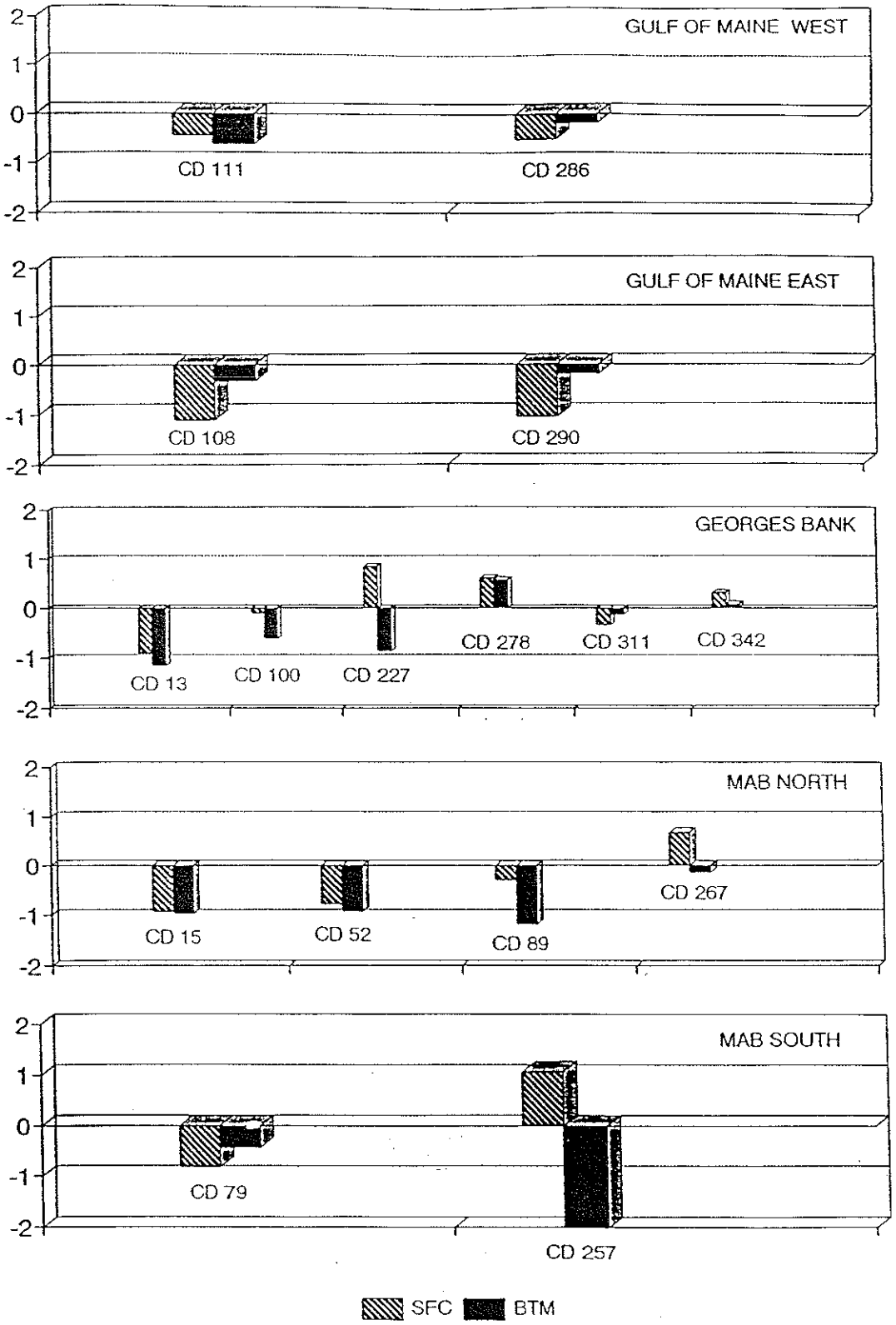


Figure 3. The 1993 areal average surface and bottom temperature anomalies from Table 2. Anomalies are presented by the mean calendar day (CD) of the observations within a particular region during a cruise.

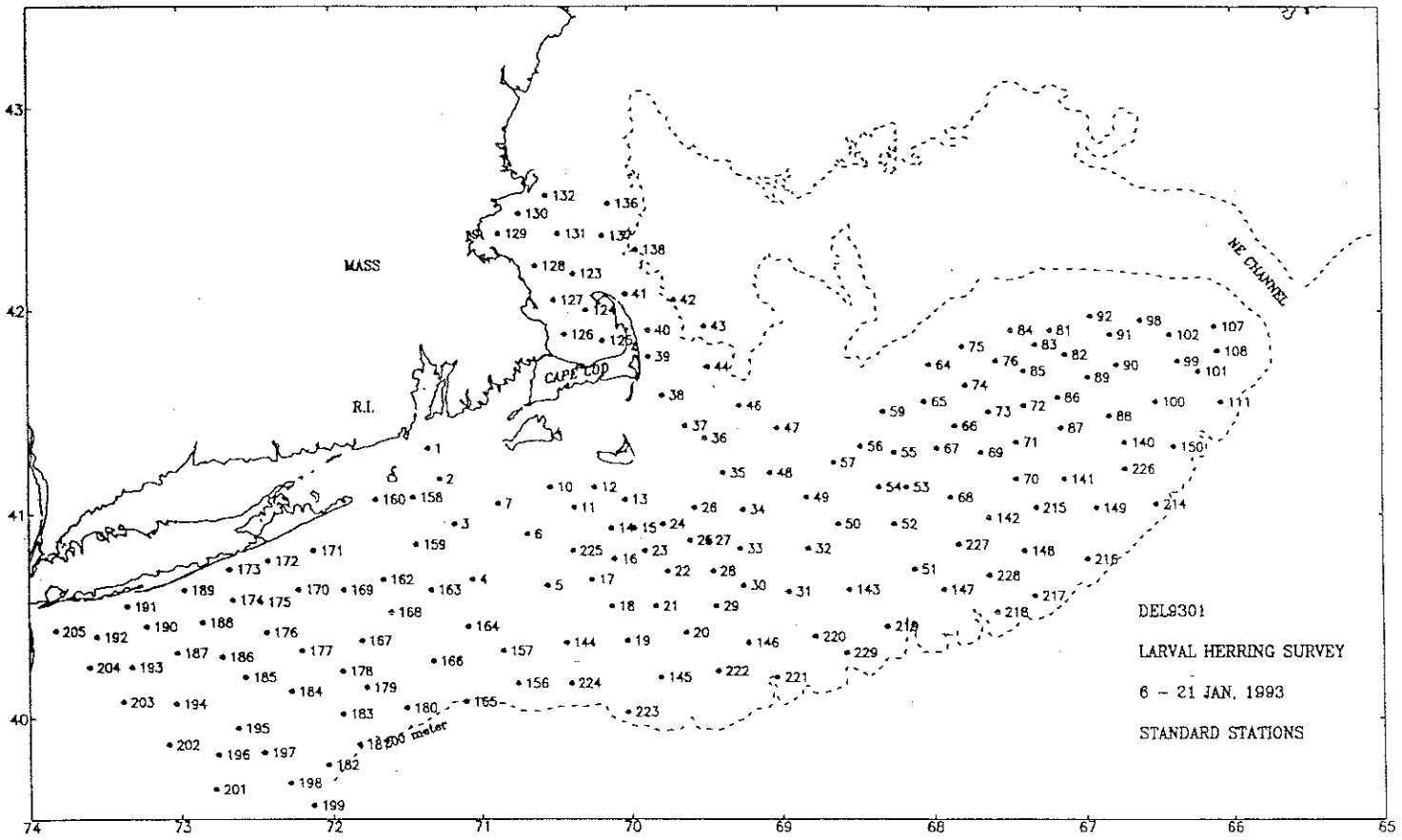


Figure 4. Hydrographic stations occupied during the larval herring/sand lance study DEL9301.

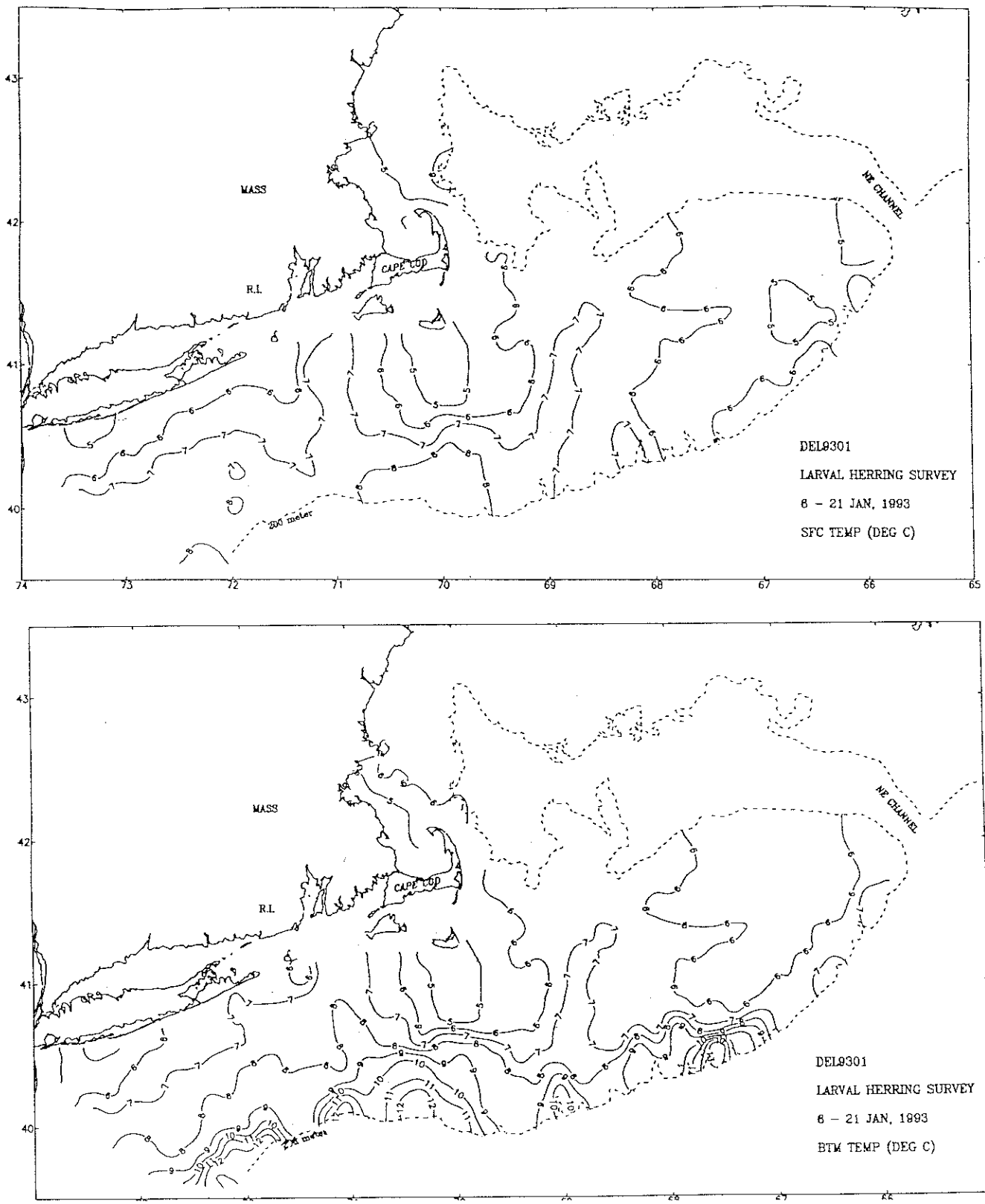


Figure 5. The surface and bottom temperature distribution for the larval herring/sand lance study DEL9301.

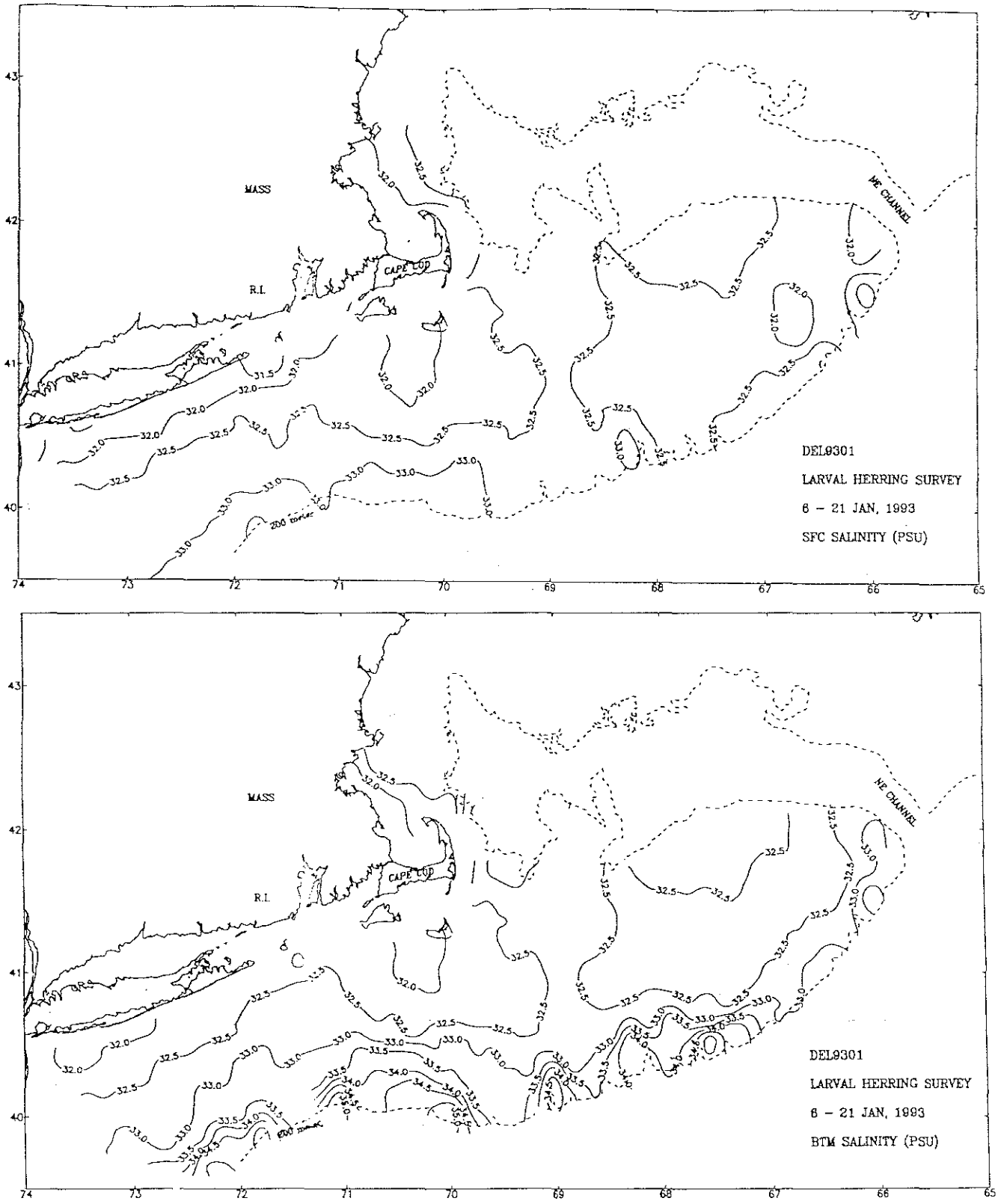


Figure 6. The surface and bottom salinity distribution for the larval herring/sand lance study DEL9301.

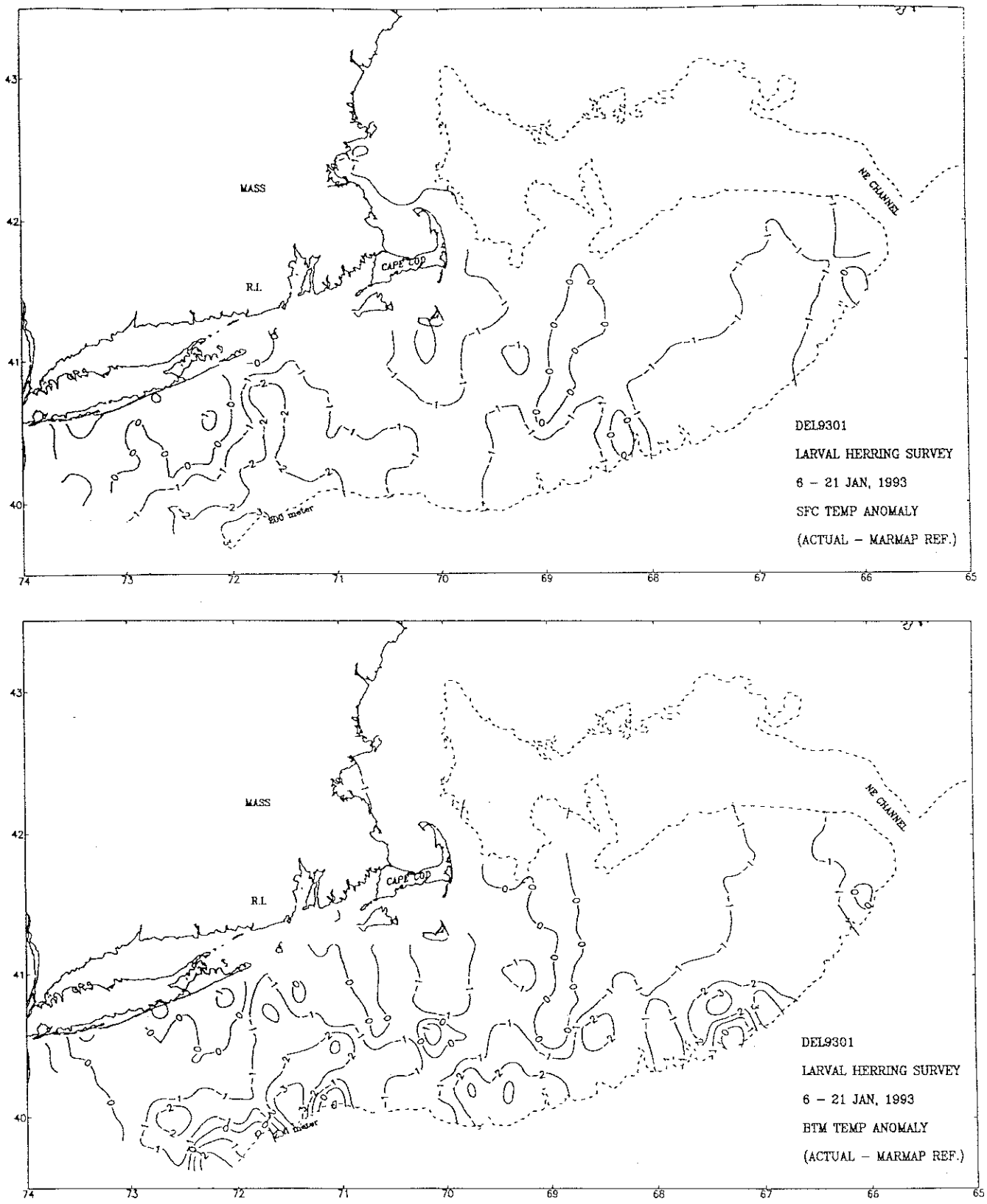


Figure 7. The surface and bottom temperature anomaly distribution for the larval herring/sand lance study DEL9301.

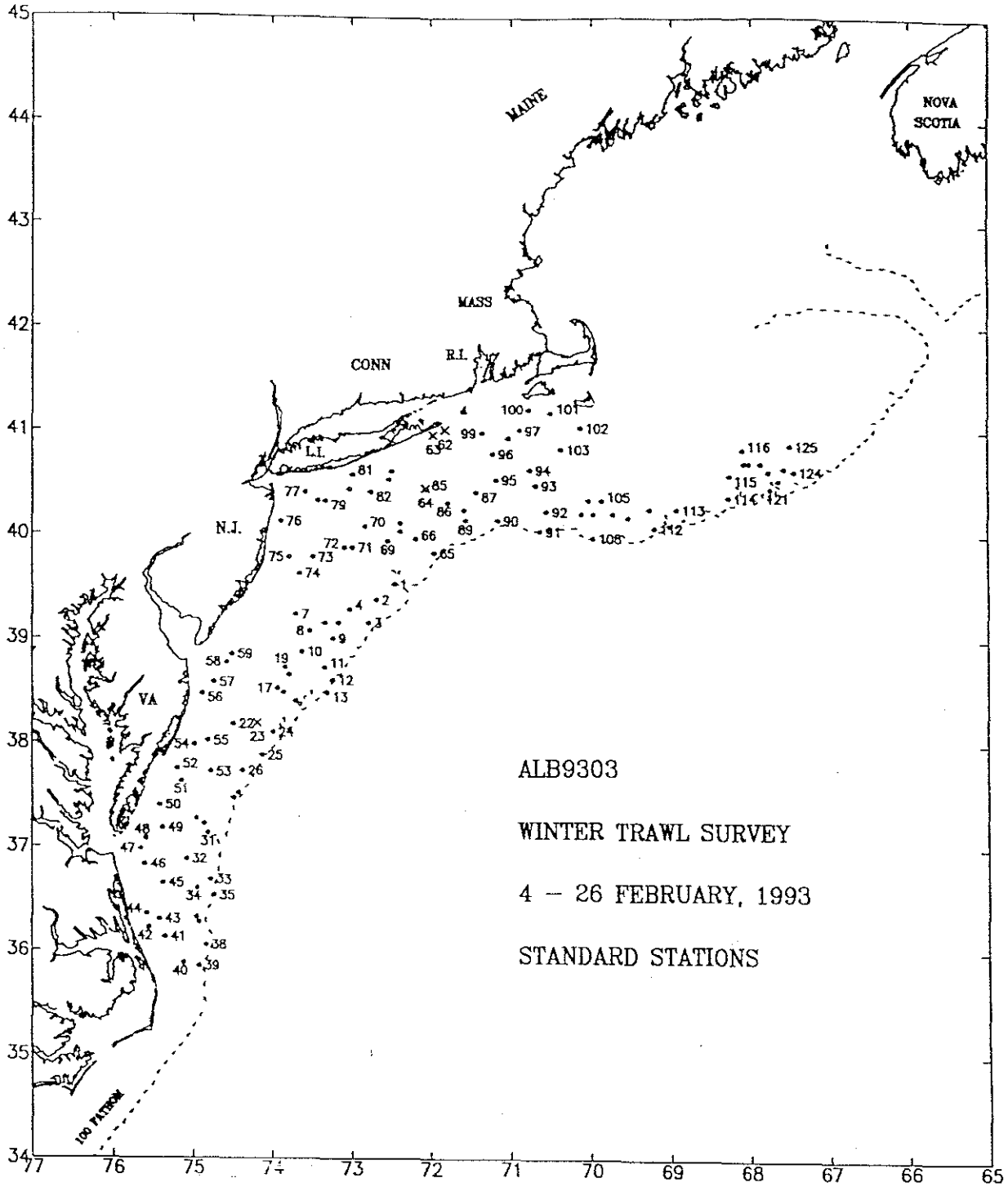


Figure 8. Hydrographic stations occupied during the winter bottom trawl survey ALB9303.

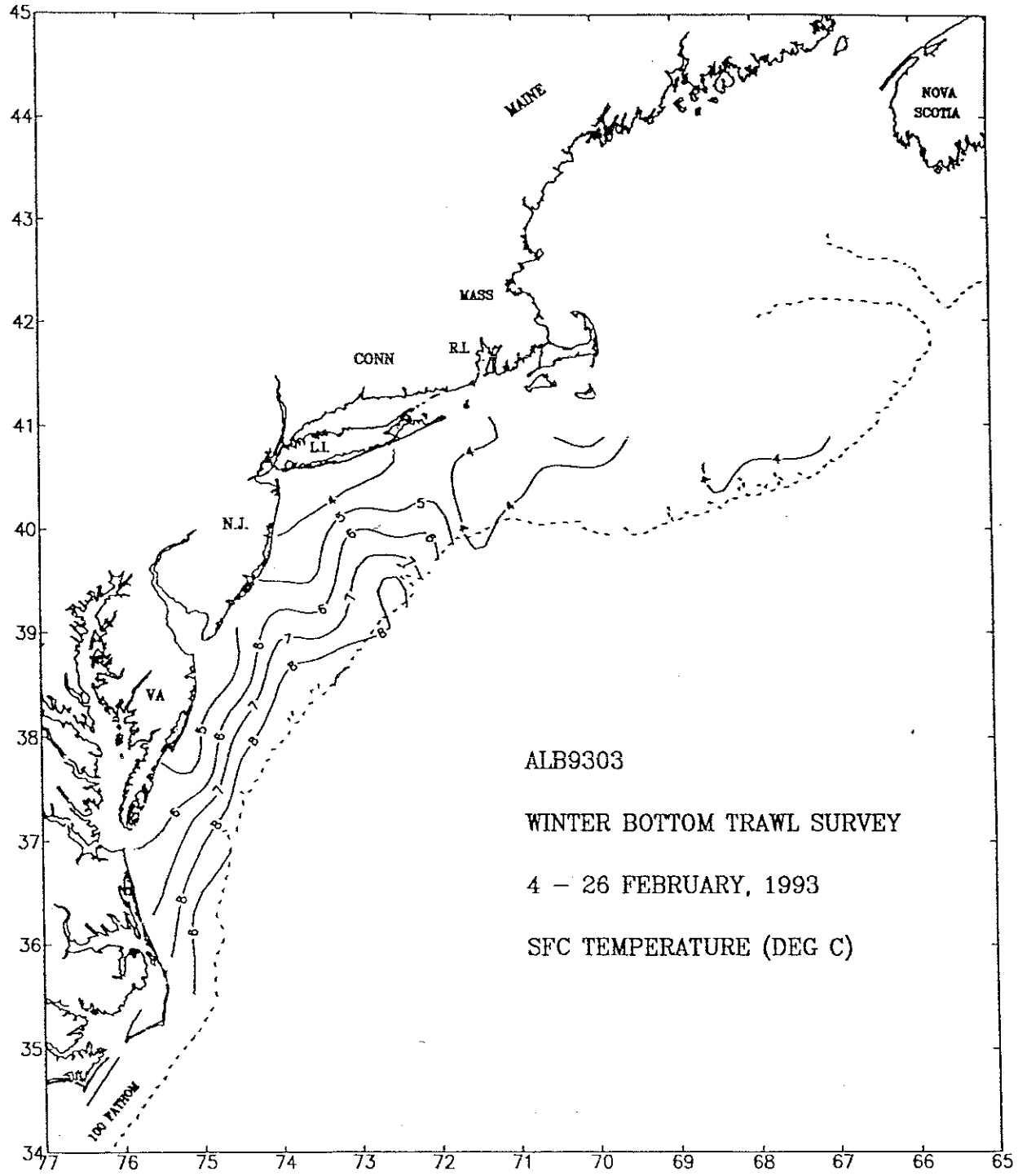


Figure 9. The surface temperature distribution for the winter bottom trawl survey ALB9303.

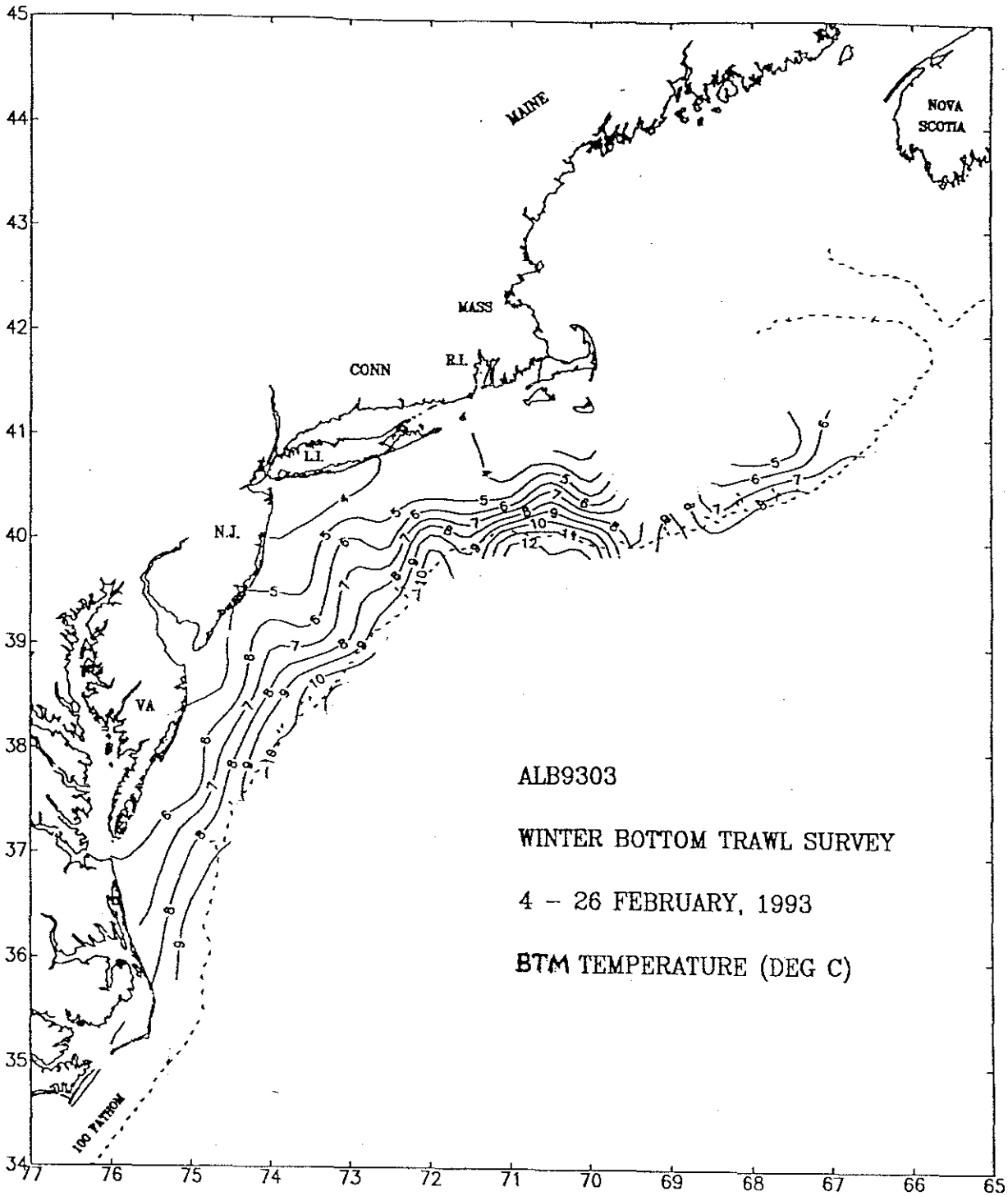


Figure 10. The bottom temperature distribution for the winter bottom trawl survey ALB9303.

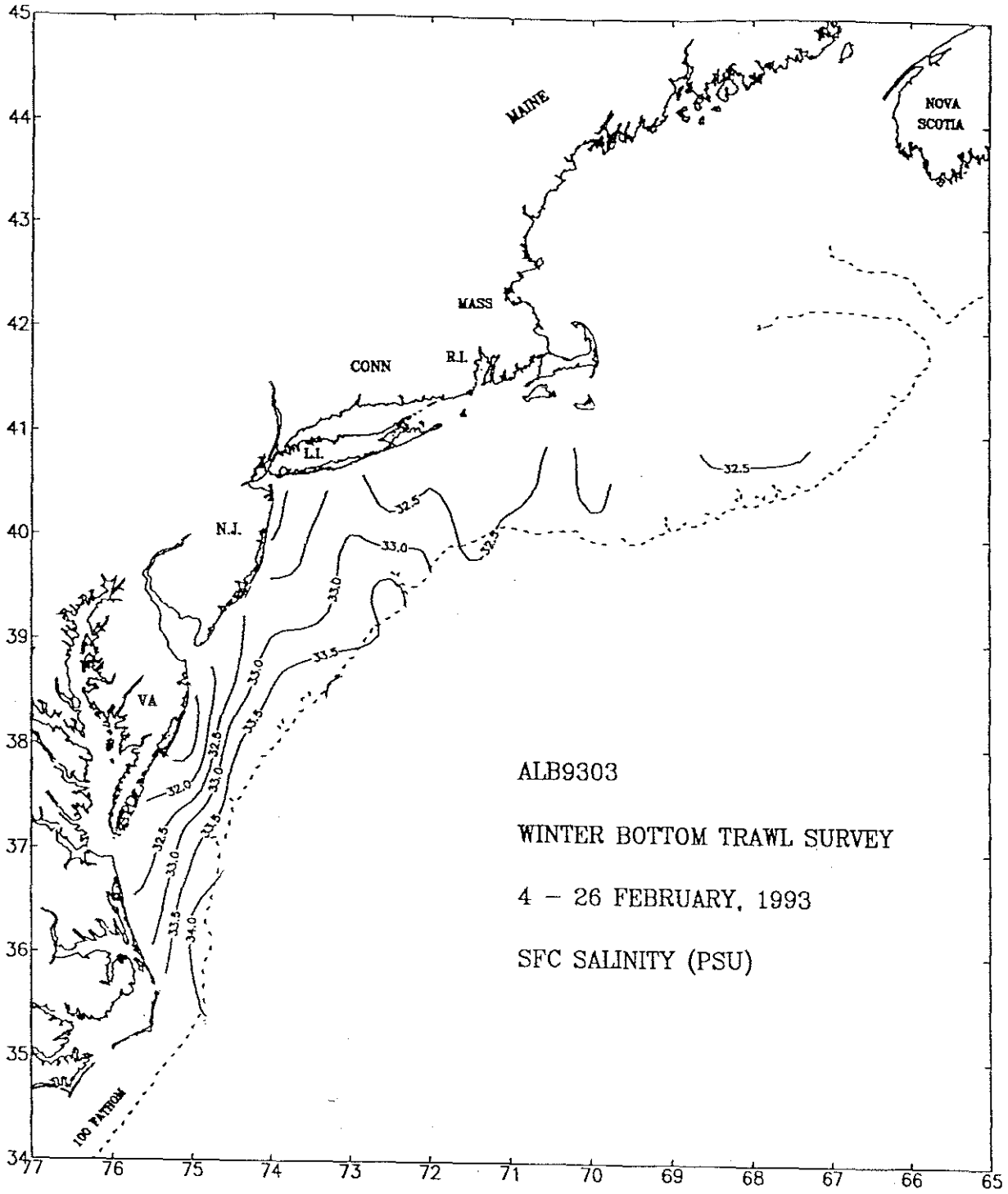


Figure 11. The surface salinity distribution for the winter bottom trawl survey ALB9303.

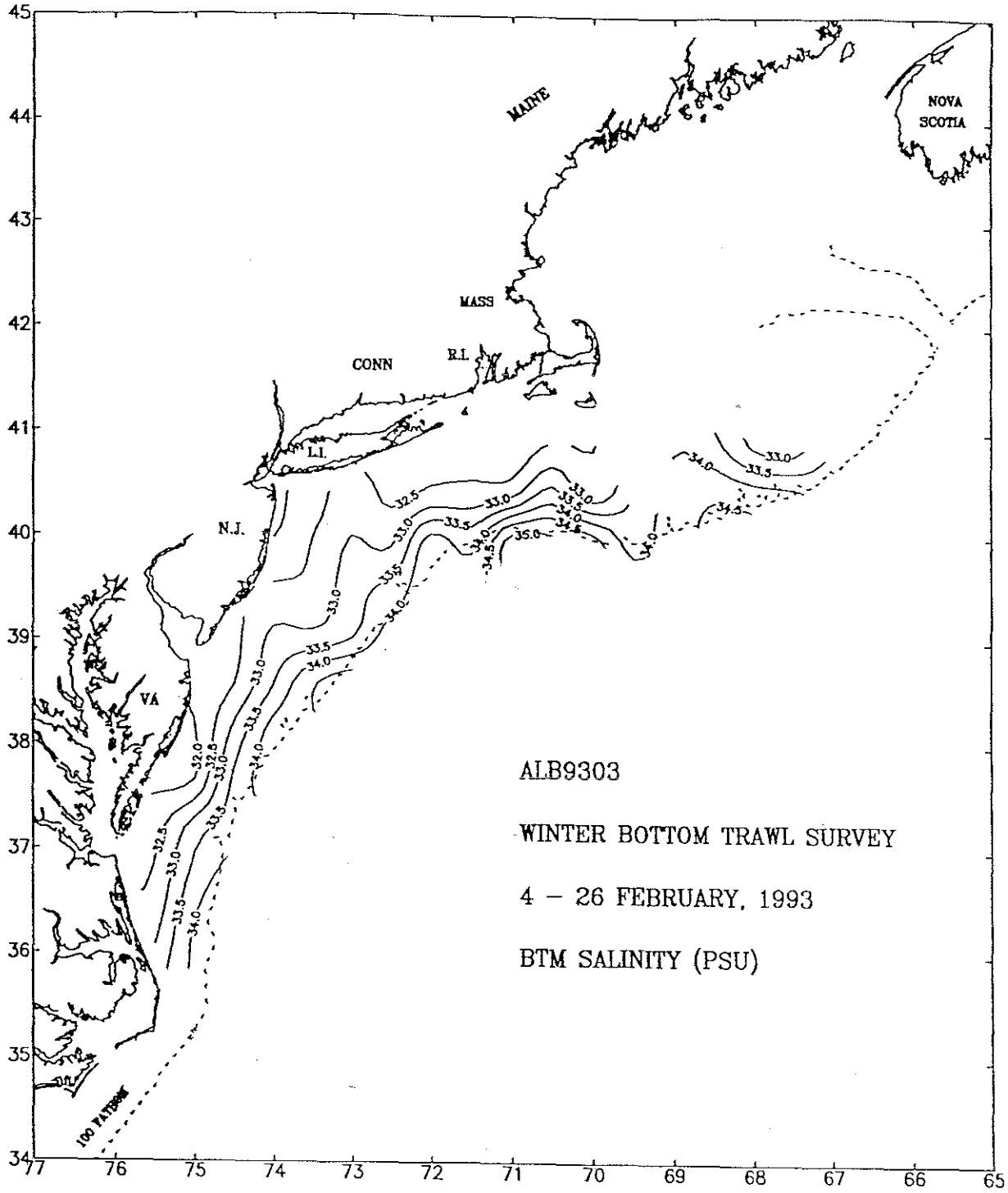


Figure 12. The bottom salinity distribution for the winter bottom trawl survey ALB9303.

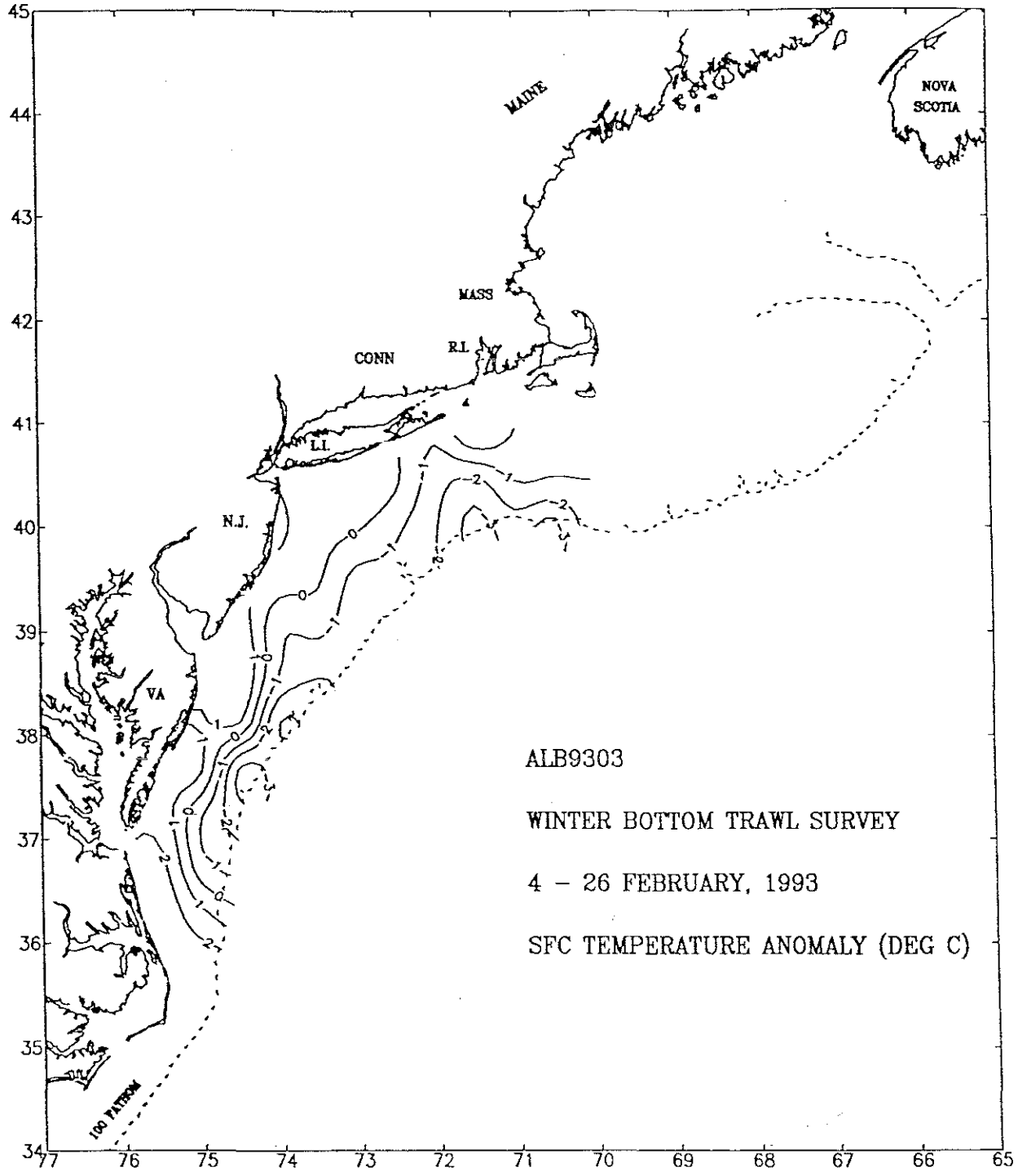


Figure 13. The surface temperature anomaly distribution for the winter bottom trawl survey ALB9303.

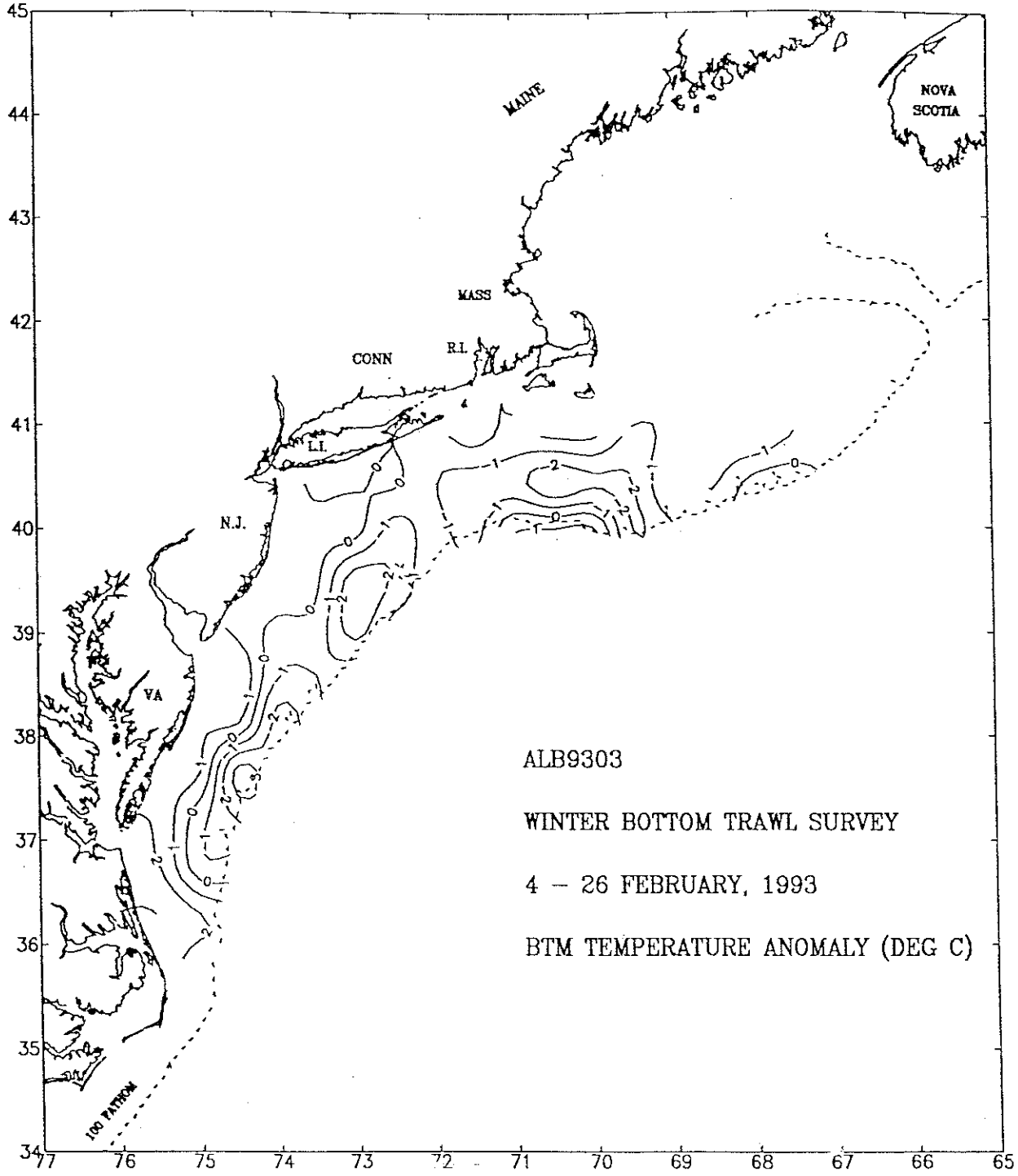


Figure 14. The bottom temperature anomaly distribution for the winter bottom trawl survey ALB9303.

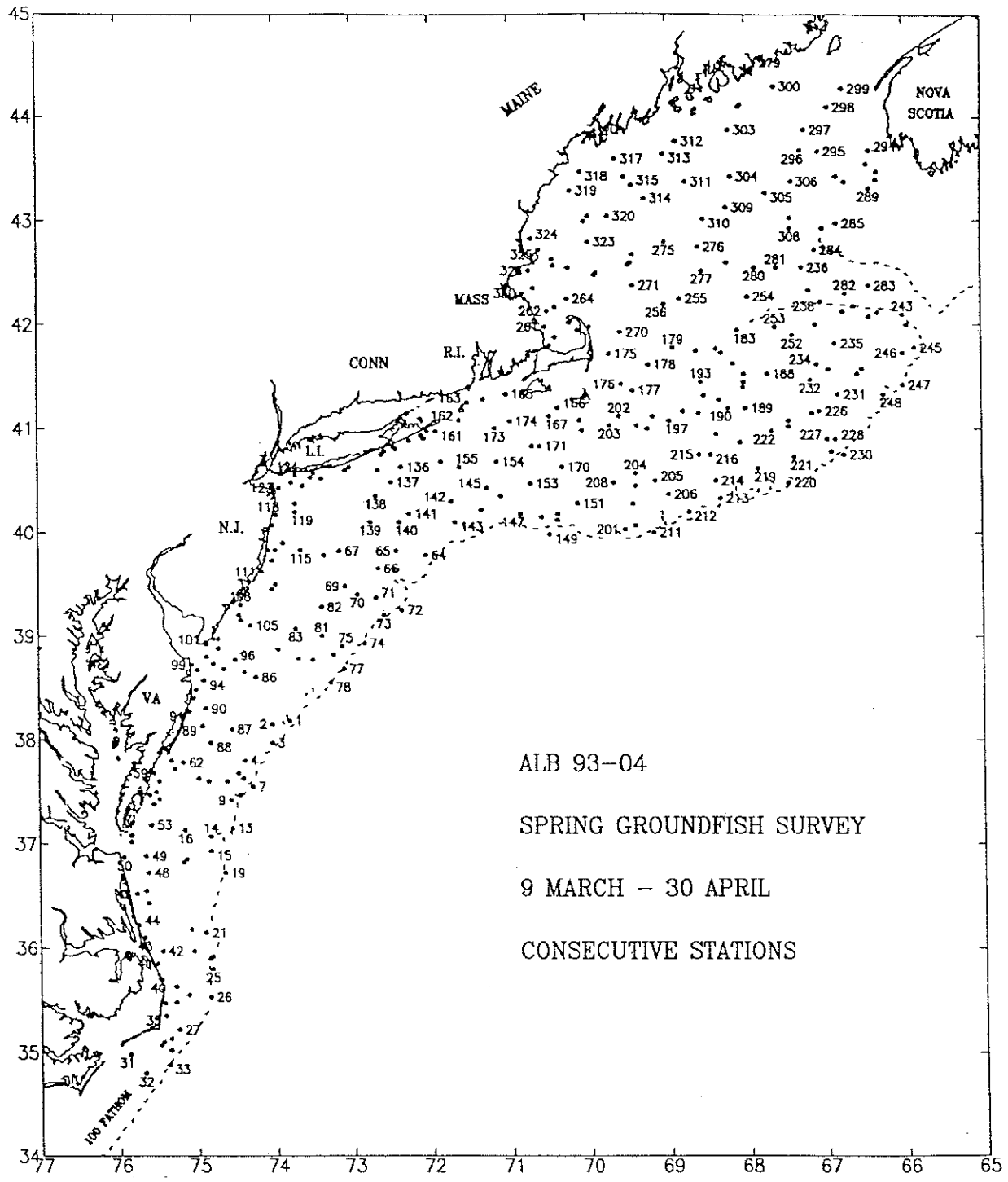


Figure 15. Hydrographic stations occupied during the spring bottom trawl survey ALB9304.

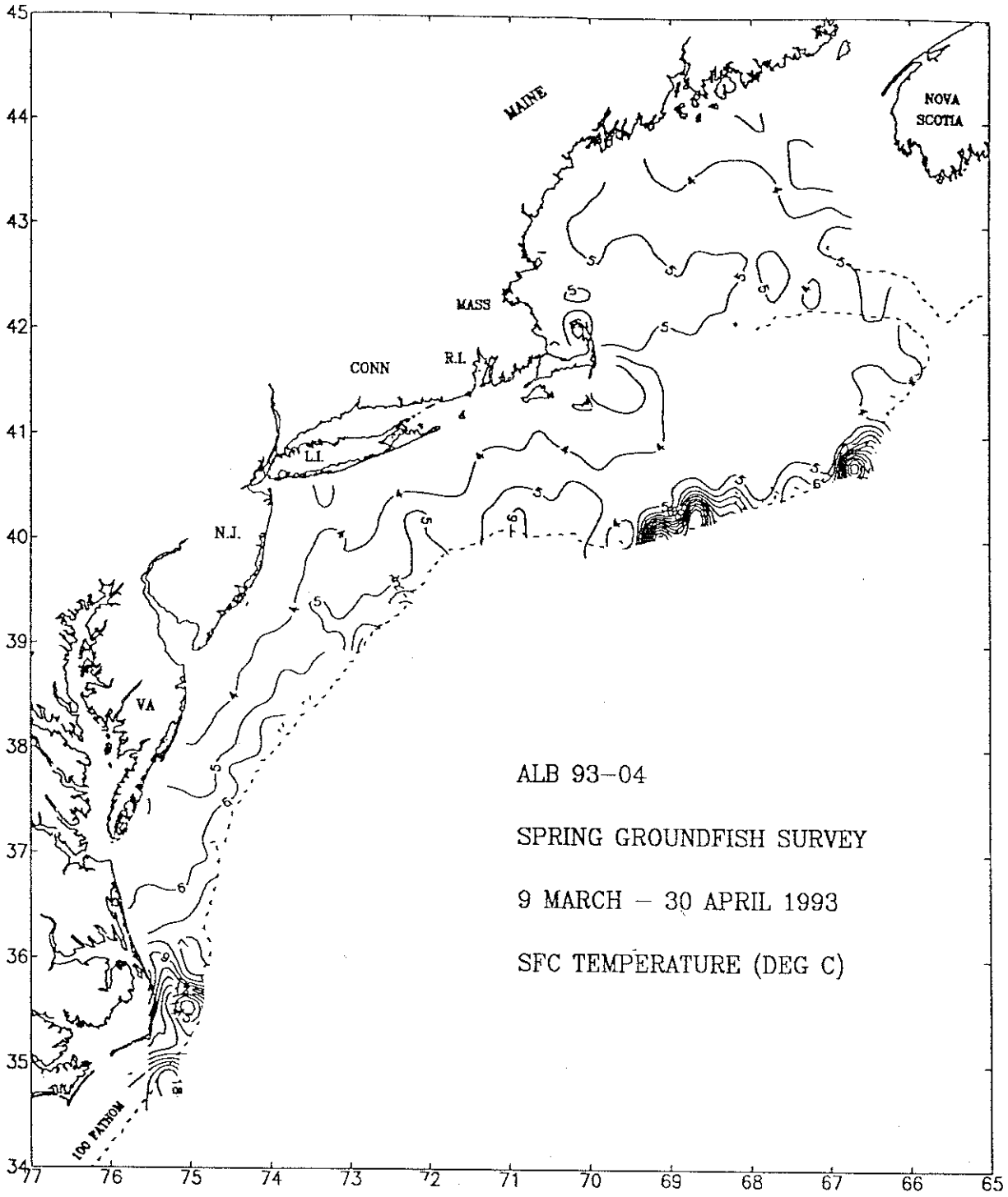


Figure 16. The surface temperature distribution for the spring bottom trawl survey ALB9304.

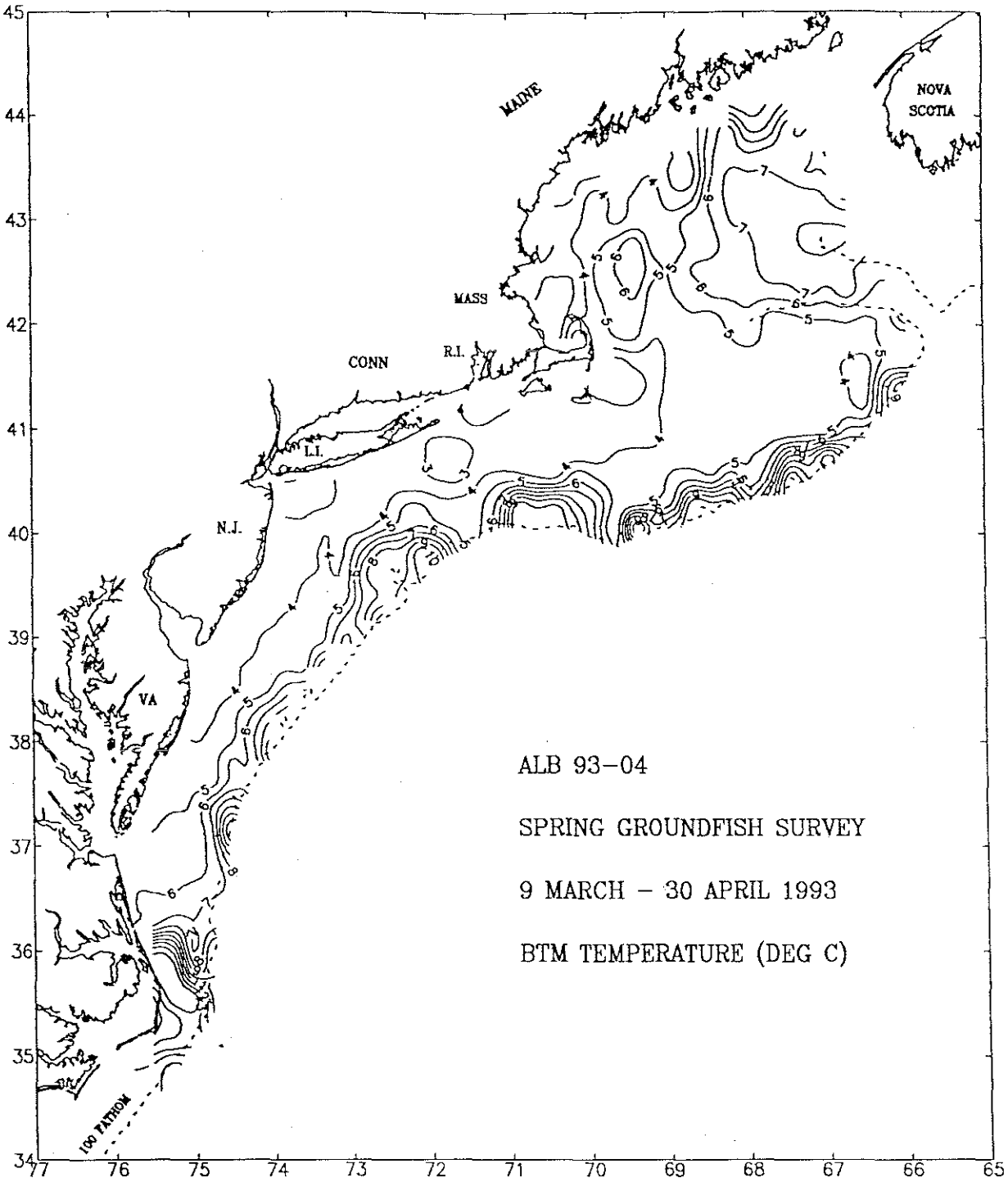


Figure 17. The bottom temperature distribution for the spring bottom trawl survey ALB9304.

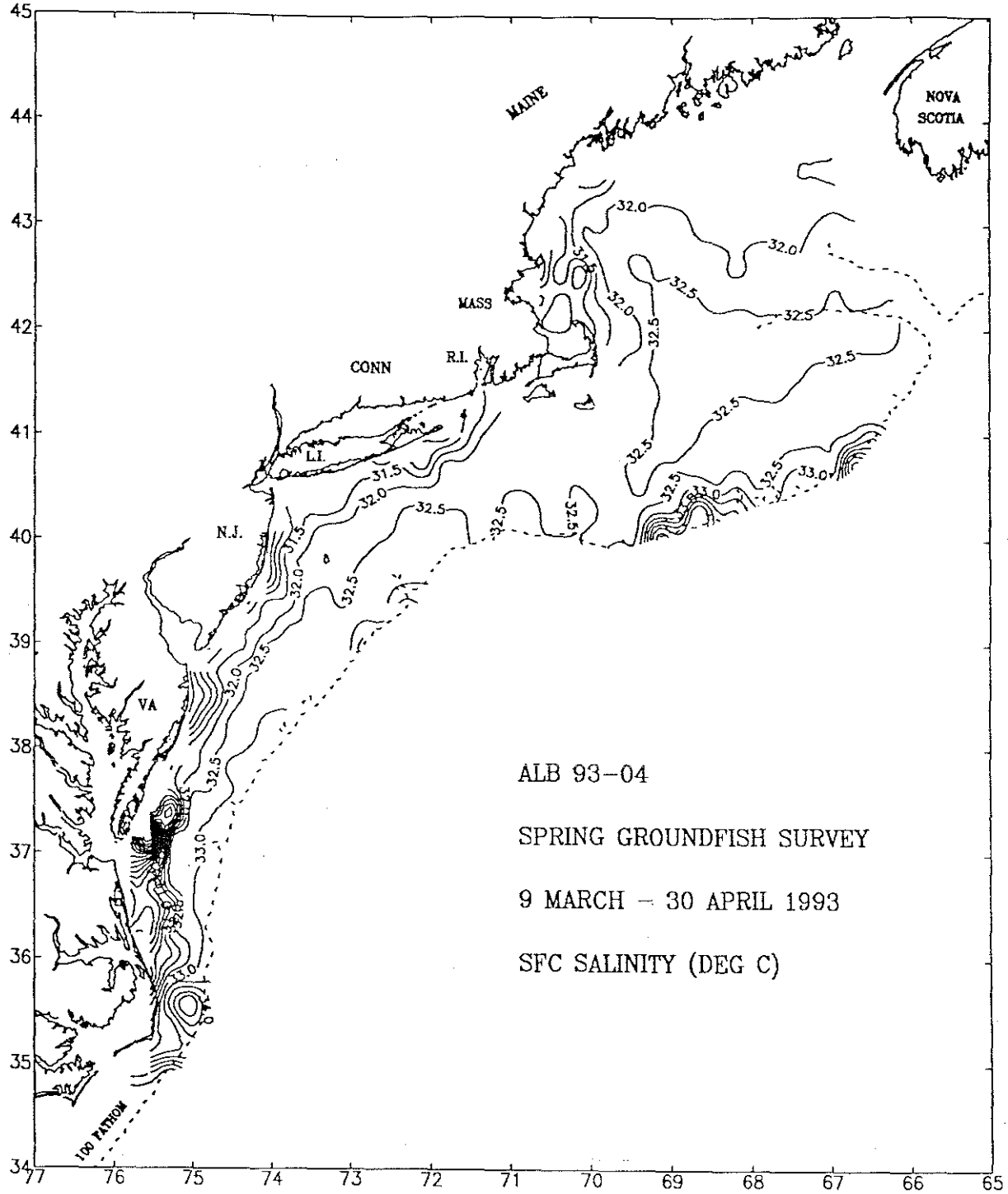


Figure 18. The surface salinity distribution for the spring bottom trawl survey ALB9304.

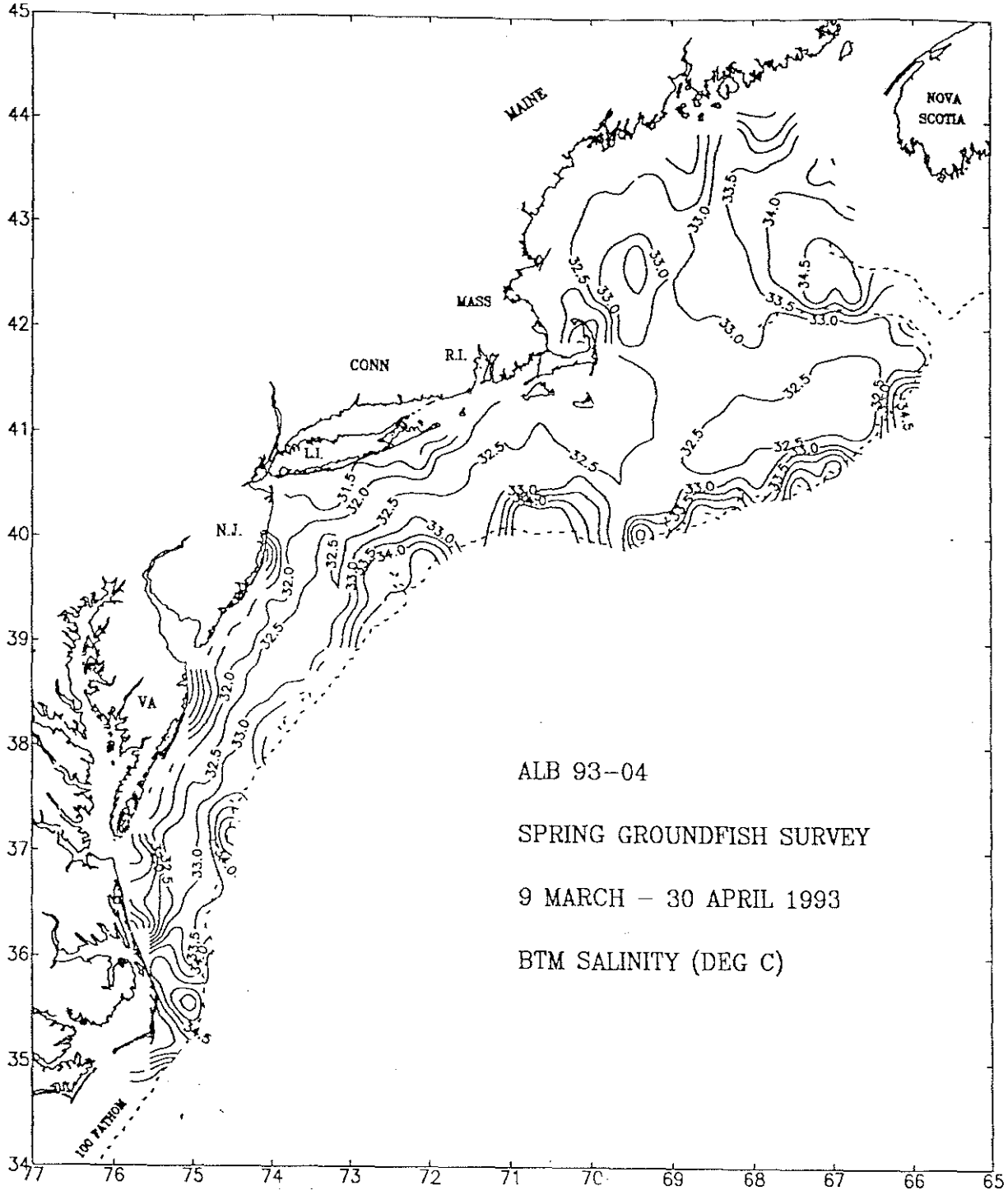


Figure 19. The bottom salinity distribution for the spring bottom trawl survey ALB9304.

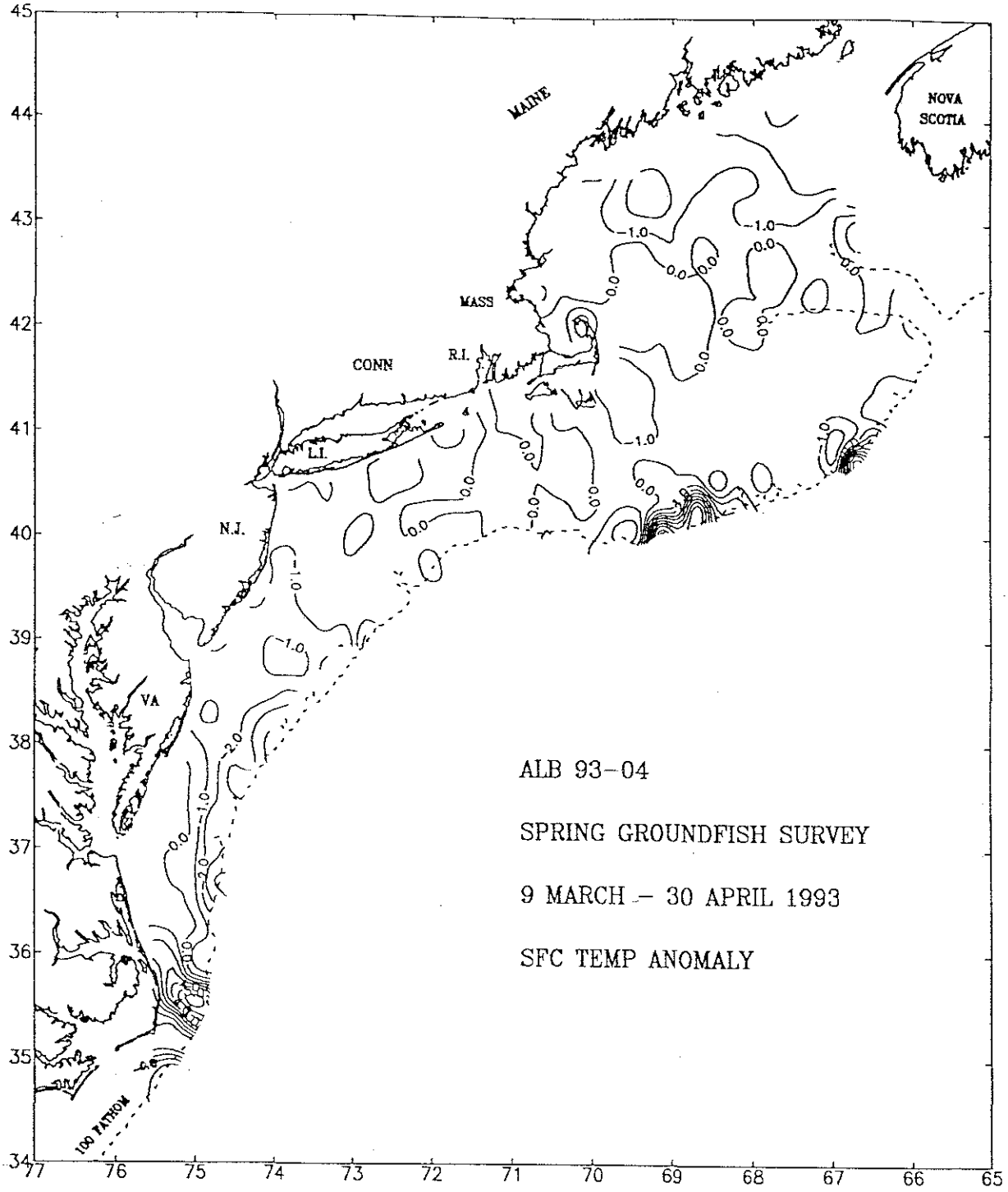


Figure 20. The surface temperature anomaly distribution for the spring bottom trawl survey ALB9304.

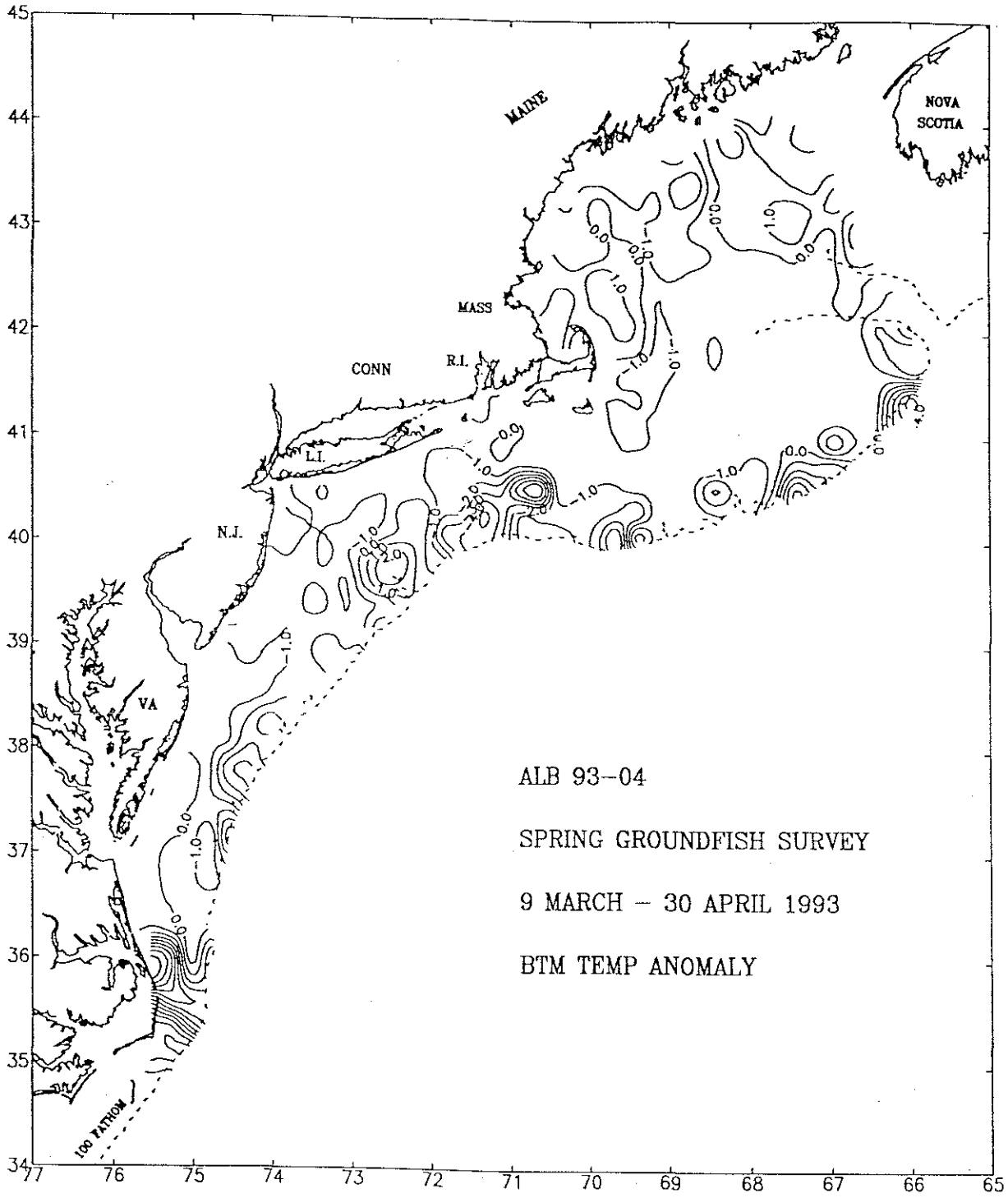


Figure 21. The bottom temperature anomaly distribution for the spring bottom trawl survey ALB9304.

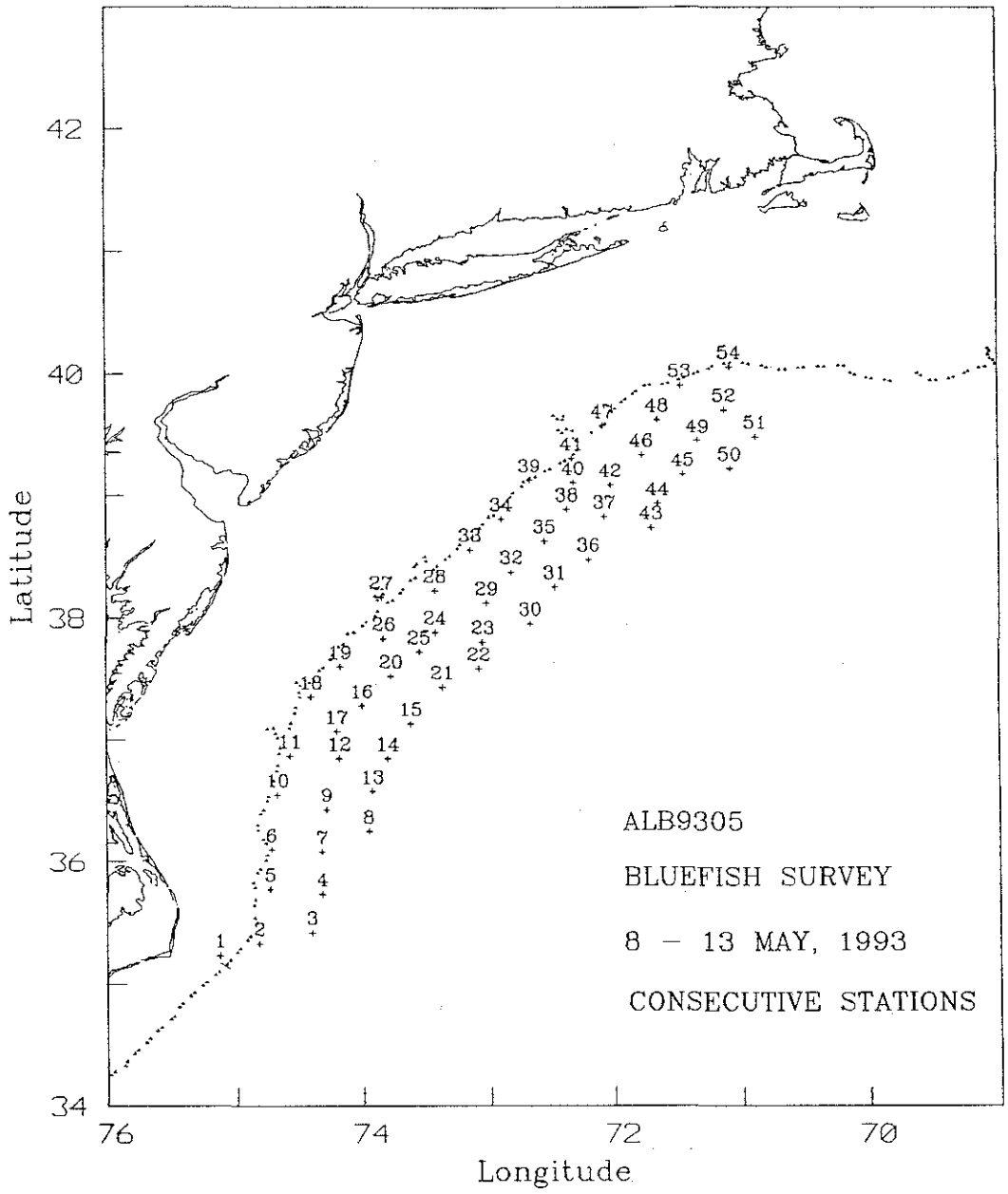


Figure 22. Hydrographic stations occupied during the bluefish survey ALB9305.

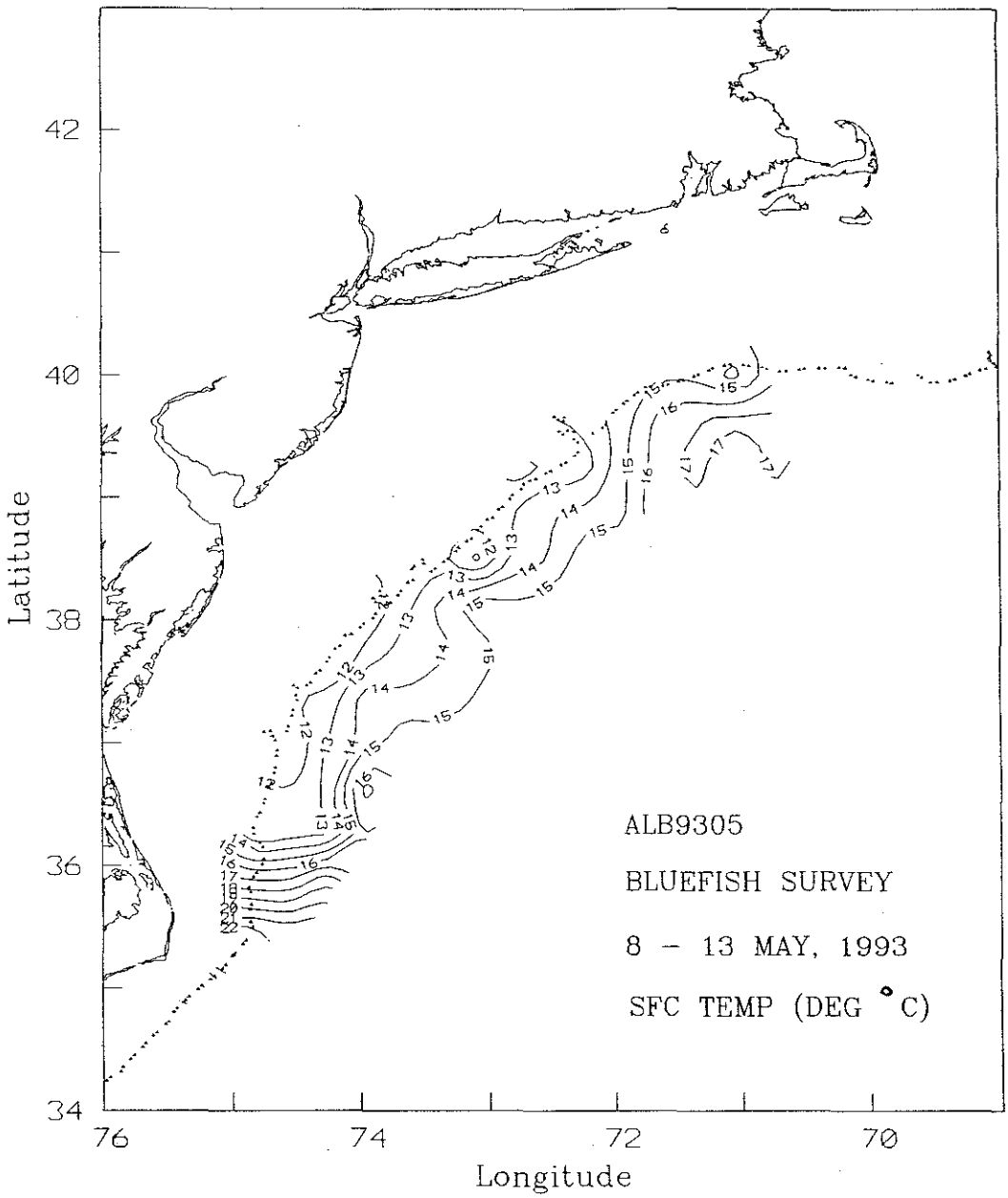


Figure 23. The surface temperature distribution for the bluefish survey ALB9305.

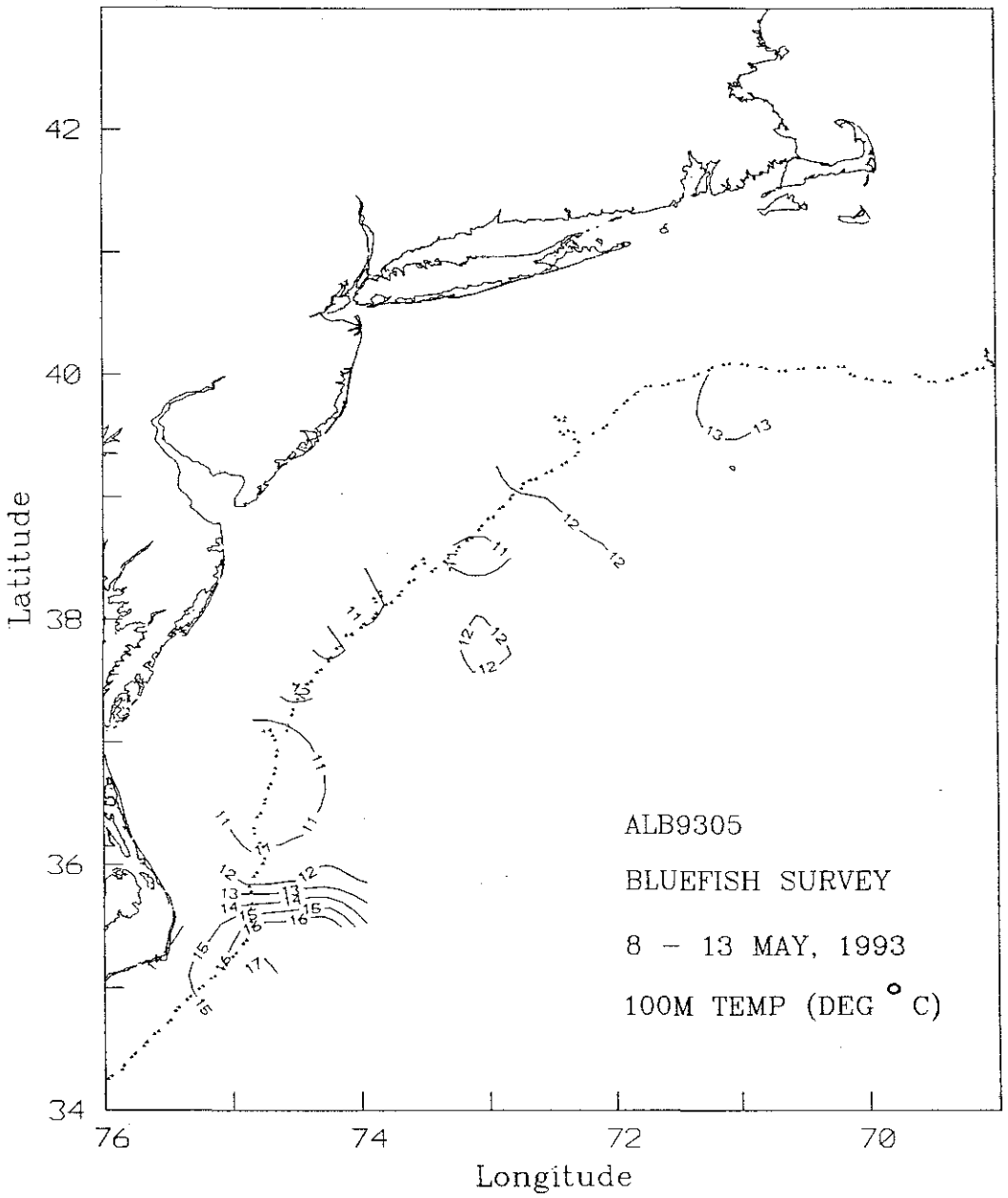


Figure 24. The 100 m temperature distribution for the bluefish survey ALB9305.

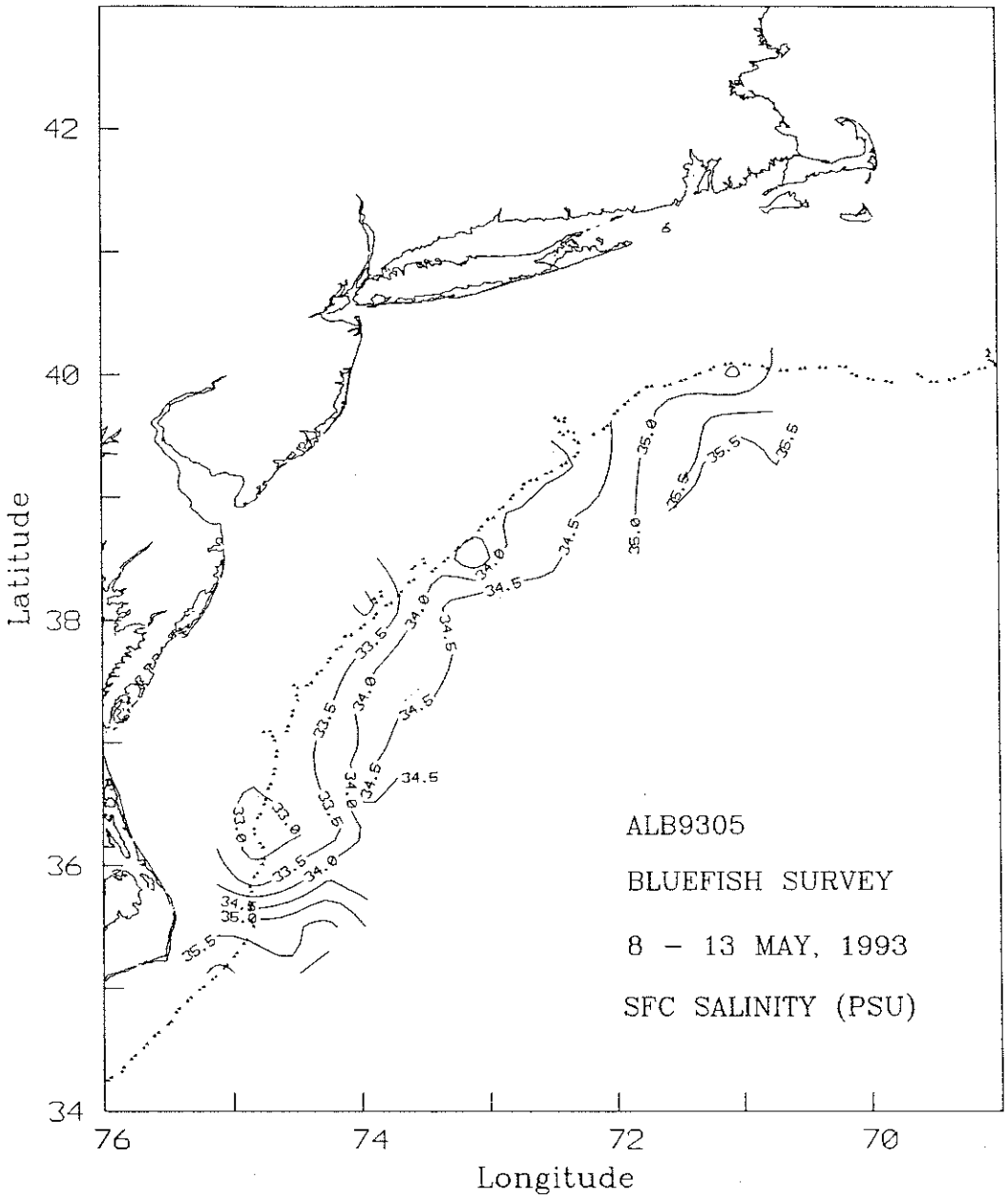


Figure 25. The surface salinity distribution for the bluefish survey ALB9305.

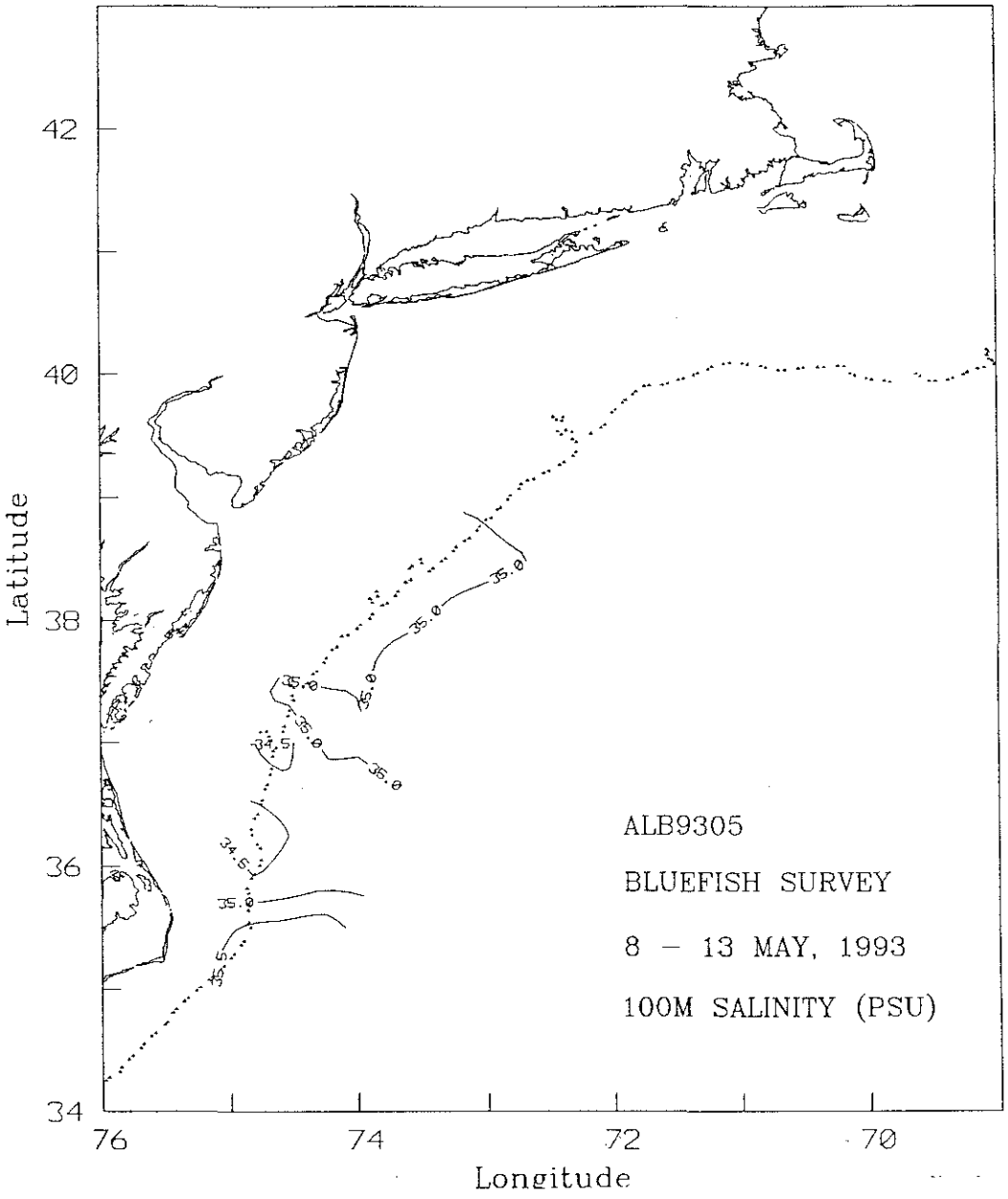


Figure 26. The 100 m temperature salinity distribution for the bluefish survey ALB9305.

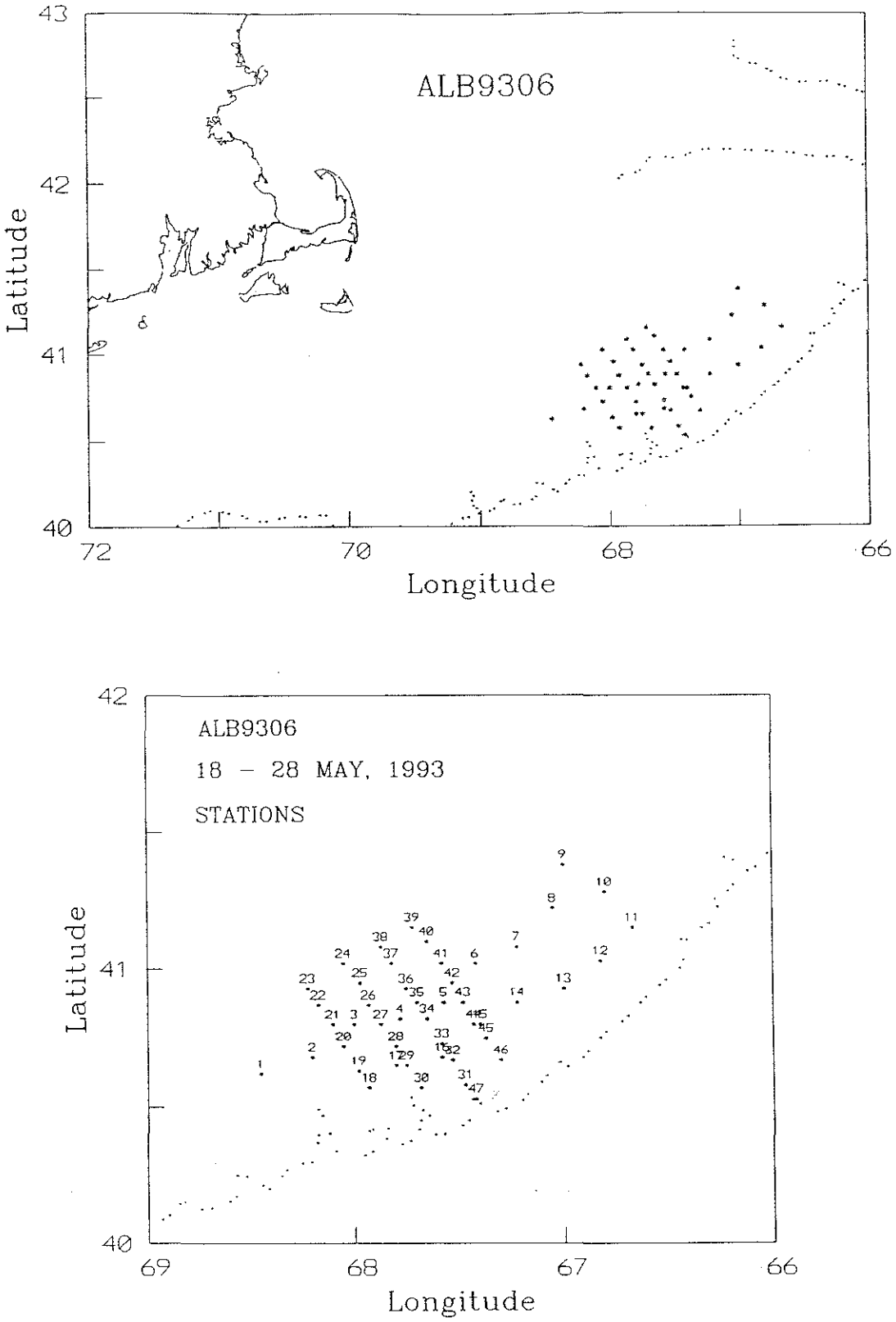


Figure 27. Hydrographic stations occupied during the Marine Ecosystem Response study ALB9306.

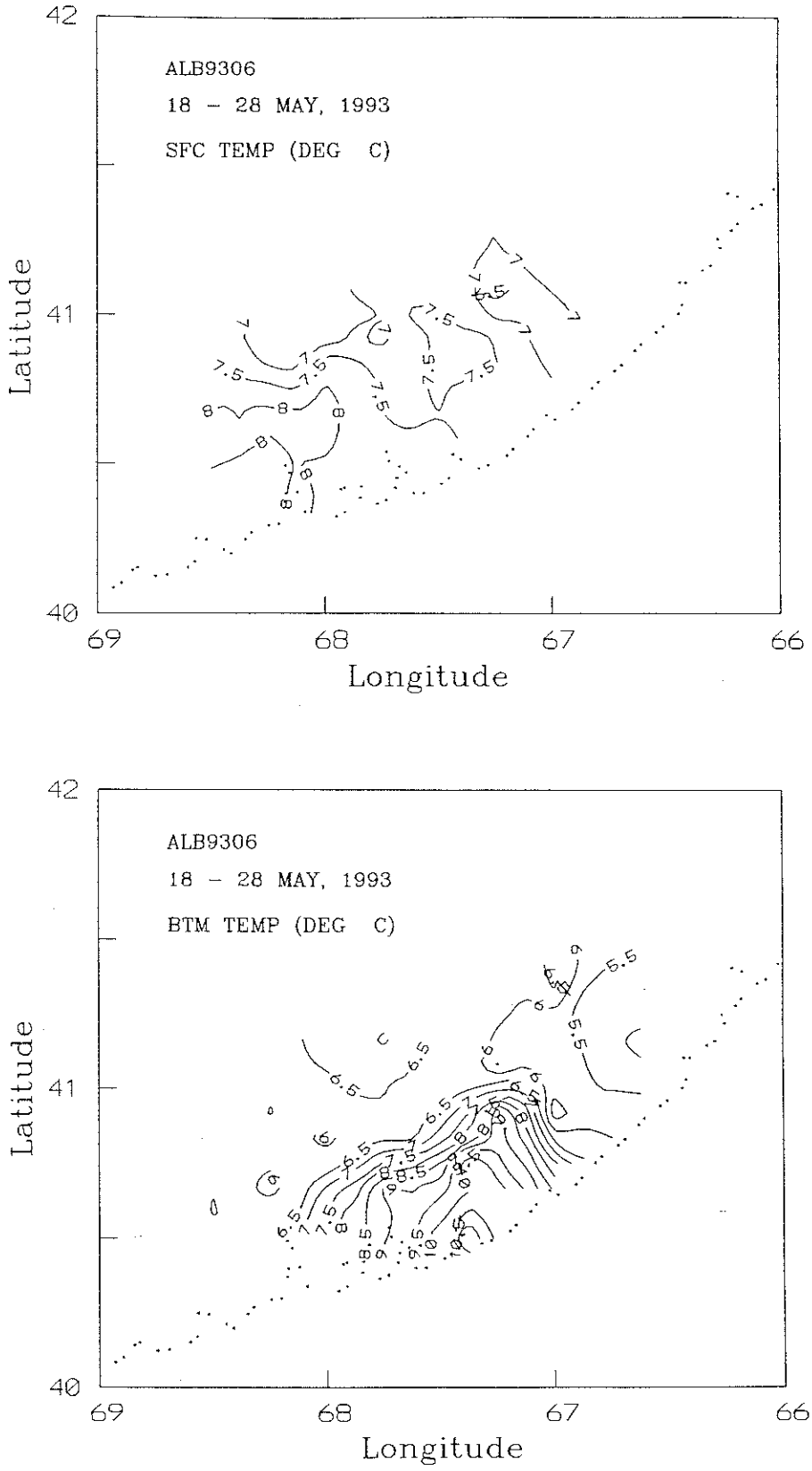


Figure 28. The surface and bottom temperature distribution for the Marine Ecosystem Response study ALB9306.

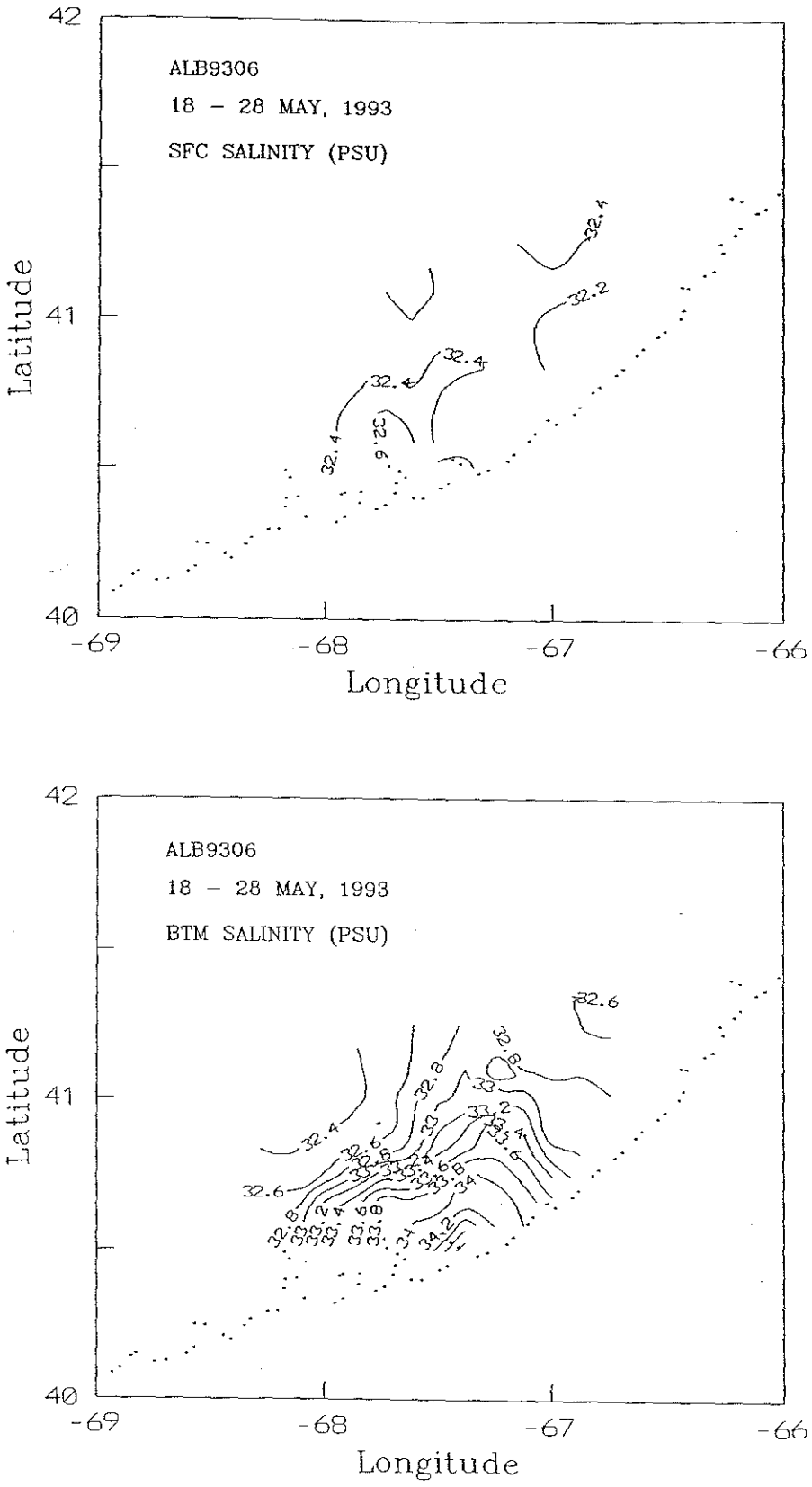


Figure 29. The surface and bottom salinity distribution for the Marine Ecosystem Response study ALB9306.

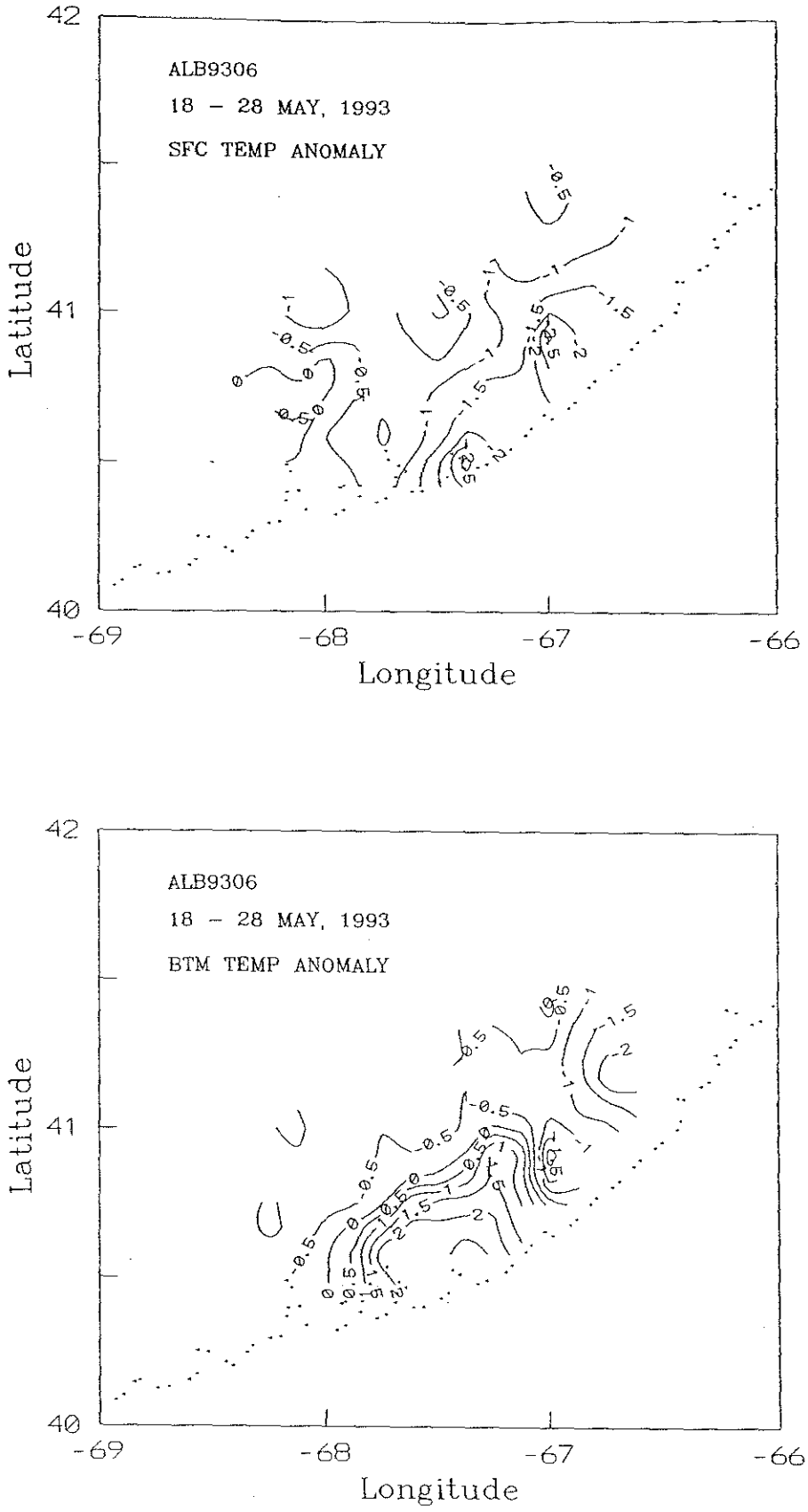


Figure 30. The surface and bottom temperature anomaly distribution for the Marine Ecosystem Response study ALB9306.

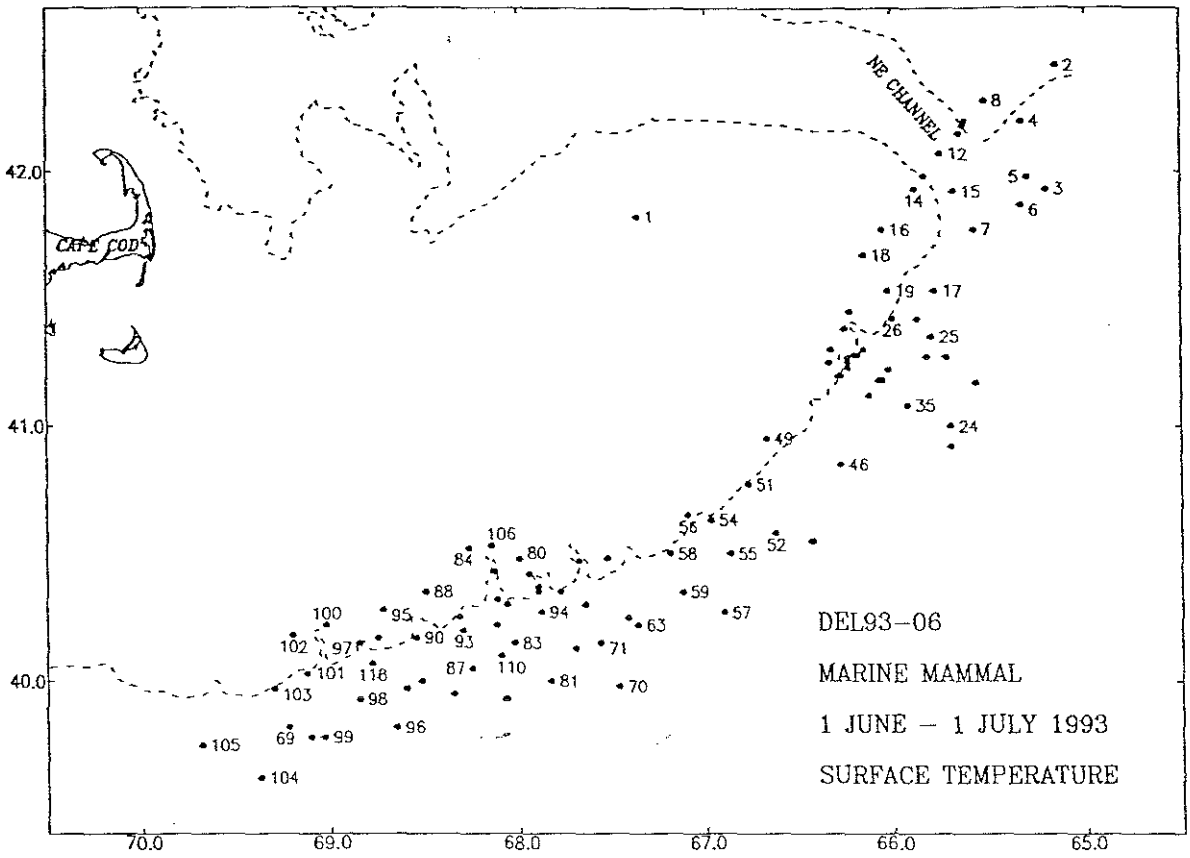
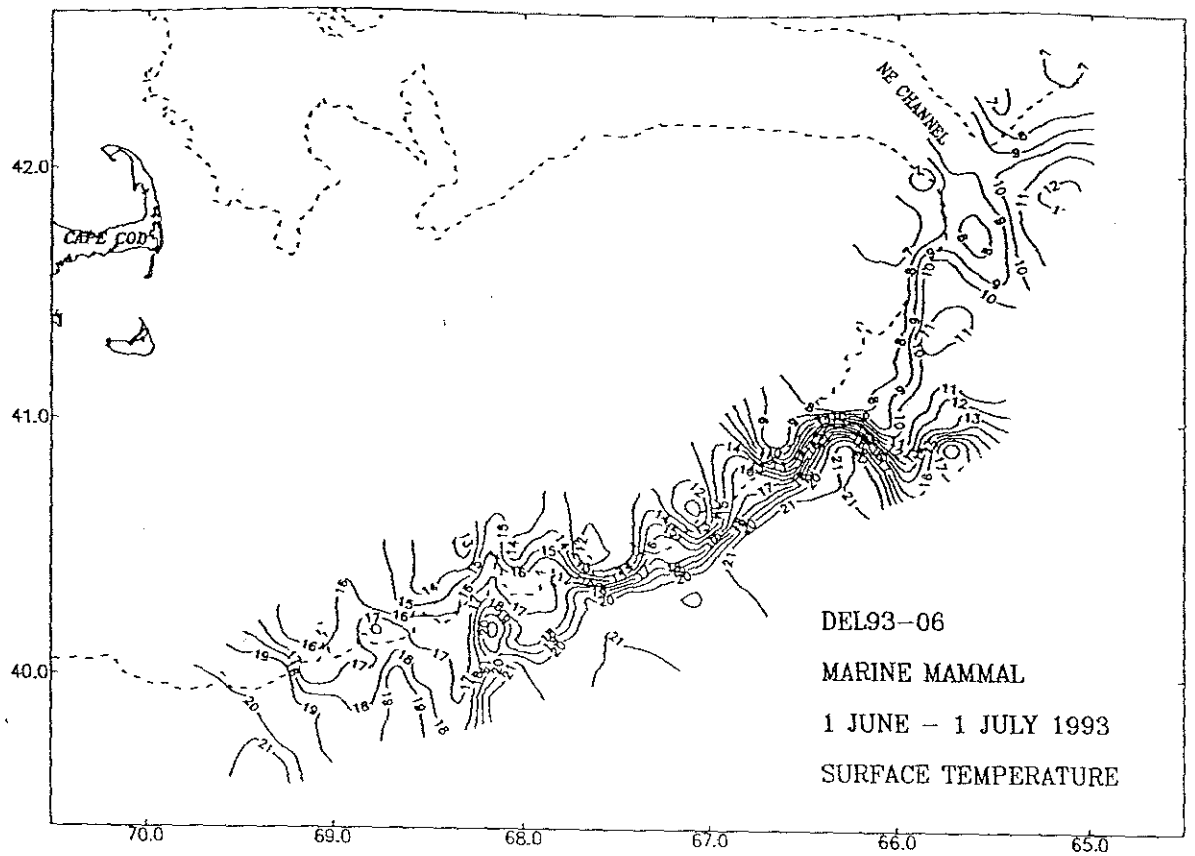


Figure 31. Hydrographic stations occupied during the marine mammal sighting survey DEL9306.



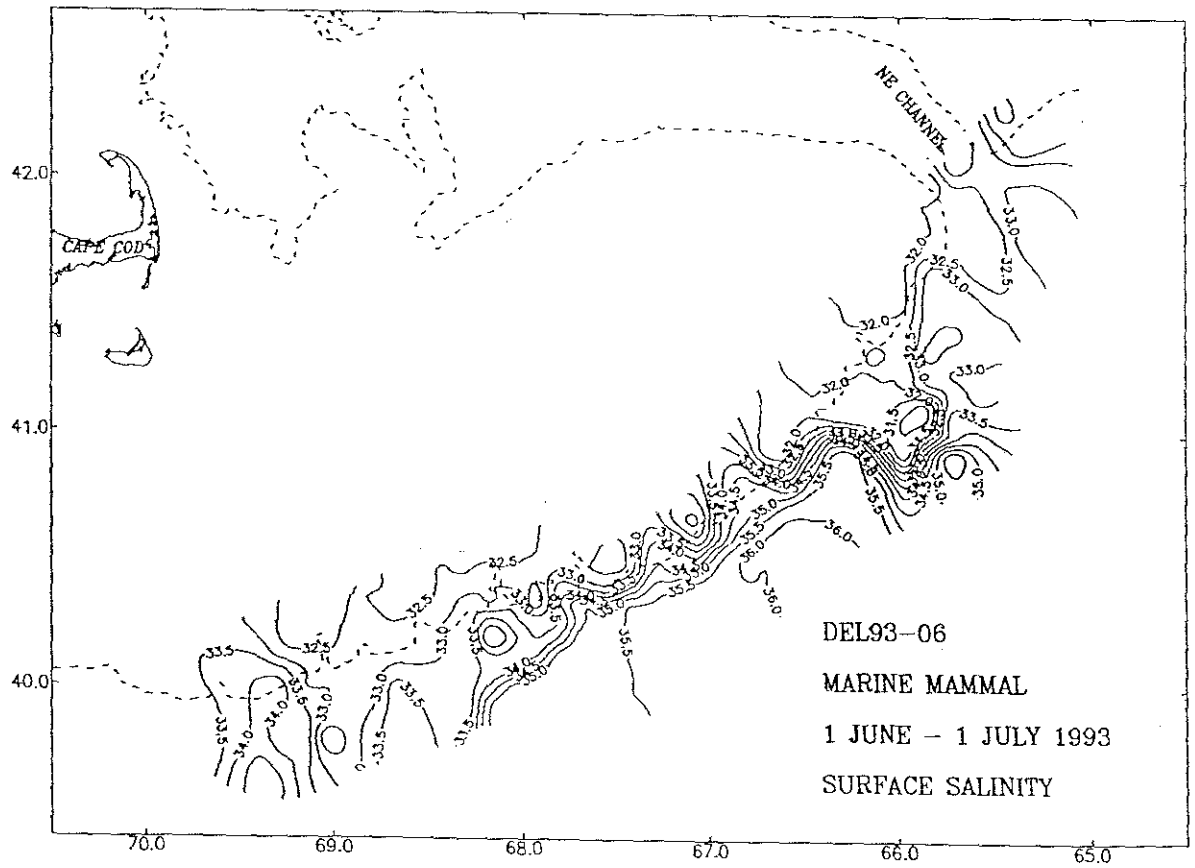


Figure 32. The surface temperature and salinity distribution for the marine mammal sighting survey DEL9306.

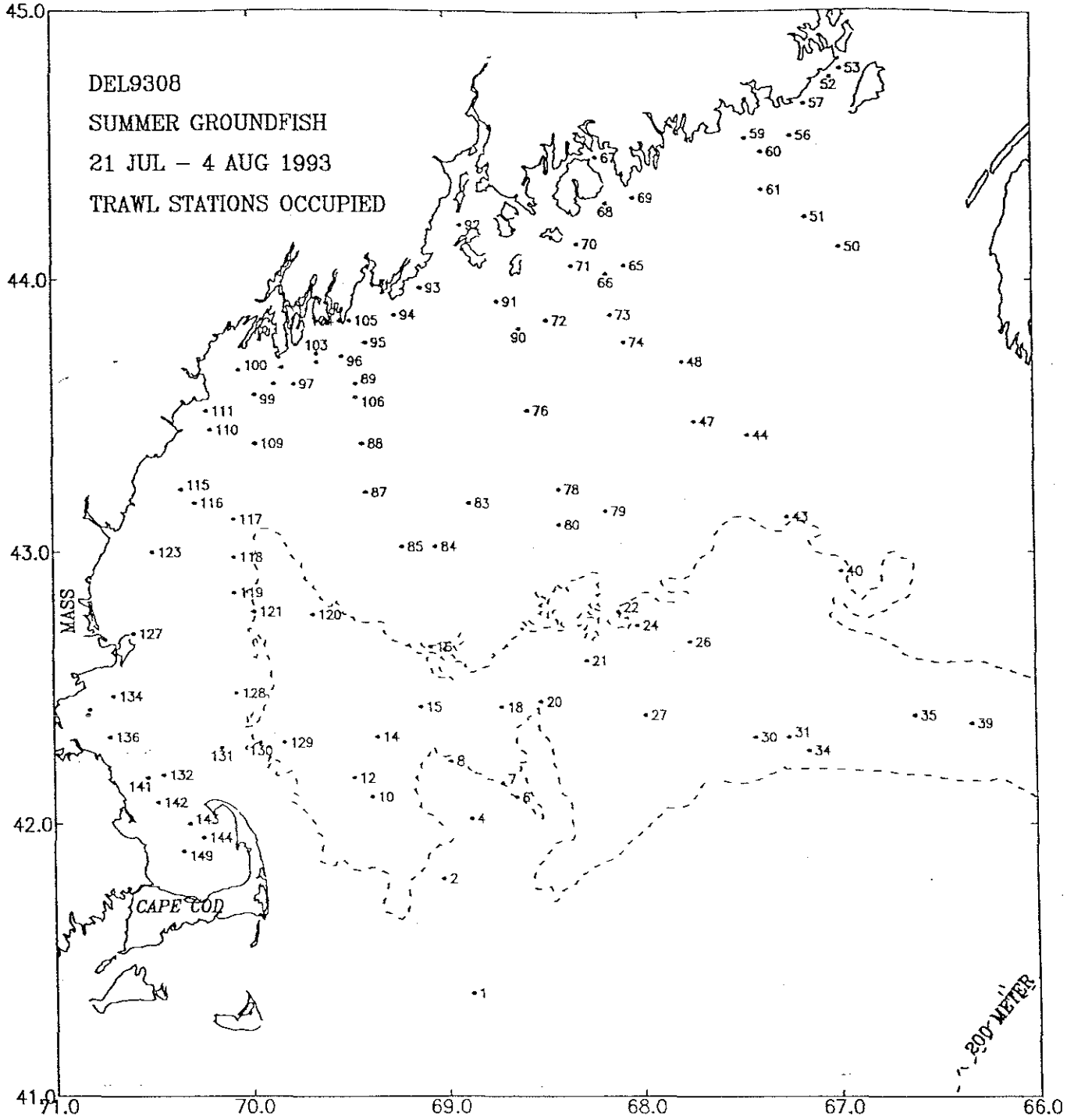


Figure 33. Hydrographic stations occupied during the summer bottom trawl survey DEL9308.

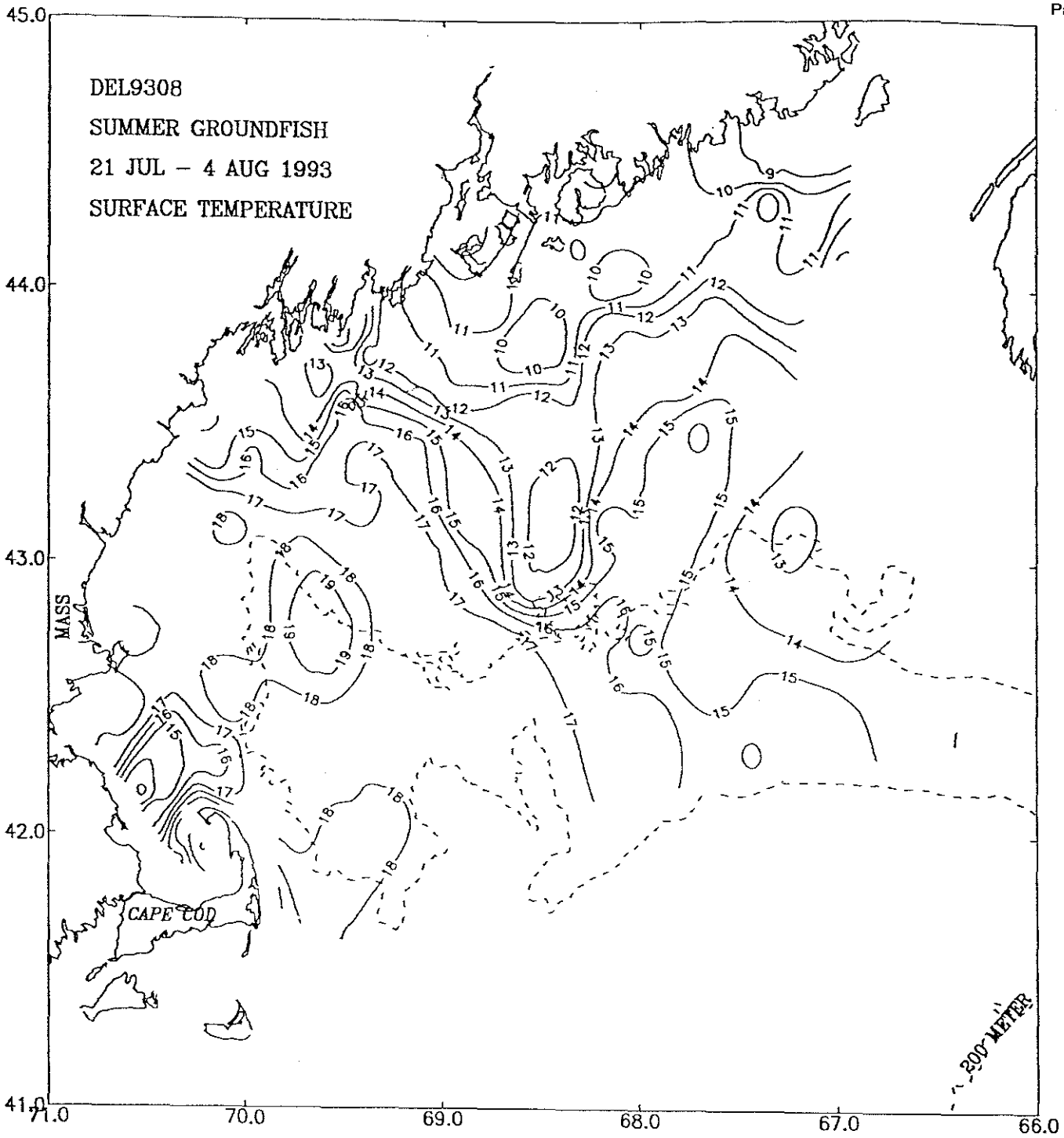


Figure 34. The surface temperature distribution for the summer bottom trawl survey DEL9308.

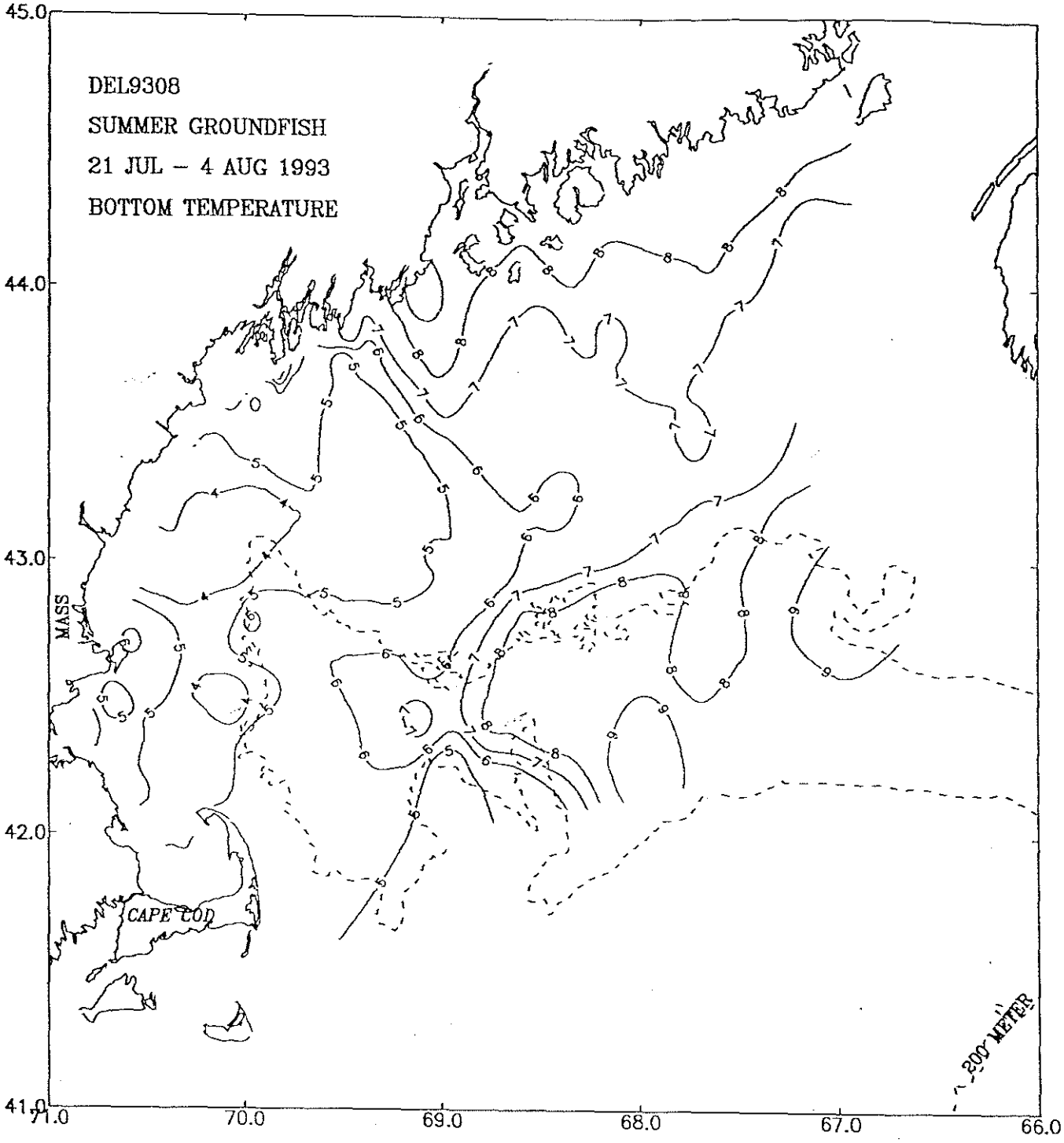


Figure 35. The bottom temperature distribution for the summer bottom trawl survey DEL9308.

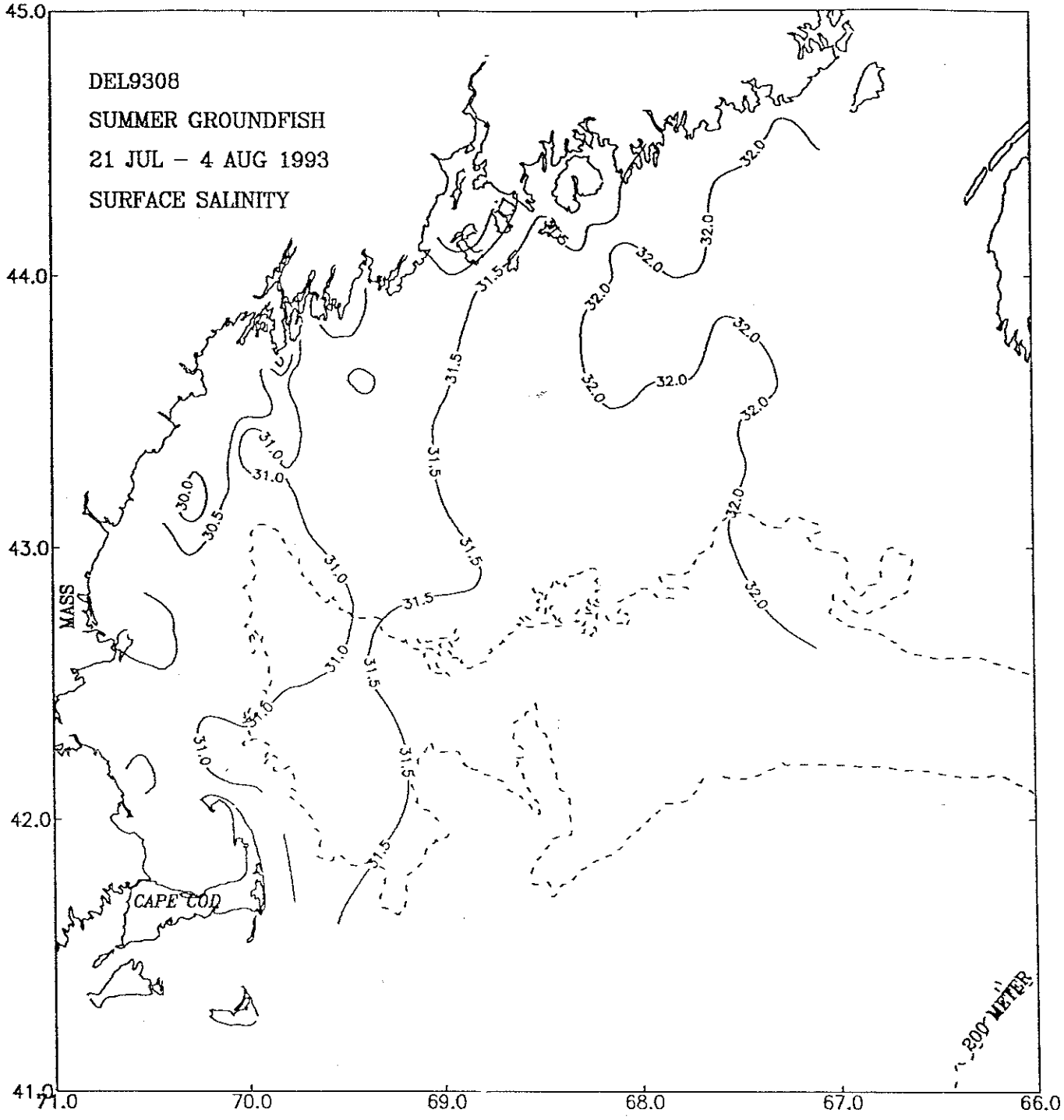


Figure 36. The surface salinity distribution for the summer bottom trawl survey DEL9308.

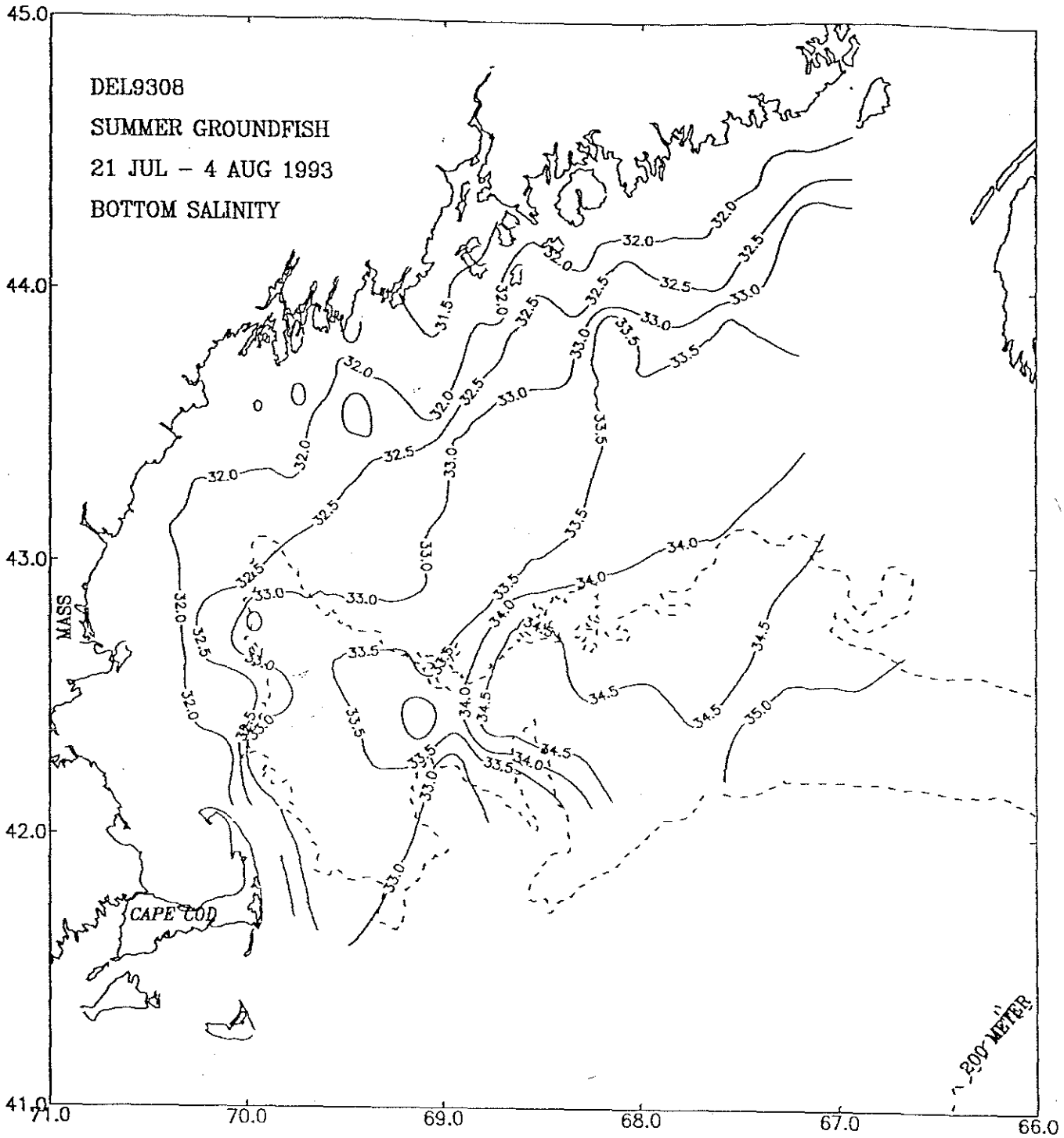


Figure 37. The bottom salinity distribution for the summer bottom trawl survey DEL9308.

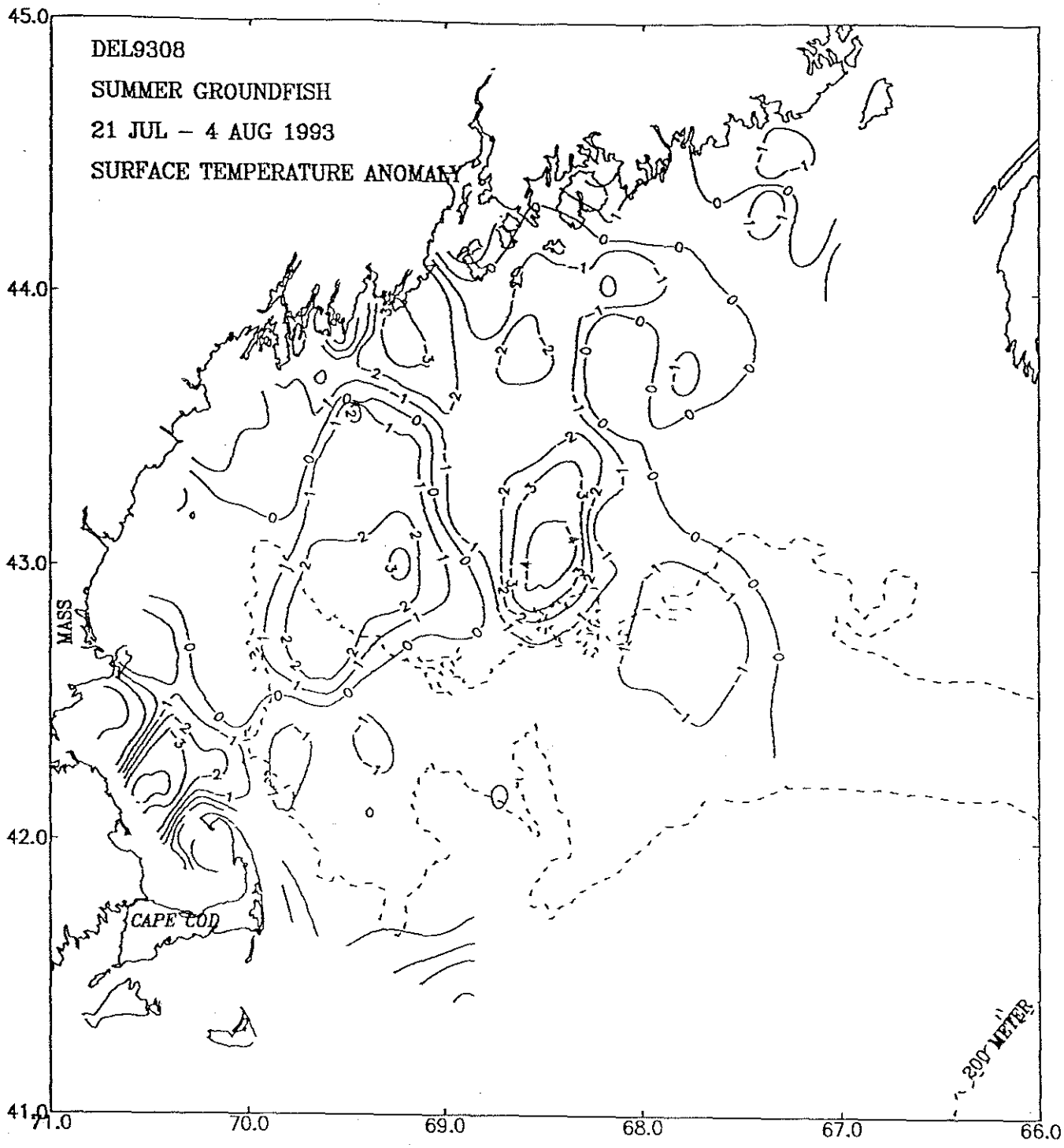


Figure 38. The surface temperature anomaly distribution for the summer bottom trawl survey DEL9308.

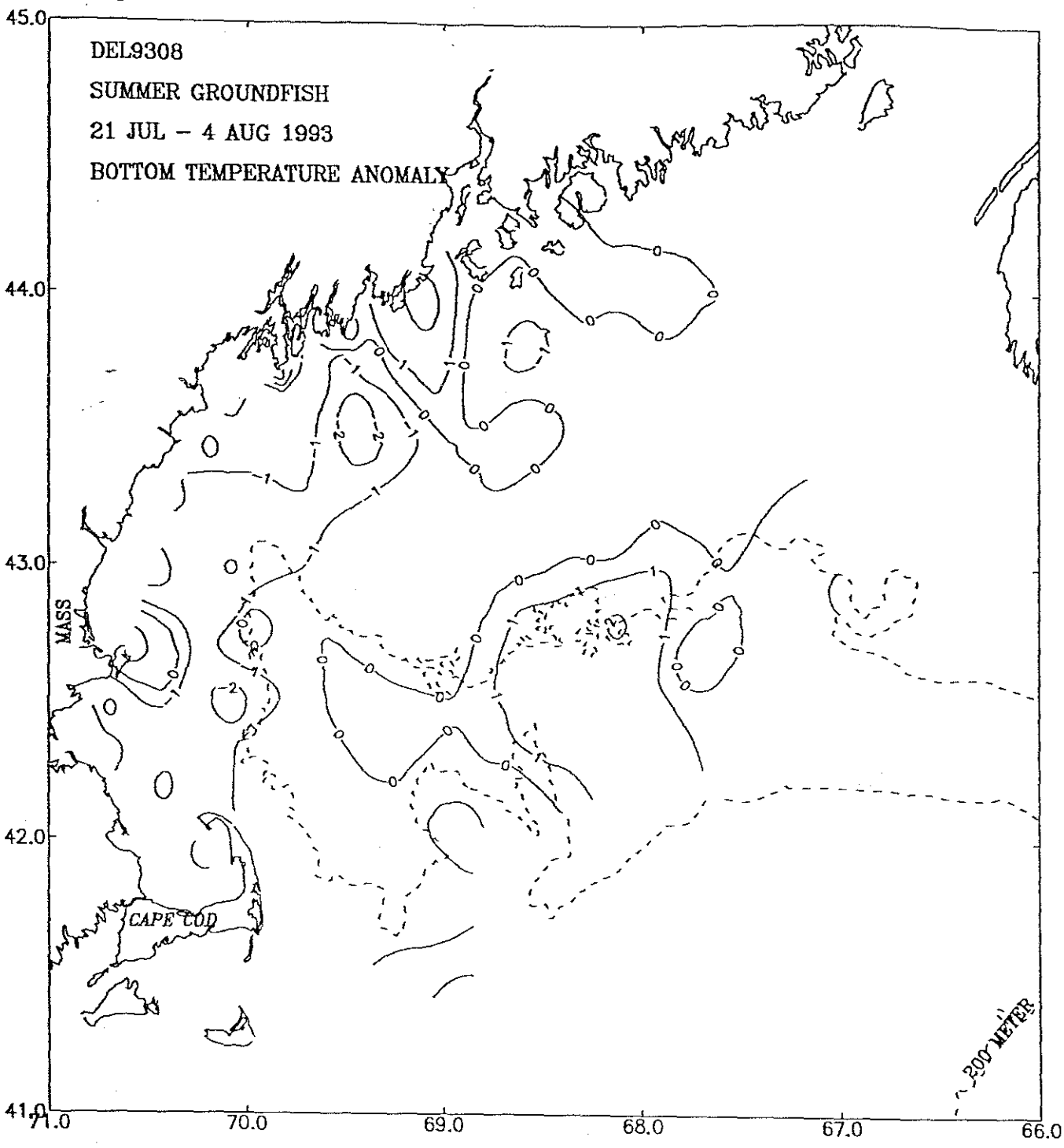


Figure 39. The bottom temperature anomaly distribution for the summer bottom trawl survey DEL9308.

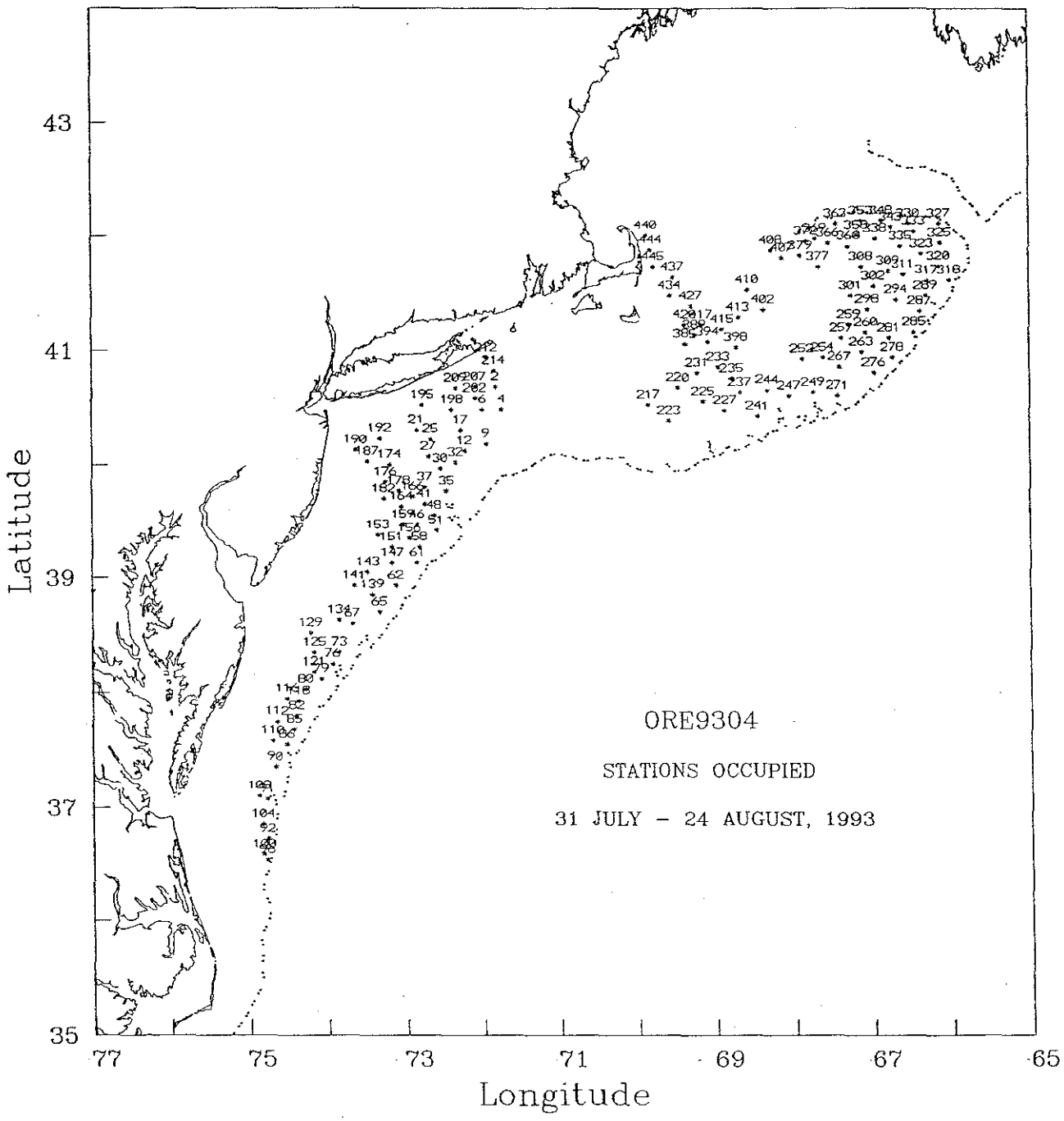


Figure 40. Hydrographic stations occupied during the scallop survey ORE9304.

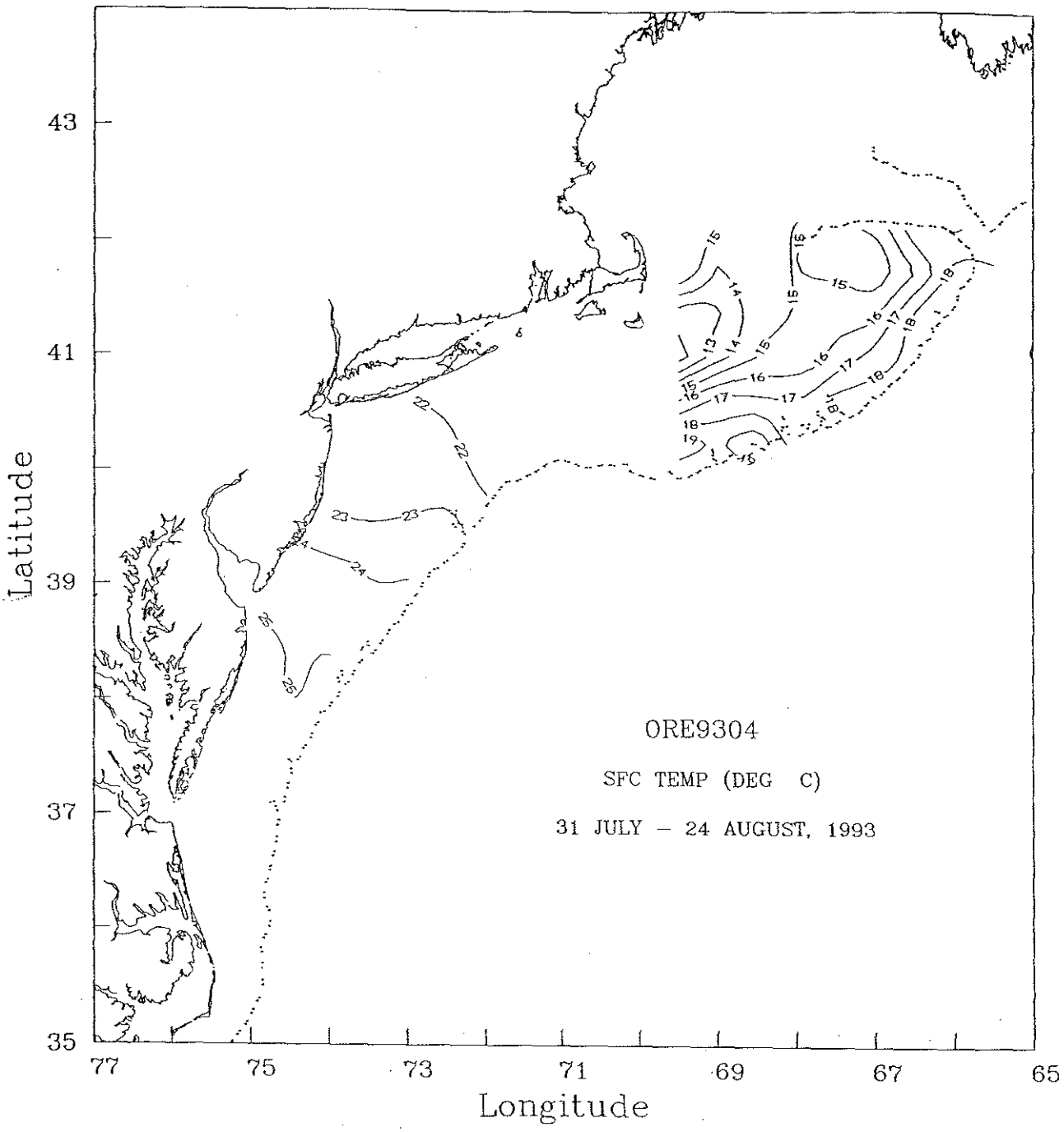


Figure 41. The surface temperature distribution for the scallop survey ORE9304.

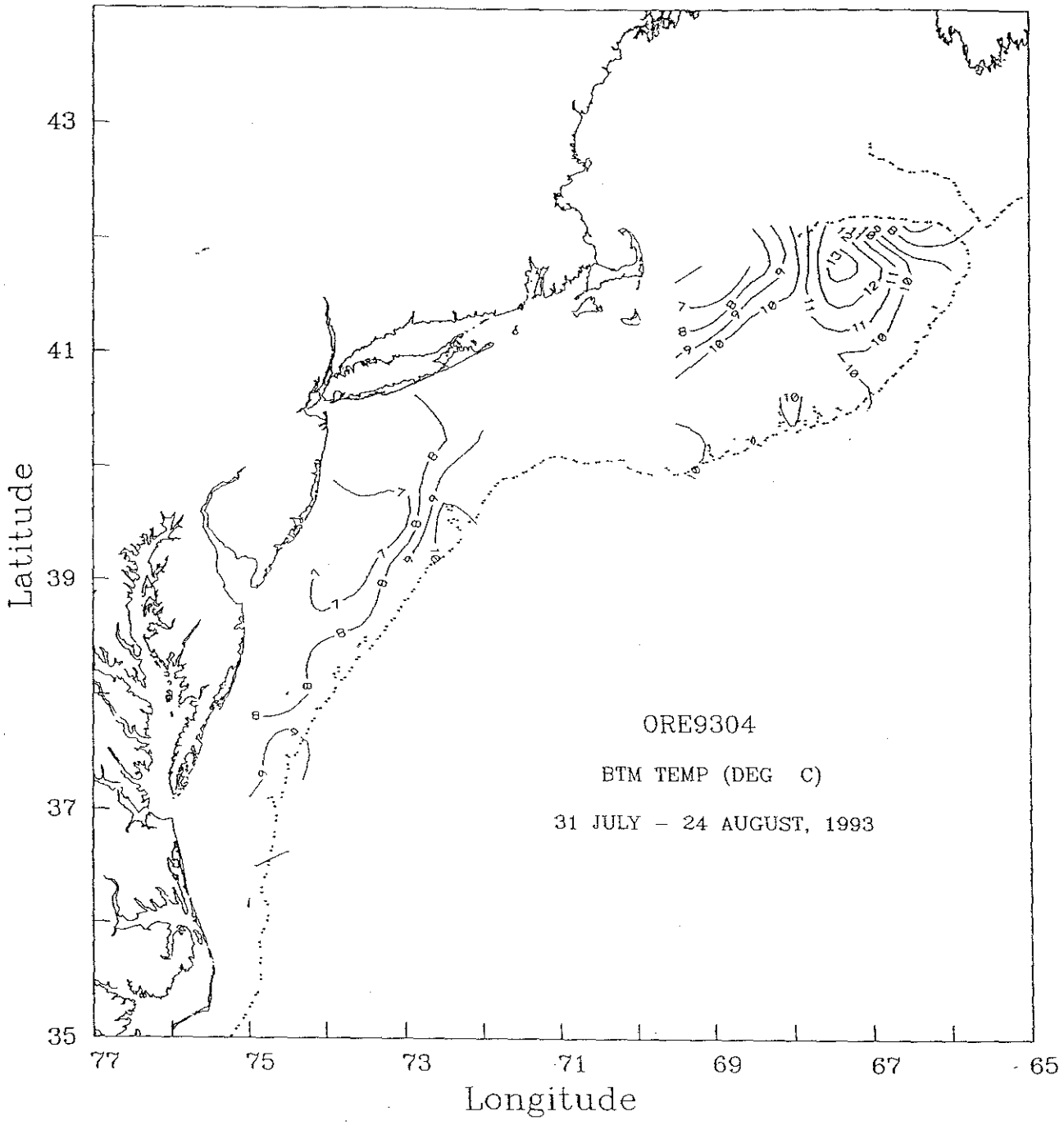


Figure 42. The bottom temperature distribution for the scallop survey ORE9304.

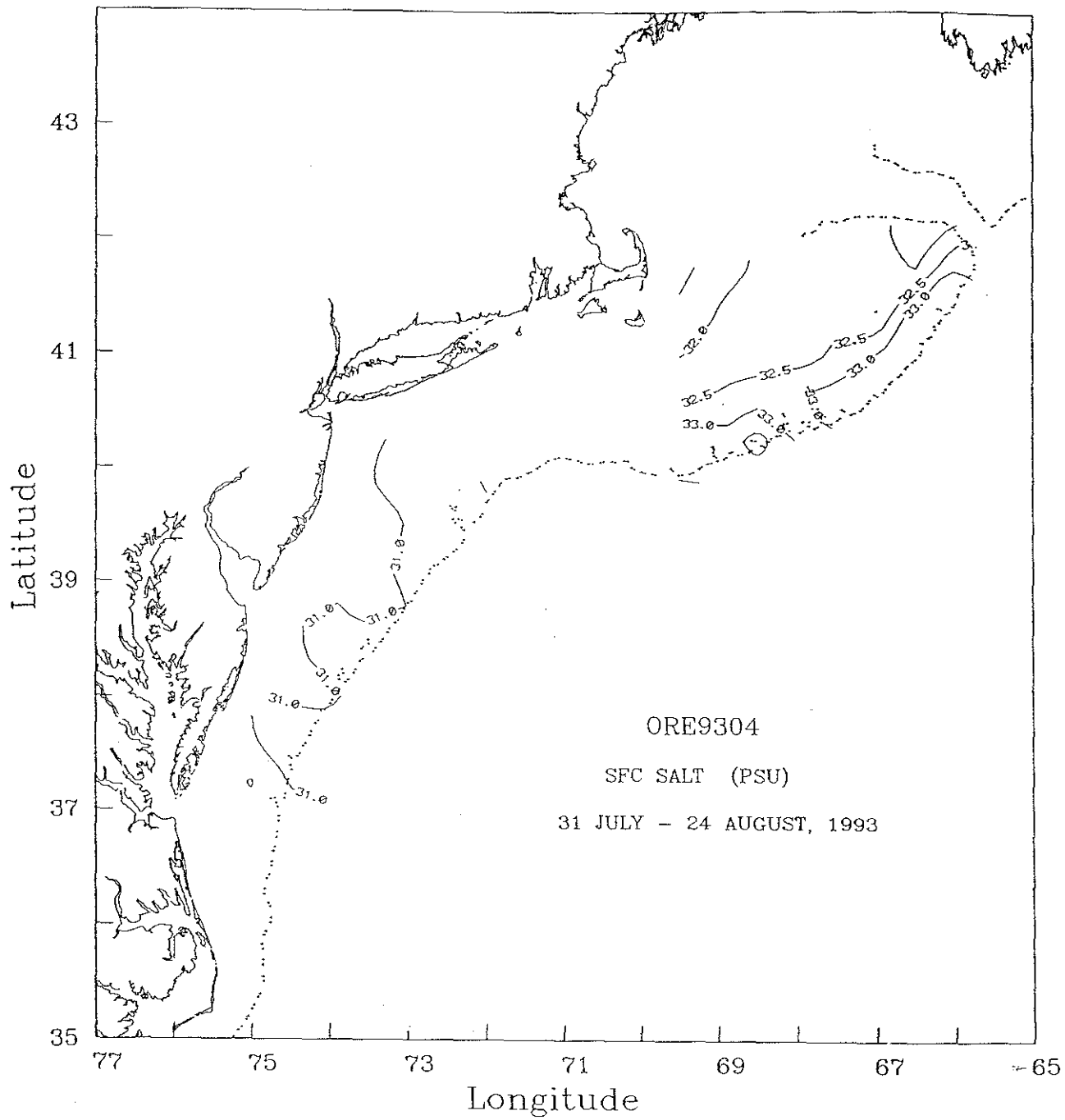


Figure 43. The surface salinity distribution for the scallop survey ORE9304.

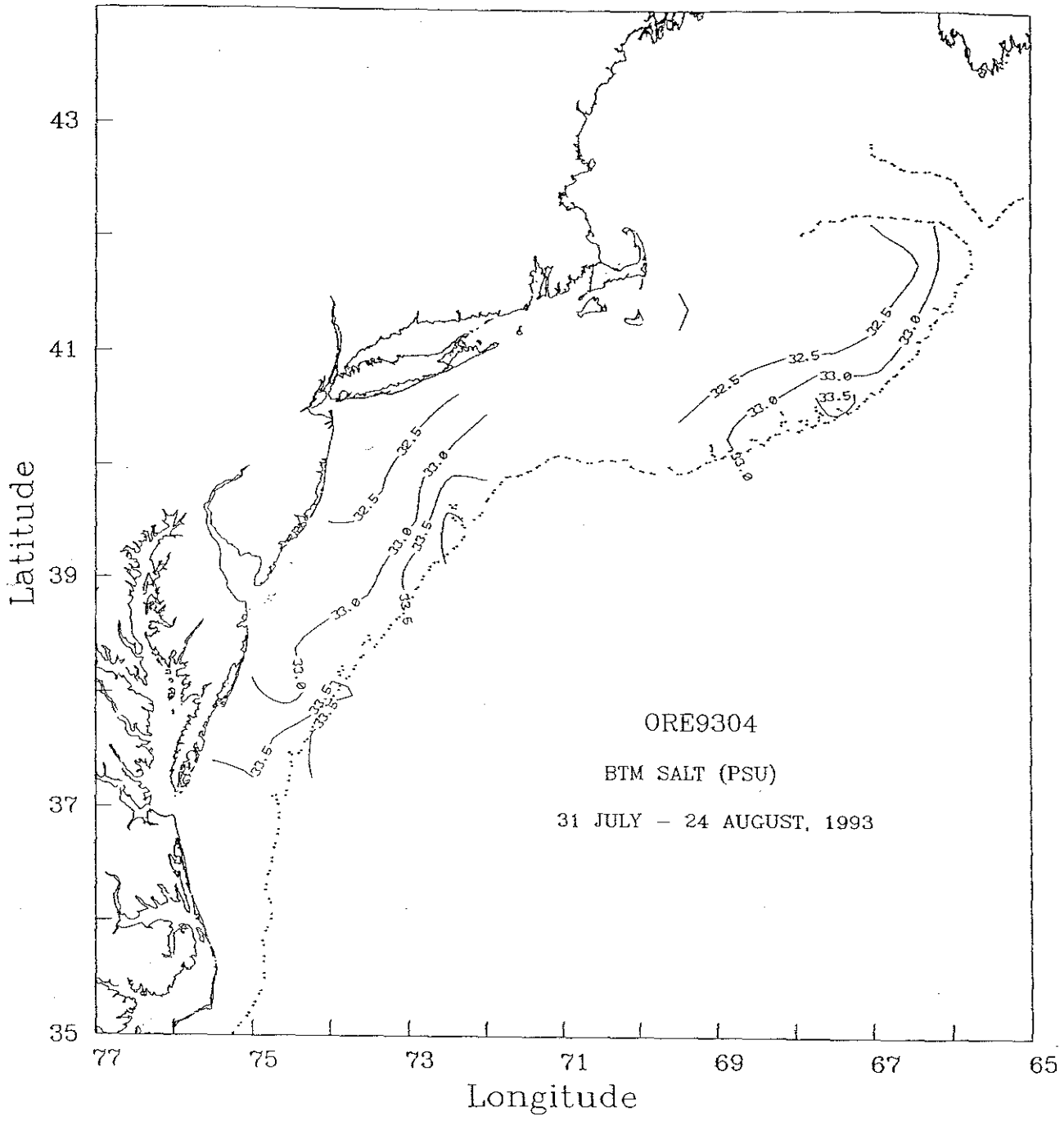


Figure 44. The bottom salinity distribution for the scallop survey ORE9304.

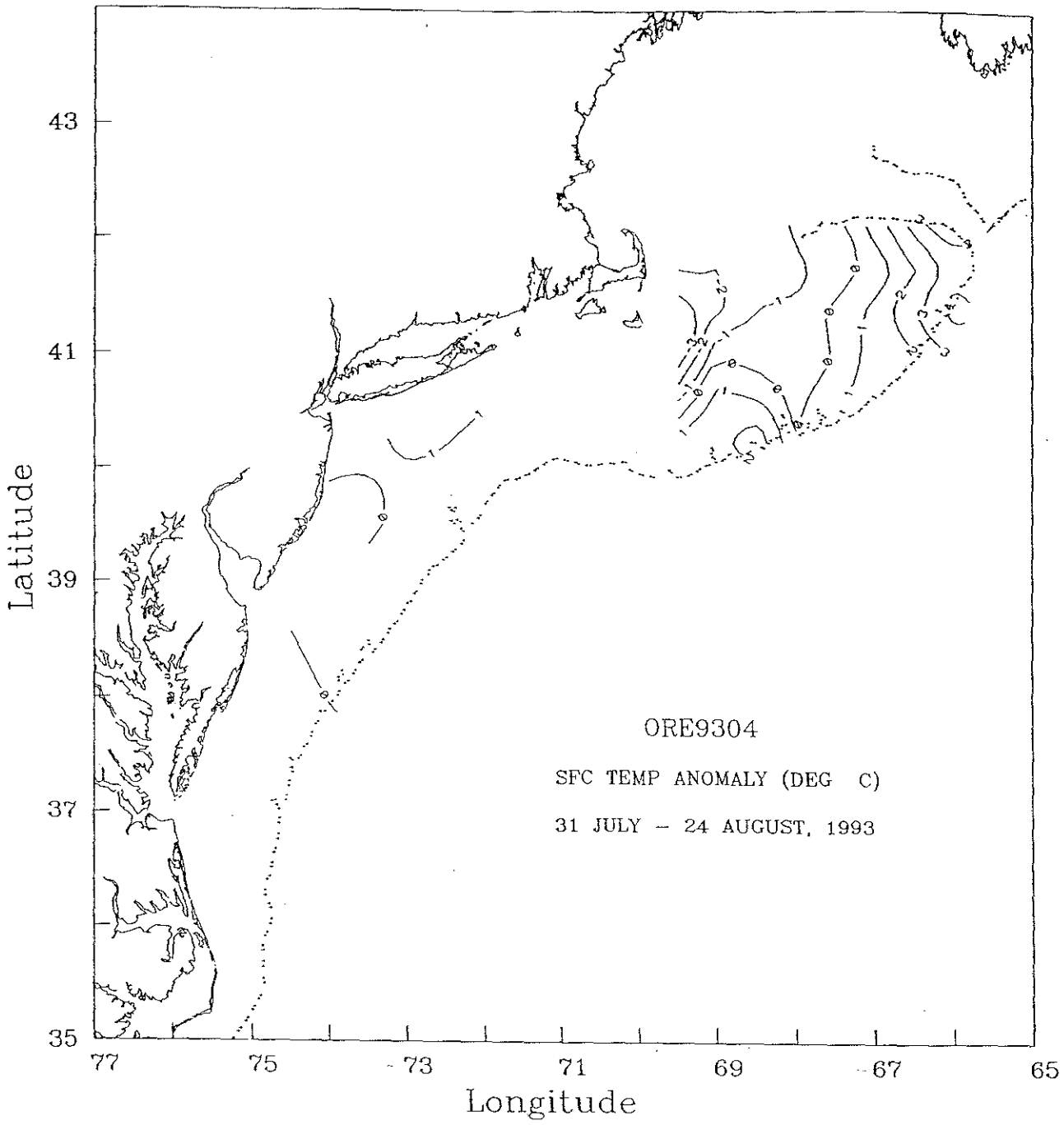


Figure 45. The surface temperature anomaly distribution for the scallop survey ORE9304.

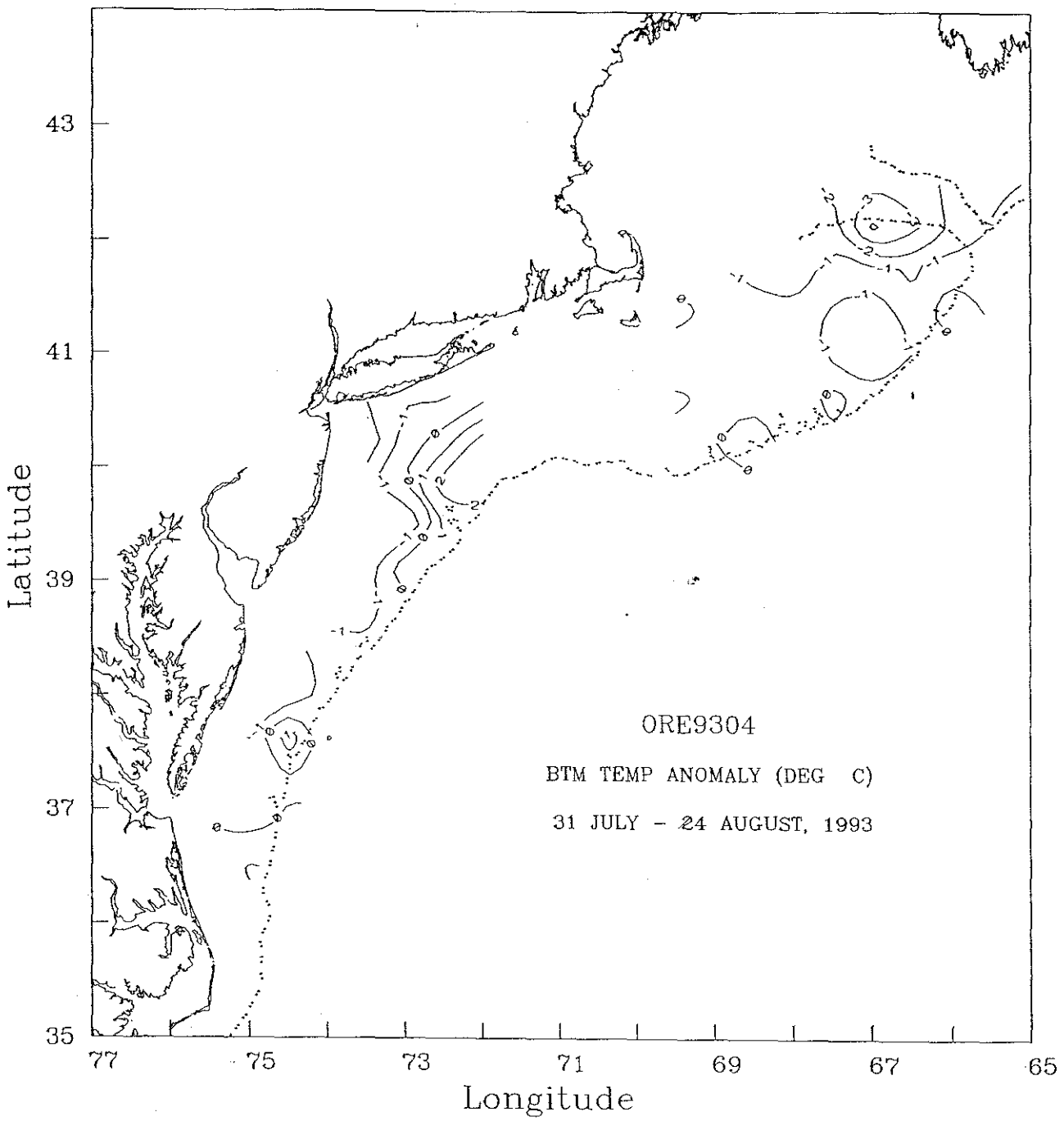


Figure 46. The bottom temperature anomaly distribution for the scallop survey ORE9304.

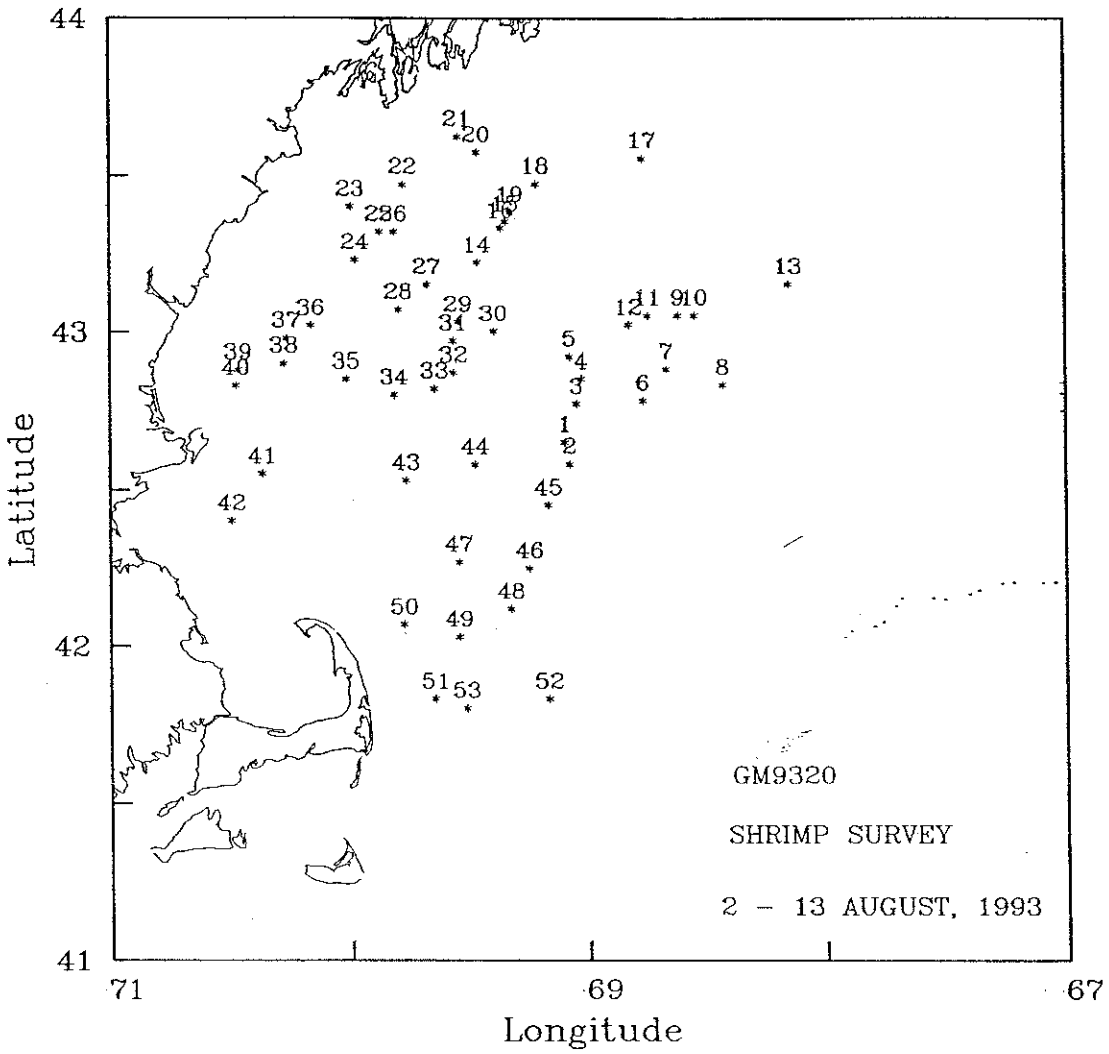


Figure 47. Hydrographic stations occupied during the shrimp survey GM9320.

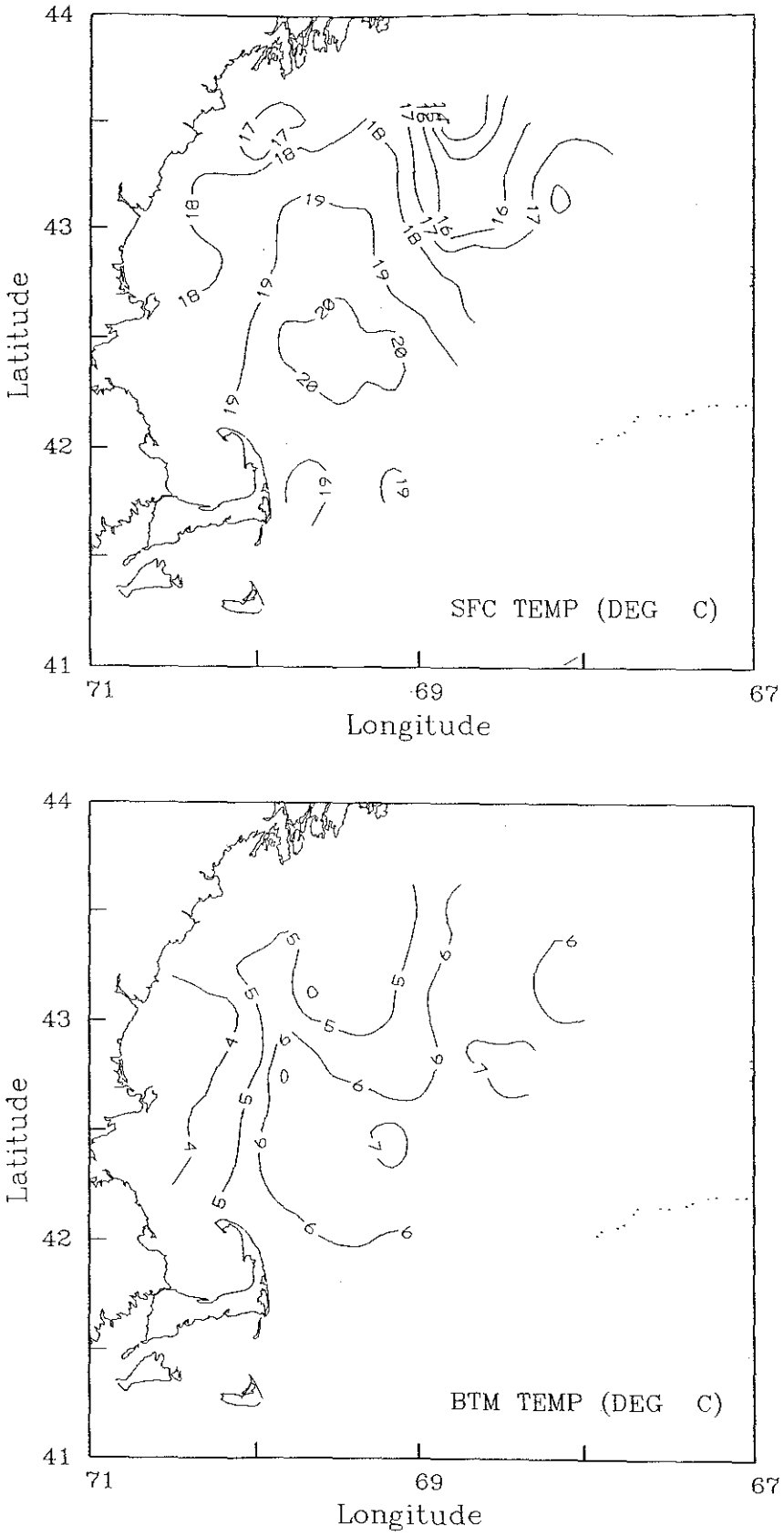


Figure 48. The surface and bottom temperature distribution for the shrimp survey GM9320.

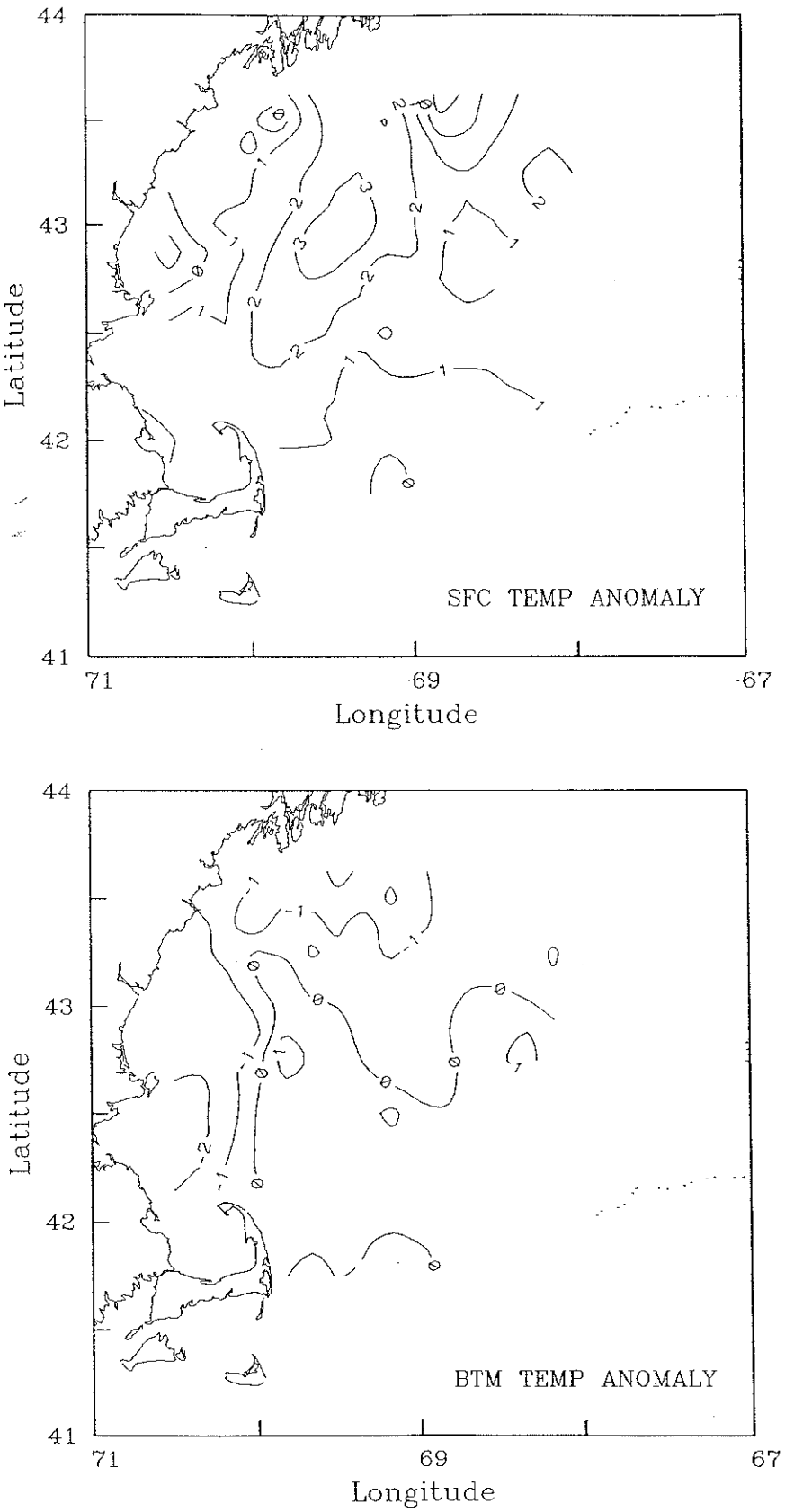


Figure 49. The surface and bottom temperature anomaly distribution for the shrimp survey GM9320.

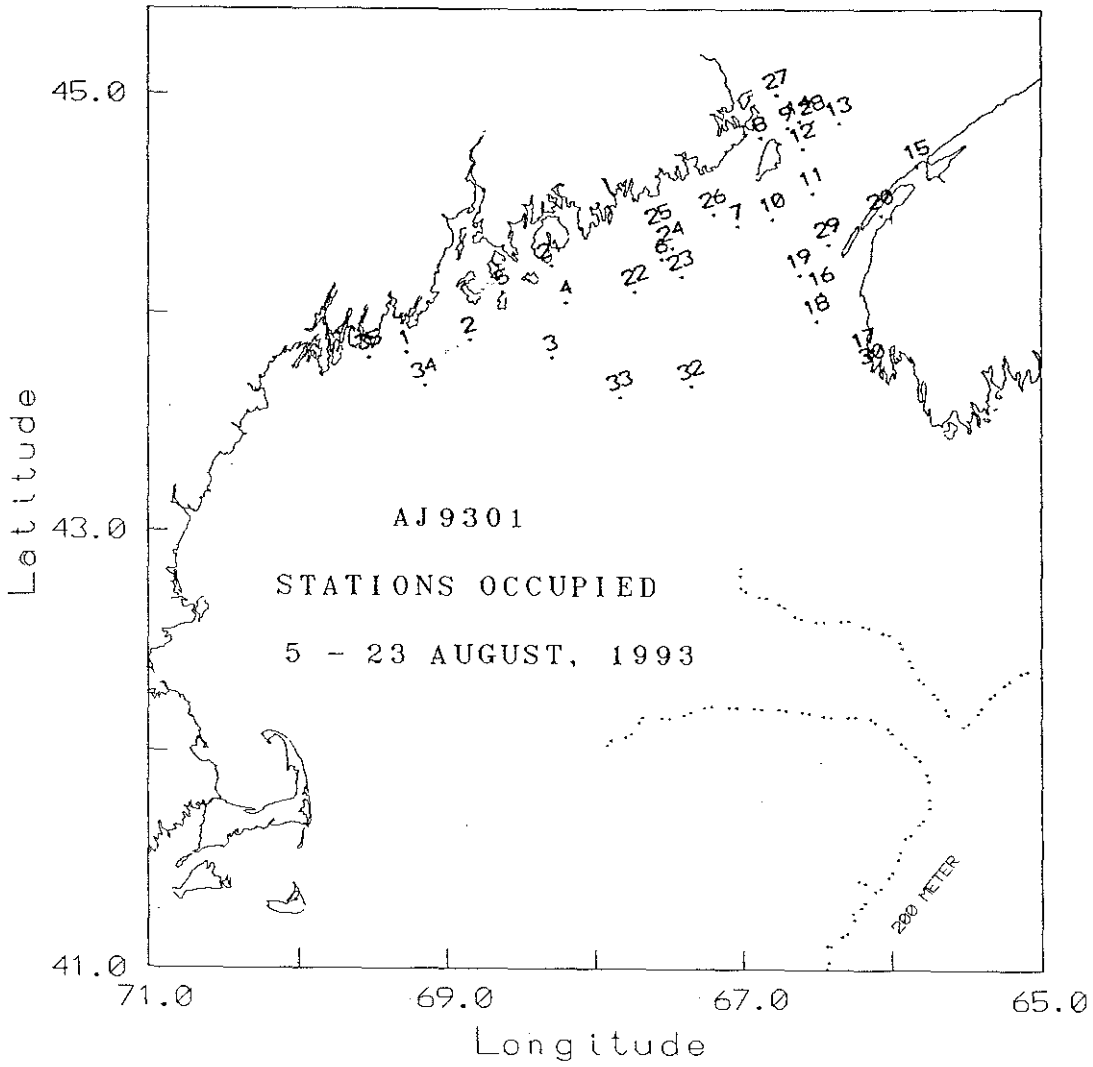


Figure 50. Hydrographic stations occupied during the harbor porpoise sighting survey AJ9301.

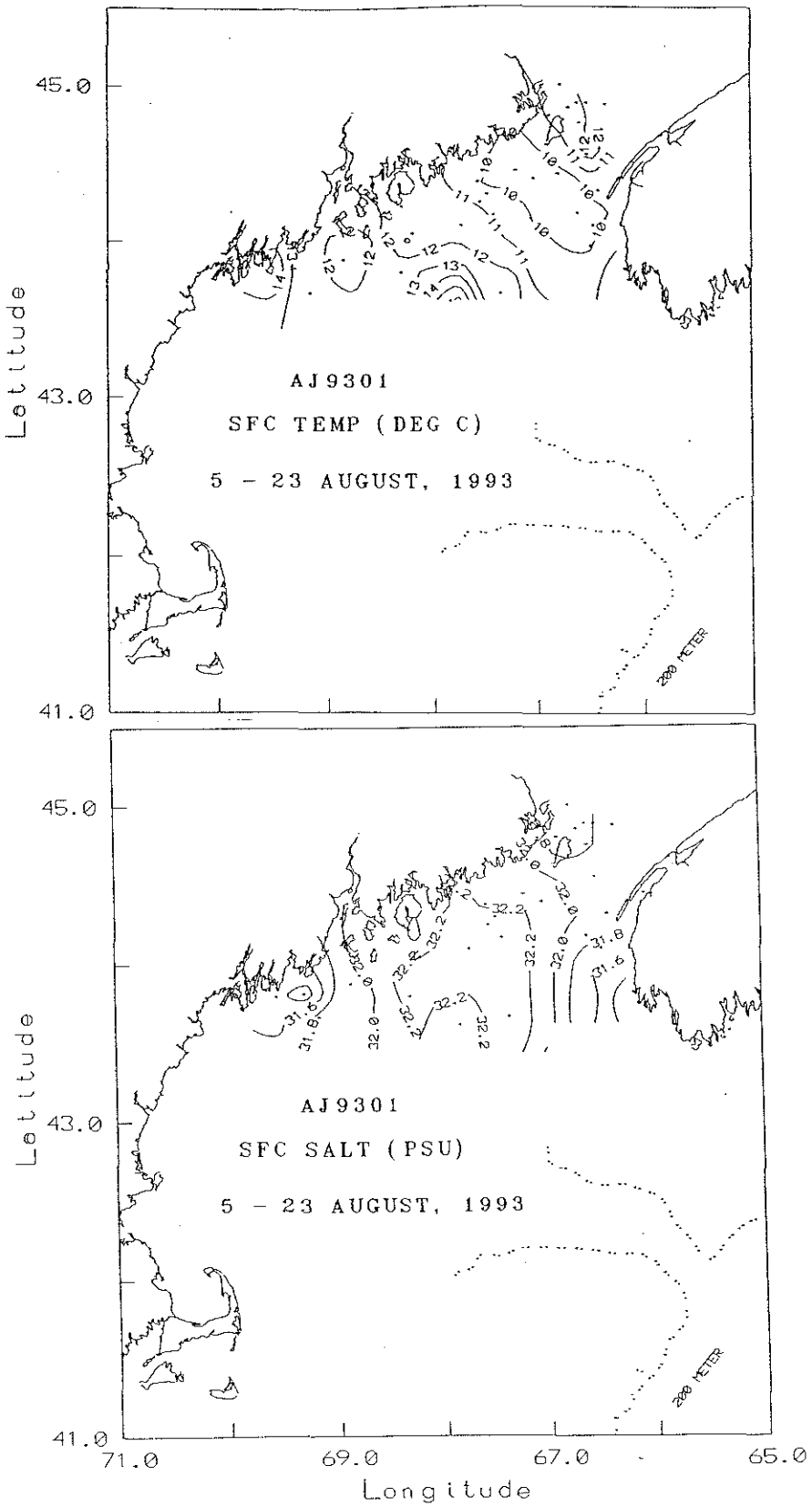


Figure 51. The surface temperature and salinity distribution for the harbor porpoise sighting survey AJ9301.

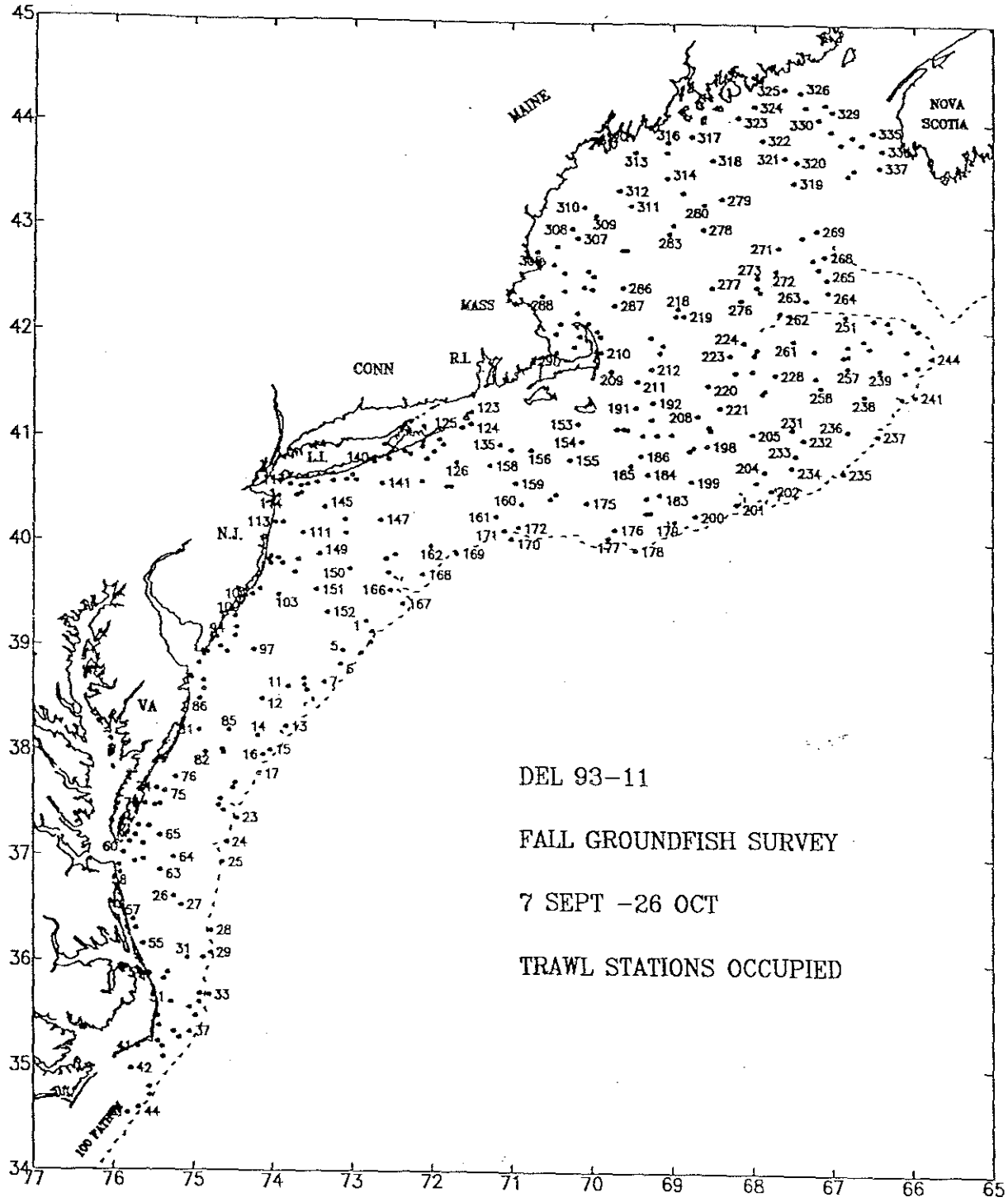


Figure 52. Hydrographic stations occupied during the fall bottom trawl survey DEL9311.

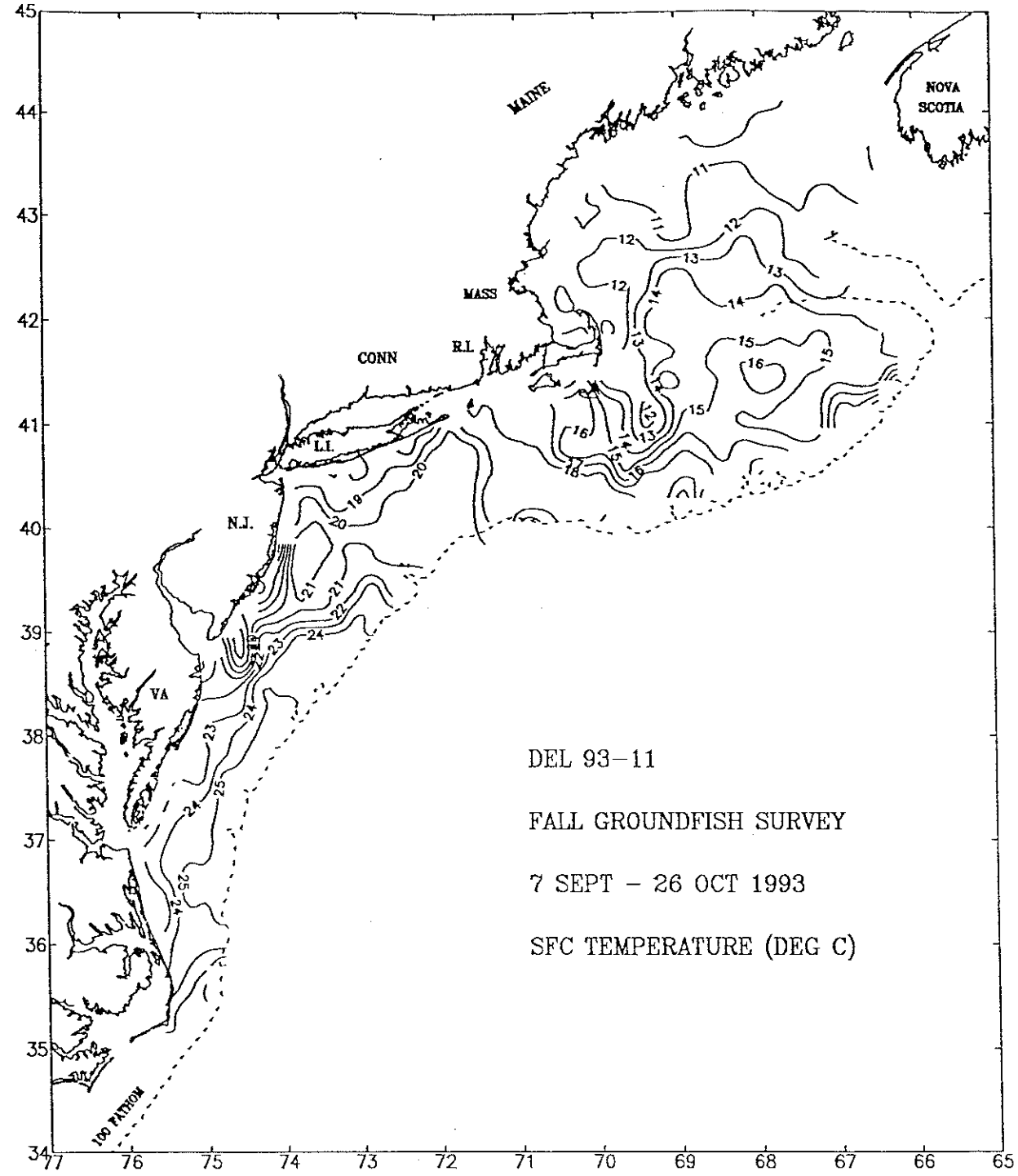


Figure 53. The surface temperature distribution for the fall bottom trawl survey DEL9311.

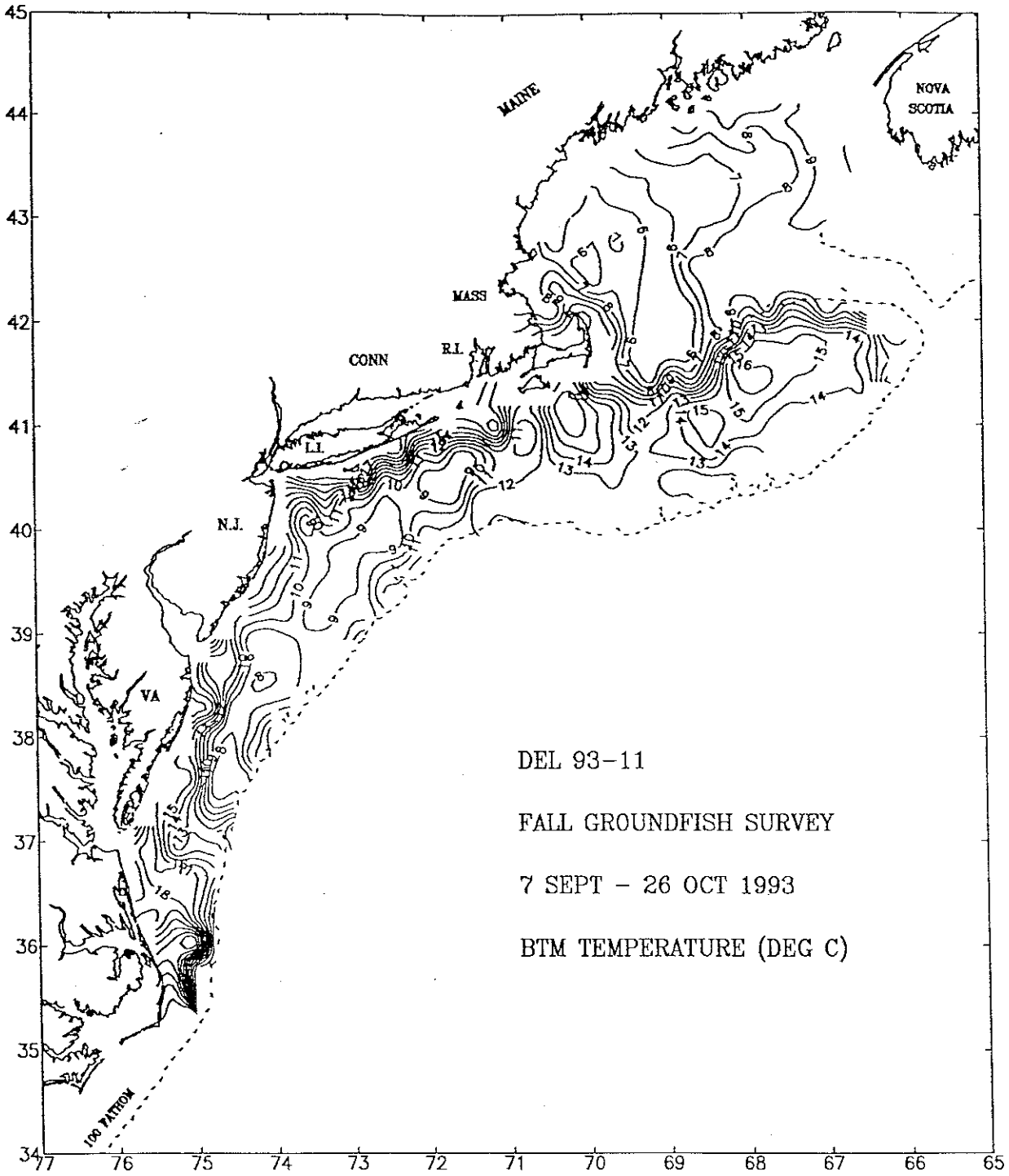


Figure 54. The bottom temperature distribution for the fall bottom trawl survey DEL9311.

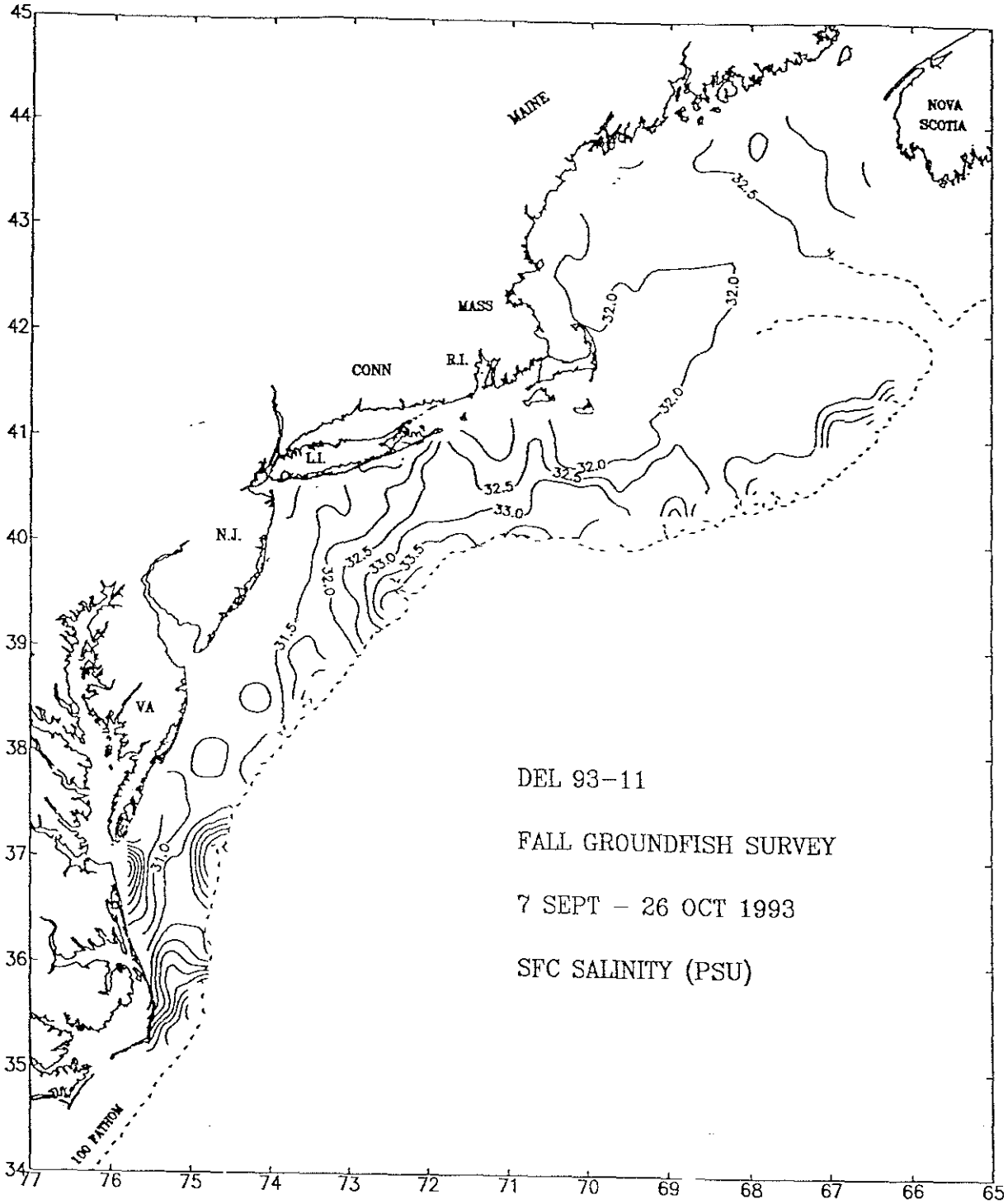


Figure 55. The surface salinity distribution for the fall bottom trawl survey DEL9311.

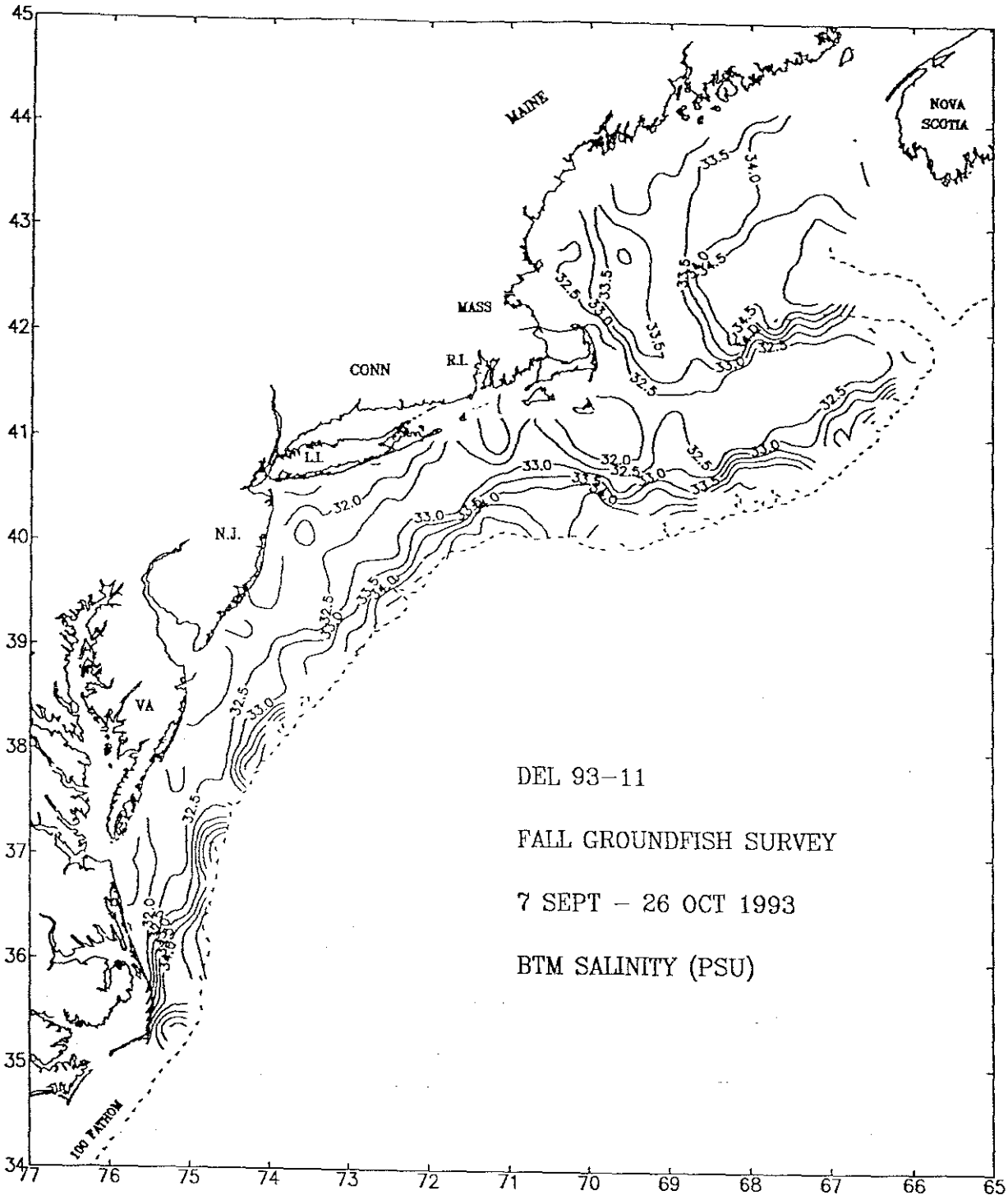


Figure 56. The bottom salinity distribution for the fall bottom trawl survey DEL9311.

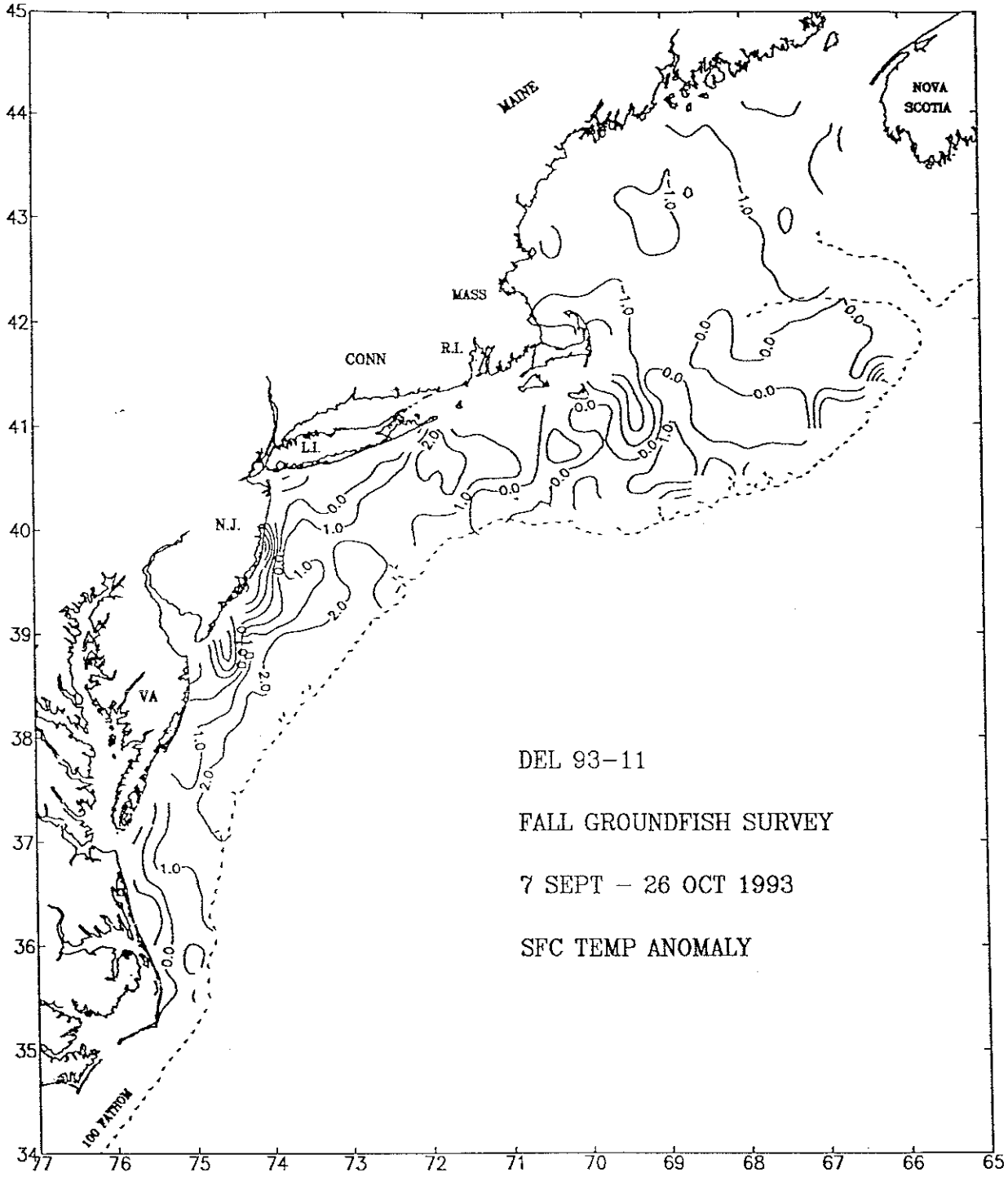


Figure 57. The surface temperature anomaly distribution for the fall bottom trawl survey DEL9311.

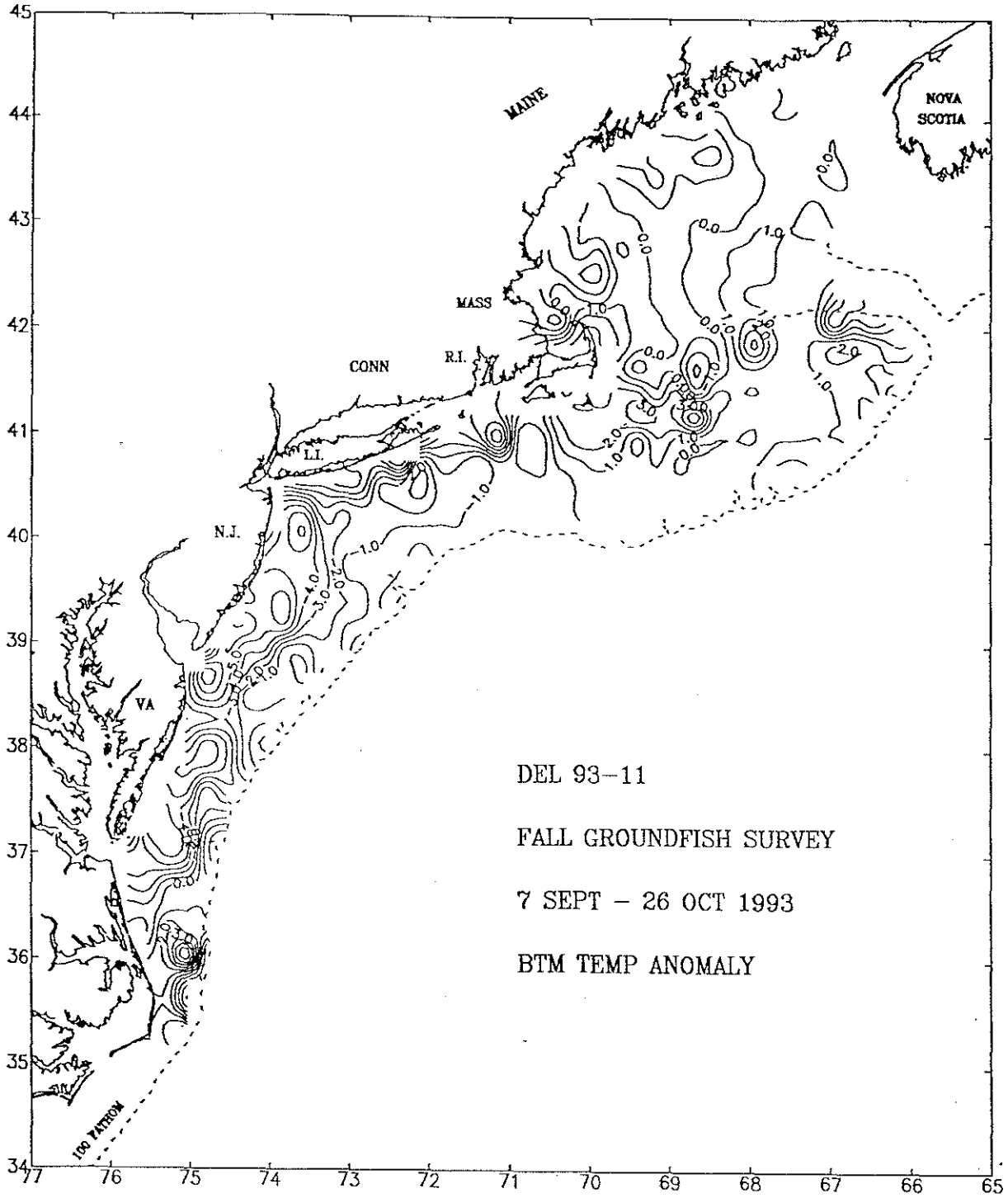


Figure 58. The bottom temperature anomaly distribution for the fall bottom trawl survey DEL9311.

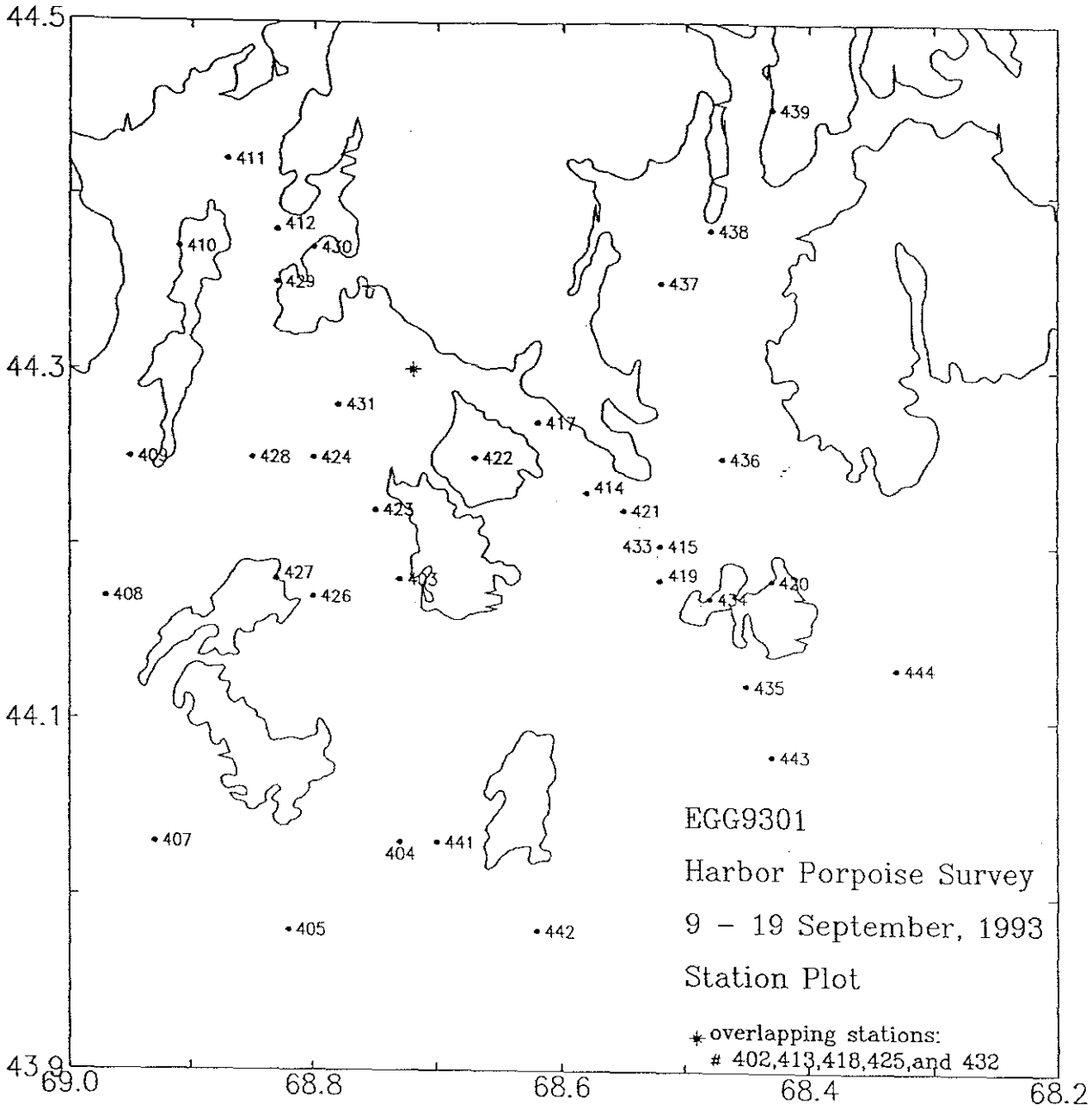


Figure 59. Hydrographic stations occupied during the harbor porpoise migration study EGG9301.

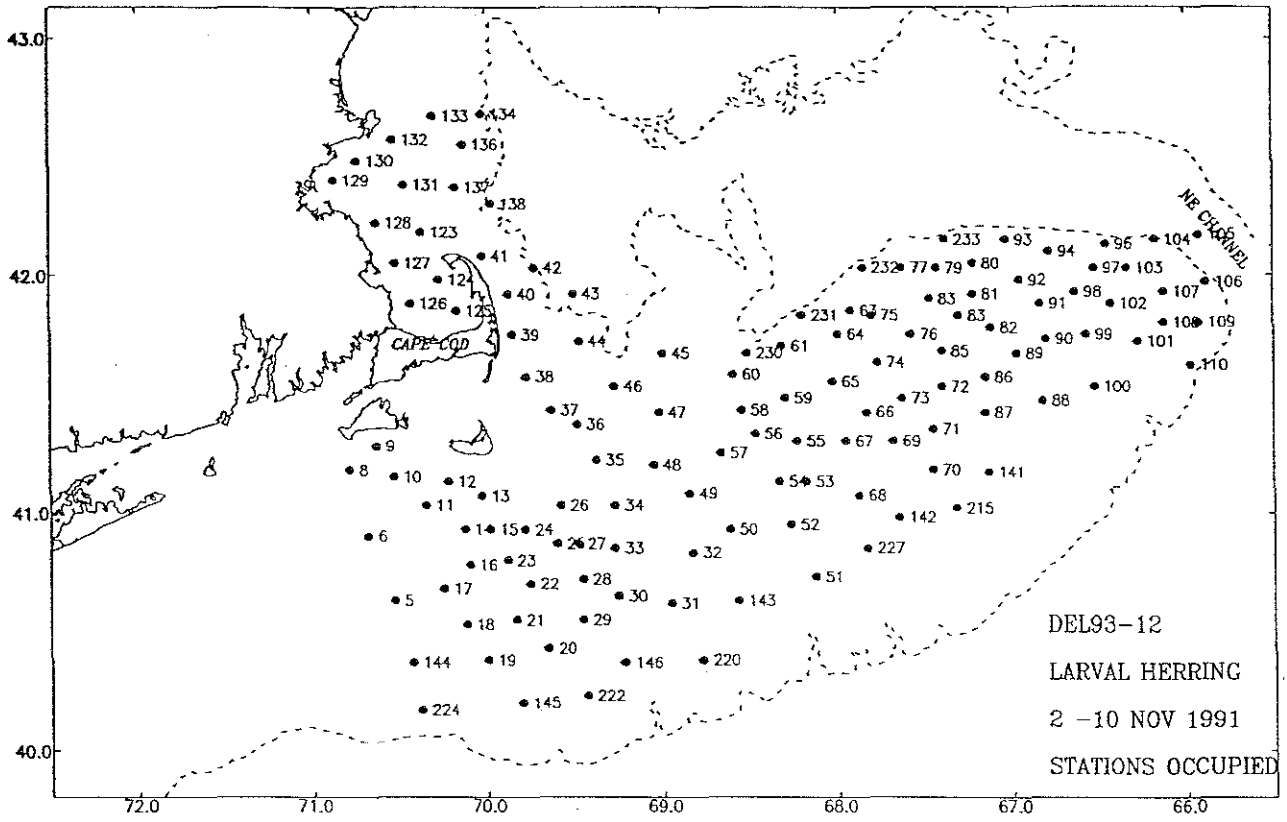


Figure 60. Hydrographic stations occupied during the larval herring/sand lance study DEL9312.

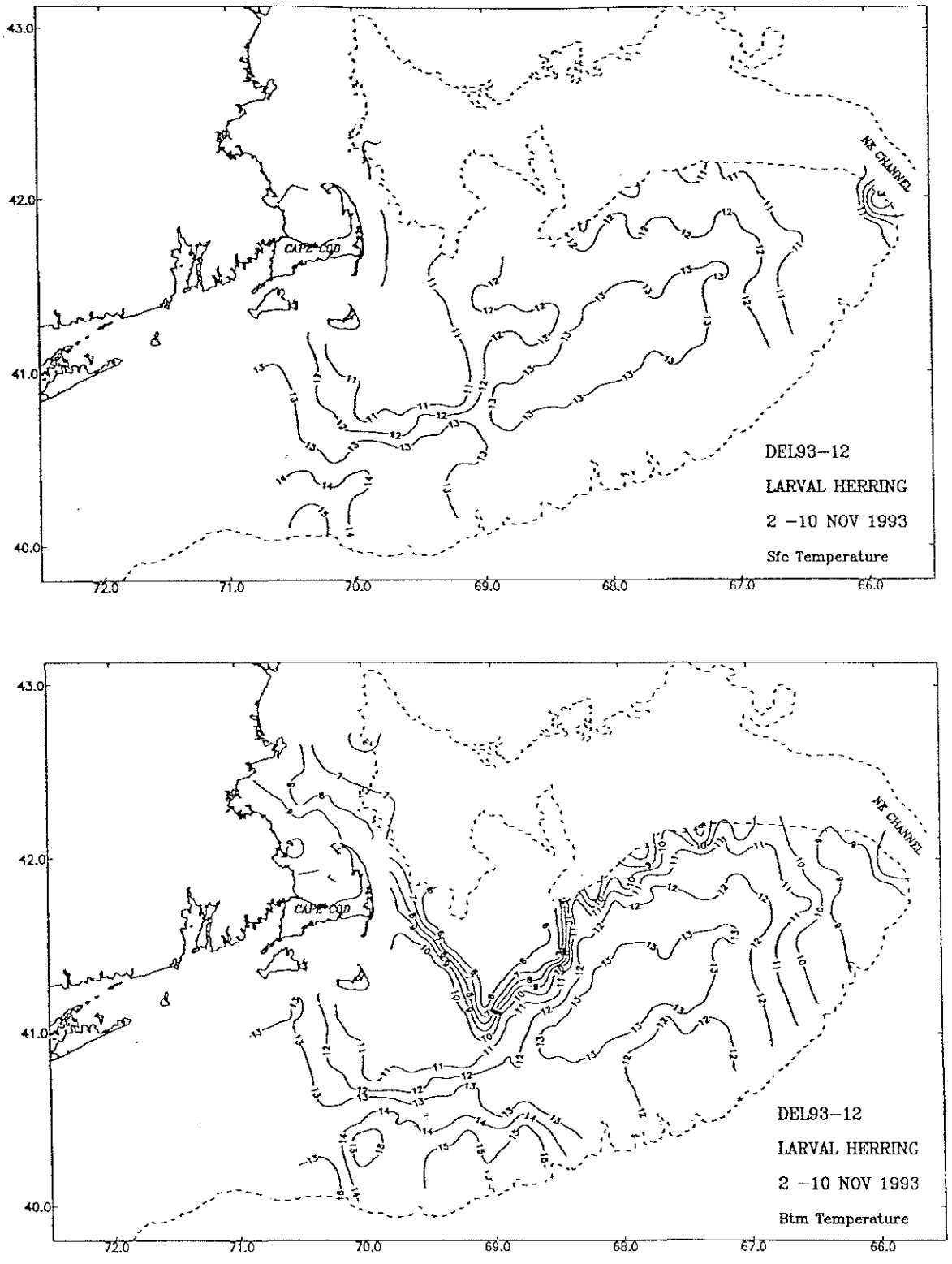


Figure 61. The surface and bottom temperature distribution for the larval herring/sand lance study DEL9312.

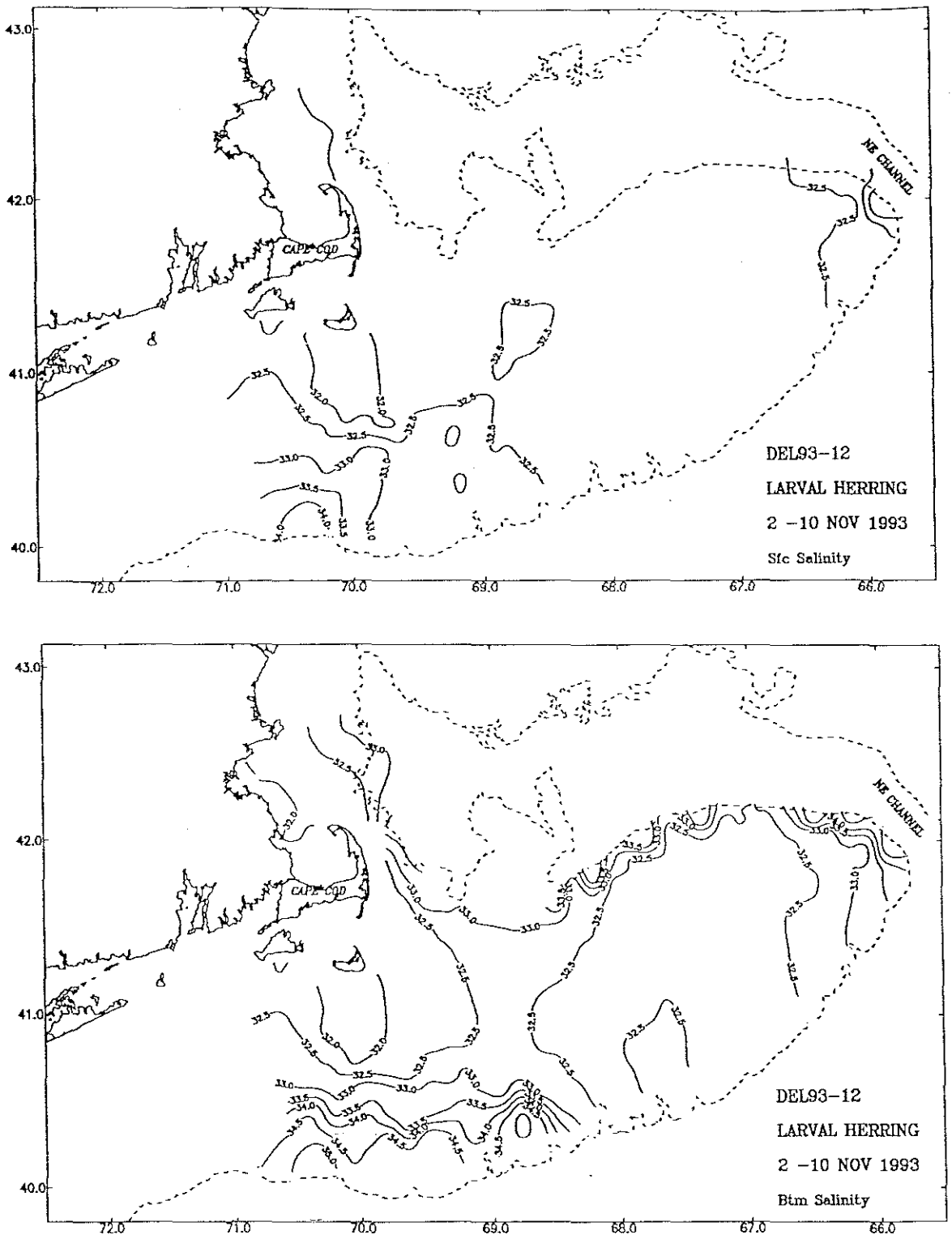


Figure 62. The surface and bottom salinity distribution for the larval herring/sand lance study DEL9312.

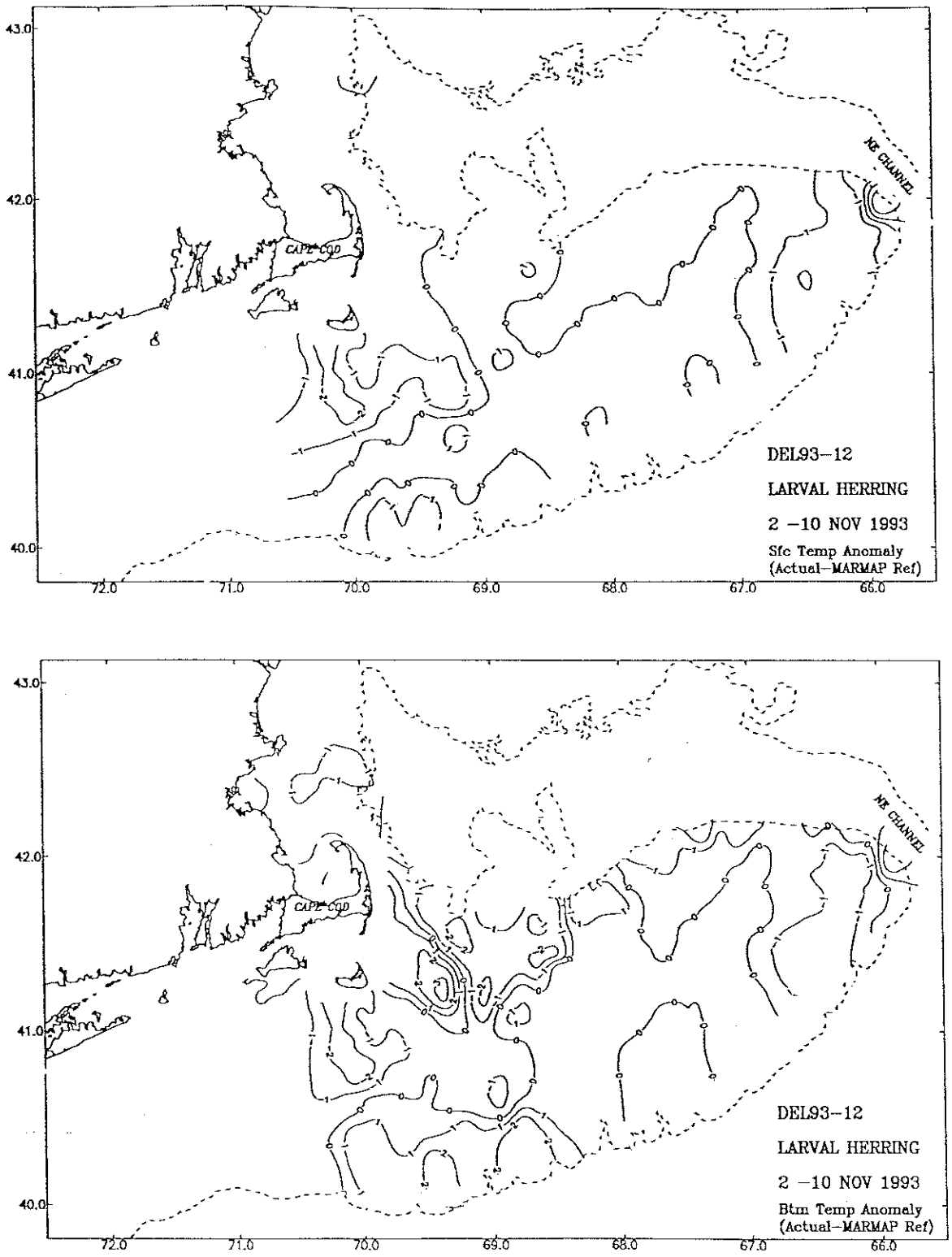


Figure 63. The surface and bottom temperature anomaly distribution for the larval herring/sand lance study DEL9312.

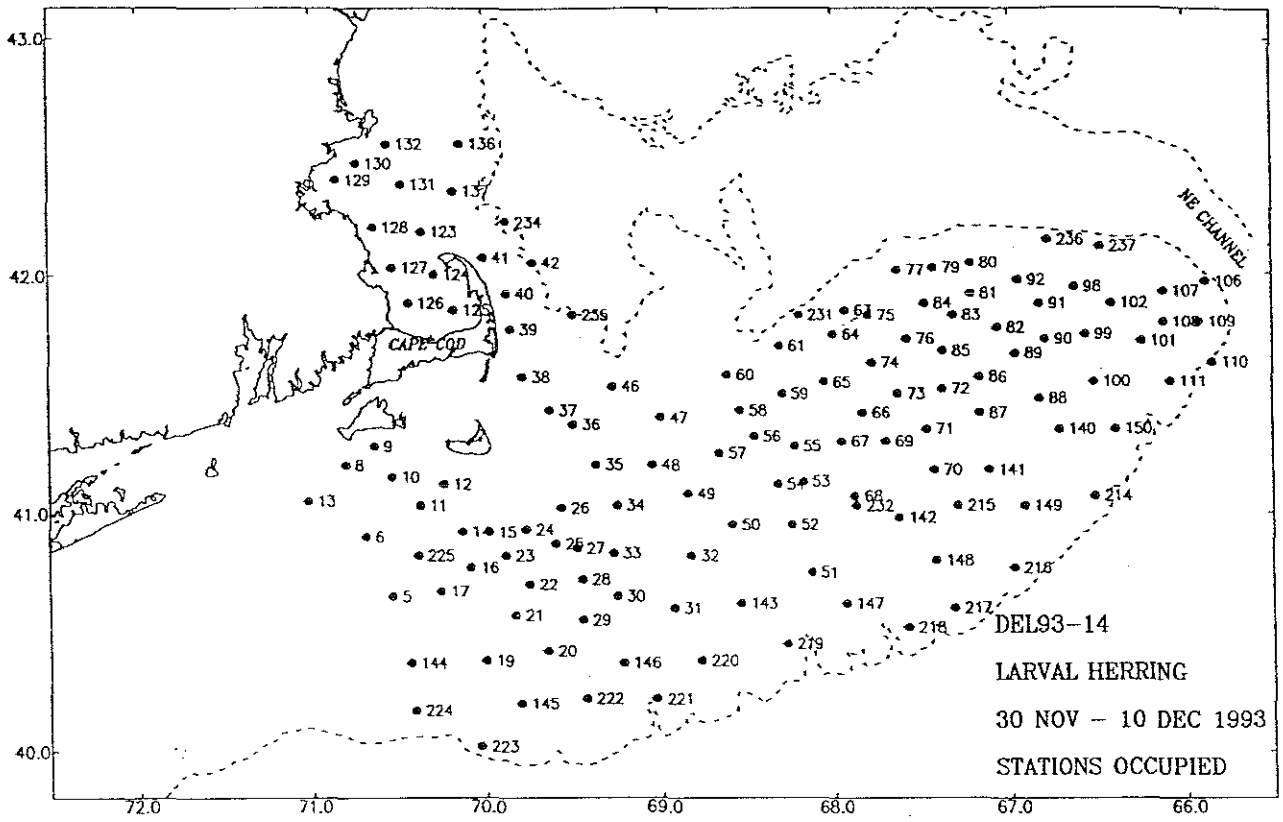
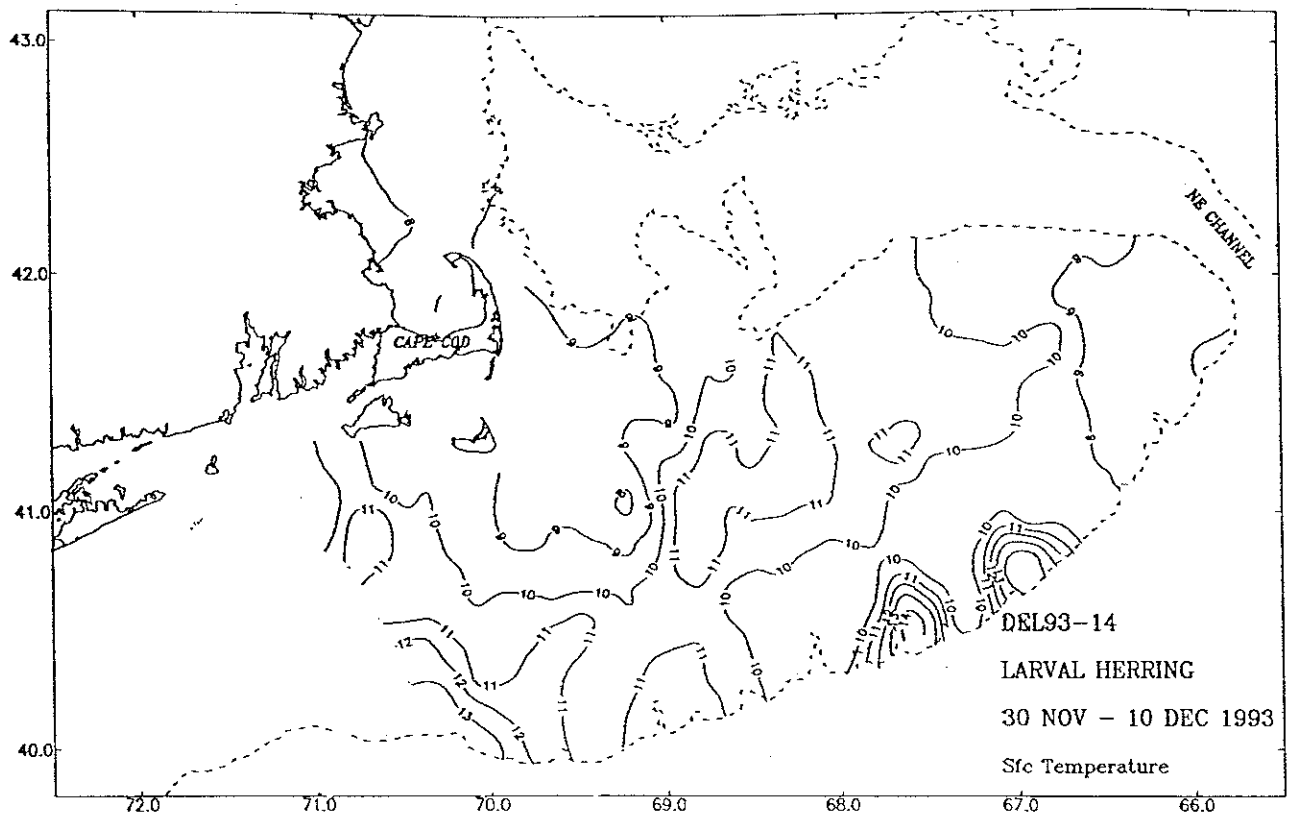


Figure 64. Hydrographic stations occupied during the larval herring/sand lance study DEL9314.



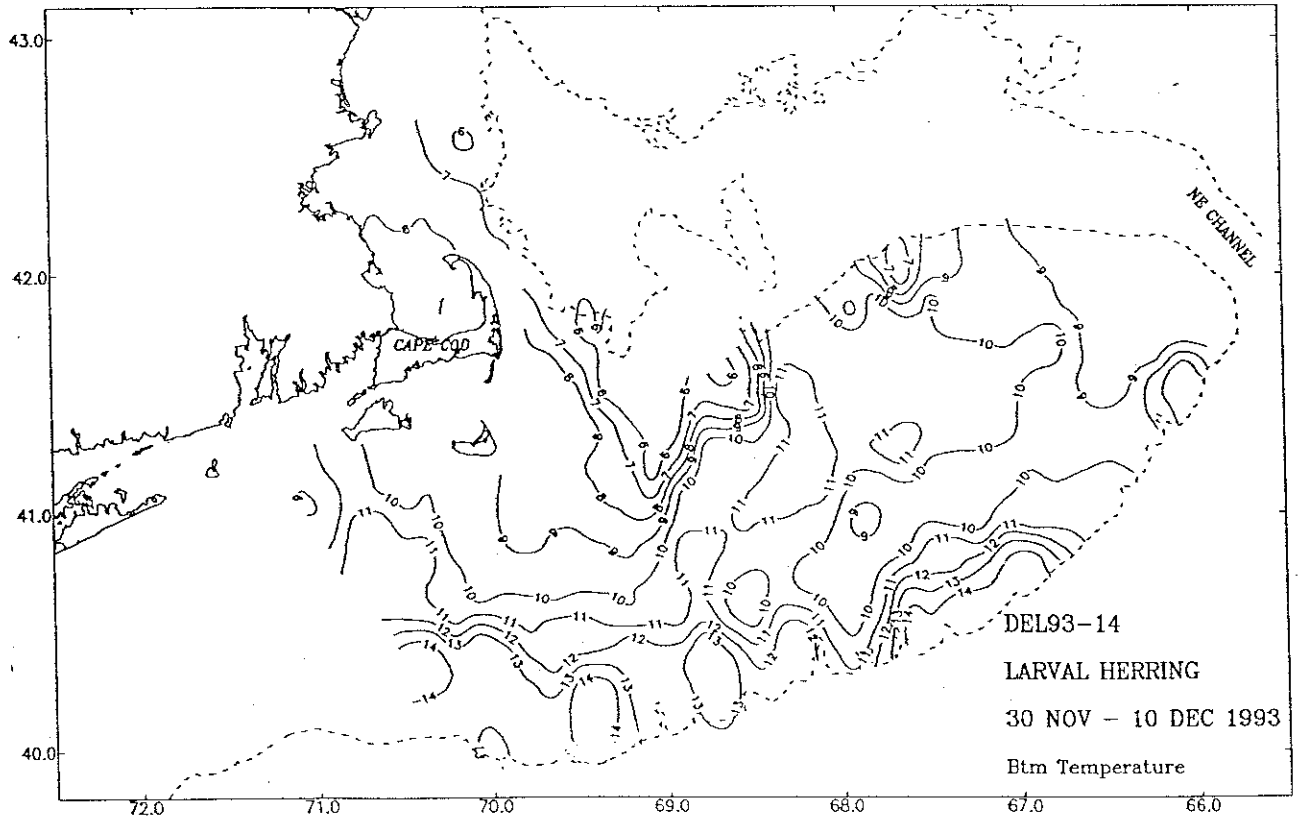


Figure 65. The surface and bottom temperature distribution for the larval herring/sand lance study DEL9314.

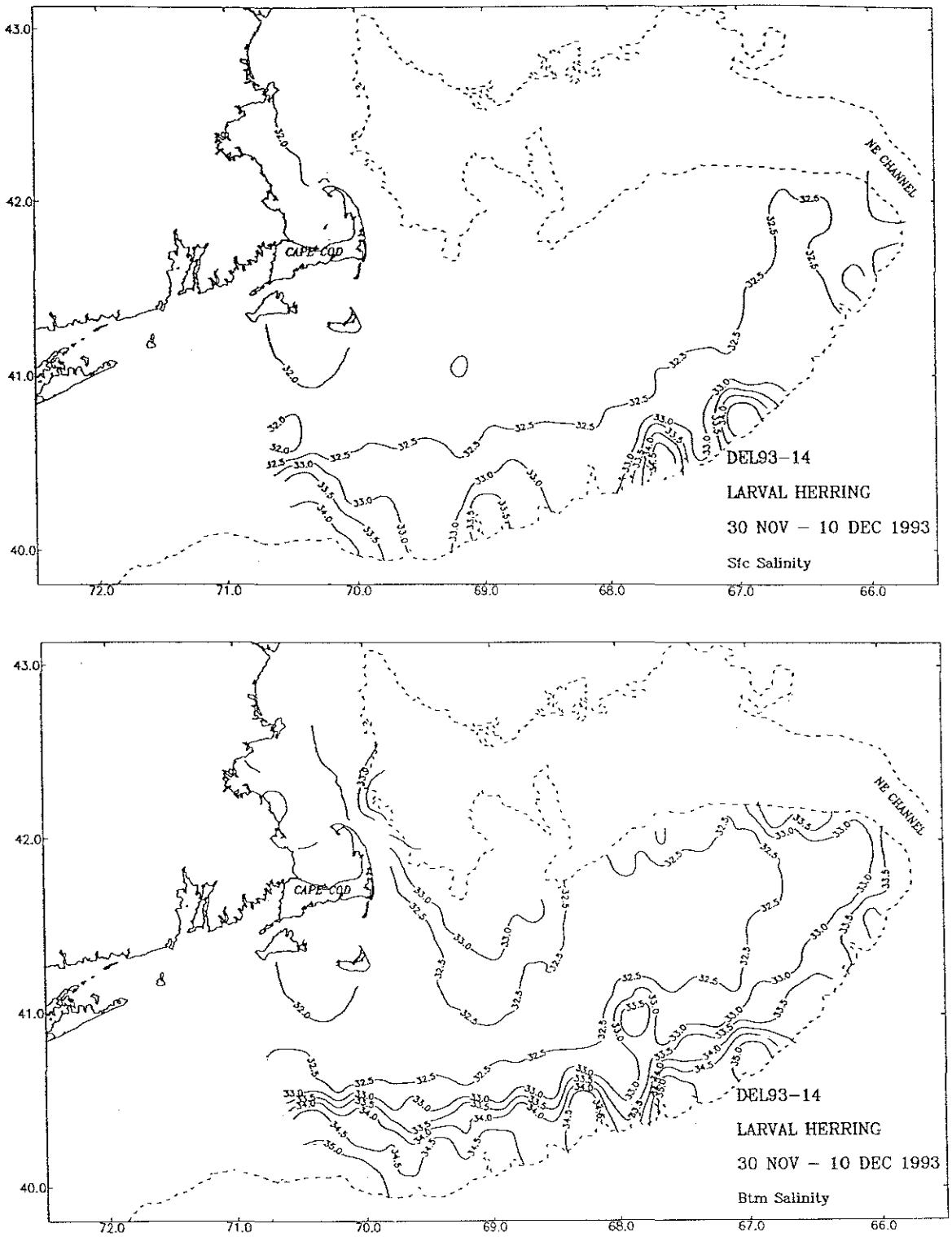


Figure 66. The surface and bottom salinity distribution for the larval herring/sand lance study DEL9314.

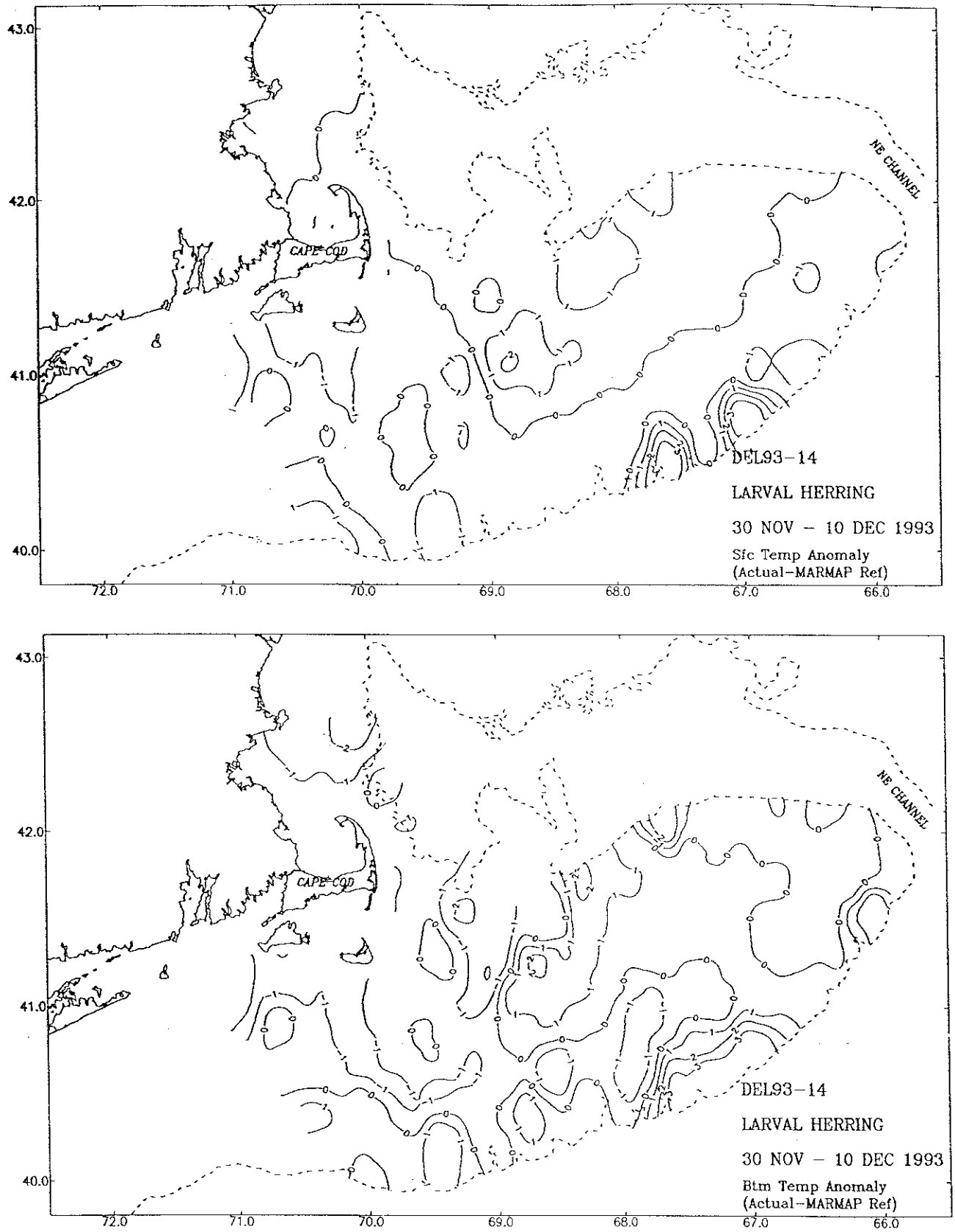


Figure 67. The surface and bottom temperature anomaly distribution for the larval herring/sand lance study DEL9314.