Cruise Report

R/V SEWARD JOHNSON Cruise 9507 to Georges Bank

US GLOBEC

NW ATLANTIC/GEORGES BANK STUDY

8-26 May 1995

Acknowledgements

We gratefully acknowledge the very able assistance provided by the officers and crew of the R/V SEWARD JOHNSON.

This report was prepared by Greg Lough, Jim Manning, Betsy Broughton, Marie Kaladis, Kate Lindner, Erich Horgan, Mari Butler, Barbara Sullivan, and Michael Moore. This cruise was sponsored by the National Science Foundation and the National Oceanic and Atmospheric Administration.

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Purpose of the Cruise

The objectives of the cruise were to (1) determine the distribution and abundance of larval and juvenile cod and haddock on the southern flank of Georges Bank in relation to water column conditions, (2) conduct site studies to determine their vertical distribution, diel variability, predator-prey relations, and biochemical content, (3) to document the abundance, distribution, and behavior of hydroids and other gelatinous predators in this same area, and (4) to measure the horizontal shear and vorticity of water parcels through smale scale drifter deployments.

Sampling Systems

MOCNESS and Bongo (described below) were the primary biological sampling systems. In order to sample the same cohort of larvae, ARGOS/GPS/VHF drifting buoys with drogues (15 m) were used to tag a parcel of water and monitor changes in stratification. Scuba diving operations were conducted to collect gelatinous organisms and record their distribution and behavior. A Remotely Operated Vehicle was used to survey benthic habitats for the presence of hydroid colonies. Other sampling systems include CTDs and several ship mounted sensors including ADCPs.

Cruise Narrative

High winds and tall seas prevented us from leaving port on Monday 8 May 1995. The R/V SEWARD JOHNSON left Woods Hole, Massachusetts at 1318 h on 9 May 1995 to begin a bongo-net survey of the southern flank of Georges Bank (Figure 1). Our first bongo station began at 0400 h 10 May 1995 at the southwest part of the bank, 40° 34.5', 68° 32.0'; stations continued towards the east, between the 70- and 100-m isobaths, about 10 miles apart. Stations were numbered consecutively from the previous cruise (SJ9505), starting with 92. The initial bongo survey ended with station 119, 1615 h on 11 May 1995, 41° 01.5', 67° 34.5'.

A fine-scale bongo grid, centered on the southern flank of the bank, began with station 120, 1945 h, 11 May 1995, 41° 09.5', 67° 42.5'. The 11 transects were oriented north-south and bongo stations were five miles apart, seven to five on a transect (Figure 1). Drifter 4a was deployed at station 122 at 2256 h, 11 May 1995, 41° 0.39', 67° 34.49', 66-m bottom depth. Drifter 6a was deployed at station 123 at 2353 h, 11 May 1995, 40° 56.50', 67° 32.50', 77-m bottom depth. Drifter 1a was deployed at station 129 at 0604 h, 12 May 1995, 40° 49.90, 67° 34.90', 77-m bottom depth. Drifter 2a was deployed at station 130 at 0726 h, 12 May 1995, 40° 54.87', 67° 38.34', 71-m bottom depth. The bongo grid ended at the Great South Channel with station 188 at 0936 h 14 May 1995. The vessel then steamed to a site in the middle of the bongo grid to set up for MOCNESS CTD operations.

Arrived at station 188 at 1315 h 14 May 1995, 40° 48.5', 67° 59.0', 65-m bottom depth. Operations began with MOCNESS tow 64. Drifter 7a was deployed at 1750 h 14 May 1995, 67°

59.90', 40° 48.37', which served as the station marker. Scuba diving observations were conducted by E. Horgan and S. Drapeau from 1308-1432 h 15 May 1995, 40° 52.47', 68° 08.22'. The vessel then steamed southeast to pick up drifter 6a, which was brought aboard at 1640 h 15 May 1995, 40° 45.42', 67° 47.32', 70 m depth. Drifter 2a then was picked up at 1700 h 15 May 1995, 40° 46.10', 67° 46.38', 70 m depth. Steamed to drifter 4a and retrieved at 1748 h 15 May 1995, 40° 40.0', 67° 49.0', 82 m depth. At 1840 h the vessel steamed southwest to begin a CTD transect frontal study.

The frontal study began at 1952 h 15 May 1995, 40° 35.0', 68° 00.0', and consisted of three CTD transects (stations 189, 190, 191) from the 53- to 107-m isobaths, each transect having about nine CTD casts spaced 1-3 miles apart. CTD transects ended at 0920 h 16 May 1995. The position of the front was used to pick a station just shoalward of the front where fish larvae may be located.

Station 192 began at 1018 h 16 May 1995, 40° 45.0', 68° 00.0', 75 m depth, with 1-m MOCNESS 74. Drifter 4b was set at 1428 h 16 May 1995, 40° 45.23', 68° 0.15', 75 m bottom, to serve as the station marker for the MOCNESS and CTD operations. Station 192 ended at 1320 h, 17 May 1992 with 1-m MOCNESS 85, and picked up drifter 4B at 1400 h 17 May 1995, 40° 45.50', 68° 13.10', 62 m depth. The vessel then steamed for Nantucket to weather the approaching storm and along the way, downloaded data from drifter 7a at 1627 h 17 May 1995, 40° 45.31', 68° 24.8', 51 m depth. Then we steamed southwest to recover drifter 1a at 1923 h 17 May 1995, 40° 21.46', 68° 57.34', 89 m depth. Arrived Nantucket harbor and anchored at 0429 h 18 May 1995; moved on the tide to Straight Wharf at 1218 h 18 May 1995.

Departed Nantucket 1400 h 20 May 1995 and steamed to shoal site near old station 148 for ROV operations. Along way retrieved drifter 7a at 2225 h 20 May 1995, 40° 33.63', 68° 38.24', 67 m depth. Arrived at station 193 at 0350 h 21 May 1995, 41° 02.30', 68° 04.92', and made 1-m MOCNESS tow 86 at 0402 h. Anchored at 0814 h 21 May 1995, 40° 58.88', 68° 06.41', 40 m depth; ROV deployed at 0900 h. CTD cast made at 1257 h. Weighed anchor at 1328 h and moved south to station 194. Anchored at 1439 h 21 May 1994, 40° 48.3', 68° 04.2', 65 m depth and commenced ROV operations at 1600 h; ROV aboard at 1645 h and CTD cast made at 1655 h. Small boat SCUBA diving observations were conducted by E. Horgan and S. Drapeau during the period 1725-1830 h. A night ROV operation was conducted during 1945-2115 h. Weighed anchor at 2224 h 21 May 1995. A 1-m MOCNESS tow was made at same station 194 at 2240 h, and a 10-m MOCNESS tow was made at 0345 h 22 May 1995.

Steamed east to station 195 where a CTD frontal transect was made from 40° 52.0', 68° 00.0' to 40° 40.0', 68° 00.0', five CTD casts during the period 0500-0726 h 22 May 1995. The vessel then steamed to station 196 along the CTD transect and began a 1-m MOCNESS tow at 0807 h 22 May 1995, 40° 45.0', 68° 00.0', 75 m depth. Following a CTD cast at 1137 h we steamed north to a shoaler station 197, 40° 48.0', 68° 00.0', 68 m depth, in order to stay out of slope water and find more gadid larvae.

Prior to setting up on station 197, four drifters (1b, 2b, 4c, 6b) were placed around the site about a 2-mile box. The center of the box, station 197, was drogued with drifter 7b at 1430 h 22 May 1992, 40° 48.02', 68° 00.03', 70 m depth. MOCNESS and CTD operations commenced at 1442 h. Talked with Chief Scientist on R/V Endeavor at 0800 h 23 May 1995 to set up joint operations; they deployed a drifter a couple miles east of Seward Johnson. Re-rigged drifter 6b with more weight on the drogue and redeployed at 2156 h 23 May 1995, 40° 52.2', 68° 08.7'.

On 24 May 1995 at 2000 h, we left drifter 7b to recover drifter 4c at 2135 h, 40° 43.52', 68° 18.40', 61 m depth. A CTD frontal transect was made from the head of Oceanographer Canyon (231 m) to the 58-m isobath, between 2328 h 24 May to 0328 h 25 May 1995. Eight CTD casts (59-66) were made every three miles along the transect starting from 40° 29.0', 68° 09.0' to 40° 51.15', 68° 11.93'.

We returned to drifter 7b (station 197) and commenced MOCNESS-CTD operations at 0830 h 25 May 1995. Final MOCNESS tow made on station 197 at 1318 h. All remaining drifters (7B, 1B, 2B, 6B) retrieved between 1416 and 1720 h 25 May 1995. Enroute to Great Round Shoals at 1755 h. A CTD transect consisting of four casts (69-72) was made across Great South Channel from east to west along 40° 54.0' between 2004 h and 2242 h 25 May 1995. The start and end positions were 68° 45.0' and 69° 10.0', resp. The Seward Johnson steamed to Woods Hole and arrived at 0815 h 26 May 1995.

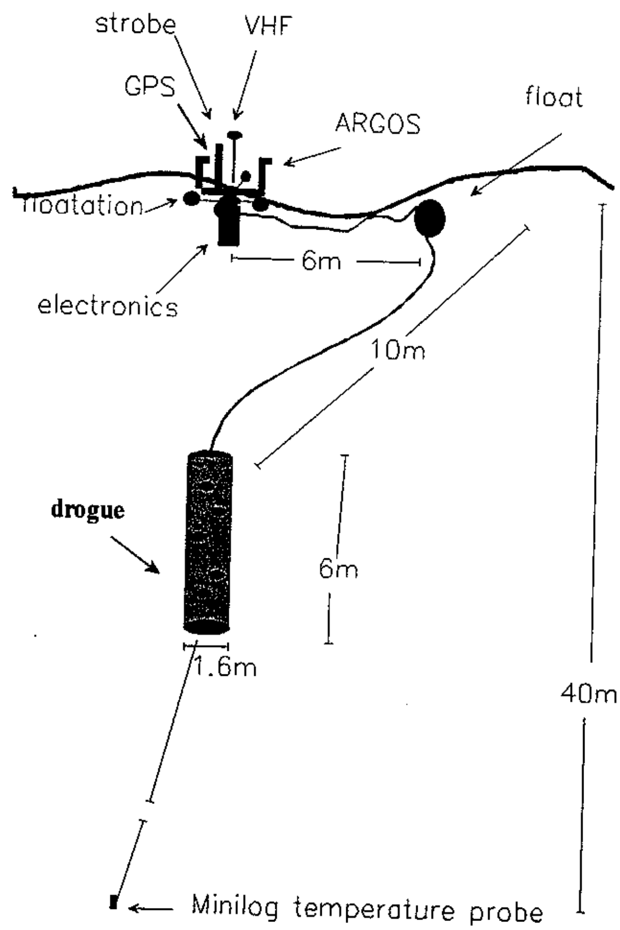
Individual Reports

Physical Oceanography (J. Manning, G. Strout, and J.Churchill)

Drifter Deployments

The configuration of the drifter is as described in previous cruise reports and sketched below. The cylindrical canister which houses the electronics with 33 D-cell batteries rides below the water line. The three antennae (ARGOS, GPS, and VHF) extend above the water line. Small styrofoam floats at the ends of two intersecting fiberglass rods provide buoyancy. The canister is tethered to a Norwegian surface float with 6 m of 1/2" polypro line. A holey sock (6 m-long and 1.6m in diameter) is tethered 10m below the float. The float acts to buffer the force of wave action and prevent the drifters antennae from submergence. A external temperature sensor is connected to the electronics. VEMCO Minilog temperature probes (9.5 cm x 2 cm cylinder) are secured to the base of the holey sock and, on a few deployments, to the end of a 25 m length of 3/16" nylon cord below the holey sock.

A total of 11 GPS/ARGOS/VHF drifter deployments were made during this cruise (Figure 2a). These included two cluster deployments (4 and 5 drifters, respectively) and two individual station marker deployments. All deployments were made within 20 miles of the Stratification Mooring Sites (ST1 and ST2) so that additional current information may become available to supplement our observations during the cruise. The purpose of the cluster deployments was to measure the degree to which a 3-4 km "patch" of water is dispersed over a period of a few days drift on the southern flank of Georges Bank. With a cluster of four or more drifters a measure of horizontal shear and vorticity may be calculated and estimates of dispersion obtained. The purpose of the station marker deployments is simply to tag a parcel of water for biological sampling. With the exception of one faulty strobe, one drogue being too buoyant, and the mysterious lose of another drogue altogether, the drifter system worked fairly well such that all 11 drifters were recovered and returned to the lab in working



order.

The first cluster deployment was made on the first two legs of the 5-mile bongo grid (10-14 May) in the vicinity of the GLOBEC Stratification Mooring array (ST1 and ST2). Drifters were deployed at four of the bongo sites (123, 124, 128, and 129) in order to seed a patch of water with slightly different water depths. Since this area of the southern flank is relatively flat, the spacing of five miles (larger than original intended) was chosen in an attempt to document a cross-bank horizontal shear that had been observed on previous cruises. While analysis of this deployment is far from complete, the most significant result was obvious within a few tidal periods of deployment. Drifter "1a", which was deployed on the southwest corner of the array, evidently got caught in a strong southwestward jet along the 100-m isobath. The cause of this jet-like flow may be related to the presence of Gulf Stream ring(s) off the bank (Figure 3) which evidently confined the usual alongbank drift into a more intense zone of southwestward flow. Mooring records for GLOBEC mooring sites should help document the timing and extent of this feature.

A comparison of the thermal stratification (as observed by temperature sensors attached to the drogue tethers) shows drifter "2a" recorded warmer water at the surface while drifter "1a" recorded warmer water at depth (Figure 4). The drogue of the later was obviously residing the upper reaches of the shelf-slope front, evidently a region of strong southwestward flow.

The second cluster deployment consisted of five drifters spaced a few miles apart (22-25 May). In order to account for the tidal advection in the time it takes to deploy all the instruments, each drifter was placed in order to obtain a rectangular box-shape array in the end. The fifth drifter was placed in the middle of the box and, when the RV-Endeavor arrived on station the following day, a sixth drifter was placed a few miles to the west of that drifter. Drifter "2b" was recovered with a missing drogue which explains its divergent path to the south (Figure 2a) evidently caused by surface wind and waves.

Data from the second cluster allowed us to examine small-scale dispersion over the southern flank. An important result is deduced by comparing the time records of the cluster's mean position with the variance of drifter locations about the mean position (Figure 2b). While tidal oscillations are prominent in the mean position records, they make relatively minor contributions to changes in position variance. This implies that the tide varies on a spatial scale much larger than the cluster size. The variance plot further reveals a significant stretching of the cluster in the along-bank direction and a compression of the cluster in the on-bank direction. The rate of increase in along-bank variance of drifter position, gives a along-bank horizontal diffusion coefficient of 3×10^6 cm^2/s. This is relatively small when compared with estimates of diffusion coefficients in near-shore environments. In future work we will compare dynamical properties determined from the cluster data (i.e.. correlation time-scales, velocity convergence, etc.) with that determined from the moored instrument records.

Three drifter deployments were made for the purpose of tagging a water mass. Drifter "7a" was deployed on 14 May at site 188 near the 60m isobath (Figure 5) and recovered on 20

Hydrography

A total of 177 CTD casts were conducted including 105 Seabird Profiler casts (Model 19) and 72 General Oceanics MarkIII cast. In addition, Seabird temperature (Model 3) and conductivity (Model 4) sensors were mounted on all 54 MOCNESS hauls.

The Profiler was attached to the wire just above the bongo-net frame. These cast were double oblique through the water column except for eight vertical cast taken with water bottle samples. While the main purpose of these deployments on the bongo hauls is to have a measure of depth (pressure) in real time, significant hydrographic information is gathered. A total of 11 cross-bank sections were conducted with five or more stations per section. While the salt correction is not complete at the time of this writing, rough plots of the distribution are appended in Figures 10-13.

Planview contours of surface and bottom temperature and salinity on the left hand panels of figure 10 depict the intrusion of slope water up on the shelf shoalward of the 80-m isobath during the 5-mile bongo grid survey. The effects of this intrusion are evident at mid-shelf stations near the 60-m isobath but are contained near bottom. The panel of drifter tracks demonstrates the "jet-like" character of the one drifter that was caught on the off-bank side of this frontal feature. The cross-bank structure of temperature and salinity are depicted in Figures 11-12, respectively, for transects 1-11 in the lower right panel of Figure 10. Transects 5-7 depicted the most intense intrusion. Following the bongo grid survey, we steamed back and forth along the 68° longitude to further resolve the frontal feature with a total of 30 MarkIII CTD casts. The results of this frontal study are presented in Figure 13.

Ichtho-Zooplankton Studies

Bongo-net Survey (G.Lough, E. Broughton, M. Kiladis)

Bongo tows were made with a 61-cm frame fitted with 0.333-mm and 0.505-mm mesh nets using standard MARMAP procedures; i.e., double-oblique from surface to within 5 m of the bottom. A SeaBird CTD (Model 19) was attached to the towing wire above the bongo to monitor sampling depth in real time and to record temperature and salinity. The 0.505-mm mesh net was sorted at sea to provide counts on the number of cod and haddock eggs and larvae. Larvae from the bongo sort were frozen for biochemical analyses ashore.

The initial bongo survey of 28 stations, 10-11 May 1995, covered the southern flank of

Georges Bank between the 60- and 90-m isobaths, from the Great South Channel to the southeast part (Figure 14). The number of cod larvae ranged 1-15 per net (1-10/100 m^3), and haddock ranged 1-6 per net (1-6/100 m^3), an order of magnitude lower than observed during the previous cruise R/V Seward Johnson 9505. Most of the larvae were caught; in shoaler water <70 m, while there was a marked absence in the deeper water >70 m. The most unusual observation was the presence of slope water (>10 °C, >34.00 ppt) well up on the flank with a surface signature near the 85-m isobath. No gadid larvae were caught in the slope water. The smallest larvae were on the western part of the survey; large cod, 10-20 mm, were caught in the shoaler stations near the 60-m isobath. Few gadid eggs were observed in the samples.

The fine-scale grid of bongo stations, five miles apart, was conducted over the period 11-14 May 1995 (Figure 15). The 68 stations sampled extended from the middle of the southern flank to the Great South Channel, on transects from about the 40-m to 95-m isobaths. Most of the cod and haddock larvae were caught shoalward of the 70-m isobath; few were found in the slope water deeper than 70 m. The highest numbers of cod and haddock were located in the middle of the grid along the 50-60-m isobaths. While both cod and haddock had similar distribution patterns, the number of cod was an order of magnitude greater than haddock. The highest catches of cod were in the range of 23-49 per 0.505-mm mesh net (10-19/100 m^3); only two haddock catches were as high as 6-7 (1-2/100 m^3) per net. The size range of cod and haddock was typically 10-20 mm SL.

MOCNESS Sampling (G. Lough, E. Broughton, M. Kiladis)

MOCNESS and CTD operations followed a drifter as the station marker (Figures 2, 5 & 6). The 1-m MOCNESS with nine 0.333-mm mesh nets was used to sample larval fish and larger zooplankton. The 1/4-m MOCNESS also is equipped with nine 0.064-mm mesh nets, which are designed to sample the smaller plankton such as copepod nauplii. The tow profile for these two nets was nominally 10-m strata within 5 m of the bottom; extra nets were used for special collections. The 1-m MOCNESS nets typically sampled for 5 minutes to filter about 250 m^3 of water; the 1/4-m MOCNESS nets for 2-3 minutes to filter about 30 m^3. The MOCNESS and CTD operations generally were alternated. The 10-m MOCNESS equipped with five 3.0-mm mesh nets generally was used twice per 24 h, once at midnight and again at midday, to collect the larger and rarer nekton. Sampling intervals for the 10-m MOCNESS were 20 m, keeping the same alternate depth horizons (0-20, 20-40, 40-60, and 60-80 m) as the 1-m MOCNESS. Each net was opened for about 10 minutes to sample about 5,000 m^3 of water. Selected MOCNESS tows from each station were sorted ashore for larval cod and haddock vertical profiles.

Station 188 was occupied from 1315 h 14 May 1995 to 1432 h 15 May 1995. Following drifter 7a, the bottom depth varied from 47-72 m. Five 1-m MOCNESS, two 1/4-m MOCNESS, and three 10-m MOCNESS tows were made during this period. From MOCNESS tow 66, only 10 cod and 6 haddock were caught (<2/100 m^3), mostly between 50 and 20-m depth (Figure 16). Cod ranged in size from 8-20 mm, while haddock were smaller, 7-12 mm. The water column was fairly well-mixed, 6.7 °C, 32.70 psu, increasing to 7.2 °C at the surface.

Station 192 was occupied from 1018 h 16 May 1995 to 1320 h 17 May 1995. The bottom depth varied from 64-85 m following drifter 4b. Seven 1-m MOCNESS, three 1/4-m MOCNESS, and two 10-m MOCNESS tows were made at this station. Two daylight tows 74 and 78 were sorted. Only 3-4 cod and haddock larvae were collected in MOCNESS tow 74 (Figure 17); the 40-30-m samples was lost ashore, so one can only say that most larvae in this tow were between 10 and 50-m depth. Average temperature and salinity in the upper 30 m were 6.4 °C, 32.56 psu, while below 40 m they were 7.6 °C, 33.18 psu, evidence of the influence of the shoalward encroachment of slope water. For MOCNESS tow 78, 27 cod and 10 haddock were caught (Figure 17). Most of the fish were located above 40 m, with a trend for the greatest abundance at 20-10 m depth. Temperature and salinity for this tow were similar to the previous one, only the slope-like water was observed deeper in the water column below 50-60 m. The length frequency of cod and haddock from this station (primarily tow 78) is similar to the initial station. Cod lengths ranged from 5-20 mm with a mode at 6 mm. Haddock lengths ranged 6-12 mm with a possible mode at 9 mm.

Station 197 was occupied from 1430 h 22 May 1995 to 1318 h 25 May 1995, following drifter 7b, 56-77 m bottom depth. A total of 15 1-m MOCNESS, six 1/4-m MOCNESS, and six 10-m MOCNESS tows were made at this station. Five 1-m MOCNESS tows were sorted for larval fish and their vertical profiles and length frequency are shown in Figure 18. Relatively few fish were caught and their densities were less than 2/100 m^3. Haddock was more abundant than cod at this station, and their lengths ranged 5-27 mm; modal lengths were near 10-11 mm. While the surface temperature decreased from about 10 °C at 1 m to 7 °C at 20 m, temperature and salinity increased with depths greater than 20 m to a maximum of 13 °C near bottom due to the slope water high up on the bank. The highest abundance of cod and haddock were found near 20-10 m depth, above the warmer slope water (see tows 93, 99, and 103). However, for tows 97 and 101 the peak abundance was deeper, between 40-20 m, corresponding with the deeper depth, >40 m, of the slope water.

Special Collections (E. Broughton)

Samples for biochemical and age analysis were taken from 53 0.505-mm mesh 61-cm bongo nets, 3 0.064-mm mesh 1/4-m MOCNESS tows, and 22 0.333-mm mesh 1-m MOCNESS tows. All samples were rinsed from the nets using minimal seawater pressure and transferred to buckets containing ice packs. Plankton from nets that were not to be sorted for biochemical samples was preserved immediately using 4% buffered formaldehyde in seawater. Plankton samples sorted for fish or invertebrates were picked in seawater filled translucent sorting trays on ice covered light tables. Every effort was made to keep samples cold during processing to delay decomposition. Plankton remaining after removal of samples was preserved with 4% buffered formaldehyde and seawater.

Table 1. Numbers of samples removed for analysis.

Investigator	**Species**	**Bongo .505mm**	**MOC 1 .333mm**	**MOC 1/4 .064mm**
Buckley	*G. morhua*	223	134	
Buckley	*M. aeglefinus*	38	124	
Burns	*G. morhua*	101	14	
Burns	*M. aeglefinus*	5		
WHOI	*G. morhua*	74	45	
WHOI	*M. aeglefinus*	2	27	
WHOI	*C. finmarchicus*		356	
WHOI	*Pseudocalanus*		80	
Kulis	*phytoplankton*			6 nets

Juvenile fish collected for Burns were measured to the nearest 0.01 mm (SL) using a Wild M5 stereomicroscope equipped with an optical micrometer then preserved in EtOH. These fish will have their age determined by otolith analysis.

Larval fish collected for WHOI were measured to the nearest 0.01 mm (SL) using a Wild M5 stereomicroscope equipped with an optical micrometer then individually frozen by suspension above liquid nitrogen. Half of the *Calanus finmarchicus* collected were individually frozen by suspension above liquid nitrogen and half were chemically fixed in formaldehyde.

Half of 1/4-m MOCNESS phytoplankton samples collected for Kulis were preserved in 10% formaldehyde and seawater. These will be examined for the presence of *P. pugens*. The remaining samples were kept alive on board ship to establish cultures of *Pseudonitzschia pugens* in the laboratory. *P. pugens* is a chain forming pennate diatom thought to be responsible for domonic acid poisoning in Canadian Georges Bank shellfish.

Biochemistry (K. Lindner)

Larval fish collected for L. Buckley were video taped on board for measurements then individually frozen in liquid nitrogen. The larvae will be analyzed for their RNA, DNA, protein content, age, and length. The data will be used to determine the nutritional condition and growth rate of the individual fish. A comparison will be made of fish taken from the sites, but due to the low numbers, analysis of the condition of larvae a discrete depths may be hindered. A complete listing of samples saved for biochemistry is included in Appendix II.

Cell Growth Studies (J. Stegeman, M. Moore, M. Morss)

Cod, haddock, and adult female *Calanus finmarchicus* were collected by 1-m MOCNESS from both the deep and shoal sites (see Table 2). Cod and haddock were also collected from the bongo survey. Larval fish and half of the *Calanus finmarchicus* samples were frozen individually by suspension above liquid nitrogen. The remaining *Calanus finmarchicus* were chemically fixed in 10% neutral buffered formalin. Before freezing, all fish were measured for standard length using a Wild M5 stereomicroscope with an eyepiece micrometer. Frozen samples will be analyzed for proliferating cell nuclear antigen expression by dot blot. Chemically fixed samples will be embedded in paraffin for analysis of proliferating cell nuclear antigen immunohistochemically. All samples will be compared to those from Seward Johnson Cruises SJ9503 and SJ9505. Sampling protocols were identical for all three cruises giving excellent time series of samples from these two stations.

Table 2. Samples removed for cell growth studies

Samples taken from:	Cod	Haddock	*Calanus finmarchicus*
bongo	88	2	
deep site	25	4	217
shoal site	20	23	212

Concurrent analysis of experimental studies completed over the first phases of this project have established important hypotheses to be tested with these field samples. We know that important nutrition results in increased expression of PCNA protein. These samples will allow us to test whether such differences are detectable in the context of well mixed vs. stratified stations.

Predation Studies

WHOI Predation Studies (E. Horgan, M. Butler)

Sampling by the GLOBEC Predation Group on this cruise included:

MOCNESS Sampling

3 MOC-10 collections (2 day, 1 night) at the station 188, a relatively "on-bank" station.

3 MOC-10 collections (2 night and 1 day) at stations 194 and 192 which were relatively "off-bank".

6 MOC-10 collections at station 197 which was an offshore, "off-bank", stratified station (4 day and 2 night).

SCUBA Operations

Two daytime SCUBA dives were done to collect and preserve gelatinous predators. The dominant gelatinous organism on both dives was the ctenophore *Bolinopsis* . Underwater preservations were made using jars with a tape port and formalin syringe.

On the first dive (station 188), large and small *Bolinopsis* sp. were abundant, with an estimated several animals per m^3 from the surface to 20-m depth. The ctenophore *Pleurobrachia* sp. was infrequent, as was the ctenophore *Beroe* sp.. Two of the physonect siphonophore *Nanomia* sp. were seen. Twelve individual *Bolinopsis* were collected for shipboard studies. Five individuals were preserved underwater: 2 *Bolinopsis* sp. and 3 *Pleurobrachia*. sp.. Hydroids were absent from this locality.

On the second dive (station 194), large and small *Bolinopsis* sp. were more common in the top five meters of the water column, but abundant to 20-m depth. The water was filled with the alga *Phaeocystis* , which became very dense at 5-m depth and persisted to 20-m depth. Large and small individuals of the amphipod *Phronima* sp., the smaller without their commensal house, were both frequent below 5-m depth. One unidentified physonect siphonophore was seen. Four *Bolinopsis* sp. were collected for shipboard studies, while another 11 *Bolinopsis* sp. were preserved underwater for later gut content analysis. Hydroids were absent from this locality.

Immunological Studies

A total of 353 individual large predators were removed from MOC-10 hauls and preserved for antibody analysis for the presence of *Calanus* in their gut contents (see Table 1). These predators included *Themisto gaudichaudii, Hyperia medusarum, Hyperia galba, Cirolana polita, Crangon septemspinosa, Meganyctiphanes norvegica*., small pandalids, large pandalids and several species of gammarids. In addition, we preserved some predatory copepods including 20 *Candacia sp.* and 50 *Centropages* sp. *Calanus* nauplii and eggs as well as later stages of *Calanus* were also sorted and preserved for analysis. We also successfully preserved 6 *C. septemspinosa* soon after they had consumed a known amount, ranging from 1-5, of adult *Calanus* females.

Gut Passage Time Studies

Other live predators from tows and dives were used in laboratory experiments to determine gut passage times. *Cirolana polita* were removed from Bongo tows and immediately fed carmine red-dyed white fish. The 8 isopods immediately consumed the fish producing a brightly colored tracer visible through their carapace. After an hour or less, the dyed fish was removed and undyed fish was added. Over the course of the cruise, more fish, hyperids, and a pieces of a dead *Dichelopandalid leptocerus* were used to subsidize their diet. No obvious fecal material was observed 13 days later, however, the isopod guts remained dyed vividly red, and periodically the isopods were video-taped. In addition, a *C. polita* was recovered from Bongo Tow #181 that had a bright green gut. Ten hours later no green was visible, yet obvious feces was not recovered. The disappearance of the green suggests that the carmine may have dyed the *C. polita* internally whereas the green did not.

On 24 May, 0103 h, a particularly full-looking *C. polita* was removed from MOC1-104 and dissected. Its gut contents were analyzed and preserved. A cursory analysis of this material showed a minimum of 11 *Calanus* , 6 *Pseudocalanus* , and 1 euphausiid. The *Calanus* ranged from CII-adults. The *Pseudocalanus* were all CV or adults and the euphausiid appeared to be a small *Meganyctiphanes norvegica*..

A gut passage study was also attempted using *Themisto gaudichaudii* as the predator. Eight individuals were placed in watch glasses with five carmine-dyed copepods each. After 46 hours no copepods had been consumed, and the experiment was aborted. This was probably due to the fact that the hyperiids tended to remain at the surface and swim in circles.

Two sets of experiments were completed using *Dichelopandalid leptocerus* as a predator. Data from these experiments can be seen in Table 2. In the first experiment animals were fed carmine-dyed copepods until they produced carmine-dyed feces. Since we were in port and unable to collect more animals, the same pandalids were allowed to feed overnight on unstained copepods. The next morning they were fed carmine-dyed copepods and another gut-passage time was calculated for each. In both runs of the experiment, in some cases *D. leptocerus* produced red feces before they had ingested a red copepod. This occurred most frequently in animals under 25 mm. We suspect that the pandalids consumed the *Calanus* feces which was often abundant in watch glasses and contained an abundance of carmine.

URI Predation Studies (B. Sullivan, D. Van Keuren)

Activities on this cruise included:

1) Mapping of hydroid distribution from bongo survey samples
2) Collections with the 1-m MOCNESS
3) Experiments on feeding and digestion of the hydroid *Clytia gracilis*
4) Gut content analysis of diver collected ctenophores
5)Survey of benthos for hydroids using the ROV Phantom S2 (reported under a separate heading)
6) Collection of live hydroids for culture and species analysis

Hydroid Distribution-

Bongo samples at stations 110-118 and 123-187 were qualitatively scored for abundance of hydroids while samples were being sorted for larval fishes (Figure 19). Abundance was scored as: 1-present; 2-abundant; 4-very abundant; 0-absent.

Hydroids were most abundant at shallow stations (60 m or less). Maximum numbers were observed along the 60-m isobath and at stations which coincided with the center of distribution of larval cod (Stations 145 and 159, 40° 53.4' N, 67° 53.0' W and 40° 48.3' N, 68° 04.2' W). It is interesting to note that the extremely high abundances observed in May 1994 on AL9403 were at a similar location, 41° 10 'N, 67° 35' W and depth (less than or EQUAL to 60 m).

This map (Figure 19) was used to select stations for the operation of the ROV Phantom S2 survey on 21 May which appeared to be prime habitat for hydroids.

MOCNESS collections-

Selected samples from the 1-m MOCNESS series will be shared with G. Lough. These will be analyzed for abundance and distribution of invertebrate predators, and where samples were preserved immediately following collection, also used for gut content analysis of predators (P). Samples from stations used for ROV surveys are marked (ROV).

Date	Time	Station	Tow number	Description
14 May	2301	188	068	Night Shallow (P)
15 May	0910	188	072	Day Shallow (P)
16 May	1018	192	074	Day Deep (P)
16 May	2110	192	079	Night Deep
16 May	0320	192	082	Night Deep (P)
17 May	0700	192	083	Day Deep (P)
21 May	0402	193	086	Night Shallow (P, ROV)
21 May	2244	194	087	Night Shallow (P, ROV)
22 May	0858	196	090	Day Stratified
23 May	0036	197	095	Night Stratified
23 May	1029	197	099	Day Stratified
24 May	0112	197	105	Night Stratified (P)
24 May	1245	197	110	Day Stratified (P)

Hydroid (*Clytia gracilis*) Experiments-

1. Preliminary experiments were conducted to determine feeding preferences/feeding rates of hydroids. Results will be used to direct future laboratory studies. Experiments were conducted at 8 °C in 1 liter jars gently aerated to produce continuous mixing.

a) Selection for *Calanus* copepodites versus *Temora* and *Centropages*. Prey/liter = 20; hydranths/liter = 50; 2 controls, 4 experimental jars; time = 24 h.

Hydroids caught but did not ingest *Calanus* copepodites at a rate of 0.16/hydranth/day (SD 0.17). No copepodites of *Centropages* or *Temora* were captured. *Calanus* that were captured were partially digested externally and then released, some while still alive but showing damage to the carapace.

b) Selection for *Calanus* eggs versus nauplii (stage N1). Prey/liter: 25 of each prey type; hydranths/liter = 50; 2 controls, 2 experimental jars; time = 24 h.

No eggs were ingested. Nauplii were ingested at a rate of 0.35 prey/hydranth/day (SD 0.11)

2. Digestion time of N1 nauplii. Gut contents of hydroids frequently contain eggs but not nauplii. Digestion time of eggs was determined to be 33 hr on a previous cruise. On this cruise we

preserved hydranths which had ingested N1 stage nauplii of *Calanus* at 7 successively longer intervals after ingestion. The hydranth gut was clearly expanded for up to 1.5 h post ingestion but nauplii were identifiable (by gut dissection) as the prey ingested for less than 15 minutes post ingestion. It is unlikely that the dissection method of gut content analysis can be used to determine feeding on early stage nauplii by hydroids.

3. Hydroid preservation for immunoassay analysis. Hydranths which had ingested N1 nauplii of *Calanus* and hydroids with empty guts were preserved for analysis by the immunoassay method and given to E. Horgan. Additional samples will be prepared at URI to continue this analysis if needed.

Analysis of Diver Collected Ctenophores-

Bolinopsis: 4 live, 10 in situ preserved for gut content analysis.
19 observed for digestion time of *Calanus* copepodites.

Digestion time was 3.8 h (SD 0.9). Diet of live *Bolinopsis* (observed through transparent gut wall) consisted mainly of copepods (*Calanus, Centropages* and *Oithona*). Larval gastropods were also observed.

Pleurobrachia: 4 in situ preserved for gut content analysis.

ROV PHANTOM S2 SURVEYS - May 21, 1995 (B. Sullivan, E. Horgan)

The objective of the ROV survey was to increase our understanding of factors which contribute to the maintenance of very high numbers of hydroids in the water column on Georges Bank. Specifically we are testing the hypothesis that hydroid colonies are resident on the Bank on the benthos below where they occur in the water column. Alternatively, 1) source populations are located off the Bank and the hydroids are advected onto it after being torn loose or, 2) hydroids live their entire life cycle in the plankton.

The ship was anchored at three stations prior to launch of the ROV Phantom S2. Stations were chosen based on 3 criteria, first, expected presence of hydroids as indicated from the bongo survey map; second, bottom characterized by sand hills and gravel troughs; third, suitability for anchoring the ship.

STATION	TIME	LAT	LON	DEPTH
1	0900	40° 58'56.86	68° 06' 27.52	44 m
2	1108	40° 58'20.62	68° 06' 57.97	48 m
3	1433	40° 48'20.80	68° 04' 12.24	67 m

Five successful dives were made, one each at stations 1 and 2, and the remaining dives at station 3. Video records were made of all dives. A total of 6 samples was collected, 4 with a grab sampler and 2 with a suction sampler equipped with two sample chambers.

SAMPLE TYPE	STATION	DESCRIPTION
Grab 1	1	fine white sand, no hydroids
Grab 2	2	fine white sand with some live hydroids
Grab 3	3	fine sand with live hydroids
Grab 4	3	fine sand, bryozoans on shell
Stbd Suction	3	2 minute filter, 0.333-mm mesh
Port Suction 1	3	hydroid attatched to shell
Port Suction 2	3	tumbling white colony of bryozoans
Port Suction 3	3	green filaments with live hydroids

1-m MOCNESS tows were made at stations 1 and 3.

RESULTS:

Station 1. This was a shallow, highly dynamic station with a bottom characterized by sand dunes and troughs. Hydroids were clearly evident on the bottom based on video survey and none were found when sand collected in the grab was sieved. Hydroids were rare but present in the MOCNESS tows.

Station 2. Depth and bottom features were similar to those at Station 1. A small number of living hydroids was recovered from grab sample 2 but hydroids were not clearly evident in videos.

Station 3. This station was deeper and there was less bottom relief. After an initial survey with the video and sampling with the grab sampler revealing abundant hydroids, the ROV was deployed with the suction sampler mounted. This sampler was used to pump plankton for two minutes through a 333 micron mesh and to retrieve large objects from the benthos. It proved very effective for acquiring relevant samples from the benthos as well as plankton suspended just above the bottom. It use will enable positive identification of organisms on the video tape surveys. (Both plankton and benthos were too complex or indistinct to allow identification from video tapes alone.) The collimated light was not used for quantifying organisms at this time but will perhaps be useful in future surveys where more time is available for multiple dives and after an identification key for plankton is developed.

Preliminary analysis of grab and suction samples as well as MOCNESS tows indicated that hydroids were abundant both in the water column and on the bottom. Streamers of filamentous material which proved to contain a great abundance of hydroids were attached to shells on the bottom. Hydroids were also present in green colored masses accumulated in depressions in the sand or around shells. Preliminary analysis of the 333 mesh pump sample indicated that the most abundant epibenthic organisms (>333 microns) were copepods, chaetognaths, and hydroids.

Personnel List

Scientific

Name	Title	Organization
1. Gregory Lough	Chief Scientist	NMFS/NEFSC,Woods Hole
2. James Manning	Oceanographer	NMFS/NEFSC,Woods Hole
3. Elisabeth Broughton	Bio. Lab. Tech.	NMFS/NEFSC,Woods Hole
4. Marie Kiladis	Bio. Lab. Tech.	NMFS/NEFSC,Woods Hole
5. Brenda Figuerido	Photographer	NMFS/NEFSC.Woods Hole
6. Glen Strout	Oceanographer	NMFS/NEFSC,Narragansett
7. Kathleen Lindner	Bio. Lab. Tech.	NMFS/NEFSC,Narragansett
8. Bruce Burns	Fish. Biol.	NMFS/NEFSC,Narragansett
9. Jacquelyn Anderson	Bio. Lab. Tech.	NMFS/NEFSC,Narragansett
10. Michael Morss	Guest Student	WHOI,Woods Hole
11. Erich Horgan	Research Asst.	WHOI,Woods Hole
12. Mari Butler	Research Asst.	WHOI,Woods Hole
13. Barbara Sullivan	Biologist	URI/GSO,Narragansett
14. Donna VanKeuran	Marine Tech.	URI/GSO,Narragansett
15. Paul Donaldson	ROV Tech.	NURC, Groton, CN
16. Susan Drapeau	ROV Tech.	NURC, Groton, CN
17. Straud Armstrong	Observer	Narragansett, RI
18. Joseph Manning	Observer	Jaffrey, NH
19. Thomas Taylor	Student	Old Dominion Univ., Suffolk, VA
20. Collen Goodfellow	Student	Bowling Green Univ., OH
21. Shelley Henderson	Student	Bowling Green Univ., OH
22. Scott Larson	Student	Univ. Minnesota, Duluth, MN

SEWARD JOHNSON Officers and Crew

1. Daniel Schwartz	Master
2. John Jetter	Chief Mate
3. Graydon Henrikson	Second Mate
4. George Fisher	Chief Engineer
5. John Terry	Assistant Engineer
6. Whitney Staley	Second Assistant Engineer
7. Charles Garrett	Seaman
8. Anthony Monocandilos	Seaman
9. Michael Martin	Seaman
10. Jason Grant	Steward
11. Bruce Ellzey	Assistant Steward
12. Cecile Crosby	Electronics Technician
13. Louis Davidson	Electronics Technician

Appendix I. Event Log

Event#	Instr	cast#	Sta#	BrdSt#	Mth	Day	L O C A L hhmm	s/e	Lat	Lon	Water Depth	Cast Depth	PI	Region	Comments
SJ12995.1	BongoSB	101	92	0	5	10	409	s	4034.50	6832.40	73	70	Lough/Caldarone	BongoGrid	
SJ12995.2	BongoSB	102	93	0	5	10	532	s	4032.30	6822.30	93	90	Lough/Caldarone	BongoGrid	
SJ12995.3	BongoSB	103	94	0	5	10	636	s	4038.50	6820.10	73	70	Lough	BongoGrid	
SJ12995.4	BongoSB	104	95	0	5	10	800	s	4033.20	6808.50	100	100	Lough	BongoGrid	Water Bottle
SJ12995.5	BongoSB	105	95	0	5	10	812	s	4033.70	6808.50	100	98	Lough	BongoGrid	
SJ12995.6	BongoSB	106	96	0	5	10	946	s	4042.50	6808.30	76	74	Lough/Caldarone	BongoGrid	
SJ12995.7	BongoSB	107	97	0	5	10	1121	s	4045.00	6756.00	74	73	Lough	BongoGrid	
SJ12995.8	BongoSB	108	98	0	5	10	1239	s	4035.20	6754.30	88	86	Lough	BongoGrid	
SJ12995.9	BongoSB	109	99	0	5	10	1357	s	4037.00	6742.30	81	80	Lough	BongoGrid	
SJ12995.10	BongoSB	110	100	0	5	10	1500	s	4045.50	6742.10	71	69	Lough	BongoGrid	
SJ12995.11	BongoSB	111	101	0	5	10	1613	s	4043.60	6729.50	89	89	Lough	BongoGrid	Water Bottle
SJ12995.12	BongoSB	112	101	0	5	10	1625	s	4043.10	6730.00	89	86	Lough	BongoGrid	
SJ12995.13	BongoSB	113	102	0	5	10	1733	s	4052.50	6730.20	79	76	Lough	BongoGrid	
SJ12995.14	BongoSB	114	103	0	5	10	1844	s	4048.10	6718.50	93	91	Lough	BongoGrid	
SJ12995.15	BongoSB	115	104	0	5	10	2002	s	4058.10	6718.10	76	74	Lough	BongoGrid	
SJ12995.16	BongoSB	116	105	0	5	10	2115	s	4052.30	6707.10	88	88	Lough	BongoGrid	
SJ12995.17	BongoSB	117	106	0	5	10	2245	s	4102.30	6704.00	69	67	Lough	BongoGrid	
SJ12995.18	BongoSB	118	107	0	5	10	2401	s	4056.00	6653.50	85	82	Lough	BongoGrid	
SJ13095.1	BongoSB	119	108	0	5	11	118	s	4101.30	6643.20	77	76	Lough	BongoGrid	
SJ13095.2	BongoSB	120	109	0	5	11	239	s	4109.20	6654.40	72	69	Lough	BongoGrid	
SJ13095.3	BongoSB	121	110	0	5	11	355	s	4118.20	6651.10	73	71	Lough/Caldarone	BongoGrid	
SJ13095.4	BongoSB	122	111	0	5	11	530	s	4113.30	6637.40	85	84	Lough	BongoGrid	
SJ13095.5	BongoSB	123	112	0	5	11	644	s	4123.20	6635.20	87	84	Lough/Caldarone	BongoGrid	
SJ13095.6	BongoSB	124	113	0	5	11	702	s	4130.00	6645.30	73	72	Lough	BongoGrid	Water Bottle
SJ13095.7	BongoSB	125	113	0	5	11	810	s	4130.40	6645.40	75	73	Lough/Caldarone	BongoGrid	
SJ13095.8	BongoSB	126	114	0	5	11	928	s	4136.10	6655.10	63	61	Lough/Caldarone	BongoGrid	
SJ13095.9	BongoSB	127	115	0	5	11	1100	s	4126.10	6657.00	66	64	Lough/Caldarone	BongoGrid	
SJ13095.10	BongoSB	128	116	0	5	11	1224	s	4117.30	6703.20	64	63	Lough	BongoGrid	
SJ13095.11	BongoSB	129	117	0	5	11	1330	s	4110.70	6711.00	62	61	Lough/Caldarone	BongoGrid	
SJ13095.12	BongoSB	130	118	0	5	11	1440	s	4106.20	6723.20	63	60	Lough/Caldarone	BongoGrid	
SJ13095.13	BongoSB	131	119	0	5	11	1600	s	4101.20	6734.20	65	65	Lough/Caldarone	BongoGrid	Water Bottle
SJ13095.14	BongoSB	132	119	0	5	11	1610	s	4101.20	6734.20	65	62	Lough/Caldarone	BongoGrid	
SJ13095.15	BongoSB	133	120	0	5	11	1945	s	4110.00	6742.10	50	47	Lough/Caldarone	BongoGrid	
SJ13095.16	BongoSB	134	121	0	5	11	2145	s	4105.40	6738.50	57	54	Lough/Caldarone	BongoGrid	
SJ13095.17	BongoSB	135	122	0	5	11	2240	s	4100.50	6735.40	65	63	Lough/Caldarone	BongoGrid	
SJ13095.18	Drifter	4a	122	0	5	11	2256	s	4100.40	6734.50	66	15	Manning/Churchill	BongoGrid	deployment
SJ13095.19	BongoSB	136	123	0	5	11	2355	s	4056.30	6732.30	71	69	Lough	BongoGrid	
SJ13195.1	BongoSB	137	124	0	5	12	49	s	4052.70	6729.20	81	78	Lough	BongoGrid	
SJ13195.2	Drifter	6a	123	0	5	12	100	s	4056.50	6732.50	74	5	Manning/Churchill	BongoGrid	deployment
SJ13195.3	BongoSB	138	125	0	5	12	131	s	4047.50	6726.00	86	84	Lough	BongoGrid	
SJ13195.4	BongoSB	139	126	0	5	12	217	s	4043.40	6722.30	94	93	Lough	BongoGrid	
SJ13195.5	BongoSB	140	127	0	5	12	314	s	4040.50	6728.20	93	92	Lough	BongoGrid	
SJ13195.6	BongoSB	141	128	0	5	12	405	s	4044.50	6731.10	87	83	Lough	BongoGrid	
SJ13195.7	Drifter	1a	129	0	5	12	604	s	4049.10	6734.90	77	15	Manning/Churchill	BongoGrid	deployment
SJ13195.8	BongoSB	142	129	0	5	12	623	s	4049.50	6734.50	77	76	Lough	BongoGrid	
SJ13195.9	BongoSB	143	130	0	5	12	708	s	4054.10	6738.10	72	69	Lough	BongoGrid	
SJ13195.10	Drifter	2a	130	0	5	12	726	s	4054.87	6738.34	71	15	Manning/Churchill	BongoGrid	deployment
SJ13195.11	BongoSB	144	131	0	5	12	800	s	4058.10	6741.10	65	64	Lough	BongoGrid	Water Bottle
SJ13195.12	BongoSB	145	131	0	5	12	813	s	4058.30	6741.30	65	65	Lough/Caldarone	BongoGrid	
SJ13195.13	BongoSB	146	132	0	5	12	905	s	4102.40	6745.00	54	53	Lough/Caldarone	BongoGrid	
SJ13195.14	BongoSB	147	133	0	5	12	958	s	4107.00	6748.10	39	37	Lough	BongoGrid	
SJ13195.15	BongoSB	148	134	0	5	12	1055	s	4104.40	6754.10	49	47	Lough/Caldarone	BongoGrid	
SJ13195.16	BongoSB	149	135	0	5	12	1135	s	4100.30	6750.50	49	48	Lough/Caldarone	BongoGrid	
SJ13195.17	BongoSB	150	136	0	5	12	1215	s	4056.10	6747.10	58	56	Lough/Caldarone	BongoGrid	
SJ13195.18	BongoSB	151	137	0	5	12	1253	s	4051.50	6744.10	64	62	Lough	BongoGrid	
SJ13195.19	BongoSB	152	138	0	5	12	1334	s	4047.30	6740.30	71	68	Lough/Caldarone	BongoGrid	
SJ13195.20	BongoSB	153	139	0	5	12	1417	s	4042.50	6737.20	80	78	Lough	BongoGrid	
SJ13195.21	BongoSB	154	140	0	5	12	1458	s	4038.40	6733.40	88	86	Lough	BongoGrid	
SJ13195.22	BongoSB	155	141	0	5	12	1540	s	4036.10	6739.30	90	89	Lough	BongoGrid	

				L	O	C A	L				Water	Cast			
Event#	Instr	cast#	Sta#	BrdSt#	Mth	Day	hhmm	s/e	Lat	Lon	Depth	Depth	PI	Region	Comments
SJ13195.23	BongoSB	156	142	0	5	12	1630	s	4040.20	6742.50	74	72	Lough	BongoGrid	Water Bottle
SJ13195.24	BongoSB	157	142	0	5	12	1640	s	4040.10	6743.10	74	72	Lough	BongoGrid	
SJ13195.25	BongoSB	158	143	0	5	12	1725	s	4044.40	6746.10	70	68	Lough	BongoGrid	
SJ13195.26	BongoSB	159	144	0	5	12	1840	s	4049.20	6749.20	69	67	Lough	BongoGrid	
SJ13195.27	BongoSB	160	145	0	5	12	1930	s	4053.40	6753.00	63	60	Lough/Caldarone	BongoGrid	
SJ13195.28	BongoSB	161	146	0	5	12	2022	s	4058.00	6756.20	58	57	Lough	BongoGrid	
SJ13195.29	BongoSB	162	147	0	5	12	2105	s	4102.10	6759.30	57	56	Lough/Caldarone	BongoGrid	
SJ13195.30	BongoSB	163	148	0	5	12	2155	s	4100.00	6805.10	53	51	Lough	BongoGrid	
SJ13195.31	BongoSB	164	149	0	5	12	2245	s	4055.40	6802.10	48	46	Lough/Caldarone	BongoGrid	
SJ13195.32	BongoSB	165	150	0	5	12	2325	s	4051.10	6758.50	65	63	Lough/Caldarone	BongoGrid	
SJ13295.1	BongoSB	166	151	0	5	13	5	s	4046.40	6755.10	72	68	Lough/Caldarone	BongoGrid	
SJ13295.2	BongoSB	167	152	0	5	13	43	s	4042.20	6752.10	80	77	Lough/Caldarone	BongoGrid	
SJ13295.3	BongoSB	168	153	0	5	13	120	s	4038.50	6748.50	82	80	Lough/Caldarone	BongoGrid	
SJ13295.4	BongoSB	169	154	0	5	13	202	s	4033.50	6745.40	100	99	Lough	BongoGrid	
SJ13295.5	BongoSB	170	155	0	5	13	239	s	4031.30	6750.10	99	98	Lough	BongoGrid	
SJ13295.6	BongoSB	171	156	0	5	13	330	s	4035.40	6754.20	89	88	Lough	BongoGrid	
SJ13295.7	BongoSB	172	157	0	5	13	426	s	4039.30	6757.30	86	84	Lough	BongoGrid	
SJ13295.8	BongoSB	173	158	0	5	13	513	s	4044.20	6801.20	77	75	Lough/Caldarone	BongoGrid	
SJ13295.9	BongoSB	174	159	0	5	13	558	s	4048.30	6804.20	66	64	Lough/Caldarone	BongoGrid	
SJ13295.10	BongoSB	175	160	0	5	13	701	s	4053.30	6808.10	61	59	Lough/Caldarone	BongoGrid	
SJ13295.11	BongoSB	176	161	0	5	13	750	s	4057.20	6810.50	59	57	Lough	BongoGrid	
SJ13295.12	BongoSB	177	162	0	5	13	845	s	4055.10	6816.50	53	51	Lough	BongoGrid	Water Bottle
SJ13295.13	BongoSB	178	162	0	5	13	855	s	4055.10	6816.50	45	43	Lough/Caldarone	BongoGrid	
SJ13295.14	BongoSB	179	163	0	5	13	945	s	4050.40	6813.40	55	54	Lough/Caldarone	BongoGrid	
SJ13295.15	BongoSB	180	164	0	5	13	1035	s	4046.30	6811.00	63	60	Lough	BongoGrid	
SJ13295.16	BongoSB	181	165	0	5	13	1120	s	4041.50	6807.40	81	79	Lough	BongoGrid	
SJ13295.17	BongoSB	182	166	0	5	13	1202	s	4037.30	6804.20	89	88	Lough	BongoGrid	
SJ13295.18	BongoSB	183	167	0	5	13	1246	s	4033.10	6801.10	99	96	Lough	BongoGrid	
SJ13295.19	BongoSB	184	168	0	5	13	1340	s	4035.20	6809.50	93	92	Lough	BongoGrid	
SJ13295.20	BongoSB	185	169	0	5	13	1435	s	4039.40	6813.00	81	78	Lough/Caldarone	BongoGrid	
SJ13295.21	BongoSB	186	170	0	5	13	1528	s	4044.20	6815.50	65	62	Lough/Caldarone	BongoGrid	
SJ13295.22	BongoSB	187	171	0	5	13	1619	s	4048.40	6819.30	58	57	Lough	BongoGrid	Water Bottle
SJ13295.23	BongoSB	188	171	0	5	13	1626	s	4048.30	6819.50	56	55	Lough	BongoGrid	
SJ13295.24	BongoSB	189	172	0	5	13	1704	s	4052.50	6822.20	52	50	Lough/Caldarone	BongoGrid	
SJ13295.25	BongoSB	190	173	0	5	13	1815	s	4050.20	6829.40	63	60	Lough	BongoGrid	
SJ13295.26	BongoSB	191	174	0	5	13	1915	s	4046.20	6825.20	53	50	Lough	BongoGrid	
SJ13295.27	BongoSB	192	175	0	5	13	2045	s	4041.40	6822.00	65	63	Lough	BongoGrid	
SJ13295.28	BongoSB	193	176	0	5	13	2140	s	4037.20	6818.40	83	80	Lough/Caldarone	BongoGrid	
SJ13295.29	BongoSB	194	177	0	5	13	2250	s	4032.50	6815.20	97	94	Lough	BongoGrid	
SJ13295.30	BongoSB	195	178	0	5	13	2338	s	4030.50	6821.10	96	95	Lough	BongoGrid	
SJ13395.1	BongoSB	196	179	0	5	14	55	s	4034.20	6824.30	86	84	Lough	BongoGrid	
SJ13395.2	BongoSB	197	180	0	5	14	221	s	4039.40	6827.40	68	66	Lough/Caldarone	BongoGrid	
SJ13395.3	BongoSB	198	181	0	5	14	335	s	4043.50	6830.40	56	66	Lough	BongoGrid	
SJ13395.4	BongoSB	199	182	0	5	14	435	s	4048.30	6833.10	59	58	Lough	BongoGrid	
SJ13395.5	BongoSB	200	183	0	5	14	527	s	4045.50	6840.80	60	59	Lough/Caldarone	BongoGrid	
SJ13395.6	BongoSB	201	184	0	5	14	616	s	4042.10	6836.50	59	56	Lough	BongoGrid	
SJ13395.7	BongoSB	202	185	0	5	14	711	s	4037.20	6833.20	66	64	Lough/Caldarone	BongoGrid	
SJ13395.8	BongoSB	203	186	0	5	14	818	s	4032.30	6830.40	82	82	Lough	BongoGrid	Water Bottle
SJ13395.9	BongoSB	204	186	0	5	14	825	s	4032.40	6830.20	82	79	Lough	BongoGrid	
SJ13395.10	BongoSB	205	187	0	5	14	925	s	4028.00	6826.50	92	91	Lough	BongoGrid	
SJ13395.11	MOC1	64	188	0	5	14	1332	s	4048.50	6759.10	69	65	Sullivan/Lough/Caldaron	Drifter	Lost #5 Bucket
SJ13395.12	MOC1	64	188	0	5	14	1418	e	4048.20	6801.40	69	65	Sullivan/Lough/Caldaron	Drifter	
SJ13395.13	MkIIICTD	1	188	0	5	14	1455	s	4048.37	6758.72	70	60	Lough	Stratified	
SJ13395.14	MOC10	65	188	0	5	14	1537	s	4049.00	6759.00	65	60	Sullivan/Lough	Drifter	Lost #4 Bucket
SJ13395.15	MOC10	65	188	0	5	14	1622	e	4047.50	6802.00	66	60	Sullivan/Lough	Drifter	
SJ13395.16	MkIIICTD	2	188	0	5	14	1652	s	4047.12	6803.69	67	60	Lough	Stratified	
SJ13395.17	Drifter	7a	188	0	5	14	1755	s	4048.37	6759.90	69	40	Manning/Churchill	Drifter	Drifter 7a w/TPOD@40
SJ13395.18	MOC1	66	188	0	5	14	1822	s	4048.68	6800.53	66	60	Sullivan/Lough/Caldaron	Drifter	
SJ13395.19	MOC1	66	188	0	5	14	2005	e	4051.24	6806.62	65	60	Sullivan/Lough/Caldaron	Drifter	

Event#	Instr	cast#	Sta#	BrdSt#	Mth	Day	hhmm	s/e	Lat	Lon	Water Depth	Cast Depth	PI	Region	Comments
				L	O	C	A L								
SJ13395.20	MOC1/4	67	188	0	5	14	2134	s	4048.48	6757.61	72	70	Sullivan/Lough	Drifter	Slope Water >40m
SJ13395.21	MOC1/4	67	188	0	5	14	2207	e	4050.33	6758.16	67	70	Sullivan/Lough	Drifter	
SJ13395.22	MOC1	68	188	0	5	14	2301	s	4053.52	6803.03	48	40	Lough/Caldarone	Drifter	Shoal Water
SJ13395.23	MOC1	68	188	0	5	14	2356	e	4055.34	6801.85	49	40	Lough/Caldarone	Drifter	
SJ13495.1	MOC10	69	188	0	5	15	113	s	4054.23	6755.43	47	40	Lough	Drifter	Shoal Water
SJ13495.2	MOC10	69	188	0	5	15	203	e	4053.24	6801.45	44	40	Lough	Drifter	
SJ13495.3	MOC1	70	188	0	5	15	529	s	4047.90	6800.90	70	65	Lough/Caldarone	Drifter	
SJ13495.4	MOC1	70	188	0	5	15	612	e	4049.30	6800.40	68	65	Lough/Caldarone	Drifter	
SJ13495.5	MkIIICTD	3	188	0	5	15	629	s	4049.25	6800.61	67	63	Lough	Stratified	
SJ13495.6	MOC10	71	188	0	5	15	718	s	4046.40	6803.70	67	62	Lough	Drifter	
SJ13495.7	MOC10	71	188	0	5	15	807	e	4047.90	6803.10	63	62	Lough	Drifter	
SJ13495.8	MkIIICTD	4	188	0	5	15	828	s	4048.20	6803.35	64	60	Lough	Stratified	
SJ13495.9	MOC1	72	188	0	5	15	910	s	4048.76	6808.27	62	58	Sullivan/Lough	Drifter	
SJ13495.10	MOC1	72	188	0	5	15	1021	e	4051.84	6805.84	64	58	Sullivan/Lough	Drifter	
SJ13495.11	MkIIICTD	5	188	0	5	15	1050	s	4051.92	6806.20	61	57	Lough	Stratified	
SJ13495.12	MOC1/4	73	188	0	5	15	1136	s	4051.82	6808.56	60	57	Lough	Drifter	No net 7,8.
SJ13495.13	MOC1/4	73	188	0	5	15	1157	e	4052.65	6807.54	62	57	Lough	Drifter	
SJ13495.14	MkIIICTD	6	188	0	5	15	1211	s	4053.03	6806.93	60	59	Lough	Stratified	
SJ13495.15	Dive	1	188	0	5	15	1330	s	4052.50	6808.20	54	18	Lough	Stratified	Scuba Dive to collect ge
SJ13495.16	Drifter	6a	189	0	5	15	1635	s	4045.75	6747.62	67	15	Manning/Churchill	BongoGrid	Recovery
SJ13495.17	Drifter	2a	124	0	5	15	1700	s	4046.10	6746.38	68	15	Manning/Churchill	Drifter	Recovery
SJ13495.18	Drifter	4a	123	0	5	15	1748	s	4040.00	6749.00	82	5	Manning/Churchill	Drifter	Recovery (Drogue at su
SJ13495.19	MkIIICTD	8	189	0	5	15	2030	s	4036.07	6800.04	90	85	Lough	Stratified	
SJ13495.20	MkIIICTD	9	189	0	5	15	2101	s	4037.11	6800.13	87	82	Lough	Stratified	
SJ13495.21	MkIIICTD	10	189	0	5	15	2129	s	4039.09	6759.99	84	79	Lough	Stratified	
SJ13495.22	MkIIICTD	11	189	0	5	15	2157	s	4041.20	6800.07	82	77	Lough	Stratified	
SJ13495.23	MkIIICTD	12	189	0	5	15	2229	s	4044.03	6800.03	86	71	Lough	Stratified	
SJ13495.24	MkIIICTD	13	189	0	5	15	2259	s	4047.00	6800.00	73	68	Lough	Stratified	
SJ13495.25	MkIIICTD	14	189	0	5	15	2323	s	4049.57	6759.88	67	62	Lough	Stratified	
SJ13495.26	MkIIICTD	15	189	0	5	15	2358	s	4053.01	6759.90	53	48	Lough	Stratified	
SJ13595.1	MkIIICTD	16	190	0	5	16	26	s	4051.20	6800.03	60	55	Lough	Stratified	
SJ13595.2	MkIIICTD	17	190	0	5	16	50	s	4048.96	6800.08	65	60	Lough	Stratified	
SJ13595.3	MkIIICTD	18	190	0	5	16	112	s	4046.94	6800.05	69	65	Lough	Stratified	
SJ13595.4	MkIIICTD	19	190	0	5	16	135	s	4044.91	6800.04	72	67	Lough	Stratified	
SJ13595.5	MkIIICTD	20	190	0	5	16	158	s	4042.96	6800.14	77	72	Lough	Stratified	
SJ13595.6	MkIIICTD	21	190	0	5	16	223	s	4040.92	6800.09	81	76	Lough	Stratified	
SJ13595.7	MkIIICTD	22	190	0	5	16	245	s	4038.96	6800.02	83	78	Lough	Stratified	
SJ13595.8	MkIIICTD	23	190	0	5	16	306	s	4037.00	6800.03	86	81	Lough	Stratified	
SJ13595.9	MkIIICTD	24	190	0	5	16	326	s	4035.10	6800.08	90	85	Lough	Stratified	
SJ13595.10	MkIIICTD	25	190	0	5	16	349	s	4033.03	6800.03	95	90	Lough	Stratified	
SJ13595.11	MkIIICTD	26	190	0	5	16	412	s	4030.79	6800.11	107	102	Lough	Stratified	
SJ13595.12	MkIIICTD	27	191	0	5	16	440	s	4031.03	6759.89	106	101	Lough	Stratified	
SJ13595.13	MkIIICTD	28	191	0	5	16	509	s	4032.81	6800.04	96	91	Lough	Stratified	
SJ13595.14	MkIIICTD	29	191	0	5	16	539	s	4034.89	6800.04	90	85	Lough	Stratified	
SJ13595.15	MkIIICTD	30	191	0	5	16	605	s	4036.92	6800.04	87	82	Lough	Stratified	
SJ13595.16	MkIIICTD	31	191	0	5	16	635	s	4038.94	6800.04	84	79	Lough	Stratified	
SJ13595.17	MkIIICTD	32	191	0	5	16	702	s	4041.00	6800.05	82	77	Lough	Stratified	
SJ13595.18	MkIIICTD	33	191	0	5	16	729	s	4042.71	6800.07	78	73	Lough	Stratified	
SJ13595.19	MkIIICTD	34	191	0	5	16	755	s	4045.04	6800.01	73	68	Lough	Stratified	
SJ13595.20	MOC1	74	192	0	5	16	1018	s	4045.10	6800.31	74	70	Lough/Caldarone	Drifter	Slope water about 40 m
SJ13595.21	MOC1	74	192	0	5	16	1134	e	4049.16	6802.81	66	70	Lough/Caldarone	Drifter	
SJ13595.22	MOC1/4	75	192	0	5	16	1322	s	4044.92	6800.03	76	70	Lough	Drifter	
SJ13595.23	MOC1/4	75	192	0	5	16	1355	e	4045.73	6800.44	75	70	Lough	Drifter	
SJ13595.24	MkIIICTD	37	192	0	5	16	1411	s	4045.81	6800.28	72	67	Lough	Drifter	
SJ13595.25	Drifter	4b	190	0	5	16	1428	s	4045.23	6800.15	74	15	Manning/Churchill	BongoGrid	Deployment
SJ13595.26	MOC10	76	192	0	5	16	1457	s	4045.39	6759.81	71	67	Lough	Drifter	
SJ13595.27	MOC10	76	192	0	5	16	1547	e	4045.49	6757.73	71	67	Lough	Drifter	
SJ13595.28	MOC1/4	77	192	0	5	16	1635	s	4043.51	6800.16	77	70	Lough	Drifter	New motor diaphram an
SJ13595.29	MOC1/4	77	192	0	5	16	1704	e	4043.94	6801.47	77	70	Lough	Drifter	

Event#	Instr	cast#	Sta#	L BrdSt#	O Mth	C Day	A L hhmm	s/e	Lat	Lon	Water Depth	Cast Depth	PI	Region	Comments
SJ13595.30	MkIIICTD	38	192	0	5	16	1733	s	4042.91	6800.39	76	70	Lough	Drifter	
SJ13595.31	MOC1	78	192	0	5	16	1805	s	4041.48	6800.36	81	77	Lough/Caldarone	Drifter	
SJ13595.32	MOC1	78	192	0	5	16	1940	e	4043.05	6802.37	80	77	Lough/Caldarone	Drifter	
SJ13595.33	MkIIICTD	39	192	0	5	16	2017	s	4043.06	6803.29	76	60	Lough	Drifter	
SJ13595.34	MOC1	79	192	0	5	16	2110	s	4041.10	6804.64	81	77	Sullivan/Lough	Drifter	Slope water > 20 meter
SJ13595.35	MOC1	79	192	0	5	16	2222	e	4044.20	6805.74	83	77	Sullivan/Lough	Drifter	
SJ13695.1	MOC1	80	192	0	5	17	20	s	4044.33	6807.40	73	70	Lough/Caldarone	Drifter	
SJ13695.2	MOC1	80	192	0	5	17	121	e	4046.75	6805.10	67	70	Lough/Caldarone	Drifter	
SJ13695.3	MOC10	81	192	0	5	17	206	s	4046.71	6804.61	67	60	Lough	Drifter	A fine tow!
SJ13695.4	MOC10	81	192	0	5	17	252	e	4044.90	6805.40	73	60	Lough	Drifter	
SJ13695.5	MOC1	82	192	0	5	17	320	s	4044.40	6805.25	74	70	Lough/Caldarone	Drifter	Sort 0,8. Pickle 1-7. Nl
SJ13695.6	MOC1	82	192	0	5	17	411	e	4044.90	6802.75	75	70	Lough/Caldarone	Drifter	
SJ13695.7	MOC1	83	192	0	5	17	700	s	4040.02	6806.87	85	80	Lough/Caldarone	Drifter	Nice Tow! Only sort net
SJ13695.8	MOC1	83	192	0	5	17	806	e	4041.50	6805.55	82	80	Lough/Caldarone	Drifter	
SJ13695.9	MkIIICTD	40	192	0	5	17	840	s	4041.70	6806.31	78	74	Lough	Drifter	Bad pressure points.
SJ13695.10	MOC1/4	84	192	0	5	17	1003	s	4041.02	6812.02	76	70	Lough	Drifter	Overcast. good tow! Slo
SJ13695.11	MOC1/4	84	192	0	5	17	1040	e	4044.04	6810.58	73	70	Lough	Drifter	
SJ13695.12	MOC1	85	192	0	5	17	1129	s	4042.86	6813.91	72	40	Lough/Caldarone	Drifter	
SJ13695.13	MOC1	85	192	0	5	17	1314	e	4046.15	6809.46	64	40	Lough/Caldarone	Drifter	
SJ13695.14	Drifter	1a	126	0	5	17	1923	s	4021.46	6857.34	89	15	Manning/Churchill	Drifter	Recovery
SJ13795.1	Drifter	7a	125	0	5	20	225	s	4033.62	6838.41	67	15	Manning/Churchill	Drifter	Recovery
SJ13895.1	MOC1	86	193	0	5	21	402	s	4102.01	6804.75	47	40	Sullivan/Lough	Drifter	
SJ13895.2	MOC1	86	193	0	5	21	449	e	4100.44	6805.10	49	40	Sullivan/Lough	Drifter	
SJ13895.3	ROV	1	1	0	5	21	900	s	4058.85	6806.45	44	44	Madin	Mixed	
SJ13895.4	ROV	1	1	0	5	21	1010	e	4058.85	6806.45	44	44	Madin		
SJ13895.5	ROV	2	2	0	5	21	1108	s	4058.25	6807.10	44	48	Madin	Mixed	
SJ13895.6	ROV	2	2	0	5	21	1224	e	4058.25	6807.10	44	48	Madin		
SJ13895.7	MkIIICTD	41	193	0	5	21	1301	s	4058.38	6807.02	43	39	Lough	Drifter	
SJ13895.8	ROV	3	3	0	5	21	1452	s	4048.38	6804.25	67	67	Madin	Mixed	
SJ13895.9	ROV	3	3	0	5	21	1545	e	4048.38	6804.25	67	67	Madin		
SJ13895.10	ROV	4	4	0	5	21	1558	s	4048.40	6804.25	67	67	Madin	Mixed	
SJ13895.11	ROV	4	4	0	5	21	1642	e	4048.38	6804.25	67	67	Madin		
SJ13895.12	MkIIICTD	42	194	0	5	21	1651	s	4048.39	6804.20	61	59	Lough	Drifter	
SJ13895.13	Dive	2	194	0	5	21	1720	s	4048.30	6804.20	65	15	Madin/Sullivan	Stratified	Scuba Dive to collect ge
SJ13895.14	ROV	5	5	0	5	21	1950	s	4048.40	6804.25	67	5	Madin	Mixed	
SJ13895.15	ROV	5	5	0	5	21	1958	e	4048.38	6804.25	67	5	Madin		
SJ13895.16	ROV	6	6	0	5	21	2000	s	4048.40	6804.25	67	67	Madin	Mixed	
SJ13895.17	ROV	6	6	0	5	21	2101	e	4048.38	6804.25	67	67	Madin		
SJ13895.18	MOC1	87	194	0	5	21	2244	s	4047.86	6803.95	66	60	Sullivan/Lough	Stratified	
SJ13995.1	MOC1	87	194	0	5	22	29	e	4046.23	6802.56	70	60	Sullivan/Lough	Stratified	
SJ13995.2	MOC10	88	194	0	5	22	318	s	4049.09	6804.74	62	60	Lough	Stratified	
SJ13995.3	MOC10	88	194	0	5	22	407	e	4048.73	6804.30	63	60	Lough	Stratified	
SJ13995.4	MkIIICTD	43	195	0	5	22	455	s	4052.03	6759.97	57	52	Lough	Stratified	
SJ13995.5	MkIIICTD	44	195	0	5	22	531	s	4049.17	6759.97	65	60	Lough	Stratified	
SJ13995.6	MkIIICTD	45	195	0	5	22	604	s	4046.00	6759.98	71	68	Lough	Stratified	
SJ13995.7	MkIIICTD	46	195	0	5	22	639	s	4042.90	6759.94	77	73	Lough	Stratified	
SJ13995.8	MkIIICTD	47	195	0	5	22	712	s	4039.81	6759.92	83	78	Lough	Stratified	
SJ13995.9	MOC1	89	196	0	5	22	807	s	4044.88	6800.05	76	70	Lough	Stratified	Aborted at 2nd net
SJ13995.10	MOC1	89	196	0	5	22	824	e	4044.88	6800.05	76	70	Lough	Stratified	
SJ13995.11	MOC1	90	196	0	5	22	858	s	4043.29	6759.35	79	70	Sullivan/Lough	Stratified	
SJ13995.12	MOC1	90	196	0	5	22	1023	e	4038.93	6757.67	85	70	Sullivan/Lough	Stratified	
SJ13995.13	MkIIICTD	48	197	0	5	22	1107	s	4038.65	6757.80	82	78	Lough	Drifter	
SJ13995.14	Drifter	1b	197	0	5	22	1245	s	4049.40	6757.22	69	15	Manning/Churchill	Drifter	deployment
SJ13995.15	Drifter	2b	197	0	5	22	1313	s	4045.58	6757.38	74	15	Manning/Churchill	Drifter	deployment
SJ13995.16	Drifter	4c	197	0	5	22	1336	s	4045.82	6800.84	73	15	Manning/Churchill	Drifter	deployment
SJ13995.17	Drifter	6b	197	0	5	22	1408	s	4049.93	6801.14	67	15	Manning/Churchill	Drifter	deployment
SJ13995.18	Drifter	7b	197	0	5	22	1431	s	4048.02	6800.03	70	15	Manning/Churchill	Drifter	deployment
SJ13995.19	MOC10	91	197	0	5	22	1442	s	4048.55	6800.17	68	65	Lough	Drifter	
SJ13995.20	MOC10	91	197	0	5	22	1535	e	4049.35	6758.59	65	65	Lough	Drifter	

Event#	Instr	cast#	Sta#	L BrdSt#	O Mth	C Day	A L hhmm	s/e	Lat	Lon	Water Depth	Cast Depth	PI	Region	Comments
SJ13995.21	MOC1/4	92	197	0	5	22	1641	s	4049.97	6800.86	67	60	Lough	Drifter	
SJ13995.22	MOC1/4	92	197	0	5	22	1708	e	4050.27	6802.45	67	60	Lough	Drifter	
SJ13995.23	MkIIICTD	49	197	0	5	22	1754	s	4050.71	6802.74	62	57	Lough	Drifter	
SJ13995.24	MOC1	93	197	0	5	22	1821	s	4052.60	6800.14	56	50	Lough	Drifter	
SJ13995.25	MOC1	93	197	0	5	22	1954	e	4052.27	6803.69	62	50	Lough	Drifter	
SJ13995.26	MOC1	94	197	0	5	22	2145	s	4050.81	6758.46	65	60	Lough/Caldarone	Drifter	
SJ13995.27	MOC1	94	197	0	5	22	2254	e	4046.51	6757.69	73	60	Lough/Caldarone	Drifter	
SJ14095.1	MOC1	95	197	0	5	23	36	s	4048.97	6758.66	70	64	Lough/Caldarone	Drifter	
SJ14095.2	MOC1	95	197	0	5	23	156	e	4045.58	6800.06	74	64	Lough/Caldarone	Drifter	
SJ14095.3	MOC10	96	197	0	5	23	255	s	4045.92	6800.85	72	64	Lough	Drifter	
SJ14095.4	MOC10	96	197	0	5	23	343	e	4049.05	6801.87	67	64	Lough	Drifter	
SJ14095.5	MOC1	97	197	0	5	23	630	s	4050.21	6803.88	65	60	Lough	Drifter	
SJ14095.6	MOC1	97	197	0	5	23	744	e	4052.25	6807.53	64	60	Lough	Drifter	
SJ14095.7	MkIIICTD	50	197	0	5	23	850	s	4050.42	6802.74	63	58	Lough	Drifter	
SJ14095.8	MOC1/4	98	197	0	5	23	906	s	4050.03	6802.55	66	60	Lough	Drifter	
SJ14095.9	MOC1/4	98	197	0	5	23	940	e	4049.78	6804.47	63	60	Lough	Drifter	
SJ14095.10	MOC1	99	197	0	5	23	1029	s	4048.670	6759.580	68	65	Lough/Caldarone	Drifter	slope water >12m
SJ14095.12	MOC1	99	197	0	5	23	1224	e	4049.090	6806.430	64	65	Lough/Caldarone	BongoGrid	
SJ14095.11	MkIIICTD	51	197	0	5	23	1234	s	4049.026	6806.770	63	60	Lough	Drifter	
SJ14095.13	MOC10	100	197	0	5	23	1339	s	4043.980	6803.840	77	70	Sullivan/Lough	Drifter	
SJ14095.14	MOC10	100	197	0	5	23	1425	e	4045.430	6804.040	72	70	Sullivan/Lough	Drifter	
SJ14095.15	MkIIICTD	52	197	0	5	23	1439	s	4045.617	6804.136	71	62	Lough	Drifter	
SJ14095.16	MOC1	101	197	0	5	23	1500	s	4045.810	6805.170	69	65	Lough	Drifter	
SJ14095.17	MOC1	101	197	0	5	23	1622	e	4047.260	6810.120	60	65	Lough		
SJ14095.18	MkIIICTD	53	197	0	5	23	1656	s	4047.900	6806.960	65	58	Lough	Drifter	
SJ14095.19	MOC1/4	102	197	0	5	23	1729	s	4048.200	6807.110	64	60	Lough	Drifter	restarted after 1st attem
SJ14095.20	MOC1/4	102	197	0	5	23	1802	e	4046.590	6806.600	66	60	Lough		
SJ14095.21	MOC1	103	197	0	5	23	1836	s	4050.410	6807.210	63	60	Lough	Drifter	
SJ14095.22	MOC1	103	197	0	5	23	2014	e	4046.700	6805.890	66	60	Lough		
SJ14095.23	MOC1	104	197	0	5	23	2256	s	4049.350	6804.020	66	60	Lough/Caldarone	Drifter	
SJ14195.1	MOC1	104	197	0	5	24	13	e	4046.070	6759.240	72	60	Lough/Caldarone	Drifter	
SJ14195.2	MOC1	105	197	0	5	24	112	s	4047.300	6803.540	66	60	Sullivan/Lough	Drifter	
SJ14195.3	MOC1	105	197	0	5	24	127	e	4046.080	6802.800	70	60	Sullivan/Lough	Drifter	
SJ14195.4	MOC10	106	197	0	5	24	207	s	4046.380	6804.960	67	60	Lough	Drifter	
SJ14195.5	MOC10	106	197	0	5	24	253	e	4045.510	6803.650	72	60	Lough		
SJ14195.6	MOC1	107	197	0	5	24	649	s	4048.150	6807.770	63	60	Lough	Drifter	
SJ14195.7	MOC1	107	197	0	5	24	758	e	4048.150	6807.770	63	60	Lough	Drifter	
SJ14195.8	MkIIICTD	54	197	0	5	24	844	s	4049.280	6807.245	62	56	Lough	Drifter	
SJ14195.9	MOC1/4	108	197	0	5	24	900	s	4049.610	6806.600	63	60	Lough	Drifter	
SJ14195.10	MOC1/4	108	197	0	5	24	934	e	4048.220	6805.230	65	60	Lough	Drifter	
SJ14195.11	MkIIICTD	55	197	0	5	24	948	s	4047.320	6804.965	65	60	Lough	Drifter	
SJ14195.12	MOC1	109	197	0	5	24	1024	s	4049.110	6806.500	63	60	Lough	Drifter	
SJ14195.13	MOC1	109	197	0	5	24	1143	e	4045.230	6800.420	73	60	Lough		
SJ14195.15	MkIIICTD	56	197	0	5	24	1223	s	4047.260	6804.643	60	60	Lough	Drifter	
SJ14195.16	MOC1	110	197	0	5	24	1245	s	4047.380	6804.770	65	60	Sullivan/Lough	Drifter	
SJ14195.14	MOC1	110	197	0	5	24	1302	e	4046.610	6804.390	67	60	Sullivan/Lough	Drifter	
SJ14195.17	MOC10	111	197	0	5	24	1337	s	4046.870	6805.100	65	60	Lough	Drifter	
SJ14195.18	MOC10	111	197	0	5	24	1417	e	4045.530	6805.730	69	60	Lough		
SJ14195.19	MOC1	112	197	0	5	24	1417	e	4046.630	6806.470	66	60	Lough		
SJ14195.20	MkIIICTD	57	197	0	5	24	1436	s	4045.316	6806.004	70	65	Lough	Drifter	
SJ14195.21	MOC1	112	197	0	5	24	1457	s	4046.630	6806.470	66	60	Lough	Drifter	
SJ14195.22	MkIIICTD	58	197	0	5	24	1620	s	4045.009	6806.189	72	67	Lough	Drifter	
SJ14195.23	MOC1/4	113	197	0	5	24	1653	s	4047.080	6808.140	65	60	Lough	Drifter	
SJ14195.24	MOC1/4	113	197	0	5	24	1727	e	4046.240	6807.980	64	60	Lough		
SJ14195.25	MOC1	114	197	0	5	24	1727	e	4046.330	6806.430	66	60	Lough		
SJ14195.26	MOC1	114	197	0	5	24	1807	s	4048.560	6808.450	62	60	Lough	Drifter	
SJ14195.27	Drifter	4c	197	0	5	24	2135	e	4043.52	6818.40	61	15	Manning/Churchill	Drifter	recovery
SJ14195.28	MkIIICTD	59	198	0	5	24	2328	s	4029.00	6809.00	231	150	Lough	Stratified	
SJ14295.1	MkIIICTD	60	198	0	5	25	12	s	4032.25	6809.68	99	94	Lough	Stratified	

				L	O	C	A L				Water	Cast			
Event#	Instr	cast#	Sta#	BrdSt#	Mth	Day	hhmm	s/e	Lat	Lon	Depth	Depth	PI	Region	Comments
SJ14295.2	MkIIICTD	61	198	0	5	25	49	1	4035.18	6809.93	90	85	Lough	Stratified	
SJ14295.3	MkIIICTD	62	198	0	5	25	124	1	4038.20	6810.34	86.4	81	Lough	Stratified	
SJ14295.4	MkIIICTD	63	198	0	5	25	157	1	4048.38	6804.25	67	71	Lough	Stratified	
SJ14295.5	MkIIICTD	64	198	0	5	25	230	1	4044.10	6811.16	68	63	Lough	Stratified	
SJ14295.6	MkIIICTD	65	198	0	5	25	300	1	4047.07	6811.60	55	50	Lough	Stratified	
SJ14295.7	MkIIICTD	66	198	0	5	25	328	1	4050.15	6811.93	58	53	Lough	Stratified	
SJ14295.8	MOC1	115	197	0	5	25	832	s	4048.620	6806.600	64	60	Lough	Drifter	
SJ14295.9	MOC1	115	197	0	5	25	1005	e	4046.190	6808.150	65	60	Lough	Drifter	
SJ14295.10	MkIIICTD	67	199	0	5	25	1047	s	4045.80	6807.54	67	150	Lough	Stratified	
SJ14295.11	MOC1/4	116	197	0	5	25	1112	s	4046.740	6806.340	66	60	Lough	Drifter	
SJ14295.12	MOC1/4	116	197	0	5	25	1203	e	4045.220	6808.050	67	60	Lough	Drifter	
SJ14295.13	MOC10	117	197	0	5	25	1231	s	4045.300	6806.960	68	60	Lough	Drifter	
SJ14295.14	MOC10	117	197	0	5	25	1318	e	4044.810	6804.730	74	60	Lough	Drifter	
SJ14295.15	Drifter	7b	197	0	5	25	1421	e	4043.51	6806.35	76	15	Manning/Churchill	Drifter	recovery
SJ14295.16	Drifter	2b	197	0	5	25	1505	e	4038.48	6803.56	88	15	Manning/Churchill	Drifter	recovery (lost sock)
SJ14295.17	MkIIICTD	68	199	0	5	25	1701	s	4041.17	6717.03	72	94	Lough	Stratified	
SJ14295.18	Drifter	1b	197	0	5	25	1727	e	4041.38	6817.80	70	15	Manning/Churchill	Drifter	recovery
SJ14295.19	Drifter	6b	197	0	5	25	1750	e	4040.87	6821.11	69	15	Manning/Churchill	Drifter	recovery
SJ14295.20	MOC1	118	197	0	5	25	2000	e	4043.810	6805.700	77	20	Lough		
SJ14295.21	MOC1	118	197	0	5	25	2000	s	4043.810	6805.700	77	20	Lough	Drifter	Net 0 only for Calanus
SJ14295.22	MkIIICTD	69	199	0	5	25	2004	1	4054.08	6845.12	71	85	Lough	GSC	
SJ14295.23	MkIIICTD	70	199	0	5	25	2037	1	4053.95	6849.23	75	81	Lough	GSC	
SJ14295.24	MkIIICTD	71	199	0	5	25	2131	1	4054.04	6858.06	79	71	Lough	GSC	
SJ14295.25	MkIIICTD	72	199	0	5	25	2242	1	4054.00	6809.83	69	63	Lough	GSC	

Appendix II. Biochemistry samples

Bongo Data

Tow#	Cod	Haddock
92	3	8
93	1	3
96	6	
110	2	6
112	1	4
113	6	
114	5	
115	4	
117	9	
118	3	1
119	5	1
120	3	
121	5	
122	4	
131	6	
132	10	
134	6	2
135	14	
136	6	2
138	2	1
145	8	
147	4	
149	14	1
150	20	1
151	3	1
152		2
153		2
158	6	
159	19	1
160	4	
162	6	1
163	12	6
169		2
170	4	1
172	11	
176	4	
180	3	
183	10	
185	5	1
Total	234	47

Appendix II (Continued): Biochemistry samples

1 Meter Mocness Data

Tow#	Net#	Cod	Haddock
64	0	0	4
	2	0	2
	3	0	7
	4	4	10
	6	0	13
66	0	12	1
	7	1	2
	8	20	0
68	0	5	0
	1	1	0
	2	10	2
	3	7	1
	4	3	0
70	0	4	0
74	0	1	1
	8	4	19
78	8	3	1
80	1	0	1
	2	0	1
	3	1	2
	4	1	0
	5	1	2
	6	1	0
	7	1	0
	8	1	0
82	0	3	3
	8	3	0
83	0	0	4
85	0	1	1
	5	4	0
	6	2	2
	7	2	8
	8	3	5
94	0	1	0
	2	1	0
	3	0	2
	4	1	5
	5	2	4
	6	1	2
95	0	4	1
	1	4	0
	2	3	1
	3	1	0
	4	0	3
	5	3	2
	6	2	0
	7	5	0
99	7	0	1
	8	3	5
104	0	5	1
	1	3	0
	2	0	1
	3	1	0
	4	1	1
	5	3	5
	6	3	1

Mocness total #= 272

Symbol	Depth	Total	
a	0-10		20
b	10-20		41
c	20-30		37
d	30-40		29
e	40-50		12
f	50-60		8
g	60-70		4
h	70-80		
i	0-bottom	78	
j	30-60		19
k	0-30		5
l	20-60		7
m	0-20		1

Total #'s

Cod=146 Haddock=126

Tow#	Cod	Haddock
64	4	36
66	33	3
68	26	3
70	4	
74	5	20
78	3	1
80	6	6
82	6	3
83		4
85	12	15
94	6	13
95	22	7
99	3	6
104	16	9

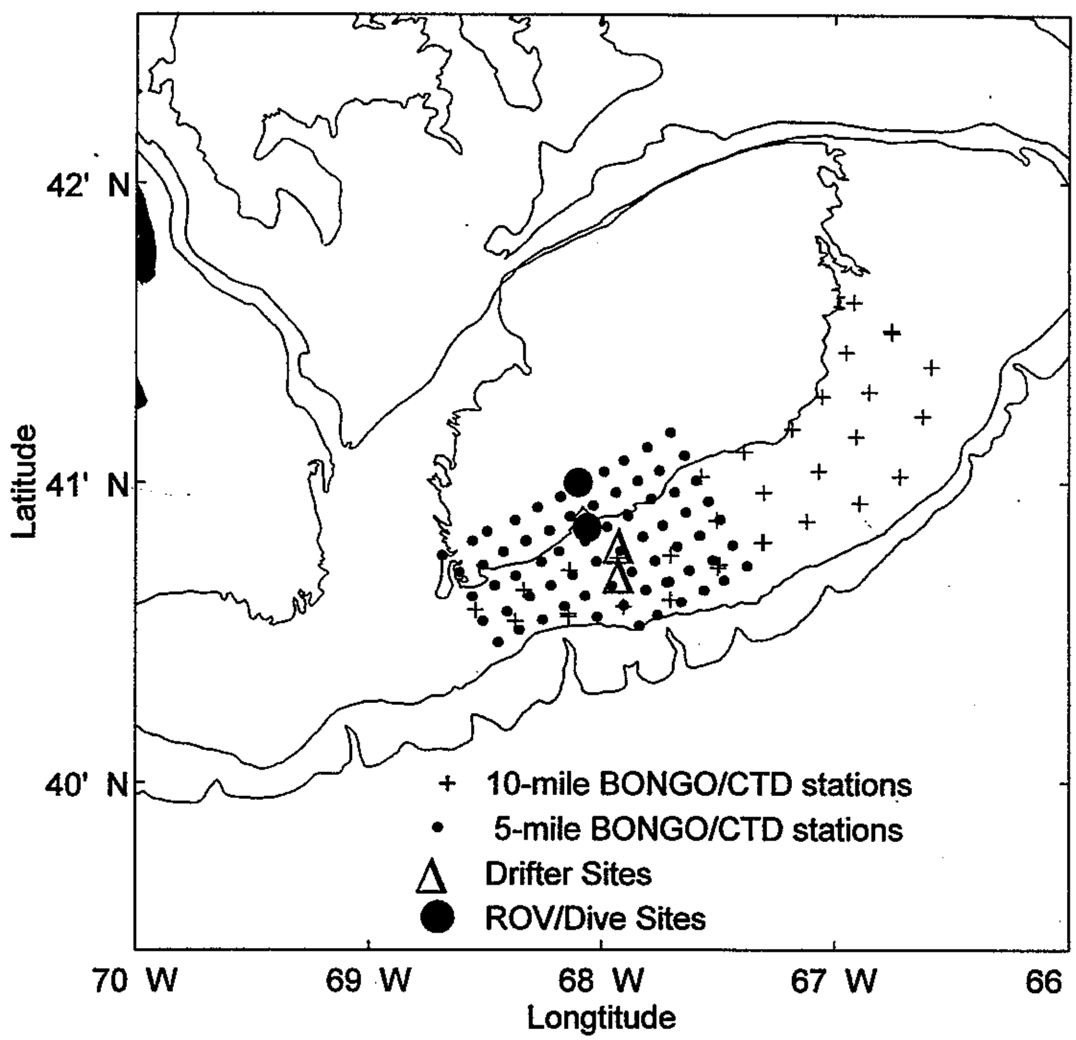


Figure 1. Area of Operations on Georges Bank for the R/V Seward Johnson Cruise 9507, 8-26 May 1995, showing two bongo surveys, two drifter sites, and two ROV (Remote Operated Vehicle) dive sites.

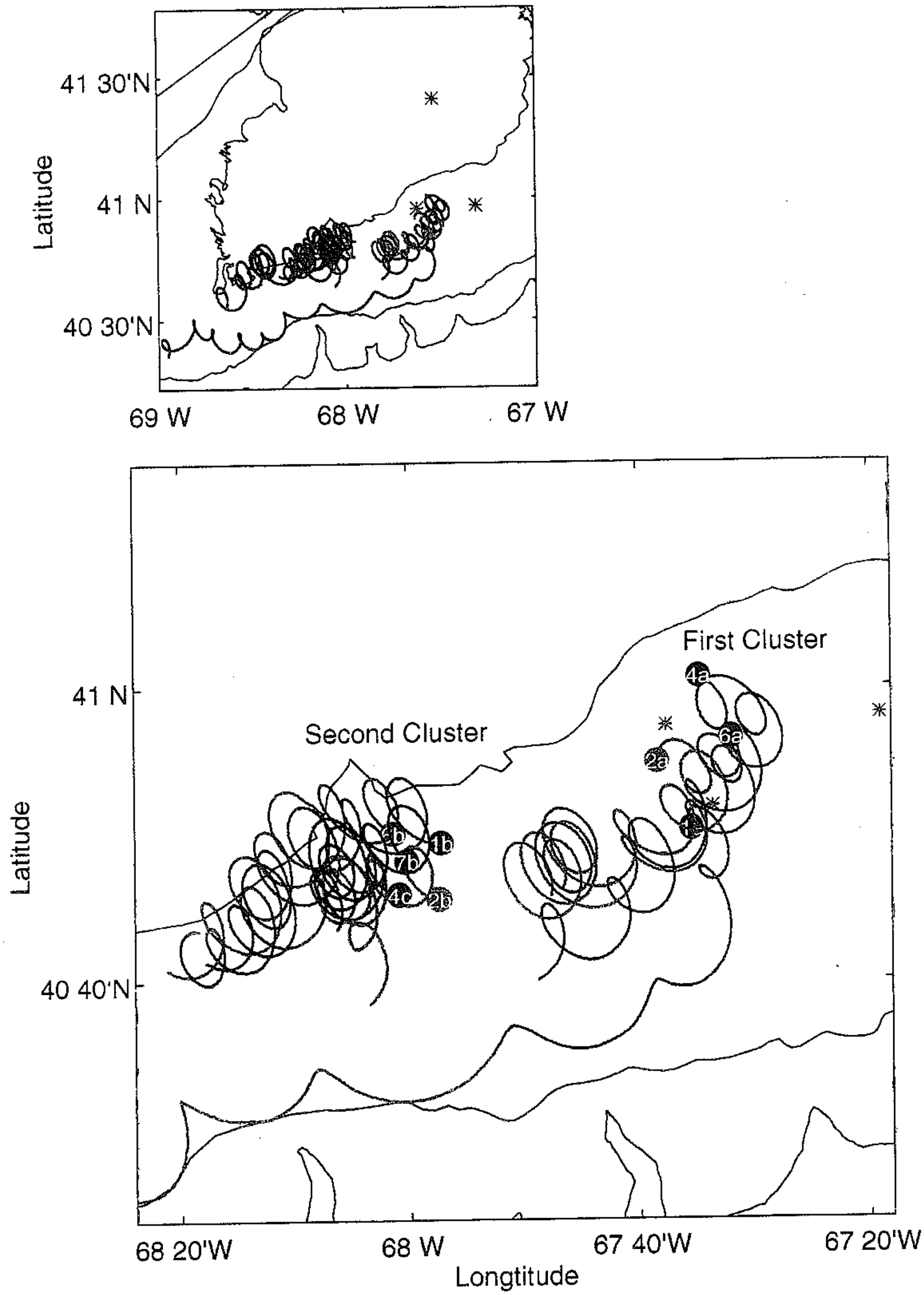


Figure 2a. Summary of drifter deployments on SJ9507. The first cluster deployment (4a,6a,1a,2a) was made at the start of the 5-mile bongo survey (11-14 May) and the second cluster deployment (1b,2b,4c,6b,7a) was made at the start of Site 197 (22-25 May). Individual deployments (7a and 4b not shown in the lower expanded plot) were made at each Site 188 and 192, respectively. Mooring locations are denoted by asterisks. Both cluster deployments were made seaward of the 60m isobath. The three isobaths in the figure are the 60, 100, and 200 meter.

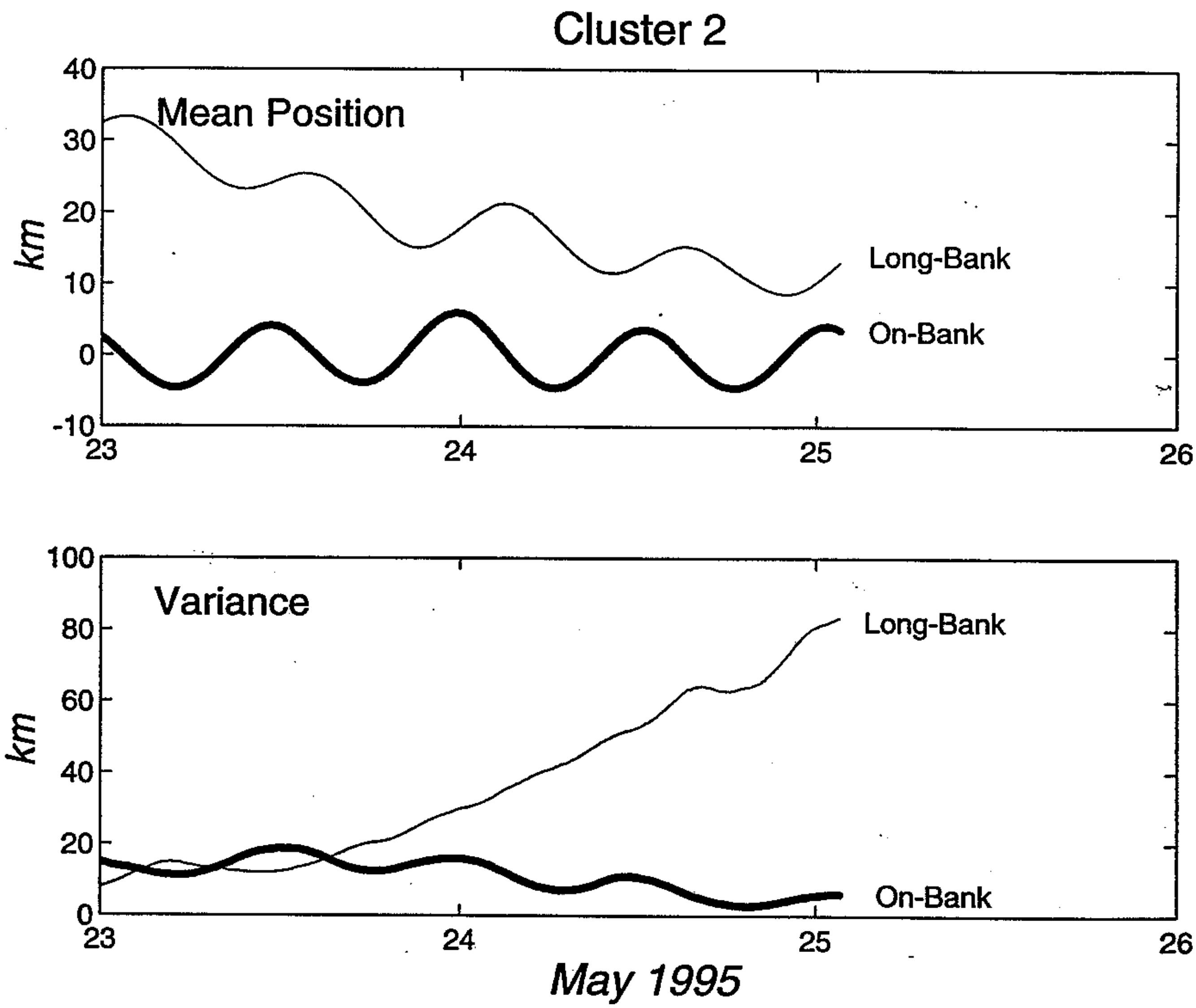
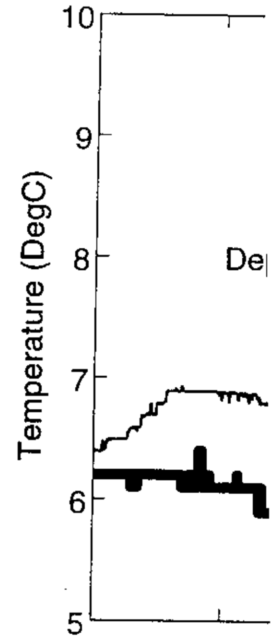


Figure 2b. The top plot show the long-bank and on-bank components of the mean position of the 2nd drifter cluster. The lower plot shows the long-bank and on-bank components of the variance of the drifter positions about the mean cluster position.



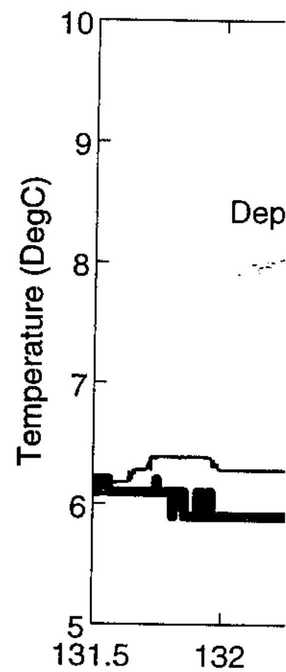


Figure 4. Record of t
(<1 m) and Minilog
is the results from de
May). While the tw
stratification is positi
(13 May) when the o
front. Note the deep

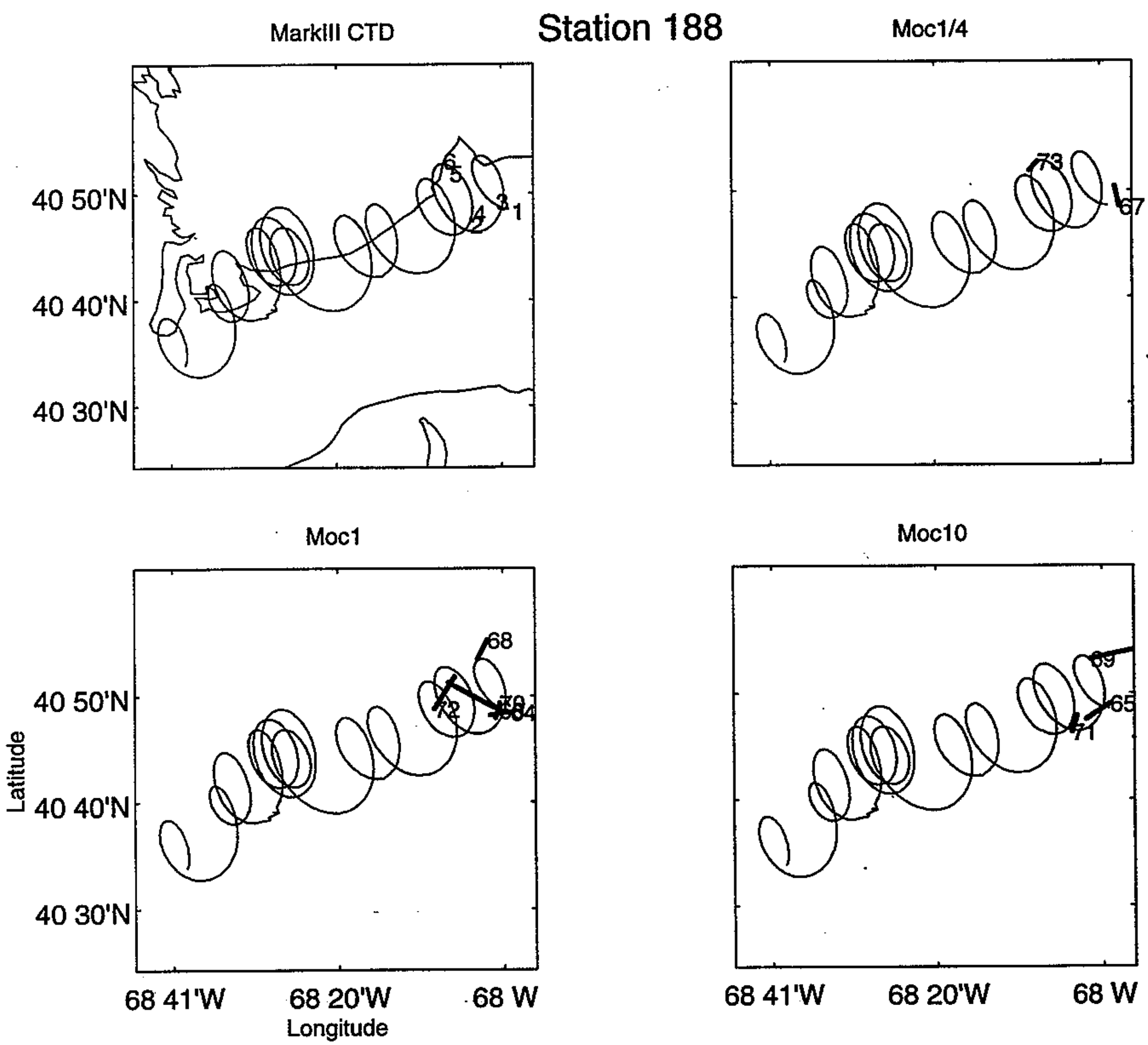


Figure 5. Sampling locations at Station 188 relative to ARGOS/GPS/VHF drifter; elliptic path. Straight lines indicate start and stop path of ship during net hauls. Numbers indicate cast number and start position. For example, the 1/4-m MOCNESS tow #67 was taken on a north-northwestward tack. The drifter path indicates a residual flow towards the southwest along the 60-m isobath which is included in the upper-right hand panel along with the 100-m and 200-m isobaths.

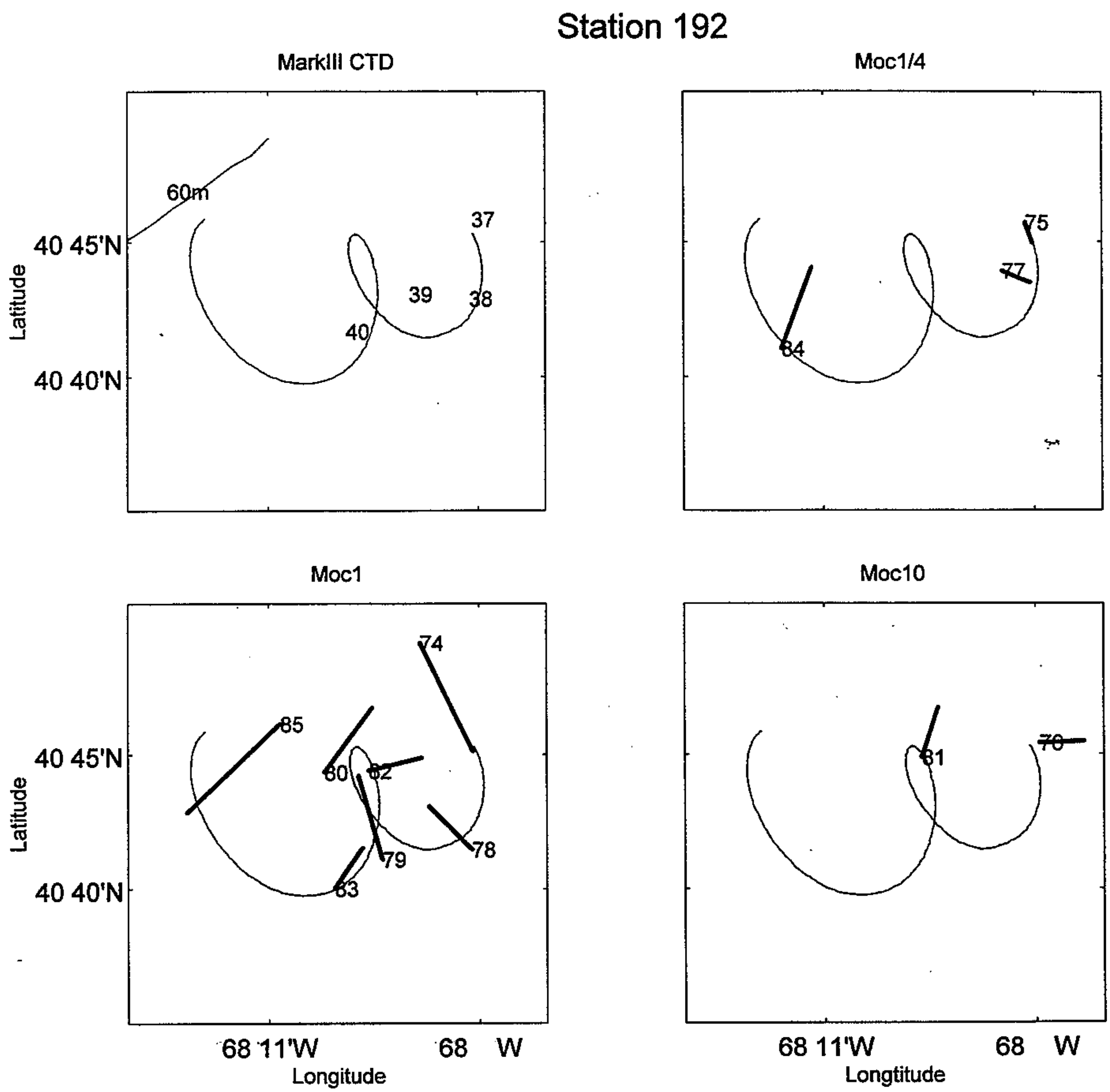


Figure 6. Sampling locations at Station 192 relative to ARGOS/GPS/VHF drifter elliptic path. Straight lines indicate start and stop path of ship during net hauls. Numbers indicate cast number and start position. For example, the 1/4-m MOCNESS tow #75 was taken on a north-northwestward tack. The drifter path indicates a residual flow towards the west in approximately 70 m of water. The 60-m isobath is included in the upper-right hand panel.

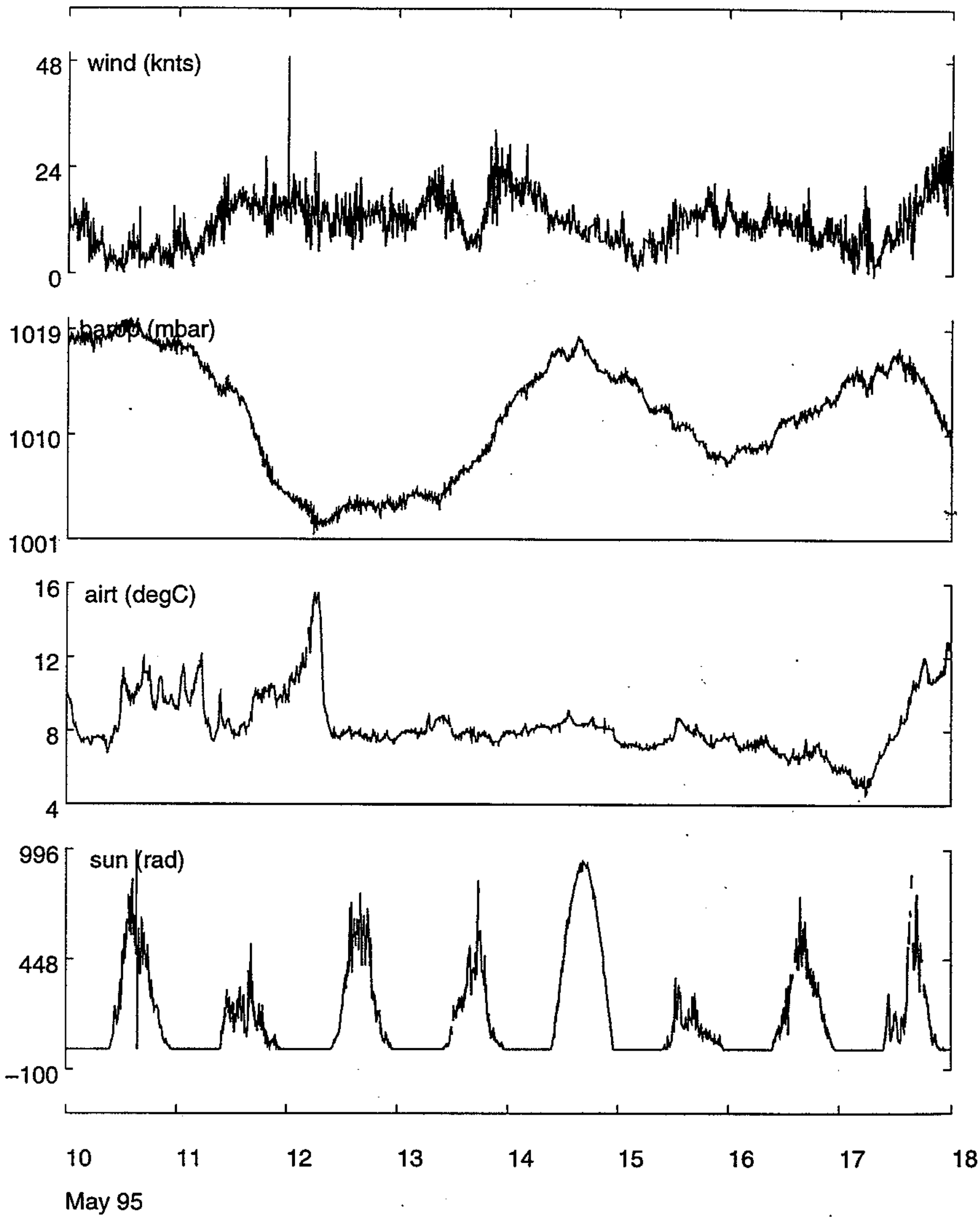


Figure 7a. Examples of shipboard meteorologic sensor data interpolated to five minute intervals (see text) for the first half of the cruise .

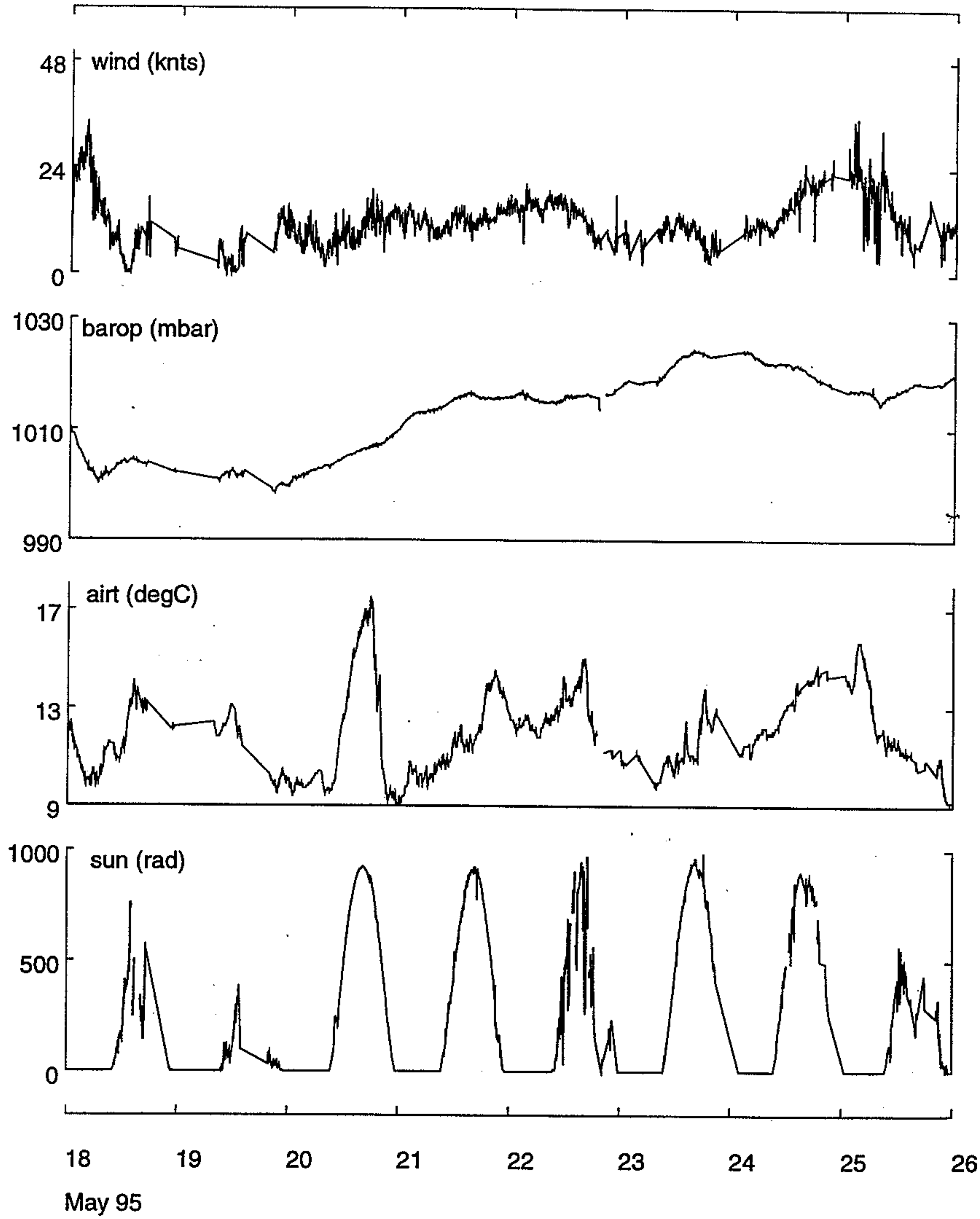


Figure 7b. Examples of shipboard meteorologic sensor data interpolated to five minute intervals (see text) for the second half of the cruise .

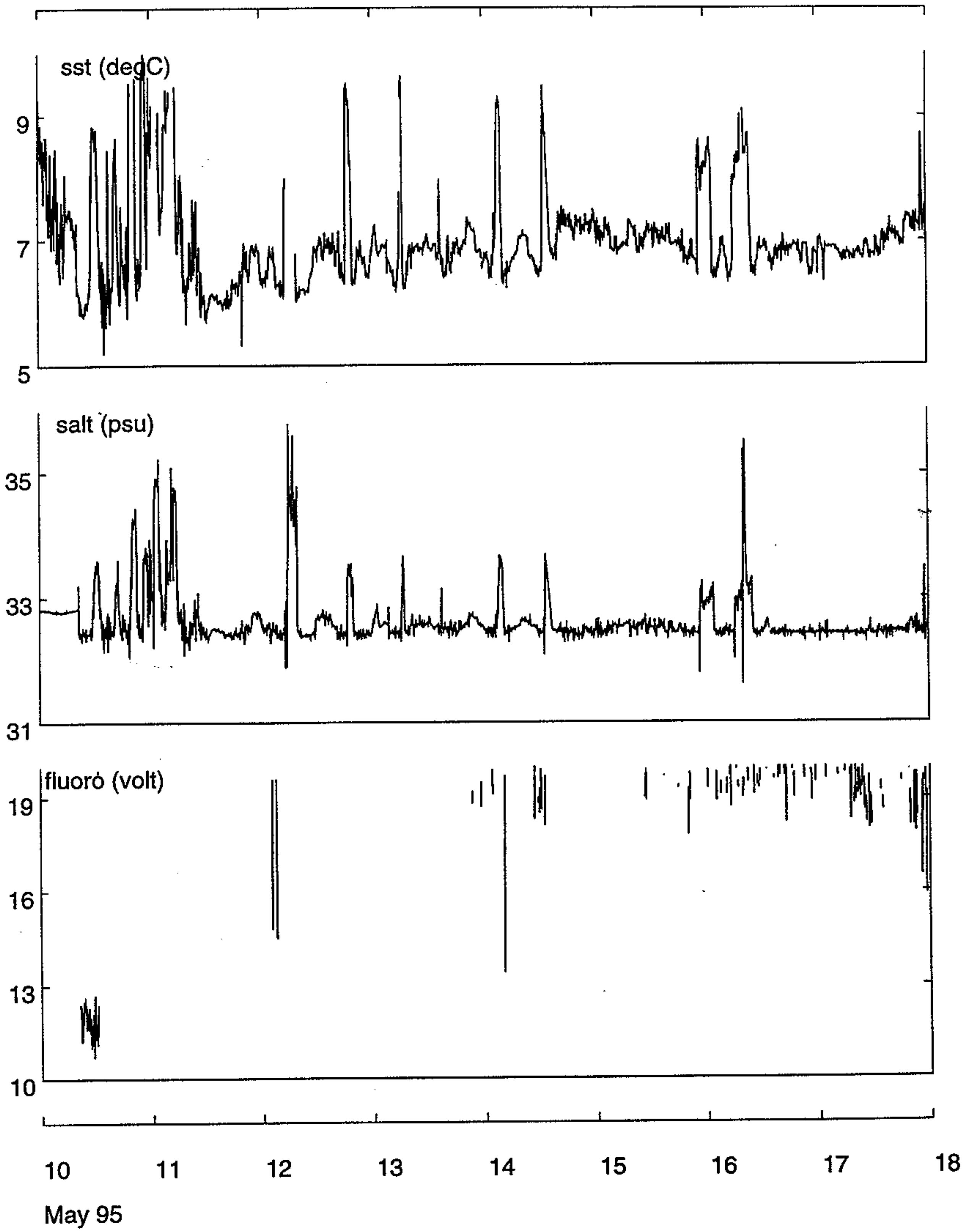


Figure 8a. Examples of shipboard hull-mounted sensor data (seasurface temperature [°C], salinity [psu], and fluorescence [volts]) interpolated to five minute intervals (see text) for the first half of the cruise.

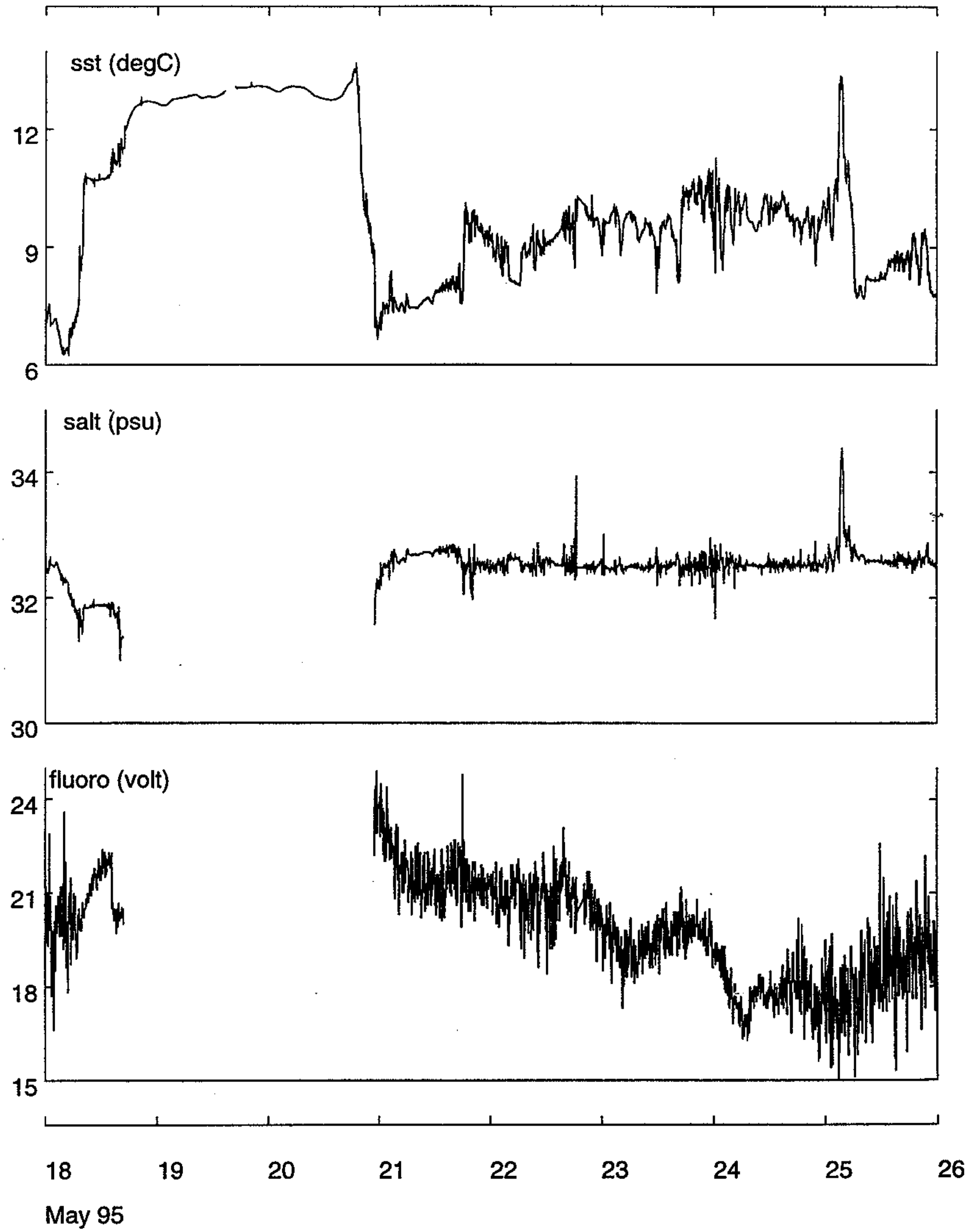


Figure 8b. Examples of shipboard hull-mounted sensor data (seasurface temperature [°C], salinity [psu], and fluorescence [volts]) interpolated to five minute intervals (see text) for the second half of the cruise.

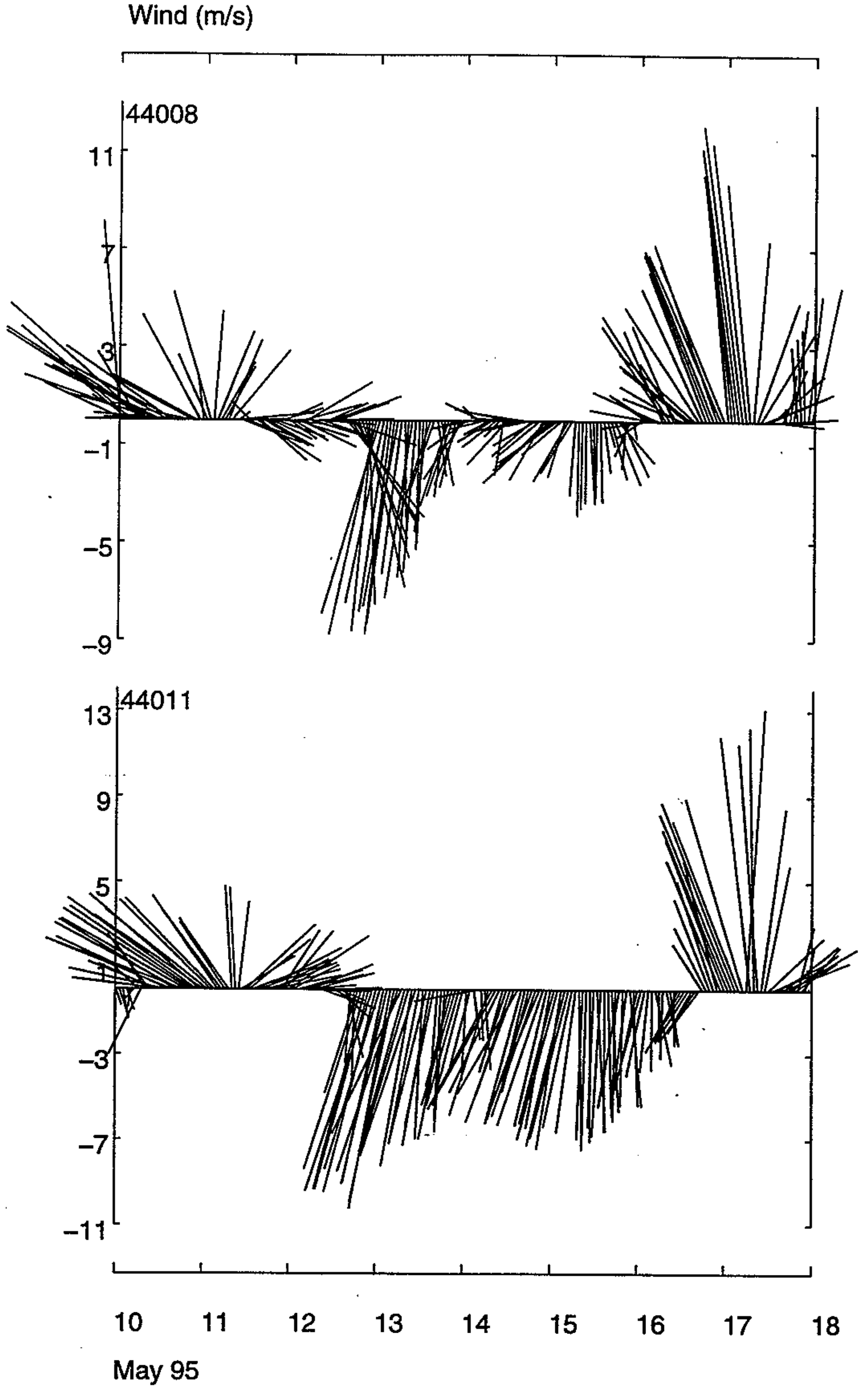


Figure 9a. Wind speed (m/s) and direction as measured at NOAA Buoys 44008 and 44011 during first leg of SJ9507.

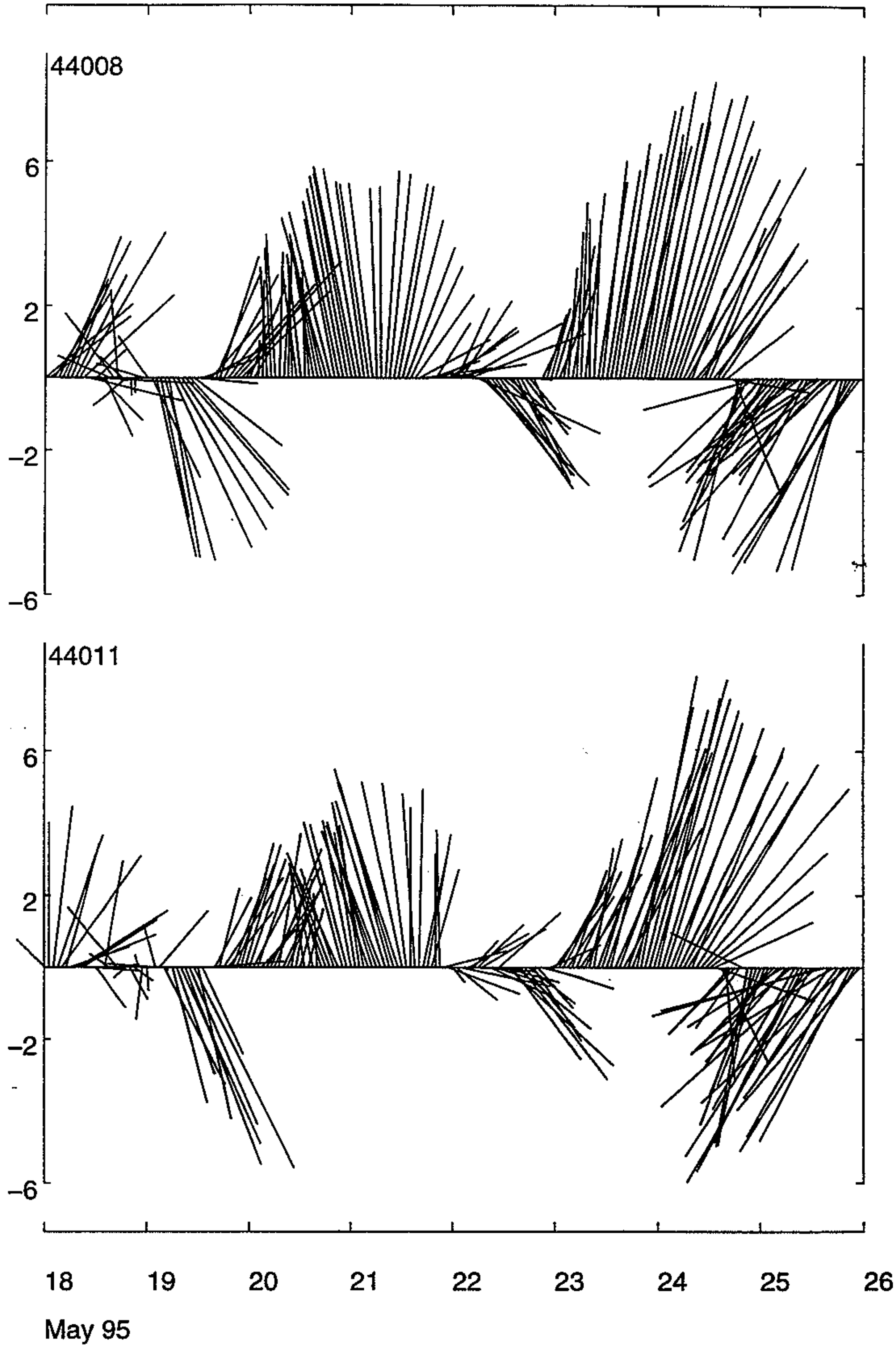


Figure 9b. Wind speed (m/s) and direction as measured at NOAA Buoys 44008 and 44011 during second leg of SJ9507.

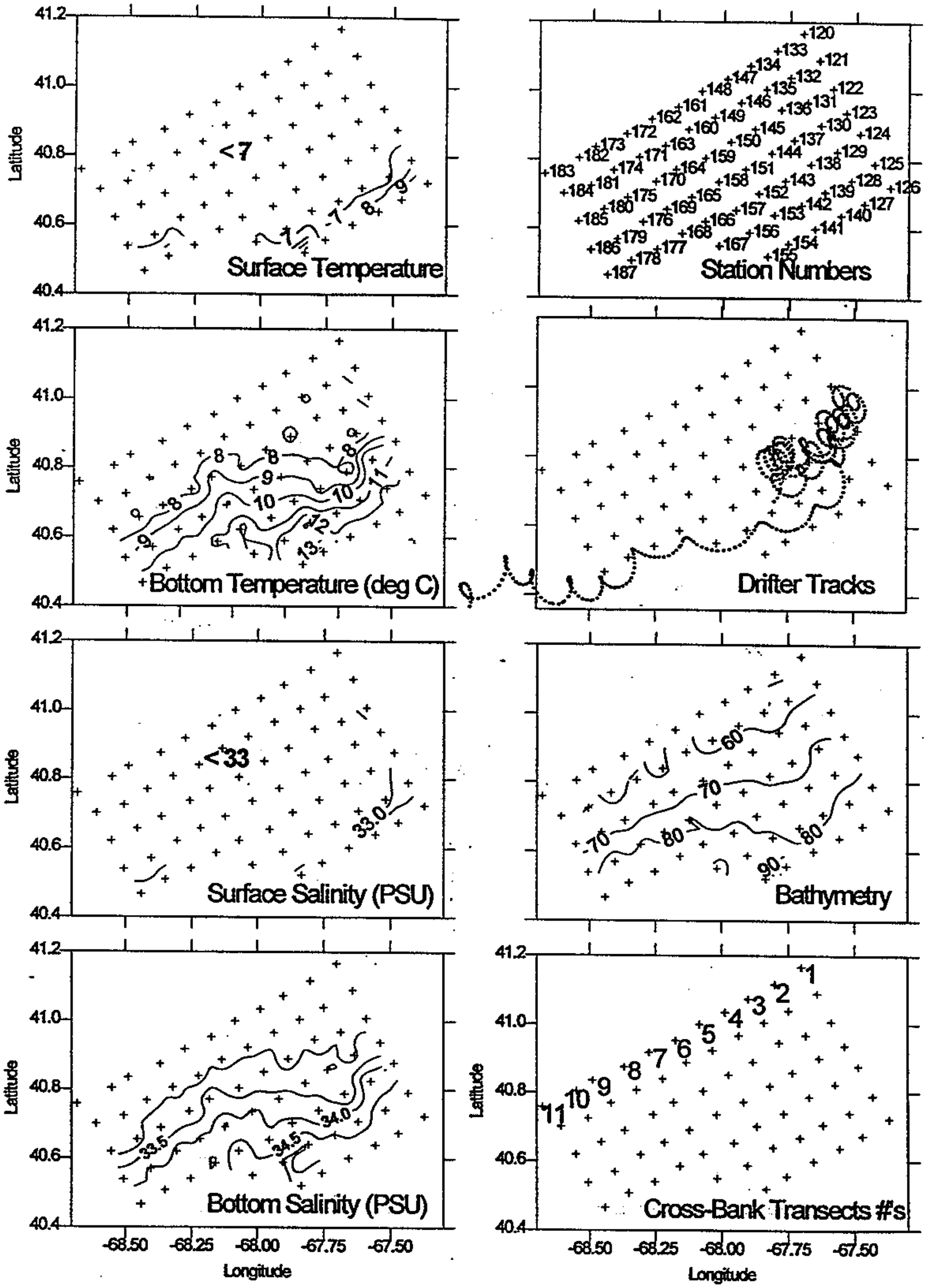


Figure 10. Results of the Seabird CTD survey conducted concurrent with of the 5-mile grid bongo survey. The oceanographic variables are contoured in the left hand panels and station numbers, drifter tracks, bathymetry, and transect numbers are shown to same scale on the left hand panels. The dominant feature is the presence of slope water encroaching on the bank near bottom.

11-12 May 1995

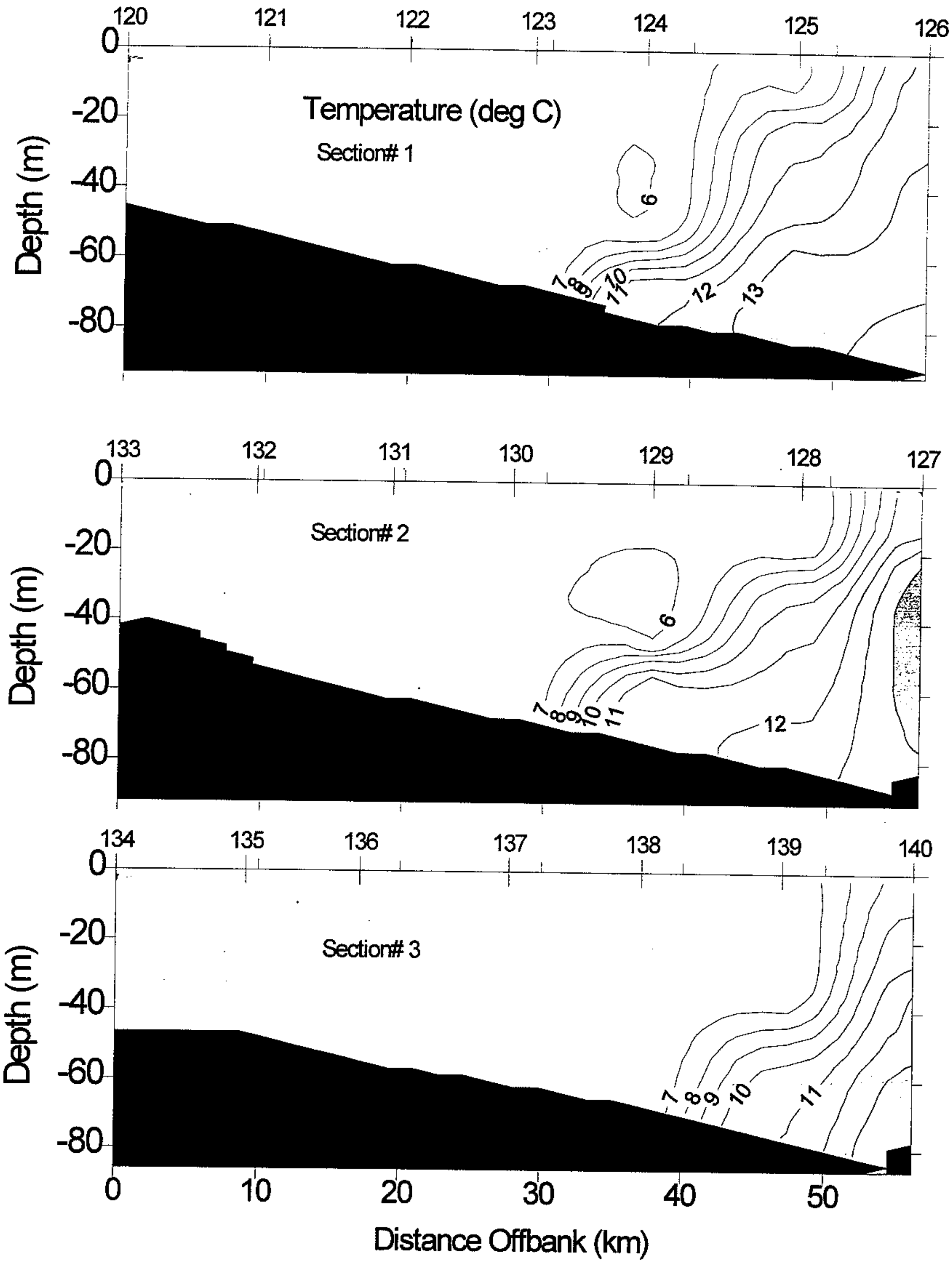


Figure 11a. Cross-bank temperature structure are recorded by the SEABIRD CTD on transects 1, 2, and 3. Contour interval is 1 ° C.

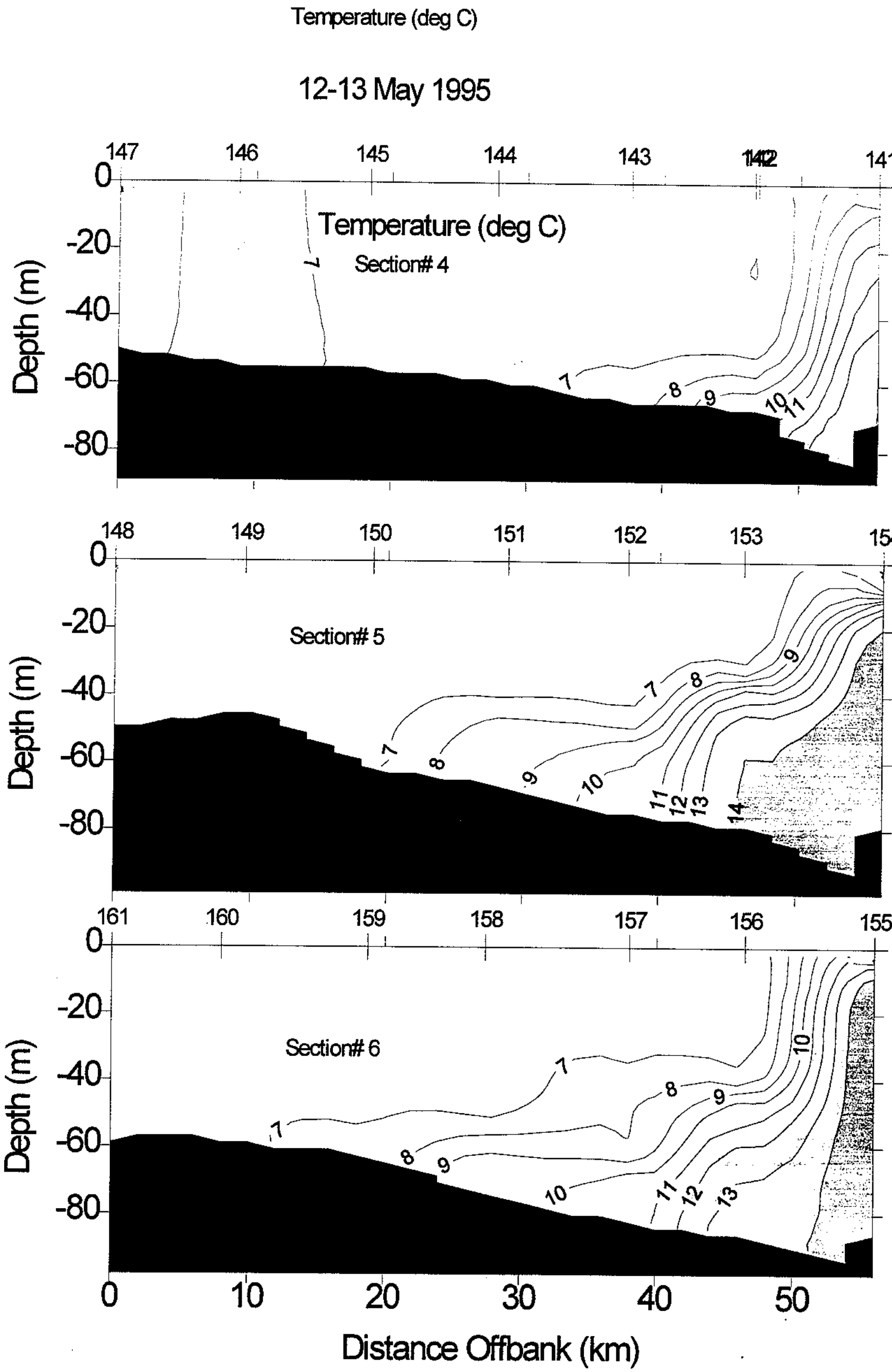


Figure 11b. Cross-bank temperature structure are recorded by the SEABIRD CTD on transects 4, 5, and 6. Contour interval is 1 ° C.

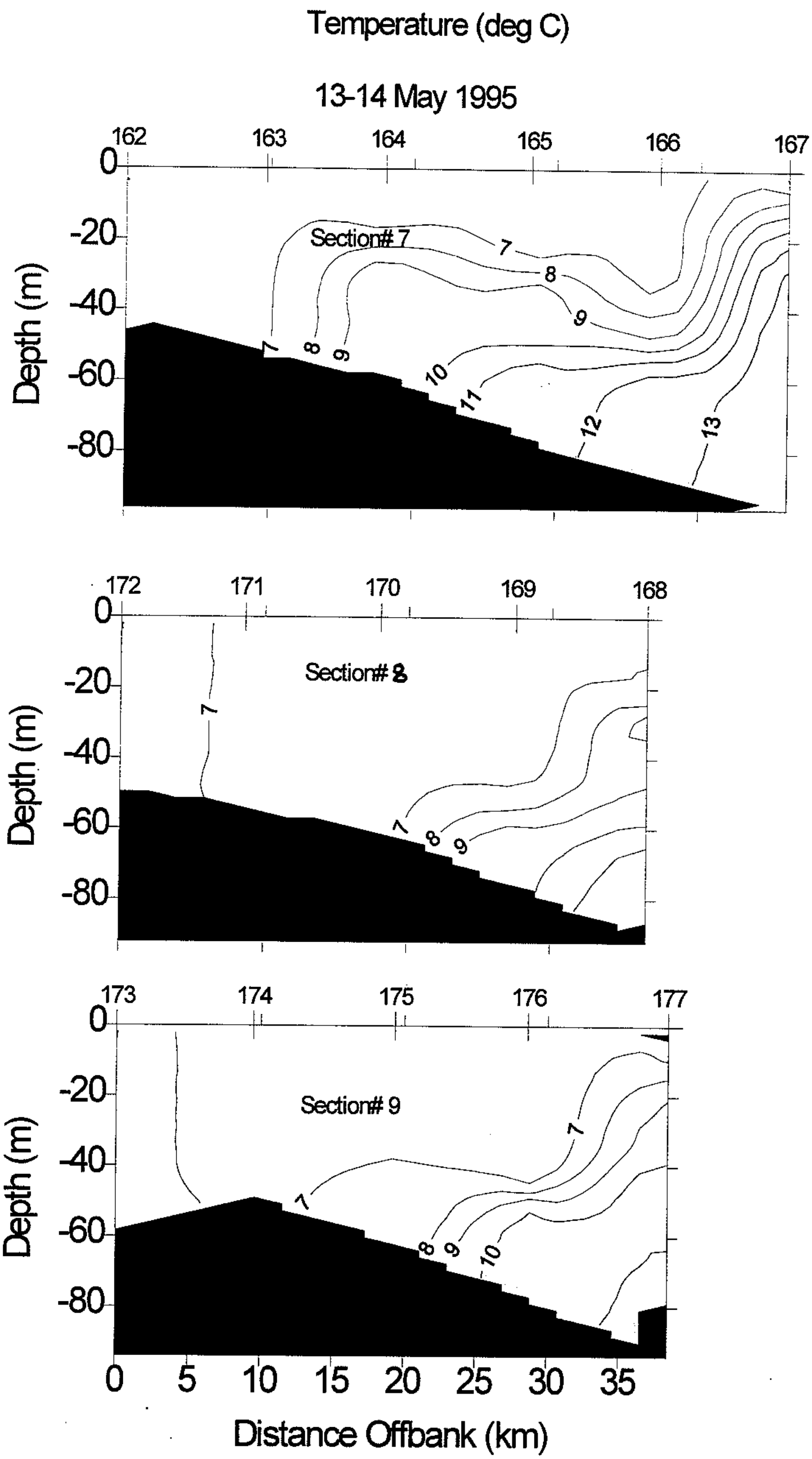


Figure 11c. Cross-bank temperature structure are recorded by the SEABIRD CTD on transects 7, 8, and 9. Contour interval is 1 ° C.

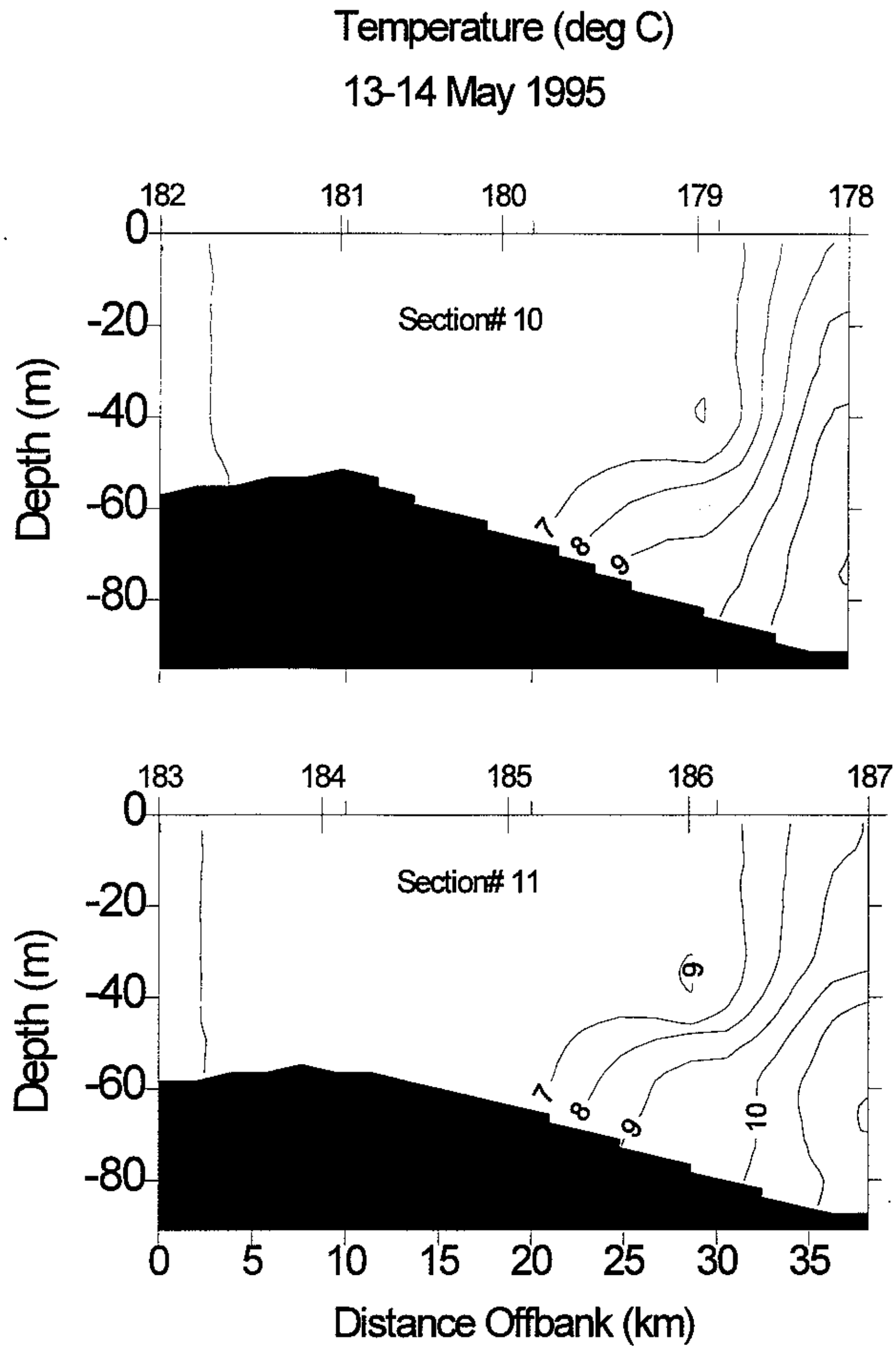


Figure 11d. Cross-bank temperature structure are recorded by the SEABIRD CTD on transects 10 and 11. Contour interval is 1 ° C.

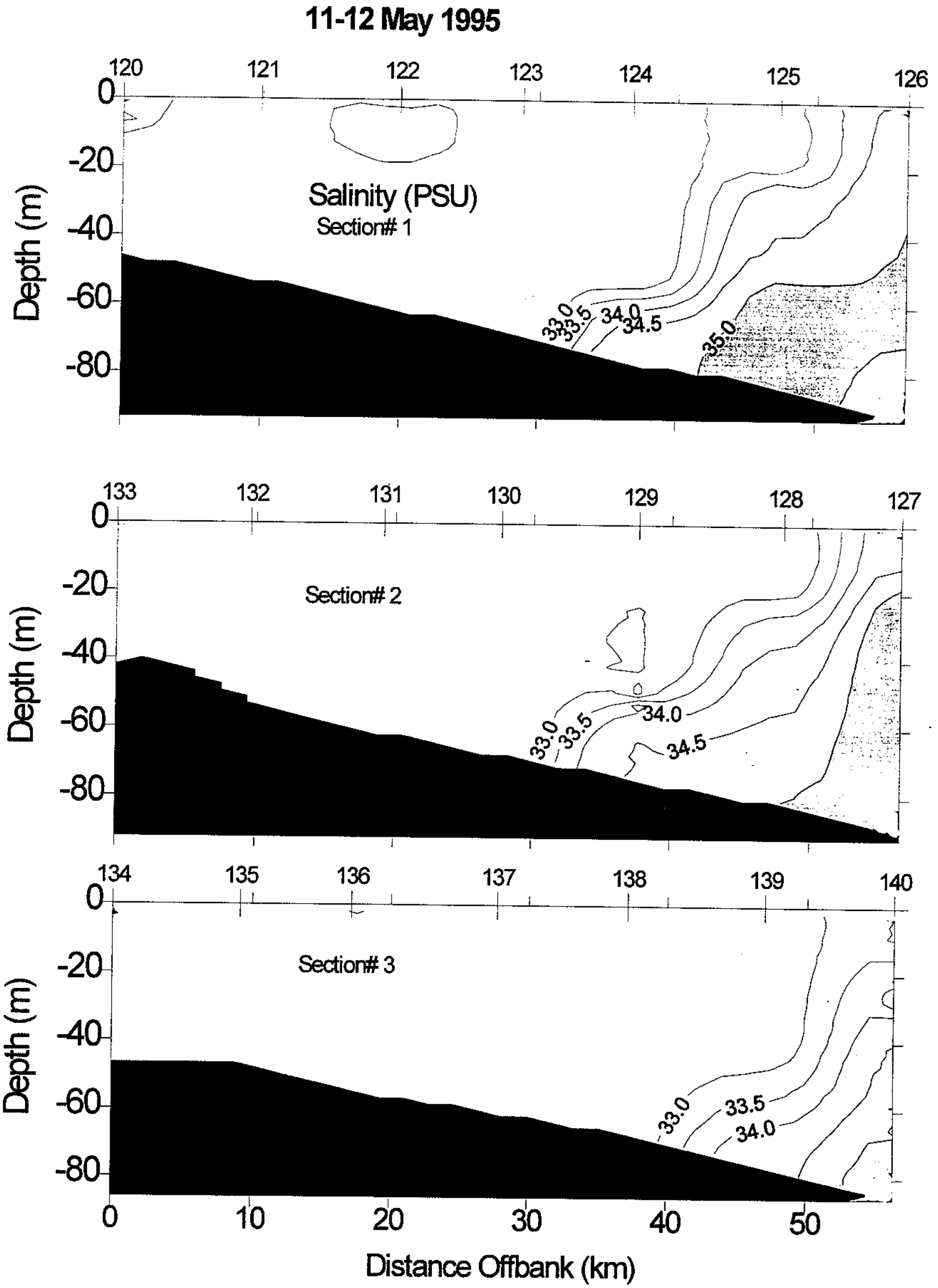


Figure 12a. Cross-bank salinity structure are recorded by the SEABIRD CTD on transects 1, 2, and 3. Contour interval is 0.5 psu.

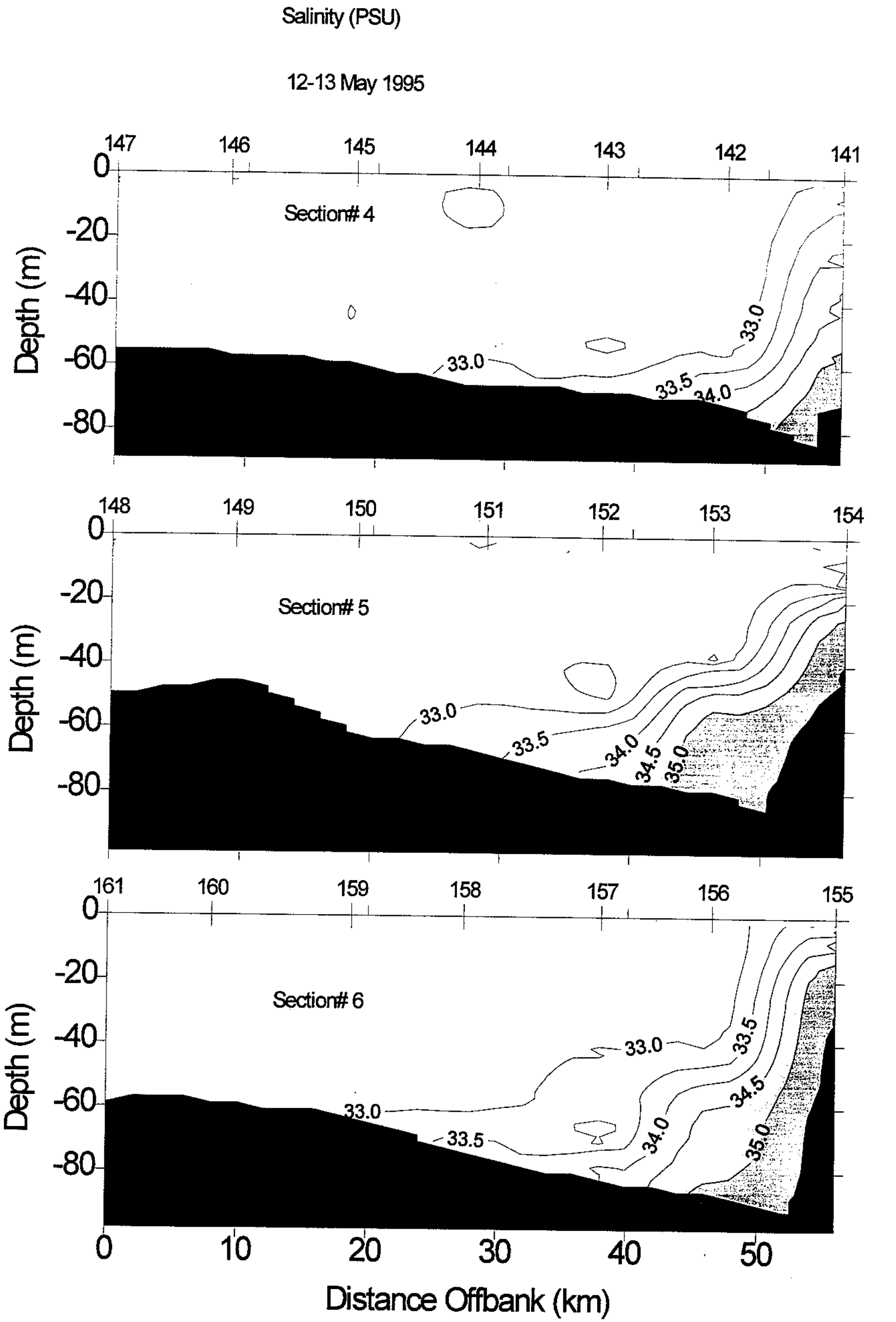


Figure 12b. Cross-bank salinity structure are recorded by the SEABIRD CTD on transects 4, 5, and 6. Contour interval is 0.5 psu.

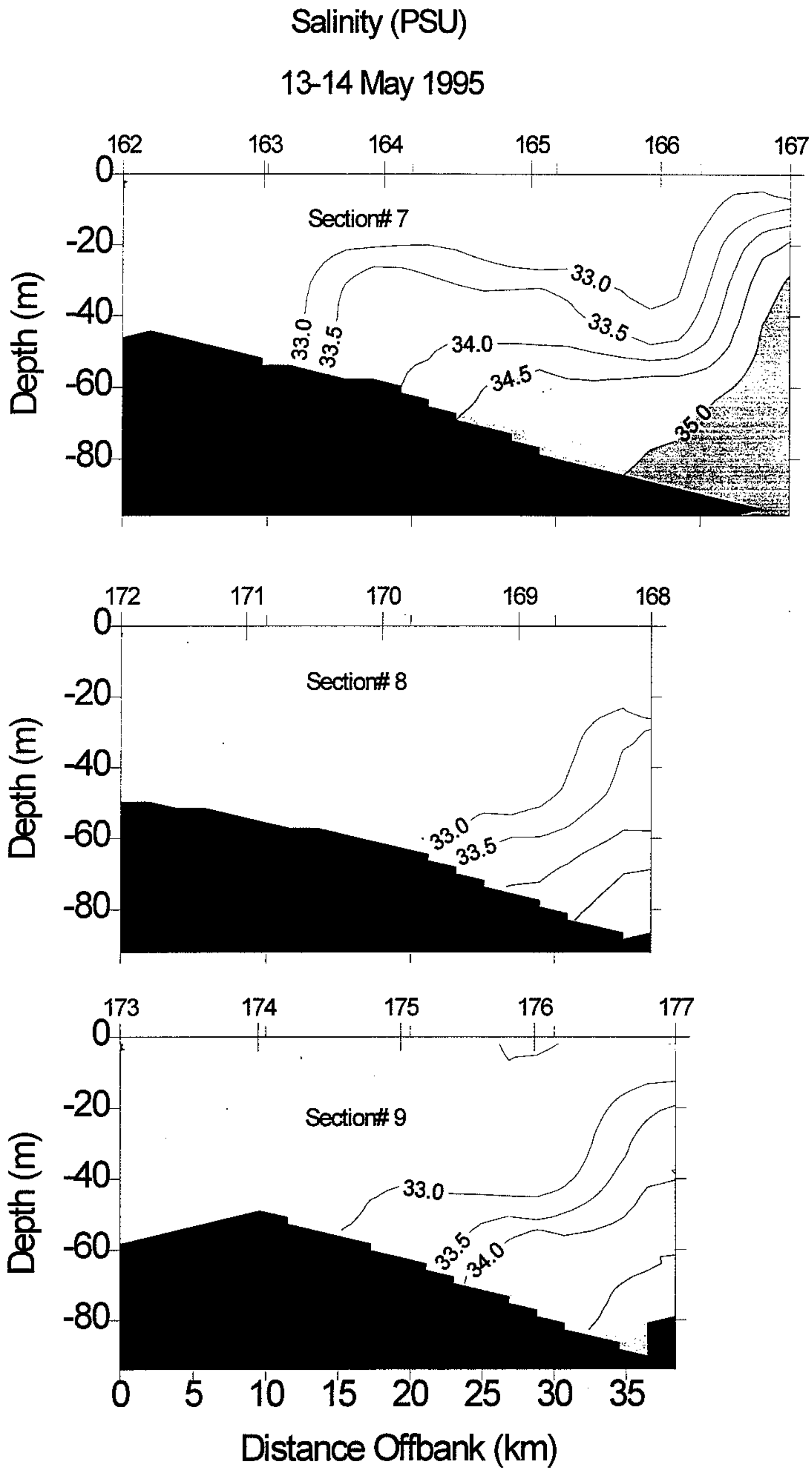


Figure 12c. Cross-bank salinity structure are recorded by the SEABIRD CTD on transects 7, 8, and 9. Contour interval is 0.5 psu.

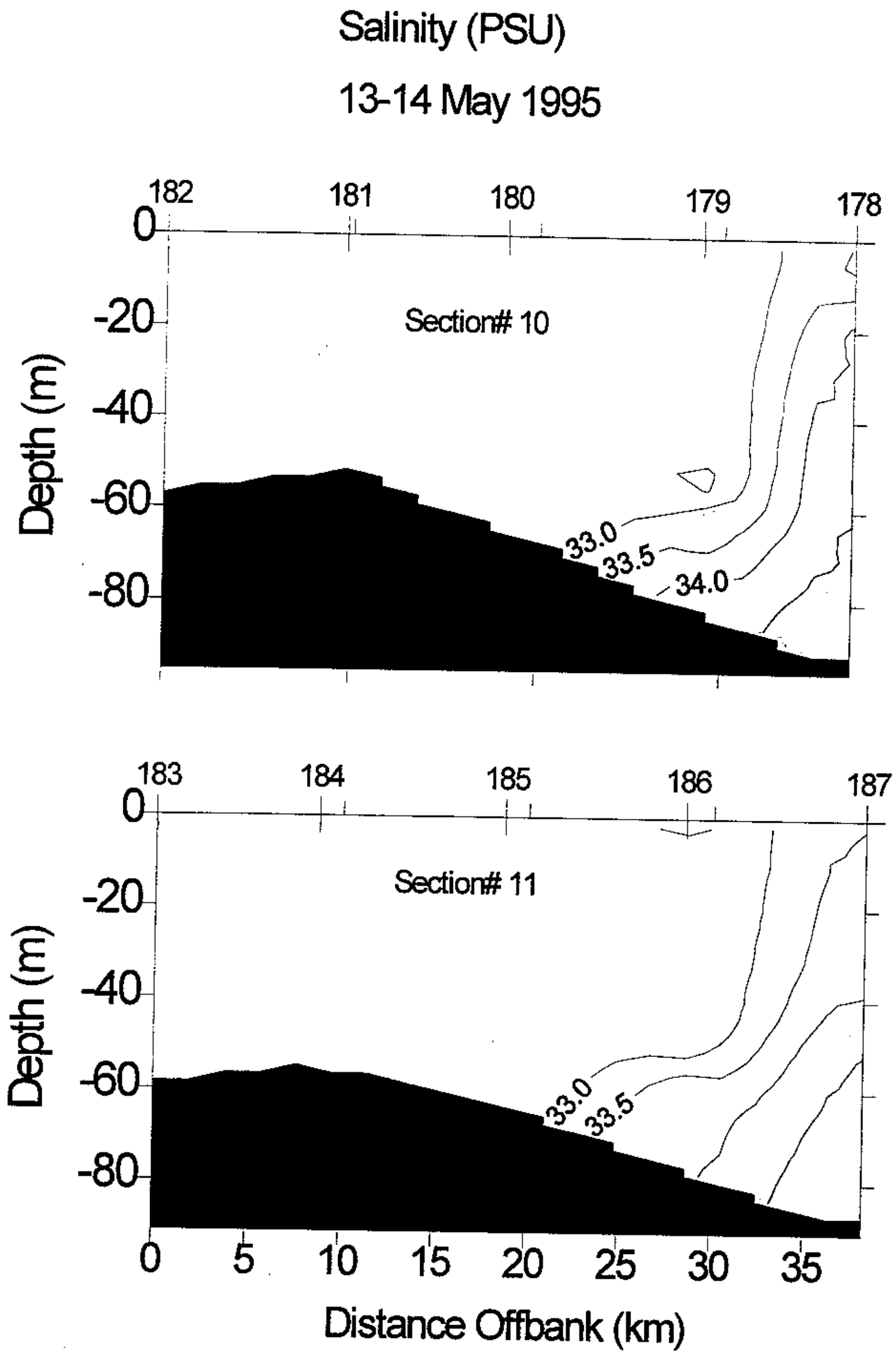


Figure 12d. Cross-bank salinity structure are recorded by the SEABIRD CTD on transects 10 and 11. Contour interval is 0.5 psu.

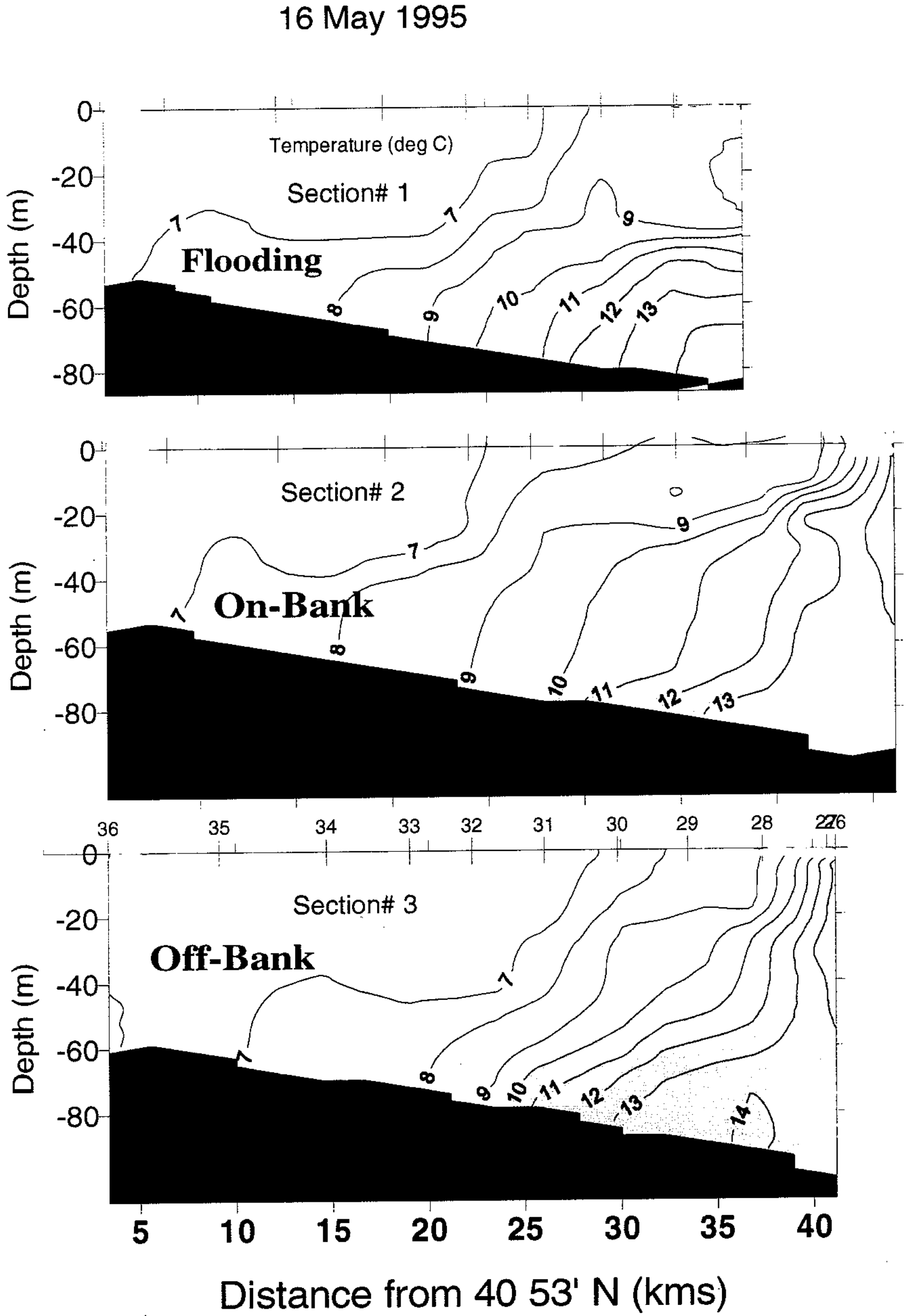


Figure 13. Cross-bank temperature structure are recorded by the MARKIII CTD on transects along 68°W during three different phases of the tide. Contour interval is 1° C.

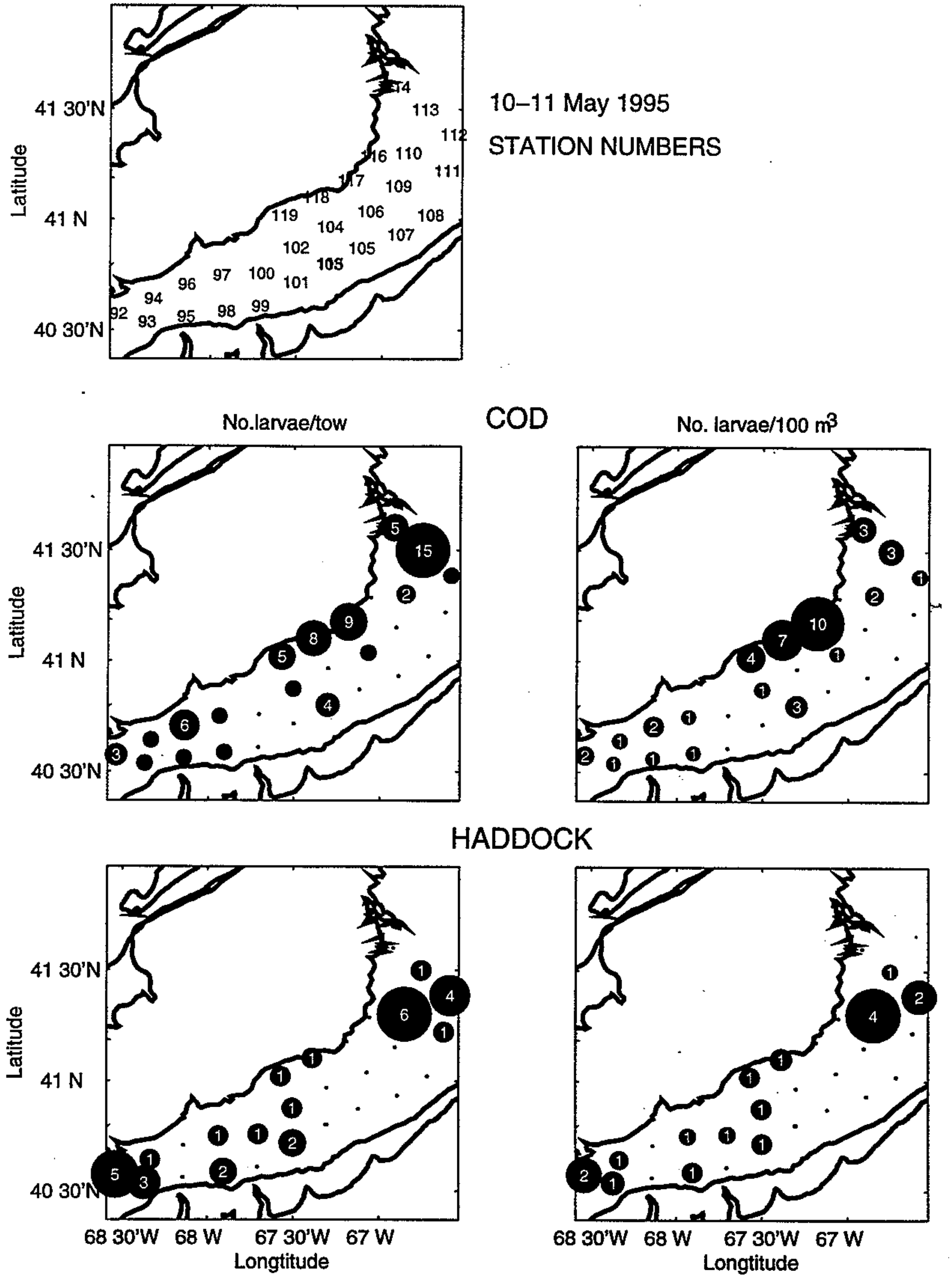


Figure 14. Distributions of cod and haddock larvae from the 10-mile bongo survey on the southern flank of Georges Bank, 10-11 May 1995. Top left panel shows bongo station location and number. Left middle and bottom panel show the number of cod and haddock larvae from the 0.505-mm bongo net (unstandardized); the right hand panels show the standardized value (no./100m^3). The 60-m-isobath runs through the center of each figure with the 100-m and 200-m isobaths shown in the lower right and upper left corners.

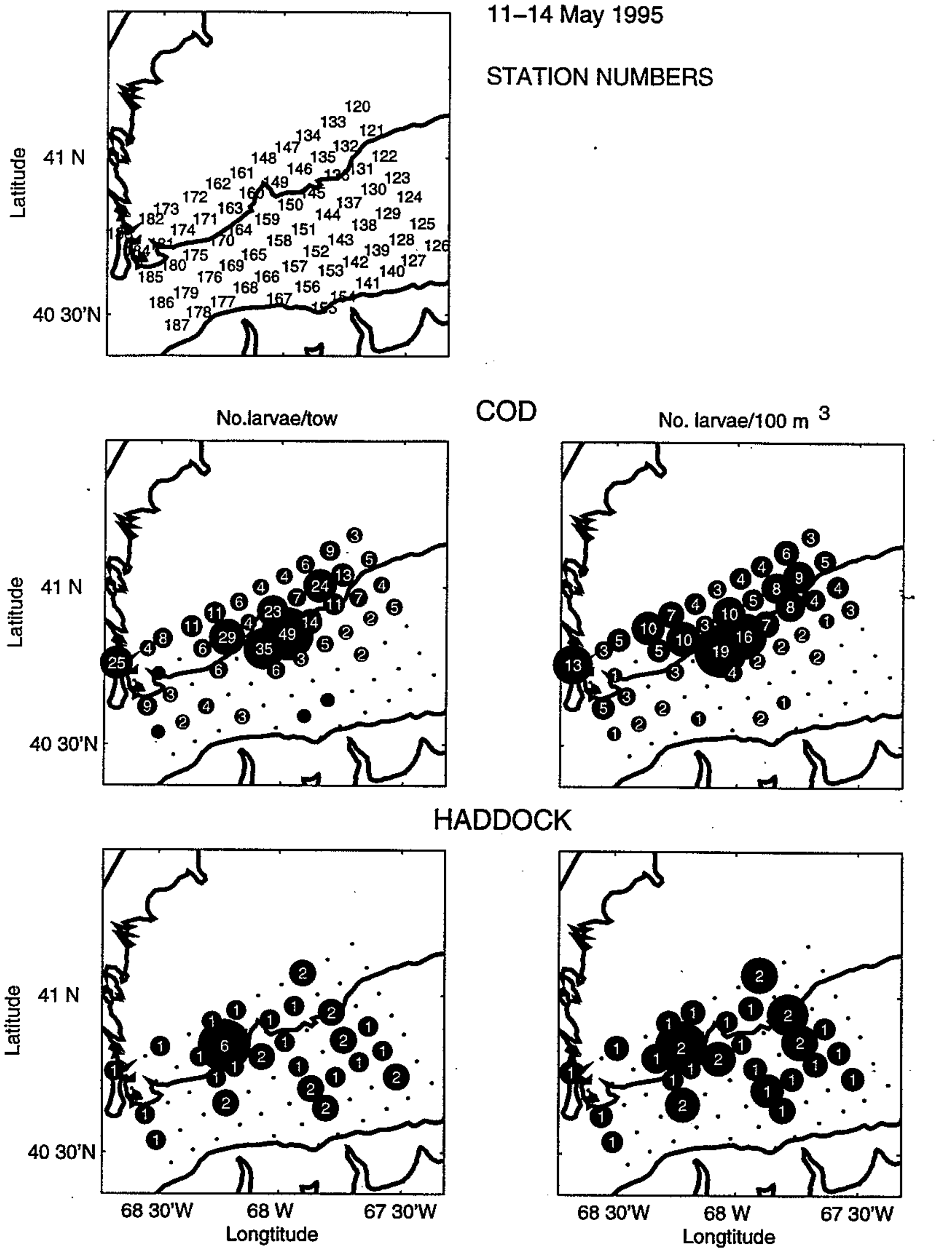


Figure 15. Distributions of cod and haddock larvae from the 5-mile bongo survey on the southern flank of Georges Bank, 11-14 May 1995. Top left panel shows bongo station location and number. Left middle and bottom panel show the number of cod and haddock larvae from the 0.505-mm bongo net (unstandardized); the right hand panels show the standardized value (no./100 m^3). The 60-m-isobath runs through the center of each figure with the 100-m and 200-m isobaths shown in the lower right corner.

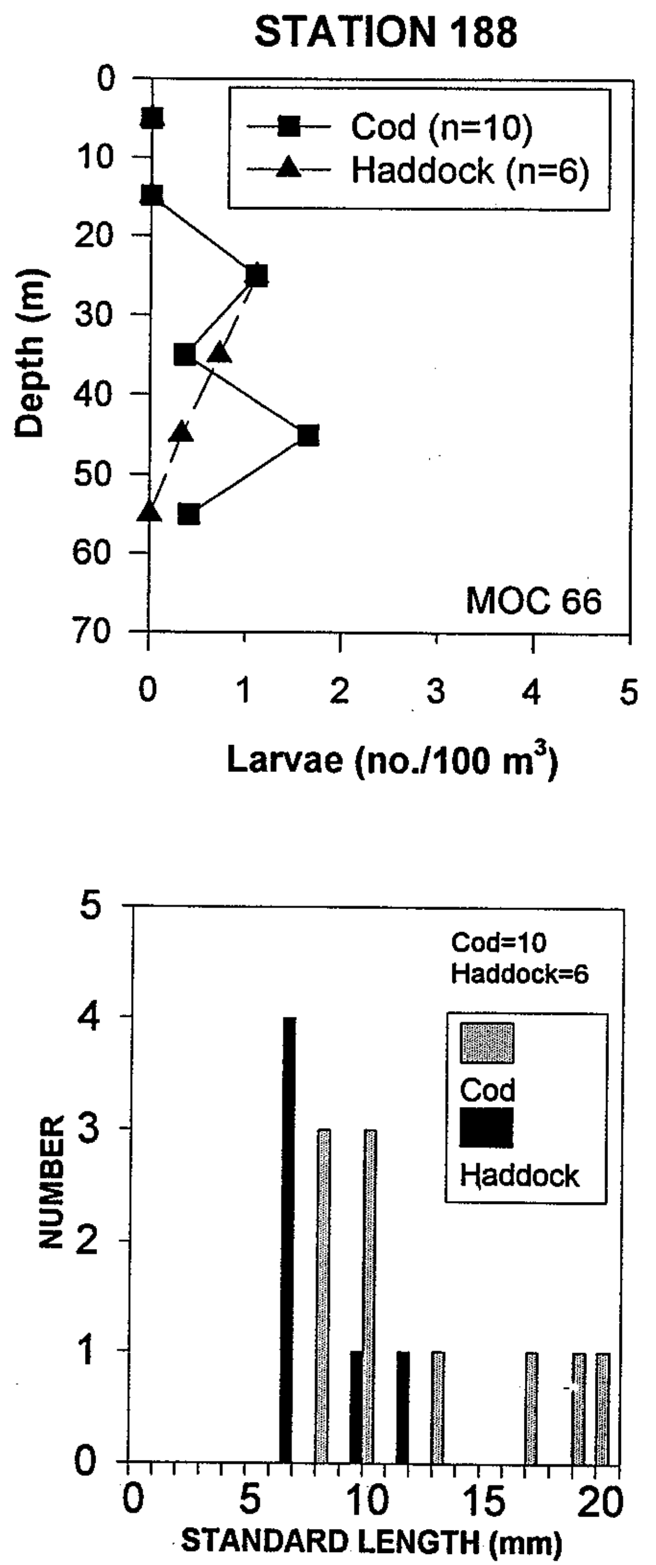


Figure 16. Vertical distributions of cod and haddock larvae (top plot) and their length frequency (bottom plot) from station 188, 1-m MOCNESS tow 66, 14 May 1995, 1902-1934 DST, 65 -66m bottom depth.

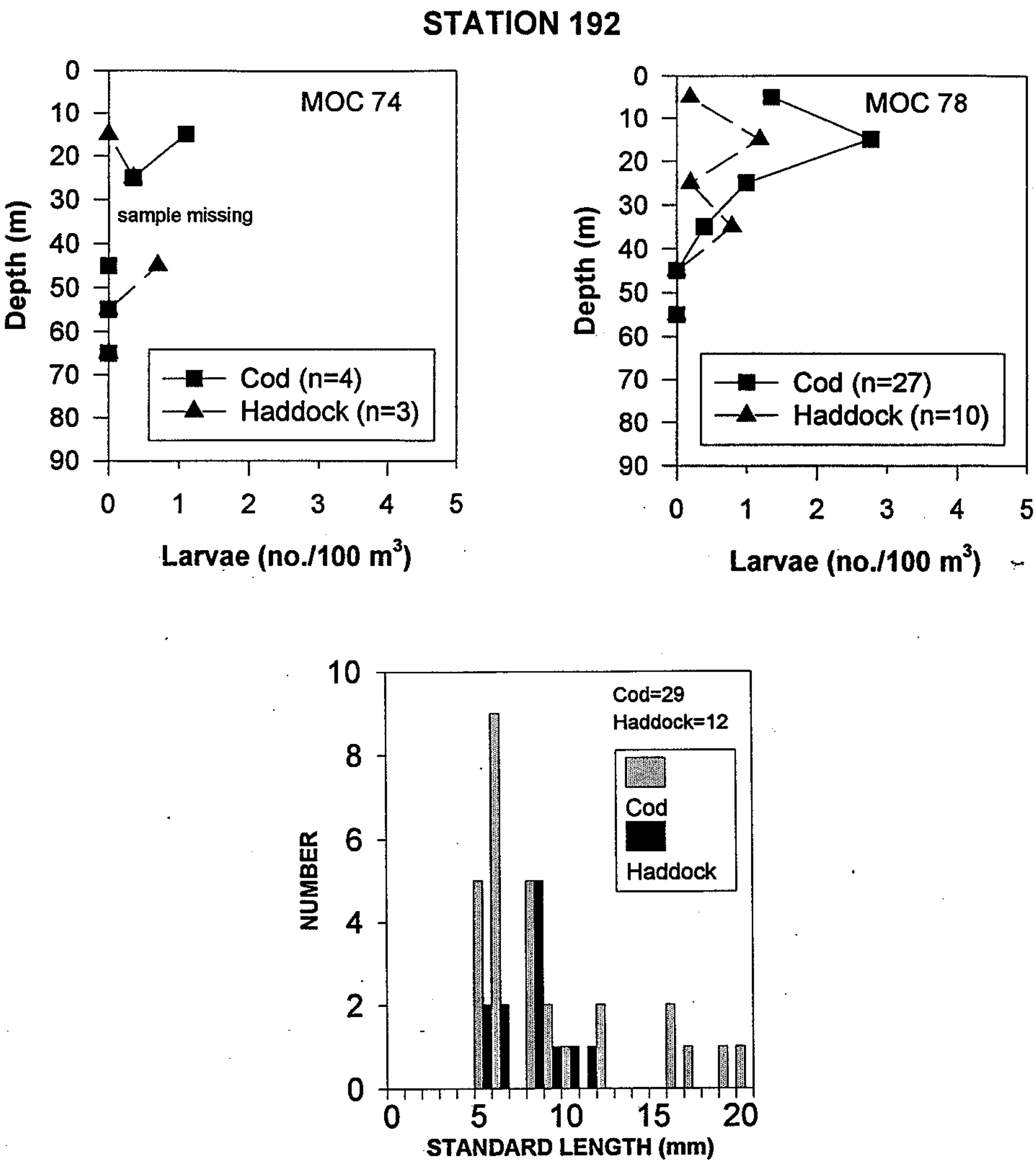


Figure 17. Vertical distributions of cod and haddock larvae (top plots) and their combined length frequency (bottom plot) from station 192, 1-m MOCNESS tow 74, 16 May 1995, 1034-1112 DST, 66-76m bottom depth, and 1-m MOCNESS tow 78, 16 May 1995, 1817-1921 DST, 80-81m bottom depth.

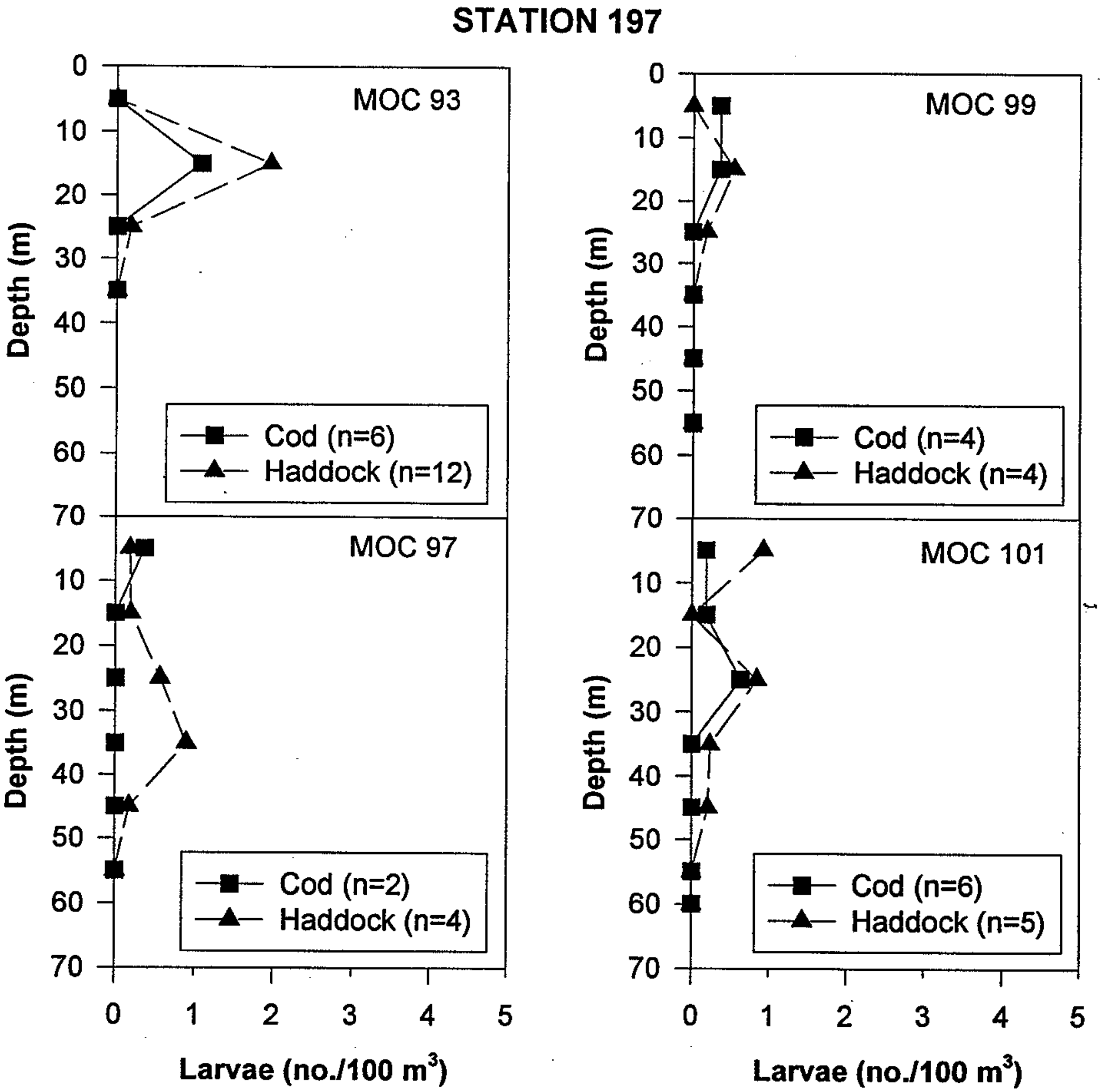
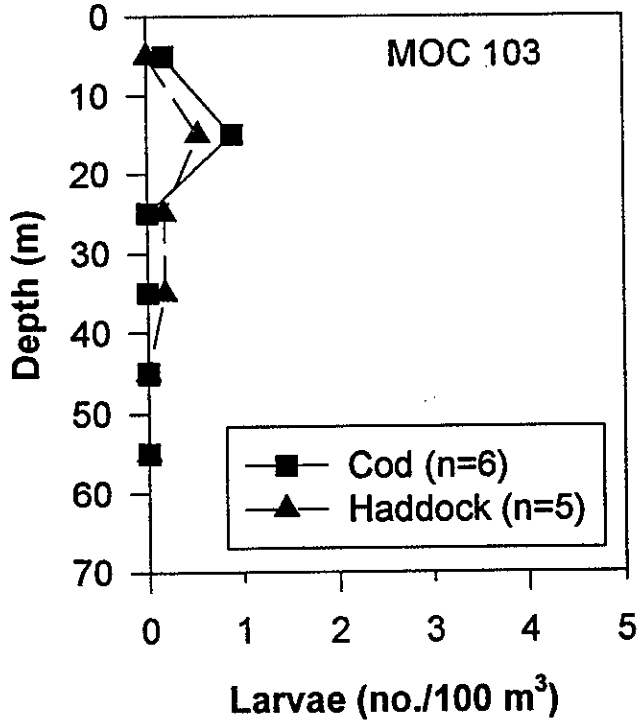


Figure 18. Vertical distributions of cod and haddock larvae and their combined length frequency (final plot) from station 197, 1-m MOCNESS tow: 93, 22 May 1995, 1830-1923 DST, 56-62-m bottom depth; 97, 23 May 1995, 0635-0736 DST, 64-65-m bottom depth; 99, 23 May 1995, 1039-1146 DST, 65-68-m bottom depth; 101, 23 May 1995, 1509-1615 DST, 60-69-m bottom depth; 103, 23 May 1995, 1847-1949 DST, 63-66-m bottom depth.

STATION 197 (CON'T)



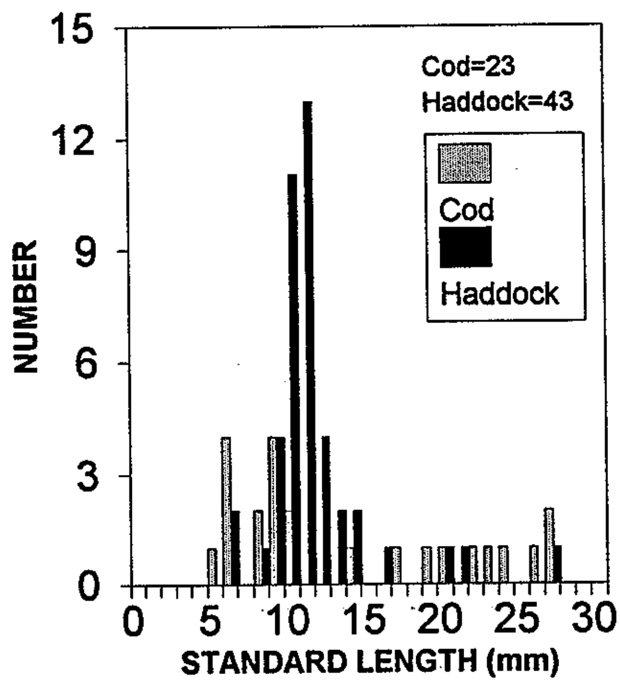


Figure 18 continued.

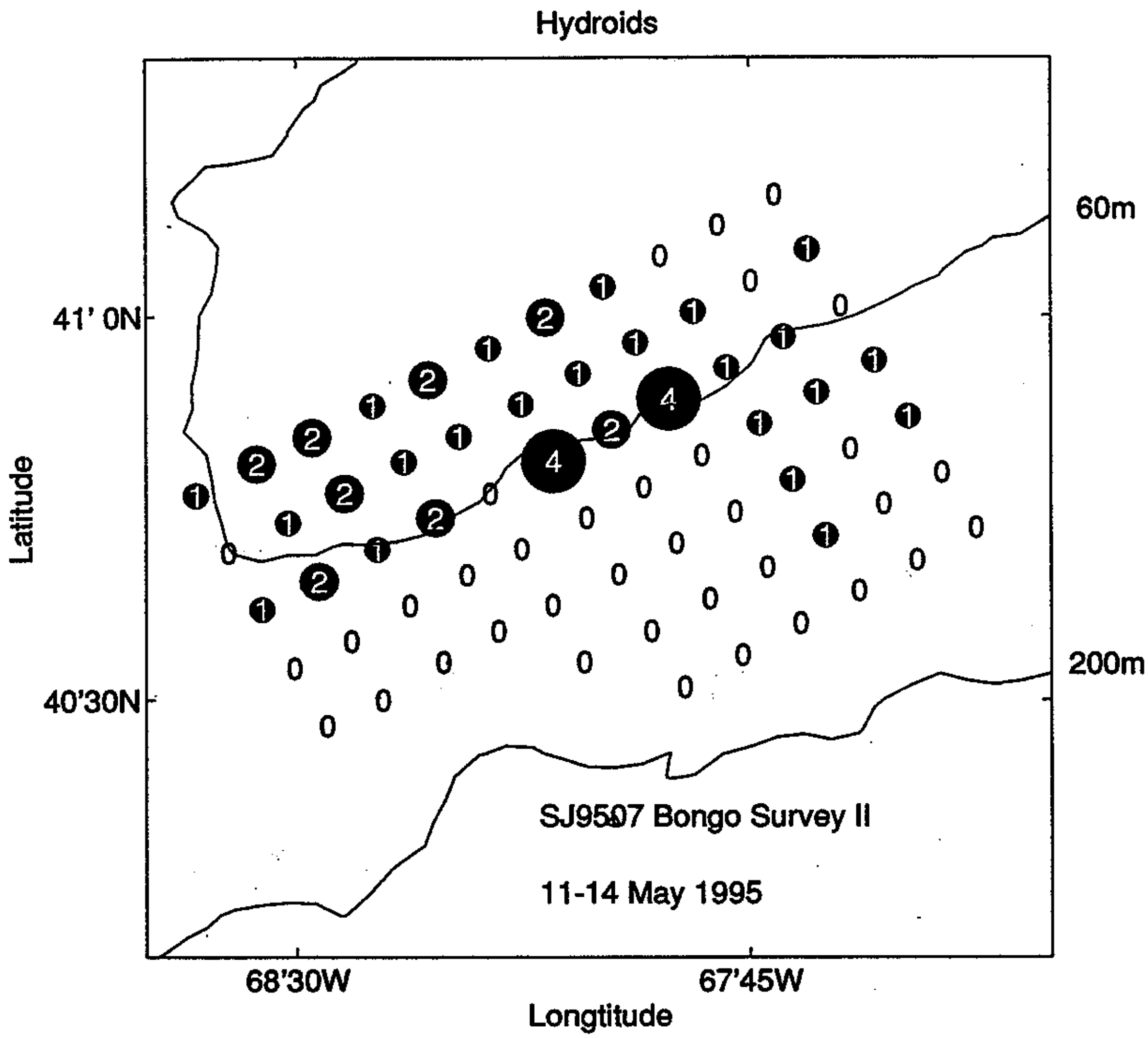


Figure 19. Distribution of the hydroid *Clytia grucilis* from the 5-mile bongo survey on the southern flank of Georges Bank, 11-14 May 1995. The samples were quantitatively scored for abundance of hydroids while samples were being sorted for larval fish: 1=present, 2=abundant, 4=very abundant, and 0=absent.