Cruise Report C-138

Scientific Activities Undertaken Aboard SSV *Corwith Cramer*

Miami, Florida – Bermuda – Dominican Republic – Miami, Florida

23 March to 1 May, 1995

Sea Education Association - Woods Hole, Massachusetts

"It is not the facts but the relation of things that results in the universal harmony that is the sole objective reality."
- Dalai Lama

Preface

This report outlines the scientific and academic program conducted aboard SSV *Corwith Cramer* during March and April, 1995. It consists of summaries of research stations occupied, data collected, and highlights some of the results obtained during oceanographic operations. It also contains a list, and conclusions of, student projects completed during the trip. The report represents a preliminary analysis of data collected during C-138.

The success of this cruise and the academic program at sea could not have been achieved without the efforts of the entire staff, to whom I cannot do justice with this short acknowledgment. The cohesiveness and camaraderie among this crew was extraordinary even by SEA standards. Captain Pete Kalajian was a joy to work with, providing endless humor and energy, all the while depleting the ship's stores of Matouks hot sauce, and giving new meaning to the song "Back in the Saddle Again." Chief Mate Dave Bank always kept his cool, though his palms may have been sweaty. Second Mate and bosun Chris Havard kept the ship shipshape and helped maintain the musical background sounds to do a SEA Semester by. Third Mate Amy Vince quietly kept her watch motivated and on the learning curve. Engineer Karen Merritt left the engine room spotless, made it the hot place to be, and maintained a high standard of witty repartee at the meal table. Steward Theresa Tiedman had the students turning out the best food I've eaten at sea and never lost her smile, even with daily interruptions for espresso-making sessions.

First Assistant Scientist Ellie "The Good News Is I Think We Can Fix It" Linen supervised the lab and kept samples, data sheets, and the chief scientist organized, while experimenting with innovative lab safety headgear and leading penguin-watching expeditions. Second Assistant Scientist Hans Bruning kept a high learning and fun quotient on his watches, despite spells of zaniness brought on by his boss. Third Assistant Scientist Doug Fischer, on his first SEA

Semester trip, stepped right into being an excellent teacher and watch officer, while fulfilling his unofficial role as computer guru. Tony Cave, completing his stint as SEA Acting President, came aboard in the Dominican Republic for the last leg, joined a watch, and proceeded to fit right in - it was a pleasure having him aboard. To the entire staff, thank you for making this a thoroughly stress-free and enjoyable trip.

Finally the most important acknowledgment goes to the students of C-138. They chased "Frigid Eduardo" in the Sargasso Sea, *Sargassum* weed - well, anywhere, humpbacks on Navidad Bank, and hats overboard off the Dominican Republic. They stayed on their mopeds in Bermuda and on their horses in the DR, and evaded sharks at swim call. Through 100 (!) science stations and countless sail changes, their spirit of constant upbeat enjoyment, hard work, and support for each other made this SEA Semester the kind of experience that makes our jobs as educators satisfying, and keeps us coming back for more. Class 138, this was *your* trip.

William R. Howard, Ph.D
Chief Scientist

Academic Program

A 24-hour science watch was kept throughout the six-weeks of *Corwith Cramer* cruise C-138. Teams of three students and one science staff member tended the lab and carried out scientific operations during these watches. Students received hands-on training in the use of biological, geological, chemical and physical oceanographic sampling gear and in processing oceanographic data. Research data gathered during the cruise was used for individual student projects and for long-term SEA research programs. Routine underway oceanographic observations were made for ongoing projects as well as student projects. Weather observations were recorded and transmitted to the National Oceanographic and Atmospheric Administration (NOAA) on a regular basis as part of SEA's ongoing participation in the NOAA ship observation program. During the last three weeks of the cruise the students themselves acted as deck and science watch leaders with minimal help from the shipboard nautical and scientific staff. On-watch exercises, and a whole-ship mission on Navidad Bank provided a challenge that required the application of both nautical and oceanographic skills and coordination of deck and lab operations.

Formal instruction took the form of lectures and demonstrations given by the science staff and covered a variety of oceanographic topics (Table 1). Cruise C-138 was the culmination of a twelve-week program in oceanography, beginning with a six-week course on shore in preparation for sea, and two three-week courses at sea. On shore each student carefully planned an independent research project, and carried it out at sea during the cruise. Students summarized their findings in research papers and seminar presentations. Letter grades for the shipboard program were determined by on-watch evaluations, project reports, a laboratory practical examination, and shorter occasional assignments. The whole at-sea program included eleven credit hours in oceanography.

Table 1. Oceanography lectures and presentations at sea

Date	Topic	Speaker
March		
27	Research Plan and Schedule	Howard
28	The Gulf Stream	Howard
29	Western Boundary Currents	Howard
30	Pelagic Birds	Linen/Bruning
31	Ocean Waves	Howard
April		
4	Gravity core and pinger deployment	Howard
11	Coral Reef Ecology	Bruning
12	Carbonate Bank Geology	Fischer
13	Lab Practical	Staff
17	Creature Features	Students
18	Creature Features	Students
19	Creature Features	Students
24	Research Project Presentations	Students
25	Research Project Presentations	Students
26	Research Project Presentations	Students

Itinerary and Ship's Complement

The general itinerary traveled during Cruise C-138 is shown in Table 2 below. Midnight and noon latitude/longitude positions are given in Table 3. Ship's staff and students are listed in Table 4.

Table 2: SSV *Corwith Cramer* Cruise 138, General Itinerary.

Port	Arrive	Depart
Miami, FL, USA		3/2495
St. Georges, Bermuda	4/5/95	4/8/95
Samana Bay, Dominican Republic	4/19/95	4/22/95
San Salvador, Bahamas	4/26/95	4/26/95
Miami, FL, USA	5/1/95	

Table 3. Midnight and Noon Positions, SSV *Corwith Cramer* Cruise 138 [1]

Date	Local Time	Latitude (N)	Longitude (W)	Location
3/24/95	0000	25° 46.3'	80° 10.1'	Alongside, Miami, FL
3/24/95	1200	25° 46.3'	80° 10.1'	Alongside, Miami, FL
3/25/95	0000	26° 38.2'	79° 54.4'	
3/25/95	1200	27° 41.7'	79° 53.9'	
3/26/95	0000	28° 12.6'	80° 8.4'	
3/26/95	1200	29° 06.9'	80° 00.5'	
3/27/95	0000	29° 34.3'	79° 10.1'	
3/27/95	1200	29° 38.6'	78° 40.3'	
3/28/95	0000	29° 59.6'	77° 55.2'	
3/28/95	1200	30° 15.1'	76° 36.7'	
3/29/95	0000	30° 53.4'	75° 46.8'	
3/29/95	1200	30° 59.4'	75° 24.9'	
3/30/95	0000	31° 14.7'	74° 03.5'	
3/30/95	1200	31° 32.9'	72° 54.3'	
3/31/95	0000	32° 14.4'	71° 44.2'	
3/31/95	1200	32° 15.9'	70° 17.1'	

[1] Position data are plotted in Figure 1.

Table 3. Midnight and Noon Positions, SSV *Corwith Cramer* Cruise 138 (cont'd)

Date	Local Time	Latitude (N)	Longitude (W)	Location
4/1/95	0000	32° 19.8'	69° 51.9'	
4/1/95	1200	32° 27.5'	69° 13.0'	
4/2/95	0000	32° 13.4'	68° 28.2'	
4/2/95	1200	32° 06.0'	68° 27.5'	
4/3/95	0000	32° 16.0'	67° 45.0'	
4/3/95	1200	32° 33.3'	66° 44.6'	
4/4/95	0000	32° 09.0'	65° 24.0'	
4/4/95	1200	32° 10.4'	64° 53.2'	
4/5/95	0000	32° 18.5'	64° 35.2'	
4/5/95	1200	32° 22.7	64° 40.8'	St. Georges, Bermuda
4/6/95	0000	32° 22.7	64° 40.8'	St. Georges, Bermuda
4/6/95	1200	32° 22.7	64° 40.8'	St. Georges, Bermuda
4/7/95	0000	32° 22.7	64° 40.8'	St. Georges, Bermuda
4/7/95	1200	32° 22.7	64° 40.8'	St. Georges, Bermuda
4/8/95	0000	32° 22.7	64° 40.8'	St. Georges, Bermuda
4/8/95	1200	32° 15.9'	64° 39.1'	
4/9/95	0000	31° 37.2'	64° 20.0'	
4/9/95	1200	30° 57.8'	64° 31.8'	
4/10/95	0000	30° 06.2'	64° 45.1'	
4/10/95	1200	29° 13.8'	64° 54.7'	
4/11/95	0000	28° 19.9'	65° 08.4'	
4/11/95	1200	27° 18.9'	65° 16.7'	
4/12/95	0000	26° 08.8'	65° 36.5'	
4/12/95	1200	24° 59.3'	65° 44.4'	
4/13/95	0000	24° 01.2'	66° 04.9'	
4/13/95	1200	23° 20.2'	66° 23.3'	
4/14/95	0000	22° 36.9'	66° 48.5'	
4/14/95	1200	22° 13.9'	67° 15.7'	
4/15/95	0000	22° 07.5	67° 23.8'	
4/15/95	1200	22° 01.3'	67° 30.4'	
4/16/95	0000	21° 46.1'	67° 50.8'	
4/16/95	1200	21° 09.0	68° 17.0'	
4/17/95	0000	20° 27.9'	68° 42.8'	
4/17/95	1200	20° 00.6'	68° 51.1'	
4/18/95	0000	19° 52.4'	68° 52.9'	
4/18/95	1200	19° 25.7'	68° 46.3'	
4/19/95	0000	19° 08.3'	68° 51.7'	
4/19/95	1200	19° 11.8'	69° 19.7'	Samana Bay, DR
4/20/95	0000	19° 11.8'	69° 19.7'	Samana Bay, DR
4/20/95	1200	19° 11.8'	69° 19.7'	Samana Bay, DR
4/21/95	0000	19° 11.8'	69° 19.7'	Samana Bay, DR
4/21/95	1200	19° 11.8'	69° 19.7'	Samana Bay, DR
4/22/95	0000	19° 11.8'	69° 19.7'	Samana Bay, DR

Table 3. Midnight and Noon Positions, SSV *Corwith Cramer* Cruise 138 (cont'd)

Date	Local Time	Latitude (N)	Longitude (W)	Location
4/22/95	1200	19° 08.5'	69° 09.8'	
4/23/95	0000	19° 43.7'	69° 32.7'	
4/23/95	1200	20° 39.3'	70° 13.4'	
4/24/95	0000	21° 38.1'	71° 01.3'	
4/24/95	1200	22° 34.3'	71° 53.0'	
4/25/95	0000	23° 37.0'	72° 36.0'	
4/25/95	1200	23° 54.0'	73° 25.4'	
4/26/95	0000	23° 49.1'	74° 14.1'	
4/26/95	1200	24° 03.3'	74° 32.4'	San Salvador, Bahamas
4/27/95	0000	24° 19.0'	74° 51.9'	
4/27/95	1200	25° 00.0'	75° 21.5'	
4/28/95	0000	25° 22.3'	76° 02.5'	
4/28/95	1200	25° 45.4'	77° 08.5'	
4/29/95	0000	25° 58.6'	77° 56.8'	
4/29/95	1200	26° 13.4'	78° 20.0'	
4/30/95	0000	26° 03.9'	79° 11.5'	
4/30/95	1200	25° 46.6'	80° 05.8'	
5/1/95	0000	25° 46.6'	80° 05.8'	
5/1/95	1200	25° 46.3'	80° 10.1'	Alongside, Miami, FL

Table 4. Ship's Complement for SSV *Corwith Cramer* Cruise C-138

Nautical Staff	
Peter Kalajian	Captain
David Bank	First Mate
Chris Havard	Second Mate
Amy Vince	Third Mate
Karen Merritt	Engineer
Theresa Tiedman	Steward
Scientific Staff	
William Howard	Chief Scientist
Ellie Linen	First Assistant Scientist
Hans Bruning	Second Assistant Scientist
Doug Fischer	Third Assistant Scientist
Visitor	
Tony Cave	Sea Education Association
Students	
Mary Elizabeth Armstrong	Syracuse University
Lisa Collins	Oberlin College
Sarah Davenport	Wheaton College
Matt Ellinghaus	University of Richmond
Laura Fravel	University of Virginia
Cara Fritz	Amherst College
Kate Gaughan	Bates College
Lynne Gieseke	Colgate University
Tracie Hayes	Simmons College
Tim Keating	DePauw University
Chad Ledgett	Stanford University
Loretta Leist	Mitchell College
Jennifer Lennert	Illinois Wesleyan University
Matt LoPiccolo	Hamilton College
Leni-Sarah Machinton	Smith College
Chris McFadden	Colgate University

Meghan O'Neil	Colby College
Clare Parker	Harvard College
Bill Payzant	Hamilton College
Patrick Ressler	Bucknell University
Meg Rowe	Vanderbilt University
Whitley Saumweber	St. Mary's College
Lisa Smith	College of Charleston
Renee Young	Davidson College
Rhea Zimmerman	University of Vermont

Scientific Program

This report is intended to document the scientific research program carried out during cruise C-138 of the SSV *Corwith Cramer*. The cruise track was planned to permit interdisciplinary study of several distinct oceanographic regimes in the western North Atlantic, including the southern and northern Sargasso Sea and Gulf Stream. Research took the form of extensive data collection (see Table 5) for ongoing SEA research programs and individual student projects (Table 6), though many data sets were used for both. The projects covered a range of physical, chemical, biological, and geological oceanographic topics with the intention of giving students a taste of what scientific study of natural systems (in this case the ocean) entails. In particular, the complex interactions among different oceanic "systems" were emphasized, and became apparent as the cruise progressed and different project data sets were compared. This report only touches upon the data we collected. The research summarized in this report represents, in part, ongoing work by individuals and agencies, and these results should not be excerpted or cited without the written permission of the Chief Scientist.

Table 5. C-138 Science Accomplishments

- 1 Fisher scoop
- 2 dip nets
- 2 gravity cores
- 4 Secchi discs
- 9 phytoplankton nets
- 13 hydrocasts
    - 156 Niskin bottles full of water
    - 135 samples "winkled" (45 hours worth)
- 17 CTDs
- 25 meter nets
- 26 neuston tows
- 50 hundred-counts, 5000 critters identified
- 63 BT's
- 67 surface stations
- 92 salinities run = 9,200 flushes of conductivity cells
- 214 PO_4 samples run
- 116 chl-a samples filtered + 67 mt/mp filtered = 125,000 ml H_2O filtered
- 960 readings of the PDR
- 38,251 meters of hydrowire deployed

Table 6. Student Research Projects, C-138.

Theme / Topic	Student(s)
Physical Oceanography/Watermasses	
Salinity Maximum Water and 18° Water Masses	Renee Young
Antarctic Intermediate Water and Mediterranean Water	Bill Payzant
Geostrophic velocities in the Sargasso Sea and Gulf Stream	Kate Gaughan
Chemical Oceanography	
Apparent Oxygen Utilization and phosphate in water masses	Clare Parker
Pollution	
Pelagic tar distribution	Meg Rowe
Pelagic tar properties and weathering	Tim Keating
Micro- and macroplastic	Chris McFadden & Tracie Hayes
Geological Oceanography	
3.5kHz echo character and bathymetry	Lisa Collins & Rhea Zimmerman
Sedimentary grain size and composition	Matt LoPiccolo
Sedimentary grain composition	Lynne Gieseke
Planktonic foraminiferal distribution in sediments	Cara Fritz
Phytoplankton	
Deep chlorophyll maxima	Lisa Smith
Phytoplankton composition and diversity	Patrick Ressler
Viral phages in cyanobacteria	Chad Ledgett & Matt Ellinghaus
Zooplankton and Neuston	
Pteropod distribution in sediments and plankton	Sarah Davenport
Planktonic foraminiferal distribution in plankton	Loretta Leist
Controls on copepod abundance	Leni-Sarah Machinton
Lunar influences on Leptocephali larvae	MB Armstrong
Distribution of *Halobates micans*	Meghan O'Neil
Vertical migration of zooplankton	Whit Saumweber
Surface-water properties: Controls on zooplankton biomass	Laura Fravel & Jennifer Lennert

Scientific Results Summary

The cruise track of C-138 covered three transects: from Miami to Bermuda, from Bermuda to Samana Bay, Dominican Republic (DR), and from Samana Bay to Miami (Figure 1; Table 2). The first leg included a few rough days crossing the Gulf Stream and Sargasso Sea, and cold weather borne to sea by North American cold fronts. An encounter with a cold-core eddy ("Where's Frigid Eduardo?") of the Gulf Stream provided an interesting look at a piece of Slope Water trapped, along with a ring of Gulf Stream, within the Sargasso Sea (Figures 2 and 3). Bermuda provided a welcome port stop and a visit to the Bermuda Biological Station and their research vessel R/V *Weatherbird II.* The transect from Bermuda to the Dominican Republic was a fast passage that traversed a wide range of gyre-scale oceanographic gradients, and provided student projects with data sets that complemented their first-leg collection. A whole-ship mission, handing over the ship to the students for a project requiring them to evaluate upwelling and sediment transport on Navidad Bank north of the Dominican Republic capped off the scientific mission, and exemplified the synergy between science and deck operations that characterized the entire trip. The sighting of breaching humpback whales on the bank was one of the most exciting moments of the entire trip.

The multidisciplinary nature of the science program on C-138 is embodied in the scope of results of the students' final science projects, summarized below. These results were distilled from the students' own preliminary interpretations of their data.

In biological oceanography, MB Armstrong's study of leptocephalus (eel) larvae found an intriguing link between leptocephali abundance and the lunar cycle (Figure 4). A study of zooplankton biomass in neuston nets revealed weak correlations between surface biomass and chlorophyll, and a weak negative correlation between biomass and surface temperature (Laura Fravel and Jen Lennert). Whit Saumweber examined day and night distribution patterns of zooplankton in order to infer vertical migration, and found overall highest densities in gyre margin stations near the Florida Continental Shelf and Navidad Bank as well as within the cold-core eddy. Night tows also showed an interesting positive correlation between mixed-layer thickness and biomass. Day tows showed higher biomasses associated with shallower mixed layers (could vertically migrating plankton be staying in thinner mixed layers in the day time?).

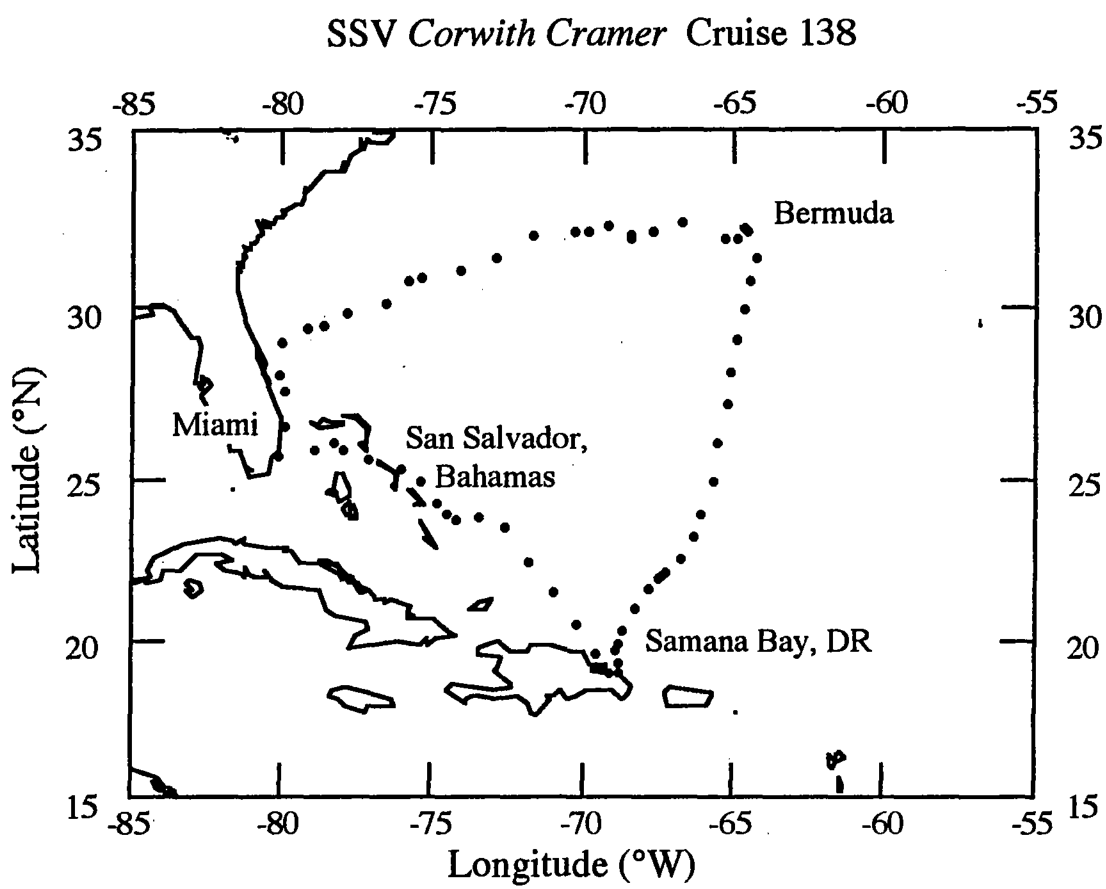

Figure 1: Midnight and Noon Positions.
Position data are given in Table 3.

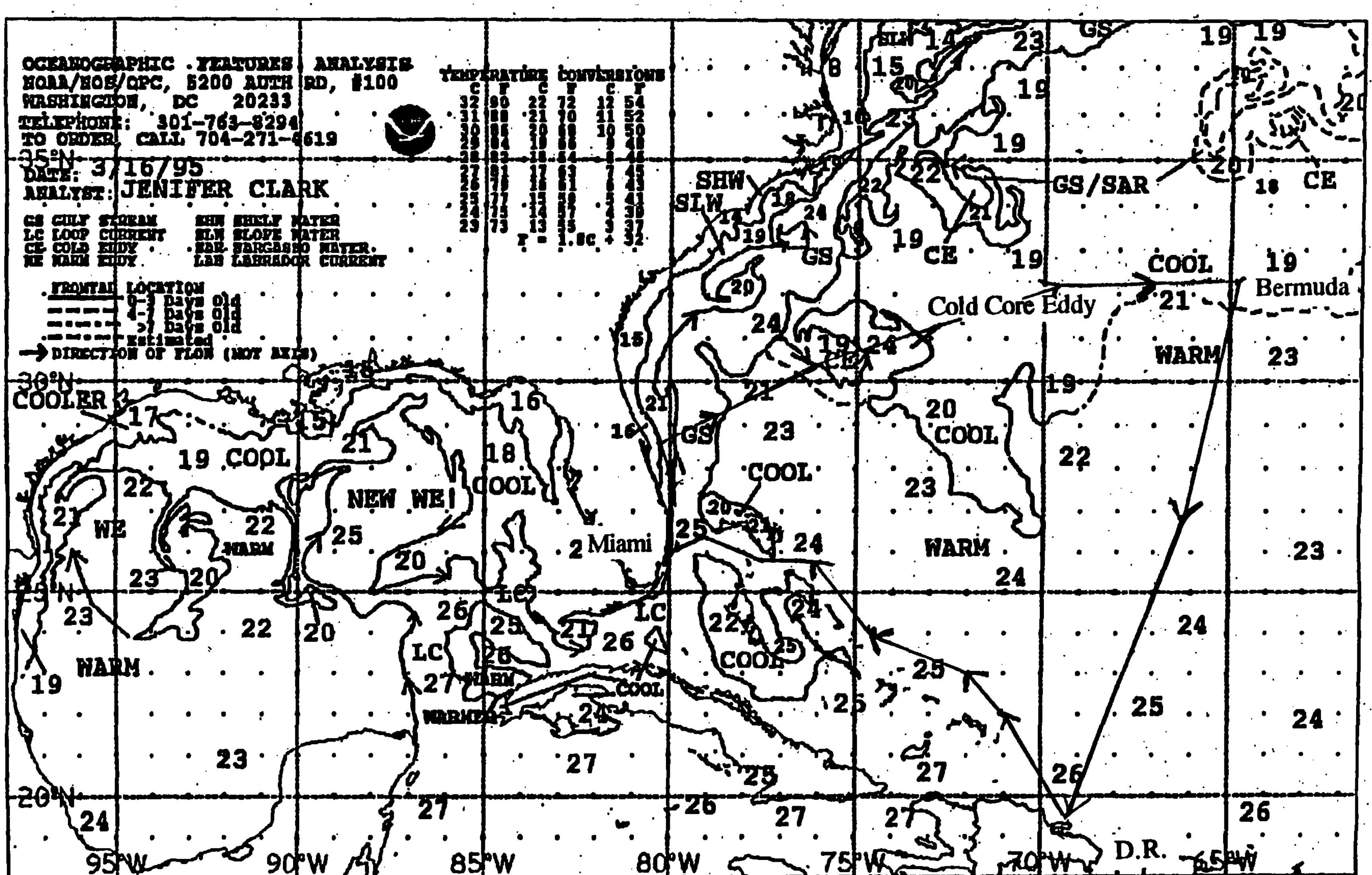

Figure 2. National Oceanographic and Atmospheric Administration (NOAA) Ocean Features Analysis of March 16, 1995 (a week before C-138 departed Miami). Note the cold-core (CE) of the Gulf Stream centered at about 30.5°~ by 76°W. C-138 crossed this feature during the first leg of the cruise. C-138 cruise is drawn on figure; positions are given in Table 3.

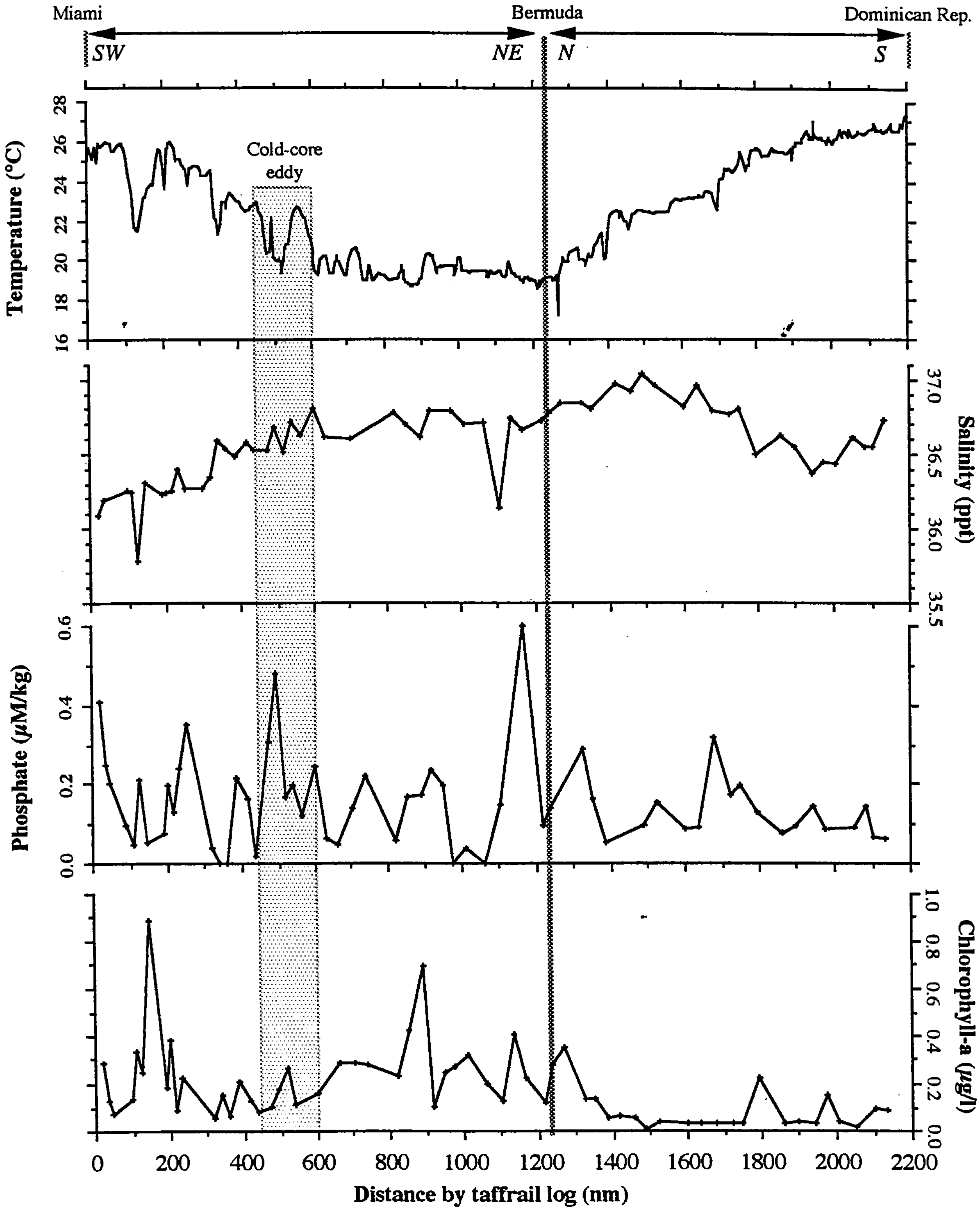

Figure 3. Surface properties along the C-138 cruise track. Data are given in Appendix D.

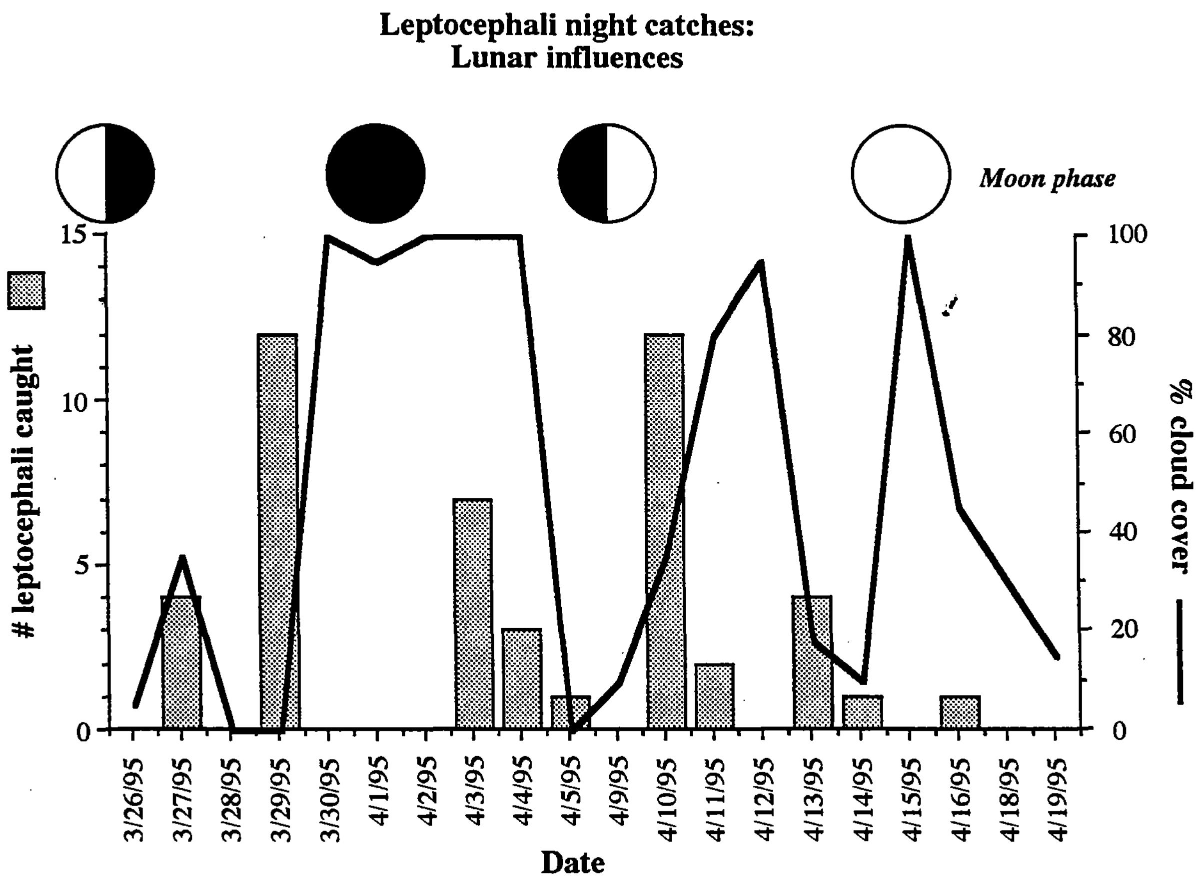

Figure 4. Catches of leptocephalus (eel) larvae during C-138, plotted with cloud cover and lunar phase. These data were used to test a hypothesis that leptocephali respond to light-dark cycles associated with moonlight.

Copepod abundance was inversely correlated with temperature (Figure 5), an observation Leni Machinton attributed to faster molts in warmer waters (a kind of "live fast, die young" hypothesis). The distribution of the marine insect *Halobates micans* showed a pattern of increasing abundance with sea-surface temperature and a predominance of males in the neuston net catches (Meghan O'Neil).

Pronounced deep chlorophyll maxima (DCM) found in most of the waters we sampled appear to be comprised of actively photosynthesizing phytoplankton communities near the level of 1% of surface light, based on the associations among chlorophyll, oxygen, phosphate distributions, and thermal structure at stations along the track (Lisa Smith). Lisa's results suggest that chlorophyll concentrations in the DCM is enhanced by density gradients at shallow pycnoclines (Figure 6). Patrick Ressler's study of phytoplankton communities at the surface and near the DCM revealed higher diversity in subsurface samples. The subsurface floras were dominated by diatoms whereas surface samples had a predominance of dinoflagellates, perhaps due the dinoflagellates' ability to live as opportunistic heterotrophs (Figure 7).

Chad Ledgett and Matt Ellinghaus completed a study of the abundance of viral phages in the plankton by attempting to infect cultures of cyanobacteria brought aboard from Woods Hole Oceanographic Institution (WHOI). This new (for SEA) cooperative research program with WHOI researchers yielded some tantalizing results: the presence of *Synechococcus* phages were present throughout the mixed layers of stations sampled in the Sargasso Sea, except at the 75-meter sample at Station 71 in the Southern Sargasso Sea. Chad and Matt suggest the possibility that since this sample was in Subtropical Underwater (a water mass distinct from the Sargasso Sea water masses from which the cultured cyanobacteria were drawn), we may have encountered a population of phages to which *Synechococcus* is immune. Though *Synechococcus* grew well in the *Cramer* lab, neither *Prochlorococcus* cultures brought from Woods Hole nor *Trichodesmium* drawn from the water column responded to our attempts at culturing them.

In physical oceanography, Renee Young tracked 18° Water by its temperature and salinity characteristics, and found its maximum in a ~100-meter-thick lens in the northern Sargasso Sea near Bermuda, close to its formation region (Figure 8). She also studied the properties of Subtropical Underwater (Salinity Maximum Water) in the Sargasso Sea, and found a maximum subsurface salinity of 37.4 ppt at 20°N latitude and 150 meters water depth, consistent with a formation region for this water mass just west of the Sahara Desert in a region characterized by

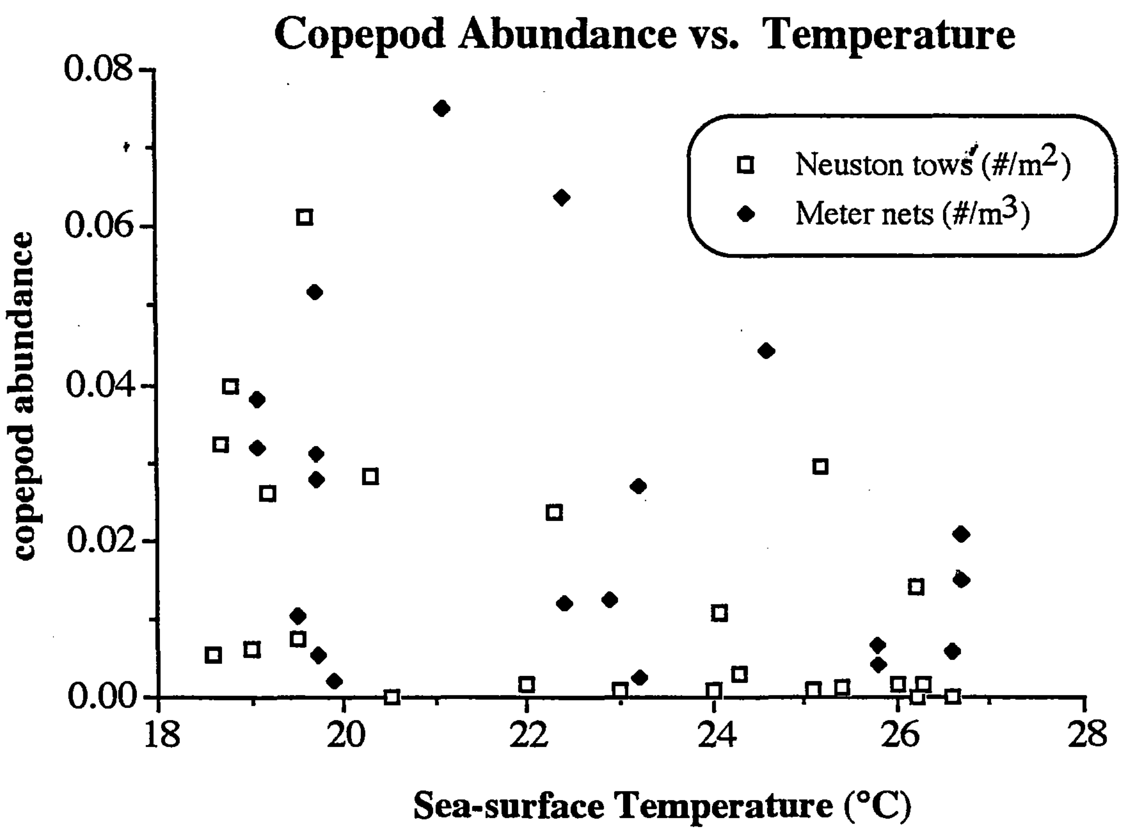

Figure 5. Relationship between copepod abundance and sea-surface temperature.

Deep Chlorophyll Maximum at Station 18 (Cold-Core Eddy)

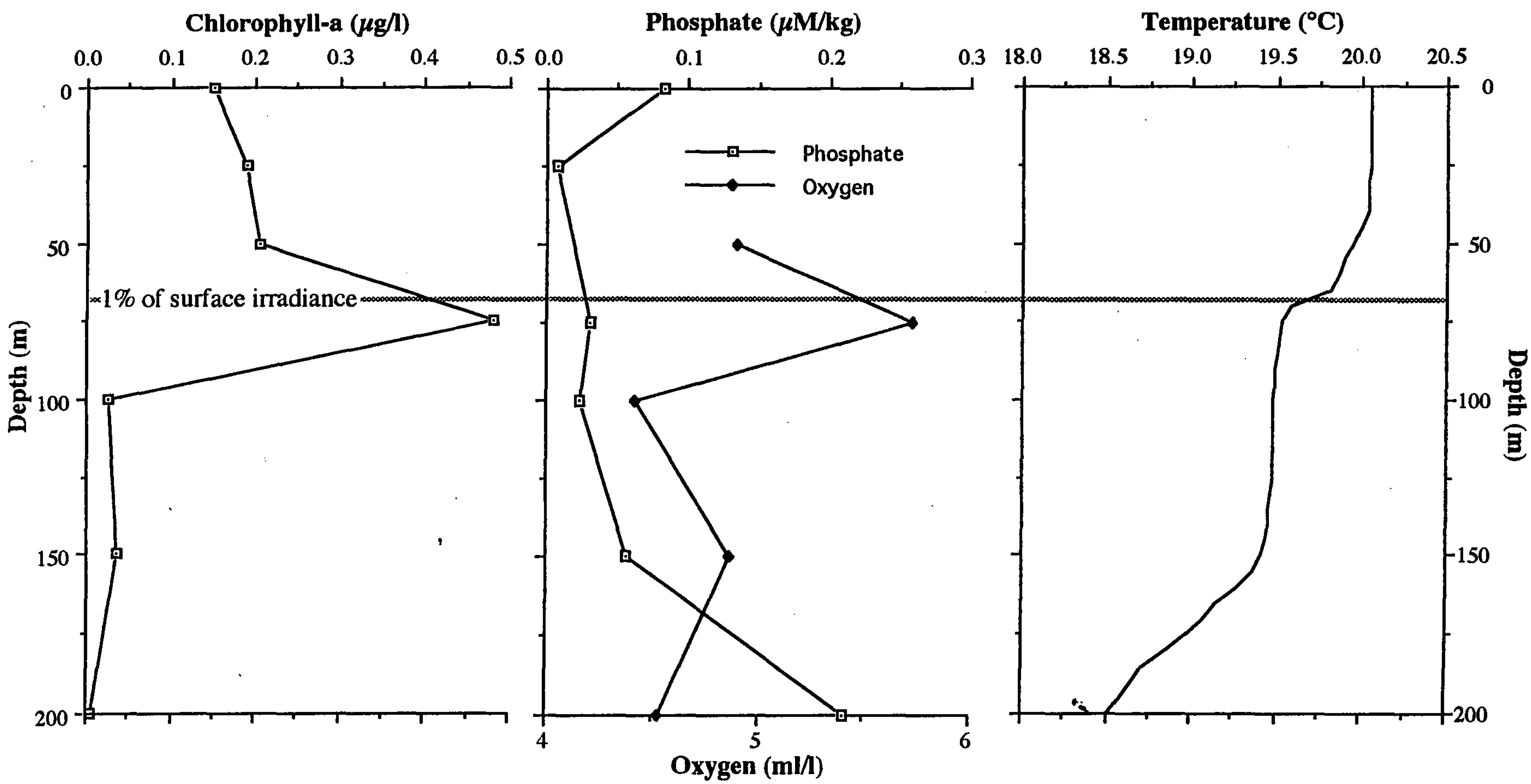

Figure 6. Deep chlorophyll maximum (DCM)at Station 18, within the cold-core eddy. Note the occurrence of the DCM just below the shallow thermocline (which coincides with the base of the euphotic zone; shaded line; defined as 1% of surface incident light) . Note also the slight oxygen maximum at the DCM, suggesting possible active photosynthesis. Chemistry data are given in Appendix C.

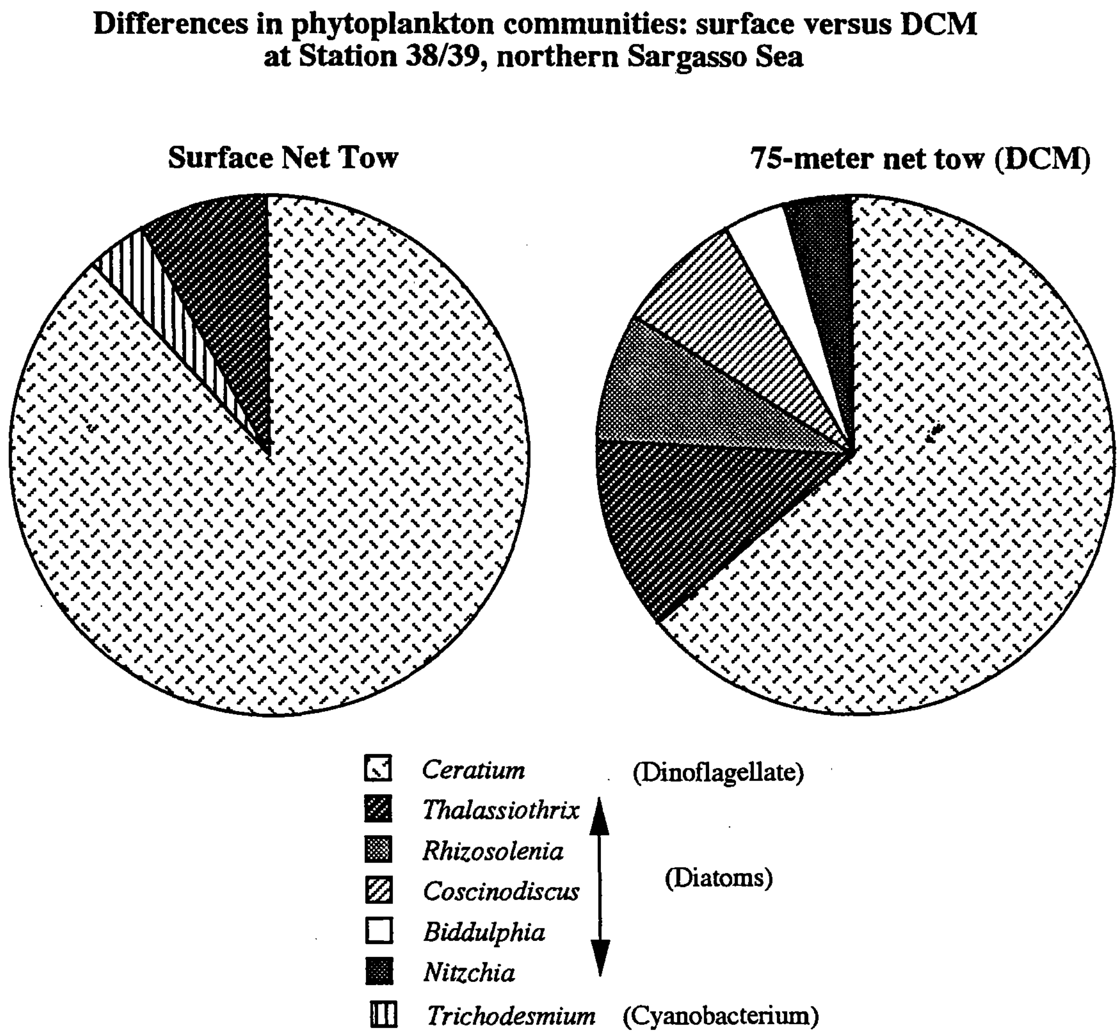

Figure 7. Phytoplankton community composition at the surface and at 75 meters (approx. depth of the Deep Chlorophyll Maximum (DCM)) at a northern Sargasso Sea station. Note higher abundance of diatoms at the DCM.

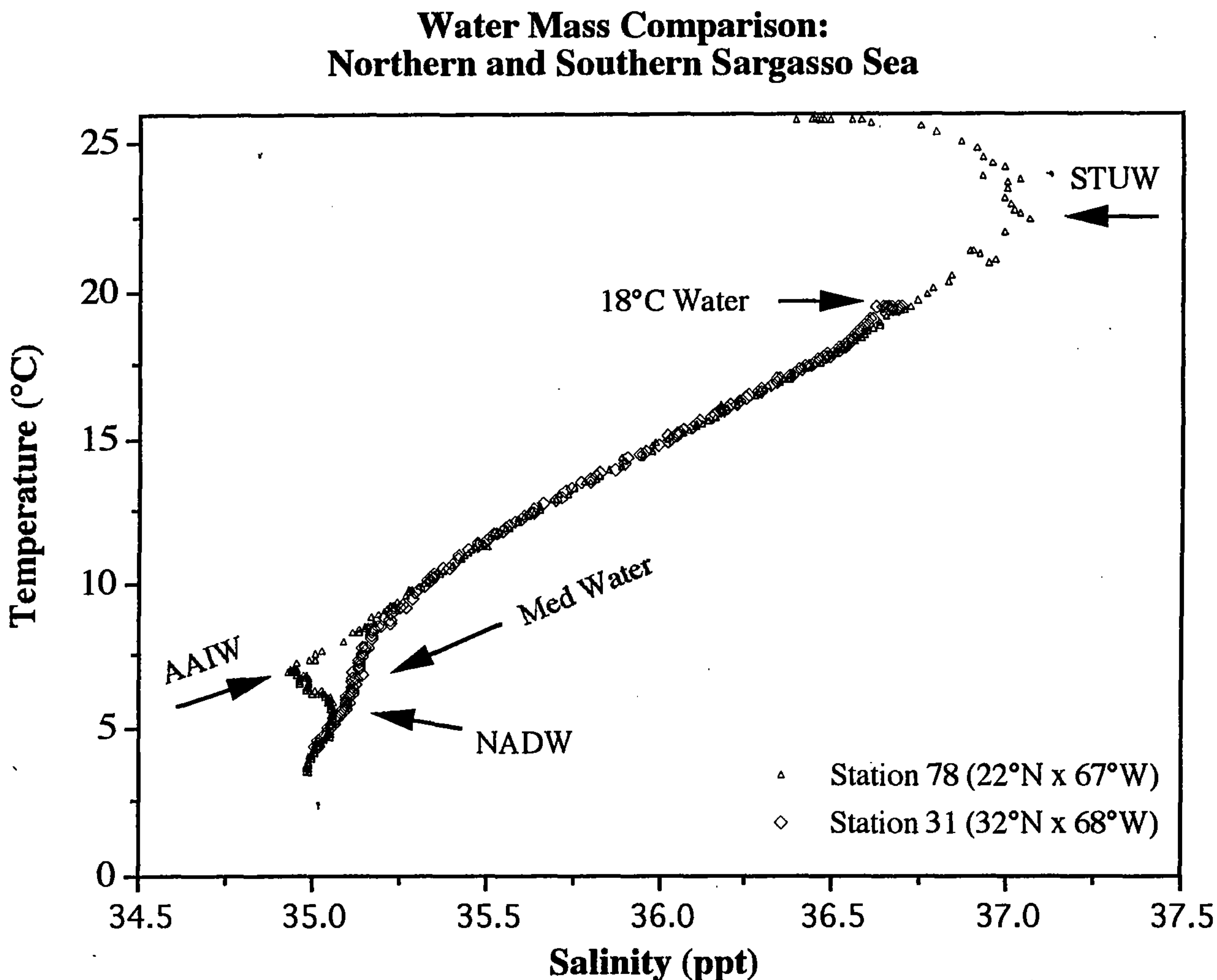

Figure 8. Temperature-salinity diagrams from northern and southern Sargasso Sea stations, showing water-mass contrasts for the two regions. Note the presence of 18° Water at Station 31 (near its formation region), and the appearance of Antarctic Intermediate Waters at Station 78. Subtropical Underwater (STUW) is near its maximum salinity at the latitude of Station 78. The two T-S diagrams converge on the North Atlantic Deep Water sequence at about 35 ppt and 3-4 °C.

high evaporation/precipitation ratios (Figure 8). Relative geostrophic velocities in the Gulf Stream and Sargasso Sea were as high as 0.5 meters/second at the surface of the Gulf Stream, with surprising surface countercurrents east of the Gulf Stream and in the Southern Sargasso Sea (Kate Gaughan; Figure 9).

Bill Payzant used temperature and salinity properties to examine the movement and mixing of Antarctic Intermediate Water (AAIW), Mediterranean Water, and North Atlantic Deep Water in the Sargasso Sea (Figure 8). A surprising finding was the presence of AAIW in the Southern Sargasso Sea and entrained in the Florida Current and its absence in the western Puerto Rico Trench just north of the Dominican Republic, suggesting that AAIW may be entering the Sargasso Sea north of the Antilles Arc but may be blocked from entering the trench by the shallow (~700 meters) Mona Passage Sill.

A chemical oceanography project by Clare Parker traced North Atlantic water masses by their phosphate and Apparent Oxygen Utilization (AOU) properties, as well and searched for chemical signatures in a cold-core eddy of the Gulf Stream. The chemical properties proved to be useful tracers of watermass movement, and suggested that the eddy may have been in a late stage of development and already mixed with gyre waters. The chemical signatures of AAIW and NADW were evident as their proportions changed between the northern and southern Sargasso Seas (Figure 10). It was also reassuring to see that our geochemistry data sets compared well with those of other oceanographic studies, such as Geochemical Ocean Sections (GEOSECS), Transient Tracers in the Oceans (TTO), and Bermuda Atlantic Time-Series (BATS), in the same area (Figure 11)

A surface sediment study completed by Lynne Gieseke and Matt LoPiccolo used a Shipek grab sampler and a gravity corer to reveal distinct patterns of deposition in sedimentary environments on the Florida Continental Shelf, Blake Plateau, Bermuda Rise, Navidad Bank and Atlantic margin of the Dominican Republic. Their results suggested that Blake Plateau, though still receiving Holocene sediments (Cara Fritz found *Globorotalia menardii*, a planktonic foraminifer only found in interglacial Atlantic sediments, in the Shipek grabs), is winnowed by strong Gulf Stream currents, evident from a grain size distribution sharply skewed toward coarser fractions (Figure 12).

Lisa Collins' and Rhea Zimmerman's work on the echo character of the seabed revealed a variety of seabed features including: hyperbolic echoes indicating rough topography and indistinct echoes with sub-bottom reflectors consistent with the fine-grain, high-carbonate sediments found

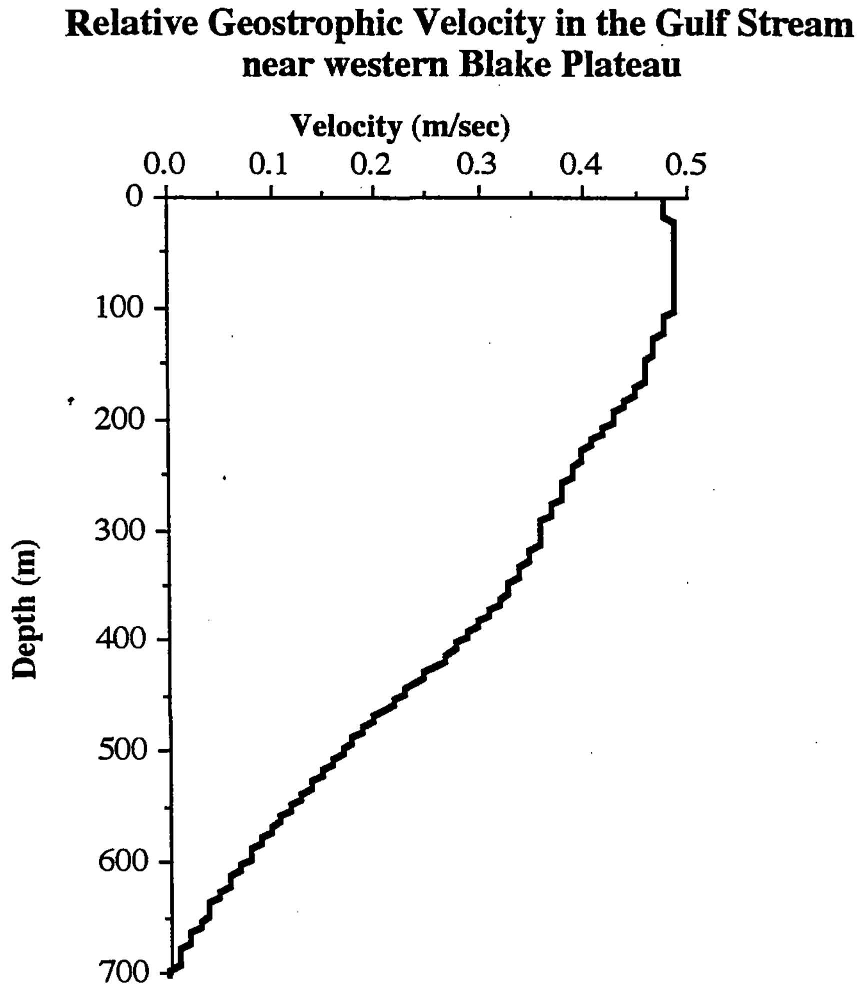

Figure 9. Relative geostrophic (northward) velocity profile in Gulf Stream (between Stations 9 and 10). Appendix A gives station locations.

Geochemical Data from northern Sargasso Sea and southern Sargasso Sea Stations

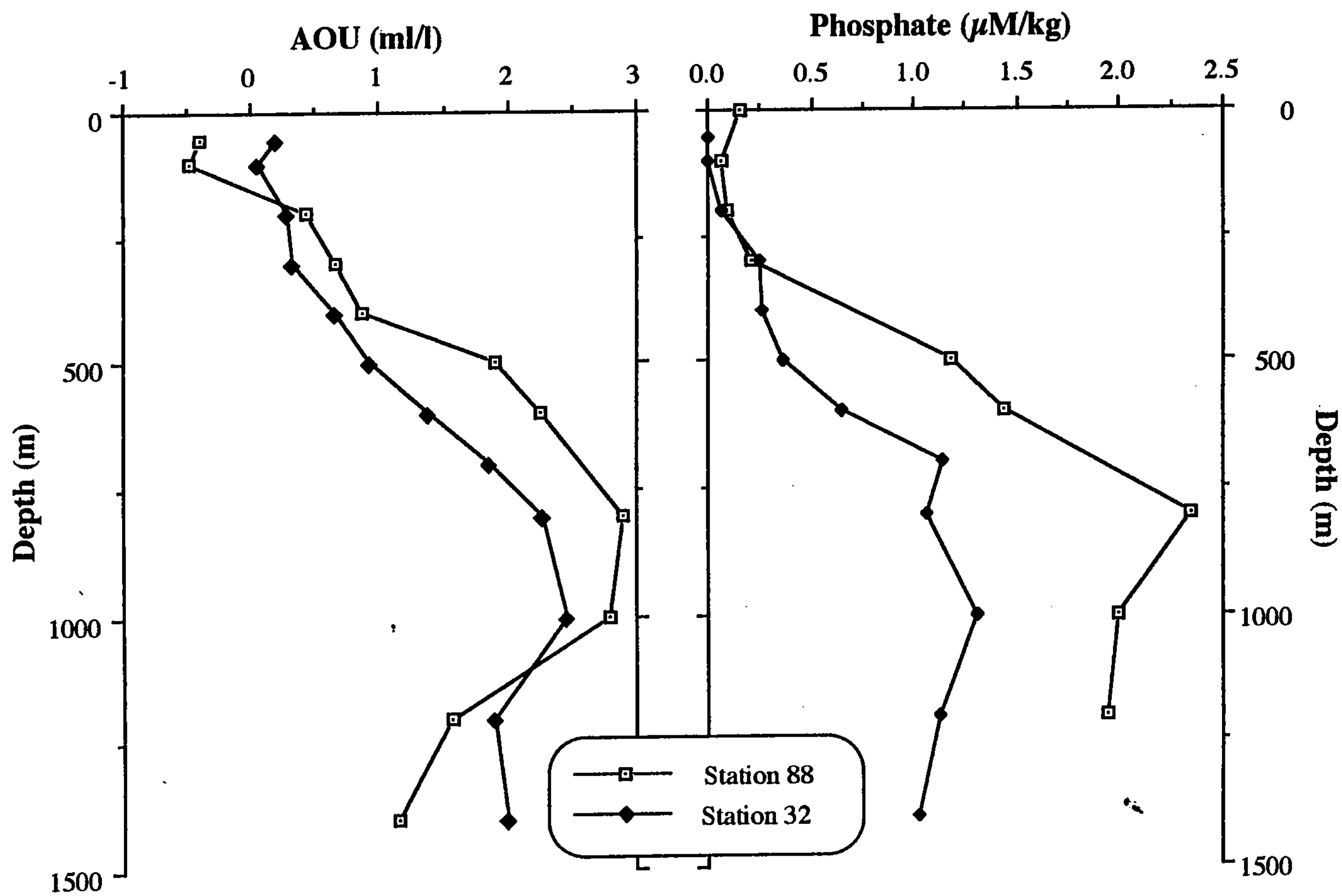

Figure 10. Apparent Oxygen Utilization (AOU) and dissolved phosphate contrasts between northern (Station 32) and southern (Station 88) Sargasso Sea stations. Higher phosphate at about 1000 meters at Station 88 is (in part) due to the presence of Antarctic Intermediate Water at the southern station. Data are given in Appendix C.

C-138 geochemical data from Station 32 compared to other data from the same area:

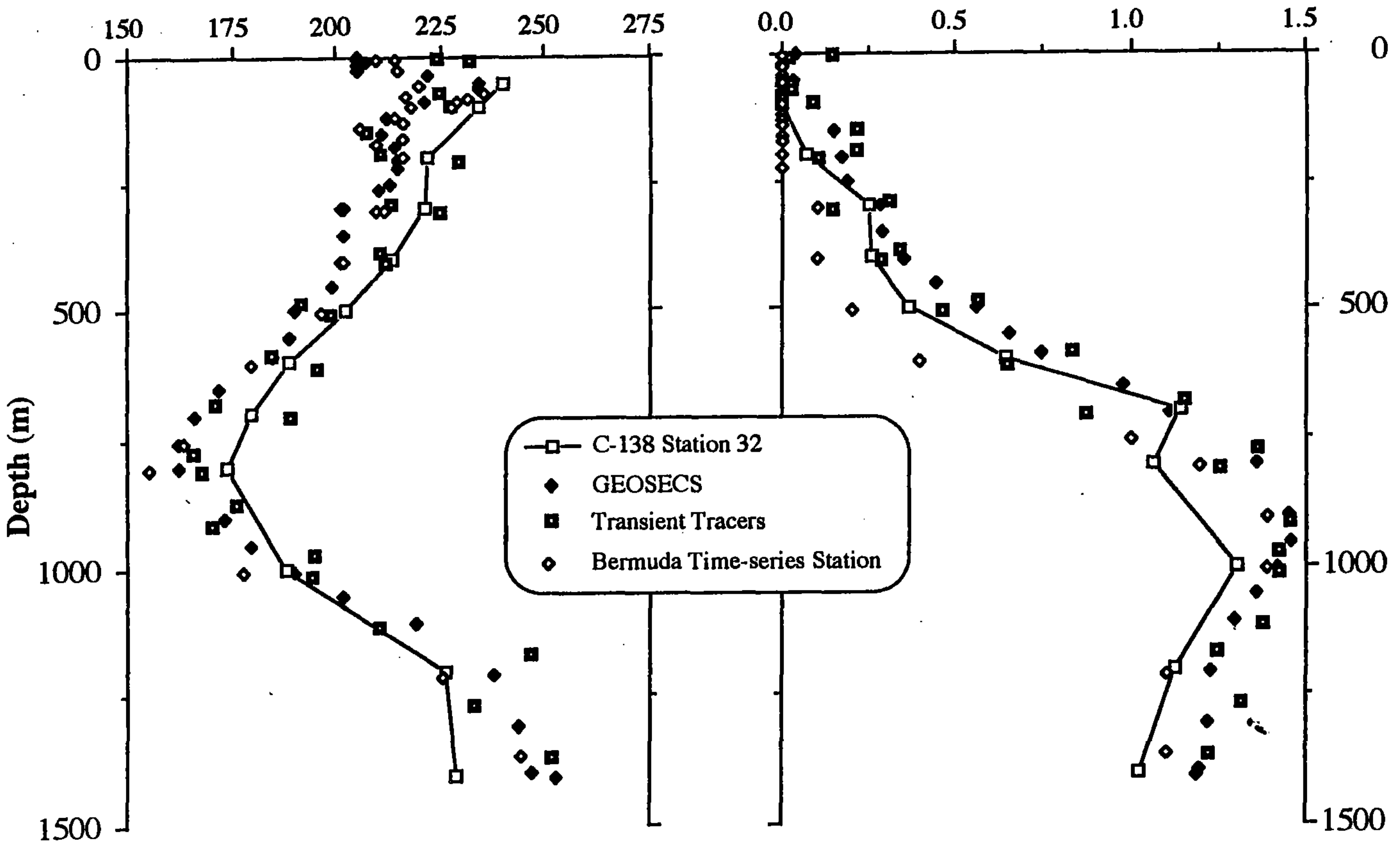

Figure 11. Comparison of dissolved oxygen and phosphate profiles near Bermuda from C-138, GEOSECS, Transient Tracers in the Ocean, and the Bermuda Atlantic Time-series Station. Data for C-138 Station are given in Appendix C.

in Shipek grabs. Their transects showed the bathymetric and echo-character signatures of the range of depositional environments crossed during the cruise, including Blake Plateau, Blake-Bahama Outer Ridge, Hatteras and Nares abyssal plains, Bermuda Rise, and Navidad Bank (Figure 13).

Cara Fritz studied planktonic foraminiferal faunas in the sediments, and found assemblages dominated by trpocal and subtropical species such as *Orbulina universa*, *Globigerinoides ruber*, and *G. sacculifer*. Gyre margin species like *Neogloboquadrina dutertrei* and *Globorotalia inflata* were present beneath the Gulf Stream, as expected. Loretta Leist studied the distribution of foraminifera in the water column, and found a close to 10% *Globorotalia hirsuta* in tows near Bermuda - high relative to the fossil abundance of *G. hirsuta* (probably due to our sampling a spring bloom of this globorotalid). Loretta also found *Neogloboquadrina pachyderma* (dextral), a subpolar species in the cold-core eddy tows, a biotic hint of the eddy's slope water origin. Sarah Davenport completed a study of the distribution patterns of pteropods in the water column and sediments, finding that in general, the sedimentary (relative) abundances of dominant species such as *Limacina inflata* match their water column abundances. Other species such as *Styliola subula* were more abundant in the sediments than in the water column, suggesting a strong seasonality in shell production.

Studies of marine pollutants on C-138 will contribute to long-term studies on the input of petroleum and plastics to the marine environment. Meg Rowe's study of pelagic tar in the Sargasso Sea revealed highest abundances of macro-tar in the northern Sargasso Sea on this cruise track and lower average concentrations in 1987-1988 and 1995 than in the years 1977-1981 and 1990. Tim Keating looked at the physical properties of pelagic tarballs and found a wide range of textures, suggesting that input of fresh petroleum continues in the Sargasso Sea. Chris McFadden and Tracie Hayes completed a study of the distribution of macro- and microplastic in the Sargasso Sea, and found highest concentrations of both pollutants in the center of the gyre and near high-ship-traffic areas. They also found that plastic pollution appeared to have decreased relative to past years, suggesting that MARPOL regulations may be having some effect (Figure 14).

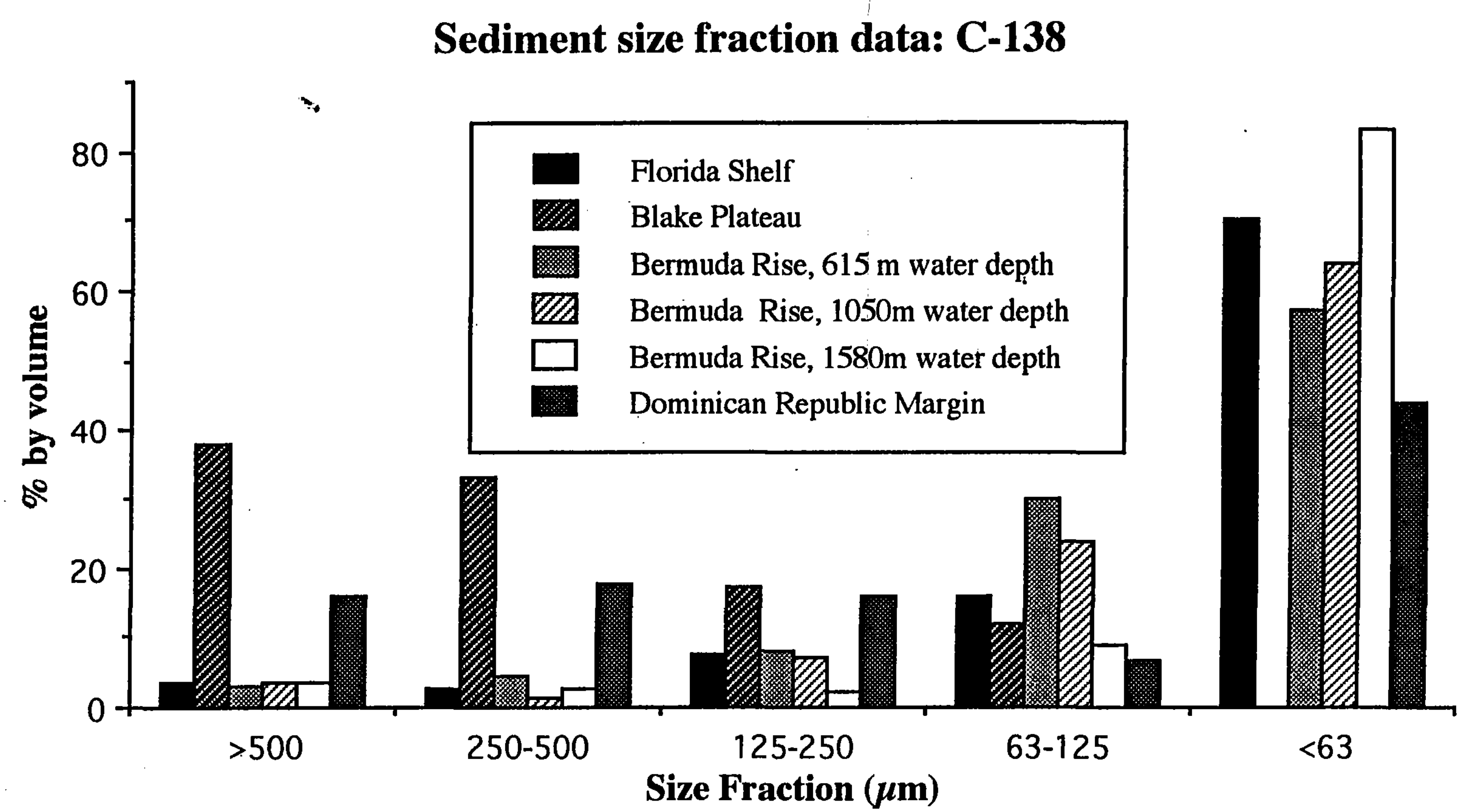

Figure 12. Sediment grain size comparison among several stations along the C-138 cruise track.

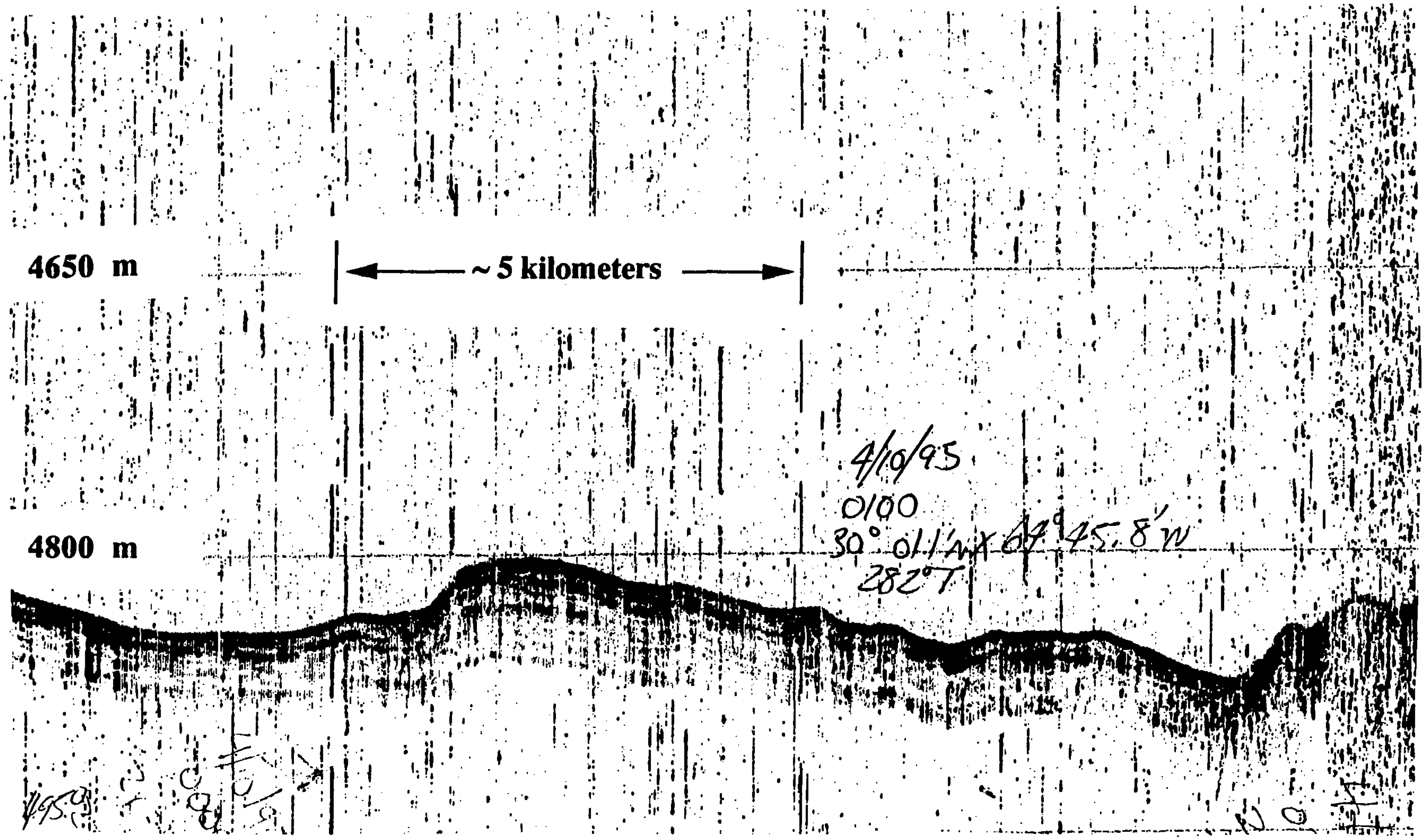

Figure 13. 3.5-kHz echo sounder record from the abyssal hill area south of the Bermuda Swell at approx. 30° N by 65° W, with subbottom reflectors showing a sediment drape at least fifty meters thick.

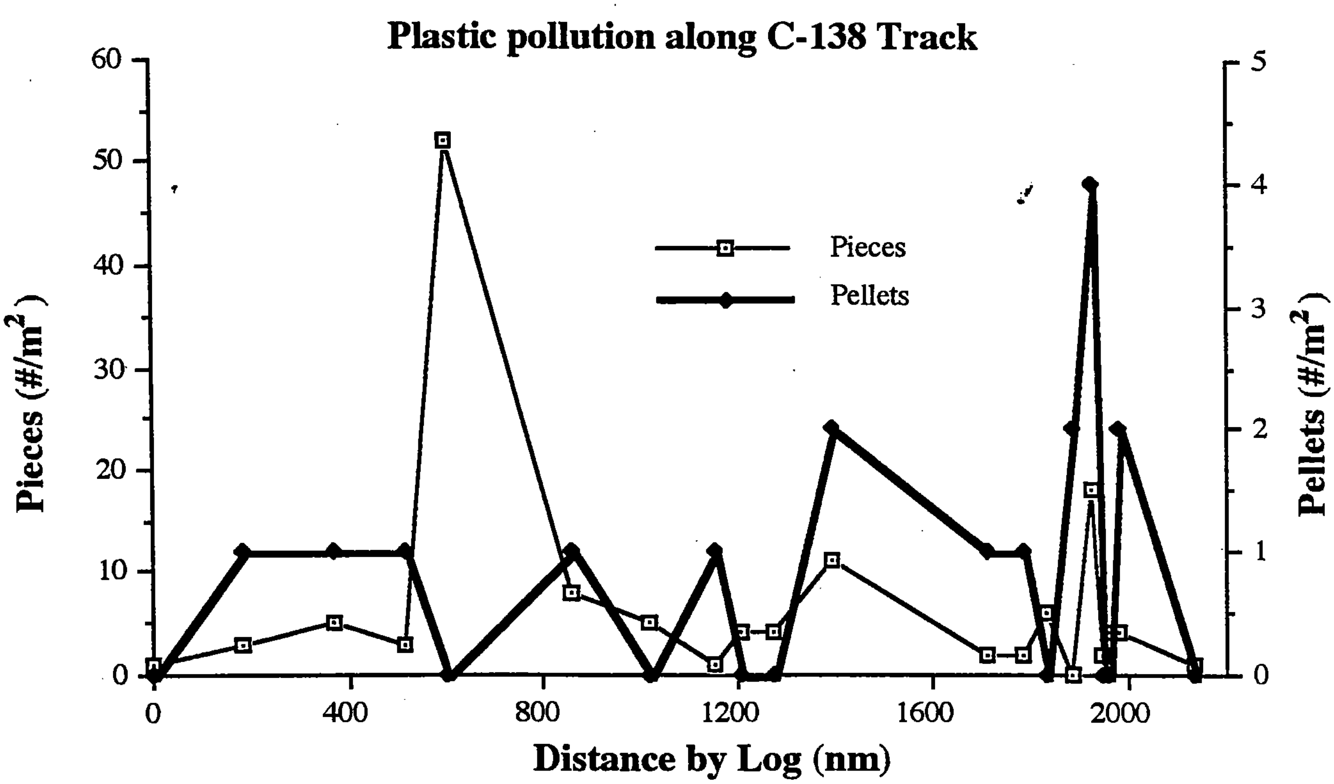

Figure 14. Macroplastic pollution along the C-138 cruise track. Data given in Appendix E.

Data Appendices

Notes for all data appendices:

1. All times are local.
2. Latitudes (north) and longitudes (west) are in decimal degrees unless otherwise indicated.
3. Blanks in data appendices indicate missing data.
4. All station locations are given in Appendix A.

Appendix A. C-138 Station Summary *

Station	Date	Time	Log (nm)	Latitude (°)	(')	Longitude (°)	(')	Equipment Deployed
1	24-Mar-95	1635	2.25	25	47	80	4	NT
2	25-Mar-95	0812	89.5	27	26	79	49	SG
3	25-Mar-95	1821	28.5	28	26	80	24	MN
4	26-Mar-95	0250	179.8	28	31	80	7	NT
5	25-Mar-95	0935	203.7	28	92	80	12	CTD
6	25-Mar-95	0935	203.7	28	55	80	7	HC
7	26-Mar-95	0945	203.7	28	55	80	8	PN
8	26-Mar-95	1425	216.4	29	19	80	1	NT
9	25-Mar-95	1824	238.5	29	50	79	69	CTD
10	27-Mar-95	0040	272.0	29	58	79	17	CTD
11	27-Mar-95	0050	272.1	29	58	79	18	MN
12	27-Mar-95	1036	315.7	29	39	78	39	CTD
13	27-Mar-95	1157	315.7	29	39	78	40	SG
14	27-Mar-95	2225	368.0	29	56	77	53	MN
15	28-Mar-95	0000	369.9	30	0	77	55	NT
16	29-Mar-95	0225	515.9	30	58	75	76	NT
17	29-Mar-95	0847	528.5	30	57	75	27	CTD
18	29-Mar-95	0847	528.5	30	57	75	26	HC
19	29-Mar-95	0825	528.5	30	57	75	27	PN
20	29-Mar-95	1013	528.5	30	58	75	27	PN
21	29-Mar-95	1127	528.5	30	58	75	20	MN
22	30-Mar-95	1212	603.2	31	15	74	30	NT
23	30-Mar-95	1130	669.5	31	23	72	54	CTD
24	30-Mar-95	1130	669.5	31	32	72	54	HC
25	30-Mar-95	2218	750.5	32	11	71	49	NT
26	31-Mar-95	1117	839.5	32	15	70	19	CTD
27	31-Mar-95	1117	840.5	32	16	70	18	HC
28	31-Mar-95	1720	849.1	32	17	70	7	MN
29	01-Apr-95	0001	861.6	32	19	69	52	NT
30	02-Apr-95	0032	938.5	32	13	68	28	MN
31	02-Apr-95	1000	964.6	32	5	68	21	CTD
32	02-Apr-95	1000	964.6	32	5	68	21	HC
33	02-Apr-95	1335	975.9	32	12	68	20	MN
34	03-Apr-95	0130	1022.5	32	17	67	43	NT
35	03-Apr-95	1016	1079.4	32	35	66	48	CTD
36	03-Apr-95	1016	1079.4	32	35	66	48	HC
37	03-Apr-95	1044	1079.4	32	34	66	47	SD
38	03-Apr-95	1057	1079.4	32	34	66	47	PN
39	03-Apr-95	1107	1079.4	32	34	66	47	PN
40	04-Apr-95	0012	1153.7	32	9	65	24	NT
41	04-Apr-95	0905	1173.0	32	9	64	58	MN
42	04-Apr-95	1010	1173.7	32	9	64	56	SD

* Separate deployments at the same location are numbered as separate stations

Appendix A. C-138 Station Summary *

Station	Date	Time	Log (nm)	Latitude (°)	(')	Longitude (°)	(')	Equipment Deployed
43	04-Apr-95	1606	1186.5	32	16	64	44	SG
44	4-Apr-95	1702	1186.5	32	17	64	43	GC
45	04-Apr-95	2140	1188.7	32	18	64	40	SG
46	05-Apr-95	0123	1208.3	32	20	64	34	NT
47	08-Apr-95	1110	1225.9	32	17	64	40	SG
48	8-Apr-95	1248	1226.0	32	15	64	39	GC
49	09-Apr-95	0020	1274.3	31	37	64	20	NT
50	09-Apr-95	0625	1290.8	31	22	64	24	CTD
51	09-Apr-95	625	1290.8	31	22	64	24	HC
52	09-Apr-95	1525	1337.7	30	39	64	38	MN
53	10-Apr-95	0208	1391.9	29	54	64	47	NT
54	10-Apr-95	1016	1431.5	29	17	64	54	CTD
55	10-Apr-95	1016	1431.5	29	17	64	54	HC
56	10-Apr-95	1000	1431.5	29	17	64	54	PN
57	10-Apr-95	1045	1431.5	29	17	64	54	PN
58	10-Apr-95	1120	1431.5	29	17	64	54	SD
59	10-Apr-95	2225	1499.1	28	22	65	9	NT
60	11-Apr-95	0045	1503.7	28	18	65	8	MN
61	11-Apr-95	0933	1565.6	27	24	65	17	CTD
62	11-Apr-95	0933	1565.6	27	24	65	16	HC
63	11-Apr-95	2237	1647.2	26	10	65	37	MN
64	12-Apr-95	0039	1649.2	26	8	65	36	NT
65	12-Apr-95	0645	1680	25	34	65	39	DN
66	12-Apr-95	1141	1716.0	25	0	65	50	NT
67	12-Apr-95	1940	1760.3	24	20	65	56	CTD
68	12-Apr-95	1940	1760.3	24	20	65	56	HC
69	13-Apr-95	0031	1783.5	23	59	66	6	NT
70	13-Apr-95	0830	1818.5	23	30	66	19	CTD
71	13-Apr-95	0830	1818.5	23	30	66	19	HC
72	13-Apr-95	0830	1818.5	23	29	66	19	PN
73	13-Apr-95	0903	1818.5	23	30	66	19	PN
74	13-Apr-95	0940	1818.5	23	29	66	19	DN
75	13-Apr-95	1331	1836.5	23	15	66	26	NT
76	13-Apr-95	2353	1886.0	22	37	66	48	NT
77	14-Apr-95	0412	1905.1	22	25	67	16	MN
78	14-Apr-95	0927	1924.8	22	14	67	15	CTD
79	14-Apr-95	1034	1924.8	22	14	67	15	HC
80	14-Apr-95	1203	1925.3	22	14	67	16	NT
81	15-Apr-95	0026	1943.6	22	8	67	24	NT
82	15-Apr-95	1251	1951.4	22	1	67	31	NT
83	15-Apr-95	0800	1949.9	22	2	67	3	DN
84	16-Apr-95	0013	1979.4	21	46	67	51	NT

* Separate deployments at the same location are numbered as separate stations

Appendix A. C-138 Station Summary *

Station	Date	Time	Log (nm)	Latitude (°)	(')	Longitude (°)	(')	Equipment Deployed
85	16-Apr-95	1345	2029.7	21	4	68	22	NT
86	16-Apr-95	2333	2070.0	20	30	68	42	MN
87	17-Apr-95	0257	2074.0	20	23	68	46	CTD
88	17-Apr-95	0257	2074.0	20	23	68	46	HC
89	17-Apr-95	1052	2099.8	20	6	68	54	FS
90	17-Apr-95	1720	2118.0	19	59	68	54	SG
91	17-Apr-95	1747	2118.0	19	58	68	54	SG
92	17-Apr-95	2118	2131.0	19	56	68	55	SG
93	17-Apr-95	2135	2131.0	19	56	68	54	SG
94	17-Apr-95	2226	2137.6	19	54	68	53	SG
95	18-Apr-95	0000	2133.1	19	52	68	53	MN
96	18-Apr-95	0142	2134.2	19	49	68	52	NT
97	18-Apr-95	0550	2149.0	19	34	68	44	CTD
98	18-Apr-95	1813	2169.0	19	11	68	50	SG
99	19-Apr-95	0020	2170.0	19	8	68	52	NT
100	27-Apr-95	2005	2807.5	26	16	75	39	MN

Code	Equipment
CTD	Conductivity-Temperature-Depth
HC	Hydrocast (Rosette)
DN	Dip Net
FS	Fisher scoop
MN	Meter Net
NT	Neuston Tow
SG	Shipek Grab
GC	Gravity Core
PN	Phytoplankton Net
SD	Secchi Disk

* Separate deployments at the same location are numbered as separate stations

Appendix B. C-138 Bathythermograph Summary

Station	Date	Time	Log (nm)	Latitude (°)	(')	Longitude (°)	(')	Surface Temp. (°C)
BT-001	24-Mar-95	2030	20.5	26	7	80	2	24.7
BT-002	24-Mar-95	2229	34.7	26	23	80	0	24.6
BT-003	24-Mar-95	2355	44.8	26	35	79	55	25.2
BT-004	25-Mar-95	0343	66.3	27	1	79	43	25.3
BT-005	25-Mar-95	1158	97.7	27	42	79	54	25.4
BT-006	25-Mar-95	1407	106.6	27	57	80	2	23.9
BT-007	26-Mar-95	0800	200.8	28	48	80	5	24.5
BT-008	26-Mar-95	1320	215.5	29	13	80	1	25.5
BT-009	26-Mar-95	1724	232.5	29	26	79	46	24.6
BT-010	26-Mar-95	2050	251.5	29	30	79	31	24.2
BT-011	27-Mar-95	0531	296.4	29	37	78	52	24.1
BT-012	27-Mar-95	1316	319.7	29	39	78	38	24.1
BT-013	27-Mar-95	1655	340.0	29	38	78	19	22.0
BT-014	27-Mar-95	2057	358.9	29	50	78	0	22.4
BT-015	28-Mar-95	0230	383.0	30	3	77	44	22.8
BT-016	28-Mar-95	0410	396.0	30	2	77	31	22.7
BT-017	28-Mar-95	0638	416.0	30	1	77	9	22.3
BT-018	28-Mar-95	0955	447.6	30	8	76	48	22.4
BT-019	28-Mar-95	1550	473.2	30	29	76	17	21.5
BT-020	28-Mar-95	1752	482.2	30	36	76	9	20.4
BT-021	28-Mar-95	2035	492.8	30	44	76	0	19.7
BT-022	28-Mar-95	2250	501.8	30	51	75	51	19.7
BT-023	29-Mar-95	0045	509.8	30	56	75	43	19.7
BT-024	29-Mar-95	0430	519.0	30	59	75	34	19.5
BT-025	29-Mar-95	1321	541.0	31	2	75	20	20.7
BT-026	29-Mar-95	1558	555.2	31	6	75	0	21.6
BT-027	29-Mar-95	1721	565.8	31	9	74	50	22.1
BT-028	29-Mar-95	2215	602.0	31	14	74	8	20.2
BT-029	30-Mar-95	0540	630.5	31	25	73	35	20.2
BT-030	30-Mar-95	0925	662.9	31	29	73	0	19.4
BT-031	30-Mar-95	1630	700.7	31	48	72	36	19.3
BT-032	30-Mar-95	2057	741.9	32	8	71	57	18.7
BT-033	31-Mar-95	0730	819.9	32	13	70	39	18.8
BT-034	31-Mar-95	1925	850.3	32	17	70	4	18.9
BT-035	01-Apr-95	1210	890.5	32	28	69	13	18.6
BT-036	01-Apr-95	1850	919.8	32	18	68	45	19.5
BT-037	02-Apr-95	0524	947.3	32	7	68	22	19.1
BT-038	02-Apr-95	1345	976.4	32	12	68	21	19.3
BT-039	04-Apr-95	1230	1174.9	32	11	64	53	18.8
BT-040	05-Apr-95	0320	1214.7	32	21	64	32	18.7
BT-041	09-Apr-95	0220	1280.0	31	32	64	21	19.5
BT-042	09-Apr-95	1255	1320.9	30	54	64	33	20.2

Appendix B. C-138 Bathythermograph Summary

Station	Date	Time	Log (nm)	Latitude (°)	(')	Longitude (°)	(')	Surface Temp. (°C)
BT-043	09-Apr-95	1940	1348.0	30	30	64	41	19.8
BT-044	10-Apr-95	0115	1386.2	29	58	64	46	20.9
BT-045	10-Apr-95	0704	1416.2	29	31	64	50	21.9
BT-046	10-Apr-95	1650	1455.5	28	58	65	2	21.3
BT-047	10-Apr-95	2050	1488.1	28	31	65	7	21.8
BT-048	11-Apr-95	0345	1521.3	28	3	65	9	21.3
BT-049	11-Apr-95	1635	1602.5	26	48	65	24	22.7
BT-050	11-Apr-95	2108	1636.6	26	18	65	35	22.6
BT-051	12-Apr-95	0613	675.0	25	39	65	39	23.0
BT-052	12-Apr-95	1236	1720.9	24	56	65	44	24.3
BT-053	12-Apr-95	1636	1750.0	24	30	65	51	24.4
BT-054	13-Apr-95	0325	1794.3	23	41	66	9	25.1
BT-055	13-Apr-95	1218	1831.0	20	17	66	24	25.1
BT-056	13-Apr-95	1925	1863.5	22	54	66	39	25.0
BT-057	14-Apr-95	0211	1895.6	22	31	66	55	25.5
BT-058	14-Apr-95	1835	1942.7	22	7	67	27	26.0
BT-059	15-Apr-95	2325	1975.0	21	48	67	50	26.0
BT-060	16-Apr-95	0720	2007.5	21	24	68	7	26.0
BT-061	16-Apr-95	1655	2049.1	20	56	68	28	26.7
BT-062	17-Apr-95	1155	2104.3	20	1	68	52	26.5

Appendix C. C-138 Hydrocast Data Summary * £

HC Station	CTD	Bottle	Depth (m)	Temp. (°C)	Salinity (ppt)	Phosphate (μM/kg)	Chl-a (μg/l)	Oxygen (ml/l)	AOU § (ml/l)
6	5	1	60	21.2	36.13	0.07	0.57	3.24	1.81
6	5	2	50	21.3	36.05	0.13	0.45	2.83	2.19
6	5	3	40	22.7	36.20	0.11	0.38	3.51	1.43
6	5	4	30	22.8	36.18	0.08	0.31	3.51	1.36
6	5	5	20	23.1	36.18	0.06	0.45	3.28	1.57
6	5	7	0	23.3	36.20	0.07	0.54		
18	17	1	1200	4.5	35.02	1.06		4.65	2.50
18	17	2	1000	5.7	35.07	1.18		4.69	2.21
18	17	3	800	8.0	35.10	1.37		3.95	2.55
18	17	4	600	12.0	35.56	1.01		3.56	2.44
18	17	5	400	16.2	36.14	0.48		4.24	1.26
18	17	6	300	17.6	36.42	0.30		4.49	0.81
18	17	7	200	17.6	36.44	0.21	0.00	4.53	0.67
18	17	8	150	19.5	36.58	0.06	0.04	4.86	0.27
18	17	9	100	19.5	36.59	0.02	0.03	4.42	0.24
18	17	10	75	19.6	36.58	0.03	0.48	5.73	0.58
18	17	11	50	19.9	36.60		0.20	4.89	0.23
18	17	12	25	20.1	36.60	0.01	0.19		
18	17	13	0	20.1	36.58	0.08	0.15		
24	23	1	1400	4.7	35.04	0.89		5.74	1.39
24	23	2	1200	5.3	35.06	1.15		5.45	1.59
24	23	3	1000	6.6	35.09	1.09		4.73	2.09
24	23	4	800	9.3	35.18	1.15		4.14	2.27
24	23	5	700	11.2	35.43	1.09		3.81	2.33
24	23	6	600	13.0	35.69	0.92		3.98	1.92
24	23	7	500	14.3	35.86	0.46		4.16	1.58
24	23	8	400	15.6	36.09	0.42		4.33	1.25
24	23	9	300	16.8	36.39	0.38		4.32	1.12
24	23	10	200	18.6	36.53	0.18		4.45	-0.80
24	23	11	100	19.7	36.65	0.00		5.26	-0.11
24	23	12	50	19.7	36.65	0.00			
24	23	13	0	19.7	36.58	0.14			
27	26	1	350	18.3	36.53			4.83	0.46
27	26	2	300	18.5	36.56	0.15		4.95	0.32
27	26	3	250	18.6	36.58	0.13		5.03	0.22
27	26	4	225	18.7	36.59	0.08	0.02	5.11	0.14
27	26	5	200	18.7	36.60	0.05	0.02	5.23	0.01
27	26	6	175	18.9	36.62	0.08	0.19	5.20	0.02
27	26	7	150	18.9	36.63	0.10	0.20	5.39	-0.17
27	26	8	125	18.9	36.62		0.22	5.33	-0.11
27	26	9	100	18.9	36.63	0.08	0.23	4.86	0.36
27	26	10	75	18.9	36.63	0.02	0.20	5.25	-0.03
27	26	11	50	18.9	36.63	0.05	0.22	5.39	-0.17
27	26	12	25	18.9	36.63	0.02	0.19	5.19	0.03
27	26	13	0	19.0	36.62	0.08	0.26		
32	31	1	1400	4.8	35.03	1.03		5.13	2.00
32	31	2	1200	5.7	35.07	1.13		5.07	1.90

* Lat/long locations of hydrocasts in Appendix A.

Appendix C. C-138 Hydrocast Data Summary * £

HC Station	CTD	Bottle	Depth (m)	Temp. (°C)	Salinity (ppt)	Phosphate (μM/kg)	Chl-a (μg/l)	Oxygen (ml/l)	AOU § (ml/l)
32	31	3	1000	7.5	35.11	1.31		4.21	2.46
32	31	4	800	11.0	35.40	1.06		3.89	2.28
32	31	5	700	13.1	35.66	1.15		4.02	1.87
32	31	6	600	15.3	36.03	0.65		4.23	1.39
32	31	7	500	16.6	36.25	0.37		4.53	0.94
32	31	8	400	17.8	36.48	0.26		4.78	0.65
32	31	9	300	18.2	36.54	0.25		4.96	0.33
32	31	10	200	18.6	36.56	0.07		4.97	0.28
32	31	11	100	19.4	36.67	0.00		5.24	0.06
32	31	12	50	19.4	36.67	0.00		5.37	0.20
32	31	13	0	19.4	36.55	0.14			
36	35	1	225	18.7	36.56	0.12	0.01	4.91	0.34
36	35	2	200	18.8	36.58	0.04	0.02	5.00	0.24
36	35	3	175	19.0	36.63	0.05	0.07	5.24	-0.03
36	35	4	150	19.1	36.65		0.07	5.30	-0.09
36	35	5	125	19.1	36.65			5.26	-0.06
36	35	6	100	19.1	36.65		0.08	5.32	-0.12
36	35	7	75	19.1	36.65		0.10	5.30	-0.10
36	35	8	50	19.1	36.64	0.16	0.31	5.16	0.05
36	35	9	25	19.1	36.65	0.01	0.31		
36	35	10	2	19.1	36.64		0.14		
51	50	1	1400	4.6	35.02	1.80		5.85	1.31
51	50	2	1200	5.4	35.07	1.96		5.50	1.52
51	50	3	1000	7.1	35.10	2.15		4.50	2.24
51	50	4	800	10.5	35.35	1.71		3.79	2.44
51	50	5	700	12.6	35.62	1.50		4.04	1.91
51	50	6	600	14.9	35.91	0.96		4.36	1.31
51	50	7	500	16.4	36.22	0.56		4.42	1.07
51	50	8	400	17.6	36.43	0.45		4.83	0.56
51	50	9	300	18.2	36.53	0.31		5.06	0.23
51	50	10	200	18.8	36.58	0.15		5.44	-0.20
51	50	11	100	19.6	36.69	0.14		5.36	-0.20
51	50	12	50	19.6	36.69	0.11		5.39	-0.24
51	50	13	0	19.7	36.60	0.20			
55	54	1	225	19.1	36.64	0.20	0.02	2.39	2.81
55	54	2	200	19.7	36.62	0.26	0.06	3.10	2.05
55	54	3	175	20.6	36.77	0.10	0.16	2.57	2.48
55	54	4	150	21.1	36.81	0.08	0.20	2.60	2.41
55	54	6	100	21.7	36.86	0.10	0.08	3.85	1.10
55	54	7	75	21.8	36.86	0.12	0.07	2.54	2.41
55	54	8	50	21.9	36.88	0.17	0.05	2.36	2.58
55	54	9	25	22.0	36.89	0.04	0.05		
55	54	10	2	22.0	36.90		0.05		
62	61	1	1600	4.4	35.04	1.49		3.32	3.88
62	61	2	1400	4.9	35.08	1.75		2.86	4.24
62	61	3	1200	5.6	35.11	1.73		5.04	1.95
62	61	4	1000	6.7	35.07	2.26		3.94	2.87

* Lat/long locations of hydrocasts in Appendix A.

HC Station	CTD	Bottle	Depth (m)	Temp. (°C)	Salinity (ppt)	Phosphate (μM/kg)	Chl-a (μg/l)	Oxygen (ml/l)	AOU § (ml/l)
62	61	5	800	9.6	35.26	1.36		3.52	2.85
62	61	6	600	13.9	35.83	0.93		2.91	2.87
62	61	7	500	15.6	36.09	0.97		3.01	2.58
62	61	8	400	17.4	36.39	0.43		3.13	2.25
62	61	9	300	18.2	36.55	0.42		4.63	0.66
62	61	10	200	19.4	36.62	0.20		1.48	3.69
62	61	11	100	20.4	36.74	0.09		3.32	1.75
62	61	12	50	21.9	36.85	0.17		3.77	1.17
62	61	13	0	22.1	36.76	0.13			
68	67	1	1600	4.4	35.02	1.80		5.86	1.33
68	67	2	1400	4.9	35.05	2.03		5.71	1.40
68	67	3	1200	5.7	35.05	2.30		4.91	2.06
68	67	4	1000	6.7	34.99	2.63		3.79	3.01
68	67	5	800	9.9	35.33	0.96		4.48	1.84
68	67	6	600	13.3	35.75	1.43		3.97	1.90
68	67	7	500	15.3	36.06	1.08		4.32	1.30
68	67	8	400	17.2	36.37	0.67		4.51	0.90
68	67	9	300	18.3	36.55	0.24		4.68	0.61
68	67	10	200	19.4	36.37	0.12		4.62	0.54
68	67	11	100	22.7	36.85	0.06		4.98	0.12
68	67	12	50	24.5	36.68	0.07		5.27	0.55
68	67	13	0	24.9	36.61	0.11			
71	70	1	225	18.9	36.62	0.13	0.01	4.60	0.62
71	70	2	200	19.3	36.64	1.12	0.01	4.45	0.74
71	70	3	175	20.2	36.78	0.08	0.03	4.08	1.11
71	70	4	150	21.0	36.92	0.12	0.04	4.32	0.69
71	70	5	125	21.9	36.80	0.06	0.11	5.10	-0.17
71	70	6	100	22.9	36.89	0.07	0.22	4.87	-0.02
71	70	7	75	23.7	36.79	0.09	0.11	4.77	0.02
71	70	8	50	24.6	36.63	0.09	0.06	4.96	-0.25
71	70	9	25	25.0	36.56	0.12	0.03	5.16	-0.47
71	70	10	2	25.0	36.57	0.10	0.03		
79	78	1	1600	4.0	35.00	1.49		6.06	1.17
79	78	2	1400	4.6	35.02	1.28		4.02	3.12
79	78	3	1200	5.5	35.08	1.94		5.05	1.94
79	78	4	1000	6.8	35.00	2.89		3.50	3.31
79	78	5	800	8.9	35.21	2.38		3.51	2.94
79	78	6	600	12.6	35.58	1.10		3.13	2.81
79	78	7	500	15.1	36.02	1.27		2.41	3.22
79	78	8	400	17.1	36.34	0.46		3.50	1.91
79	78	9	300	18.2	36.53	0.73		2.91	2.38
79	78	10	200	19.7	36.73	0.14		2.51	2.73
79	78	11	100	23.7	36.92	0.13		3.15	1.63
79	78	12	50	25.8	36.46	0.12		3.92	0.71
79	78	13	0	25.9	37.47	0.12			
88	87	1	1400	4.3	35.00			6.05	1.16
88	87	2	1200	5.0	35.01	1.94		5.51	1.58

* Lat/long locations of hydrocasts in Appendix A.

Appendix C. C-138 Hydrocast Data Summary * £

HC Station	CTD	Bottle	Depth (m)	Temp. (°C)	Salinity (ppt)	Phosphate (μM/kg)	Chl-a (μg/l)	Oxygen (ml/l)	AOU § (ml/l)
88	87	3	1000	6.2	35.01	2.00		4.10	2.79
88	87	4	800	8.0	35.03	2.34		3.72	2.89
88	87	6	600	11.8	35.48	1.44		3.79	2.26
88	87	7	500	14.1	35.86	1.18		3.85	1.91
88	87	8	400	16.7	35.26			4.59	0.87
88	87	9	300	18.2	36.54	0.20		4.64	0.65
88	87	10	200	20.7	36.68	0.09		4.62	0.43
88	87	11	100	25.3	36.93	0.07		5.14	-0.49
88	87	12	50	25.7	36.49			5.04	-0.40
88	87	13	0	26.4	36.39	0.15			

£ Hydrocast data from Stations 31/32 and 77/78 plotted in Figures 8, 10, 1nd 11.
§ Apparent Oxygen Utilization (AOU) defined as:
[Saturation Oxygen Concn.] - [Observed Oxygen Concn.]

* Lat/long locations of hydrocasts in Appendix A.

Appendix D. C-138 Surface Station Summary

Station	Date	Time	Log (nm)	Latitude	Longitude	Temperature (°C)	Salinity (ppt)	Phosphate (μM/kg)	Chl-a (μg/l)
SS-001	24-Mar-95	2025	20.5	26.06	80.02	24.7	36.09	0.41	0.29
SS-002	24-Mar-95	2225	34.2	26.23	80.00	24.6	36.19	0.25	0.12
SS-003	24-Mar-95	2355	44.8	26.35	79.55	25.2		0.20	0.07
SS-004	25-Mar-95	0343	66.3	27.01	79.43	25.3			
SS-005	25-Mar-95	0738	89.5	27.22	80.43	24.8		0.10	
SS-006	25-Mar-95	1158	97.7	27.42	79.54	25.4	36.26		0.13
SS-007	25-Mar-95	1407	106.6	27.57	80.02	23.9	36.24	0.05	0.34
SS-008	25-Mar-95	1710	123.2	28.12	80.13	21.1	35.78	0.21	0.25
SS-009	25-Mar-95	2126	144.5	28.20	80.09	22.3	36.31	0.05	0.89
SS-010	26-Mar-95	0550	192.3	28.33	80.01	24.7	36.23	0.08	0.19
SS-011	26-Mar-95	0800	200.7	28.48	80.05	24.5	36.24	0.20	0.38
SS-012	26-Mar-95	1320	215.5	29.13	80.01	25.5	36.25	0.13	0.09
SS-013	26-Mar-95	1723	232.5	29.26	79.47	24.6	36.40	0.24	0.23
SS-014	26-Mar-95	2050	251.5	29.30	79.31	24.2	36.27	0.35	
SS-015	27-Mar-95	0530	296.4	29.37	78.52	24.1	36.27		
SS-016	27-Mar-95	1316	319.7	29.39	78.40	24.1	36.34	0.04	0.05
SS-017	27-Mar-95	1655	340.0	29.38	78.19	22.0	36.59	0.00	0.15
SS-018	27-Mar-95	2053	358.9	29.49	78.01	22.4	36.54	0.00	0.06
SS-019	28-Mar-95	0230	383.0	30.03	77.44	22.8	36.49	0.22	0.21
SS-020	28-Mar-95	0638	416.0	30.01	77.09	22.3	36.57	0.16	0.13
SS-021	28-Mar-95	0952	437.6	30.07	76.48	22.4	36.52	0.02	0.08
SS-022	28-Mar-95	1548	473.2	30.29	76.17	21.5	36.52	0.31	0.10
SS-023	28-Mar-95	2035	492.8	30.44	76.00	19.7	36.68	0.48	0.18
SS-024	29-Mar-95	0430	519.0	30.59	75.34	19.5	36.51	0.17	0.27
SS-025	29-Mar-95	1319	541.0	31.02	75.20	20.7	36.71	0.20	0.11
SS-026	29-Mar-95	1719	565.6	31.09	74.50	22.1	36.63	0.12	
SS-027	29-Mar-95	2215	602.0	31.14	74.79	20.0	36.80	0.25	0.16
SS-028	30-Mar-95	0535	630.5	31.25	73.35	19.4	36.61	0.06	
SS-029	30-Mar-95	0925	662.9	31.29	73.00	19.4		0.05	0.29
SS-030	30-Mar-95	1630	700.7	31.48	72.36	19.3	36.60	0.14	0.29
SS-031	30-Mar-95	2051	741.0	32.08	71.58	18.7		0.22	0.28
SS-032	31-Mar-95	0730	819.9	32.14	70.39	18.8	36.78	0.06	0.24
SS-033	31-Mar-95	1925	850.3	32.17	70.04	18.9	36.71	0.17	0.43
SS-034	01-Apr-95	1210	890.5	32.28	69.13	18.6	36.61	0.18	0.70
SS-035	01-Apr-95	1846	919.8	32.18	68.45	19.5	36.80	0.23	0.10
SS-036	02-Apr-95	0521	947.3	32.07	68.22	19.1		0.20	0.25
SS-037	02-Apr-95	1345	976.4	32.12	68.21	19.3	36.80	0.00	0.27
SS-038	02-Apr-95	2210	1012.0	32.13	67.53	18.8	36.70	0.04	0.32
SS-039	03-Apr-95	0712	1060.5	32.34	67.08	19.1	36.71	0.00	0.20
SS-040	03-Apr-95	1520	1101.5	32.28	66.21	19.0	36.14	0.15	0.13
SS-041	03-Apr-95	2100	1135.5	32.14	65.45	19.4	36.75		0.41
SS-042	04-Apr-95	0353	1164.0	32.09	65.11	18.5	36.67	0.60	0.23
SS-043	05-Apr-95	0315	1214.7	32.21	68.31	18.7	36.72	0.10	0.12
SS-044	08-Apr-95	1545	1238.0	32.07	64.30	18.9	36.78	0.14	0.28
SS-045	08-Apr-95	2250	1268.9	31.42	64.20	19.2	36.84		0.35
SS-046	09-Apr-95	1255	1320.9	30.54	64.33	20.2	36.85	0.29	0.14
SS-047	09-Apr-95	1940	1348.0	30.30	64.41	19.8	36.81	0.16	0.13

Appendix D. C-138 Surface Station Summary

Station	Date	Time	Log (nm)	Latitude	Longitude	Temperature (°C)	Salinity (ppt)	Phosphate (μM/kg)	Chl-a (μg/l)
SS-048	10-Apr-95	0110	1386.2	29.59	64.46	20.9		0.05	0.06
SS-049	10-Apr-95	0704	1416.2	29.31	64.50	21.9	36.98		0.06
SS-050	10-Apr-95	1650	1455.5	28.58	65.02	21.3	36.93		0.06
SS-051	10-Apr-95	2050	1488.1	28.31	65.07	21.8	37.04	0.10	0.01
SS-052	11-Apr-95	0345	1521.3	28.03	65.09	21.3	36.96	0.15	0.04
SS-053	11-Apr-95	1635	1602.5	26.48	65.24	22.7	36.82	0.09	0.03
SS-054	11-Apr-95	2105	1636.6	26.18	65.35	22.6	36.96	0.09	0.04
SS-055	12-Apr-95	0613	1675.0	25.39	65.39	23.0	36.79	0.32	0.03
SS-056	12-Apr-95	1236	1720.9	24.56	65.44	24.3	36.77	0.18	0.03
SS-057	12-Apr-95	1636	1750.0	24.30	65.52	24.4	36.81	0.20	0.03
SS-058	13-Apr-95	0325	1794.3	23.49	66.09	25.1	36.50	0.13	0.22
SS-059	13-Apr-95	1925	1863.5	22.54	66.39	25.0	36.63	0.08	0.03
SS-060	14-Apr-95	0211	1895.6	22.31	66.54	25.5	36.55	0.10	0.04
SS-061	14-Apr-95	1835	1942.7	22.07	67.27	26.0	36.37	0.14	0.03
SS-062	15-Apr-95	2320	1975.0	21.48	67.49	26.0	36.45	0.09	0.15
SS-063	16-Apr-95	0720	2007.5	21.24	68.07	26.0	36.43		0.04
SS-064	16-Apr-95	1655	2049.1	20.56	68.28	26.7	36.61	0.09	0.02
SS-065	17-Apr-95	0635	2080.5	20.10	68.52	26.1	36.55	0.14	
SS-066	17-Apr-95	1155	2104.3	20.17	68.52	26.5	36.56	0.07	0.09
SS-067	18-Apr-95	0035	2133.5	19.51	68.52	26.3	36.73	0.06	0.09

Appendix E. C-138 Neuston Data Summary * £

Station	Date	Time	Surface temp. (°C)	Tow Distance (m)	Zooplankton biomass (g)	Macrotar (g)	Plastic pieces (#)	Plastic pellets (#)	*Sargassum* (g)
1	24-Mar-95	1635	24.8	1852	55		0	1	1.0
4	26-Mar-95	0250	24.1	1296	20.0	0.0	4	0	1.0
8	26-Mar-95	1425	25.2	370	20.0	0.0	0	0	43.0
15	28-Mar-95	0000	22.3	167	11.0	0.2	5	1	0.0
16	29-Mar-95	0225	19.6	1667	130.0	6.0	3	1	0.0
22	30-Mar-95	1212	20.5	1852	0.6	1.0	52	0	0.0
25	30-Mar-95	2218	18.8	1852	99.9	0.0	0	0	0.0
29	01-Apr-95	0001	18.7	2407	105.0	0.2	9	0	0.0
34	03-Apr-95	0130	19.0	1852	45.0	0.0	0	0	0.0
40	04-Apr-95	0012	19.2	1852	60.0	0.0	0	0	0.0
46	05-Apr-95	0123	18.6	2408	25.0	0.2	0	0	0.0
49	09-Apr-95	0020	19.5	1944	50.0	0.8	4	0	0.0
53	10-Apr-95	0208	20.3	1852	75.0	0.2	0	12	0.0
59	10-Apr-95	2225	22.0	2778	7.0	0.0	2	0	0.0
64	12-Apr-95	0039	23.0	1852	3.0	0.0	0	0	0.0
66	12-Apr-95	1141	24.3	1852	20.0	1.2	2	1	0.5
69	13-Apr-95	0031	24.0	1852	9.0	0.2	2	1	0.5
75	13-Apr-95	1331	25.1	1852	1.5	0.2	6	2	0.0
76	13-Apr-95	2353	25.4	2778	8.0	0.1	0	2	0.0
80	14-Apr-95	1203	26.2	1480	45.0	0.6	18	4	0.0
81	15-Apr-95	0026	26.0	926	6.0	0.0	0	2	0.0
82	15-Apr-95	1251	26.0	1150	90.0	0.2	0	4	0.0
84	16-Apr-95	0013	26.1	1852	30.0	0.0	0	1	0.0
85	16-Apr-95	1345	26.2	1852	3.0	0.0	0	0	0.0
96	18-Apr-95	0142	26.3	1852	7.5	0.0	0	0	0.0
99	19-Apr-95	0020	26.6	1852	3.0	0.0	0	0	0.0

* Station locations given in Appendix A.
£ Plastic piece and plastic pellet abundance data plotted in Figure 14.

Appendix F. C-138 Meter Net Data Summary *

Station	Date	Time	Tow Depth (m)	Tow length (m)	Zooplankton biomass (g)	Zooplankton density (g/m^3)	Net Type
3	25-Mar-95	1821	20	711	75	0.13	1m
11	27-Mar-95	0050	40	1737	184	0.14	1m
14A	27-Mar-95	2225	40	2263	60	0.03	1m
14B	27-Mar-95	2225	40	676	57	0.11	1m
21	29-Mar-95	1127	200	3740	190	0.05	1m
28	31-Mar-95	1720	300	698	190	0.02	2m
30A	02-Apr-95	0032	200	1423	70	0.06	1m
30B	02-Apr-95	0108	200	2181	100	0.06	1m
33A	02-Apr-95	1335	200	3269	51	0.02	1m
33B	02-Apr-95	1335	200	1099	113	0.13	1m
41A	04-Apr-95	0905	40	187	14	0.10	1m
41B	04-Apr-95	0905	40	1931	110	0.07	1m
52A	09-Apr-95	1525	200	1231	35	0.01	2m
52B	09-Apr-95	1525	200	2024			2m
60A	11-Apr-95	0045	40	283	35	0.16	1m
60B	11-Apr-95	0045	40	1820	70	0.05	1m
63A	11-Apr-95	2237	50				1m
63B	11-Apr-95	2237	50	1582	5	0.00	1m
63C	11-Apr-95	2237	50	671	20	0.04	1m
77A	14-Apr-95	0412	50	540	8	0.02	1m
77B	14-Apr-95	0412	50	2009	25	0.02	1m
86A	16-Apr-95	2333	200	2978	80	0.03	1m
86B	16-Apr-95	2333	2009	1274	45	0.04	1m
95	18-Apr-95	0000	200	2616	29	0.01	1m
100	27-Apr-95	2005	500				1m

* Station locations given in Appendix A.

Appendix G. C-138 Sediment Sampling Summary *

Station	Equipment	Locale	Water Depth (m)	Qualitative Description
2	SG	Florida Shelf	300	FORAMS, PTEROPODS
13	SG	Blake Plateau	800	FORAMS, PTEROPODS
43	SG	Bermuda Rise	615	ALGAE, CORALLINE FRAGS, FORAMS
44	GC	Bermuda Rise	574	NO RECOVERY
45	SG	Bermuda Rise	55	RHODOLITHS
47	SG	Bermuda Rise	1015	FORAMS, PTEROPODS, SPICULES
48	GC	Bermuda Rise	1580	FORAMS, PTEROPODS
89	FS	Navidad Bank	26	CALCAREOUS ALGAE
90	SG	Navidad Bank	32	ALGAE AND GASTROPODS
91	SG	Navidad Bank	32	BENTHIC ALGAE
92	SG	Navidad Bank	27	CALCAREOUS ALGAE
93	SG	Navidad Bank	33	CALCAREOUS ALGAE
94	SG	Navidad Bank	1080	PTEROPODS, FORAMS
98	SG	Dominican Rep. Margin	870	PTEROPODS, FORAMS

* Station locations and key to equipment codes given in Appendix A.