CRUISE REPORT

W-57

Scientific Activities

Key West - St. Petersburg - Dry Tortugas - Savannah - Woods Hole

08 April 1981 - 20 May 1981

R/V Westward

Sea Education Association

Woods Hole, Massachusetts

SHIPBOARD DRAFT

PREFACE

The objective of this cruise report is to compile the data collected by 24 undergraduate students and 3 staff scientists on cruise W-57 of the R/V Westward. The report consists almost entirely of the abstracts of research projects conducted by the students with some guidance by the teaching staff. The scientific merit of these papers reflects the industry and enthusiasm of these students, and their energy and warmth made this cruise one of the finest I've ever experienced.

The staff, too, was helpful and interested in all aspects of the scientific mission of the cruise. Without their friendly support the goals we set for ourselves could not have been attained. Carl Chase, Captain, musician, and master story teller, headed the nautical staff and set a relaxed tone to the cruise that enabled all of us to focus our energies on the business at hand. The Chief Mate, John Metcalf, brought his experiences of the early days of the program to his duties as Head of Nautical Science, thereby enriching our present-day familiarity of the ship. Gayle Biddle navigated with an ever-cheerful smile and Charles (Chip) Swicker drove the students to ever greater heights of rust-busting by keeping his own smile hidden behind very dark sunglasses. Engineer John Thomson contributed as much with his music as he did to morale by fixing the galley stove. And finally, Sally Kaul, Chief Steward, sailed her last cruise with us and continued to satisfy the most demanding of gourmet standards. I express my appreciation to each of the nautical staff for their efforts in helping us carry out our research.

I am also grateful to a talented scientific staff. Dorinda (Rindy) Ostermann has sailed with us for seven cruises and each time I have sailed with her I have been newly amazed at her endless energy and enthusiasm.

It was Rindy's last cruise, as well as Sally's, and she will be sorely missed. This cruise was Diane Eskenasy's first cruise on the Westward; I hope it will not be her last. Not only did she round out the oceanographic program with her geology background, she also entertained us greatly with her imaginative Feature Creatures and her musical ability on the nose harp.

We had two Visiting Scholars on this cruise: Tyler Martin for Leg I from Key West to St. Petersburg and Dave Jackson for Leg II from St. Petersburg to Savannah. Mr. Martin shared his experiences on the U.S.S. Constitution and his extensive knowledge of maritime history with us. Mr. Jackson, publisher of the National Fisherman, brought a warmth and interest in our program that inspired students (and staff). His climb to the spreaders was cheered by all.

This report was prepared mostly at sea. It has the disadvantages of lack of follow-up in library research and proper quiet for reflection on the data. However, putting the abstracts and data in one place while the memories of the cruise are still fresh is valuable - it gives us a first picture of what our part of the ocean was like this spring, 1981.

Mary Farmer
Chief Scientist
W-57

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INTRODUCTION

This cruise report provides a record of scientific research activities conducted aboard the R/V Westward during the laboratory section of the Introduction to Marine Science course - NS225 at Boston University. The itinerary (Table 1) and ship's track for W-57 (figures 1 and 2) provided the opportunity for extensive work in the Gulf of Mexico as well as some complementary studies in the Gulf Stream, the Sargasso Sea, and in east Florida Shelf waters. Ship's complement is given in Table 2.

The academic program at sea consists of studying two aspects of the ocean: (1) how a ship responds to changes in and over the ocean, and (2) how the ocean itself varies as we move across its surface. How these subjects are presented is described in the appendix. The major portion of the second question is answered through the design and carrying out of individual research projects. These projects are finished while the students are still aboard, and it is the abstracts of these projects that comprise the bulk of this report. Some of the research also represented the ongoing work of individuals and agencies that have extended their assistance to our students. Material reported here should not be excerpted or cited without written permission of the Chief Scientist.

Figure 1. Cruise track for cruise W-57 of the R/V Westward.
Dates given next to noon position.

Figure 2. Locations of scientific stations conducted on cruise W-57. In addition to the 31 stations shown here, an otter trawl was done at 40°45'N, 71°51'W.

TABLE 1. Itinerary for cruise W-57 of the R/V Westward

<u>Port</u>	<u>Arrival</u>	<u>Departure</u>
Key West, Florida	-	08 April 1981
St. Petersburg, Florida	20 April 1981	22 April 1981
Dry Tortugas, Florida	25 April 1981	25 April 1981
Savannah, Georgia	05 May 1981	09 May 1981
Woods Hole, Massachusetts	20 May 1981	-

TABLE 2. Ship's complement for R/V Westward cruise W-57

Nautical Staff

Carl A. Chase, B.A. Ocean Operator	Captain
John Metcalf, B.S. Master, Uninspected Vessels	Chief Mate
Charles Swicker, B.A. Ocean Operator	Second Mate
Gayle Biddle, B.A. Ocean Operator	Third Mate
John Thomson, B.E. Electrical Engineering	Chief Engineer
Sally Kaul, M.Ed.	Chief Steward

Scientific Staff

Mary Farmer, Ph.D. Biological Oceanography	Chief Scientist
Dorinda Ostermann, B.S. Biological Oceanography	Assistant Scientist
Diane Eskenasy, M.S. Geology	Assistant Scientist

Visitors

Tyler Martin (Leg I)	Maritime History
David Jackson (Leg II)	Maritime Publishing

Students

Carin J. Ashjian, Junior, Cornell University
 Lynn M. Azzinaro, Senior, University of Rhode Island
 Rebecca H. Buchthal, Junior, Middlebury College
 Elizabeth A. Carr, Junior, Cornell University
 Elizabeth W. Conger, Junior, Middlebury College
 Douglas S. Eisinger, Senior, Cornell University
 Douglas J. Falkner, Junior, Dartmouth College
 Marla Gearing, Senior, Cornell University
 Victoria A. George, Junior, Cornell University
 Nancy I. Hendrickson, Junior, Princeton University
 Jenny E. Hinshaw, Junior, Wellesley College
 Britt A. Holmen, Junior, Colby College
 Christina A. King, Junior, Bucknell University
 Carol A. Mancuso, Junior, University of Delaware

TABLE 2. (continued)

Students (continued)

Marianne C. Marchi, Junior, Connecticut College
Kelley A. Paterson, Senior, Cornell University
Craig J. Peck, Junior, Colgate University
E. Denley Poor, Junior, Brown University
Daniel G. Quible, Junior, University of Rochester
Charles H. Robinson, Junior, Middlebury College
Richard A. Shinn, Sophomore, Carleton College
Deborah R. Smith, Sophomore, Eckerd College
Frank S. Wilson, Sophomore, Duke University
Thomas C. Zetkulic, Sophomore, University of Vermont

COOPERATIVE PROGRAMS

Cooperative Ship Weather Observation Program (NOAA)

The R/V Westward is certified to gather weather observations for the U.S. National Oceanic and Atmospheric Administration in cooperation with an international weather program. The data, collected at 0600 and 1200 Greenwich Mean Time, form part of a global grid for forecasting and satellite surface-truth purposes.

On W-57, 38 sets of observations were collected, of which 68% were successfully transmitted. Of these, 15 were copied by November Mike Gulf, New Orleans, LA, to which the 16 transmissions in the Gulf of Mexico were initially addressed. After passing through the Florida Straits, 22 transmissions were addressed to November Mike November, Portsmouth, VA and 11 of these were successfully copied.

LONG TERM INTERNAL PROGRAMS

Over the years a few topics have shown themselves particularly amenable to studies by students on the R/V Westward. On nearly every cruise projects are undertaken in one or more of these areas, and data collected for these projects have become increasingly standardized and useful as each new student contributes to the information we have accumulated.

One of these subjects, the distribution of spiny lobster larvae, has become an area of research interest to me. On this cruise the larvae were studied by a team of three students (Azzinaro, Buchthal, and Poor) whose project helped demonstrate that the adult populations of Florida spiny lobsters may be maintained at least in part by recruitment of larvae from Caribbean populations.

Two other subjects of long-term interest have been marine mammal and pelagic bird observations. Tim Ramage (Curator, Natural History Museum of the Rhode Island School of Design) has established the system we use for recording and storing these data. He gave a great deal of guidance to the two students whose project consisted of recording all observations of marine mammals on this trip (Conger and Zetkulich) and he has done a preliminary analysis of the bird data, which is included in this report.

A study of the possible Caribbean origin of some of Florida's spiny lobsters

Lynn Azzinaro, Rebecca Buchthal, and E. Denley Poor

ABSTRACT

A controversy exists regarding the maintenance of Florida's spiny lobster population. After spiny lobsters spawn, the females migrate from the shallow water where they live to deep water where they release their eggs. The eggs hatch to larvae, called phyllosoma larvae, which stay in surface waters for as long as eight months before they settle out, in shallow water, to become adults. Some researchers believe that the larvae of Florida lobsters are entrained in local waters for the duration of their larval life, and that adult populations maintain themselves by the settling out of locally produced larvae. Others argue that larvae from Florida lobsters get carried away on oceanic currents such as the Gulf Stream and that adult populations must be maintained by recruitment of larvae produced by other populations.

In this study, 14 phyllosoma larvae were collected at stations in the Loop Current, Gulf of Mexico, Sargasso Sea, and the East Florida Shelf. Nine of these larvae were determined by their stage to have hatched in December (Table 3). Florida lobsters do not spawn from November to January, but Caribbean lobsters do, so these larvae must have been of Caribbean origin. It is not known whether such larvae actually do settle out and contribute to Florida populations, but three of the nine larvae of probable Caribbean origin were found at a station very close to shore on the East Florida Shelf.

TABLE 3. Approximate dates of hatching of phyllosoma larvae collected in the Loop Current, Gulf of Mexico, and Gulf Stream

<u>Station</u>	<u>Date</u>	<u>Location</u>	<u>Taxonomic Family</u>	<u>Stage of Larva</u>	<u>Approx. Age (wks)</u>	<u>Approx. Date of Hatching</u>
W57-1	04/10/81	Loop Current	Palinuridae	VI-IX	20	Dec 1980
W57-2	04/11/81	Loop Current	Palinuridae	VI-IX	20	Dec 1980
W57-6	04/16/81	Gulf of Mexico	Scyllaridae	X-XI	28	Oct 1980
W57-21	04/28/81	Gulf Stream	Scyllaridae	VI-XI	20	Dec 1980
W57-22	04/28/81	Gulf Stream	Palinuridae	X-XI	28	Oct 1980
W57-22	04/28/81	Gulf Stream	Palinuridae	VI-IX	20	Dec 1980
W57-22	04/28/81	Gulf Stream	Palinuridae	III-V	12	Feb 1981
W57-24	04/30/81	Sargasso Sea	Scyllaridae	VI-IX	20	Dec 1980
W57-24	04/30/81	Sargasso Sea	Palinuridae	VI-IX	20	Dec 1980
W57-25	05/01/81	Sargasso Sea	Palinuridae	III-V	12	Feb 1981
W57-30	05/03/81	East Florida Shelf	Palinuridae	X-XI	28	Oct 1980
W57-30	05/03/81	East Florida Shelf	Palinuridae	VI-IX	20	Dec 1980
W57-30	05/03/81	East Florida Shelf	Palinuridae	VI-IX	20	Dec 1980
W57-30	05/03/81	East Florida Shelf	Palinuridae	VI-IX	20	Dec 1980

Observations of cetaceans on cruise W-57 of the R/V Westward

Elizabeth W. Conger and Thomas C. Zetkulić

ABSTRACT

Sightings of marine mammals along the cruise track of the R/V Westward were accompanied by collection of environmental data to look for any relationship between the presence of cetaceans and water masses or sea state. Specifically, temperature, salinity and Beaufort scale sea state were noted at the time of each sighting.

Cetacea were seen in the Gulf of Mexico and on the east coast of Florida, up to the Savannah River. These include two species of whales and three species of dolphins (figure 3 and appendix V). There was no relationship between either temperature or salinity and dolphin distribution. Tursiops truncatus was found in salinities ranging from 9 ‰ to 36 ‰, allowing us to conclude that this species can withstand a fair amount of variation. Of special interest was a correlation between depth and distribution of Stenella plagiodon. These Atlantic spotted dolphins are most commonly found outside the 100-fathom curve. However, on W-57 all sightings were within the 50-fathom curve, suggesting that these cetaceans were migrating inshore to breed and give birth. This migration was earlier than recorded in previous literature.

Figure 3A. Locations of marine mammal sightings between Key West, Florida and St. Petersburg, Florida.

Figure 3B. Locations of marine mammal sightings from St. Petersburg to Savannah, Georgia.

Bird sightings on W-57

Tim Ramage

A standard 10-minute watch system is used on the R/V Westward to record presence (or absence) of pelagic and terrestrial birds along the cruise track.

All birds recorded after passing through the Straits of Florida were pelagic birds whereas in the Gulf of Mexico several terrestrial birds were sighted, especially Cattle Egrets (Appendix VI). A comparison of figures 4A and 4B shows these differences and also shows that the two major feeding aggregations of birds seen, both consisting of Gulls, Jaegers, and Shearwaters, occurred on the front (or edge) of the Loop Current.

The few sightings of marine species are to be expected along this cruise track during April and May. Most tropical marine species would be near or on their breeding sites at that time, so an open water cruise should find few resident species. The marine species sighted are transitory in the tropics and are found in higher latitudes during the summer months.

Figure 4A. Average number of all birds seen per 1° square block along the cruise track of W-57.

Figure 4B. Average number of marine birds seen. Loop Current information is based on satellite temperature-sensing data. Key for the symbols is given in Figure 4A.

OCEANOGRAPHIC STUDIES ON W-57

Introduction and summary

Oceanographic studies on W-57 were done almost entirely to accomplish the individual projects designed by the students while in Woods Hole, before the cruise began. Data to answer the questions raised in the project proposals were collected during science watch by hourly collections of surface temperatures, bathythermographs at regular intervals, and by heaving the ship to for 32 oceanographic stations (see Appendix II for a list of station procedures). Data from the bathythermographs and the hydrocasts are summarized in Appendices III and IV, respectively. Of the 32 stations, 18 were in the Gulf of Mexico, 4 in the Gulf Stream, 3 in the Sargasso Sea, and the remaining 7 on the continental shelf, 1 of which was north of Cape Hatteras (Figure 2).

For most of the water column studies in the Gulf of Mexico it was important to distinguish Loop Current water, which is really water from the Caribbean Sea that has been channeled through the Yucatan Straits, from ordinary Gulf of Mexico water. Since Caribbean water is warmer than Gulf of Mexico water, we began our search for the Loop Current by running bathythermographic (BT) analyses at frequent intervals. These BTs gave us temperature plotted against depth at each lowering of the instrument into the water. A series of BT profiles gave us the information we needed to construct a graph of isotherms (e.g., figure 6). When the 72°F warm water isotherm sank to a depth between 400 and 600 ft, we considered we were in the Loop Current. The numbers next to the dots in figure 5 show the depth (in feet) of the 72°F isotherm. The isotherm profile in figure 6 shows clearly that stations 1 and 2 were within the Loop Current and station 3 was in Gulf of Mexico water. Station 4 was again within the Loop Current, although closer to the edge than either stations 1 or 2, and station 5 was clearly an edge station (figure 7). Using the BT data and the set and drift data from figure 5, we constructed contour lines for the Loop Current at the time we were passing through the region (figure 8). These corresponded well with satellite information

of surface temperatures at the time. Similar analyses satisfied us that stations 19 through 22 were in the Gulf Stream and that stations 20 and 21 were closer to the western edge of the Stream than were stations 19 and 22 (figure 9).

The average surface characteristics of Loop Current water were clearly different from Gulf of Mexico water, and the stations at the edges of the Current showed mixing between the two water masses. Loop Current water was warmer and slightly fresher than Gulf of Mexico water (Table 4). This latter finding was surprising, since Caribbean water is considered to be very salty. However, even the shelf stations in the Gulf of Mexico were saline (Table 4), and stations 8, 10, 12, and 14, conducted for sediment studies to be discussed later, had an average salinity of 36.36 ± 0.09 ‰. Gulf of Mexico water in the region of our study is on an annual basis greatly influenced by the salinity of Caribbean, or Loop Current, water. The unusually high salinity on the West Florida Shelf was matched by a high salinity on the East Florida Shelf, where the saltiness was nearly as great as that of the Sargasso Sea (Table 4). These findings may reflect the severe drought conditions being experienced by Florida now. Such a condition would result in greatly reduced river runoff in the region, and thus to an increased salinity in shelf waters.

In summary, water masses were identified first by temperature structure of the water column. Interpretations of these data were then done by using hydrocast and biological samples taken for the student projects. The remainder of this Introduction summarizes the results of these projects.

A study of mixing between Loop Current and Gulf of Mexico water showed that although surface salinities in the Gulf of Mexico were higher than Loop Current water, deeper water in the Gulf was less saline than the Loop, as would be expected (Gearing). Biological indicators showed some transport of plankton from the Caribbean into the Gulf of Mexico. However, in general, the diatom Chaetoceros decipiens remained in Loop Current water and Coscinodiscus remained in Gulf water (Hinshaw). Of the zooplankton, more euphausiids were found in the Loop Current and more hyperiid amphipods in Gulf water than vice versa (Wilson).

Figure 5. Locations of bathythermograph lowerings in the Gulf of Mexico. Dots give the position of the lowering. Numbers beside the dot = depth (ft) of the 72°F isotherm. Vectors = set (direction of arrow) and drift (length of arrow) of the Westward according to difference of dead reckoning position from Loran C fix.

Figure 6. Lines of equal temperature along a BT transect from near Key West to station 3. Arrows show positions of stations 1-3. Positions of the BTs given in figure 5.

Figure 7. Lines of equal temperature along a BT transect from station 3 to station 5. Arrows show station positions. Positions of the BTs given in figure 5.

Figure 8. Position of the Loop Current for the period 10 April to 16 April 1981 based on depth of 72°F isotherm and set and drift data of the R/V Westward. Contour lines = depth of the 72°F isotherm in feet. Arrows show direction of flow of the current. Large numbers in circles = stations. Dots = BT positions.

Figure 9. Proposed position of the Gulf Stream within the Straits of Florida for the period 27 April to 28 April 1981. Symbols as in figure 8.

TABLE 4. Characteristics of surface waters of the water masses sampled on Legs I and II of cruise W-57. Station positions are shown in figure 2.

<u>Water Mass</u>	<u>Station No.</u>	<u>Temperature (°C)</u>	<u>Salinity (°/oo)</u>	<u>Oxygen (ml.l⁻¹)</u>	<u>Silicate (uM)</u>
Loop Current	1	26.30	36.16	4.97	1.98
	<u>2</u>	<u>26.01</u>	<u>36.20</u>	<u>4.97</u>	<u>1.40</u>
	Average	26.16	36.18	4.97	1.69
Edge of Loop Current	4	23.78	36.40	5.27	0.60
	<u>5</u>	<u>25.23</u>	<u>36.27</u>	<u>5.28</u>	<u>-</u>
	Average	24.50	36.34	5.28	0.60
Gulf of Mexico	<u>3</u>	23.30	36.41	5.30	1.10
West Florida Shelf	6	24.70	36.34	4.15	2.8
	<u>18</u>	<u>25.84</u>	<u>36.36</u>	<u>-</u>	<u>1.6</u>
	Average	25.27	36.35	4.15	2.2
Gulf Stream					
Center	19	27.00	36.14	5.13	1.7
	<u>22</u>	<u>26.80</u>	<u>36.20</u>	<u>5.21</u>	<u>1.6</u>
	Average	26.90	36.17	5.17	1.6
Edge	20	26.90	36.32	-	3.5
	<u>21</u>	<u>27.00</u>	<u>36.16</u>	<u>5.11</u>	<u>1.6</u>
	Average	26.95	36.24	5.11	2.6
Sargasso Sea	23	24.00	-	-	-
	24	24.38	36.48	4.33	0.9
	<u>25</u>	<u>24.14</u>	<u>36.38</u>	<u>4.22</u>	<u>1.2</u>
	Average	24.17	36.43	4.28	1.0
East Florida Shelf	26	23.02	36.46		
	27	23.0 *	36.39 *		
	28	23.4 *	36.28 *		
	29	23.4 *	36.50 *		
	<u>30</u>	<u>23.2 *</u>	<u>36.48 *</u>		
	Average	23.2	36.42		

*Samples taken from bucket, not Nansen bottle.

Midwater fish populations in the Northern Sargasso Sea were more similar to Gulf of Mexico populations than were Southern Sargasso Sea populations. It was hypothesized that the Gulf Stream could transport the Gulf of Mexico fish to the Sargasso Sea, but that could not be demonstrated on W-57 (Smith). The vertical migration of some of these midwater fish, the myctophids, was more affected by moonlight than by environmental temperature (Mancuso and Marchi). Finally, blue copepods were found in the nutrient-poor waters of the Sargasso Sea, the Gulf Stream and the Loop Current whereas orange copepods were found in all water masses (King).

Sediment sampling was done on two transects across the West Florida Shelf (figure 10). Along the northern transect hydrocasts were done at stations 8, 10, 12, 14 and along the southern track at stations 16, 17, and 18. Numbers beginning with 21 and continuing through 65 corresponded to samples taken with the Scoop Fish Underway Sediment Sampler. Of the samples analyzed for foraminifera distribution, the ones in the most shallow water showed the highest concentration of Globigerinoides ruber. In deeper water, G. ruber was partially displaced by Neogloboquadrina dutertrei and other members of the shelf assemblage (George and Hendrickson). Radiolaria were much more scarce than foraminifera, but their distribution showed an apparent relationship to surface temperature (Falkner and Peck). The sediments were distributed in bands parallel to the coast showing an unexpected size distribution that may be related to storm transport of materials. The compositional zonation of sediments described in the literature was seen, including an oolite band that may indicate the presence of an earlier shoreline (Holmen).

The last oceanographic project was conducted on the East Coast of Florida at station 26-30 (figure 2). This study was of a submarine spring off Crescent Beach, Florida. The spring has apparently decreased in intensity over the last 25 years, and at least part of this decrease may be due to the current drought in Florida (Ashjian).

Figure 10. Sediment sample locations along the West Florida Shelf. Hydrocasts were done at stations 8, 10, 12, 14, 16, 17, and 18. Depth contours in fathoms.

LOOP CURRENT STUDIES

A study of the Loop Current and mixing along its edges

Marla Gearing

ABSTRACT

The purpose of this project was to examine the characteristics of Loop Current water as compared to the surrounding water in the Gulf of Mexico. Temperature, salinity, and silicate concentration were measured at six stations: two in the Gulf of Mexico, two in the Loop Current, and two on the edge of the current (Table 4 and figure 8). Beneath the surface layer, the two Loop Current stations had higher temperatures, higher salinities, and lower silicate concentrations than the two Gulf of Mexico stations; the edge stations had characteristics intermediate between the Loop Current and the Gulf of Mexico, which suggested that mixing has occurred along the boundaries of the current (figure 11).

The two Loop Current stations were also compared with two Gulf Stream stations where the same parameters were measured. Slight differences were found between the two currents: Loop Current water had higher temperature, higher salinity, and lower silicate concentration than Gulf Stream water (figure 11). These differences might be accounted for by some mixing of Gulf Stream water with North Equatorial Current water entering through the Old Bahama Channel.

Figure 11. Selected profiles of physical and chemical characteristics of three water masses and one mixed water profile. Station numbers are: 3 = Gulf of Mexico; 2 = Loop Current, 4 = mixed Gulf and Loop water; 22 = Gulf Stream.

Diatoms as water mass indicators

Jenny Hinshaw

ABSTRACT

Diatoms were collected in six phytoplankton tows to study their value as water mass indicators: two in Loop Current water, one in Gulf of Mexico water, one in mixed water, and two in the shelf water. Similarity, quantity, and diversity comparisons were used to distinguish these four water masses. The following formula was used to study similarity: $S = 2C / A + B$ where A and B equal the number of species in stations A and B respectively, and C equals the species common to both. The similarity test showed the two Loop stations and the two shelf stations were the most similar ($S = 0.83$ and 0.82 , respectively). The Gulf station compared to one Loop station and to the shelf stations individually were the least similar (0.57 , 0.56 , and 0.52 , respectively). The Gulf station, surprisingly had fewer cells than the Loop station (Table 3). However, the Gulf station, had three times more zooplankton biomass than one of the Loop stations, suggesting three times more grazing. Therefore, diatom quantities alone did not show productivity of the Gulf compared to the Loop. The diversity index, $S-1/\ln N$ (S =#of species, N = total cell count), for the Gulf station was different by two standard deviation points from the Loop stations (table 5). The lower diversity index for the Gulf suggests a higher productivity rate compared to the other stations. The diversity index for edge station 4 was greater than the Gulf and the Loop diversity indices (Table 5). Also, the quantity of diatoms in this mixed water was intermediate of the Gulf and Loop stations. The higher concentration of silicate in water beneath the surface of Gulf water may indicate a higher productivity potential compared to the Loop water. For such a short term study the use of species as water mass indicators was not practical, considering seasonal changes. However, in this season Coscinodiscus indicated the Gulf water and Chaetoceros decipiens indicated the Loop water (figure 12). Overall, the similarity, quantity, and diversity comparisons provided a definite distinction between the Loop and Gulf waters.

Figure 12. Pie diagrams for the diatoms found at each station. Numbers in the circles represent percent of total count. Stations 1 and 2 = Loop Current; Station 3 = Gulf of Mexico; Station 4 = Mixed Water; Stations 6 and 18 = West Florida Shelf.

TABLE 5. List of diatom species for each station and percent of total count. Diversity index and zooplankton biomass for the stations are also given.

<u>Species</u>	Frequency of cells (%)					
	<u>St. 1</u>	<u>St. 2</u>	<u>St. 3</u>	<u>St. 4</u>	<u>St. 6</u>	<u>St. 18</u>
Bacteriastum hyalinum	5.30	20.87		2.47	3.86	20.12
Chaetoceros A	8.58	4.92	3.80	3.18	5.43	8.28
Chaetoceros B	1.26	0.59			2.77	3.55
Chaetoceros decipiens	28.28	17.91	3.80	12.37	32.33	17.75
Chaetoceros diversus	0.25			2.12		0.59
Chaetoceros gracilis	1.26	2.16		3.18	1.08	4.14
Chaetoceros peruvianum	4.54	4.53		2.47	2.17	3.55
Coscinodiscus A	1.77	1.57	37.97	9.54	1.08	1.18
Ditylum A	0.25	0.20			0.12	1.18
Ditylum B	0.50				0.24	1.18
Ditylum brightwellii	0.76	0.20		0.71		
Hemiaulus nauckii	10.35	6.69	2.53	10.95	5.67	5.32
Hemiaulus membranaceus	1.77	3.35		6.71	2.53	2.37
Navicula A	3.03	0.79	18.99	3.18	3.14	5.92
Navicula B	6.31	6.69	3.80	1.06	1.08	
Nitzschia closterium	4.54	0.98	3.80	12.72	1.21	7.10
Nitzschia longissima	0.50					
Nitzschia seriata (?)	9.50	4.13	8.86	1.77	8.93	2.37
Penate A	0.25					
Rhizosolenia A	0.25		8.86			
Rhizosolenia alata	0.25	0.20		2.12	1.33	5.92
Rhizosolenia B	2.52	3.15	2.53	9.89	6.76	4.73
Rhizosolenia styliiformis	7.58	7.68		0.35		
Thalassiothrix frauenfeldii	0.25	0.98				
Chaetoceros daniscus		1.77		0.35	1.21	0.59
Navicula C		1.38	3.80	3.53	0.84	2.96
Rhizosolenia acuminata		2.16				
Chaetoceros D				3.89		
Chaetoceros filiformis				3.18	3.86	

(continued)

TABLE 5. (continued)

<u>Species</u>	Frequency of cells (%)					
	<u>St. 1</u>	<u>St. 2</u>	<u>St. 3</u>	<u>St. 4</u>	<u>St. 6</u>	<u>St. 18</u>
Rhizosolenia delicatula				1.41	1.21	
Rhizosolenia stolterfothii				2.83	7.12	0.59
Ditylum C					1.08	
Chaetoceros coarctatus					0.24	
Chaetoceros furca					1.21	
Rhizosolenia cylindrus					1.21	0.59
Skeletonema A					0.24	
Thalassiothrix nitzschoides					2.05	
Total No. of cells ($\times 10^3$)	4.87	4.70	1.31	2.61	5.30	6.43
Diversity Index	3.84	3.37	2.29	3.90	4.02	3.90
Zooplankton Biomass (ml/m^3)		9.024	0.073	0.087	(0.07)	0.024

Zooplankton community structure analysis of the Loop Current of the
Gulf of Mexico

Frank S. Wilson

ABSTRACT

A comparison was made between zooplankton community structure in the Loop Current and in Gulf of Mexico water based on two Loop Current stations, one Gulf of Mexico station and one intermediate station as determined by physical data (Table 4). Samples taken in oblique tows to 100 meters depth with the 505 μ mesh meter net and preserved in 5% formaldehyde were analyzed for biomass by volume displacement. Sub-samples of 6 ml were counted and organisms were identified under a dissecting microscope. Loop Current stations had a larger relative abundance of euphausiids (15.7 and 16.9% of total individuals) than the Gulf of Mexico (5.4%) and intermediate (2.6%) stations (figure 13). More hyperiid amphipods appeared in the Gulf of Mexico station (8.1%) than in either the intermediate (2.3%) or Loop Current (both less than 2%) stations. These variances may have been related to nutrient level differences. Low nutrient levels could cause an increase in the relative abundance of lower trophic level individuals such as euphausiids, while higher nutrient levels would cause the relative abundance of higher carnivores such as hyperiids to increase. Due to the small number of samples, limited count time, and lack of seasonal data, these results are not conclusive, but do show substantial structural variances in the zooplankton communities studied.

Zooplankton Community Structure Analysis
505 μ Meter net oblique tows to 100m
W-57; Spring 1981

Figure 13. Pie diagrams of zooplankton composition at two Loop Current, one Gulf of Mexico, and one intermediate station.

A comparison of three populations of mesopelagic fish

Deborah Ruth Smith

ABSTRACT

Mesopelagic fish in the Western North Atlantic are divided into mesofaunal regions (Backus et al. 1969). The intent of this project was to compare the mesofaunal regions of the Gulf of Mexico and the Southern Sargasso Sea with focus mainly on the mixing or isolation of mesofaunal genera. The Gulf Stream was sampled as a possible avenue by which mixing could occur. Simultaneous meter net tows were taken at three stations in the various water masses. The results showed no mixing of the mesofauna between the Gulf of Mexico and the southern Sargasso Sea. This may be because of the distinctly different physical characteristics of each water mass. The Gulf Stream was the most productive of the sampled water masses, but a similarity index showed that it was not similar to the other masses and therefore did not aid in mixing.

Backus, R.H., J.E. Craddock, R.I. Haedrich, and D.L. Shores. 1969.
Mesopelagic fishes and thermal fronts in the Western Atlantic
and Sargasso Sea. Mar. Biol. 3:87-106.

DRS*

Effects of temperature on diurnal vertical migration patterns of
midwater myctophids

Carol Mancuso and Marianne Marchi

ABSTRACT

Diurnal vertical migration, daily up and down mass movement of organisms in the water column, is a phenomenon observed in the behavior patterns of the family Myctophidae, among other midwater fish. This is a study of the effect of temperature on the migratory patterns of these fish. Three sampling areas of different temperatures were chosen: The Gulf of Mexico, Gulf Stream and Sargasso Sea. In each water mass, three meter nets were towed simultaneously, twice in a twenty-four hour period, once at noon, and once at midnight. The thermocline and general temperature profile was noted from the bathythermograph and hydrocast data. Biomass and number of Myctophids were determined for each station. Lunar phase was noted during evening tows. From these observations, it seems that the effect of temperature was minimal; a general overall pattern was repeated in each water mass regardless of temperature. It seemed however, that light intensity had a much more marked effect. The number of Myctophids present in the Gulf of Mexico, a water mass with high nutrient content, was apparently reduced by the conditions of a full moon. Temperature may have an effect on the niche separation of species, but this would be difficult to test.

Variability in coloration of copepods

Christina King

ABSTRACT

Copepods from several locations including the Loop Current, the Gulf of Mexico, the Gulf Stream, the Sargasso Sea, and the coast of Florida were collected and counted by color to determine if one color was characteristic of different locations.

Orange and colorless copepods were ubiquitous and not specific to any one location. Orange was the predominant color in the Gulf of Mexico (70%), the Gulf Stream (62%), the Sargasso Sea (67%), and the Florida coast (82%).

Blue copepods were found in smaller numbers in the Gulf Stream (15%), the Loop Current (6%), and the Sargasso Sea (5%).

It is hypothesized that diet-derived carotenoids cause orange pigmentation. Colorless copepods may either have a slower rate of assimilation of internal body pigments into external body color, or they could be different species with different feeding habits.

Blue pigmentation is found in nutrient-poor waters, therefore blue copepods could be an example of cryptic coloration, an adaptation for disguise from predators in the bluer, nutrient-poor water. Blue copepods are found in most abundance in the Gulf Stream (15%), which may be from additional influx of copepods from the Caribbean that are picked up by the Gulf Stream and carried north.

SEDIMENTS ON THE WEST FLORIDA SHELF

Distribution patterns of planktonic foraminifera across the West Florida Shelf

Victoria A. George and Nancy I. Hendrickson

ABSTRACT

The relative abundances of planktic foraminifera were studied in 16 samples along two transects across the West Florida Shelf between 26 N and 28 N (figure 10). The samples of bottom sediment were collected with a Scoopfish Underway Bottom Sampler and the 63u to 500u size fraction was separated and microsplit. Frequency counts of 340 specimens were made on each sample and the relative abundances were compared to variations in distance offshore (depth), surface salinity, and surface temperature.

A number of trends in relative abundances of these species across both transects are apparent (figure 14 and 15). Globigerinoides ruber showed a marked increase in relative abundance with distance inshore. Surface salinity and surface temperatures did not vary outside the preferred ranges established by Jones (1974), and distance offshore or depth was the only physical factor observed that affected relative abundances.

The number of fauna inhabiting the shelf waters was small, consisting of 16 species, with some samples containing as few as 10. Globigerinoides ruber was dominant, constituting roughly 40 to 80% of each sample. Maximum concentrations of G. ruber occur in the surface to 100m depth range within the water column (Jones 1974). Other species that form minor components of the assemblages studied, such as G. sacculifer and N. dutertrei, live deeper within the water column (Jones 1974.) As the water becomes shallower, those species that live in deep water lose their preferred environment, so their populations decrease, whereas species that live in the upper part of the water column, such as G. ruber, are not affected in this adverse manner. Thus, G. ruber increased and G. sacculifer and N. dutertrei decreased in number as the water gets shallower near shore. The small percentage of deep water

planktic foraminifera in shallow, near shore waters can be explained by currents and storms sweeping them inshore.

Planktic foraminifera have generally been considered to be reliable indicators for both regional and transoceanic correlation, but only in beds deposited in the outer continental shelf or deeper (Cifelli and Smith, 1974). It has been thought that the middle and upper continental shelf have too few faunal elements and the populations are too small to provide any significant trends (Poag and Valentine, 1976). The trends observed in this study, however, are significant and are consistent over both transects. Therefore, it is likely that planktic foraminifera do provide a reliable indicator of water depth for all but the extreme inner continental shelf.

Cifelli, R., and R.K. Smith, 1974. Distributional patterns of planktonic foraminifera in the Western North Atlantic. *J. Foram. Res.* 4(3): 112-125.

Jones, J.I., 1974. The ecology and distribution of living planktic foraminifera in the Straits of Florida. *Dept. Oceanogr. Florida State U., Tallahassee.*

Poag, C.W., and P.C. Valentine, 1976. Biostratigraphy and ecostratigraphy of the Pleistocene basin, Texas-Louisiana. 26:185-256.

Figure 14. Cumulative frequency distribution of foraminifera in the sediments of the West Florida Shelf. Northern transect.

Figure 15. Cumulative frequency distribution of foraminifera in the sediments of the West Florida Shelf. Southern transect.

Radiolaria in sediment samples on the West Florida Shelf

Douglas Falkner and Craig Peck

ABSTRACT

The purpose of this project was to determine the effects of a previously reported low salinity water mass (33 ‰) on radiolaria in the sediments on the West Florida Shelf. A scooper fish was used to take sediment samples along two transects (figure 10). Salinity and surface water temperature were taken along the northern transect. No low salinity water mass was found and only surface water temperature was taken on the southern transect. Data were analyzed for correlation with average grain size, depth, salinity and surface temperature (Table 6). The only possible correlation found was between surface water temperature and radiolarian abundance. At the four sites where radiolaria were found, the temperatures ranged between 25.0°C and 26.8°C. At all other sites the temperature was below 23.5°C. However, radiolaria are too scarce in the sediments on the West Florida Shelf to serve as good environmental indicators and the relationship was not statistically significant. Further research into relationship between the surface water temperature and radiolarian population is encouraged.

TABLE 6. Relationships between radiolarian distribution in surface sediments on the West Florida Shelf and sediment grain size, depth, and surface temperature and salinity.

<u>Station No.</u>	<u>Median Grain Size (mm)</u>	<u>Depth of Water (m)</u>	<u>Surface Salinity (‰)</u>	<u>Surface Temperature (°C)</u>	<u>No. of Radiolarians</u>
Geo. 21	0.190	180	36.43	23.3	0
Geo. 34	0.200	43	36.29	22.3	0
Geo. 53	0.375	36	-	23.0	0
Geo. 57	0.880	54	-	25.0	2
Geo. 60	0.440	140	-	25.4	3
Geo. 63	0.395	207	-	26.0	8
W57-7	0.250	-	36.35	23.5	0
W57-10	0.580	232	36.41	23.2	0
W57-12	1.090	54	36.25	21.8	0
W57-15	0.140	31	36.31	21.9	0
W57-17	0.830	47	-	22.8	0
Geo. 65	0.932	396	-	26.8	7

Holocene bottom sediments of the West Florida Shelf

Britt A. Holmen

ABSTRACT

The sediments on the West Florida Shelf were examined along two transects (figure 10) for two reasons. The first was to determine whether the relationship between grain size and distance from shore followed the generalization that coarser sediments are found closer to shore because of the higher energy environment associated with shallow water wave action. The second reason was to determine whether the six compositional zones described by Gould and Stewart (1955) could be re-defined. Analysis of the sediments included wet sieving through sieve sizes 2.00, 0.250, 0.150, and 0.063 mm, and subsequent weighing of the size fractions to determine weight percentages. Cumulative curves were used to calculate median diameter and sorting coefficient. Compositional analysis was performed using a compound microscope to examine slides of the 0.150 mm fraction from each station.

The median diameter map (figure 16) indicated that there was a band of coarser material offshore surrounded by finer sediments on both sides. The band was parallel to the shelf contours. Two hypotheses were proposed to explain this apparently anomalous condition: (1) storm transport may deposit coarse sediments far from shore, and (2) contour currents may create a high energy environment that allows coarse material to be deposited, but prevents deposition of finer grained sediments. It is most probable that both forces acting together are responsible for the conditions found on the shelf.

The composition analysis revealed four of the six zones described by Gould and Stewart (figure 17). These were the mollusc shell zone, the algal sand zone, the oolite zone and the foraminifera/sand zone, with increasing distance offshore. The oolite band has not been confirmed since the original study. It could have been formed only in water less than five meters deep and thus its presence indicates an ancient shoreline in the region.

Gould, H.R., and R.H. Stewart. 1955. Continental terrace sediments in the Northeastern Gulf of Mexico. In Finding ancient shorelines. Publ. Soc. Econ. Pal. Min. Amer. Assoc. Petrol. Geol. 3, pp. 2-19.

Figure 16. Contour map of median grain size of sediments along the West Florida Shelf. Whole numbers = station positions. Decimal numbers = median diameter of grains, in mm.

Figure 17. Sediment composition of the West Florida Shelf (after Gould and Stewart, 1955). Station numbers are superimposed on the patterns described in the key.

CRESCENT BEACH SPRING STUDY

Condition characteristics and activity of the submarine spring off Crescent Beach, Florida

Carin Ashjian

ABSTRACT

The submarine spring 2.5 miles off Crescent Beach was studied primarily to determine the characteristics and, as a secondary objective, to estimate if the discharge from the spring had decreased since the last study.

The spring is believed to be the result of an artesian system in which fresh water is recharged into the aquifer on land and moves out under the continental shelf through permeable limestone beds overlain with impervious clay and marl beds until it reaches a point of discharge. It was described in 1961 as an active spring producing periodic surface boils, a surface slick, and a distinct turbidity plume (Brooks 1961).

The present study was conducted on May 31, 1981. Visual observations, hydrocasts, sediment samples, phytoplankton tows, and fathometer tracing were used to define features.

The spring was active with features similar to those described by Brooks. In addition, a low salinity bubble (figure 18) with salinity contours was found. Comparison of salinity values from 1969 and 1981 found that the spring had increased in salinity since 1961. The higher salinities may be a result of (1) decrease in the volume of spring discharge or (2) an increase in the salinity of the aquifer.

Brooks, H.K. 1961. The submarine spring off Crescent Beach, Florida. Quart. J. Fla. Acad. Sci. 24(2):122-134.

Figure 18. Cross-sectional analysis of salinity vs. depth at four stations near Crescent Beach Spring. Bottom contour based on fathometer readings across the spring site. Upper section of the figure shows a plan view of the region and indicates the slick area and direction of flow of the turbidity plume.

OTHER STUDIES ON W-57

Total hull resistance of the R/V Westward

Daniel G. Quible

ABSTRACT

Ship designing incorporates many factors derived from research before the finished product is launched. One of those factors is total hull resistance, which aids in shaping and designing a hull which is clean, efficient and yet functional. The Westward's total hull resistance was experimentally determined using a portable knotmeter set-up lashed to the bowsprit. It was found that the Westward's resistance was 500 pounds at low speeds, 1200 pounds at speeds of 5 to 6 knots and beyond that the resistance increased to 4800 pounds at a speed of 6.5 knots. Resistance would be substantially less if the stern were not so blunt.

Storage space on board the R/V Westward

Elizabeth A. Carr

ABSTRACT

S.E.A. is designing a new research vessel to expand their program, and information is needed concerning the amount of storage space required. My project was to measure storage on Westward and offer recommendations for the new ship.

Thirteen categories of food supplies were established. Storage of goods on Westward seemed adequate for more categories. Retainment of features that have proven successful, such as the storage of canned goods under bunks, is recommended. Improvements were also suggested, such as increasing the size of the reefer, and enlarging the storage space for pots and pans. Storage space used at present for each category (Table 7) combined with the recommendations, should make a successful storage layout possible.

TABLE 7. Present storage space available for food on the R/V Westward

<u>Category of food</u>	<u>Volume of space available (ft³)</u>
Frozen food	31.1
Eggs (greased)	11.9
Refrigerated food	13.1
Canned goods	89.2
Dry stores (grains, etc.)	192.9
-within reach of galley, additional	36.0
Crackers	24.3
Baking goods	8.4
Paper products	24.6
Cleaning supplies	37.6
Condiments	23.4
Small miscellaneous	10.5
Fresh vegetables (elephant table)	11.0
Total below decks storage	534.2

Physical changes in students aboard the R/V Westward cruise W-57

Douglas Eisinger

ABSTRACT

Westward's student crew is often made up primarily of students who have little if any experience on the open ocean. The immediate effects of this are well known: seasickness is prevalent during the first few days aboard the ship. Of more important interest though are what the possible long-term changes might be to the students' physical condition as they become acclimated to life aboard Westward. This study attempted to discern and observe some of these longer-term changes in the student group as a whole.

Starting on the shore component and lasting through the cruise, eight tests were used to gauge physical change: weight, blood pressure, heart rate, calf and arm circumference, triceps skinfold measurement, Uristix test for proteinuria, and daily caloric intake. Data indicated that three factors may be at work upon the student: lack of sleep, dehydration and environmental stress (both physical and mental). Weight was maintained even though caloric intake was greatly increased, blood pressure decreased and heart rate increased, and calf and arm sizes increased. It appears that a high level of physical activity aboard the Westward, combined with the factors mentioned above, provides for a lifestyle that is physically demanding and change inducing. However, standard deviations were often as large as the mean change, and six weeks may be too short a time period for these changes to be significant.

A study of project interest aboard the R/V Westward

Richard Shinn

ABSTRACT

The purpose of this study was to find out why certain students did not enjoy doing their projects aboard W-57. It was hypothesized that reasons for students disliking their projects would be that those students did not understand the true purpose of scientific methodology and expected therefore that the scientific method would, by itself, reveal interesting ideas about the qualities of nature. It was found, however, that the reason was not this but rather that scientific methodology had taken away from the original fascination. These students had chosen their projects for emotional reasons. When the reality of study became tedious, these students lost their interest in what they were studying. It was also found that most students did not lose interest, and some even became more interested as their projects progressed.

Producing a film documentary aboard the R/V Westward

Kelley Paterson and Charles Robinson

ABSTRACT

Our project was to produce a film documentary portraying "Education at S.E.A." from a student's perspective. The film when completed will serve as a documentation of our voyage from Key West to Woods Hole and will serve as an educational film by explaining some of the basics in field oceanography and by teaching some of the sailing procedures aboard a 125-foot staysail schooner. The project has combined our literary and communications backgrounds with our science experience aboard the Westward. We borrowed a 16-mm movie camera and accessory equipment from CBS television network. As of this date, nearly all of the filming has been completed. Some of the film has been sent to be developed and the rest will be sent out when we reach Woods Hole. Final editing of the film will take place this summer. The expected date of completion is August 28, 1981. Our paper includes a rough draft script which served as a guide during the filming process. Financial aspects of the project are also discussed. Several suggestions are offered for those who may wish to do a film project in the future. The project was unique in that the camera served as an omniscient eye, which could capture and perceive the total essence of the Westward experience. Although the success of the film is an important factor in determining the success of the project, the project has already proved successful as a great learning experience.

APPENDICES

APPENDIX I. The Academic Program

Marine Science Program: W-57

Mary Farmer
Head of Marine Science

The Marine Science program aboard R/V Westward was composed of three areas of activity, each of which was given equal emphasis on the final evaluation.

1. Lectures

Lectures were given each weekday while at sea. Many of the topics covered were related to areas of the sea we were passing through while others pertained to sampling and analytical methods. Information obtained during lectures and science watch was evaluated by quizzes and by a final practical exam.

2. Science watch

A 24-hour science watch was maintained throughout the cruise; watch-standers consisted of a member of the staff plus three students. Their responsibilities included maintenance of the science log, execution of scientific stations, analysis of samples, and interpretation of data. In addition, time was made available for research projects and personal instruction.

Students compiled a collection of fauna and flora ("Feature Creatures") under supervision from a wide variety of marine environments in an attempt to become familiar with the diversity of life in the ocean. This collection served as the basis for study of different phyla, and evaluation in this area was by means of the practical examination.

3. Individual research project

While in Woods Hole, each student was required to define a research project to be carried out on board. Any subject could be chosen, the only constraints being that

- (i) the project should take advantage of the opportunities offered by Westward, and
- (ii) it should be approached, executed, and written up in a scientific fashion.

The projects covered physical, geological, and biological oceanography as well as ocean engineering, naval archaeology, and human physiology. Each student presented a 15-minute seminar on the project and its results and submitted a written report before leaving ship. In addition, three of the projects were selected for presentation to the Woods Hole scientific

community upon return of the vessel to Woods Hole at the end of the cruise.

Nautical Science Program: W-57

John Metcalf
Head of Nautical Science

The purpose of the Nautical Science program on Westward for W-57 was three-fold:

- (i) To test in practice the theory learned ashore.
- (ii) To help the students develop into cautious and thoughtful seamen.
- (iii) To help the students develop various skills in seamanship and navigation.

To carry out these goals, formal lectures were given every weekday, along with continuing informal lectures and demonstrations on watch. Written and practical exams tested student development in the skills of seamanship and navigation. Students were also required to keep a sea project notebook and to carry out a running fix of the ship's position.

APPENDIX II. W-57 Station Summary

Station #	Date	Time	Latitude (N)	Longitude (W)	BT#	Secchi Disc	Hydro- cast	Phyto- plankton tow	Zoo- plankton tow	IKMT	Sediment sample
W57-1 ✓	10 APR81	1445	24°50.8'	84°31.7'	8	x	x	x	0-100m		
W57-2 ✓	11 APR81	0605	25°23.4'	85°22.9'	12		x	x	0-100m		
W57-3 ○	12 APR81	0540	25°38'	87°04'	18	x	x	x	0-100m	x	
W57-4 ○	13 APR81	0400	26°17'	87°10'	24	x	x	x	0-100m		
W57-5 ○	14 APR81	1230	28°27.4'	87°06.4'	33		x	x	0-100, 200m	x	
W57-6 ✓	16 APR81	1430	26°33.5'	85°17.6'	45	x	x	x	100, 200, 400m		
W57-7	17 APR81	0715	26°56.3'	84°51.4'							x
W57-8	17 APR81	1800	27°31.4'	84°39.4'			x				x
W57-9	17 APR81	2145	27°32.7'	84°29.6'							x
W57-10	18 APR81	2317	27°36.6'	84°22.6'			x				x
W57-11	18 APR81	0310	27°42'	84°21'							x
W57-12	18 APR81	0630	27°44.8'	84°07.6'			x				x
W57-13	19 APR81	0520	27°41.6'	83°52.0'							x
W57-14	19 APR81	1315	27°42.5'	83°35.1'			x				x
W57-15	19 APR81	1730	27°41.6'	83°20.0'							x
W57-16	22 APR81	2120	27°18'	83°09'							x
W57-17	24 APR81	0750	27°06.5'	83°43.0'							x
W57-18	24 APR81	0545	26°07.8'	84°29.0'			x	x			x
W57-19 ○	27 APR81	1300	23°57.3'	80°48.4'	57	x	x	x	100, 200, 400m		
W57-20 ○	28 APR81	0015	24°35.7'	80°27.8'			x		0-50m		
W57-21 ✓	28 APR81	1230	25°11.5'	80°05.4'	61	x	x	x	0-100m		
W57-22 ✓	28 APR81	2345	25°24.7'	79°45.0'	66		x	x	0-100, 200m		
W57-23	30 APR81	1000	27°58.8'	78°15.1'	75		x				

APPENDIX II (continued)

Station #	Date	Time	Latitude (N)	Longitude (W)	BT#	Secchi Disc	Hydro- cast	Phyto- plankton tow	Zoo- plankton tow	IKMT	Sediment sample
W57-24/	30 APR81	2200	29°09.8'	78°17.6'			x	x	0, 100, 200m		
W57-25 ✓	01 MAY81	0720	29°17.2'	78°32'		x	x	x	100, 200, 400m		dredge
W57-26	03 MAY81	0615	29°47.1'	81°0.9'		x	x	x			
W57-27	03 MAY81	0855	29°47.1'	81°12.6'		x	x	x			
W57-28	03 MAY81	1020	29°47'	81°13'			x	x			
W57-29	03 MAY81	1115	29°47'	81°13'			x	x			x
W57-30 ✓	03 MAY81	1200	29°47'	81°13'		x	x	x	8m		x
W57-31	10 MAY81	1030	31°58'	79°47'		otter trawl only					
W57-32	17 MAY81					otter trawl only					

APPENDIX III. W-57 Bathythermograph summary

<u>BT#</u>	<u>Date</u>	<u>Time</u>	<u>Latitude (N)</u>	<u>Longitude (W)</u>	<u>Surface T (°F)</u>	<u>Mixed Layer (ft)</u>
1	09 Apr 81	1653	24°17.2'	82°13.3'	75.7	55
2	10 Apr 81	0130	24°35.6'	83°17.5'	75.2	125
3	10 Apr 81	0350	24°40.2'	83°34.8'	75.0	60
4	10 Apr 81	0801	24°43.8'	84°00.5'	74.6	135
5	10 Apr 81	0950	24°44.5'	84°07.6'	77.0	38
6	10 Apr 81	1135	24°44.7'	84°15.6'	78.8	192
7	10 Apr 81	1250	24°46.4'	84°21.0'	78.8	240
8	10 Apr 81	1430	24°51.0'	84°30.9'	79.8	160
9	10 Apr 81	2315	24°57.3'	84°48.8'	78.8	180
10	11 Apr 81	0029	25°02.3'	84°55.3'	78.4	162
11	11 Apr 81	0218	25°09.3'	85°04.3'	76.6	210
12	11 Apr 81	0540	25°22.6'	85°21.7'	78.4	200
13	11 Apr 81	1320	25°37.3'	85°45.6'	79.3	120
14	11 Apr 81	1520	25°39.1'	85°56.5'	79.7	100
15	11 Apr 81	1835	25°43.0'	86°13.5'	78.4	40
16	11 Apr 81	2320	25°44.48'	86°34.13'	75.2	120
17	12 Apr 81	0230	25°40.9'	86°48.1'	75.2	145
18	12 Apr 81	0500	25°38.0'	86°59.9'	74.6	140
19	12 Apr 81	1925	25°36.75'	87°11.14'	74.8	~ 100
20	12 Apr 81	2135	25°47.8'	87°07.2'	74.9	80
21	12 Apr 81	2315	25°57.26'	87°06.32'	75.2	140
22	13 Apr 81	0048	26°06.1'	87°05.64'	76.1	140
23	13 Apr 81	0220	26°12.09'	87°07.5'	75.2	120
24	13 Apr 81	0325	26°17.48'	87°10.40'	75.0	45
25	13 Apr 81	1215	26°23.04'	87°35.87'	76.8	~ 40
26	13 Apr 81	1730	26°52.98'	87°42.02'	78.0	30
27	13 Apr 81	1905	27°05'	87°42'	74.8-74.0	400
28	13 Apr 81	2220	27°18'	87°40'	74.8-74.0	520
29	14 Apr 81	0050	27°41.4'	87°35.3'	74.8-74.6	100
30	14 Apr 81	0520	27°58.17'	87°25.36'	78.0	85

APPENDIX III. W-57 Bathythermograph summary (continued)

<u>BT#</u>	<u>Date</u>	<u>Time</u>	<u>Latitude (N)</u>	<u>Longitude (W)</u>	<u>Surface T(°F)</u>	<u>Mixed Layer(ft)</u>
31	14 Apr 81	0848	28°11'	87°17'	78.4	80
32	14 Apr 81	1158	28°25'	87°08'	77.3-77.0	80
33	14 Apr 81	2030	28°23'	86°49'	77.0	40
34	15 Apr 81	0200	28°13.8'	86°34.6'	77.5-77.0	110
35	15 Apr 81	0600	27°59.8'	86°14.3'	77.5-77.0	90
36	15 Apr 81	0805	27°45.85'	86°05.59'	77.1	100
37	15 Apr 81	1315	27°28'	86°01'	78.0-77.4	105
38	15 Apr 81	1736	27°05'	85°54'	78.2-78.0	40
39	15 Apr 81	1955	26°51.9'	85°49.7'	77.1-77.0	40
40	16 Apr 81	0235	26°25.62'	85°38'	75.7-75.0	55
41	16 Apr 81	0530	26°16.73'	85°34.07'	75.2-75.0	105
42	16 Apr 81	0806	26°11'	85°29'	74.8	90
43	16 Apr 81	1130	26°24.6'	85°21.9'	76.4	85
44	16 Apr 81	1250	26°29.3'	85°19.7'	76.4	70
45	16 Apr 81	1400	26°32.2'	85°18.3'	76.1	30
46	26 Apr 81	0620	24°13.6'	82°33.67'	77.9	35
47	26 Apr 81	0815	24°02.61'	82°25.61'	79.7	80
48	26 Apr 81	1000	23°50'	82°15'	80.6	110
49	26 Apr 81	1130	23°41'	82°11'	80.6	100
50	26 Apr 81	1335	23°31'	82°03'	81.0	40
51	26 Apr 81	1500	23°31'	81°57'	81.0	40
52	26 Apr 81	1630	23°41.6'	81°56.1'	81.0	20
53	26 Apr 81	1920	23°59.2'	81°52.71'	77.5	20
54	26 Apr 81	2220	23°57.83'	81°46.61'	77.7	40
55	27 Apr 81	0240	23°40.0'	81°29.05'	81.6	210
56	27 Apr 81	0800	23°59.21'	81°09.86'	79.7	50
57	27 Apr 81	1150	23°59.0'	80°51.9'	80.6	190
58	27 Apr 81	2000	24°18'	80°36.2'	80.4	178
59	27 Apr 81	2200	24°27.1'	80°36.2'	80.6	140
60	28 Apr 81	0700	24°58.67'	80°16.29'	79.8	25

APPENDIX III. W-57 Bathythermograph summary (continued)

<u>BT#</u>	<u>Date</u>	<u>Time</u>	<u>Latitude (N)</u>	<u>Longitude (W)</u>	<u>Surface T (°F)</u>	<u>Mixed Layer (ft)</u>
61	28 Apr 81	1128	25°07.4'	80°09.4'	80.6	40
62	28 Apr 81	1720	25°14.58'	80°00.28'	80.6	40
63	28 Apr 81	1930	25°14.45'	79°51.46'	80.5	180
64	28 Apr 81	2100	25°14.19'	79°45.83'	80.2	230
65	28 Apr 81	2215	25°19.26'	79°44.64'	80.2	200
66	28 Apr 81	2324	25°24.71'	79°45.03'	80.3	200
67	29 Apr 81	0712	25°51.44'	79°45.36'	80.3	200
68	29 Apr 81	2000	27°34.95'	79°25.41'	79.4	10
69	29 Apr 81	2130	27°42.27'	79°15.15'	79.0	40
70	29 Apr 81	2345	27°46'	79°02'	77.7	60
71	30 Apr 81	0130	27°48.6'	78°50.05'	76.8-76.0	30
72	30 Apr 81	0330	27°51.4'	78°38.3'	75.5	50
73	30 Apr 81	0530	27°55.8'	78°28.9'	75.7	35
74	30 Apr 81	0730	27°59.89'	78°20.32'	76.2	40
75	30 Apr 81	0930	27°58.80'	78°15.13'	75.0	80
76	30 Apr 81	1400	28°01.02'	78°15.3'	75.2	120
77	30 Apr 81	1510	28°05.1'	78°14.9'	75.9	20
78	30 Apr 81	1730	28°22.69'	78°15.33'	77.0	20
79	30 Apr 81	1830	28°31.66'	78°15.68'	76.6	20
80	30 Apr 81	1930	28°40.35'	78°16.04'	76.6	20
81	30 Apr 81	2030	28°48.1'	78°16.3'	75.5	60
82	30 Apr 81	2145	28°57.5'	78°17.0'	75.5	50
83	01 May 81	0720	29°17.2'	78°32.0'	75.6	40

APPENDIX IV. Summary of hydrocast data

Station #	Date	Time	Depth (m)	Temperature (°C)	Salinity (‰)	Oxygen (ml.l ⁻¹)	Silicate (μM.l ⁻¹)
W57-1 ✓	10 Apr	1755 (second cast) " " " "	0	26.30	36.163	4.97	1.98
			45	25.95	36.132	4.94	2.25
			105	25.35	36.500	4.44	1.93
			67	25.88	36.151	5.10	2.25
			267	17.16	36.337	3.78	5.30
			483	10.99	35.392	3.48	14.10
W57-2 ✓	11 Apr	0735	0	26.01	36.201	4.97	1.40
			81	25.18	36.426	4.55	1.85
			191	19.07	36.642	3.82	3.30
			301	16.13	36.210	3.76	5.10
			480	11.48	35.463	3.21	12.20
			674	7.88	35.010	3.33	20.00
W57-3 0	12 Apr	0730	14	23.30	36.412	5.30	1.10
			74	20.72	36.470	4.88	2.20
			180	14.22	35.908	3.49	8.30
			286	10.72	35.539	3.40	12.50
			460	6.97	34.996	3.67	20.00
			710	5.69	35.009	3.95	20.60
W57-4 0	13 Apr	0615	2	23.78	36.402	5.27	0.60
			50*	23.62	36.337	5.26	0.30
			90	22.15	36.398	5.40	0.80
			115	20.07	36.468	4.22	2.60
			185	16.93	36.317	4.04	3.70
			281	13.95	35.827	3.56	9.20
W57-5 0	14 Apr	1930	0	25.23	36.268	5.28	
			30*	24.26	36.304	5.32	
			52*	22.35	36.794	4.28	
			80.4	20.83	36.521	4.76	
			103.1	19.93	36.512	4.51	
			147.6	17.55	36.345	3.95	

*Estimated depth.

APPENDIX IV. Summary of hydrocast data (continued)

<u>Station#</u>	<u>Date</u>	<u>Time</u>	<u>Depth</u> <u>(m)</u>	<u>Temperature</u> <u>(°C)</u>	<u>Salinity</u> <u>(‰)</u>	<u>Oxygen</u> <u>(ml.l⁻¹)</u>	<u>Silicate</u> <u>(μM.l⁻¹)</u>
W57-6 ✓	16 Apr	1430	0	24.70	36.337	4.15	2.8
			60*	20.54	36.436	5.55	0.04
			179	17.37	36.337	3.73	4.2
			283	16.84	35.941	3.62	7.0
			472	9.16	35.124	3.28	16.8
			678	6.59	34.906	3.50	18.5
W57-8	17 Apr	0830	0	23.34	36.450		
			15	22.90	36.422		
			65	19.97	36.228		
			101	19.18	36.388		
			145	16.79	36.248		
			182	16.64	36.236		
W57-10	18 Apr	0120	0	23.19	36.413		
			19*	22.96	36.420		
			42*	21.18	36.425		
			61	19.79	36.423		
			90	19.04	36.372		
			111	17.94	36.342		
W57-12	18 Apr	0740	7	21.46	36.247		
			20	21.00	36.251		
			29*	18.73	36.206		
W57-14	19 Apr	1445	0	21.85	36.308		
			10*	21.24	36.324		
			25	18.9	36.321		
W57-18	24 Apr	0635	5	25.84	36.364		1.6
			50	21.23	36.408		1.4
			100	19.27	36.372		2.3
			145	pretripped	36.317		2.1
			190	16.25	36.162		6.2

*Estimated depth.

APPENDIX IV Summary of hydrocast data (continued)

Station#	Date	Time	Depth (m)	Temperature (°C)	Salinity (‰)	Oxygen (ml.l ⁻¹)	Silicate (μM.l ⁻¹)
W57-19 0	27 Apr	1545	0	27.00	36.143	5.13	1.7
			66	26.89	36.137	5.17	1.8
			123	23.89	36.742	4.32	1.8
			197	19.02	36.543	4.24	2.9
			297	15.25	36.065	3.89	6.8
			380	11.98	35.527	3.63	11.0
W57-20 0	28 Apr	0230	0	26.9	36.325	**	3.5
			2	26.85	-	**	1.4
			59	25.57	36.195	5.09	1.1
			107	22.31	36.425	5.40	1.8
			149	19.96	36.375	5.31	-
			195	13.71	35.808	5.79	8.3
W57-21 ✓	28 Apr	1313	0	27.00	36.159	5.11	1.6
			28	26.74	36.134	5.23	1.7
			51	24.90	36.293	5.41	1.5
			74	23.24	36.377	5.63	1.15
			111	22.14	36.414	5.45	1.25
			149	18.38	36.214	5.02	3.0
W57-22 ✓	28 Apr	0300	0	26.8	36.195	5.21	1.6
			67	25.95	36.265	5.04	2.7
			87	24.56	36.625	4.38	1.5
			198	17.83	36.442	3.85	3.9
			290	13.90	35.875	3.61	8.3
			399	10.42	35.352	6.22	14.4
W57-23	30 Apr	1212	0	24.00			
			30	23.79			
			81	22.71			
			188	20.65			
			375	18.31			
			765	11.90			

*Estimated depth.

**Sample lost.

APPENDIX IV. Summary of hydrocast data (continued)

Station#	Date	Time	Depth (m)	Temperature (°C)	Salinity (‰)	Oxygen (ml.l ⁻¹)	Silicate (μM.l ⁻¹)
W57-24 ✓	30 Apr	2306	0	24.38	36.477	4.33	0.9
			22	23.89	36.456	4.32	0.9
			101	21.55	36.615	4.34	0.7
			184	19.69	36.563	4.13	1.0
			395	17.69	36.420	4.18	1.6
			766	11.01	35.423	3.15	11.1
W57-25 ✓	1 May	0900	0	24.14	36.381	4.22	1.2
			19	23.71	36.535	4.27	1.3
			69	21.04	36.630	4.24	1.4
			160*	19.57	36.688	3.96	2.5
			365	18.08	36.495	3.91	2.4
			755	9.96	35.294	2.85	13.7
W57-26	3 May	0600	0	23.02	36.462		
			8*	22.98	36.478		
			13*	23.04	36.460		
W57-27	3 May	0925	0	23.0**	36.387		
			10*	22.896	36.455		
			20*	22.874	36.480		
			30*	22.918	36.484		
			30*	22.912	36.489		
			38*	23.004	36.076		
W57-28	3 May	1030	0	23.4**	36.280		
			8*	22.911	36.317		
			15*	22.872	36.365		
W57-29	3 May	1103	0	23.4**	36.499		
			8*	22.95	36.470		
			15*	22.87	36.470		
W57-30 ✓	3 May	1200	0	23.2**	36.484		
			8*	23.12	36.413		
			15*	22.96	36.482		

*Estimated depth.

**Sample obtained from bucket, not Nansen bottle.

APPENDIX V. Data summary of cetacean sightings on Cruise W-57

<u>Genus species</u>	<u>I.D.</u> <u>Quality</u>	<u>Date</u>	<u>Time</u>	<u>Latitude</u> <u>(N)</u>	<u>Longitude</u> <u>(W)</u>	<u>Ts (°C)</u>	<u>S (°/oo)</u>	<u>Z (fm)</u>	<u>Sea</u> <u>State</u>	<u>Vessel</u> <u>Speed</u> <u>(kts)</u>	<u>Position</u>
Physeter catodon	1	13 Apr 81	1430	26°36'	87°42'	26.2	36.173	1530	5	4 S	Abeam & crossed bow
Delphinus delphis	1	14 Apr 81	0830	28°10.22'	87°17.15'	25.8	36.305	1500	2	5 S	Bow
"	1	14 Apr 81	0930	28°12'	87°16'	25.8	36.305	1500	2	5 S	Bow
"	1	17 Apr 81	0815	26°56.32'	84°51.45'	23.7	36.350	250	3	Hove to	Bow
"	1	17 Apr 81	1110	27°08'	84°47'	23.7	36.363	115	4	5 S	Bow
"	2	23 Apr 81	0345	27°07.88'	83°20.89'	22.8	36.114	25	1	2 S	Bow
Stenella plagiodon	2	18 Apr 81	0530	27°42.7'	84°18.2'	22.2	36.409	40	1	6 M	Bow
"	2	22 Apr 81	2040	27°21.29'	83°03.4'	23.5	36.067	13	2	8 S	Bow
"	1	23 Apr 81	0700	27°06'	83°27'	22.8	36.392	25	1	3 S	Bow
"	1	03 May 81	0200	29°44.2'	80°44.3'	22.4	36.326	11	2	5 S	Bow
"	2	04 May 81	2330	30°31.41'	80°36.7'	21.4	35.917	12	1	5 S	Bow
Tursiops truncatus	1	19 Apr 81	1030	27°38.32'	83°46.67'	22.1	36.322	40	1	2 S	Astern to bow
"	2	04 May 81	2030	31°21.94'	80°48.14'	21.2	35.073	15	1	4 S	Bow
"	1	05 May 81	0930	32°05'	81°02'	22.9	<9.282	20	1	4 M	Off bow
Grampus griseus	2	22 Apr 81	1120	27°05.83'	83°34.05'	24.0		23	1	2 S	Astern
"	3	01 May 81	0730	29°16.83'	78°32.54'	24.2	36.424	350	2	2 S	Abeam
Possible whale	3	26 Apr 81	0455	24°17.48'	82°45.25'	25.3		100	2	3 S	Abeam

APPENDIX V. Data summary of cetacean sightings on cruise W-57 (continued)

Genus species	I.D. Quality	Date	Time	Latitude		Longitude		Ts (°C)	S (°/oo)	Z (fm)	Sea State	Vessel	
				(N)		(W)						Speed (kts)	Position
No identification	3	15 Apr 81	1930	26°55'		85°49'		25.3		1780	3	4 S	Bow
"	3	18 Apr 81	1545	28°01'		84°00'		22.7	36.277	26	1	Hove to	Abeam
"	3	19 Apr 81	0030	27°55.9'		83°48.07'		22.3	36.299	23	1	2 S	Astern
"	3	22 Apr 81	1430	27°41.6'		83°19.8'		24.0		16	1	2 M	Off bow
"	3	26 Apr 81	0320	24°17.48'		82°45.25'		25.3	36.411	100	2	3 S	Bow
"	3	29 Apr 81	1045	26°28.33'		79°40.66'		26.8	36.10	200	2	7 M	Abeam
"	3	03 May 81	2100	30°27.2'		81°08.81'		22.0	35.021	11	2	6 M	Bow

APPENDIX V.

Data summary of cetacean sightings from Savannah to Woods Hole - W-57

<u>Genus species</u>	<u>I.D. Quality</u>	<u>Date</u>	<u>Time</u>	<u>Latitude (N)</u>	<u>Longitude (W)</u>	<u>Sea State</u>	<u>Vessel Speed: knots</u>	<u>Position</u>
Delphinus delphis	1	14 May 81	0800	36°16.47'	73°58.96'	1	3	Bow
"	1	15 May 81	0800	37°36.33'	73°46.44'	1	5	Bow
Stenella plagiodon	1	10 May 81	0730	31°55.0'	79°59.0'	1	7	Bow
"	1	10 May 81	0800	31°58.18'	79°52.05'	1	7	Bow
Tursiops truncatus	2	11 May 81	0630 0830 1530	32°44.5'	77°27.49'	5	3	10 yards off bow
"	3	12 May 81	1500	35°05.76'	74°36.21'	3	7	400 yards off stern
Grampus griseus	2	14 May 81	1600	36°35.56'	73°38.28'	1	Hove to	100 yards off bow
Stenella coeruleoalea	1	14 May 81	1430 1500 1600	36°35.56'	73°38.28'	1	3	20 yards off bow

I.D. Quality:

1. Definite
2. Possible/probable
3. Poor

Sea State:

Beaufort scale

APPENDIX VI A. Bird sightings during the 10-minute bird watch on W-57

Location 1 blocks N x W	Date	Effort (counts)	Species	Birds/Count	Marinebirds only/count
24 x 81	09 Apr 81	6	3 shearwaters 1 unid. bird	.6	.6
24 x 84	10 Apr 81	3	10 jaegers	3.3	3.3
25 x 85	11 Apr 81	1	2 cattle egrets	2	0
25 x 86	11 Apr 81	2	1 unid. gull 1 unid. passerine	1	.5
27 x 87	13 Apr 81	3	5 shearwaters 3 parasitic jaegers 1 cattle egret 2 unid. bird	3.6	3.3
27 x 86	15 Apr 81	3	1 unid. bird	.3	.3
26 x 85	16 Apr 81	3	1 jaeger 4 laughing gulls 1 barn swallow 1 cattle egret	2.3	1.6
27 x 84	17 Apr 81	2	1 jaeger 20 cattle egrets	10.5	.5
27 x 83	23 Apr 81	3	1 barn swallow	.3	0
23 x 81	26 Apr 81	3		0	0
25 x 80	28 Apr 81	2	2 terns	1	1
27 x 79	29 Apr 81	3		0	0
31 x 80	04 May 81	3	1 laughing gull	.3	.3
35 x 74	12 May 81	3	2 unid. birds	.6	.6 *
40 x 73	17 May 81	3	4 imm. herring gulls	1.3	1.3 *

*Not shown on map (figure 4)

APPENDIX VI B. Bird sightings outside the 10-minute watch

<u>Species</u>	<u>#</u>
Shearwater spp.	several
Petrel spp	2
Sula spp.	1
Gannet	1
Tropicbird	2
Frigatebird	3
Sparrow Hawk	2
Pigeon Hawk	2
Osprey	1
Cattle Egret	38
Jaeger spp.	several
Laughing gull	7
Gull spp.	33
Tern spp.	2
Chuck-wills-widow	1
Kingbird	1
Barn Swallow	9
Warbler spp.	12
Sparrow spp.	1