CRUISE REPORT

W-132

SCIENTIFIC ACTIVITIES UNDERTAKEN ABOARD THE *SSV WESTWARD*

Miami - Jamaica - Roatan - Miami

24 March 1994 - 30 April 1994

Sea Education Association
Woods Hole, Massachusetts

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Preface

On the 24th of March 1994, a company of 22 students arrived at the Port of Miami to board the *SSV Westward* for a 6-week journey into the warm waters of the Bahamas and Caribbean Sea. Their adventure was not only in the places which were travelled, but through the experience of life at sea working aboard a sailing vessel, and in learning first hand about the practical realities of scientific study of the sea. The biological and physical properties of the ocean were visually revealed rather than through theory prescribed by a textbook. The geologic nature of the sea floor, became not only a topic for interested study, but an important factor to examine during anchoring and navigating the vessel.

While spirits were high on our departure, seasickness cast its unpleasant spell on those both experienced and inexperienced. However, several courageous, though possibly delirious, participants were seen riding the bowsprit in pure exhilaration. During our second week aboard ship, a breakfast of biscuits and gravy heralded the birthday of our fearless leader, Captain Terry Hayward, as well as the mild mannered Miles (known to break into rap when viper fish abound). In the guise of helping Brannon on his project, we all got to sample the white sands and clear waters of the island West Plana Cay in the Bahamas. With sorrow it was discovered that the windward side of the island was littered with both plastic debris and tremendous quantities of gooey tar.

Following our sail through the Windward Passage, Seth showed us his dip-netting skills and landed many a sargassum prize for Betsy's ciguatara project. Our arrival in Jamaica was accompanied by the offerings of the natives. Though substances of other persuasion have been the problem in the past, during this trip, offers of love seemed to be a more prevalent problem, particularly for Sarah and Brian. Laundry became the name of the game in Jamaica and the *Westward* was decked out in everyone's finest (relatively speaking of course). Two spots on the island quickly became favorites among the crew and students: Reach Falls and Hunters dock bar. River rafting aboard bamboo style floats also was a well enjoyed experience.

Upon leaving Jamaica, a week of intense and sometimes frantic paced scientific sampling was to ensue. Several deep hydrocasts and meter net tows accompanied fast and furious sampling over Pedro and Rosalind Banks. Each rock dredge and shipek grab brought up new and exciting samples.

As the heat continued to increase, Shep fought back with a multitude of daily saltwater dousings. Several flying fish boarded the ship, though Tim remained fishless off the line. During a brief stop in French Harbor, Roatan, all of us enjoyed the pleasant breezes and hearty drinks at the Yacht Club's veranda bar. After Cathy Sherrill joined the ship we were off to Port Royal for two days of snorkeling, hiking, and hull scrubbing. The unspoiled richness of Roatan was revealed in the small and isolated harbor. Initiates to the reef environment were treated to its natural beauty and spectacular underwater life.

A miraculous thing happened following our departure from Roatan: Tim caught a fish. And it was not in the most common way - Mahi Mahi on a fly rod! Student presentations ensued during the last week of our voyage and many hours of hard work and effort produced some interesting talks. Clear weather and a fair breeze allowed for an excellent photo opportunity on one day. A short ride in the zodiac produced a bevy of smiles and hopefully many good pictures of the ship. That same day, a shrewd trade of rum for swordfish landed us several days worth of delicious fresh fish. With strong winds developing, the *Westward* all but flew towards Miami. Taking a short break to clean-up and enjoy one of the final nights aboard, we anchored at Cay Sal Bank. One of the highlights of this last swizzle had to be the schooner races. Many creative and highly sophisticated vessels were manufactured and christened with the appropriate names. Unfortunately, rough weather in the racing seas swamped many of the entries and their crews alike. Fun was had by all!

Many thanks to Captain Terry Hayward not only for his excellent leadership and sailing skills, but personally for his supportive and enjoyable companionship. Our trip was also made both fun and safe by the capable seamanship and teaching skills of the Mates: Sean Bercaw, Beth Doxsee, and Virginia Land. We still wonder if Doxsee Clams does anything but clams; maybe scallop puffs? After a difficult first leg, Engineer Will Banks recovered exceptionally well and kept the ship in great shape and running smoothly. Much appreciation to Will in his diligent and well humored attempts at repairing scientific equipment. The food aboard ship was not only delicious, but produced in a more organized manner than I have ever seen. Thanks to Steward Amy McKee, keep up the good work.

Within the science department, three Assistant Scientists aided in both the teaching and research aspects of the program. First Assistant Caroline Sheild provided excellent knowledge in a wide variety of topics, a never ending willingness to help, and her own special brand of humor. Thanks also to Second Assistant, Tim Remick for his enjoyable participation and helpful guidance to the students. On her first voyage with SEA, Third Assistant Scientist, Victoria Rectenwald provided helpful assistance in the laboratory and a pleasant perspective.

Much of the success of each SEA program has to be attributed to the students. And the participants aboard W-132 certainly deserve this honor. Though one of the largest group of procrastinators with which I have worked, you were also one of the most pleasant. As a group, the W-132 students worked extremely well together for whatever tasks were at hand, and were supportive of one another even under trying conditions. Thanks for your participation. I hope that this was an experience which taught you a great deal, both as science students and as people. Good luck in all of your future endeavors !

Ellen J. Prager
Chief Scientist, W-132

W-132 Crew and Student Participants

Science Staff

Chief Scientist	Ellen Prager
First Assistant Scientist	Caroline Sheild
Second Assistant Scientist	Tim Remick
Third Assistant Scientist	Victoria Rectenwald

Nautical Staff

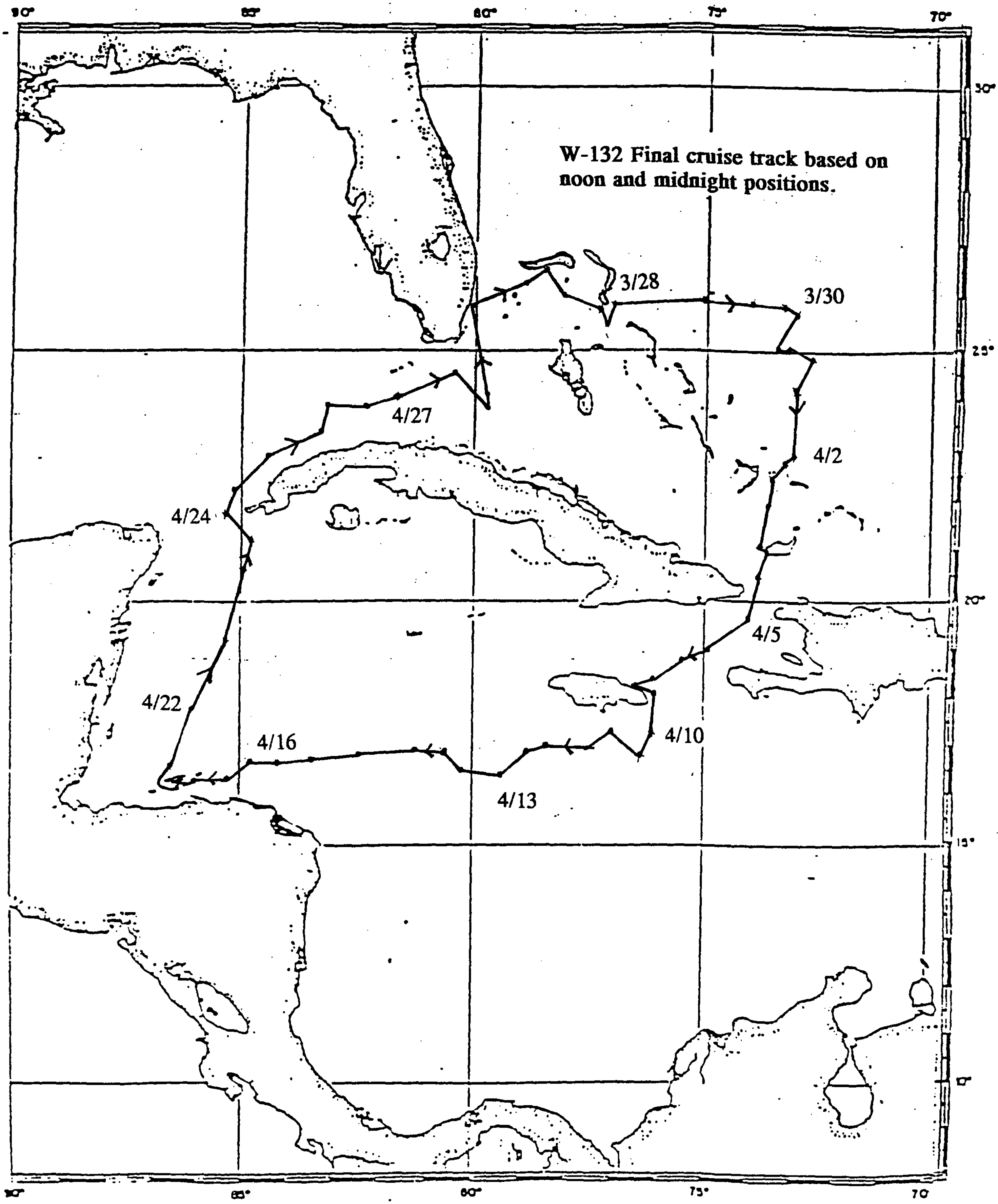
Captain	Terry Hayward
Chief Mate	Sean Bercaw
Second Mate	Beth Doxsee
Third Mate	Virginia Land
Engineer	Will Bank
Steward	Amy McKee

Students

Janine Ahmed	Mt. Holyoke College
Seth Cameron	Middlebury College
Sarah Davis	Middlebury College
Kristian Demary	Mt. Holyoke College
Brian Dursi	Colgate University
Andrew Enright	Middlebury College
Laurie Felsing	Kenyon College
Brannon Fisher	Colgate University
Heather Fremgen	Middlebury College
David Giesecke	Cornell University
Chris Gostyla	Middlebury College
Justin Harrison	Middlebury College
Betsy Humphrey	Middlebury College
Miles Jurgens	Univ. of Mass.
Erin Koenig	Univ. of Colorado
Beau Lescott	College of the Holy Cross
Ilana Lidsky	Cornell University
Susan Moulton	Middlebury College
Geralyn Sculli	Fairfield University
Jon Shepherd	Middlebury College
Rachel Weaver	Middle Tenn. State University
Ian Zelo	Cornell University

Visitors

Cathy Sherrill	Sea Education Assoc.


W-132 Final cruise track based on noon and midnight positions.
3/28
3/30
4/2
4/5
4/10
4/13
4/16
4/22
4/24
4/27
90°
85°
80°
75°
70°
30°
25°
20°
15°
10°

W-132 Academic Program

	Topic	Lecturer
Week 1		
3/24	Orientation	Staff
3/28	Caribbean Geology	Ellen Prager
3/29	Epi-Mesopelagic Life	Ellen Prager
3/30	Langmuir Circ. Cells	Ellen Prager
	Oxygen Titration Chemistry	Caroline Sheild
3/31	Discussion: Ocean Dumping	
Week 2		
4/1	Coral Reefs (rained out)	Ellen Prager
4/4	Creature Features	
4/5	Coral Reefs (the return)	Ellen Prager
4/6	Waves	Ellen Prager
4/7	Arrive Jamaica	
Week 3		
4/11	Rosalind Bank Station Work	
4/12	Coastal Bay Circulation and Computer Modeling	Ellen Prager
4/13	Practical Exam	
4/14	Discussion: Modern vs. Traditional Technology	
Week 4		
4/17	Mangroves	Tim Remick Caroline Sheild
4/18	Arrive Roatan	
Week 5		
4/22	Final Exam	
4/23	Ocean Microcosms	V. Recktenwald
4/25	Project Presentations	
4/26	Project Presentations	
4/27	Project Presentations	

Student Research Projects:

Janine Ahmed: Factors Affecting the Distribution and Diversity of Zooplankton

Seth Cameron: The Horizontal Distribution of Leptocephali in the Sargasso Sea

Sarah Davis: Distribution of Tar in the Sargasso Sea and Caribbean Sea

Kristian Demary: The Bleaching of the Benthic Foraminifera, *Amphistegina gibbosa*

Brian Dursi: A Comparison Between Formation, Sedimentation and Response to Sea-Level Between The Bahama Banks and the Carbonate Platforms of the Caribbean Sea

Andrew Enright: Pedro Bank, Mixing vs. Topographic Upwelling: A Study of Chlorophyll *a*, Phosphates, Dissolved Oxygen and Isotherm Structures

Laurie Felsing: The Distribution and Abundance of *Sargassum natans* and *fluitans* in the Caribbean and Sargasso Seas

Brannon Fisher: Sedimentary Environments and Processes Effecting Sub-Marine Sediment Transport on West Plana Cay

Heather Fremgen: Salinity Maximum Water: Properties and Flow

David Giesecke: Water Circulation Within the Bahamas and Caribbean Sea: Current Analysis Using the Geostrophic Equation

Chris Gostyla: On the Presence of Antarctic Intermediate Water in the Southwest North Atlantic Ocean and Caribbean Sea

Justin Harrison: The Deep Chlorophyll Maximum: The Pycnocline: Is it the Controlling Factor for its Existence?

Betsy Humphrey: A Study of Dinoflagellates Associated with Ciguatera on Pelagic Macroalgae

Emile Jurgens: the Distribution of Phyllosoma Larvae in the Bahamas and Caribbean

Erin Koenig: Distribution and Characteristics of Ciguatera in Benthic Communities

Beau Lescott: A Study on the Selectivity in Feeding and the Migratory Behavior of Myctophidae

Ili Lidsky: An Analysis of Form, Morphology, and Composition of Carbonate Nodules and

Calcium Carbonate Encrustation on Two Banks in the Northwestern Caribbean

Susan Moulton: Pteropods as Indicators of Tropical and Subtropical Water Masses in the Southern Sargasso and Caribbean Seas

Geralyn Sculli: Horizontal and Vertical Distribution of Myctophids in the Southern Sargasso and Caribbean Seas

Jonathan Shepherd: Types, Distribution, and Abundance of Pelagic Plastics in the Southern Sargasso and Caribbean Seas

Rachel Weaver: Factors Controlling Abundance and Distribution of *Halobates micans* in the Gulf Stream, Sargasso and Caribbean Seas

Ian Zelo: The Caribbean Sea Nutrient Gradient: Its Identification and Its Effects on Dominance and Competition in the Benthic Community

Cruise Summary

Along the W-132 cruise track, participants investigated regional variations in the physical, chemical, and biological properties of the southwestern North Atlantic Ocean and within waters of the Caribbean Sea. Geologic studies of sediments and sea floor morphology were conducted on the shallow carbonate banks of the Bahamas and on two banks, Pedro and Rosalind, in the Caribbean. Pollutant concentrations were examined at the sea surface along the cruise track and on the island of West Plana Cay in the Bahamas. Data was collected by all on board and then interpreted as part of individual 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-132 is shown in Figure 1. The first area of oceanographic research was the Bahamas and adjacent waters of the southwestern Sargasso Sea. Near the end of this first leg, an afternoon was spent on West Plana Cay studying sedimentary depositional processes around the southern tip of the island. After sailing through the Windward Passage, research resumed just north of Jamaica. Following a short port stop in Jamaica, work continued east and south of the island. In the Caribbean Sea research intensified as the ship approached Pedro Bank and continued at a hectic pace till Rosalind Bank was traversed. Following a brief stop in Roatan, Honduras, the *SSV Westward* headed towards its final destination, Miami, Florida. Little sampling was done on the last leg of the cruise to allow for data analysis, and completion of individual reports (refer to Appendix A for location of sampling stations). The following text represents a summary of preliminary data interpretations by the students participating in cruise W-132.

Water Mass and Current Flow Studies

Two projects were performed to identify and examine the characteristics of specific water masses. Distribution of salinity and temperature with depth were examined along the W-132 cruise track to examine the presence and extent of salinity maximum water (Heather Fremgen) and Antarctic Intermediate Water (Chris Gostyla). Formed during the summer in the North Atlantic, salinity maximum water typically sinks to mid-water depths and flows south. Results of this study found the characteristic temperature and salinities (greater than 36.6 ppt) of this water mass from the surface to approximately 240 m near the Bahamas and at similar depths in the Caribbean (Figure 2). A relatively high oxygen concentration was found to correlate with the presence of Salinity Maximum Water. The occurrence of this water mass was more distinct in the waters studied in the Caribbean than those off the Bahamas, and no Salinity Maximum Water was found in the waters just north or south of the Windward Passage. Findings suggest that during the early spring the Salinity Maximum Water which is present in the Caribbean results from transport north by the Caribbean Current through the Caribbean Sea. Salinity Maximum Water probably enters the Caribbean Sea mainly through the passages between the Lesser Antilles Islands as opposed to that

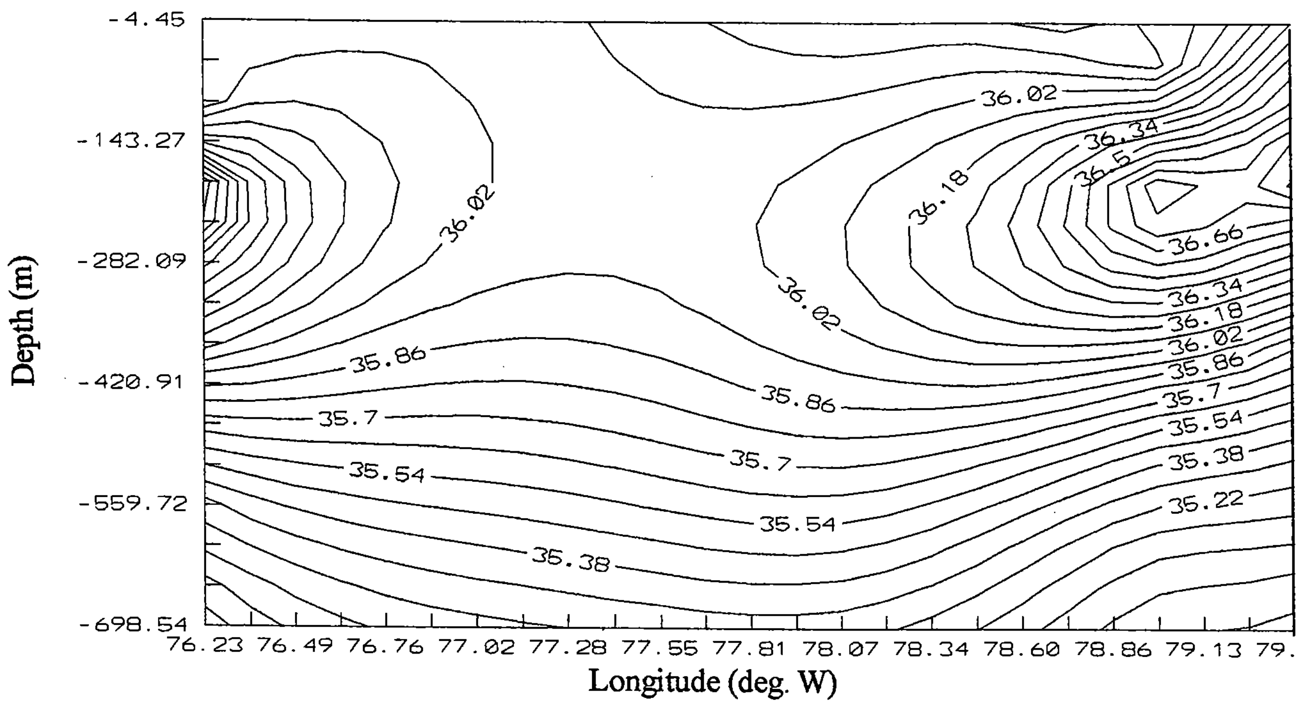


Figure 2 : Cross-section of salinity with depth south of Jamaica to Rosalind Bank, isohalines are in ppt. Salinity Maximum Water is indicated by two core structures.

between Cuba and Haiti. In addition, Salinity Maximum Water found in the vicinity of the Bahamas may occur due to transport and trapping by the Antilles Current.

Antarctic Intermediate Water (AAIW) is a relatively deeper water mass. It forms at the Antarctic Polar Front, sinks, and flows north at depths between approximately 600 and 1000 m. AAIW is typically characterized by temperatures ranging between 4 and 10°C, a salinity minimum between 34.7 and 34.97 ppt, as well as relatively high concentrations of phosphate and silicate. No clear evidence of AAIW was found during the first leg of the voyage. The presence of this water mass was first observed east of Jamaica at a depth of approximately 800 - 1000 m. A thicker wedge of AAIW was found at the stations conducted southwest of Jamaica at depths between 700 and 1000 m. Relatively high concentrations of phosphate and silicate were found in conjunction with the AAIW water mass. As with the previously discussed water mass, results indicate that AAIW travels northward through the Caribbean Sea after entering at its southeasterly entrances, with little or any passing through the Windward Passage.

Using the geostrophic method, and data obtained with a CTD, an examination of current flow east of the Bahamas, east-southeast of Jamaica, and between Pedro and Rosalind Banks was performed (David Giesecke). The magnitude and direction of flow was calculated between stations based on 10 m depth intervals. Findings suggest the presence of a counterclockwise eddy within the Sargasso Sea just east of the Northwest Providence Channel in the Bahamas. A countercurrent and possible eddy was also found east of Jamaica. As has previously been suggested, calculations also revealed that the strength of the northwestwardly flowing Caribbean Current was an order of magnitude greater on Rosalind Bank as compared to Pedro Bank.

Pelagic Pollution

Studies were conducted to examine the distribution and abundance of pelagic plastics (John Shephard) and tar (Sarah Davis) along the cruise track. Both of these projects examined present-day concentrations of these pollutants and compared them with previously collected data. Results of neuston net tows suggest that both plastic and tar are found in greater abundance in the Sargasso Sea as compared to the Caribbean (Figure 3). Explanations for this include the trapping effect of the anticyclonic gyre present in the Sargasso Sea, as well as the sieve effect of the islands surrounding the Caribbean Sea.

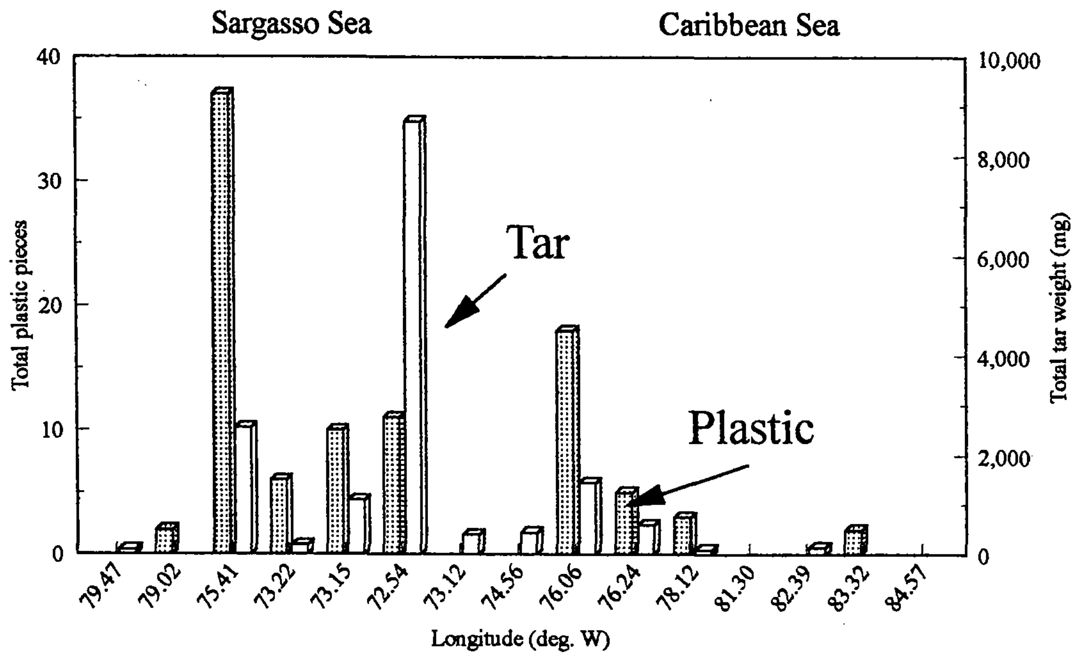


Figure 3: Total plastic pieces and tar collected in successive neuston tows each covering approximately 1 nautical mile.

Of the plastics collected, pieces of manufactured products were more common than pelletal raw materials. Results suggested an increase in plastic pieces as compared to findings prior to legislation in 1988 which restricted dumping. However, it is not clear if an increase in plastic pieces results from increased dumping or the breakdown of what is already present. An abundance of both plastics and tar was found on the windward beach of West Plana Cay. In contrast, little stranded pollution was found on the leeward side of the island. Levels of tar collected along the cruise track were found to be highest in connection with commonly used shipping lanes. No definite long-term trends in the concentration of tar within the southwestern Sargasso or Caribbean Seas could be interpreted from the data collected. Further examination of this topic is warranted in future studies.

Biological Studies

A large number of the research projects undertaken during W-132 focused on biological aspects of the ocean. Some of these studies examined the distribution and abundance of specific organisms, while others were of a more general nature. Two such projects focusing on broader scale topics were 1) the location and exploration of the causal factors in the presence of a deep chlorophyll maximum along the cruise track (Justin Harrison), and 2) the regional distribution, abundance, and diversity of zooplankton (Janine Ahmed).

Data from CTD casts and analysis of water samples collected at discrete depths with Niskin bottles suggest the presence of a deep chlorophyll maximum (DCM) at 100 m in the Sargasso Sea and 80 m in the Caribbean. When available, measurement of light penetration indicated that the DCM occurs below the 1% light level (Figure 4) . Findings also showed that it occurs either in conjunction with or just above the nutricline and/or the thermocline (Figure 5). Results of this study lend support to two theories, each of which attempt to explain the presence of the DCM; 1) its location represents the optimal growing conditions for phytoplankton or 2) it is the result of dead organic matter which has collected on the density barrier provided by the thermocline (pycnocline).

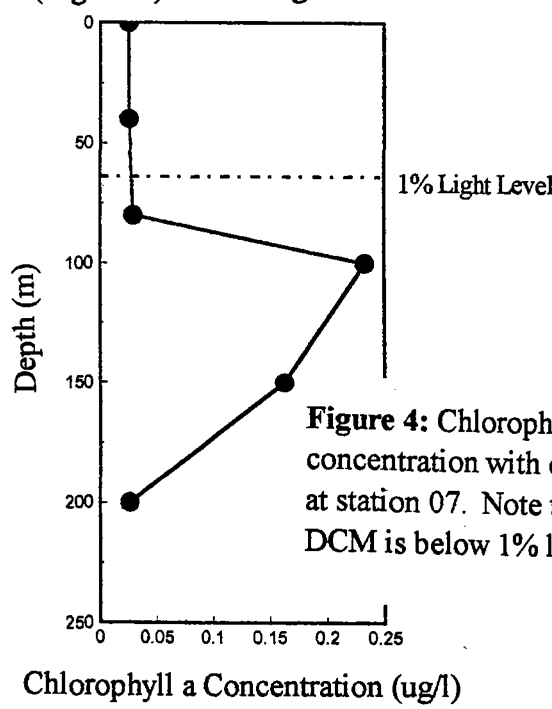


Figure 4: Chlorophyll *a* concentration with depth at station 07. Note that the DCM is below 1% light level.

Examination of zooplankton collected in meter and neuston net tows showed several interesting relationships. Commonly found within the nets were copepods, mysids, euphausiids, siphonophores, pteropods, amphipods, and isopods. The abundance of zooplankton was greatly increased in night neuston tows as compared with those performed during the day. Additionally, the diversity of the organisms collected appeared to decrease at night. These results are believed to be the result of vertical migration which increased the population of those organisms which migrate to the surface at night, consequently increasing abundance and decreasing diversity. It was also found along the cruise track that fewer zooplankton were found where chlorophyll and phosphate levels were low. Thus suggesting the importance of nutrient concentrations and phytoplankton productivity in controlling zooplankton abundance.

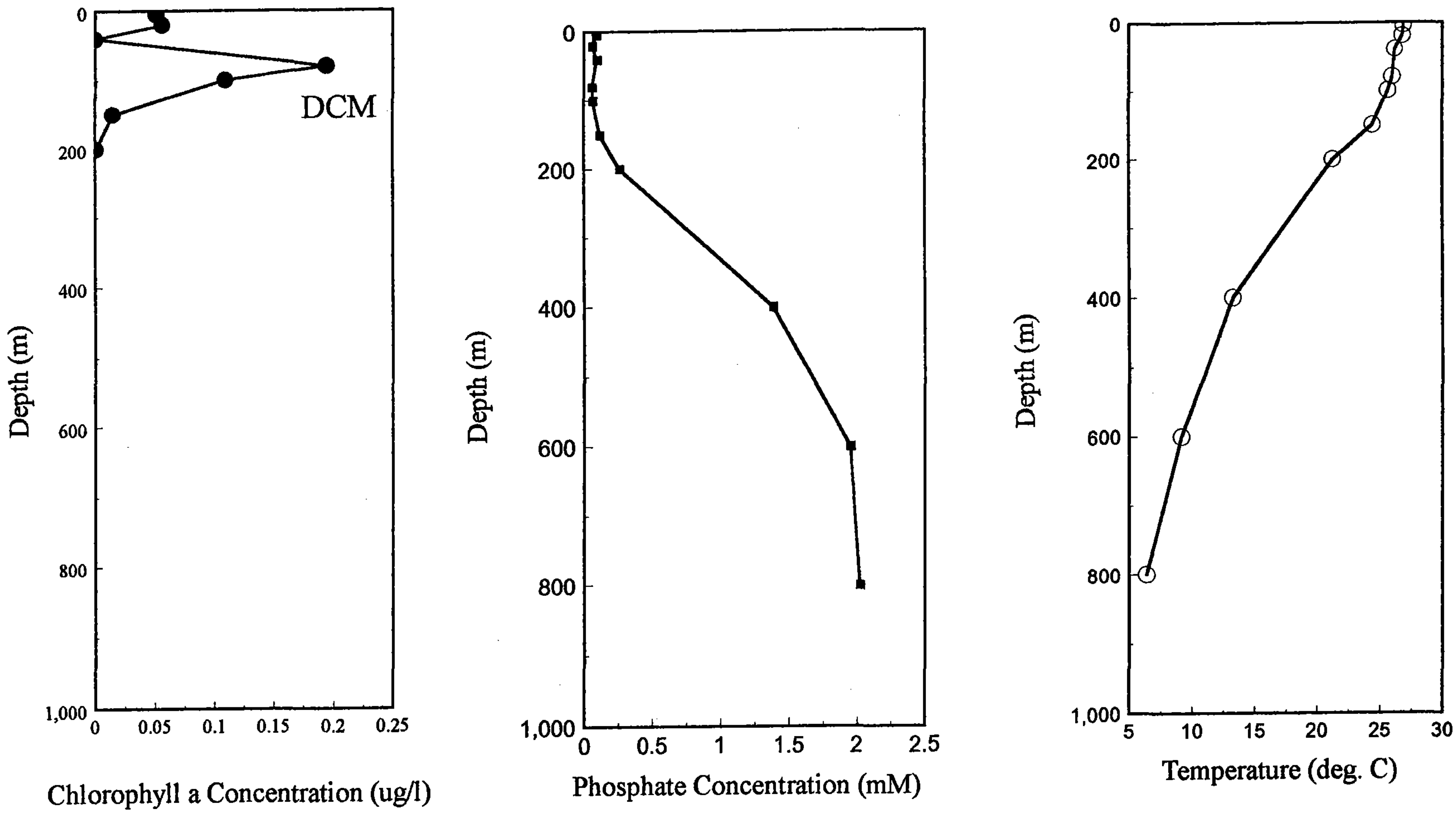
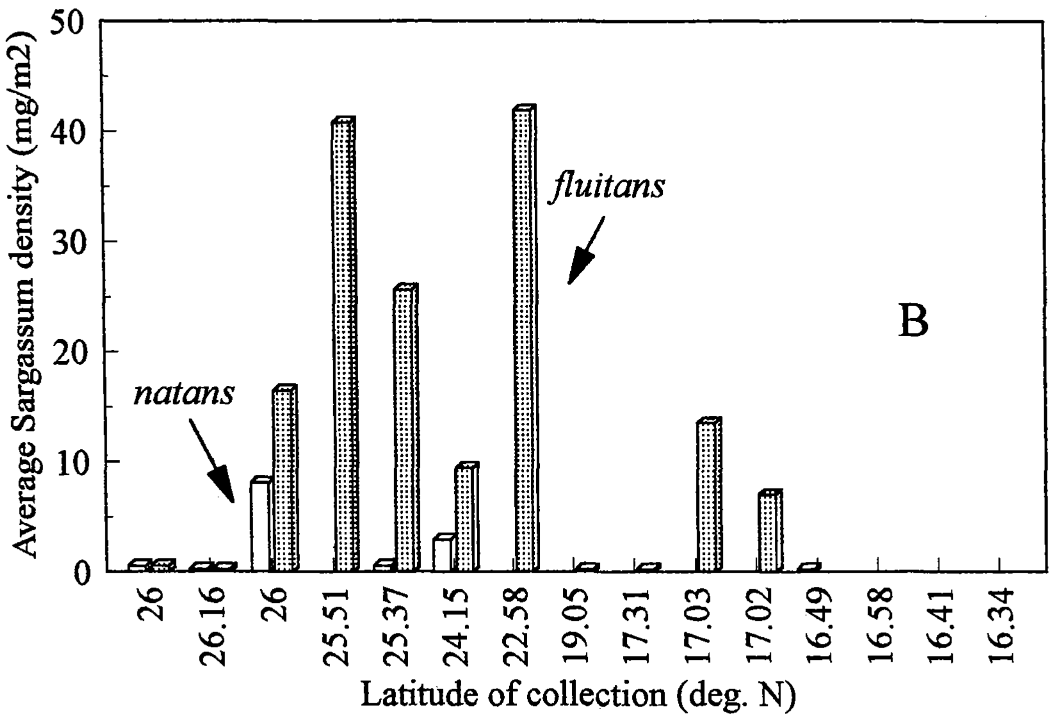


Figure 5: Profiles of chlorophyll *a*, phosphate, and temperature with depth at station 028.

Two of the student research projects examined organisms living at the air-sea interface. One of these studies was conducted to investigate the distribution, abundance, and potential spawning grounds of the marine insect *Halobates micans* (Rachel Weaver). Results suggest that *H. micans* abundance is strongly controlled by sea surface temperature; increasing numbers of the insect were collected at warmer water temperatures. More were also collected at night than day due to their visual acuity and ability to avoid the nets. The greatest number of nymphs were collected in the Sargasso Sea, suggesting that this is a possible area of spawning. The other study within this zone of the ocean focused on the distribution and abundance of the pelagic seaweed Sargassum (Laurie Felsing). The distribution of Sargassum was found to be quite patchy in both the Sargasso Sea and Caribbean, with a greater abundance occurring in the Sargasso Sea (Figure 6A). This is believed to occur due to the trapping effect of the gyre system. Data suggests that optimal temperatures for growth of *Sargassum fluitans* range between 25 and 26.5° C, whereas for the species *Sargassum natans* it is less than approximately 24.5° C. This would explain the tendency to catch more *S. fluitans* than *S. natans* in increasingly warm waters along the cruise track (Figure 6B). When this study's data was compared to that from previous cruises no clear trend was found in long-term abundance. Additionally, though suggested in the literature, no relationship was found between Sargassum abundance and concentrations of tar.

Several benthic organisms have larvae which are planktonic until metamorphosis into a form in which recruitment to the benthos can take place. Both eels and the spiny lobster have a larvae and life cycle of this type. It is not clear how the non-swimming larvae move to their adult habitats or if local eddy systems provide for isolated populations and/or large-scale oceanic currents mix populations among and between regions. Along the W-132 cruise track both phyllosoma (Emile Jurgens), the larvae of the spiny lobster, and leptocephali (Seth Cameron), that of eels, were collected and studied. An attempt was made to determine where these larvae originated, what was their path of transport, and could they provide information to determine if local retention or downstream recruitment would play a role in their return to a habitat suitable for adult life. Nine phyllosomes and two juvenile spiny lobster were caught along the W-132 cruise track. All were identified as being relatively late stage larvae, suggesting that they were from last year's spawning, thought to occur late April to June. The location from which the larvae were collected support both the local retention and upstream recruitment theories. Late stage larvae were found within the area just east of the Bahamas in which a possible eddy was identified based on geostrophic data. This supports the idea that local eddies function to retain larvae within local populations. Larvae were also collected from within the Caribbean Current suggesting that large-scale flow is responsible for the transport of these larvae possibly from the islands of the Lesser Antilles. Consequently, they will either be lost or settle at a site downstream of their origin.

Studies of leptocephali or eel larvae suggest that several families may spawn within the Southern Sargasso Sea. Eels within the Congridae, Xenocongridae, Muraenidae, and Ophichthidae families were all caught within net tows along the W-132 cruise track. Based on their size, age was estimated. It was found that they did indeed become older with distance from the Southern Sargasso Sea. In contrast, this pattern was not found for



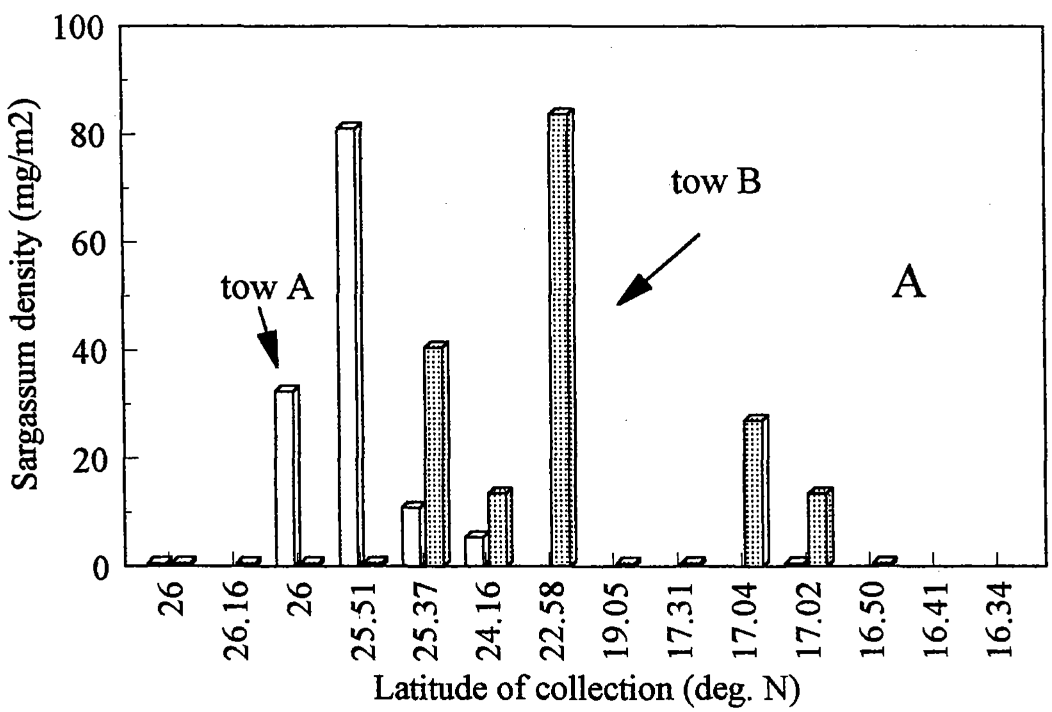


Figure 6 : Average sargassum density collected along the W-132 cruise track (A) and patchiness reflected in density of successive tows (B).

specimens of the family Moringuidae which were caught. It is suspected that these eels may spawn within the southwestern Caribbean Sea. In addition to leptocephali, two eels which had very recently metamorphosed past the larvae stage were collected just east of the Bahamas. These findings are further evidence for the eddy indicated by physical data, and also supports the concept of local circulation as a means of entraining eels within or to coastal habitats.

Due to regional species distributions, several types of marine organisms have been suggested as useful water mass indicators. The distributions of two such organisms, pteropods (Susan Moulton) and the mesopelagic fish myctophidae (Geralyn Sculli), were examined as potential water mass indicators along the cruise track. Pteropods were collected using both a 2-meter net and neuston net. Specimens were separated out from collections and identified to the species level. The distribution of species was compared to previously reported data to determine if individual species or groupings of such could be used as water mass indicators. Results suggest that while some species were found within the areas expected, e.g. *Limacina bulmoides* within principally subtropical waters, other "indicator" species were found either in several water masses or in one not previously reported as appropriate. Findings suggest that while further research and sampling is needed to confirm distribution and abundances, some species such as *Styolia subula* and *Cresius a forma acicula* do not appear to be accurate indicators of water mass distribution.

The distribution of myctophidae species along the W-132 cruise track was found to be both supportive and contradictory as evidence for their use as water mass indicators. For instance, individual species which reportedly represent temperate-subtropical waters were collected from waters classified as tropical. However, other results suggested a distinct pattern of faunal change when crossing regional boundaries which are often used to distinguish water masses. Further work is needed to examine these changes and determine if they support use as an indicator. Sampling did reveal that due to differences in depths of vertical migration, it is important to use methods which sample both at the surface, as well as at depth. Myctophidae of the genus myctophum were collected only at the surface in the neuston net, while those of the genus diaphus were found only at depth using the meter net.

Another aspect of the myctophidae studied was their feeding behavior (Beau Lescott). Previous research has suggested that these mesopelagic lantern fish are non-selective feeders, eating what is most abundant in the surrounding waters. However, recent SEA projects have discovered that some species may indeed feed selectively. To pursue this question, the stomach of each myctophid was dissected and when possible, the gut contents identified. The type of organisms found in the stomach was then compared to the composition of the zooplankton population caught in the same tow in which the fish was found. Pteropods and shrimp were the most commonly identified materials found within the myctophidae. Whereas these were not the most abundant zooplankton in the water column in which the myctophid were feeding, it suggests that the fish were exhibiting selectivity in choosing its prey. Because of the difficulty in differentiating the identity of stomach contents, further research is needed to confirm these findings and to investigate if there are any species specific feeding patterns.

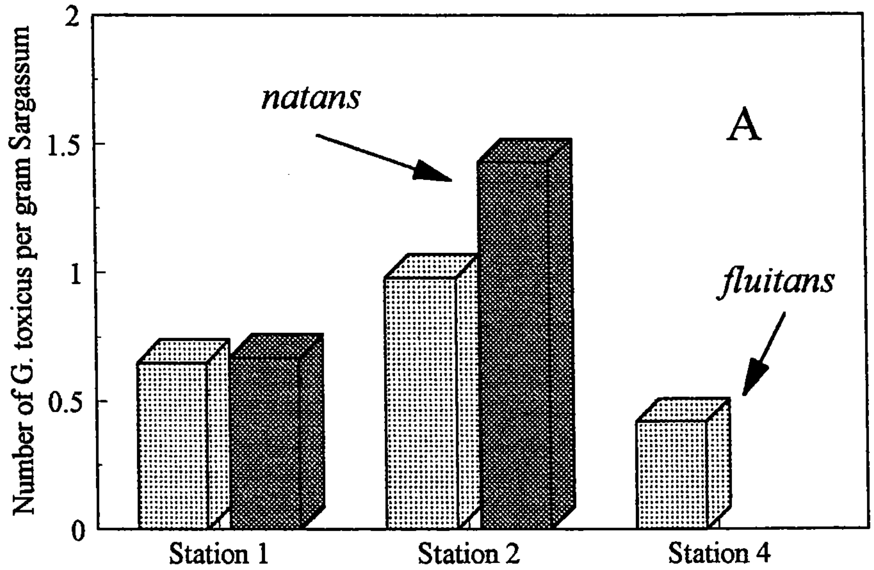
Two student research projects focused on the presence and abundance of dinoflagellates known to produce a poison called ciguatoxin. When concentrated within larger fish which may be caught and eaten, this toxin is believed to have been responsible for wide spread and common illnesses, primarily in tropical regions. While one study examined the occurrence and abundance of these dinoflagellates on pelagic macroalgae (Betsy Humphrey), the other centered its attention on their occurrence on differing species of benthic macroalgae (Erin Koenig). Previous research suggests that *Gambierdiscus toxicus* produces ciguatoxin and may be transported between islands and coastal communities on pelagic macroalgae. Findings aboard the *SSV Westward* support this conclusion. *G. toxicus* was found on sargassum in the Bahamas, Sargasso Sea, and waters south of the Windward Passage in the Caribbean Sea. There seemed to be no preference for sargassum species or relationship to the amount of algae present (Figure 7). Results also clearly show that sampling with a neuston net is an ineffective means of collection as compared to a dip net due to the washing action of flow during the neuston tow process.

Eight species of macroalgae were collected off the island of West Plana Cay in the Bahamas, and from Roatan in Honduras. *G. toxicus* was found on four of the eight samples. Other dinoflagellates often found in association with *G. toxicus* were found on these and several of the other samples. No clear pattern with regard to abundance, habitat preference or host algal species type was found. Results suggest that the distribution of the organisms associated with the ciguatoxin is patchy. The benthic species which harbored *G. toxicus* in concentrations ranging from 0.25 to 1.3 organisms per gram were identified as *Sargassum pteropleuron*, *Turbinaria turbinata*, *Penicillus dumetosus* and one unidentified species.

In a recently published report, benthic foraminifera of the species *Amphistegina gibbosa* were found bleached within the sediments of Conch Reef off Florida. Laboratory studies showed that bleaching may occur as a response to increased ultra-violet (UV) radiation. It was hypothesized that bleaching found in Florida in 1991 was a response to increased UV levels that have occurred due to the 1991 Mt. Pinatubo eruption. During the W-132 cruise, specimens of *A. gibbosa* were collected from Pedro and Rosalind Banks in the Caribbean Sea to determine if bleaching is occurring within an area outside of the Florida region (Kristian Demary). From a total of 61 live individuals collected on Pedro Bank, only 2 were completely bleached and 18 partially bleached. On Rosalind Bank, only one completely bleached individual was collected and 16 partially bleached specimens (Figure 8). Data suggest that bleaching may be occurring in areas outside of Conch Reef, but potentially on a much smaller scale than previously found in the Florida region.

Geological and Bank Top Studies

During a brief stop on West Plana Cay research was undertaken to examine the sediments and patterns of transport along the southern shore (Brannon Fisher). Sediment



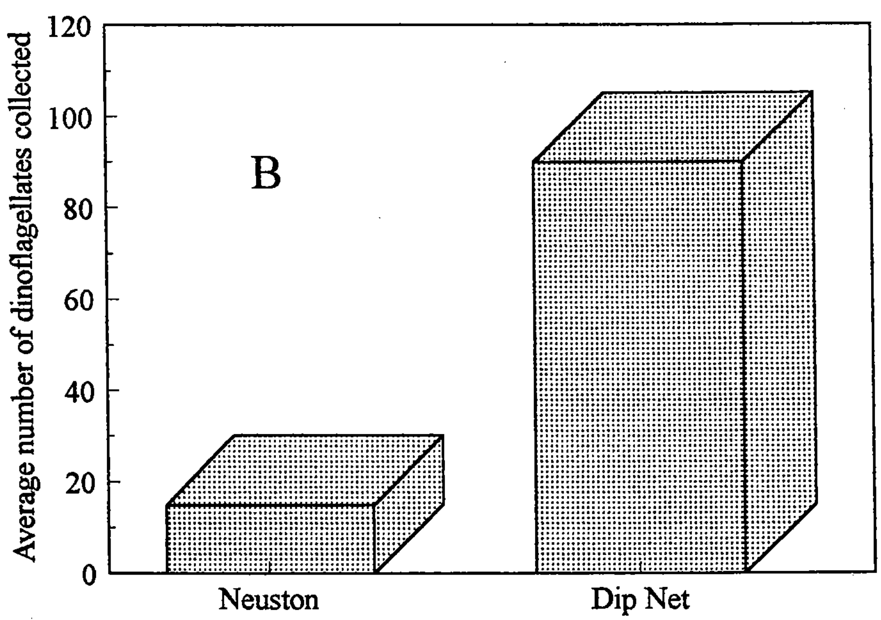


Figure 7: Abundance of dinoflagellate *G. toxicus* found on *S. fluitans* and *S. natans* (A), and (B) total number dinoflagellates found on algae collected with neuston tows versus dip net.

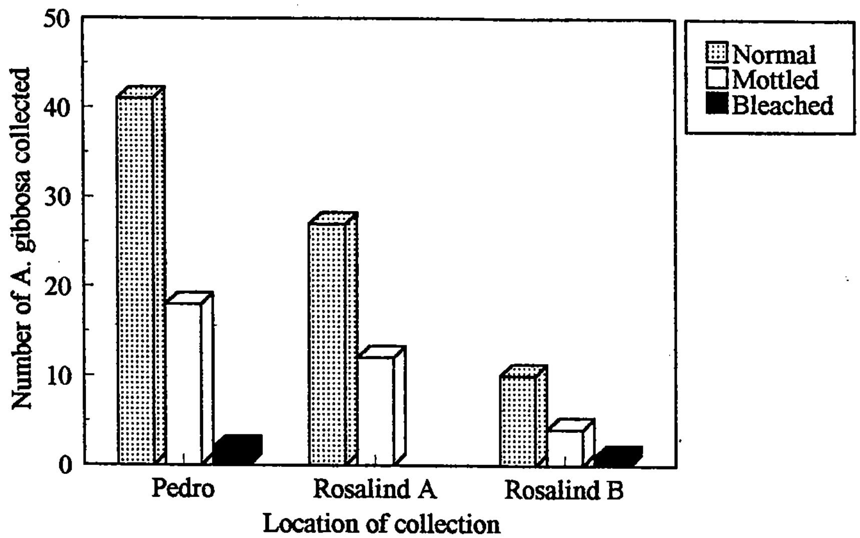


Figure 8: Results of research examining bleaching of benthic foraminifera found on Pedro and Rosalind Banks.

samples were collected from various sites along the windward and leeward margin of the southern end of the island. On the leeward shore, surface sediments were taken along a transect from the beachface and waterline to 15 meters seaward of the beach. Analyses of sediment composition and grain size suggest that sediments fine northward along the leeward shore due to transport via water movement. Higher wave energy on the windward side results in the presence of coarser sediments (Figure 9). Various reef derived materials making up the sediments on the southern tip and leeward shores of the island may originate either from the windward reefs or scattered patch reefs found off the leeward shore (Figure 10). Due to deposition of coarse-grained sediments at its boundaries, a small cove on the southern side of the island appears to be infilling with finer-grained materials. Water within the vicinity of this cove appeared greener and more turbid than within the surrounding areas. In addition, patch reefs found in the area appear blanketed with sediment and many of the surfaces are clear of living organisms. In contrast, patch reefs off the more western leeward shore seem to be healthy and flourishing.

Previous studies have suggested that the growth of carbonate nodules occurs on many of the shallow banks within the Caribbean Sea. A project was conducted to investigate the occurrence and composition of these nodules on Pedro and Rosalind Banks (Ili Lidsky). Additionally, while snorkeling in a shallow bay in Jamaica several nodules were collected to use for comparison with those to be found on the banks. In a total of 6 rock dredges, three on each bank (Figure 11), very few, if any true nodules were found. On Pedro Bank, dredging recovered carbonate encrusted whole bivalve shells coated with sponge and green algae. On Rosalind Bank, coral rubble and pieces of bivalve shells covered with a slight encrustation and a diversity of non-calcified growth were collected. While some coralline algae growth was found, the principle encruster appeared to be the foraminifera *Gypsina vesicularis*. Encrustations appeared thicker on materials from Pedro Bank as compared to

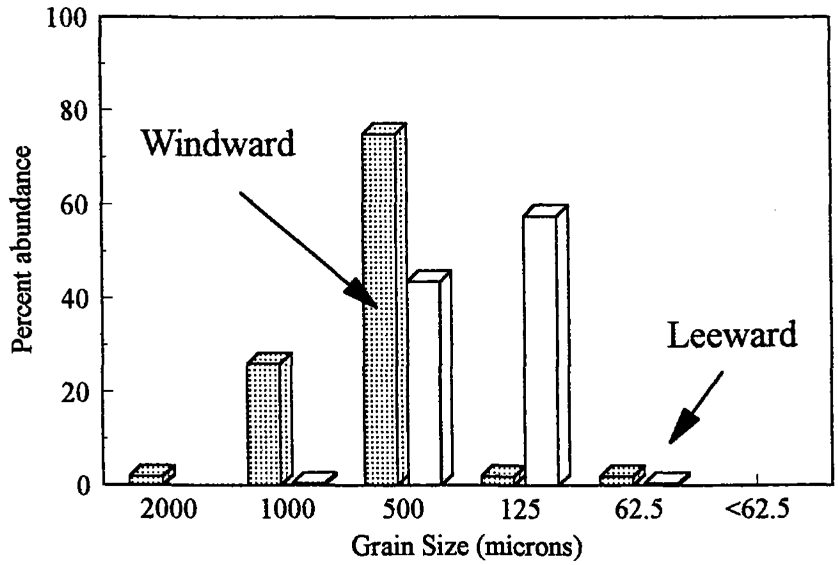


Figure 9: Grain size distribution from sediments collected at the waterline from windward and leeward shores of West Plana Cay.

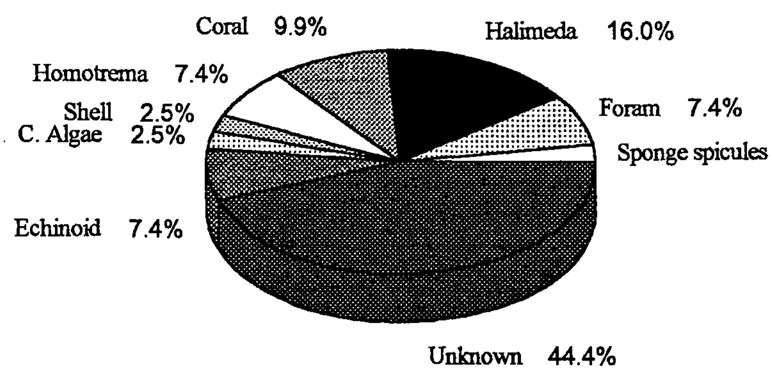
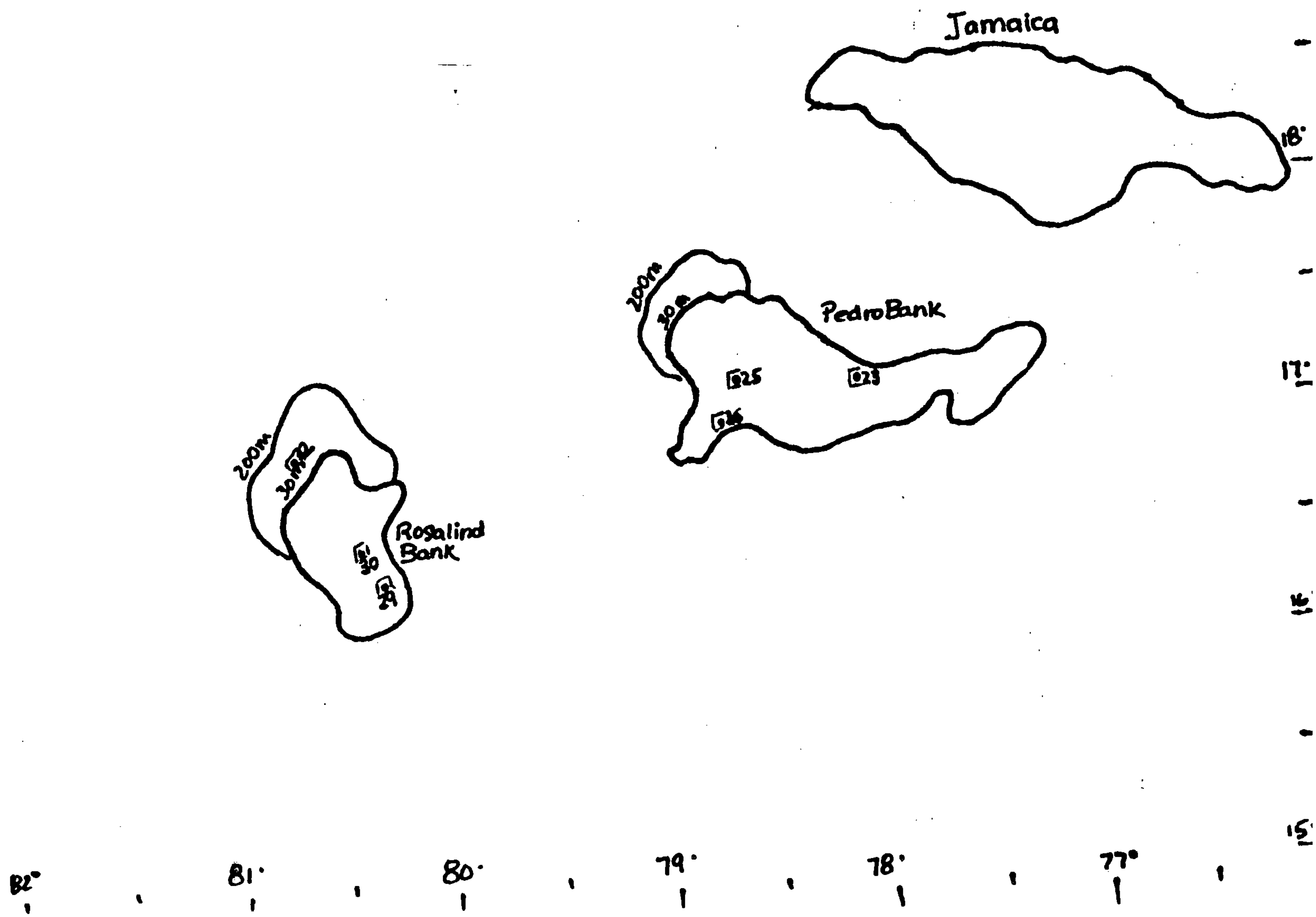


Figure 10: Composition of sediment sample collected from West Plana Cay beach.

Figure 11: Map of rock dredging locations on Pedro and Rosalind Banks. (after Lidsky, 1993)

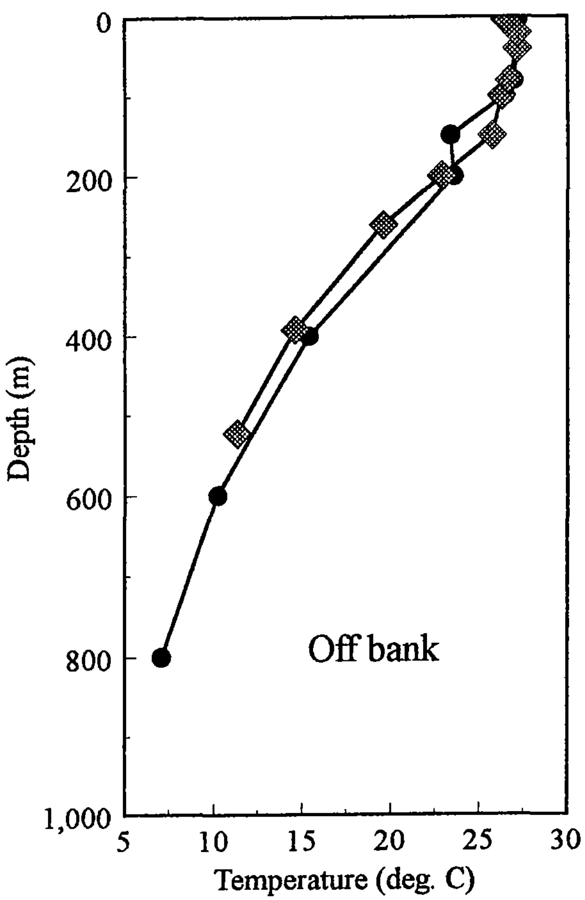


those from Rosalind Bank. One explanation for the difference may be a stronger current which transports materials over and off of Rosalind Bank more rapidly than on Pedro Bank. Further research is needed to confirm the surprising findings that no true nodule growth is actually occurring on either of these banks. In contrast, the nodules collected in Jamaica were true rhodoliths composed completely of columnar growing crusts of coralline algae.

In continuing with the bank theme, another project was performed to compare and contrast the overall structure and sediments of the extensive shallow banks in the Bahamas with the relatively smaller and isolated Caribbean Banks (Brian Dursi). With the use of echo sounding and sediment sampling, sea floor topography and composition were compared. Within the Bahamas, profiles revealed soft-sediment covered terraces and slopes; evidence of their continued progradation and coelescencing nature of their formation. On Pedro Bank, one of the most significant findings was that although the average depth is reportedly approximately 30 m, our data suggests that the bank top sits at 15 - 20 m. The slope up the bank was steep and isolated terraces were found at depths below those in the Bahamas. No terraces were found along the steep slopes of Rosalind Bank, though what appears to be a relatively deep (40 m) furrow was found at its leeward edge. Due to transport over the bank, sediments tended to become finer leeward. Evidence of coral reef presence on the leeward sides of both Pedro and Rosalind Banks was found though data suggests that they are at depths deeper than those on the windward side of the Bahamian Islands. In addition, these reefs do not provide an effective barrier, thus allowing strong currents to pass over these banks and transport sediment into the deeper surrounding waters.

Hydrographically, both Pedro and Rosalind Bank have been reported to influence the chemistry and biology of the overlying and surrounding waters. Due to their shallow depths and the northwestward flow of the Caribbean Current, these banks are thought to facilitate topographic upwelling. In addition, because of the increase in banks and ridges to the west, combined with land-derived nutrient inputs, an east-west nutrient gradient is reported to occur within the Caribbean Sea. Two projects were undertaken to examine these two phenomena: 1) topographic upwelling over the banks (Andrew Enright) and 2) an east-west nutrient gradient partially caused by this upwelling (Ian Zelo).

Although previous data suggested upwelling as a means of nutrient input as evidenced by cooler bank top water temperatures, no evidence of this phenomenon could be found. Waters overlying the bank and its edge were warmer than the surrounding waters, possibly due to solar heating and isotherm structures as well as phosphate concentrations did not show the bank edge patterns expected if upwelling was occurring. A slight increase in chlorophyll levels on the leeward edge of Pedro Bank was found and is thought to indicate a slight rise in productivity. Temperature profiles and phosphate concentrations show that bank top waters are well-mixed (Figures 12 and 13), consequently it is believed that mixing via the passage of the Caribbean Current over the banks may be responsible for increased productivity on the leeward bank edge.



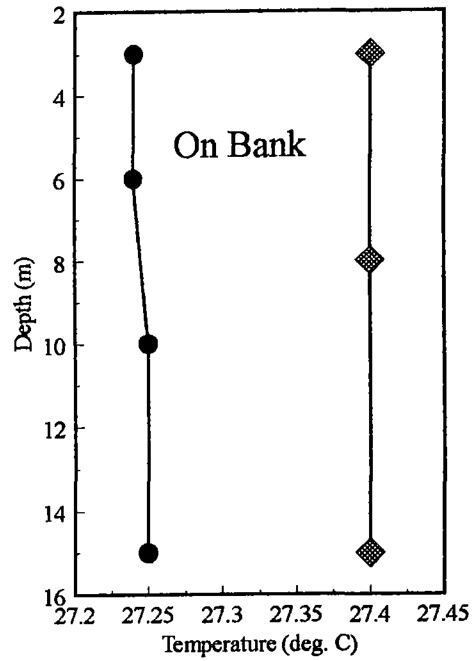
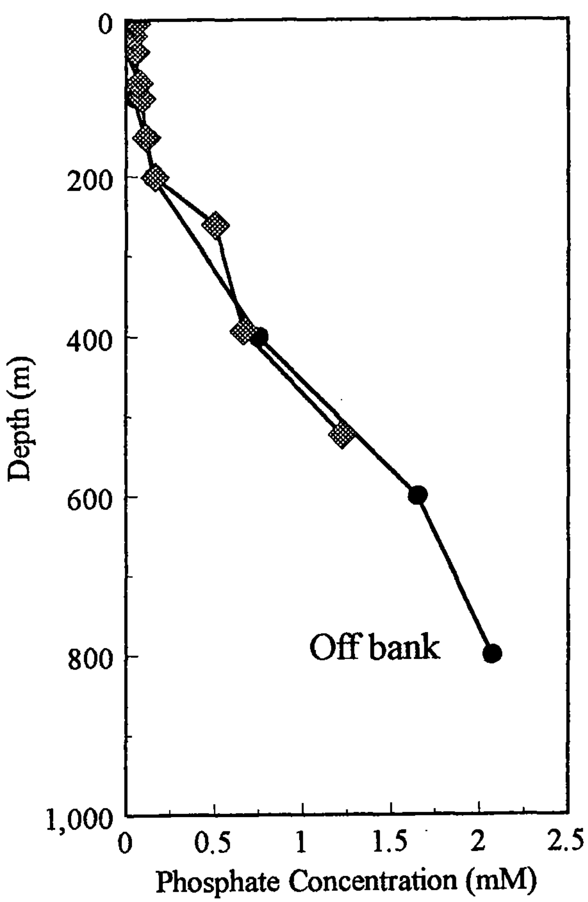


Figure 12 : Comparison of off and on bank temperature profiles at Pedro Bank.



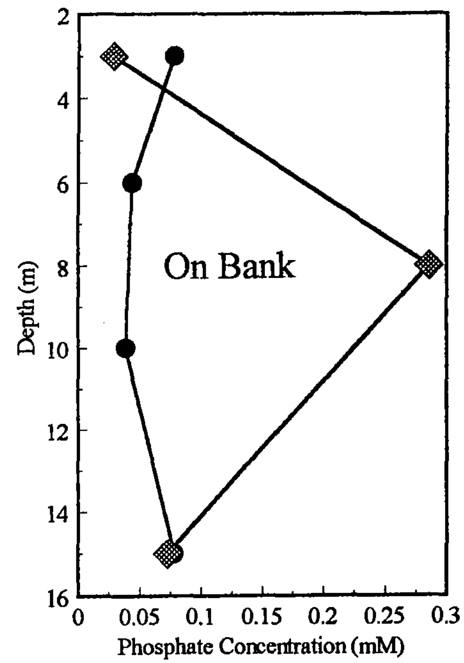


Figure 13: Comparison of off and on bank profiles of phosphate concentrations at Pedro Bank.

Water sampling for chlorophyll *a*, phosphate, and oxygen concentrations along cruise track showed no significant evidence in support of an east-west nutrient gradient. Nutrient concentrations and levels of associated materials appeared to fluctuate randomly along the track. Benthic communities were examined to determine if their composition could reveal the effects of a nutrient gradient. Results of this part of the study also came up negative. Corals typically found in nutrient-poor environments were found on Rosalind Bank, farther west than expected and populations of bivalves and boring sponge were collected farther east than was expected. In addition, it was believed that the abundance of both coralline algae and Halimeda would increase to the west, but this trend was not in evidence. This study does not support the concept of a nutrient gradient in the Caribbean Sea, however due to the limited extent of sampling, further study is need to substantiate or refute this finding.

Appendix A: Station Locations

CTD Stations

Station	Date	Time (hrs)	Log (nm)	Latitude (deg. N)	Longitude (deg. W)	Locale	Depth (m)
W-132 -007	27-Mar-94	1225	169.8	25.49	77.28	NW PROVIDENCE CHANI	1000
W-132 -008	28-Mar-94	1102	318.9	26.67	75.33	SOUTH SARGASSO SEA	200
W-132 -009	29-Mar-94	2122	396.3	25.51	74.15	SOUTH SARGASSO SEA	1020
W-132 -011	30-Mar-94	2121	467.8	25.40	73.15	SW NORTH ATLANTIC	1100
W-132 -012	31-Mar-94	2128	549.1	25.01	73.32	SW NORTH ATLANTIC	1100
W-132 -015	03-Apr-94	0022	698.3	22.53	73.13	SOUTHERN SARGASSO SI	1100
W-132 -016	05-Apr-94	2145	966.8	19.08	74.54	SOUTH WINDWARD PASS	1000
W-132--017	06-Apr-94	2150	1016.8	18.24	76.08	NE OF JAMAICA	1000
W-132 -019	10-Apr-94	2111	1117.6	17.07	77.23	SOUTH OF JAMAICA	1100
W-132 -021	11-Apr-94	0215	1183.5	17.10	77.30	PEDRO BANK	20
W-132 -020A	11-Apr-94	1251	1166.2	17.14	77.09	E OF PEDRO BANK	1000
W-132 -020B	11-Apr-94	1415	1166.2	17.14	77.10	E OF PEDRO BANK	150
W-132 -022	12-Apr-94	0108	1198.7	17.06	77.52	PEDRO BANK	17
W-132 -023	12-Apr-94	0538	1220.7	17.03	78.10	PEDRO BANK	10
W-132 -027A	13-Apr-94	0427	1276.3	16.39	17.58	PEDRO BANK	1050
W-132 -027B	13-Apr-94	0603	1276.3	16.39	17.58	PEDRO BANK	200
W-132 -028	13-Apr-94	1552	1311.6	16.14	79.39	EAST ROSALIND BANK	0
W-132 -030	14-Apr-94	0524	1358.5	16.21	80.29	ROSALIND BANK	19
W-132 -031	14-Apr-94	0906	1371.6	16.33	80.39	ROSALIND BANK	24

Hydrocast Stations

Station	Date	Time (hrs)	Log (nm)	Latitude (deg. N)	Longitude (deg. W)	Locale
W-132 -007	27-Mar-94	1320	169.8	2.00	77.29	NW PROVIDENCE CHANNEL
W-132 -008	28-Mar-94	2205	318.8	26.08	75.32	SOUTH SARGASSO SEA
W-132 -011	30-Mar-94	1023	467.8	25.40	73.15	SW NORTH ATLANTIC
W-132 -016	05-Apr-94	2222	966.8	19.08	74.54	SOUTH WINDWARD PASSAGE
W-132 -019	10-Apr-94	2213	1117.6	17.07	76.23	SOUTH OF JAMAICA
W-132 -020	11-Apr-94	1300	1166.2	17.14	77.09	PEDRO BANK
W-132 -021	11-Apr-94	2015	1183.5	17.10	77.30	PEDRO BANK
W-132 -022	12-Apr-94	0117	1198.7	17.06	77.52	PEDRO BANK
W-132 -023	12-Apr-94	0538	1220.7	17.03	78.10	PEDRO BANK
W-132 -027	13-Apr-94	0516	1276.3	16.39	78.59	PEDRO BANK
W-132 -028	13-Apr-94	1552	1311.6	16.14	79.39	EAST ROSALIND BANK
W-132 -030	14-Apr-94	0533	1358.5	16.21	80.29	ROSALIND BANK
W-132 -031	14-Apr-94	0915	1371.6	16.33	80.39	ROSALIND BANK

Neuston Tow Stations

Station	Date	Time (hrs)	Log (nm)	Latitude (deg. N)	Longitude (deg. W)	Locale
W-132 -001	25-Mar-94	1538	15.5	26.36	79.47	GULF STREAM
W-132 -001	25-Mar-94	1602	16.7	26.36	79.47	GULF STREAM
W-132 -002	26-Mar-94	0004	57.5	26.15	79.02	GULF STREAM
W-132 -002	26-Mar-94	0030	58.6	26.15	79.02	GULF STREAM
W-132 -008	29-Mar-94	0219	321.0	26.00	75.41	SOUTH SARGASSO
W-132 -008	29-Mar-94	0313	322.5	25.58	75.44	SOUTH SARGASSO
W-132 -010	30-Mar-94	1100	435.1	25.51	73.22	SOUTH SARGASSO
W-132 -010	30-Mar-94	1100	435.1	25.51	73.22	SOUTH SARGASSO
W-132 -011	31-Mar-94	0357	469.7	25.37	73.15	SOUTH SARGASSO
W-132 -011	31-Mar-94	0357	469.7	25.37	73.15	SOUTH SARGASSO
W-132 -014	02-Apr-94	0007	615.6	24.16	72.54	SOUTH SARGASSO

Station	Date	Time (hrs)	Log (nm)	Latitude (deg. N)	Longitude (deg. W)	Locale
W-132 -014	02-Apr-94	0042	616.9	24.14	72.55	SOUTH SARGASSO
W-132 -015	02-Apr-94	2200	694.6	22.58	73.12	SOUTH SARGASSO
W-132 -015	02-Apr-94	2243	695.7	22.58	73.12	SOUTH SARGASSO
W-132 -016	06-Apr-94	0010	958.1	19.05	74.56	NORTH OF JAMAICA
W-132 -016	06-Apr-94	0041	959.9	19.00	74.56	NORTH OF JAMAICA
W-132 -018	10-Apr-94	1002	1095.5	17.31	76.06	SE OF JAMAICA
W-132 -018	10-Apr-94	1036	1096.8	17.28	76.06	SE OF JAMAICA
W-132 -019	11-Apr-94	0154	1117.5	17.05	76.24	SOUTH OF JAMAICA
W-132 -019	11-Apr-94	0233	1119.0	17.02	76.24	SOUTH OF JAMAICA
W-132 -023	12-Apr-94	0709	1222.0	17.02	78.12	PEDRO BANK
W-132 -023	12-Apr-94	0740	1223.1	17.02	78.12	PEDRO BANK
W-132 -034	15-Apr-94	0002	1420.2	16.50	81.30	SW ROSALIND BANK
W-132 -034	15-Apr-94	0026	1421.6	16.50	81.31	SW ROSALIND BANK
W-132 -035	15-Apr-94	1135	1479.2	16.58	82.39	SW CARIBBEAN
W-132 -036	16-Apr-94	0018	1535.1	16.41	83.32	SW CARIBBEAN
W-132 -036	16-Apr-94	0053	1535.1	16.41	83.32	SW CARIBBEAN
W-132 -037	17-Apr-94	0000	1614.2	16.34	84.57	NORTH OF HONDURAS
W-132 -037	17-Apr-94	0028	1615.7	16.34	84.57	NORTH OF HONDURAS

Meter Net Stations

Station	Date	Time (hrs)	Log (nm)	Latitude (deg. N)	Longitude (deg. W)	Locale
W-132 -008	29-Mar-94	1240	318.7	26.04	75.36	SOUTH SARGASSO
W-132 -011	31-Mar-94	0009	468.0	25.39	73.14	SOUTH SARGASSO
W-132 -017	06-Apr-94	2320	1017.0	18.21	76.10	NORTH EAST OF JAMAICA
W-132 -019	11-Apr-94	0015	1117.3	17.05	76.23	SOUTH OF JAMAICA
W-132 -027	13-Apr-94	0305	1275.2	16.40	78.55	SW OF PEDRO BANK

Phytoplankton Net Tows

Station	Date	Time (hrs)	Log (nm)	Latitude (deg. N)	Longitude (deg. W)	Locale
W-132 -013	01-Apr-94	0625	564.6	25.02	73.07	SOUTH SARGASSO SEA

Shipek Stations

Station	Date	Time (hrs)	Log (nm)	Latitude (deg. N)	Longitude (deg. W)	Locale	Depth (m)
W-132 -003	26-Mar-94	1420	76.7	26.30	78.46	EAST OF FREEPORT	18
W-132 -003	26-Mar-94	1420	76.7	26.30	78.46	EAST OF FREEPORT	18
W-132 -004	26-Mar-94	1435	76.7	26.30	78.47	EAST OF FREEPORT	28
W-132 -005	26-Mar-94	1459	76.7	26.30	78.47	EAST OF FREEPORT	368
W-132 -006	26-Mar-94	1546	76.7	26.27	78.48	EAST OF FREEPORT	697
W-132 -021	11-Apr-94	2040	1183.5	17.09	77.30	PEDRO BANK	30
W-132 -022	12-Apr-94	0144	1198.7	17.06	77.51	PEDRO BANK	17
W-132 -023	12-Apr-94	0600	1220.7	17.03	78.10	PEDRO BANK	19
W-132 -024	12-Apr-94	1038	1235.4	17.03	78.24	PEDRO BANK	20
W-132 -025	12-Apr-94	1724	1251.7	17.02	78.45	PEDRO BANK	23
W-132 -033	14-Apr-94	1659	1389.5	16.48	80.56	ROSALIND BANK	303

Rock Dredge Stations

Station	Date	Time (hrs)	Log (nm)	Latitude (deg. N)	Longitude (deg. W)	Locale	Depth (m)
W-132 -023	12-Apr-94	0600	1220.7	42.00	17.03	PEDRO BANK	19
W-132 -024	12-Apr-94	1038	1235.4	17.03	78.24	PEDRO BANK	20
W-132 -025	12-Apr-94	1724	1251.7	17.02	78.46	PEDRO BANK	23

Station	Date	Time (hrs)	Log (nm)	Latitude (deg. N)	Longitude (deg. W)	Locale	Depth (m)
W-132 -026	12-Apr-94	2320	1262.0	16.53	78.50	PEDRO BANK	
W-132 -029	14-Apr-94	0223	1347.9	16.14	80.20	ROSALIND BANK	16
W-132 -030	14-Apr-94	0553	1558.9	16.21	80.29	ROSALIND BANK	19
W-132 -031	14-Apr-94	0933	1371.6	16.33	80.39	ROSALIND BANK	25
W-132 -032	14-Apr-94	1311	1385.7	16.46	80.49	ROSALIND BANK	37

BT Stations

Station	Date	Time (hrs)	Log (nm)	Latitude (deg. N)	Longitude (deg. W)	Depth (m)
BT-001	10-Jun-91	2355	107.5	39.48	70.07	15.5
BT-001	25-Mar-94	1445	11.9	25.56	79.50	26.9
BT-002	26-Mar-94	0630	75.0	26.24	78.50	24.6
BT-003	26-Mar-94	2042	101.0	26.13	78.25	25.7
BT-004	26-Mar-94	2326	114.4	26.05	78.11	25.0
BT-005	27-Mar-94	0030	113.0	25.35	77.17	25.0
BT-006	27-Mar-94	1937	186.0	25.51	77.18	25.4
BT-007	28-Mar-94	0630	42.0	25.50	76.49	25.4

Surface Sample Stations

Station	Date	Time (hrs)	Log (nm)	Latitude (deg. N)	Longitude (deg. W)
SS-001	25-Mar-94	1950	38.5	26.10	7.00
SS-002	26-Mar-94	0437	69.5	26.21	78.54
SS-003	26-Mar-94	2018	98.5	26.14	78.27
SS-004	27-Mar-94	0210	128.0	26.06	77.54
SS-005	27-Mar-94	0955	161.0	25.45	77.37
SS-006	27-Mar-94	2031	190.4	25.47	77.20
SS-007	28-Mar-94	0223	222.5	25.40	77.09
SS-008	28-Mar-94	0801	250.4	25.54	76.40
SS-009	28-Mar-94	1325	280.4	26.07	76.08
SS-010	29-Mar-94	0830	343.5	25.57	75.24
SS-011	29-Mar-94	1353	370.5	25.56	74.51
SS-012	29-Mar-94	2333	398.8	25.50	74.13
SS-013	30-Mar-94	1330	441.1	25.49	73.24
SS-014	31-Mar-94	0611	475.6	25.33	73.18
SS-015	31-Mar-94	1100	505.9	25.08	73.32
SS-016	31-Mar-94	1918	543.2	24.58	73.41
SS-017	01-Apr-94	0930	573.4	25.57	72.56
SS-018	01-Apr-94	2050	605.2	24.27	72.47
SS-019	02-Apr-94	0525	632.0	24.00	73.06
SS-020	02-Apr-94	1400	660.9	23.32	73.10
SS-021	02-Apr-94	2100	691.0	23.02	73.10
SS-022	03-Apr-94	0440	707.6	22.43	73.17
SS-023	03-Apr-94	1915	740.0	22.25	73.39
SS-024	04-Apr-94	0050	771.5	21.54	73.38
SS-025	04-Apr-94	0620	801.5	21.25	73.43
SS-026	04-Apr-94	1810	831.5	20.52	73.41
SS-027	05-Apr-94	0835	893.5	19.48	73.55
SS-028	05-Apr-94	1548	923.5	19.24	74.19
SS-029	06-Apr-94	0041	959.9	19.04	74.58
SS-030	06-Apr-94	1115	990.1	18.50	75.38
SS-031	07-Apr-94	0312	1024.5	18.15	76.18
SS-032	10-Apr-94	0015	1050.6	18.09	76.16
SS-033	10-Apr-94	0600	1079.5	17.40	76.02

Station	Date	Time (hrs)	Log (nm)	Latitude (deg. N)	Longitude (deg. W)
SS-034	10-Apr-94	1645	1113.8	17.11	76.20
SS-035	11-Apr-94	0818	1143.8	17.04	76.47
SS-036	14-Apr-94	1745	1390.0	16.48	80.56
SS-037	15-Apr-94	0200	1428.6	16.50	81.40
SS-038	15-Apr-94	0905	1463.3	17.02	82.30
SS-039	15-Apr-94	1920	1508.6	16.48	83.07
SS-040	16-Apr-94	1030	1573.3	16.44	84.16
SS-041	17-Apr-94	0305	1624.8	16.25	85.10

Appendix B: Hydrocast Data

Station	Date	Time (hrs)	Log (nm)	Latitude (deg. N)	Longitude (deg. W)	Bot #	Depth Target	Corr.	Temp (deg. C)	Salinity (ppt)	Phosph. (mM)	Chl a (ug/l)	Oxygen (ml/l)	Silicate (mM)
W-132 -007	27-Mar-94	1320	169.8	2.00	77.29	1	0	0	25.27	36.540	0.056	0.025	0.00	
W-132 -007	27-Mar-94	1320	169.8	25.49	77.29	2	40	40	24.23	36.680	0.012	0.025	4.83	
W-132 -007	27-Mar-94	1320	169.8	25.49	77.29	3	80	80	24.00	36.700	0.185	0.029	4.94	
W-132 -007	27-Mar-94	1320	169.8	25.49	77.29	4	100	100	23.84	36.700	0.012	0.233	5.17	
W-132 -007	27-Mar-94	1320	169.8	25.49	77.29	5	150	150	23.71	36.710	0.051	0.163	4.94	
W-132 -007	27-Mar-94	1320	169.8	25.49	77.29	6	200	200	21.15	36.700	0.148	0.026	4.85	
W-132 -008	28-Mar-94	2205	318.8	26.08	75.32	1	1000	796	10.13	35.350	1.241		3.71	
W-132 -008	28-Mar-94	2205	318.8	26.08	75.32	2	800	637	13.15	35.720	0.906		4.08	
W-132 -008	28-Mar-94	2205	318.8	26.08	75.32	3	600	478	15.23	36.040	0.525		4.48	
W-132 -008	28-Mar-94	2205	318.8	26.08	75.32	4	400	319	18.09	36.570	0.239		4.44	
W-132 -008	28-Mar-94	2205	318.8	26.08	75.32	5	200	189	20.03	36.690	0.174	0.051	4.61	
W-132 -008	28-Mar-94	2205	318.8	26.08	75.30	6	150	141	20.76	36.660	0.160	0.089	5.13	
W-132 -008	28-Mar-94	2205	318.8	26.08	75.32	7	100	95	21.44	36.690	0.217	0.046	4.94	
W-132 -008	28-Mar-94	2205	318.8	26.08	75.32	8	80	76	21.83	36.690	0.185	0.058	4.53	
W-132 -008	28-Mar-94	2205	318.8	26.08	75.32	9	40	38	22.53	36.700	0.221	0.027	4.90	
W-132 -008	28-Mar-94	2205	318.8	26.08	75.32	10	20	19	24.18	36.740	0.246	0.029	5.04	
W-132 -008	28-Mar-94	2205	318.8	26.08	75.32	11	0	0	24.15	36.830	0.221		0.00	
W-132 -011	30-Mar-94	1023	467.8	25.40	73.15	1	1000	1000	6.70	36.060	1.252		4.45	
W-132 -011	30-Mar-94	1023	467.8	25.40	73.15	2	800	800	10.10	35.320	1.185		3.57	
W-132 -011	30-Mar-94	1023	467.8	25.40	73.15	3	600	600	14.30	35.880	0.482		3.92	
W-132 -011	30-Mar-94	1023	467.8	25.40	73.15	4	400	400	17.62	36.450	0.303		4.77	
W-132 -011	30-Mar-94	1023	467.8	25.40	73.15	5	200	200	19.01	36.610	0.080	0.003	4.93	
W-132 -011	30-Mar-94	1023	467.8	25.40	73.15	6	150	150	20.76	36.730	0.041	0.016	4.83	
W-132 -011	30-Mar-94	1023	467.8	25.40	73.15	7	100	100	21.50	36.730	0.249	0.101	5.27	
W-132 -011	30-Mar-94	1023	467.8	25.40	73.15	8	80	80	22.27	36.760	0.036	0.091	4.94	
W-132 -011	30-Mar-94	1023	467.8	25.40	73.15	9	40	40	24.64	36.700	0.099	0.032	4.85	
W-132 -011	30-Mar-94	1023	467.8	2.00	73.15	10	20	20	25.84	36.580	0.254	0.007	4.95	
W-132 -011	30-Mar-94	1023	467.8	25.00	73.15	11	0	0		99.999	0.031	0.009	99.99	
W-132 -016	05-Apr-94	2222	966.8	19.08	74.54	1	1000	988	5.47	34.920	1.766		4.30	
W-132 -016	05-Apr-94	2222	966.8	19.08	74.54	2	800	790	7.49	34.930	1.563		3.19	
W-132 -016	05-Apr-94	2222	966.8	19.08	74.54	3	600	592	11.47	35.480	1.175		3.52	
W-132 -016	05-Apr-94	2222	966.8	19.08	74.54	4	400	395	15.25	36.050	0.589		3.94	

Station	Date	Time (hrs)	Log (nm)	Latitude (deg. N)	Longitude (deg. W)	Bot #	Depth Target	Corr.	Temp (deg. C)	Salinity (ppt)	Phosph. (mM)	Chl a (ug/l)	Oxygen (ml/l)	Silicate (mM)
W-132 -019	10-Apr-94	2213	1117.6	17.07	76.23	1	1000	1000	5.48	34.890	1.831		4.55	
W-132 -019	10-Apr-94	2213	1117.6	17.07	76.23	2	800	800	6.97	34.850	2.632		3.37	
W-132 -019	10-Apr-94	2213	1117.6	17.07	76.23	3	600	600	9.94	35.200	1.598		3.29	
W-132 -019	10-Apr-94	2213	1117.6	17.07	76.23	4	400	400	15.15	35.960	0.792		3.90	
W-132 -019	10-Apr-94	2213	1117.6	17.07	76.23	5	200	200	23.40	36.790	0.189	0.001	3.93	
W-132 -019	10-Apr-94	2213	1117.6	17.07	76.23	6	150	150	26.14	36.340	0.044	0.053	4.77	
W-132 -019	10-Apr-94	2213	1117.6	17.07	76.23	7	100	100	27.36	35.920	0.000	0.052	4.51	
W-132 -019	10-Apr-94	2213	1117.6	17.07	76.23	8	80	80	27.30	35.930	0.010	0.054	4.78	
W-132 -019	10-Apr-94	2213	1117.6	17.07	76.23	9	40	40	27.44	35.940	0.083	0.029	4.65	
W-132 -019	10-Apr-94	2213	1117.6	17.07	76.23	10	20	20	27.44	35.940	0.083	0.031	4.77	
W-132 -019	10-Apr-94	2213	1117.6	17.07	76.23	11	0	3	27.20	36.082	0.019	0.029	0.00	
W-132 -020	11-Apr-94	1300	1166.2	17.14	77.09	1	800	800	7.07	34.820	2.074		3.19	0.685
W-132 -020	11-Apr-94	1300	1166.2	17.14	77.09	2	600	600	10.22	35.210	1.651		3.14	15.730
W-132 -020	11-Apr-94	1300	1166.2	17.14	77.09	3	400	400	15.41	36.040	0.753		3.67	6.114
W-132 -020	11-Apr-94	1300	1166.2	17.14	77.09	4	200	200	23.56	36.927	0.155		4.08	1.404
W-132 -020	11-Apr-94	1300	1166.2	17.14	77.09	5	150	150	23.37	36.227	0.107	0.043	4.71	1.590
W-132 -020	11-Apr-94	1300	1166.2	17.14	77.09	6	100	100	26.45	36.077	0.049	0.067	4.89	1.709
W-132 -020	11-Apr-94	1300	1166.2	17.14	77.09	7	80	80	26.98	35.741	0.078	0.131	4.97	3.181
W-132 -020	11-Apr-94	1300	1166.2	17.14	77.09	8	40	40	27.15	35.790	0.000	0.048	5.23	1.764
W-132 -020	11-Apr-94	1300	1166.2	17.14	77.09	9	20	20	27.22	35.790	0.015	0.149	5.16	2.658
W-132 -020	11-Apr-94	1300	1166.2	17.14	77.09	10	0	3	27.23	35.698	0.005	0.168	99.99	2.658
W-132 -021	11-Apr-94	2015	1183.5	17.10	77.30	1	15	15	27.25	35.810	0.078	0.090	5.01	
W-132 -021	11-Apr-94	2015	1183.5	17.10	77.30	2	10	10	27.25	35.810	0.039	0.067	4.56	
W-132 -021	11-Apr-94	2015	1183.5	17.10	77.30	3	5	6	27.24	35.800	0.044	0.064	4.82	
W-132 -021	11-Apr-94	2015	1183.5	17.10	77.30	4	0	3	27.24	35.817	0.078	0.061		
W-132 -022	12-Apr-94	0117	1198.7	17.06	77.52	1	15	15	27.40	35.890	0.073	0.060		
W-132 -022	12-Apr-94	0117	1198.7	17.06	77.52	2	8	8	27.40	35.890	0.286	0.077		
W-132 -022	12-Apr-94	0117	1198.7	17.06	77.52	3	0	3	27.40	35.883	0.029	0.046		
W-132 -023	12-Apr-94	0538	1220.7	17.03	78.10	1	10	10	27.38	35.860	0.015	0.311	4.96	
W-132 -023	12-Apr-94	0538	1220.7	17.03	78.10	2	0	3	27.32	35.913	0.024	0.312	4.87	

Station	Date	Time (hrs)	Log (nm)	Latitude (deg. N)	Longitude (deg. W)	Bot #	Depth Target	Corr.	Temp (deg. C)	Salinity (ppt)	Phosph. (mM)	Chl a (ug/l)	Oxygen (ml/l)	Silicate (mM)
W-132 -027	13-Apr-94	0516	1276.3	16.39	78.59	1	800	523	11.33	35.310	1.223			9.197
W-132 -027	13-Apr-94	0516	1276.3	16.39	78.59	2	600	392	14.62	35.980	0.668		3.74	3.390
W-132 -027	13-Apr-94	0516	1276.3	16.39	78.59	3	400	261	19.60	36.620	0.505		3.39	4.207
W-132 -027	13-Apr-94	0516	1276.3	16.39	78.59	4	200	200	22.84	36.950	0.165	0.004	4.59	1.956
W-132 -027	13-Apr-94	0516	1276.3	16.39	78.59	5	150	150	25.72	36.630	0.114	0.015	4.62	1.292
W-132 -027	13-Apr-94	0516	1276.3	16.39	78.59	6	100	100	26.26	36.220	0.091	0.302	4.85	1.399
W-132 -027	13-Apr-94	0516	1276.3	16.39	78.59	7	80	80	26.70	35.920	0.072	0.175	4.94	1.742
W-132 -027	13-Apr-94	0516	1276.3	16.39	78.59	8	40	40	27.16	35.830	0.054	0.033	4.95	3.010
W-132 -027	13-Apr-94	0516	1276.3	16.39	78.59	9	20	20	27.16	35.820	0.040	0.031	5.04	2.110
W-132 -027	13-Apr-94	0516	1276.3	16.00	78.59	10	0	4	26.49	36.300	0.058	0.008		
W-132 -028	13-Apr-94	1552	1311.6	16.14	79.39	1	800	800	6.38	34.806	2.024		3.40	24.451
W-132 -028	13-Apr-94	1552	1311.6	16.14	79.39	2	600	600	9.14	35.062	1.954		3.39	18.346
W-132 -028	13-Apr-94	1552	1311.6	16.14	79.39	3	400	400	13.26	35.629	1.386		3.27	10.279
W-132 -028	13-Apr-94	1552	1311.6	16.14	79.39	4	200	200	21.26	36.907	0.263	0.001	3.84	2.037
W-132 -028	13-Apr-94	1552	1311.6	16.14	79.39	5	150	150	24.43	36.840	0.119	0.015	4.25	1.588
W-132 -028	13-Apr-94	1552	1311.6	16.14	79.39	6	100	100	25.61	36.646	0.067	0.109	4.76	4.527
W-132 -028	13-Apr-94	1552	1311.6	16.14	79.39	7	80	80	25.98	36.502	0.058	0.194	4.87	1.671
W-132 -028	13-Apr-94	1552	1311.6	16.14	79.39	8	40	40	26.18	36.444	0.095	0.000	4.84	1.588
W-132 -028	13-Apr-94	1552	1311.6	16.14	79.39	9	20	20	26.78	36.260	0.063	0.056	5.04	1.861
W-132 -028	13-Apr-94	1552	1311.6	16.14	79.40	10	0	4	26.85	36.259	0.091	0.051	0.00	2.204
W-132 -030	14-Apr-94	0533	1358.5	16.21	80.29	1	15	15	27.25	35.990	0.057	0.270		
W-132 -030	14-Apr-94	0533	1358.5	16.21	80.29	2	8	8	27.25	35.990	0.166	0.020		
W-132 -030	14-Apr-94	0533	1358.5	16.21	80.29	3	0	3	27.62	35.966	0.033	0.221		
W-132 -031	14-Apr-94	0915	1371.6	16.33	80.39	1	15	15	27.62	35.960	0.062	0.135		
W-132 -031	14-Apr-94	0915	1371.6	16.33	80.39	2	8	8	27.62	35.950	0.077			
W-132 -031	14-Apr-94	0915	1371.6	16.33	80.39	3	0	3	27.62	35.970	0.023	0.075		

Appendix C: Net Tow Data

Neuston Net Data

Station	Date	Time (hr)	Temp (deg. C)	Latitude (deg. N)	Tow Dist. (nm)	Zoopl. (ml)	Tar (g)	Plastic Pieces	Pellets	Sargassum *fluitans*	*natans*	Phyll. #	Linuche (ml)
W-132 -001	25-Mar-94	1538	26.8	26.36	1852	3.0	2.00	0	0	0.0	0.0	0	0.00
W-132 -001	25-Mar-94	1602	26.8	26.36	1852	3.4	0.00	0	0	0.0	0.0	0	0.00
W-132 -002	26-Mar-94	0004	26.5	26.15	1852	53.0	0.00	2	0	0.0	0.0	0	0.00
W-132 -002	26-Mar-94	0030	26.5	26.15	1852	56.0	0.00	0	0	0.0	0.0	0	0.00
W-132 -008	29-Mar-94	0219	24.3	26.00	1852	1.5	8.00	12	0	60.0	30.0	0	0.00
W-132 -008	29-Mar-94	0313	24.3	25.58	1852	5.0	0.00	45	0	1.0	0.0	0	0.00
W-132 -010	30-Mar-94	1100	24.9	25.51	1852	1.0	21.00	5	0	150.0	0.0	0	0.00
W-132 -010	30-Mar-94	1100	24.9	25.51	1852	1.0	0.00	0	0	1.0	0.0	0	0.00
W-132 -011	31-Mar-94	0357	25.5	25.37	1482	1.0	1.00	3	0	20.0	0.0	0	0.00
W-132 -011	31-Mar-94	0357	25.5	25.37	2130	1.0	1.00	7	1	75.0	1.0	0	0.00
W-132 -014	02-Apr-94	0007	25.3	24.16	1852	8.0	14.00	9	0	10.0	1.0	0	0.00
W-132 -014	02-Apr-94	0042	25.3	24.14	1852	9.0	1.00	2	0	25.0	10.0	0	0.00
W-132 -015	02-Apr-94	2200	26.4	22.58	1852	90.0	1.00	0	0	6.5	0.0	2	0.00
W-132 -015	02-Apr-94	2243	26.4	22.58	1852	52.0	0.00	1	0	155.0	0.0	1	0.00
W-132 -016	06-Apr-94	0010	27.4	19.05	1852	150.0	1.00	0	0	0.0	0.0	0	140.00
W-132 -016	06-Apr-94	0041	27.4	19.00	1852	220.0	0.00	0	0	1.0	0.0	0	210.00
W-132 -018	10-Apr-94	1002	27.3	17.31	1852	1.0	0.00	11	0	0.0	0.0	0	0.00
W-132 -018	10-Apr-94	1036	27.3	17.28	1852	1.0	0.00	7	0	1.0	0.0	0	0.00
W-132 -019	11-Apr-94	0154	27.0	17.05	1852	0.0	0.00	2	0	0.0	0.0	0	1.00
W-132 -019	11-Apr-94	0233	27.0	17.02	1852	25.0	0.00	3	0	50.0	0.0	0	0.00
W-132 -023	12-Apr-94	0709	27.3	17.02	1852	0.5	0.00	3	0	4.0	0.0	0	0.00
W-132 -023	12-Apr-94	0740	27.3	17.02	1852	0.0	0.00	0	1	25.0	0.0	0	0.00
W-132 -034	15-Apr-94	0002	26.8	16.50	1852	23.0	0.00	0	0	0.0	0.0	2	0.00
W-132 -034	15-Apr-94	0026	26.8	16.50	1852	9.0	0.00	0	0	0.0	0.0	2	0.00
W-132 -035	15-Apr-94	1135	27.2	16.58	1852	4.0	0.00	0	0	0.0	0.0	0	0.00
W-132 -036	16-Apr-94	0018	27.3	16.41	1852	0.0	0.00	0	0	0.0	0.0	0	0.00
W-132 -036	16-Apr-94	0053	27.3	16.41	1852	25.0	0.00	2	0	0.0	0.0	0	0.00
W-132 -037	17-Apr-94	0000	27.0	16.34	1852	0.0	0.00	0	0	0.0	0.0	0	0.00
W-132 -037	17-Apr-94	0028	27.0	16.34	1852	18.0	0.00	0	0	0.0	0.0	0	0.00

Meter Net Data

Station	Date	Time (hr)	Temp. (deg. C)	Latitude (deg. N)	Dist. (m)	Zoopl. (ml)	Tar (g)	Plastic Pieces	Pellets	Sargassun *fluitans*	*natans*	Phyll. #	Linuche (ml)
W-132 -001	25-Mar-94	1538	26.8	26.36	1852	3.0	2.00	0	0	0.0	0.0	0	0.00
W-132 -001	25-Mar-94	1602	26.8	26.36	1852	3.4	0.00	0	0	0.0	0.0	0	0.00
W-132 -002	26-Mar-94	0004	26.5	26.15	1852	53.0	0.00	2	0	0.0	0.0	0	0.00

Station	Date	Time (hr)	Temp. (deg. C)	Latitude (deg. N)	Dist. (m)	Zoopl. (ml)	Tar (g)	Plastic Pieces	Pellets	Sargassun *fluitans*	*natans*	Phyll. #	Linuche (ml)
W-132 -002	26-Mar-94	0030	26.5	26.15	1852	56.0	0.00	0	0	0.0	0.0	0	0.00
W-132 -008	29-Mar-94	0219	24.3	26.00	1852	1.5	8.00	12	0	60.0	30.0	0	0.00
W-132 -008	29-Mar-94	0313	24.3	25.58	1852	5.0	0.00	45	0	1.0	0.0	0	0.00
W-132 -010	30-Mar-94	1100	24.9	25.51	1852	1.0	21.00	5	0	150.0	0.0	0	0.00
W-132 -010	30-Mar-94	1100	24.9	25.51	1852	1.0	0.00	0	0	1.0	0.0	0	0.00
W-132 -011	31-Mar-94	0357	25.5	25.37	1482	1.0	1.00	3	0	20.0	0.0	0	0.00
W-132 -011	31-Mar-94	0357	25.5	25.37	2130	1.0	1.00	7	1	75.0	1.0	0	0.00
W-132 -014	02-Apr-94	0007	25.3	24.16	1852	8.0	14.00	9	0	10.0	1.0	0	0.00
W-132 -014	02-Apr-94	0042	25.3	24.14	1852	9.0	1.00	2	0	25.0	10.0	0	0.00
W-132 -015	02-Apr-94	2200	26.4	22.58	1852	90.0	1.00	0	0	6.5	0.0	2	0.00
W-132 -015	02-Apr-94	2243	26.4	22.58	1852	52.0	0.00	1	0	155.0	0.0	1	0.00
W-132 -016	06-Apr-94	0010	27.4	19.05	1852	150.0	1.00	0	0	0.0	0.0	0	140.00
W-132 -016	06-Apr-94	0041	27.4	19.00	1852	220.0	0.00	0	0	1.0	0.0	0	210.00
W-132 -018	10-Apr-94	1002	27.3	17.31	1852	1.0	0.00	11	0	0.0	0.0	0	0.00
W-132 -018	10-Apr-94	1036	27.3	17.28	1852	1.0	0.00	7	0	1.0	0.0	0	0.00
W-132 -019	11-Apr-94	0154	27.0	17.05	1852	0.0	0.00	2	0	0.0	0.0	0	1.00
W-132 -019	11-Apr-94	0233	27.0	17.02	1852	25.0	0.00	3	0	50.0	0.0	0	0.00
W-132 -023	12-Apr-94	0709	27.3	17.02	1852	0.5	0.00	3	0	4.0	0.0	0	0.00
W-132 -023	12-Apr-94	0740	27.3	17.02	1852	0.0	0.00	0	1	25.0	0.0	0	0.00
W-132 -034	15-Apr-94	0002	26.8	16.50	1852	23.0	0.00	0	0	0.0	0.0	2	0.00
W-132 -034	15-Apr-94	0026	26.8	16.50	1852	9.0	0.00	0	0	0.0	0.0	2	0.00
W-132 -035	15-Apr-94	1135	27.2	16.58	1852	4.0	0.00	0	0	0.0	0.0	0	0.00
W-132 -036	16-Apr-94	0018	27.3	16.41	1852	0.0	0.00	0	0	0.0	0.0	0	0.00
W-132 -036	16-Apr-94	0053	27.3	16.41	1852	25.0	0.00	2	0	0.0	0.0	0	0.00
W-132 -037	17-Apr-94	0000	27.0	16.34	1852	0.0	0.00	0	0	0.0	0.0	0	0.00
W-132 -037	17-Apr-94	0028	27.0	16.34	1852	18.0	0.00	0	0	0.0	0.0	0	0.00

Appendix D: W-132 Noon and Midnight Positions

Date	Time	Latitude (deg. N)	Longitude (deg. W)
3-25-94	1200	25.48	80.03
3-26-94	0000	26.16	79.02
3-26-94	1200	26.31	78.46
3-27-94	0000	26.05	78.08
3-27-94	1200	25.49	77.28
3-28-94	0000	25.34	77.22
3-28-94	1200	26.06	77.15
3-29-94	0000	26.08	75.31
3-29-94	1200	25.57	75.01
3-30-94	0000	25.49	74.1
3-30-94	1200	25.5	73.25
3-31-94	0000	25.39	73.14
3-31-94	1200	25.03	73.36
4-01-94	0000	25.02	73.27
4-01-94	1200	24.54	72.44
4-02-94	0000	24.14	72.55
4-02-94	1200	23.4	73.11
4-03-94	0000	22.57	73.14
4-03-94	1200	22.34	73.37
4-04-94	0000	21.59	73.38
4-04-94	1200	21.01	73.42
4-05-94	0000	20.24	73.48
4-05-94	1200	19.36	74.03
4-06-94	0000	19.06	74.56
4-06-94	1200	18.48	75.39
4-07-94	0000	18.2	76.1
4-07-94	1200	18.11	76.27
4-08-94	0000	Alongside, Port Antonio, Jamaica	
4-08-94	1200	Alongside, Port Antonio, Jamaica	
4-09-94	0000	Alongside, Port Antonio, Jamaica	
4-09-94	1200	Alongside, Port Antonio, Jamaica	
4-10-94	0000	18.1	76.16
4-10-94	1200	17.24	76.08
4-11-94	0000	17.06	76.23
4-11-94	1200	17.12	77.06
4-12-94	0000	17.06	77.47
4-12-94	1200	17.03	78.29
4-13-94	0000	16.51	78.51
4-13-94	1200	16.2	79.29
4-14-94	0000	16.15	80.1
4-14-94	1200	16.44	80.47
4-15-94	0000	16.5	81.3
4-15-94	1200	16.55	82.47
4-16-94	0000	16.42	83.3
4-16-94	1200	16.44	84.25
4-17-94	0000	16.34	84.57
4-17-94	1200	16.31	85.25
4-18-94	0000	16.23	86.07
4-18-94	1200	16.21	86.22
4-19-94	0000	16.2	86.28
4-19-94	1200	16.25	86.18
4-20-94	0000	Anchored, Roatan, Honduras	
4-20-94	1200	Anchored, Roatan, Honduras	
4-21-94	0000	Anchored, Roatan, Honduras	
4-21-94	1200	16.25	86.18
4-22-94	0000	16.54	86.33
4-22-94	1200	17.59	86.05
4-23-94	0000	19.25	85.28
4-23-94	1200	20.34	85.01
4-24-94	0000	21.13	84.56
4-24-94	1200	21.52	85.11

Date	Time	Latitude (deg. N)	Longitude (deg. W)
4-25-94	0000	22.15	85.05
4-25-94	1200	22.59	84.31
4-26-94	0000	23.13	83.35
4-26-94	1200	23.55	83.19
4-27-94	0000	23.51	82.28
4-27-94	1200	24.04	81.52
4-28-94	0000	24.3	80.36
4-28-94	1200	23.56	79.52
4-29-94	0000	23.53	79.47
4-29-94	1200	Anchored Cay Sal Bank	
4-30-94	0000	25.08	79.57
4-30-94	1200	Alongside Miami, FL	