CRUISE REPORT

W-47

Scientific Activities

Woods Hole - Newfoundland - Nova Scotia - Woods Hole

25 July 1979 - 05 September 1979

R/V WESTWARD

Sea Education Association

Woods Hole, Massachusetts

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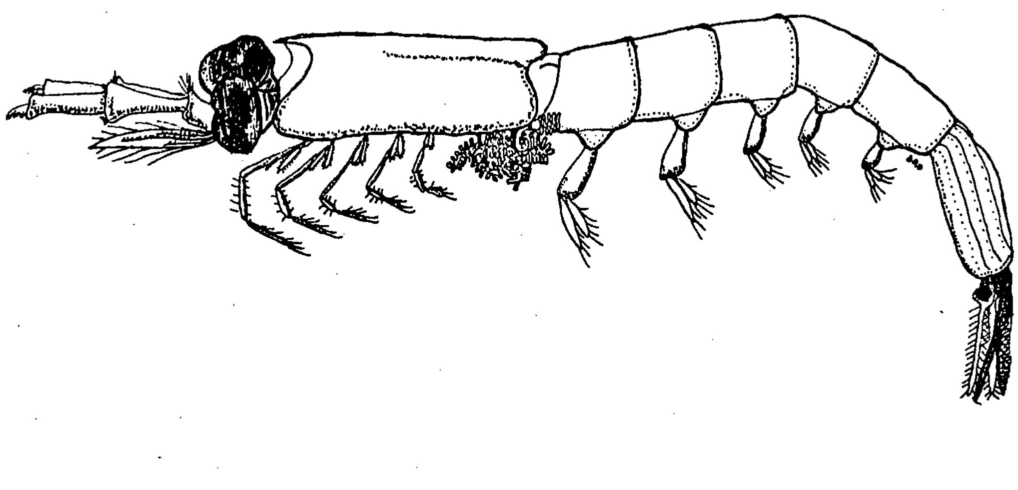

TABLE OF CONTENTS

PREFACE

The objective of this cruise report is to summarize the data collected on W-47 as part of Boston University course NS-224, Marine Science Laboratory. The bulk of this report comes from abstracts of the final papers of student projects. These research projects were conceived on shore during NS-221, Introduction to Marine Science, carried out on the ship, and completed before disembarkation. As such, they represent preliminary interpretations of data. The complete reports are kept in the files of the Sea Semester program and are available from the Chief Scientist upon request.

It was my pleasure on this cruise to rely upon the support and cooperation of an exceedingly competent crew and scientific staff. I thank Captain Don Thomson for his sincere interest in the scientific program and for his assiduous efforts in seeing that the nautical and scientific aspects of the studies done were equally presented. Richard Ogus, Chief Mate, provided us with a tremendous sense of humor as well as seeing that Westward was kept ship-shape. Armin Elsaesser conducted excellent navigation throughout grueling days of fog, and Jeff Bolster kept us well informed on all historical sights. Gil Stuart performed admirably in the engine room while Mary Hutchinson performed equally well in the galley - a necessary job for our morale! The two Assistant Scientists - Abby Ames and Rindy Ostermann - provided the bursts of energy and ongoing enthusiasm that I came to depend on for a well-rounded science program.

Our visitors this trip brought diversity and always fresh outlooks to the cruise. Dr. Katherine Keenan focused on the small - the tiny marine ciliates found living on copepods - and Jean Maguire listened to the large - she recorded the songs of pilot whales on the cruise. Dr. John Parry provided very enjoyable lectures on maritime history and also was our most persistent bird-watcher.

We were warmly welcomed in St. John's by the Department of Fisheries and the Environment. It was interesting for all of us to visit the Biological Station and to meet the scientists there.

I would like to thank all these people as well as the students, who were always stimulating and often provocative, for contributing to the success of W-47.

Mary Farmer
Chief Scientist

INTRODUCTION

This report is the result of the research that took place on cruise W-47 of the R/V Westward (figure 1). The ship's itinerary is given in table 1 and the ship's complement is listed in table 2.

The academic program consisted of daily lectures and weekly quizzes by the staff. The student projects that are reported here were the main focus of the science program. Emphasis was placed on the collection, recording, and analysis of data within the context of individual research plans.

Most of the science education on the cruise took place during science watch. Students on watch in the laboratory learned the operation of oceanographic equipment, the chemical and biological cook-up of samples, and analysis of data. Becoming familiar with demonstration organisms and proper maintenance of a scientific log were also part of the science watch.

Stations conducted and hydrographic data are compiled in the appendices for reference and planning of future Westward cruises. Material reported here should not be excerpted or cited without written permission of the Chief Scientist.

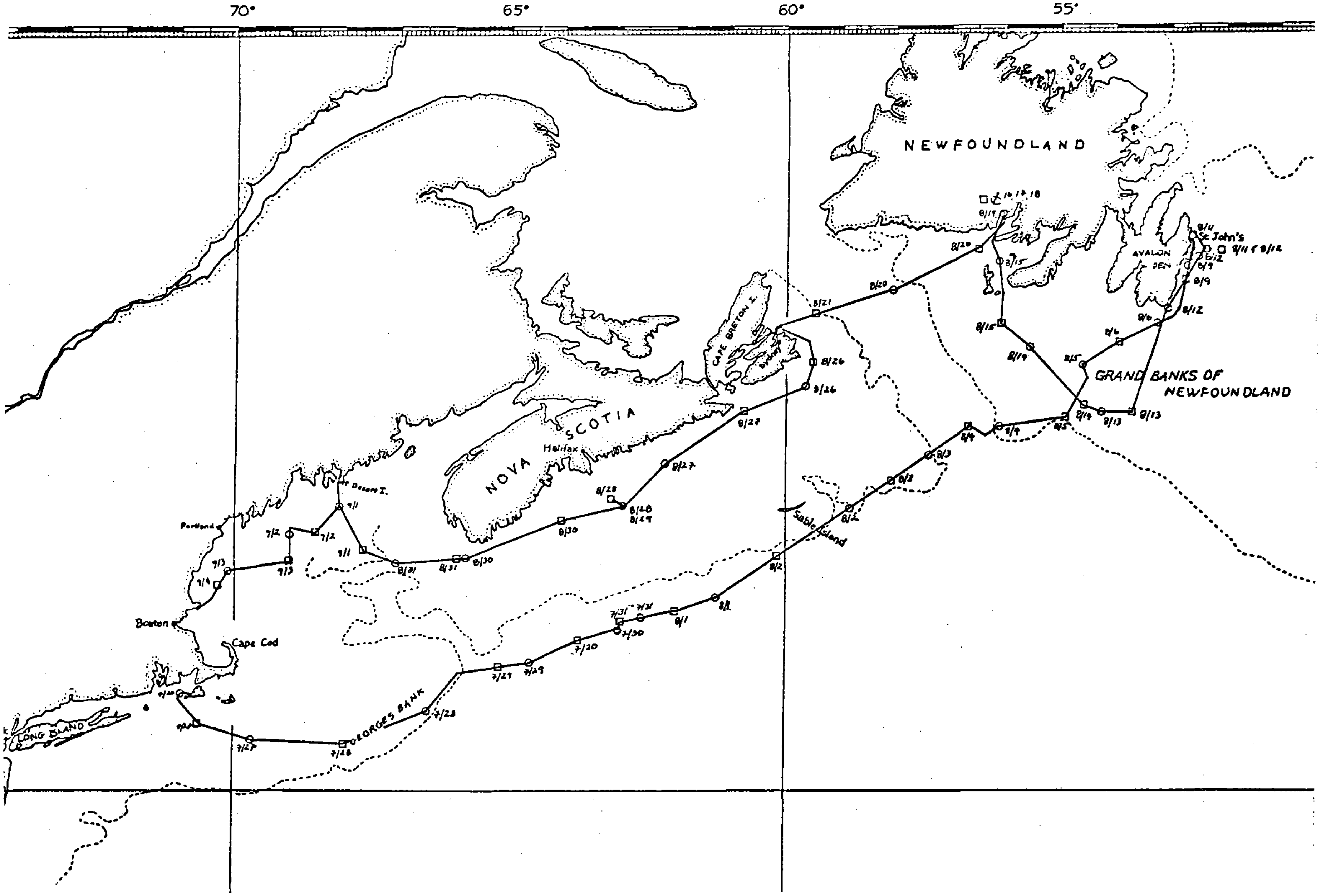

Fig. 1. Track of cruise W-47 of the research vessel Westward.

Table 1. Itinerary of R/V *Westward* cruise W-47.

Port	Arrival	Departure
Woods Hole, Massachusetts	---	25 July 1979
St. John's, Newfoundland	08 August 1979	10 August 1979
Sydney, Nova Scotia	21 August 1979	25 August 1979
Boston, Massachusetts	05 September 1979	---

Table 2. Ship's complement for R/V Westward cruise W-47.

Nautical Staff	
Donald M. Thomson, Jr.	Captain
Richard C. Ogus	Chief Mate
Armin E. Elsaesser	Second Mate
William Jeffrey Bolster	Third Mate
Gilbert R. Stuart	Chief Engineer
Mark L. Hutchinson	Steward
Scientific Staff	
M. Abigail Ames	Scientist
Mary W. Farmer	Chief Scientist
Dorinda R. Ostermann	Scientist
Visiting Scholars	
Katherine Keenan (Leg I)	Yeshiva University, NY
Jean Maguire (Leg II)	University of Pennsylvania
John Parry (Leg III)	Harvard University, MA
Students	
Frances B. Barker	Colorado College
Mary Boutselis	Kenyon College, OH
Amy S. Bower	Tufts University, MA
Kenneth F. Bradley	Cornell University, NY
Susan E. Carpenter	University of Vermont, VT
David L. Divins	Boston University, MA
Douglas D. Dubner	Washington University, MO
Thomas C. Enlow	Brandeis University, MA
Margi G. Flood	Holy Cross College, MA
Andrew T. Goode	Colby College, ME
Howard A. Hast	Vassar College, NY
Marguerite Johnstone (Margot)	Eckerd College, CO
Marjorie B. Kaplan	Cornell University, NY
Kevin F. Muench	Boston College, MA
Lori J. Nelson	St. Mary's College, MN
Marie E. Pfeiffer	Santa Clara University, CA
German E. Reyes	George Mason University, VA
Katharine A. Schomp	Williams College, MA
Elizabeth S. Selke (Stacy)	Pomona College, CA
Amy M. Stone	Mount Holyoke College, MA
Barton A. Thompson	Colorado College
Kristen D. Thompson	Wellesley College, MA
Edward F. Tokarski, Jr.	University of Pennsylvania
Maxwell P. Wilkie	Queens College, Cambridge, England

SCIENTIFIC OBJECTIVES AND SUMMARY

The cruise track of W-47 followed closely the continental shelf and slope waters of the United States and Canada. These waters are very productive and are the site of some very important fishing grounds. Georges Bank (U.S.) and the Grand Banks of Newfoundland (Canada). Our chemical and biological studies reflected this high production (especially Reyes and Selke) although questions other than production were of interest to many of our students. The reports reflect these interests.

Associated with these productive waters was a great deal of fog. This condition directly affected two projects, one on weather (B. Thompson) and one on electronic navigation (K. Thompson).

A three-day stop in Bay d'Espoir on the southern coast of Newfoundland provided fruitful study for all and specifically enabled a few students to conduct research when their original projects had not been successful for reasons beyond their control. The studies done there were interesting enough to make follow-up work in the area very desirable.

SHELF AND SLOPE STUDIES

Water masses along the continental shelf and slope of Northeastern United States and Eastern Canada are not stable. Attempts to define the various masses of water by identifying distinctive characteristics such as temperature-salinity diagrams have shown patterns that change with time and space in ways that are not easily predictable. These waters seem to be part of a dynamically active system, and this activity may partially account for the high productivity of the area.

A study by Reyes showed that nutrient concentrations alone were not helpful in identifying the water masses. Bower, however, was able to define three water masses in the Laurentian Channel, which is a system defined by outflow from the Gulf of St. Lawrence, a constraint that makes its dynamics fairly predictable.

The argument that the instability of shelf and slope waters may enhance productivity is based on the likelihood that such instability would return nutrients to the euphotic zone, where they can be used by the primary producers, more quickly than they would be returned by biological processes alone. The high production rates found in shelf and slope water, combined with low rates in a very stable fjord (Selke), and the inconclusive results on zooplankton excretion rates (Divins and Nelson) support this idea.

Several studies of biological aspects of shelf and slope waters supplemented existing knowledge of the area: two species of euphausiids were identified as slope water organisms while another was found in both shelf and slope waters (Wilkie); cetacean behavior appeared to be affected by temperature in some species and by latitude in others (Stone); pelagic and coastal bird habitats were seen to overlap in the Laurentian Channel (Bradley); crab larvae appeared to be concentrated by eddy effects (Flood); and finally, some mesopelagic fish seemed to migrate to shallow water for reproduction (Barker).

Other studies raised questions that could not be resolved on one cruise. Does oil pollution affect phytoplankton species diversity (Carpenter)? Do algae survive after consumption by zooplankton (Dubner)? Does protein content change with trophic level (Boutselis)? Can terrestrial moths be attracted to sea-going vessels by responding to their acoustical output (Kaplan)?

Nutrient distribution along the continental shelf and slope of the western North Atlantic

German E. Reyes

ABSTRACT. The area in the Northern Atlantic corresponding to latitudes 41° 31' and 44° 52' North and to the western longitudes of 65° 56' and 56° 52', which encloses the U.S. continental slope and shelf, the Scotian Shelf, and the Laurentian Channel largely show diversity in productivity as a result of complex interrelations between physical and biological environmental factors. Different water masses act upon this environment causing horizontal and vertical fluctuations in nutrient concentrations.

Nitrate, phosphate and silicate determinations were done to examine the effects of these interacting factors on nutrient concentrations in the area of study. Concentrations of all nutrients were reduced in surface waters and increased with depth. Water from the Laurentian Channel apparently carried the greatest nutrient load and in this case concentrations were highest at a depth of about 300 meters. A 24-hour station conducted in slope water showed diurnal changes in nutrient concentrations in surface waters (above 150 meters) but not with depth. Nutrient profiles alone were not sufficient to distinguish the water masses studied.

The water masses of the Laurentian Channel

Amy Bower

ABSTRACT. The glacially scoured Laurentian Channel separating the Scotian Shelf and the Grand Banks provides a rigid trough which directs the motion of water masses. Previous literature suggests the presence of three water masses in the channel: Labrador Current water approaches the channel from the east, open ocean water enters the channel from the south, and St. Lawrence River water empties out of the channel. The purpose of this study was to identify the relative positions of these water masses on the basis of temperature and salinity. Data were collected on two parallel bathythermograph (BT) transects of the channel, supplemented with hydrocast data.

With the use of BT profiles, temperature with depth, salinity with depth, and temperature-salinity diagrams, the thermohaline structure and circulation can by hypothesized. A lens of fresh water was found at the top of the water column in mid-channel (figure 2). Very cold water was found on the eastern ridge of the channel (figure 2). Very saline water indicative of open ocean water was found only on the western side of the channel (figure 2) due to the blocking effect of a sill on the eastern side of the channel entrance.

These relative positions indicate that bathymetry, as well as salinity and temperature, influences circulation in the Laurentian Channel.

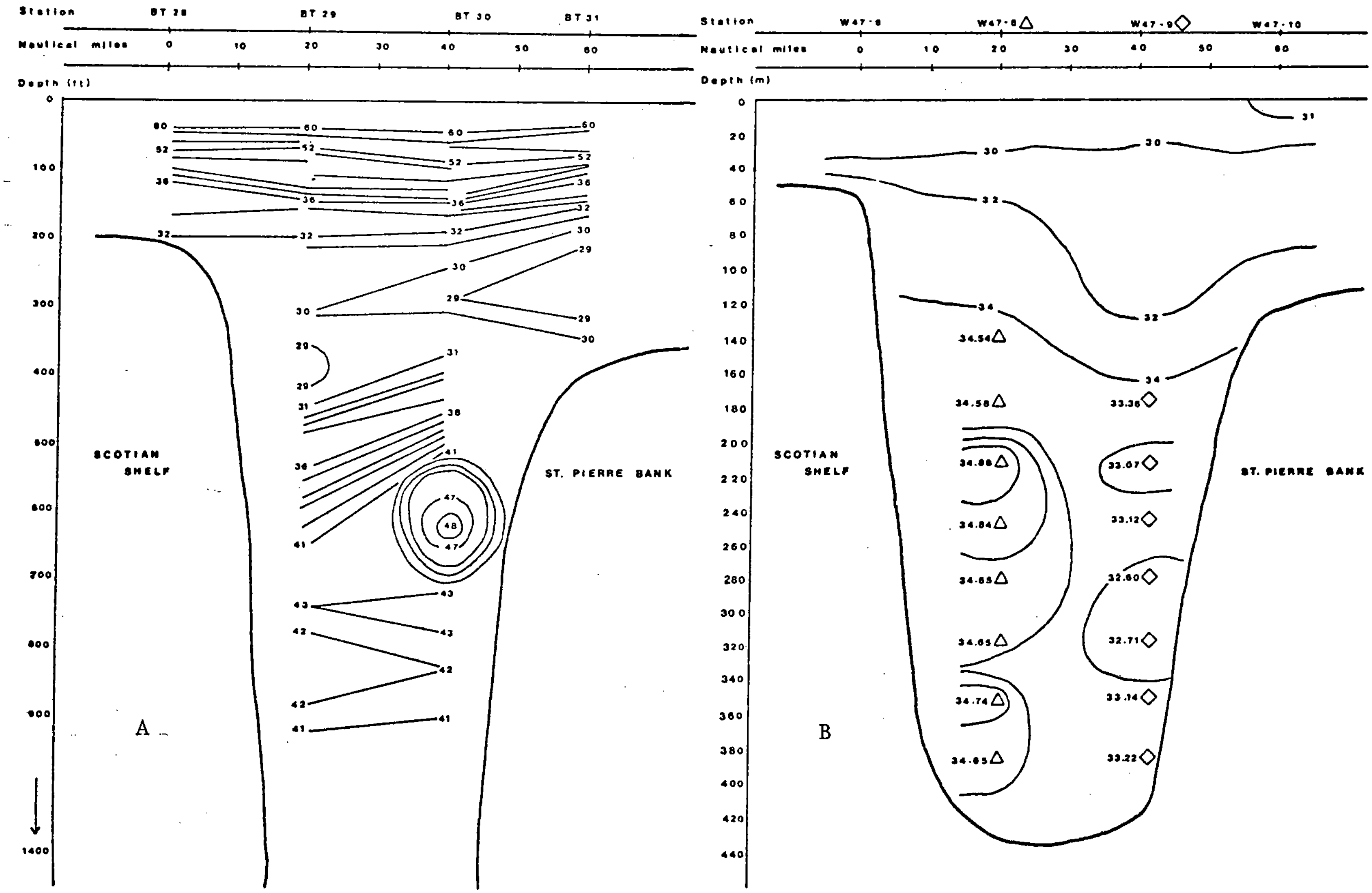

Fig. 2. A. Bathythermograph profile of the Laurentian Channel. Depth in feet, temperature in degrees Farenheit. B. Salinity profile of the Laurentian Channel. Depth in meters, salinity in parts per thousand.

Primary productivity in the surface water of the North Atlantic.

Stacy Selke

ABSTRACT. Primary productivity in the surface water above a continental shelf, a continental slope, and in a fjord were compared using light and dark bottles and a modified Winkler method. The continental shelf water (254 g $C/m^2/yr.$) was slightly more productive than the continental slope water (22y g $C/m^2/yr.$). Both the continental shelf and the continental slope water were much more productive than the fjord water (25 g $C/m^2/yr.$). The reason the shelf water was more productive than the slope water was most likely due to the depth of the water at each site. In the shallower shelf water the nutrients from the bottom could be recycled faster. The shelf water was also closer to land, making the nutrients from freshwater drainage more available. The geologic structure of the fjord was most likely the cause of the low productivity in this area. A sill at the mouth of the fjord prevented any deep ocean currents from stirring up the bottom water of the fjord, therefore the nutrients available at the surface were limited.

Possible long range effect of oil pollution on phytoplankton species diversity.

Susan E. Carpenter

ABSTRACT: Many types of pollution of major importance are found in connection with marine environments, one of which is oil pollution. I chose to look at this problem using species diversity as an environmental indicator of pollution or disruption.

A total of nine sampling stations were taken. Two oil wells in each of two transects were included along with either two or three other stations.

Samples were taken using a standard phytoplankton net, mesh aperature 0.063 millimeters. A total of six species were identified and the number of individuals in each species was recorded. The concentration of organisms at the sample stations varied between 817.7 organisms/meter^3 to 6714.4 organisms/meter^3 and their diversity indices varied from 0.354 to 0.610.

Of the six species found, four were dinoflagellates, three being of the same genus, and the other two species were diatoms. The abundance of these species was variable among the different samples and a correlation could not be drawn. The hypothesized direct relationship between concentration and diversity was not evident.

It is concluded that whether industrial activity has an effect on primary productivity cannot be determined from this study. The variability in the samples does not allow us to draw any specific conclusions.

Algal survival after consumption by herbivores

Douglas Dubner

ABSTRACT. This project was an attempt to observe if any marine phytoplankton survived after being eaten and passed through marine herbivore's digestive systems. The contents of marine herbivore's stomachs was extracted and placed in f/4 growth medium for three weeks. No growth of algae was observed. These results suggest that either shipboard facilities for growth are minimal or that suitable organisms for stomach extraction were not found, or both. If growth had been observed, then this finding might be considered as a factor in the calculations of biomass of primary producers, and other physical qualities of the ocean. It also might influence the distribution and evolution of phytoplanktors. This experiment did not show any evidence of algal survival after the algae was eaten by herbivores, however these results are probably not universal. Experiments of this nature should be reproduced with better growth conditions and better samples.

Determination of phosphorus excretion by zooplankton

David Divins

ABSTRACT. Every living organism excretes phosphorus, mostly in the form of the orthophosphate ion. There is a phosphorus cycle in the oceans, in which it may be used by long chain of organisms before it is returned to the sea. The phosphorus content of the oceans varies seasonally. When conditions favor growth in the photosynthetic zone, the phosphorus content decreases. When conditions no longer favor growth, the phosphorus levels return to around 1.25 ug-at P/liter in the North Atlantic. The maximum amount of dissolved phosphorus occurs at a depth of 1000 meters. The purpose of this project was to measure the amount of phosphorus excreted by zooplankton. Zooplankton samples were collected from meter tows at different depths, and a representative sample was placed in a bucket of sea water from the surface. Samples were taken every hour for five hours and analyzed within 24 hours. The method for determining the phosphorus concentration was from Stickland and Parsons. There was a steady increase in all samples through the first three hours and a rapid jump at the fifth hour. These increases could have been due to three factors. The first is that is was the natural excretion of the organisms. The second was that they were using up stored energy, which requires the excretion of phosphorus. Lastly, as the organisms decayed, phosphorus was liberated from their bodies. To conclude, zooplankton did exhibit an increase in phosphorus output, but the exact reason for this increase was not exactly concluded.

Effects of light intensity on zooplankton excretion.

Lori Nelson

ABSTRACT. Zooplankton excretion is limited by several factors. These include availability of food, space, and temperature. Another factor is now thought to control excretion, specifically ammonia and phosphorus excretion; it is light intensity. To determine exactly what effects light intensity have on zooplankton excretion, samples were taken from meter net tows towed at 25 meters. Samples were placed in eight separate jars. Four of the jars were covered with aluminum foil and four were left uncovered to create the light and dark conditions necessary for the experiment. Excretion rates of ammonia and phosphorus were monitored over a period of three hours for both light and dark conditions. Light intensity exhibited no controlling effect on phosphorus excretion rates. Light intensity did appear to have some effect on the excretion rate of ammonia by zooplankton, but a conclusive statement as to the type of relationship that exists was not possible.

Protein content as a function of trophic level

Mary Boutselis

ABSTRACT. This project was designed to investigate protein content as a function of trophic level. My hypothesis was that protein content increases with organisms the higher up they are on the food chain. Although I could not obtain any data on it, I considered a second factor in oceanic protein sources: the efficiency of energy transfer with trophic levels.

Four groups of organisms were considered: phytoplankton, herring larvae, zooplankton, and lantern fish. I employed a colorimetric test which included a standard curve made from known quantities of bovine plasma albumen. From the curve, I extracted the protein content of each sample. The results showed phytoplankton to contain the least protein (5.2 mg/mg sample) and fish the most (46 mg/mg). Fish larvae and zooplankton had 9.1 mg/mg and 22.5 mg/mg, respectively. This data suggests that protein content is directly related to trophic level.

Effects of salinity, temperature, bottom depth, and surface currents on the distribution of crab larvae.

Margi G. Flood

ABSTRACT. Many larvae of benthic species spend the initial portions of their lives as plankton. The concentration of the larvae in surface waters is believed to indicate the density of benthic populations located upcurrent from the larval collection site. Relative numbers of crab larvae per tow were compared with the bottom depth and the surface water current of the collection areas. There appeared to be a relationship between large concentrations of larvae and areas where the surface currents altered direction due to affects of land masses or opposing currents. Eddy formation as a concentrator of larvae is suspected as the cause.

A study on the vertical migration of euphausiids in slope and shelf waters off the Nova Scotian coast.

Maxwell Wilkie

ABSTRACT. Two 24 hour stations at slope and shelf water locations were conducted. Three nets were towed three and four times, respectively, within the 24 hour period sampling the water column at approximately 0, 150, and 300 meters. These samples were concentrated and the species of euphausiid contained therein were identified. The population densities of these species were then determined by using calibrated flow meters and by counting the euphausiids in sub-samples. These densities were correlated with light intensities from a Kahl Irradiometer and with temperature profiles obtained by using a bathythermograph at the bottom of each tow.

It was found that three species inhabited the slope waters whilst only one of these species was present on the shelf. In particular it was found that the two species found only in the slope water were located in discrete populations at night.

Hence, although no direct evidence for the above mentioned trend was found, valid data of a slightly different sort was obtained.

The vertical migration of mesopelagic fish

Frances Barker

ABSTRACT. The vertical migration of luminescent fish of the families Myctophidae, Stomedtidae, Gonostomatidae, Sternoptychidae, and Chauliodidae was investigated. It was thought that there would be more individuals at the surface at night than during the day. To collect data, simultaneous tows were made at three depths every six hours at two twenty-four stations. The organisms were sorted taxanomically and counted. At Station 1, located 120 miles from land, adults from the families Myctophidae and Gonostomadtidae, and some unidentifiable larvae were found. At Station 2, located 40 miles from land, larvae were collected. Data was analyzed by graphing the number of organisms per cubic meter of water from each tow with time of day. Some migration took place among the adults of Station 1 and the larvae of Station 2 probably in response to changes in light intensity. Not all luminescent fish migrate upwards at night. The ten-fold difference between the number of larvae at Station 1 and Station 2 suggests that these mesopelagic fish prefer to lay their eggs in the more productive coastal waters.

Insects in the marine environment

Majorie Kaplan

ABSTRACT. The purpose of this study was to examine the types and distribution of insects present in the oceanic atmosphere in relation to their distance offshore. Several species of Lepidoptera were present up to 125 miles offshore in the North Atlantic between Nova Scotia and Newfoundland. This most probably occurred due to convectional wind currents that carried these insects out to sea. Three Noctuid moths were found, suggesting the possibility that they were attracted to *Westward*'s fathometer (Noctuids have tympanal auditory organs capable of detecting frequencies from 3 to over 100 kHz).

Fishing on R/V *Westward*.

Andrew Goode

ABSTRACT. For my project I dealt with various fishing techniques ranging from jigging for cod to using an otter trawl. I wanted to see how different methods of fishing commonly practised on power driven boats could be used on *Westward*. I trolled while under power, under sail, and jigged while the boat was hove to. To a lesser extent I included in my study stomach analysis of fish from *Westward*'s trawls and possible future methods of fishing. Deep sea fishing, I found, was vastly different from coastal fishing. The weather conditions wouldn't permit deep water jigging while the ship was hove to.

The distribution of cetaceans sighted on W-47

Amy Stone

ABSTRACT. Since colder water tends to be a more productive environment, cetaceans migrate north in the summer in search of the most abundant food supply, be it krill or squid and fish. With the cruise track of W-47 crossing the Grand Banks, it was expected that a large variety of cetaceans would be seen. The purpose of this project was to plot the distribution of cetaceans sighted, noting any variation in distribution as a possible function of water temperature or latitude. Three species of dolphins and four species of whales were sighted (figure 3). It appeared that the saddleback dolphin, *Delphinus delphis*, and the striped dolphin, *Stenella coeruleoalba*, travel together and limit their migration north by latitude rather than by water temperature. The three species of baleen whales sighted seem to prefer the colder water, while the only toothed whale seen, the Atlantic Pilot, congregated on the Grand Banks. The northern distribution of the Atlantic white-sided dolphin, *Lagenorhynchus acutus*, began where the distribution of the saddleback and striped dolphins ended, and the white-sided dolphins were frequently found traveling with the Atlantic pilot whales.

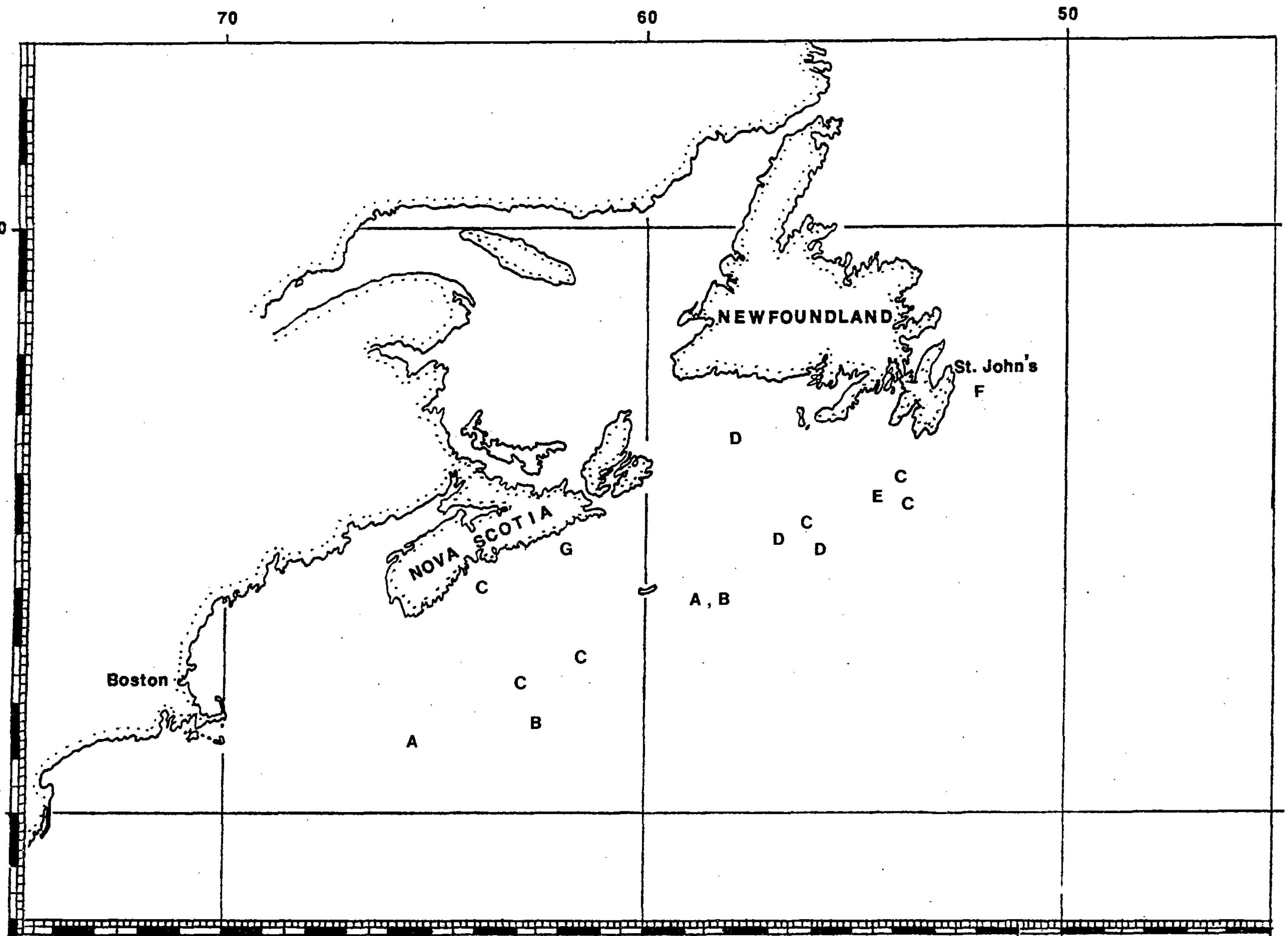

Fig. 3. Sightings of marine mammals along cruise track of W-47. Key: A = Delphinus delphis; B = Stenella coeruleoalba; C = Globicephela melaena; D = Lagenorhynchus acutus; E = Balaenoptera acutorastruta; F = Megaptera novaeangliae; G = B. borealis

Pelagic and coastal bird distributions. The north Atlantic, August 1979.

Kenneth Bradley

ABSTRACT. The purpose of this study was to observe the type and number of birds found in the coastal and ocean waters traversed by the R/V *Westward*, and to compare these sightings with air and sea conditions. An important motivation for work of this nature results from concern over the increasing number of off-shore oil spills. The effect of these spills on oceanic birds can only be understood when the distribution of those birds is understood as well. At the conclusion of the cruise the data is to be released to the Manomet bird observatory which is conducting a larger study of the same nature.

The data did not suggest a correlation between type or number of birds sighted and the selected environmental factors to a significant level. It did, however, delineate the separate pelagic and coastal habitats (table 3). There were no coastal sightings further than 25 miles offshore except in the Laurentian channel. The apparent density of birds in the two areas was quite different. The Laurentian channel was shown to be a habitat for both pelagic and coastal species. In the channel a value for bird density was encountered between those values which were earlier found for pelagic and coastal habitats. This further supports the direct observation that this is a mixed pelagic and coastal habitat.

Finally an adaptation of the Greater Shearwater was observed. The shearwater has a wing structure that makes it appear to be struggling and inefficient in low wind conditions. A model for the wings was put forward. The model suggests that the bird has adapted to maintain a greater than normal wing angle with the horizon. This minimizes problems from changing lift and sideways forces in high, gusting winds.

Table 3. Birds sighted on cruise W-47 of the R/V <u>Westward</u>.

Scientific Name	Common Name
Charadriiformes	
Laridae	
Sterna hirundo	Common tern
Larus marinus	Great black-backed gull
L. argentatus	Herring gull
Rissa tridactyla	Black-legged kittiwahe
Alcidae	
Fratercula arctica	Common puffin
Stercorariidae	
Catharacta skua	Shua
Procellariiformes	
Procellariidae	
Puffinus gravis	Greater shearwater
Hydrobatidae	
Oceanites oceanicus	Wilson's petrel
Policaniformes	
Sulidae	
Morus bassanus	Gannet
Gaviiformes	
Gavia immer	Common loon
Pelecaniformes	
Phalacrocoracidae	
Phalacrocorax carbo	European cormorant
P. auritus	Double-breasted cormorant

Bay d'Espoir Studies

From July 16 to 18 the R/V *Westward* was anchored at Indian Point in the Bay d'Espoir on the southern coast of Newfoundland (figure 4). Shore study groups were organized to examine the flora, fauna and geology of the area.

The area of study was a small section at the head of the west arm of Bay d' Espoir. This arm is a narrow fjord, fed by Brook d'Espoir and several waterfalls along its length (figure 4). The water is clear, it is brown in color, and it foams readily. The fjord is tidally influenced throughout its length, but the water at its head is quite fresh (figure 5). Granite cliffs overgrown with conifers, alders, and birch extend along either side of the fjord. At the head of the fjord the contours of the land rise more gently than along the sides, and it was here that we embarked upon our land studies. The sites selected for concentration are shown in figure 4 although in the end data were collected all along the trail and up to the 600 foot contour line. Reports of the study groups and of individual projects conducted in Bay d'Espoir follow.

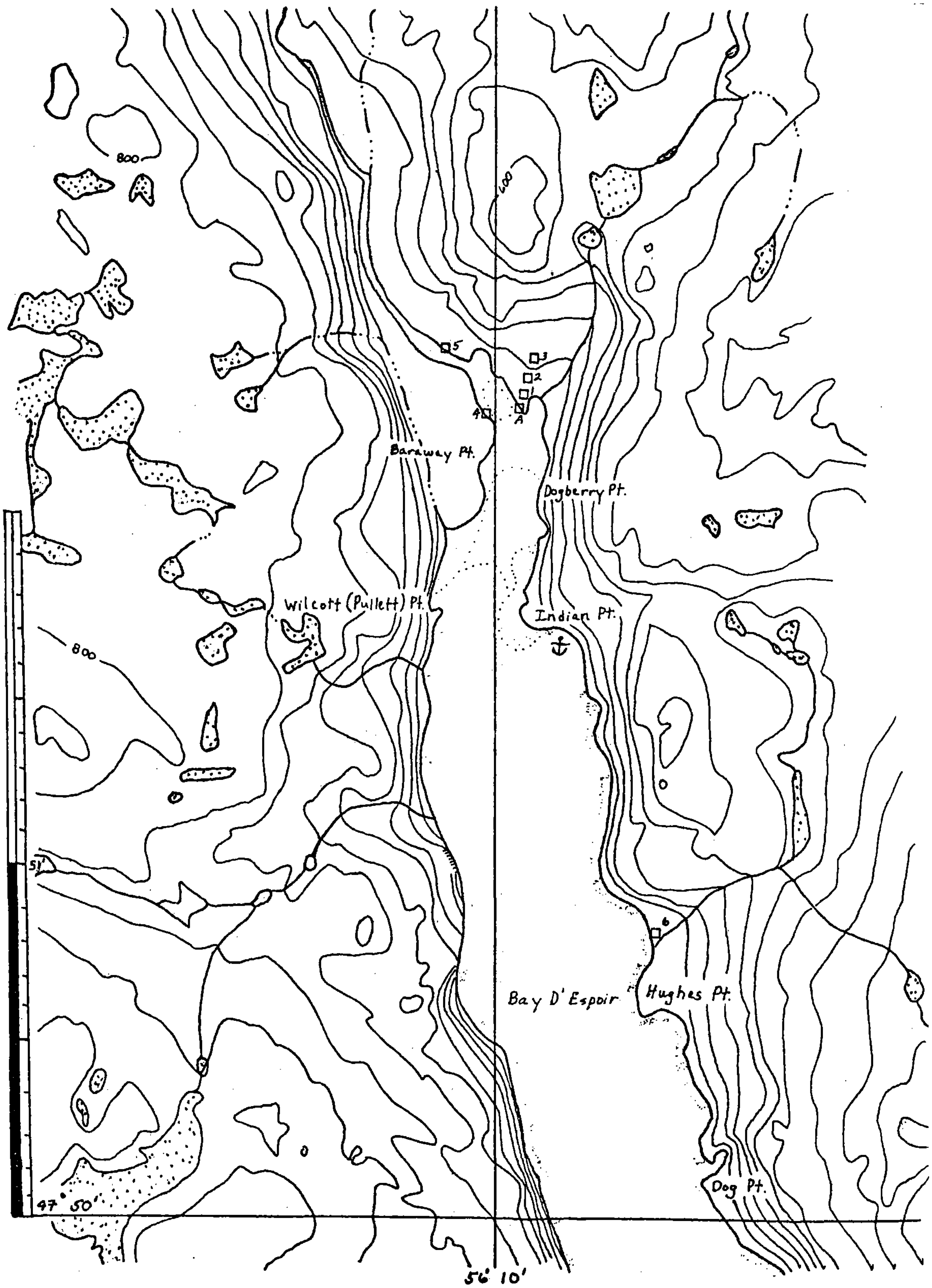

Fig. 4. Sites of Bay D'Espoir studies. Ship was anchored at Indian Point, stations were established ashore. Station A was intertidal; all other stations were on land.

Bay d'Espoir Survey Report: Birds

Bay d'Espoir is characterized by a dramatic change in habitat within a very short distance. In the small area observed there were a number of distinctly different avian environments. For this reason we divided the region into four areas. While environments in such close proximity must by necessity be closely interrelated, we felt the enormous differences in such things as water, vegetation, soil and exposure to the wind and sun justified this division.

Observations were made over the course of three days. Each day a trip was made from the boat to the head of the fjord and then into the mainland, up the incline at the fjord's head. Observations ended at the "hilltop" at an elevation of approximately 650 feet. Equipment consisted merely of several field identification guides and two binoculars, one 10 x 50 and one 7 x 35.

The first habitat was the fjord waterway from the ship to the landing at the head of the fjord. On the water two species of gulls were sighted, Larus argentatus and Larus marinus, the Great Black-Backed and Herring Gulls. Immatures of both species were also seen. Also in the water area were the Common Term, Sterna hirundo, and the Common Loon, Garia immer. An unidentified sandpiper was also seen. Both the gulls and the loon breed and winter in this area, but the tern breeds in the region and moves south for the winter.

It was over this area that the Bald Eagle, Halineetus leucocephalus, was first sighted. The Bald Eagle is a fisherman, requiring a water way, but nests in high trees or cliffs. Therefore, the meeting of the fjord and its towering walls provide this eagle with a perfect home. The Bald Eagle does not specifically migrate south in the winter. However, it does respond to the climate by traveling to where its food supply is not cut off by ice and snow. It would be interesting to discover whether the Eagles winter here at Bay d'Espoir. The Eagles were ultimately sighted from all the habitats while they were flying overhead or perching on the rocky craigs.

The second habitat was essentially a delta formed by Bay d'Espoir brook and another creek running into the head of the fjord. In this area are many low bushes such as strawberries and small trees. There are several locations where the conifores have grown up to form small patches of woods. In one such patch we sighted a bird we believe to be Dendroica pinus, subspecies pinus. Commonly known as the Pine Warbler, this sighting is notable because the birds summer range extends only up to the very south of Canada. Also sighted in this habitat were the Boreal Chickadee, Parus hudsonicus; the Yellow-Bellied Flycathcer, Empidonax flaviventris; the White-Throated Sparrow, Zonotrichia albicollis and the Black and White Warbler, Mniotilta varia.

No other birds were sighted in the third or fourth habitat groups further up the mountain. However, further away from the fjord where the winds are less withering these habitats may support other birds.

The area of the fur forests which surround the Bay d'Espoir in other directions were not explored by us at all. Therefore, we can say nothing about what birdlife they might contain.

The small area around Bay d'Espoir is able to support a broad range of birdlife. This is partly because of the wide variety of habitats found here. Ultimately this diversity must be attributed to glacial action. The sheer transition from mountain top to fjord is the most immediate evidence of this. In addition the very productive area of the Grand Banks offshore, another result of glacial activity, could have many effects on the environment, but we did not directly study this relationship. All of these questions could be profitably studied further. Besides the simple value of learning more about this fascinating area, further study could point out new areas of interaction between distinct but closely situated habitats.

Vegetational Analysis, Bay d'Espoir

The aim of the vegetation group was to determine the floral ecosystems found within the Bay d'Espoir study area. The group hoped to learn something about the successional patterns of the ecosystem as well as the adaptations which the inhabitants of the ecosystems had evolved to survive in this particular environment. Finally, the interreaction between the vegetation, fauna and geology was studied to gain a more in depth knowledge of how the entire ecosystem is organized.

It was planned to study the vegetation of the Bay d'Espoir area through the use of meter square quadrats in the intertidal and in the land areas. Although three intertidal and four land quadrats were analyzed for species composition (table 4), the information was not quantitatively useful. The vegetation of the area dictated the use of much larger quadrants to correctly characterize the vegetation types. Instead, three vegetation types were classified and studied as follows:

Intertidal

The intertidal flora was dominated by *Fucus* and *Ascophyllum*, two species of brown algae which occurred in a mixed association. The limits of this *Fucus*-*Ascophyllum* association extended from the lower tide zone, where the algae formed a dense mat covering the rocky bottom to the middle shore zone. The mat extended approximately 25 feet from its origin on the shoreline down the gradual slope of the intertidal bottom. A species of brown algae which extended above all other zones in the intertidal was *Ralfsia*. This genus makes up the "black zone," a zone recognized in many intertidal areas worldwide. *Ralfsia* is an indicator of the mid-tide level.

Species diversity in the area was generally low due to the great physical stresses encountered by the plants. All species of algae found in BDE are generally recognized as salt water species although they were found growing in an area where fresh water input was of great importance during the ebbing tide.

Forest

The forest of Bay d'Espoir contained spruce, fir, larch alder, and birch. This vegetation type is known as taiga and is found in a large belt across the northern latitudes. Most of the taiga occupies an area which was disturbed by glaciers during the last ice age. This forest has a dense canopy which reduces the shrub and herb layer. Because of the cold climate and acidic nature of the conifer needles, the leaf litter decays slowly leaving a deep humus layer and tannic acid ground water.

The dominant trees around Bay d'Espoir were the needle leafed evergreen conifers. These trees are well adapted to this area because of their thick cutinized epidermal layer and heavy walled sclerenchyma which protects the leaves from the cold harsh winters. In addition, the stomates are sunk deep into the epidermis to reduce water loss due to transpiration. The alders, birch and larch battle the harsh winters by loosing their leaves in the fall. These species are known to colonize disturbed areas in the northern latitudes. The alder is especially adapted to recolonization because it is able to fix nitrogen from the atmosphere. An area which has been glaciated is usually devoid of soil and nutrients needed for plant growth. The alder is able to grow in such areas and while doing so improves the soil by adding nitrogen and leaf litter. In the years following, as the soil profile improves, it is possible for other trees such as spruce and fir to come in eventually leading to the climax community.

Bog

Although no true bogs were found in the area, representative bog plants were found throughout. The ground cover was entirely dominated by a thick spongy layer of sphagnum moss containing great quantities of water. Growing out of the moss were four different species of *Vaccinnium* and shrubs in the class Ericaeae which are typical in bog associations. Small stunted individuals of larch and black spruce dotted the landscape but did not appear to be in a healthy growing state. The occurrence of the pitcher plant and sundew, two insectiverous plants, further indicates the acidic, low nutrient environment found in the area .

Table 4. Vegetation Species List from a shore survey in Bay d'Espoir.

INTERTIDAL		
Spartina sp.	Gramiales	
Enteromorpha sp.	Chlorophyta	
Chorda sp.	Phaeophyta	
Fucus vesiculosus	Phaeophyta	Bladderwrack
Ascophyllum sp.	Phacophyta	Rockweed
Ralfsia sp.	Phacophyta	
FOREST		
Gymnospermae		
Coniferales (Order)		
Pinaceae	*Larix laricina*	American Larch
	Abies balsamea	Balsam fir
	Juniperus horizontalis	Trailing juniper
	Picen mariana	Black spruce
Angiospermae		
Dicutyledonene (Class)		
Fagales (Order)		
Corylacene	*Alnus rugosa*	Speckled Alder
	Betula sp.	Birch
Sapindales		
Aceracene	*Acer rubrium*	Red Maple
BOG		
Myricales		
Myricaceae	*Myrica gale*	Sweet gale
Ericales		
Ericacene	*Kalmia angustifolia*	Sheep Laurel
	Champaedophne calyculata	Leatherleaf
	Vaccinum ssp.	Cranberry
	Vaccinuum corymbosum	Common Highbush Blueberry
	V. angustifolium	Cafe Low Blueberry
	Andromeda glaucophylla	Bog Rosemary
	Ledum groerlandicum	Labrador Tea

Various mosses and lichens.

Sphagnum moss being dominant.

A preliminary geologic survey of the Indian Point area, Bay d'Espoir, Newfoundland.

Ed Tokarski

ABSTRACT. The Bay d'Espoir region provided an area of scenic beauty as well as being interesting geologically. A survey was conducted of the area near the Indian Point anchorage of Westward. The predominant rock type of the area was granite, with a large number of schists and gneisses which indicate a slightly more complicated history than simply Pleistocene erosion. There was no evidence of contact metamorphism and no glacial or sedimentary deposits. Structures present included frost wedging and freeze fracture as well as glacial scars on the bedrock faces. Numerous landslides were present in the fjord.

Several remarkable specimens of plagioclase feldspar, biotite, and smoky quartz were collected. The major mineral group of the area was composed of 40% quartz and 40% plagioclase feldspar, 15% biotite and 5% muscovite, and one gradation from quartz to gneiss was observed in the outcrops present, which were basically northeast to southwest.

Taking into account the rock types found as well as the topography and surface features observed, a preliminary outline is advanced as to the reason behind the spectacular topography in the area. The hypothesis suggests glacial and fluvial erosion along a weakened area in the granite adjacent to a strike fault outlined by Hermitage Bay. The deep scar represented by the north arm of Bay d'Espoir is today subjected to erosion by both spring and fall frost wedging as well as by high spring fooods during thaws.

The conclusion of this study is that Bay d'Espoir and the surrounding region is the result of unified history which includes tectonic, glacial and fluvial processes.

The carbon dioxide system and the influences of biological, chemical, geological, and physical factors upon the system at Laurentian Channel and Bay d'Espoir.

Kevin Muench

ABSTRACT. The purpose of this study was to gain in an understanding of the carbon dioxide system and the biological, chemical, geological and physical factors that may influence this system at the surface waters (less than 400 meters) of the Laurentian Channel and Bay d'Espoir.

From hydrocasts water samples were obtained and tested for salinity and pH. The pH was determined with the use of Phydrion Paper. The salinity, as defined in terms of chlorinity, was obtained via titration with silver nitrate. The temperature was obtained using the bathythermograph.

The pH was found to be constant at 8.4 for the Laurentian Channel, where as, at Bay d'Espoir the pH had a range of 1.1 (7.0 to 8.1). The temperature range at the Laurentian Channel was 19.0° (-1.5 to 17.5°C). At Bay d'Espoir the temperature was smaller 15.8°C (-1.2 to 14.6 C). The salinity range for the Laurentian Channel was 4.55‰ (28.67 to 34.08) and the salinity range for Bay d'Espoir was 10.68‰ (23.7 to 34.47).

It was found that the temperature and salinity effects together would in theory produce pH changes that would not be able to be monitored due to the limitations in the method. At the fjord we were able to characterize certain geochemical and physical factors that might influence the pH, for example, the chemical weathering of rock and the effects of the tides on the circulation of the waters of the fjord.

Mixing of fresh stream waters and fjord waters

Douglas Dubner

ABSTRACT. This is an analysis of the north North Bay waters concerned with the mixing of fresh stream waters with salty oceanic waters. Samples were collected at strategic locations on the streams and on the surface of the fjord to try and locate areas and degrees of mixing. Values for salinity, concentration of phosphates, and temperature were obtained (figure 5). Weather and tidal conditions are variables that affect this study. All of the phosphate levels were low. The salinities of the streams were low. There was a gradual increase in salinity as you moved towards the ocean. There was also an increase in temperature as you moved away from the land masses. The surface waters of the fjord and the stream waters show a clear relationship with each other. They both have low phosphate levels and there was clear evidence of gradual mixing of these waters in the direction of deeper waters and the ocean.

A study of phosphorus and silicate concentrations in Bay d'Espoir.

Kate Schomp

ABSTRACT. In Bay d'Espoir, a fjord located on the southern coast of Canada, the concentrations of the phosphate and silicate were studied at various locations and depths within and without the fjord (figure 4). A spectrophotometric method was used to measure the nutrients concentrations. From the data collected, it appeared that the water mass was little affected by land run-off and the waterfalls in the area. The fjord seemed to be a highly stratified water system due to the sill. The low nutrient concentrations found (0.05 ug at PO_4/1 throughout and 1.0 ug at SiO_4/ liter in surface waters) were consistent with the low level of productivity of the surface water.

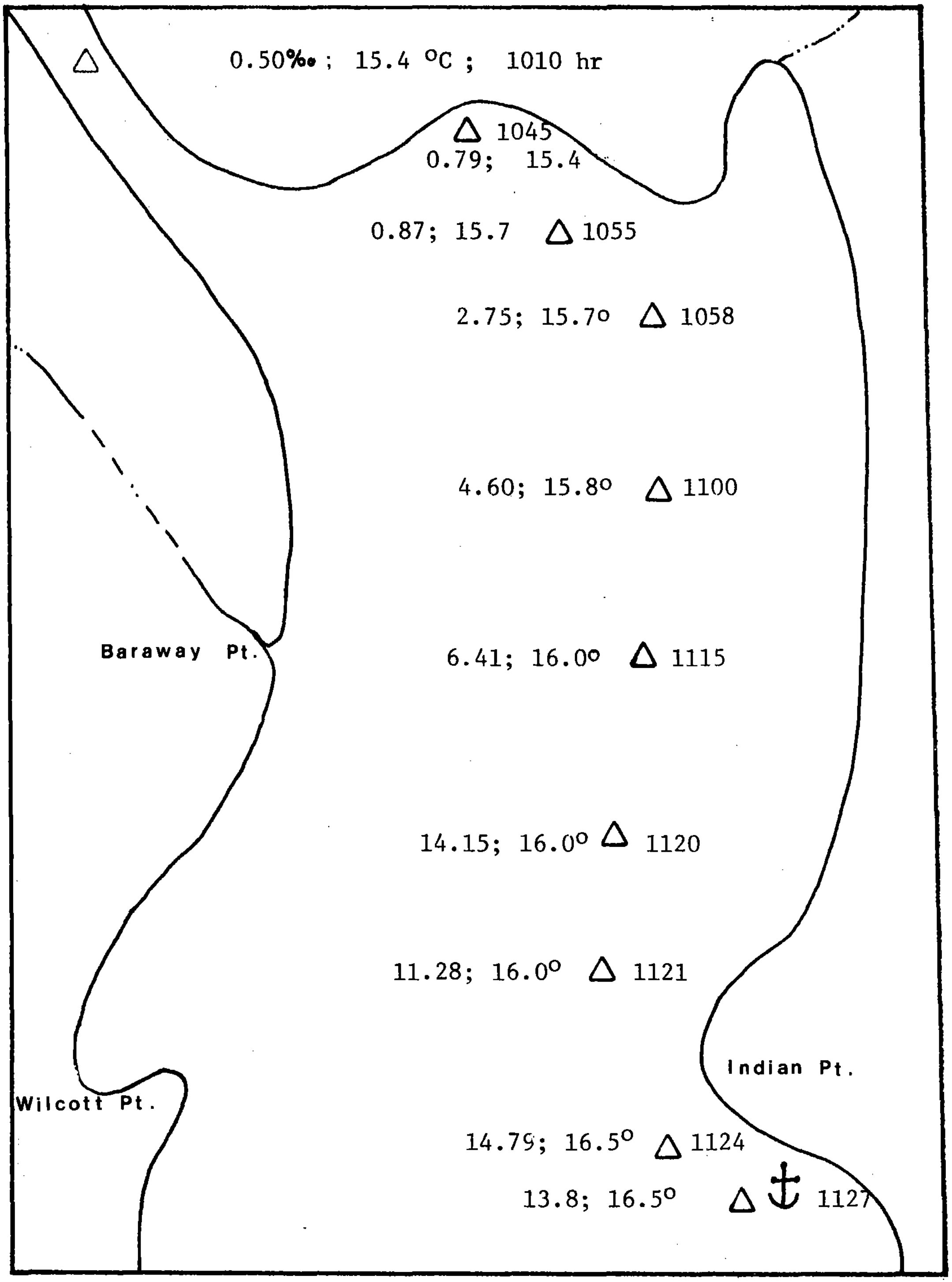

Fig. 5. Stations taken from the dory at the head of Bay D'Espoir (see figure 4). First number = salinity in parts per thousand; second number = temperature in degrees Centigrade; third number = time of day in nautical hours.

Marie Pfeiffer

ABSTRACT. On W-47 the opportunity arose to study the intertidal organisms of a fjord located off Hermitage Bay on the southwest coast of Newfoundland. A second site, an inlet off of St. Ann's Harbour, Nova Scotia, was selected to put this study in perspective. The purpose of this comparison was to determine: 1) whether the Laurentian Channel is a biological barrier to species, and 2) productivity of the respective areas. Samples were collected at low tide along a line transect through the intertidal zone in both of these areas. It was found that some invertebrates inhabited both areas while other were limited to one or the other. Besides the differences in species, the sites also demonstrated a large difference in productivity. The St. Ann's area contained far more biomass than that of the fjord. The Laurentian Channel did not appear to be a barrier to species. It was postulated, however, that Nova Scotia and Newfoundland have not been separated long enough to determine this.

The physiological adaptations of Fucus and Ascophyllum to salinity fluctuations in their environment.

Margot Johnstone

ABSTRACT. Intertidal algae undergo a tremendous amount of stress due to their environmental surroundings. They must endure dessication, temperature fluctuations, salt-water immersion, and varying wave regimes. Two common intertidal algae, Fucus and Ascophyllum (figure 6) can be found under all the conditions. How have they specifically adapted to those conditions?

The ability of Fucus and Ascophyllum to endure those stressful conditions, particularly salinity fluctuations, must call for specific morphological and physiological modifications. To deal with the different pressures exerted, their cells may have adapted by increasing their cell wall size or to absorb and discharge salt ions to balance the osmotic pressure.

Fucus and Ascophyllum were studied because they were salt water species found abundantally in relatively fresh water regime (2.4‰) of Indian Pt., Newfoundland. Samples were collected for comparison in an area of low salinity, near fresh water outlets at St. Ann's Harbour, Nova Scotia.

The purpose of my experiment was to see if there was in fact a physiological adaptation for osmotic regulation by the two species. Samples from both sites were rinsed, dried, then ground up in distilled water and tested for total salt content. The titration procedure used apparently was inappropriate for this test; the expected precipitation and color change did not occur. It was concluded that other methods must be used to determine the internal salt content of seaweeds.

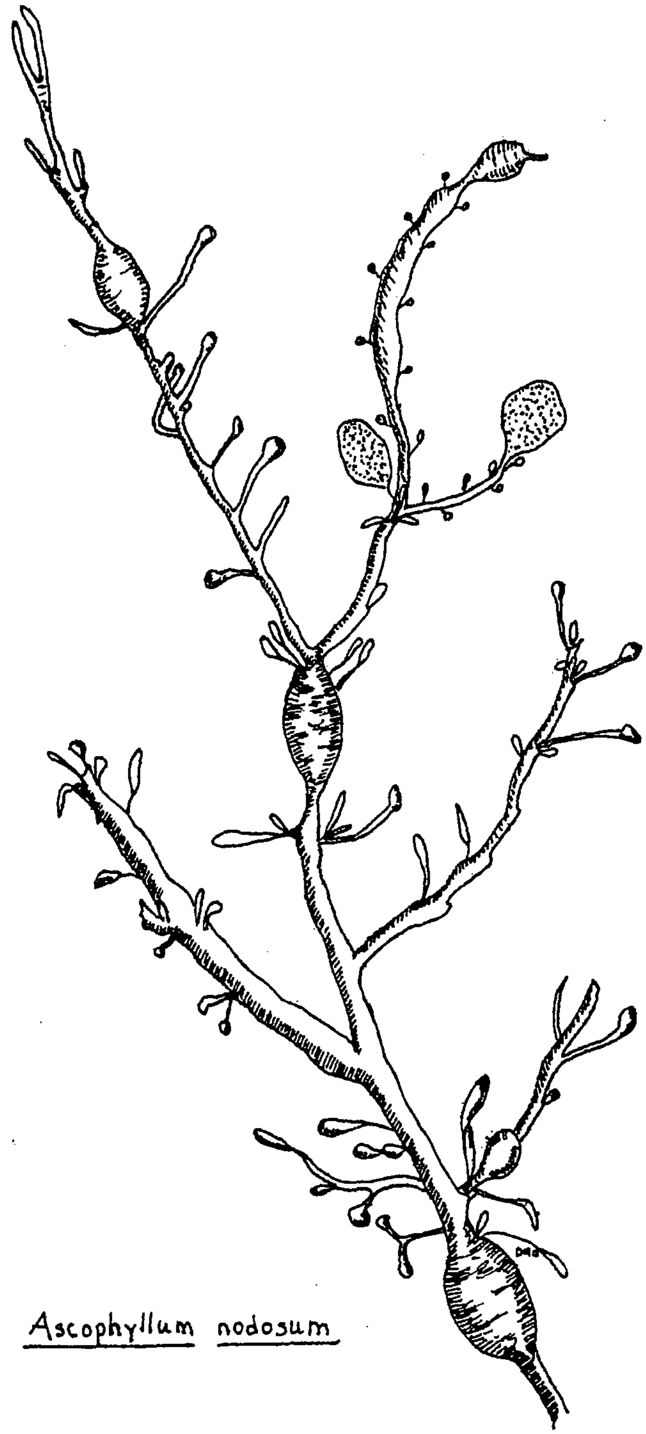

Fig. 6. The intertidal algae, <u>Ascophyllum</u> <u>nodosum</u>, found in nearly fresh water at the head of Bay D'Espoir.

Single station weather forecasting at sea.

Barton A. Thompson

ABSTRACT. The purpose of my project was to gain a practical understanding of meteorology, which could be put to use on a daily basis. Preparation consisted of obtaining a firm grasp of basic meteorological theory. Observations were made four times a day following the procedures defined by the National Weather Service. Five storms were documented and described. Some factors, such as pressure, sea temperature, air temperature, wind direction, humidity, and visibility proved to be useful indicators of the weather. Other potential indicators, such as swell and cloud development, were not as useful due to an inability to observe them properly.

Survival at sea.

Thomas C. Enlow

ABSTRACT. Survival at sea depends on the ship's crew being able to handle various emergencies. Their ability to handle emergencies will depend upon the availability of reliable equipment, and the emergency procedures that everyone will follow. Thus, the equipment and procedures should be studied. The equipment was inventoried and any bad equipment was repaired, replaced, or noted. The emergency procedures were evaluated and modified. The results showed that although minor changes had to be made in equipment and procedures, overall everything was in good condition. There was no evacuation plan so one was drawn up (figure 7). Each of the areas studied must be continually studied and modified. This will provide *Westward* and her crew with the best possible guarantee against disaster.

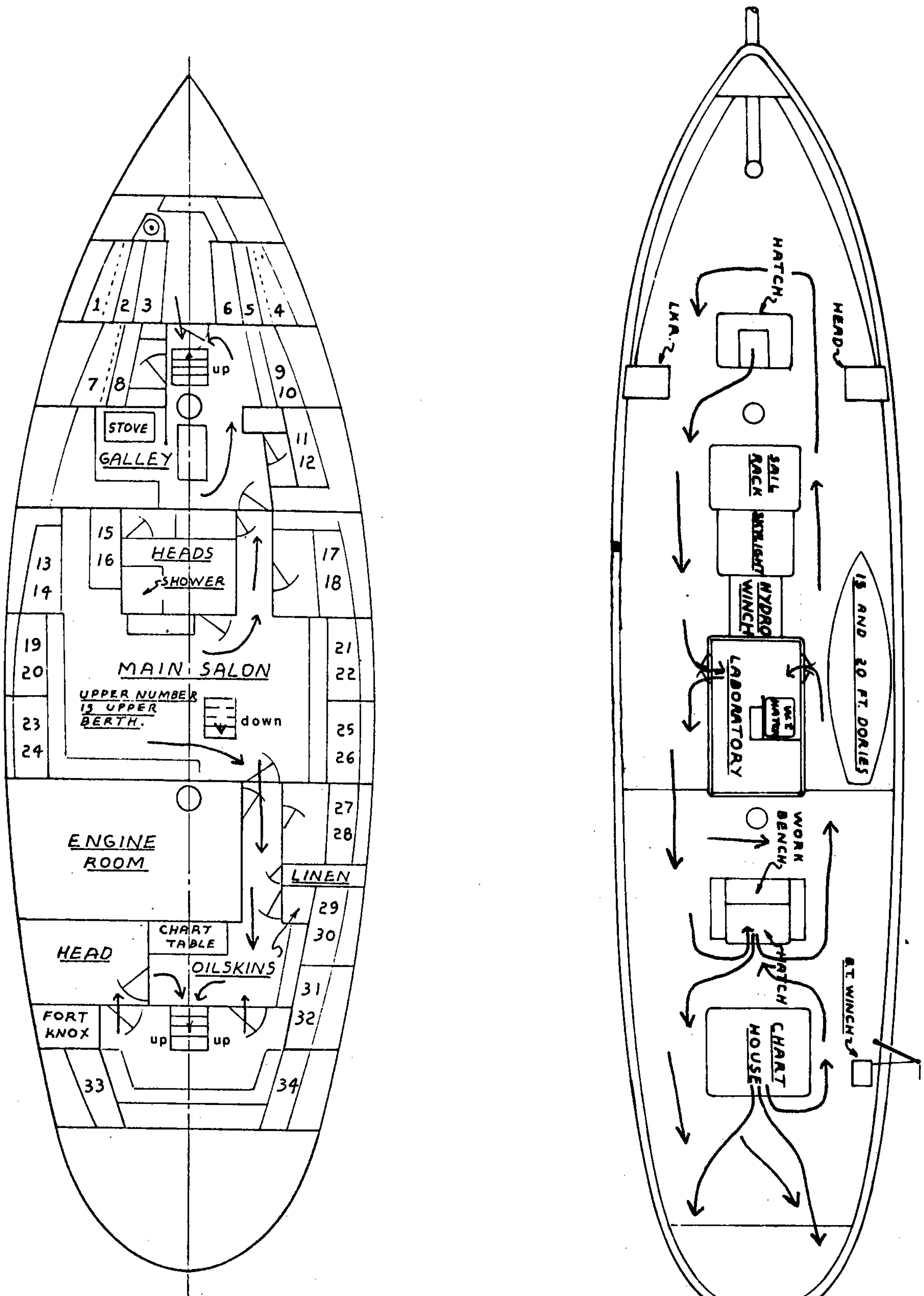

Fig. 7. Evacuation plan for the Westward.

Atmospheric effects on Loran-C reception.

Kristin D. Thompson

ABSTRACT. Because of the distance of the W-47 cruise track from areas of good Loran-C reception, *Westward* was dependent almost entirely upon skywaves for its Loran-C coverage. Skywaves, reflected primarily off the E-layer in the middle ionosphere, are absorbed by the lower D-layer at times of high solar influx, i.e., daytime or times of high solar activity. This absorption causes poor reception of Loran signals. Twice during observations of the Loran-C, Aurora Borealis was also observed. Aurorae are indicators of high solar acitvity: when high energy particles are ejected from the sun, they become trapped in the earth's magnetic field and are transferred to the regions of the earth's magnetic poles. This high influx of protons and electrons excites and ionizes atoms in the atmosphere. When the atoms de-excite or recombine, photons of light are emitted: Aurora. For approximately five minute intervals of observation of each master/slave pair (GRI's 7930, 9930, and 9960) the following were recorded: average time differences, average SNR readings, weather, possible internal interference (radar, VHR, engine, etc,), and other pertinent information (warning or indicator lights). During, directly preceding and following the observations of Aurorae, there were instances of fluctuation in time difference, decrease in SNR, and illumination of the SNR warning light when the SNR was quite high enough for good reception. There was one instance of fluctuation in time difference seemingly unrelated to Aurora. From these data it became clear that there was a correlation between the occurrence of Aurora and poor Loran-C reception.

A report of student reactions to life aboard Westward, W-47.

Howie Hast

ABSTRACT. A report of student reactions to life aboard Westward is needed in SEA's library. Using a humanistic approach this paper gives a report of W-47 student reactions to seven subjects concerning life on Westward. Seven times during the cruise students were asked to write essays on certain subjects (Table 5). These essays were evaluated with respect to an information sheet filled out during the shore component showing age, sex, experience aboard ships, work experience, and outside interests. All information and essays were kept confidential. Results revealed no correlation between background and attitudes shown in the essays. This report can act as a framework on which future projects of a similar nature are based.

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Table 5. Essay topics chosen for a study of reactions to life aboard the Westward.

Essay subject
1) First impressions of Westward and ship life.
2) Comments during/after first rough weather.
3) Reaction to being in first port.
4) Work and Discipline on Westward.
5) Comments on communal living on Westward.
6) What will you tell your friends about Westward? What won't you tell them?
7) Has the Westward experience lived up to your expectations?

VISITING SCIENTIST STUDIES

Ciliated protozoa in boreal waters

Kathy Keenan

ABSTRACT. New tows taken from waters between Woods Hole, Massachusetts and St. John's, Newfoundland were examined for ciliated protozoa. The stalked, peritrichous ciliates, *Zoothamnium* and *Eipstylis* were found on copepods and the margins of *Sargassum* weed and bryozoans at coastal stations. However, epiphytic diatoms such as *Licomorpha* and *Striatella* and an unidentified organism resembling a fungus occurred often on both the carapace and appendages of copepods.

Loricate tintinnids were common. Attempts at culturing them with particle-based media were unsuccessful. Although not prevalent in net tows, several species of the planktonic ciliate genus *Uronema* appeared in culture vessels after several days. Seed populations were evidently collected from surface waters, bloomed in anaerobic laboratory cultures and subsequently grew luxuriantly in well-oxygenated culture media. Densities reached about 10^5/ml. Two species could be cultured on board *Westward* and appear to be good model systems for studying the response of marine planktonic ciliates to sudden changes in substráte concentration.

Acoustical and behavioral observations of Cetaceans

Jean E. Maguire

ABSTRACT. The purpose of this study was to collect information concerning the distribution and behavior of marine mammals observed during *Westward*'s journey between Saint John's, Newfoundland and Sydney, Nova Scotia. The ship's hydrophones were to be employed to collect acoustical data when conditions permitted.

Two sightings of large, unidentified whales were made during the early part of the voyage. The most frequently observed marine mammal was the small pilot whale (*Globicephala* sp.), also referred to as "pothead" and "blackfish." Pilot whales were observed fairly close to the ship on three different occasions. The animals remained in the area for periods of up to forty minutes. Hydrophones were used on one occasion to listen to and record the sounds made by these whales. The tape was approximately thirty minutes in length and primarily consisted of clicks with occasional squeals also occurring.

The observational data and a copy of the pothead tape were given to William Watkins of the Woods Hole Oceanographic Institution for further analysis and to be added to the collection of marine mammal data previously obtained from that region.

ONGOING COOPERATIVE PROGRAMS

Weather Observations (NOAA)

Weather observations were carried out twice daily when the ship was more than four miles from land. Transmission of observations was made immediately and all records were sent to the National Weather Service, NOAA, AOML, Miami, Florida.

Shark Longlining/Tagging (NMFS)

The Westward cooperates with the National Marine Fisheries Service in a program to discover and explain the migratory habits of certain species of shark in the North Atlantic. One longline was set in the Gulf of Maine and no sharks were caught on this cruise. Data are sent to the Narragansett Laboratory, NOAA, NMFS, Rhode Island.

APPENDICES

Puffinus gravis

APPENDIX I. Station log from cruise W-47 of the R/V *Westward*.

Station	Date	Time	Latitude (N)	Longitude	Procedures
W47-1	26 July 1979	1715	41° 18.8'	70° 58.2'	Bathythermograph (BT); meter net tow
W47-2	28 July 1979	2357	41° 38.8'	65° 55.9'	BT; phytoplankton tow; hydrocast; meter net tow
W47-3A	30 July 1979	0635	42° 17.98'	62° 54.74'	BT; phytoplankton tow; hydrocast; simultaneous zooplankton tows (4 depths)
W47-3B	30 July 1979	1305	42° 19.6'	62° 56.7'	Same as 3A
W47-3C	30 July 1979	1925	42° 19.12'	62° 55.15'	Same as 3A
W47-3D	31 July 1979	0745	42° 15'	62° 59'	Same as 3A
W47-4	03 Aug. 1979	0302	44_ 36'	57° 39'	Phytoplankton tow
W47-5	03 Aug. 1979	0445	44° 40'	57° 31'	Phytoplankton tow
W47-7	03 Aug. 1979	0700	44° 41'	57° 25'	BT; phytoplankton tow; hydorcast; sediment grab; meter net tow
W47-7	03 Aug. 1979	1528	44° 53.74'	57°15.82'	Phytoplankton tow
W47-8	03 Aug. 1979	1800	44° 48.70'	56° 57.65'	BT; phytoplankton tow; hydrocast; sediment grab
W47-9	04 Aug. 1979	0315	44° 52'	56° 28'	BT; hydrocast; sediment grab
W47-10	04 Aug. 1979	1145	44° 59'	56° 07'	BT; hydrocast; hydrophone station
W47-11	05 Aug. 1979	0615	45° 31'	54° 28'	BT; sediment grab; otter trawl; zooplankton tows (2 depths)
W47-12	07 Aug. 1979	0720	47° 10.38'	52° 30.81'	Meter net town
W47-13	10 Aug. 1979	2150	47° 32.5'	52° 35.1'	BT; hydrocast; meter net tow
W47-14	11 Aug. 1979	0645	47° 21'	52° 16'	BT; hydrocast; meter net tow; sediment grab; otter trawl
W47-15	13 Aug. 1979	1110	45° 08'	54° 15'	Phytoplankton tow; sediment grab; otter trawl
W47-16	13 Aug. 1979	2002	45° 14'	54° 22.5'	Phytoplankton tow
W47-17	14 Aug. 1979	0015	45° 23.5'	54° 23.5'	Phytoplankton tow
W47-18	14 Aug. 1979	0253	45° 26'	54° 48'	Phytoplankton tow
W47-19	19 Aug. 1979	0105	47° 51.55'	56° 09.70'	Hydrocast; sediment grab
W47-20	19 Aug. 1979	0630	47° 46.6'	56° 08.1'	Hydrocast

Appendix I, continued.

Station	Date	Time	Latitude (N)	Longitude(W)	Procedures
W47-21	19 Aug. 1979	0900	47° 41.63'	46° 09.15'	Hydrocast
W47-22	19 Aug. 1979	1345	47° 35.9'	56° 10.8'	Hydrocast; sediment grab
W47-23	20 Aug. 1979	2130	46° 29'	59° 17'	BT; zooplankton tow
W47-24	21 Aug. 1979	0400	46° 32'	59° 30'	BT; zooplankton tow
W47-25A	27 Aug. 1979	2005	43° 58'	62° 54.5'	BT; phytoplankton tow; hydrocast; simultaneous zooplankton tows (3 depths)
W47-25B	28 Aug. 1979	0335	44° 00.1'	62° 54.5'	Same as 25A
W47-25C	28 Aug. 1979	1040	43° 58'	62° 54.5'	Same as 25A
W47-25D	28 Aug. 1979	1610	43° 58'	62° 54.5'	Same as 25A

APPENDIX II. Bathythermograph log of cruise W-47 of the R/V *Westward*.

BT No.	Date	Time	Latitude (N)	Longitude (W)
1	26 July 1979	1715	41° 13.8'	70° 58.2'
2	27 July 1979	1245	40° 41.3'	69° 35'
3	27 July 1979	1440	40° 42'	69° 14'
4	27 July 1979	1555	40° 41'	69° 03'
5	27 July 1979	1725	41° 39'	69° 46.1'
6	27 July 1979	1900	40° 38'	68° 35'
7	27 July 1979	2045	40° 36'	68° 22'
8	27 July 1979	2230	40° 32.1'	68° 10'
9	28 July 1979	0020	40° 38'	67° 57'
10	28 July 1979	0220	40° 38.5'	67° 39.8'
11	28 July 1979	0420	40! 41'	67° 41'
12	29 July 1979	0000	41° 38.3'	65° 55.9'
13	29 July 1979	1230	41° 46'	64° 52'
14	29 July 1979	1347	41° 50.5'	64° 53'
15	29 July 1979	1510	41° 56'	64° 40'
16	29 July 1979	2100	41° 58.8'	64° 15.9'
17	29 July 1979	2240	42° 02'	64° 02'
18	30 July 1979	0045	42° 06.25'	63° 47.19'
19	30 July 1979	0208	42° 09'	63° 33'
20	30 July 1979	0320	42° 11'	63° 20'
21	30 July 1979	0455	42° 14'	63° 07'
22	30 July 1979	0635	42° 17.98'	62° 54.74'
23	30 July 1979	1305	42° 19.6'	62° 56.7'
24	30 July 1979	1315	42° 19.6'	62° 56.7'
25	30 July 1979	1925	42° 19.12'	62° 55.15'
26	30 July 1979	1940	42° 19'	62° 55'
27	31 July 1979	0745	42° 15'	62° 59'
28	03 Aug. 1979	0650	44° 43'	57° 24'
29	03 Aug. 1979	1800	44° 48.7'	56° 57.65'
30	04 Aug. 1979	0315	44° 52'	56° 28'
31	04 Aug. 1979	1225	44° 59'	56° 07'
32	04 Aug. 1979	1300	44° 58'	56° 08'
33	05 Aug. 1979	0140	45° 23'	54° 58'
34	05 Aug. 1979	0340	45° 35.5'	54° 47.5'
35	05 Aug. 1979	0630	45° 42.5'	54° 31.0'
36	10 Aug. 1979	2215	47° 32.5'	52° 35.1'
37	11 Aug. 1979	0645	47° 21'	52° 16'
38	19 Aug. 1979	0630	47° 46.6'	56° 08.1'
39	19 Aug. 1979	0900	47° 41.63'	56° 09.15'
40	19 Aug. 1979	1345	47° 35.9'	56° 10.8'
41	20 Aug. 1979	1008	46° 55.5'	57° 49'
42	20 Aug. 1979	1215	46° 49'	58° 03'
43	20 Aug. 1979	1400	46° 44.7'	58° 21.3'
44	20 Aug. 1979	1550	46° 39.2'	58° 40.7'
45	20 Aug. 1979	1730	46° 35.0'	58° 55'
46	20 Aug. 1979	1930	46° 29'	59° 05'
47	20 Aug. 1979	2130	46° 29'	59° 17'
48	20 Aug. 1979	2225	46° 30.5'	49° 24.5'
49	21 Aug. 1979	0110	46° 25.5'	59° 31'

Appendix II, continued.

BT No.	Date	Time	Latitude (N)	Longitude (W)
50	21 Aug. 1979	0400	46° 32'	59° 30'
51	27 Aug. 1979	2010	43° 58'	62° 54.5'
52	27 Aug. 1979	2025	43° 58'	62° 54'
53	28 Aug. 1979	0012	44° 04.5'	63° 03.0'
54	28 Aug. 1979	0335	44° 00.1'	62° 54.5'
55	28 Aug. 1979	0350	44° 00'	62° 54'
56	28 Aug. 1979	1050	43° 58'	62° 54.5'
57	28 Aug. 1979	1105	43° 58'	62° 54'
58	28 Aug. 1979	1610	43° 58'	62° 54.5'
59	28 Aug. 1979	1625	43° 58'	62° 54'

APPENDIX III. Hydrographic data from cruise W-47 of the R/V *Westward*.

Station	Depth	T_s	S‰
W47-2	0	14.94	32.10
	20	13.17	32.48
	40	9.36	32.90
	60	7.42	32.86
	80	7.41	33.32
	100	---	---
W47-3A	0	4.54	33.20
	75	14.85	
	150	14.83	35.15
	225	15.52	34.93
	300	15.32	35.08
	375	16.52	35.04
	450	7.50	34.99
	525	7.87	34.95
	600	---	34.93
	675	---	
	750	10.26	35.08
	825	---	34.87
W47-3B	0	---	32.85
	75	8.22	33.99
	150	---	32.21
	225	---	35.06
	300	7.61	34.79
	375	---	34.77
	450	6.56	34.92
	525	5.96	34.93
	600	5.12	34.70
	675	5.08	34.70
	750	10.49	34.70
	825	4.62	34.75
W47-3C	0	---	33.02
	75	9.19	34.53
	150	---	35.29
	225	---	35.12
	300	8.06	34.79
	375	7.18	34.75
	450	6.18	34.48
	525	4.98	34.46
	600	5.33	34.73
	675	4.71	34.90
	750	5.63	34.97
	825	4.48	34.84