CRUISE REPORT

W - 134A

SCIENTIFIC ACTIVITIES UNDERTAKEN ABOARD THE *SSV WESTWARD*

Woods Hole, MA - Woods Hole, MA

5 August 1994 - 14 August 1994

Sea Education Association
Woods Hole, Massachusetts

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Preface

This cruise report provides an outline of the scientific and academic activities conducted aboard the *SSV Westward* during cruise W-134A in the summer of 1994. Included within this document are a list of participants, the final cruise track, a complete listing of sampling stations, and a summary of the results from group research projects. This report is not intended as a final analysis or interpretation of the data generated during W-134A. A cruise log and all data are available through the Sea Education Association and the Chief Scientist.

After three weeks in Woods Hole and a schedule which left little time for idleness, the 1994 SEA Experience participants took to the sea. As the *SSV Westward* left the dock, the air was filled with anticipation (who was that man in the sailor suit?). While some met the upcoming challenge with youthful exuberance, others seemed laden with doubts and anxiety. The shore component had been rewarding for all those involved and now it was time to see and do what could only be spoken of in the classroom. More than other groups, these teachers were aware of both the gains to be had, as well as the potential discomforts which often accompany lofty goals.

Our first night at anchor in Tarpaulin Cove was met with an outpouring from the skies. While the dedicated crew stood watch, the teacher participants got their last night of typical sleep. The next day, as the sun broke through the clouds and orientation to the ship was complete, we raised the sails and truly began the voyage. Quickly leaving sight of land, we arrived at our first science station that evening. Though some unexpectently fell subject to the throes of Neptune (seasickness), many jumped right in to initiate the trip's data collection. Unfortunately, a series of then frustrating, now somewhat comical, mishaps lent this first site the nickname - the station from hell. In retrospect, getting all of our fumbles over with at this time meant for excellent success at the rest of the stations.

As the ship sailed seaward, pushed by a favorable northwesterly wind, we quickly traversed the inner shelf, outer shelf, and reached the open ocean. Data collection persisted at a furious pace and participation was at an all time high. At each station all available hands jumped in, learned, and did a fine job of operating all of the necessary equipment. When samples were brought up, there was never a lack of inquisitive eyes peering into the bucket. By the open ocean station, all those stricken with seasickness were more than recovered and the ship's complement was up and running. Several dolphin sightings brought wonder and excitement to all on board. Waiting for the wind to turn, the ship headed back along our original track. This gave the nautical staff time to explain and fine tune the *SSV Westward's* tacking capabilities. As the wind died, we motored for a short time towards Hydrographer's Canyon. Upon reaching this next site of research, the wind returned in our favor. We then continued our scientific exploration of the region as favorable winds blew us to our next destination, Georges Bank.

Though the current was running strong, we performed our station work and wrapped up the sampling portion of the cruise. During our next two days heading towards and through the Cape Cod Canal, analyses and interpretation of the data were in full throttle. After passing through the Canal, we anchored in Mattapoisett (home to the infamous Al Hickey - sailor chiropractor extraordinare). A quiet night readied the participants for their last day aboard. The following morning after getting underway, the ship's company turned to and gave the *Westward* a well deserved cleaning. We then anchored in Tarpaulin Cove and the last day's festivities began. The first, a fest of scientific learning, occurred as each research group presented their interpretation of data collected. The second celebration was a food, wine, and song-filled evening which included an interesting and sometimes heated debate about today's educational practices. In the meantime, another group of revelers was discussing life-raft etiquette and somewhat unorthodox survival techniques.

There is no doubt that much of the overwhelming success of this cruise was facilitated by the ship's crew. Not only were they capable seamen (and women), and teachers, but also inspired an air of humor, respect, and enthusiasm. Thanks first to our fearless leader, Captain John Wigglesworth, whose patience and laid back confidence was an inspiration to all. My personal appreciation goes to John for a wonderful educational and cooperative attitude which made working and living with him a pleasure. The nautical staff was lead by the ever capable Chief Mate, Al Hickey. While he did not have to show us his skills at delivering twins, he aptly guided and taught A-Watch. Second Mate, Tim Kenna, brought both skill and humor to his watch, and even found the Canyon when we were all in doubt. Though his first trip with SEA, Third Mate, Marco Liebig, did a fine job learning while teaching in a confident and calm manner. Engineer, Dave Reynolds - what can I say - his humor and knowledge speaks for itself and kept us all both laughing and intrigued (except when pumping the sump into the plankton nets - oops). Both the Steward, Laura Fitton, and Assistant Steward, Claire Prochaska, kept our taste buds happy and our bellies full.

Science on board was aided by the sure hands of the three assistant scientists. My fullest thanks to them all for making this a most pleasurable and low stress journey. First Assistant, Leah Feinberg, brought quiet confidence to all her activities on board, both teaching and operational. Second Assistant, Ricky Arnold, though returning from Morocco for a short stay with SEA, as always his humorous and pleasant personality were a welcome addition to the science staff. And he was the second half of the Dave and Ricky show (lets hope Sarah's twins are girls). On his second cruise with SEA, Third Assistant Scientist, Jeff Schell, was both knowledgeable and eternally enthusiastic. Upon finishing his Master's thesis, we can only hope for his return to SEA.

And last, but in no way least, thanks to the teacher participants of W-134A. As students your curiosity and thirst for knowledge were a joy, and as shipmates, you were both fun and amiable. I hope you are all able to impart your interest and enthusiasm to your students and that this experience will benefit them as well as you in the years to come. Many thanks also to Pat Harcourt (and Peter Barsness, on shore) for her participation, incredible energy and positive influence on the ship. SEA Experience has gained a new level of value with their participation concerning curriculum application of the SEA experience. Best of luck to you all, hope you stay in touch!

Ellen J. Prager
Chief Scientist, W-134A

W-134A Participants

Science Staff

Ellen Prager	Chief Scientist
Leah Feinberg	First Assistant Scientist
Ricky Arnold	Second Assistant Scientist
Jeff Schell	Third Assistant Scientist

Nautical Staff and Crew

John Wigglesworth	Captain
Al Hickey	Chief Mate
Tim Kenna	Second Mate
Mark Liebig	Third Mate
Dave Reynolds	Engineer
Laura Fitton	Steward
Claire Prochaska	Assistant Steward

Teacher Participants

Cheryl Awtrey	Mt. Horeb Middle School, Mt. Horeb, WI
Jack Balcome	Newfield Central H.S., Newfield, NY
John Buckley	Cohasset H.S., Cohasset, MA
Sharon Chapman	Amherst Pelham Reg. Jr. H.S., Amherst, MA
Sarah Claytor	Friends' Central School, Wynnewood, PA
Christine Donovan	Sunnyside H.S., Tucson, AZ
Susan Freeman	Sunny Brae Middle School, Arcata, CA
Susan Griffiths	Paradise Valley Ele., Morgan Hill, CA
David Inskeep	Northwestern H.S., Kokomo, IN
Allen Kelley	Tucson High Magnet School, Tucson, AZ
Kenneth Koga	Public School 6M and 243M, New York, NY
Mellie Lewis	Atholton Elementary School, Columbia, MO
Clark Lusk	Hayden Lake Elementary, Hayden Lake, ID
T. Brad McCarver	Troup County Comp. H.S., LaGrange, GA
Libby Moore	Stephens County Middle, Eastonollee, GA
Katherine Murphy	Sound Experience, Poulsbo, WA
Karen Nelson	Paradise Valley Ele., Morgan Hill, CA
Lisa Parr	Corona H.S., Corona, CA
Paula Patrick	Hallett Elementary, Denver, CO
Susan Peters	Osterville Bay Elementary, Osterville, MA
Phyllis Schmitt	Harmony School, Occidental, CA
Susan Thornton	Pine Bush H.S., Pine Bush, NY
Melissa Warner	The Prairie School, Racine, WI

Curriculum Facilitator

Pat Harcourt

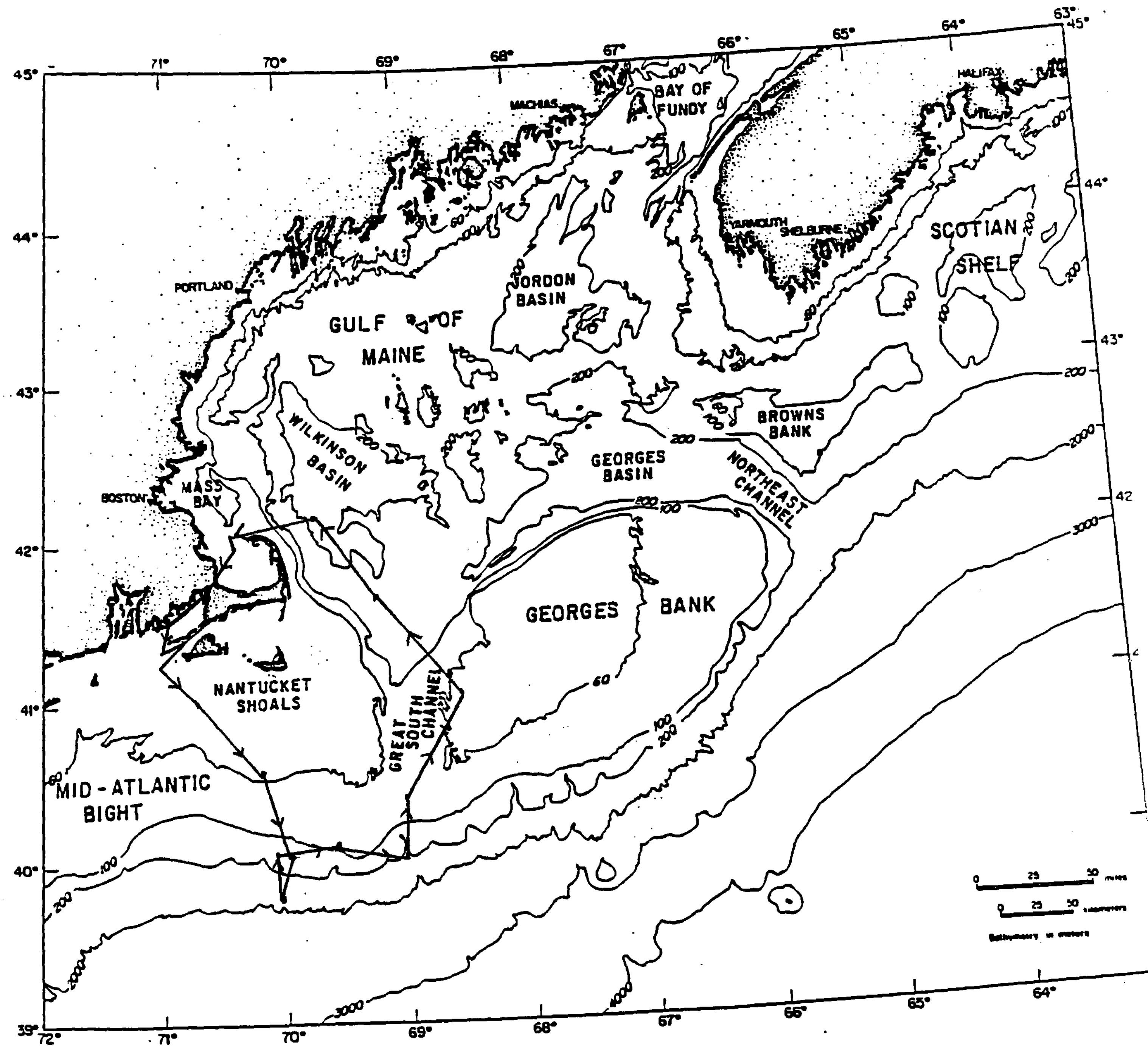


Figure 1: Final cruise track based on noon and midnight positions.

W-134A Academic Program

Date	Topic
Friday, 8/5/94	Arrive and Orientation
Saturday, 8/6/94	Safety Drills and Inner Shelf Stations
Sunday, 8/7/94	Demonstration Davit Setup and Secchi Disk Outer Shelf Station
Monday, 8/8/94	Epi-Mesopelagic Organisms Open Ocean Station
Tuesday, 8/9/94	Discussion Ocean Dumping Hydrographer's Canyon Stations
Wednesday, 8/10/94	Research Group Meetings Georges Bank Stations
Thursday, 8/11/94	Langmuir Circulation and Sound in the Sea
Friday, 8/12/94	Research Group Meetings
Saturday, 8/13/94	Research Project Presentations
Sunday, 8/14/94	Arrive Woods Hole

Cruise Summary

Along the W-134A cruise track, participants investigated regional variations in the physical, chemical, and biological properties of the shelf and offshore marine environments south of Cape Cod, within Hydrographer's Canyon and on Georges Bank. Geologic studies of the sediments and sea floor morphology were also conducted during the transit of the shelf, up the Canyon, and across Georges Bank. Data were collected by all on board and then interpreted as part of group research projects. These studies provide significant information regarding the current state of the ocean and sea floor, as well as adding to the long-term database being compiled at Sea Education Association.

The cruise track followed by the *SSV Westward* during W-134A is shown in Figure 1. Following our departure from Woods Hole, the first area of sampling was the shallow continental shelf just south of Cape Cod (station 002). As we progressed seaward, scientific sampling included a second inner shelf station (003). Research on the outer shelf occurred at two major station sites: 1) in an area referred to as the Mud Patch (station 004), and 2) a slightly deeper site further offshore (005). The ship then continued its journey seaward, moving off the slope and into the deep waters of the North Atlantic. Station work in the open ocean (008) included a 1000 m hydrocast, 200 m meter net tow, day and night neuston net tows and the deployment of a phytoplankton net. Following a period of low wind, the *SSV Westward* headed northeast towards Hydrographer's Canyon. Our transect up the Canyon was a bit indirect, two stations were conducted, one at the Canyon's mouth (009) and one at its head (010). Then it was on to Georges Bank. As we neared the Bank proper, a station (012) was conducted in the surrounding waters for comparative purposes. On Georges Bank, oceanographic sampling included two shipek grabs (013, 014), a CTD cast with two Niskin bottles (013) and neuston net tows. Once work was completed on Georges Bank we headed west toward the Cape Cod Canal and the final days of the voyage.

To facilitate interpretation, comparison, and presentation of data, the participants were subdivided into three research groups focusing on samples taken from: 1) the inner shelf and Georges Bank, 2) the outer shelf and Hydrographer's Canyon, and 3) data collected at the open ocean site. The following text represents preliminary interpretation of the data by the teachers participating in W-134A. Further information and/or data may be obtained from the Chief Scientist and/or Sea Education Association.

Inner Shelf and Georges Bank

The objectives of this group were to investigate and compare oceanographic conditions on the inner shelf with those on Georges Bank. Research was performed to examine how biomass relates to the physical and chemical differences on Georges Bank and the shallow shelf south of Cape Cod.

Geologically, results suggest several significant differences between Georges Bank and the inner shelf site. Sediments collected from the inner shelf were composed mainly of relatively well-sorted, medium to fine-grained quartz sand. On Georges Bank sediments were found to be less well-sorted and contain more biogenic materials including shell fragments, worm tubes, and benthic organisms. Additionally, these sediments exhibited an extensive algal mat which appeared to effectively bind sediments at the surface.

Contrasts in the physical and chemical structure of the water column overlying the inner shelf and Georges Bank were also found. A profile of temperature measured at station 003 on the inner shelf shows a distinct thermocline at approximately 15 m (Figure 2). A warm, slightly lower salinity water mass exists as a well-mixed layer above the colder, more saline deeper waters. In comparison, on Georges Bank the entire water column appears well-mixed (Figure 3). This contrast also occurs in bank-top versus the surrounding waters. The surface water on Georges Bank is also, in general, colder and less saline than on the inner shelf. Both these variations in the overall level and vertical distribution of temperature and salinity may be explained by tidal mixing. While summer warming and typically lower winds create a stratified water column on the inner shelf, twice daily tidal mixing over Georges Bank produces a vertically homogenous water column. This phenomena is also apparent in the distributions of phosphate and chlorophyll *a* with depth.

As shown in Figure 4, both chlorophyll *a* and phosphate exhibit a relatively constant concentration with depth over Georges Bank. In contrast, on the inner shelf chlorophyll was found to peak at approximately 15 m and phosphate to increase with depth. This pattern is typical of stratified waters and was also found on the outer shelf. The phenomenon of a chlorophyll maximum at depth is known as the DCM (deep chlorophyll maximum) and will be addressed later. Although it was expected that phosphate, a product of decomposition, would be higher on Georges Bank, concentrations were greatest at depth on the inner shelf. Mixing on Georges Bank should disperse nutrients throughout the water column making them readily available for uptake by organisms. On the other hand, stratification on the inner shelf traps these nutrients at depth leaving them to accumulate to higher concentrations. Profiles of oxygen concentration show, on Georges Bank, a pattern similar to that of phosphate and on the inner shelf an inverse relationship (due to oxidation of organic matter during decomposition).

Biologic studies at these two sites included topics such as phytoplankton composition and zooplankton abundance and diversity. On both the inner shelf and Georges Bank a variety of both diatoms and dinoflagellates were found, however diatoms appeared to be the most dominant phytoplankton type. Two neuston net tows conducted on Georges Bank found the highest zooplankton biomass encountered during the cruise. The sample was undeniably dominated by the crab larvae, megalops. The unusual abundance of megalops suggests a recent bloom of these organisms. Though a variety of zooplankton were found at the inner shelf stations, the most common were copepods.

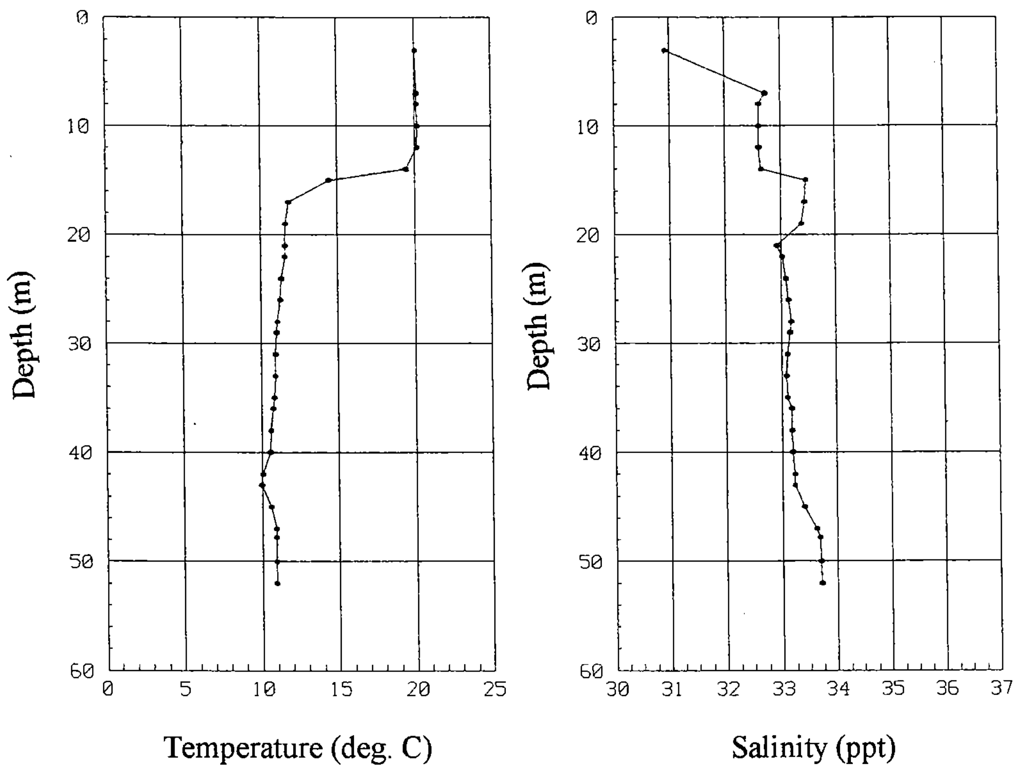


Figure 2: Temperature and salinity profiles at station 003 on the inner shelf.

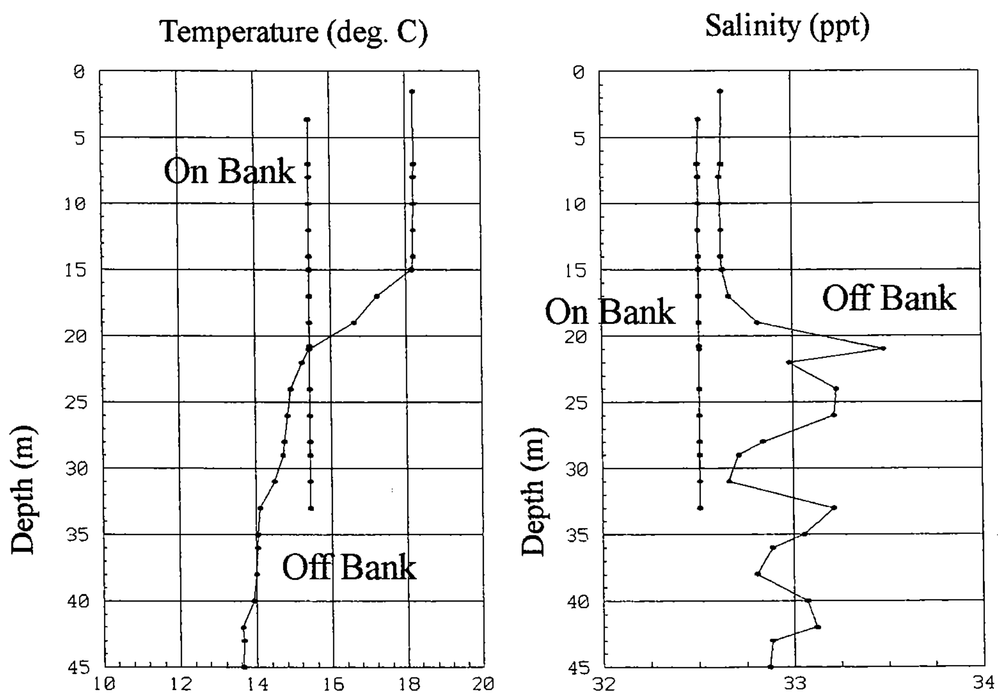


Figure 3 Temperature and salinity profiles from southwest of Georges Bank and on Georges Bank.

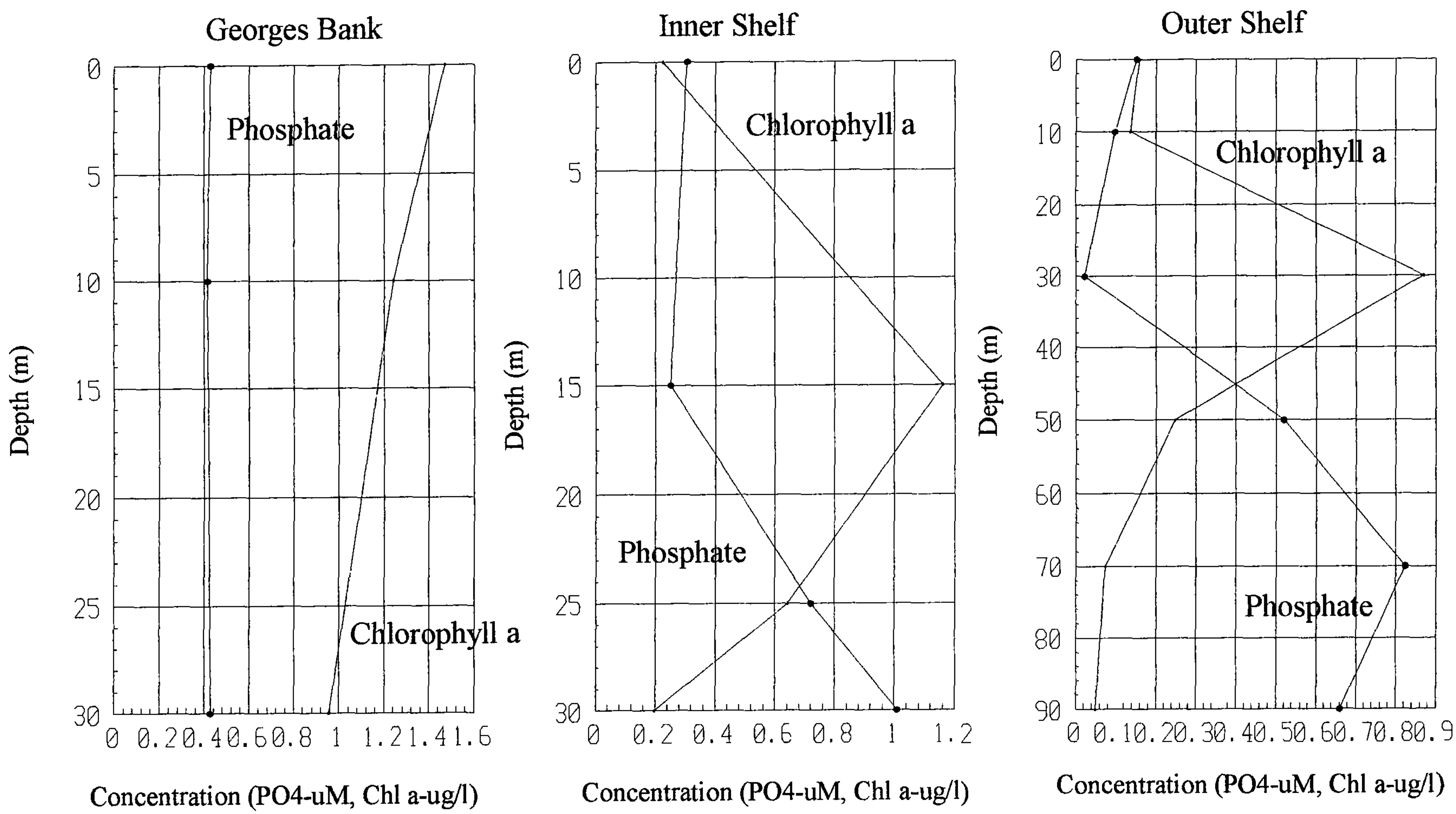


Figure 4: Profiles of phosphate and chlorophyll a from stations on Georges Bank, the inner shelf, and the outer shelf.

Outer Shelf Group

The main objectives of this research group were to investigate the oceanographic properties of the Mud Patch area on the outer shelf, and those within Hydrographer's Canyon. It was originally proposed that the Canyon would be a more energetic environment than the Mud Patch, and that this would cause significant differences in the biology, physical, and chemical nature of the overlying waters as well as in the geology of the sea floor.

Sediments collected from both the Mud Patch and a site on the deeper portion of the outer shelf, suggest that the sea floor is covered with finer-grained sediments than the inner shelf (Figure 5). While terrigenous materials are still present, an increased biogenic component occurs in the form of foraminifera shells. At the Mud Patch an interesting sample was collected which was rich in echinoderms such as brittle stars and small sand dollars. It also contained an abundance of fecal pellets. Sea floor topography as investigated with a Precision Depth Recorder (PDR) shows a bottom dominated by soft sediment and in the canyon suggests the presence of one or more slump features (see Appendix E for sample PDR echo traces).

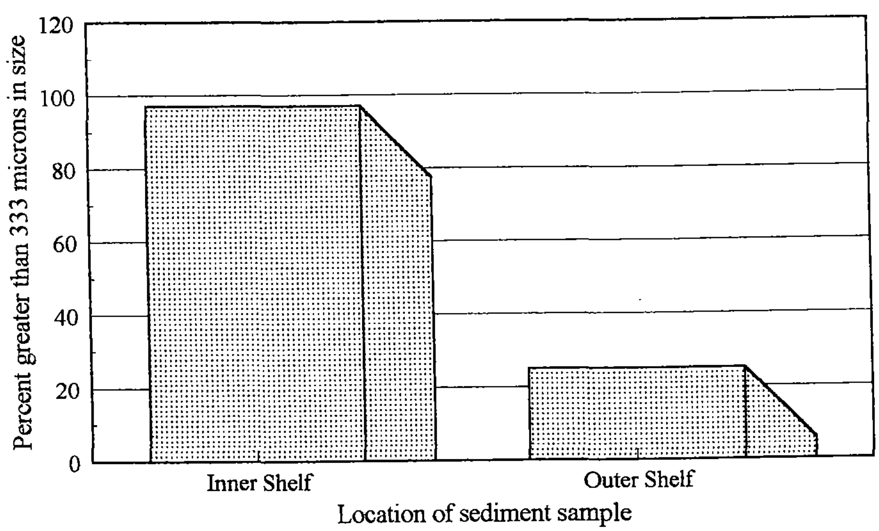


Figure 5 : Grain size distribution in sediments from the inner and outer shelf stations.

Figure 6 shows the profiles of temperature and salinity measured on the outer shelf. A thermocline occurs at approximately 20 m at station 004 and 30 m at station 005. A greater difference between the two sites is found in the profiles of salinity, where a much lower salinity is found at station 004 than 005. The salinity of the more seaward station is more typical of an open water site, whereas the lower salinity of the shallower site may be indicative of input by shelf water and/or land runoff (particularly given a strong northerly wind for one or more days prior to sampling). The same measurements done at the mouth and head of Hydrographer's Canyon show a pattern similar to that at station 005 with some interesting differences (Figure 7). While a distinct thermocline occurs at approximately 20 -

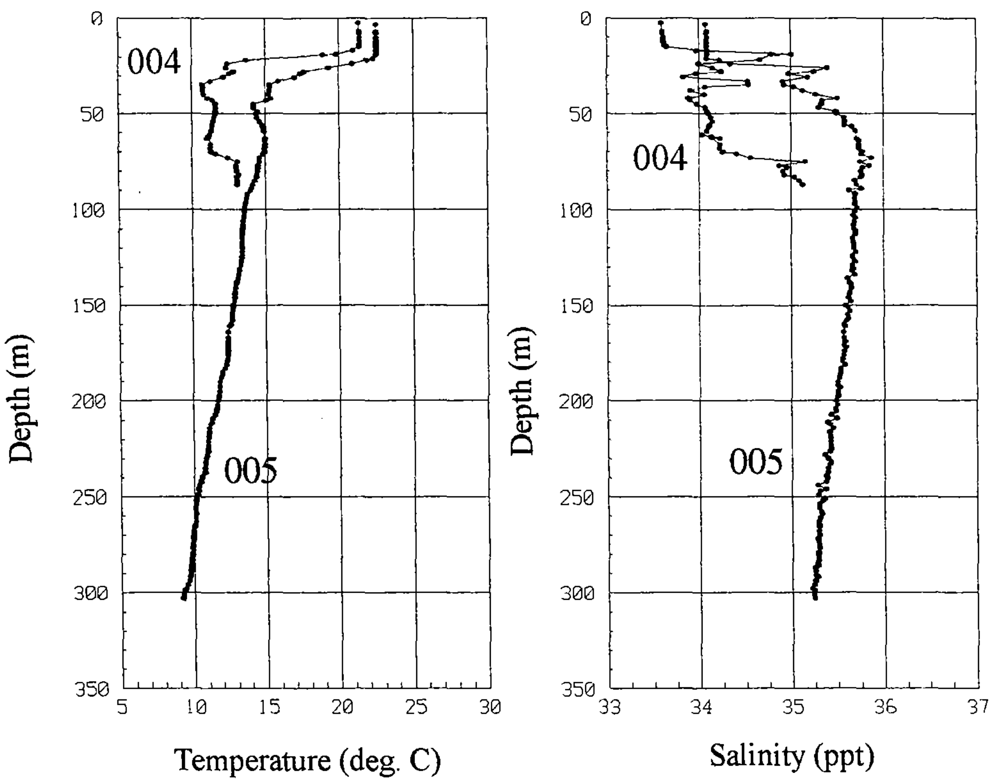


Figure 6: Temperature and salinity profiles from stations 004 and 005 on the outer shelf.

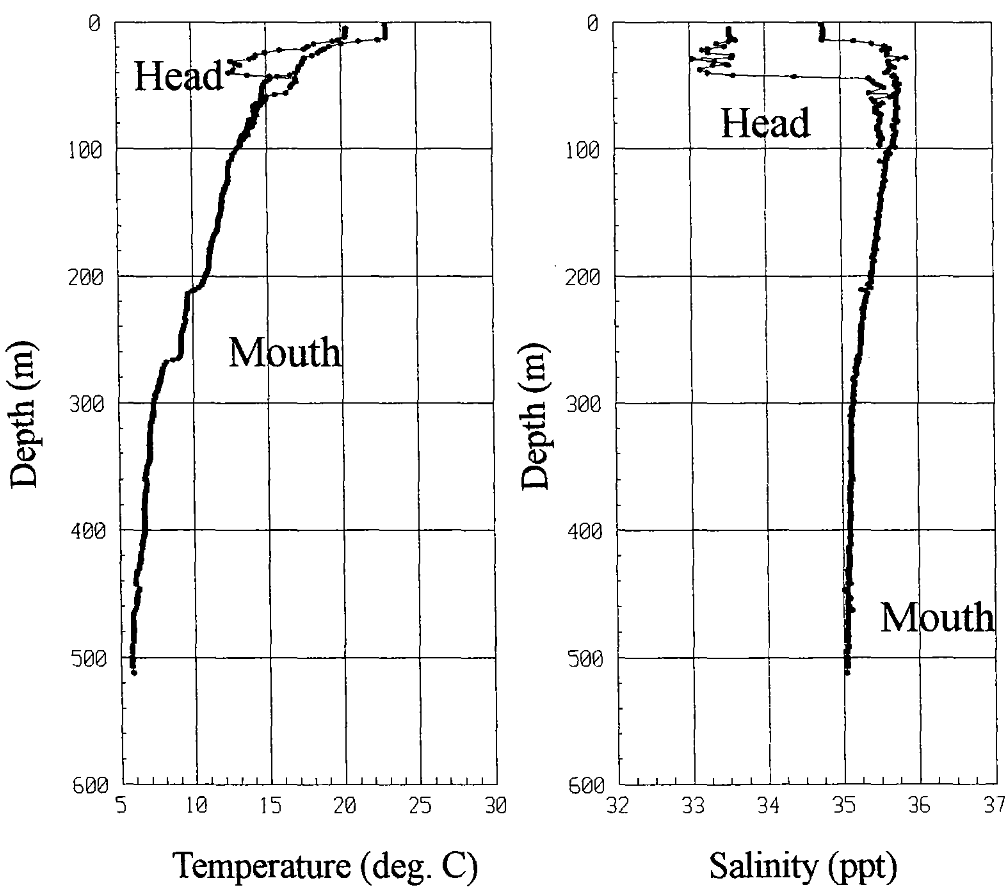


Figure 7: Temperature and salinity profiles from within Hydrographer's Canyon.

30 m, a temperature inversion occurs in the head of the canyon at about 60 m. At the canyon head, a strong increase in salinity also occurs at this depth. A possible explanation for this pattern is the intrusion of some other water mass in the canyon. One such water mass could be the remains of a warm core eddy, now slightly colder and more dense than originally, thus leading to its presence slightly beneath the surface. Other evidence supporting this possibility are the sightings of Portuguese Man-o-war in the area and the identification of a dinoflagellate more typically found in subtropical or tropical waters.

On the outer shelf, the distribution of chlorophyll *a*, phosphate, and oxygen with depth were found to be similar to that of the inner shelf (refer to Figure 4). Although the distribution of phosphate with depth at the mouth of Hydrographer's Canyon shows a common pattern of increasing with depth, at the canyon's head, a peak in concentration occurs at approximately 30 m (Figure 8). Two possible explanations for this occurrence are 1) it is actually a phosphate minimum at 60 m associated with an intruding water mass as discussed earlier, or 2) human error during collection or analysis contaminated the 30 m water sample. The profile of chlorophyll at both canyon sites appears similar to those at the inner and outer shelf, with a DCM at approximately 30 m. At the canyon's mouth, oxygen decreases with depth as is common as decomposition typically increases in deeper waters. However, at the canyon head oxygen appears to increase with depth; this phenomenon may be attributed to the same cause given previously to explain phosphate distribution.

A meter net tow conducted at station 005 on the outer shelf collected a sample dominated by copepods and euphausiids. In a tow through Hydrographer Canyon copepods were also found to be very abundant, however a wider variety of other organisms were also found, these included ctenophores, pteropods, shrimp, chaetognaths, a large jellyfish, and a most spectacular iridescent copepod, Sapphrina iris. One of the interesting findings by this group was the correlation of copepod color and time of sampling. During the daytime, neuston tows collected mainly blue copepods, whereas at night primarily red copepods were found. This difference may be linked to vertical migration; the red copepods being deeper water species coming to the surface during the night and the blue living there during the day.

Open Ocean Group

The primary objective of this group was to study the oceanographic properties of the open ocean as compared to those of the inner and outer shelf. Due to depth at this site, no sediment samples were collected, however review of samples collected on a transect seaward from Cape Cod led to the following observations. As distance from shore increased, the grain size of sediments tended to decrease and the abundance of contributions from a biogenic source increased. The shells of both benthic and pelagic foraminifera were better preserved in the more seaward samples probably due to less influx by terrigenous materials and the soft cushioning effect of the fine-grained sediments found within this offshore setting.

Profiles of temperature and salinity from the open ocean station are shown in Figure 9. A thermocline and significant increase in salinity occurs between approximately 25 and

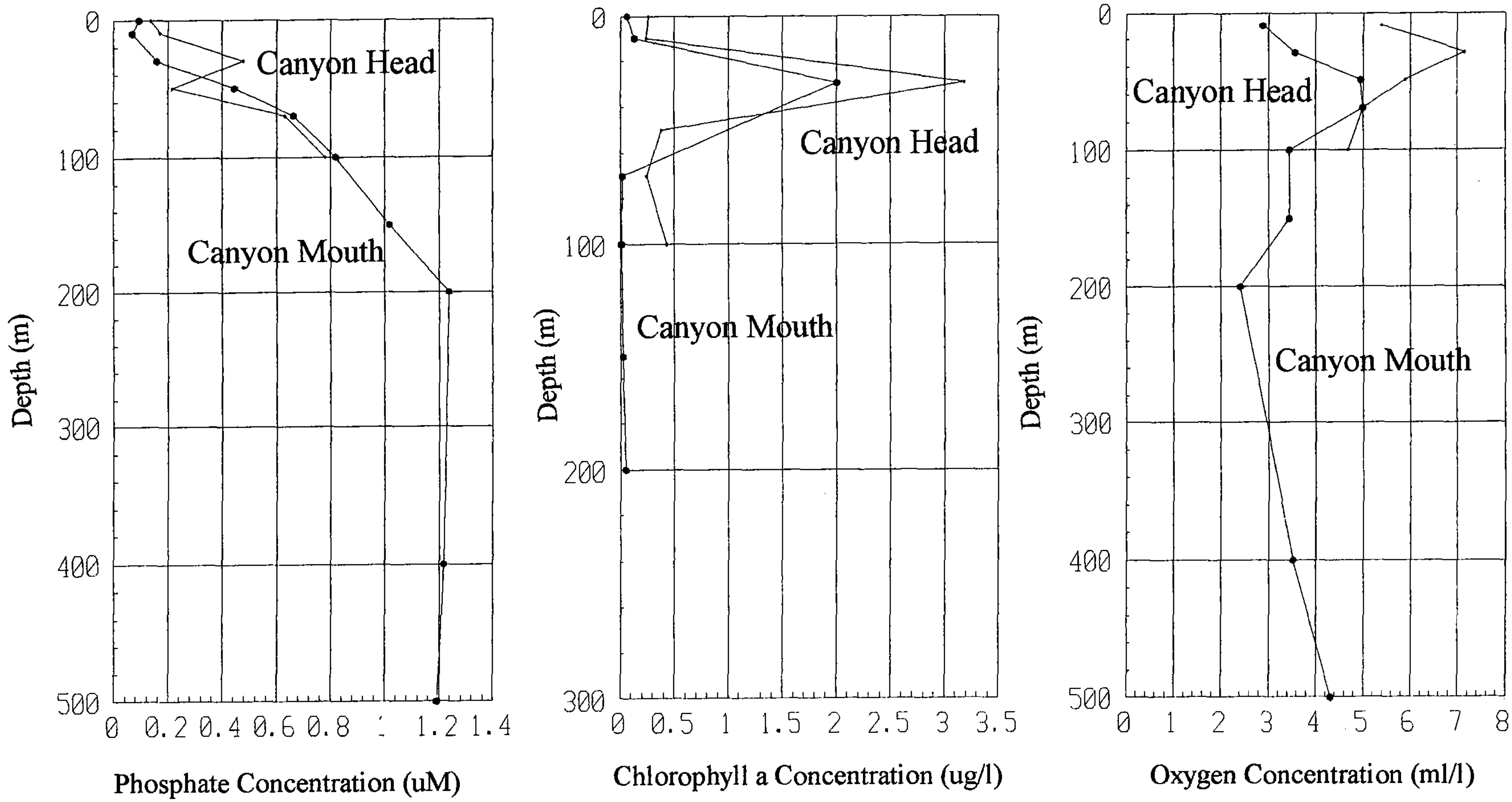


Figure 8: Concentration of phosphate, chlorophyll a, and oxygen with depth in Hydrographer's Canyon.

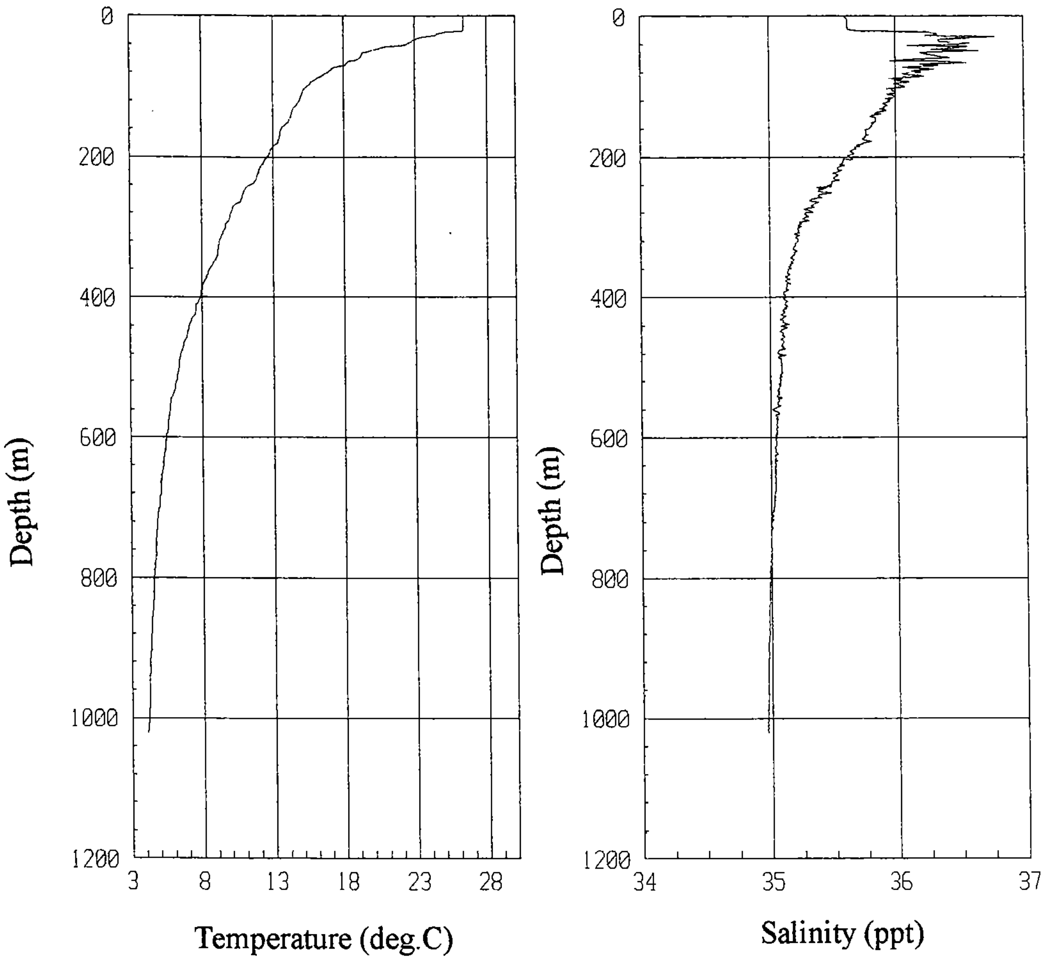


Figure 9: Temperature and salinity profiles from station 008, open ocean.

50 m. The relatively warm, high salinity shallow waters are suggestive of the influence of the Gulf Stream and or a recent warm core eddy. As shown in Figure 10, a T - S diagram suggests that below the transition from the warm, highly saline surface waters exists a relatively cold, lower salinity water mass. Examination of oxygen concentration with depth shows a surprising increase between 250 and 800 m (Figure 11). It was suggested that given the temperature and salinity values of the water and its relatively high oxygen content, this may be lower slope water which contains water from the deep southerly flowing Labrador Current. A slight decrease in phosphate concentrations is also found at depth and may signify an absence of decomposition in the relatively young bottom water.

A strong DCM was found to occur at approximately 50 m at station 008. One of the main questions posed by this group was what does this actually reflect, a large population of living phytoplankton or the collection of dead organic matter above the density barrier provided by the thermocline (pycnocline). Whereas the DCM occurred at a shallower depth at the other stations, it does indicate a relationship with the thermocline, as it too was

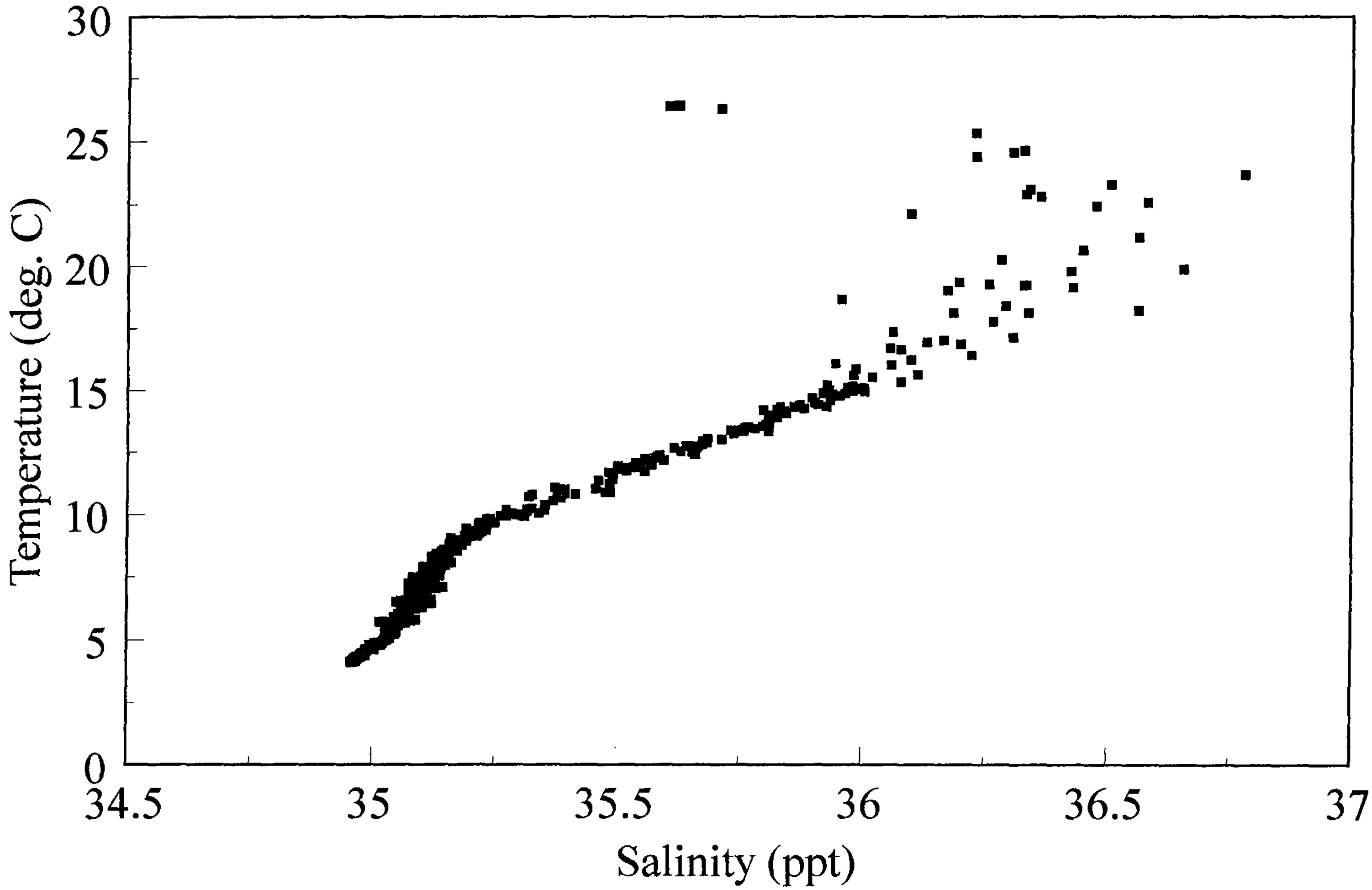


Figure 10: T-S diagram of CTD data from the open ocean station 008.

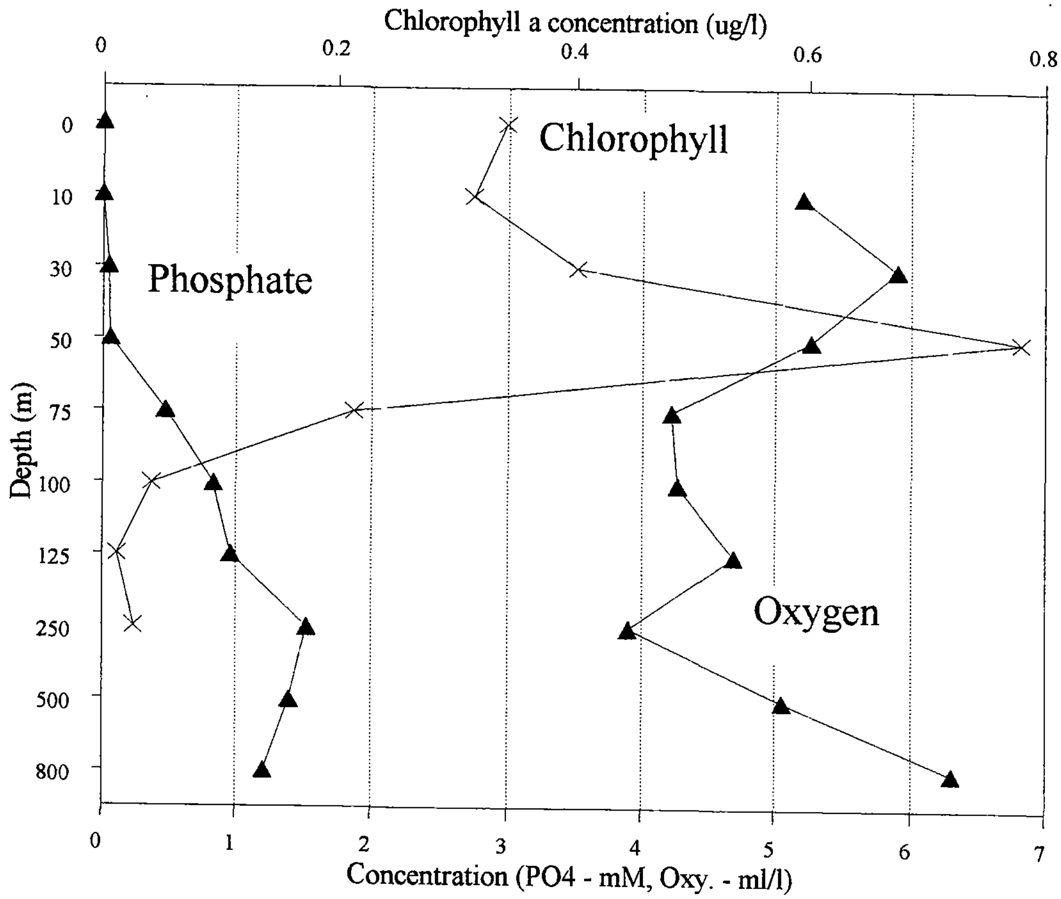


Figure 11: Results of hydrocast at the open ocean station.

shallower at those sites. At the other sites, phosphate appears to decrease and oxygen increase at the DCM (refer to Figure 11). Data from station 008 suggests that phosphate is low and then increasing below the DCM, and that the pattern of oxygen concentration is decreasing. A peak in oxygen is apparent just above the DCM, but this may be a function of sampling depths rather than a true maximum. Using a secchi disk, the 1% light level was estimated to occur at this site at 47 m. Hence data is conflicting, light level suggest that perhaps, in this instance, the DCM is a result of sinking organic material collecting within the thermocline zone. However, a low concentration of phosphate and an oxygen increase associated at these depths would suggest a photosynthesizing population, using phosphate and producing oxygen. The mystery of the DCM continues.

Investigation into the composition of the phytoplankton population along the cruise track found an interesting trend. Observations suggest that in the open ocean, dinoflagellates are more common than diatoms. However, near shore and over Georges Bank the opposite was found to be true, diatoms dominating the dinoflagellates. Theory suggests that the lack of nutrients in the open ocean results in a highly competitive population for scarce resources.

Consequently, the more motile dinoflagellates are better able to compete. Additionally, near shore and in zones of upwelling, current movements facilitate the floating of diatoms with a denser silicious test.

The low productivity of open oceanic waters as compared to environments such as the inner shelf and Georges Bank was clearly demonstrated by biologic samples collected during W-134A. As compared to Georges Bank the zooplankton biomass density is relatively low at station 008 (Figure 12). In contrast, the diversity appears to be higher. Note on Figure 12 that the relative abundance of different types of organisms is greater in the open ocean versus Georges Bank. Day and night neuston tows also showed significant differences in biomass collected. Due to vertical migration by epi-mesopelagic organisms, tows performed at night caught a much greater abundance of organisms than those done during the day. In the neuston tows, both species of the pelagic seaweed sargassum were collected. However, it was found that *Sargassum fluitans* was more prevalent than *S. natans*. It has been suggested that *S. fluitans* is more common in warmer waters, thus another piece of evidence suggesting the recent influence of a warm core eddy in the vicinity.

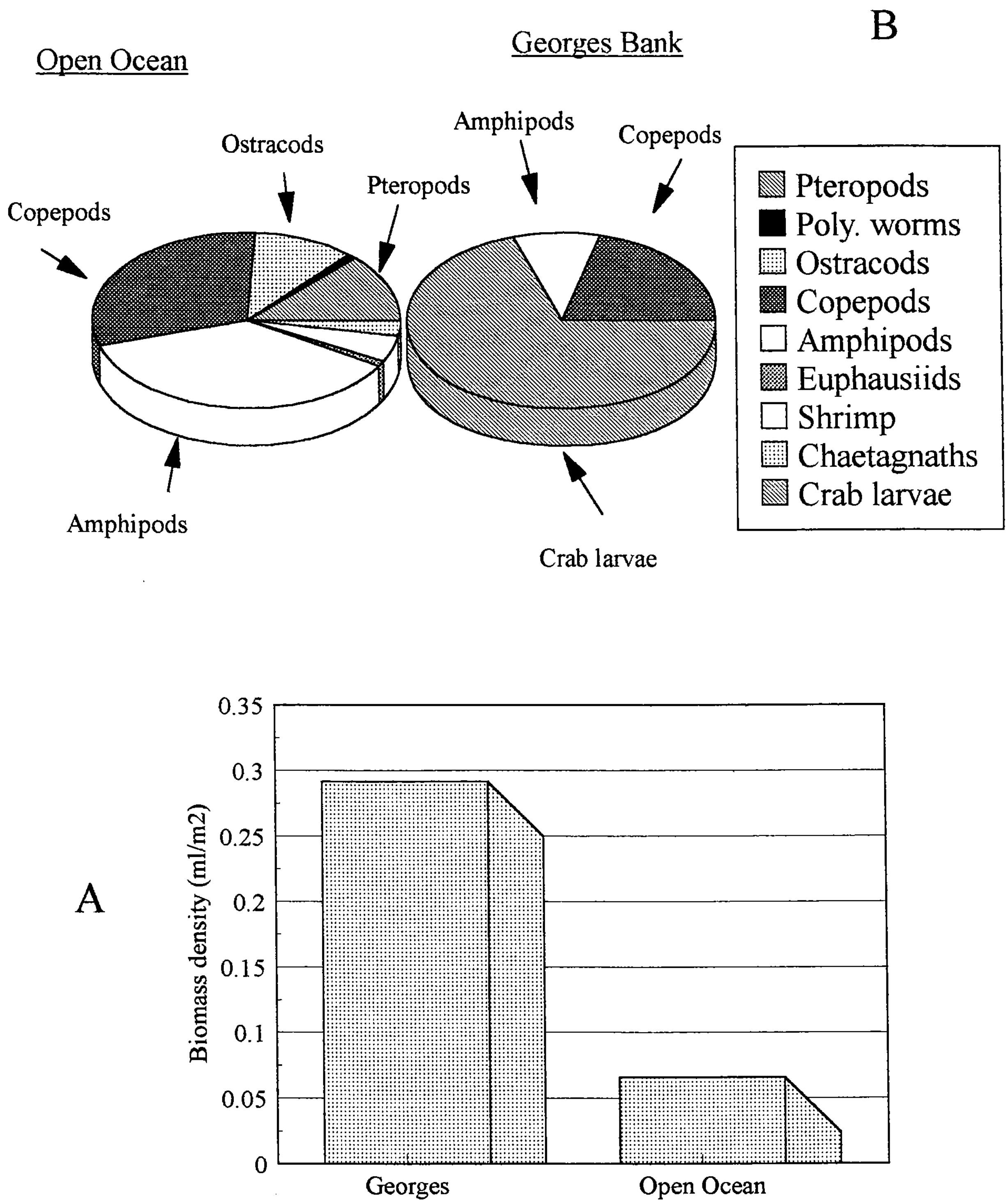


Figure 12: Comparison of biomass (A) and diversity(B) of zooplankton sampled at the open ocean site and over Georges Bank.

Appendix A: Station Locations

Ctd Stations

Station	Date	Time (hr)	Log (nm)	Lat. (deg.N)	Long. (deg. W)	Locale	Depth (m)
W-134A-003	07-Aug-94	0455	44.3	40.40	70.32	Inner Shelf	50
W-134A-004	07-Aug-94	1714	82.0	40.08	70.05	Outer Shelf	90
W-134A-005	07-Aug-94	2225	90.1	39.56	69.59	Outer Shelf	300
W-134A-008	08-Aug-94	2015	124.0	39.15	69.26	Open Ocean	1000
W-134A-009	10-Aug-94	0347	131.0	40.05	69.03	Hydro. Canyon	500
W-134A-010	10-Aug-94	0737	235.5	40.11	69.05	Hydro. Canyon	100
W-134A-012	10-Aug-94	1831	270.0	40.47	68.47	SW Georges	50
W-134A-013	11-Aug-94	0018	283.9	40.59	68.37	Georges Bank	30

Hydrocast Stations

Station	Date	Time (hr)	Log (nm)	Lat. (deg.N)	Long. (deg. W)	Locale
W-134A-002	06-Aug-94	2008	21.0	41.01	70.54	Inner Shelf
W-134A-003	07-Aug-94	0455	44.3	40.40	70.32	Inner Shelf
W-134A-004	07-Aug-94	1645	82.0	40.08	70.51	Outer Shelf
W-134A-008	08-Aug-94	2110	124.0	39.16	69.27	Open Ocean
W-134A-009	10-Aug-94	0347	131.0	40.05	69.03	Hydro. Canyon
W-134A-010	10-Aug-94	0757	134.0	40.11	69.05	Hydro. Canyon
W-134A-013	11-Aug-94	0010	283.9	40.60	68.37	Georges Bank

Meter Net Stations

Station	Date	Time (hr)	Log (nm)	Lat. (deg.N)	Long. (deg. W)	Locale	Depth (m)
W-134A-003	07-Aug-94	0543	43.2	40.40	70.31	Outer Shelf	30
W-134A-005	07-Aug-94	2330	90.1	39.55	69.59	Outer Shelf	300
W-134A-008	08-Aug-94	2234	123.0	39.15	69.26	Open Ocean	200
W-134A-009	10-Aug-94	0515	231.0	40.05	69.01	Hydro. Canyon	100

Neuston Net Stations

Station	Date	Time (hr)	Log (nm)	Lat. (deg.N)	Long. (deg. W)	Locale
W-134A-002A	06-Aug-94	2114	21.2	41.00	70.53	Inner Shelf
W-134A-002B	06-Aug-94	2114	21.2	41.00	70.53	Inner Shelf
W-134A-003A	07-Aug-94	0642	44.5	40.40	70.31	Outer Shelf
W-134A-003B	07-Aug-94	0717	46.0	40.40	70.31	Outer Shelf
W-134A-004A	07-Aug-94	1832	82.0	40.06	70.05	Outer Shelf
W-134A-004B	07-Aug-94	1912	83.0	40.06	70.05	Outer Shelf
W-134A-006A	08-Aug-94	1117	120.0	39.20	69.28	Slope
W-134A-006B	08-Aug-94	1117	121.0	39.20	69.28	Slope
W-134A-008A	09-Aug-94	0020	124.0	39.13	69.22	Open Ocean
W-134A-008B	09-Aug-94	0020	124.0	39.13	69.22	Open Ocean
W-134A-015A	11-Aug-94	0204	284.0	41.02	68.35	Georges Bank
W-134A-015B	11-Aug-94	0204	284.0	41.02	68.35	Georges Bank

Phytoplankton Net Stations

Station	Date	Time (hr)	Log (nm)	Lat. (deg.N)	Long. (deg. W)	Locale
W-134A-001	06-Aug-94	0802	0.0	41.28	70.45	Tarpaulin Cove
W-134A-003	07-Aug-94	0434	43.0	40.39	70.32	Inner Shelf
W-134A-004	07-Aug-94	1658	82.0	40.08	70.06	Mud Patch
W-134A-008	08-Aug-94	2047	124.0	39.15	69.26	Open Ocean
W-134A-010	10-Aug-94	0754	235.5	40.10	69.05	Hydro. Canyon
W-134A-013	11-Aug-94	0019	283.9	40.59	68.36	Georges Bank

Shipek Stations

Station	Date	Time (hr)	Log (nm)	Lat. (deg.N)	Long. (deg. W)	Locale	Depth (m)
W-134A-002	06-Aug-94	1930	21.0	41.02	70.55	Inner Shelf	36
W-134A-003	07-Aug-94	0429	43.0	40.40	70.32	Outer Shelf	58
W-134A-004	07-Aug-94	1645	82.0	40.08	70.06	Mud Patch	120
W-134A-005	07-Aug-94	2200	90.1	39.56	69.59	Outer Shelf	330
W-134A-013	10-Aug-94	0010	283.9	40.59	68.37	Georges Bank	46
W-134A-010	10-Aug-94	0826	134.0	40.11	69.06	Hydro. Canyon	134
W-134A-011	10-Aug-94	0941	235.5	40.10	69.04	Hydro. Canyon	300
W-134A-012	11-Aug-94	1850	270.0	40.47	68.47	SW of Georges	67
W-134A-014	11-Aug-94	0108	283.9	41.01	68.36	Georges Bank	0

BT Stations

Station	Date	Time (hr)	Log (nm)	Lat. (deg.N)	Long. (deg. W)
BT-001	07-Aug-94	1200	64.6	40.27	70.10
BT-002	08-Aug-94	1100	120.0	39.25	69.32

Surface Stations

Station	Date	Time (hr)	Log (nm)	Lat. (deg.N)	Long. (deg. W)
SS-001	06-Aug-94	1400	0.0	41.26	70.47
SS-002	07-Aug-94	0041	31.0	40.51	70.43
SS-003	07-Aug-94	1155	62.5	40.29	70.10
SS-004	08-Aug-94	0300	94.0	39.46	69.52
SS-005	08-Aug-94	1640	123.0	39.16	69.27
SS-006	09-Aug-94	1000	154.4	39.41	69.54
SS-007	09-Aug-94	1850	188.5	40.00	70.03
SS-008	10-Aug-94	0100	221.0	40.05	69.18
SS-009	10-Aug-94	1400	250.0	40.28	68.58

Appendix B: Hydrocast Data

Station	Date	Time (hrs)	Log (nm)	Latit. (deg. N)	Longit. (deg. W)	Locale	Bott #	Depth (m)	Temp. (deg. C)	Salinity (ppt)	Phosphate (mM)	Chl a (ug/l)	Oxygen (ml/l)
W-134A-002	06-Aug-94	2008	21.0	41.01	70.54	INNER SHELF	1	30		33.436	1.008	0.198	6.07
W-134A-002	06-Aug-94	2008	21.0	41.01	70.54	INNER SHELF	2	25		33.213	0.719	0.642	6.02
W-134A-002	06-Aug-94	2008	21.0	41.01	70.54	INNER SHELF	3	15		33.357	0.251	1.160	7.71
W-134A-002	06-Aug-94	2008	21.0	41.01	70.54	INNER SHELF	4	0		33.013	0.306	0.225	
W-134A-003	07-Aug-94	0455	44.3	40.40	70.32	INNER SHELF#2	1	50	10.91	33.700	0.844	0.337	5.85
W-134A-003	07-Aug-94	0455	44.3	40.40	70.32	INNER SHELF#2	2	30	10.94	33.080	0.246	2.450	8.10
W-134A-003	07-Aug-94	0455	44.3	40.40	70.32	INNER SHELF#2	3	10	20.15	32.610	0.107	0.654	6.42
W-134A-003	07-Aug-94	0455	44.3	40.40	70.32	INNER SHELF#2	4	5	20.14	32.610	0.162	0.044	6.81
W-134A-003	07-Aug-94	0455	44.3	40.40	70.32	INNER SHELF#2	5	0	20.11	32.240	0.102	0.379	
W-134A-004	07-Aug-94	1645	82.0	40.08	70.51	OUTER SHELF	1	90	13.01	35.180	0.660	0.049	6.45
W-134A-004	07-Aug-94	1645	82.0	40.08	70.05	OUTER SHELF	2	70	11.26	34.260	0.824	0.074	5.75
W-134A-004	07-Aug-94	1645	82.0	40.08	70.05	OUTER SHELF	3	50	11.52	34.110	0.520	0.248	5.75
W-134A-004	07-Aug-94	1645	82.0	40.08	70.51	OUTER SHELF	4	30	12.10	33.890	0.022	0.871	6.78
W-134A-004	07-Aug-94	1645	82.0	40.08	70.51	OUTER SHELF	5	10	21.37	33.610	0.097	0.135	5.94
W-013A-004	07-Aug-94	1645	82.0	40.08	70.51	OUTER SHELF	6	0	21.31	32.260	0.152	0.159	
W-134A-008	08-Aug-94	2110	124.0	39.16	69.27	OPEN OCEAN	2	800	4.80	34.900	1.207		6.30
W-134A-008	08-Aug-94	2110	124.0	39.16	69.27	OPEN OCEAN	3	500	6.80	35.000	1.397		5.05
W-134A-008	08-Aug-94	2110	124.0	39.16	69.27	OPEN OCEAN	4	250	11.10	35.000	1.526	0.027	3.90
W-134A-008	08-Aug-94	2110	124.0	39.16	69.27	OPEN OCEAN	5	125	14.70	35.500	0.963	0.013	4.69
W-134A-008	08-Aug-94	2110	124.0	39.16	69.27	OPEN OCEAN	6	100	16.00	36.200	0.834	0.043	4.27
W-134A-008	08-Aug-94	2110	124.0	39.16	69.27	OPEN OCEAN	7	75	17.40	36.200	0.470	0.214	4.22
W-134A-008	08-Aug-94	2110	124.0	39.16	69.27	OPEN OCEAN	8	50	20.10	36.500	0.057	0.779	5.26
W-134A-008	08-Aug-94	2110	124.0	39.16	69.27	OPEN OCEAN	9	30	23.90	35.600	0.042	0.401	5.90
W-134A-008	08-Aug-94	2110	124.0	39.16	69.27	OPEN OCEAN	10	10	26.40	35.600	0.000	0.313	5.20
W-134A-008	08-Aug-94	2110	124.0	39.16	69.27	OPEN OCEAN	11	0	26.40	35.600	0.000	0.341	
W-134A-009	10-Aug-94	0347	131.0	40.05	69.03	HYDR. CANYON	1	500	5.74	35.040	1.192		4.31
W-134A-009	10-Aug-94	0347	131.0	40.05	69.03	HYDR. CANYON	2	400	6.63	35.090	1.219		3.52
W-134A-009	10-Aug-94	0347	131.0	40.05	69.03	HYDR. CANYON	3	200	10.79	35.400	1.237	0.053	2.41
W-134A-009	10-Aug-94	0347	131.0	40.05	69.03	HYDR. CANYON	4	150	11.87	35.500	1.020	0.024	3.45
W-134A-009	10-Aug-94	0347	131.0	40.05	69.03	HYDR. CANYON	5	100	13.01	35.810	0.821	0.011	3.45
W-134A-009	10-Aug-94	0347	131.0	40.05	69.03	HYDR. CANYON	6	70	14.29	35.740	0.662	0.021	5.00
W-134A-009	10-Aug-94	0347	131.0	40.05	69.03	HYDR. CANYON	7	50	14.84	35.710	0.445		4.95
W-134A-009	10-Aug-94	0347	131.0	40.05	69.03	HYDR. CANYON	8	30	17.42	35.610	0.158	2.004	3.57

Station	Date	Time (hrs)	Log (nm)	Latit. (deg. N)	Longit. (deg. W)	Locale	Bott #	Depth (m)	Temp. (deg. C)	Salinity (ppt)	Phosphate (mM)	Chl a (ug/l)	Oxygen (ml/l)
W-134A-009	10-Aug-94	0347	131.0	40.05	69.03	HYDR. CANYON	9	10	22.97	34.780	0.069	0.134	2.88
W-134A-009	10-Aug-94	0347	131.0	40.05	69.03	HYDR. CANYON	10	0	22.95	34.760	0.091	0.059	
W-134A-010	10-Aug-94	0757	134.0	40.11	69.05	HYDR. CANYON	1	100	13.16	35.500	0.781	0.429	4.69
W-134A-010	10-Aug-94	0757	134.0	40.11	69.05	HYDR. CANYON	2	70	14.14	35.460	0.631	0.243	5.01
W-134A-010	10-Aug-94	0757	134.0	40.11	69.05	HYDR. CANYON	3	50	16.66	35.520	0.215	0.374	5.90
W-134A-010	10-Aug-94	0757	134.0	40.11	69.05	HYDR. CANYON	4	30	13.61	32.780	0.476	3.178	7.14
W-134A-010	10-Aug-94	0757	134.0	40.11	69.05	HYDR. CANYON	5	10	20.32	33.530	0.171	0.240	5.39
W-134A-010	10-Aug-94	0757	134.0	40.11	69.05	HYDR. CANYON	6	0	20.29	33.520	0.136	0.256	
W-134A-013	11-Aug-94	0010	283.9	40.60	68.37	GEORGES BANK	1	30	15.43	32.510	0.427	0.954	7.07
W-134A-013	11-Aug-94	0010	283.9	40.60	68.37	GEORGES BANK	2	10	15.42	32.510	0.414	1.242	7.64
W-134A-013	11-Aug-94	0010	283.9	40.60	68.37	GEORGES BANK	3	0			0.427	1.469	

Appendix C: Net Tow Data

Meter Net Tows

Station	Date	Time (hrs)	Log (nm)	Latit. (deg.N)	Long. (deg.W)	Depth (m)	Zoopl. (ml)	Locale
W-134A-003	07-Aug-94	0543	43.2	40.40	70.31	30	390.00	Outer Shelf
W-134A-005	07-Aug-94	2330	90.1	39.55	69.59	300	255.00	Outer Shelf
W-134A-008	08-Aug-94	2234	123.0	39.15	69.26	200	135.00	Open Ocean
W-134A-009	10-Aug-94	0515	231.0	40.05	69.01	100	420.00	Hydro. Canyon

Neuston Net Tows

Station	Date	Time (hrs)	Log (nm)	Latit. (deg.N)	Long. (deg.W)	Temp. (deg. C)	Dist. (m)	Zoopl. (ml)	Plastic pieces	Sargassum (g) *fluitans*	Sargassum (g) *natans*	Locale
W-134A-002A	06-Aug-94	2114	21.2	41.00	70.53	20.6	1852	170.0	0	0.0	0.0	Inner Shelf
W-134A-003A	07-Aug-94	0642	44.5	40.40	70.31	19.5	1852	39.0	0	0.0	0.0	Outer Shelf
W-134A-003B	07-Aug-94	0717	46.0	40.40	70.31	19.5	2315	200.0	0	15.0	0.0	Outer Shelf
W-134A-004A	07-Aug-94	1832	82.0	40.06	70.05	21.4	1111	29.5	0	0.0	0.0	Outer Shelf
W-134A-004B	07-Aug-94	1912	83.0	40.06	70.05	21.4	1852	32.5	0	1.5	0.0	Outer Shelf
W-134A-006A	08-Aug-94	1117	120.0	39.20	69.28	25.9	1852	50.0	0	15.0	0.0	Slope
W-134A-006B	08-Aug-94	1117	121.0	39.20	69.28	25.8	1852	22.0	0	70.0	5.0	Slope
W-134A-008A	09-Aug-94	0020	124.0	39.13	69.22	26.2	0	45.0	0	50.0	0.0	Open Ocean
W-134A-008B	09-Aug-94	0020	124.0	39.13	69.22	26.2	0	36.0	0	0.0	5.0	Open Ocean
W-134A-015A	11-Aug-94	0204	284.0	41.02	68.35	15.6	1852	540.0	1	0.0	30.0	Georges Bank
W-134A-015B	11-Aug-94	0204	284.0	41.02	68.35	15.6	0	350.0	1	0.0	0.0	Georges Bank

Phytoplankton Net Tows

Station	Date	Time (hrs)	Log (nm)	Latit. (deg.N)	Long. (deg.W)	Description	Locale
W-134a-001	06-Aug-94	0802	0.0	41.28	70.45	Diatoms, Dinoflag.	Tarpaulin Cove
W-134A-003	07-Aug-94	0434	43.0	40.39	70.32	Centric Diatoms	Inner Shelf
W-134A-004	07-Aug-94	1658	82.0	40.08	70.06		Mud Patch
W-134A-008	08-Aug-94	2047	124.0	39.15	69.26	Dinoflagellates	Open Ocean
W-134A-010	10-Aug-94	0754	235.5	40.10	69.05	Dinoflagellates	Hydro. Canyon
W-134A-013	11-Aug-94	0019	283.9	40.59	68.36	Centric Diatoms	Georges Bank

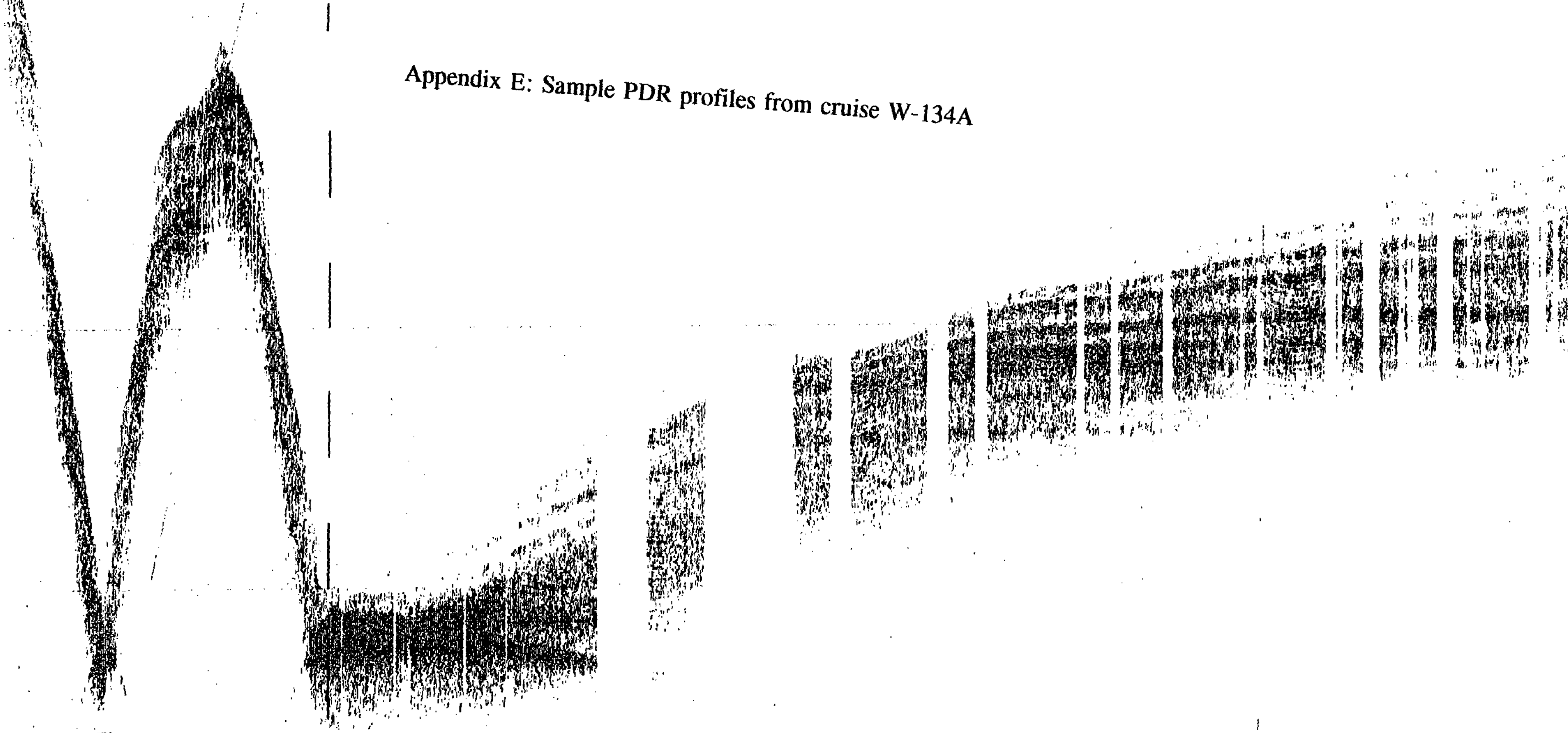
Appendix D: Hourly Data

Date	Time (hrs)	Log (nm)	Lat. (deg. N)	Long. (deg. W)	Press. (mb)	Temp. (deg. C)	Depth (m)
06-Aug-94	1400	0.0	41.26	70.47	1019.80	21.50	27
06-Aug-94	1500	5.0	41.22	70.53	1019.80	19.00	23
06-Aug-94	1600	8.5	41.17	70.53	1019.90	17.80	31
06-Aug-94	1700	12.2	41.12	70.54	1019.50	18.40	29
06-Aug-94	1800	15.3	41.08	70.55	1019.50	16.50	30
06-Aug-94	1900	20.2	41.32	70.54	1019.80	20.40	37
06-Aug-94	2000	21.0	41.06	70.54	1019.05	19.90	44
06-Aug-94	2100	21.0	41.00	70.53	1020.00	20.60	46
06-Aug-94	2200	21.5	40.58	70.51	1020.00	20.60	50
06-Aug-94	2300	25.0	40.57	70.49	1020.10	20.70	52
07-Aug-94	0000	28.4	40.53	70.45	1020.00	20.50	50
07-Aug-94	0100	32.5	40.49	70.41	1020.10	20.10	54
07-Aug-94	1000	54.0	40.35	70.17	1021.50	19.20	56
07-Aug-94	1100	59.8	40.31	70.13	1021.30	19.50	61
07-Aug-94	1200	60.5	40.27	70.10	1021.50	20.90	71
07-Aug-94	1300	70.0	40.21	70.09	1021.00	20.30	79
07-Aug-94	1400	77.5	40.15	70.09	1021.10	19.80	93
07-Aug-94	2000	85.5	40.01	70.02	1020.00	21.80	159
07-Aug-94	2100	90.0	39.57	69.60	1021.00	22.00	221
07-Aug-94	2200	90.1	39.56	69.59	1020.01	21.90	335
07-Aug-94	2300	90.0	39.55	69.59	1020.10	22.00	360
08-Aug-94	0000	90.2	39.54	69.58	1020.50	23.00	413
08-Aug-94	0100	90.0	39.12	69.57	1020.50	22.60	802
08-Aug-94	0200	90.3	39.50	69.36	1021.00	22.50	1025
09-Aug-94	0500	132.4	39.20	69.32	1018.80	25.20	2513
09-Aug-94	0600	135.5	39.23	69.36	1019.00	25.80	2437
09-Aug-94	0700	139.7	39.27	69.40	1019.00	25.50	2400
09-Aug-94	0800	144.0	39.32	69.45	1020.00	24.60	2325
09-Aug-94	0900	148.9	39.36	69.49	1019.50	24.50	2250
09-Aug-94	1000	154.4	39.41	69.54	1020.00	23.00	2175
09-Aug-94	1100	159.9	39.45	70.00	1020.30	23.90	1688
09-Aug-94	1200	164.3	39.49	70.04	1020.50	23.10	1013
09-Aug-94	1300	168.2	39.53	70.07	1020.50	22.60	884
09-Aug-94	1700	180.0	40.01	70.15	1020.00	21.70	240
09-Aug-94	1800	184.2	40.01	70.08	1020.00	21.40	180
09-Aug-94	1900	189.9	40.00	70.02	1020.00	22.20	165
09-Aug-94	2000	194.0	40.00	69.54	1020.00	21.40	150
09-Aug-94	2100	199.5	40.00	69.48	1020.00	22.00	135
09-Aug-94	2200	205.0	40.02	69.40	1020.00	21.00	120
09-Aug-94	2300	210.0	40.03	69.37	1020.00	21.50	105
10-Aug-94	0000	217.0	40.03	69.25	1020.00	21.00	90
10-Aug-94	0100	221.0	40.05	69.18	1019.00	22.50	98
10-Aug-94	0200	226.0	40.05	69.09	1019.00	22.10	135
10-Aug-94	0300	231.0	40.04	69.02	1020.00	22.00	750
10-Aug-94	0700	234.5	40.10	69.05	1019.00	21.30	165
10-Aug-94	0900	235.4	40.12	69.06	1020.00	20.60	165
10-Aug-94	1000	235.5	40.11	69.04	1020.50	20.80	233
10-Aug-94	1100	238.0	40.14	69.03	1020.50	20.80	98
10-Aug-94	1200	242.0	40.19	69.02	1020.00	21.60	90
10-Aug-94	1300	246.0	40.24	69.00	1020.00	21.00	75
10-Aug-94	1400	250.0	40.20	68.58	1020.00	19.60	75
10-Aug-94	1500	255.0	40.34	68.54	1020.00	19.00	75

10-Aug-94	1600	259.0	40.38	68.53	1019.00	19.30	60
10-Aug-94	1700	265.0	40.43	68:48	1019.00	18.60	60

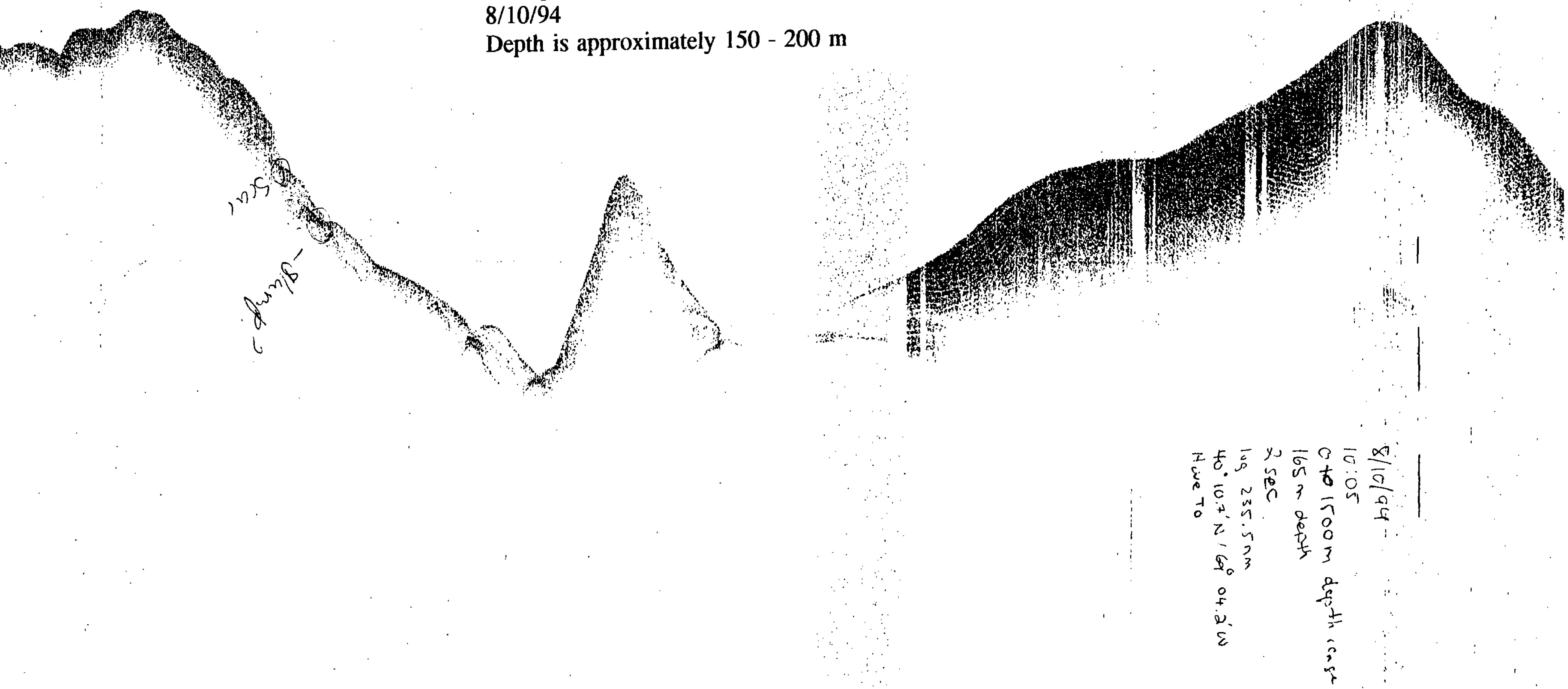
Date	Time (hrs)	Log (nm)	Lat. (deg. N)	Long. (deg. W)	Press. (mb)	Temp. (deg. C)	Depth (m)
10-Aug-94	1800	270.0	40.47	68.47	1019.00	18.70	63
10-Aug-94	1900	270.0	40.47	69.47	1019.00	18.50	65
10-Aug-94	2000	271.0	40.49	68.45	1019.00	18.30	62
10-Aug-94	2100	274.0	40.51	68.44	1019.00	15.40	62
10-Aug-94	2200	278.0	40.56	68.42	1020.00	15.80	56
10-Aug-94	2300	281.0	41.00	68.41	1020.00	15.20	55
11-Aug-94	0000	283.0	40.59	68.36	1021.00	15.00	46
11-Aug-94	0100			ON STATION			
11-Aug-94	0200	284.0	41.03	68.35	1021.00	15.50	56
11-Aug-94	0300	285.0	41.04	68.34	1020.00	15.80	60
11-Aug-94	0400	288.0	41.06	68.35	1020.00	16.00	55
11-Aug-94	0500	294.0	41.06	68.42	1020.00	14.80	61
11-Aug-94	0600	298.0	41.10	68.46	1021.00	14.80	68
11-Aug-94	0700	303.0	41.03	68.50	1021.00	17.90	93
11-Aug-94	0800	310.0	41.19	68.57	1022.00	19.10	134
11-Aug-94	0900	314.0	41.22	69.00	1022.00	19.50	152
11-Aug-94	1000	319.0	41.28	69.06	1022.00	19.70	144
11-Aug-94	1100	323.0	41.33	69.11	1022.00	19.90	163
11-Aug-94	1200	328.0	41.31	69.15	1023.00	19.90	183
11-Aug-94	1300	333.0	41.45	69.19	1022.00	19.90	179
11-Aug-94	1400	336.0	41.47	69.22	1022.00	19.60	174
11-Aug-94	1500	339.0	41.49	69.22	1022.00	19.50	186
11-Aug-94	1600	342.0	41.52	69.22	1022.00	19.40	201
11-Aug-94	1700	345.2	41.56	69.24	1021.80	19.30	204
11-Aug-94	1800	305.0	41.59	69.25	1023.00	19.10	208
11-Aug-94	1900	353.2	42.00	69.28	1021.40	19.10	206
11-Aug-94	2000	358.0	42.02	69.34	1021.10	20.20	214
11-Aug-94	2100	362.4	42.03	69.41	1021.00	20.20	212
11-Aug-94	2200	365.8	42.05	69.46	1021.20	20.00	206
11-Aug-94	2300	369.2	42.08	69.50	1021.20	19.50	124
12-Aug-94	0000	373.2	42.11	69.55	1021.3	19	169
12-Aug-94	0100	379	42.13	70.01	1021.3	17.5	98
12-Aug-94	0200	383	42.17	70.09	1021.2	17	68
12-Aug-94	0300	388	42.19	70.14	1021.2	17	31
12-Aug-94	0400	391.8	42.22	70.19	1021.2		32
12-Aug-94	0500	393	42.24	70.21	1021.2	17.2	34
12-Aug-94	0600	395.5	42.24	70.23	1021.5	17.1	29
12-Aug-94	0700	399	42.2	70.23	1022	15	92
12-Aug-94	0800	403.9	42.15	70.22	1024	16.4	80
12-Aug-94	0900	408	42.11	70.23	1024.5	17	60
12-Aug-94	1000	414.3	42.05	70.24	1024	17.2	55
12-Aug-94	1100	418	41.58	70.23	1024	18	42
12-Aug-94	1200	422	41.53	70.26	1024	18.5	27
12-Aug-94	1300	422.8	41.51	70.27	1024	18.7	25
12-Aug-94	1400						
12-Aug-94	1500		41.44	70.38	1023.9	21.9	10
12-Aug-94	1600	426	41.39	70.43	1023.5	23.4	5
12-Aug-94	1700	426	41.39	70.48	1023.2	23.5	5

Appendix E: Sample PDR profiles from cruise W-134A

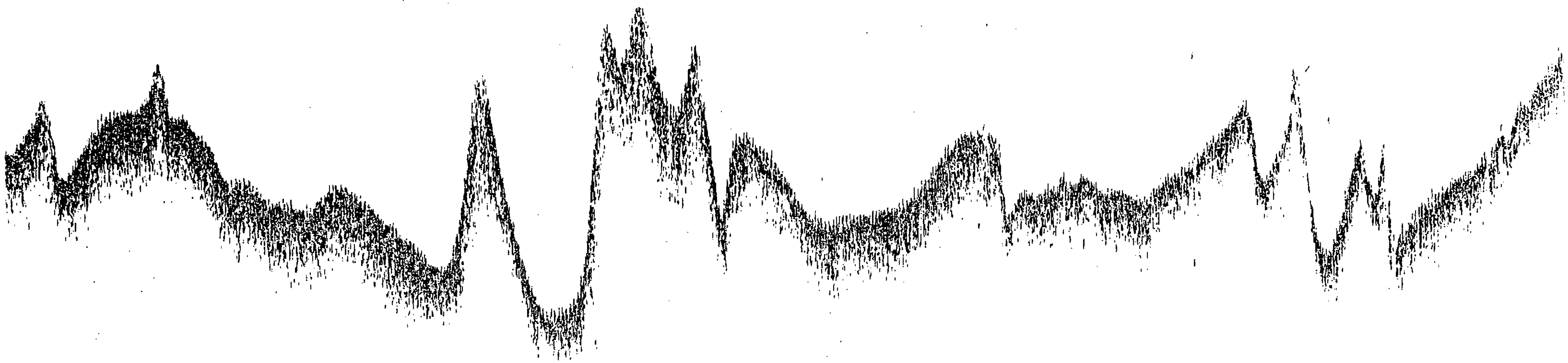


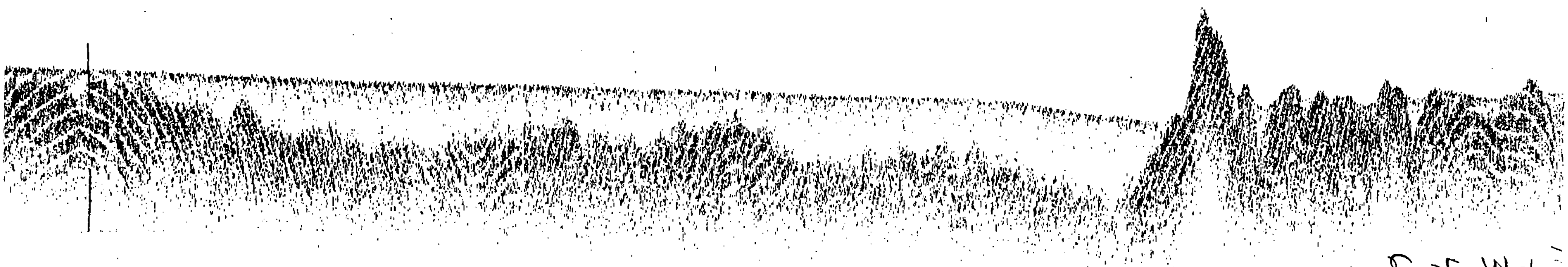
PDR profile from within Hydrographer Canyon, trace is indicative of soft, fine-grained sediments
8/10/94
Depth is approximately 500 - 750 m

PDR profile from the east side of Hydrographer's Canyon
8/10/94
Depth is approximately 150 - 200 m



PDR profiles from on top of Georges Bank
8/11/94
Depth is approximately 40 - 50 m





8-11-94

345.2 nm
41° 56'.06
69° 23.50
345 PSC

PDR profile approaching Cape Cod Bay and the Canal, note substrate underlying recently deposited sediments, could be indicative of previous low sea level stand.
8/11/94
Depth is approximately 200 m