CRUISE REPORT

W-53

Scientific Activities

Woods Hole - Sydney - Bay of Islands - Lunenburg - Newport

23 July - 3 September 1980

R/V Westward

Sea Education Association

Woods Hole, Massachusetts

SHIPBOARD DRAFT

Lophius americanus
(American goosefish)

PREFACE

This Cruise Report presents a brief outline of the scientific research completed during cruise W-53 aboard the R/V Westward. Reports of the status of on-going projects, of the projects designed specifically for this cruise, and of the traditional academic program are included. In addition, abstracts from the research projects proposed and completed by the students are presented. The limitations of the lack of library facilities and restricted time are clearly reflected in the contents. However, I feel that it is important for the students to complete their projects, and to submit a written report before the end of the program.

Once again, I owe much of the success of this cruise and its scientific program to an outstanding and skillful Marine and Nautical Science staff. Special thanks should go to Rob Moir, who was in charge of the shipboard laboratory, and upon whom I was able to depend throughout the cruise. His cheerful attitude and enthusiasm were greatly appreciated, and his knowledge of pelagic birds and marine mammals proved to be a major contribution to the cruise.

Allan Stoner, who participated as an Assistant Scientist, brought with him a vast knowledge of marine biology, and his enthusiasm was an example to us all. I am sure the students and staff wish him luck in his new position at SEA.

I am particularly indebted to the Captain, Carl Chase, not only for his endless interest and help in completing the scientific objectives of the cruise, but also for all he contributed to the other aspects of life aboard ship. His constant efforts in this regard added much to the experience that the students will remember. I also owe thanks to Jeff Bolster, Terry Hayward, and Gayle Biddle for their cooperation and assistance in running scientific stations, and their skillful handling of the ship. Paul Fiske, our engineer, showed a great deal of interest in the students and the activities, and was very helpful to me on several occasions in the lab. Finally, Cathy Cunningham deserves thanks from all of us for her constant patience, and her ability to produce fine meals, every day - no matter how difficult the conditions!

In addition to the SEA staff, three visiting scientists participated in different legs of this cruise. Dr. Bud Foulke (Leg 1) broadened our

interests with sea stories and poetry. Kathy Lynch (Leg 2) conducted whale watches throughout her stay aboard R/V Westward; this work will provide some data for her graduate degree. Dr. Pat Lohmann (Leg 3) collected sediment samples from the Wilkinson Basin for paleocirculation studies. I thank all three for their contributions to the cruise.

Finally, for all of us who participated in this cruise, the 12th August will be remembered as a special day. Carl Chase invented a song - first performed on that day off the coast of Newfoundland - that recorded two scientific phenomena which had become the key words for the cruise. "Green Flash over the Moho" will always be the theme tune for W-53!

Susan E. Humphris
Chief Scientist
Cruise W-53

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INTRODUCTION

This cruise report summarizes the preliminary results of the scientific research conducted aboard R/V Westward during the laboratory section of the Introduction to Marine Science course - NS 225 at Boston University.

The itinerary and ship's track for W-53 (Table 1 and Figure 1) took us to both open ocean and nearshore marine environments. These allowed us to expose the students to all the different oceanographic operations within the capabilities of the R/V Westward, and provided a variety of possibilities for individual student research projects.

This cruise report is composed mainly of abstracts from student projects and includes preliminary analyses of the research designed specifically for the cruise.

Research conducted during W-53 partly represents on-going work of individuals and agencies that have extended their assistance to our students. Material reported here should not be excerpted or cited without permission of the Chief Scientist.

TABLE 1

Itinerary of R/V Westward Cruise W-53

	<u>Depart</u>	<u>Date</u>	<u>Arrive</u>	<u>Date</u>
Leg 1	Woods Hole, Mass.	23 July 1980	Sydney, Nova Scotia	5 Aug. 1980
Leg 2	Sydney, Nova Scotia	7 Aug. 1980	Lark Harbour, Bay of Islands, Newfoundland	12 Aug. 1980
	Lark Harbour, Bay of Islands	14 Aug. 1980	Penguin Arm, Bay of Islands	14 Aug. 1980
	Penguin Arm, Bay of Islands	16 Aug. 1980	Goose Arm, Bay of Islands	16 Aug. 1980
	Goose Arm, Bay of Islands	17 Aug. 1980	Lunenburg, Nova Scotia	24 Aug. 1980
Leg 3	Lunenburg, Nova Scotia	26 Aug. 1980	Newport, Rhode Island	3 Sept. 1980

Figure 1 Cruise track of Westward W-53 — 23 July to 3 September 1980

TABLE 2

Ship's Complement for R/V Westward Cruise W-53Nautical Staff

Carl A. Chase, B.A., Ocean Operator	Captain
W. Jeff Bolster, B.A.	Chief Mate
Terry A. Hayward, III, B.A., J.D.	Second Mate
Gayle Biddle, B.A.	Third Mate
Paul W. Fiske	Chief Engineer
M. Cathy Cunningham, B.A.	Steward

Scientific Staff

Susan E. Humphris, Ph.D.	Chief Scientist
Rob Moir, M.S.	Second Scientist
Allan W. Stoner, Ph.D.	Third Scientist

Visitors

Robert Foulke, Ph.D.	Skidmore College
Kathy Lynch, B.Sc.	Memorial University St. John's, Newfoundland
G. Pat Lohmann, Ph.D.	Woods Hole Oceanographic Institution

Students

Paul A. Carpentier, Sophomore, Assumption College, Biology

John Christopher Carrier, Junior, University of Utah, Biology/Chemistry

Peter B. deMenocal, Sophomore, St. Lawrence University, Geology

Barbara J. Ensign, Sophomore, Oberlin College, Religion

Martha (Betsey) Field, Junior, Dartmouth College, Environmental Studies/
Biology

Rick Gould, Senior, Bowdoin College, Physics

Michael D. Gregg, B.S., Haverford College, Physics & Philosophy;
presently graduate student at Yale University, Dept. of Astronomy

Ronald S. Hagan, Senior, Washington State University, Environmental
Science and Sociology

Mary B. Hannum, Junior, St. Francis College, Marine Biology

Mary Jane Jones, Senior, St. John's University, Biology

Students (continued)

Patricia Keoughan, B.S., M.S., SUNY/New Paltz, Education;
presently a fourthgrade teacher.

Elizabeth (Leigh) Klein, Junior, Middlebury College, Environmental
Biology

Ronald (Jim) Koch, Junior, Colby College, Zoology

Elizabeth Langstaff, Sophomore, Trinity University, Environmental
Studies

Ann Leverette, Senior, Warren Wilson College, Environmental Management

Patricia Mace, Junior, Trinity University, Biology/Environmental Studies

Lisa Maynes, Junior, Cornell University, Physics

Catherine MacLeod, Junior, St. Lawrence University, Psychology/
Anthropology

Elizabeth Ober, Junior, Colby College, Biology

Alexander D. Politis, Senior, SUNY/Cortland, Biology

Abbey Rosso, Junior, Cornell University, Biology

James Salomon, Sophomore, Cornell University, Engineering

Emily B. Tibbott, Sophomore, Wesleyan University, Religion

Andrew Umhau, Senior, Davidson College, Premedicine

ACADEMIC PROGRAM

Three areas of activity involved the students in aspects of Marine Science, and provided different ways in which they might learn about the oceans.

A 24-hour science watch was maintained throughout the cruise, and consisted of a member of the staff plus three students. Their responsibilities included maintenance of the science log, execution of scientific stations, and continuation of the program in terms of sample analysis and interpretation of data. This time was also used for learning sampling and analytical techniques, and for individual instruction as required.

A collection of fauna and flora ("Feature Creatures") was assembled from a variety of marine environments in an attempt to familiarize the students with the diversity of life in the ocean (Appendix Ia). This collection served as the basis for study of different phyla, and evaluation was by means of a practical examination near the end of the cruise.

While at sea, lectures (the topics of which are noted in Table 3) were given each weekday. These served two main functions. Firstly, they supplemented the information learned on watch concerning sampling and analytical methodology, ensuring that the fundamental principles behind various techniques were understood. Secondly, they provided the opportunity to discuss the on-going research activities, and to consider the oceanographic characteristics of the specific areas in which we were working. A written examination at the end of the cruise was used to evaluate the information gained by the students in all aspects of Marine Science (Appendix Ib).

In addition, each student was required to complete a research project, either individually or as a small group. These projects were defined during the Shore Component, and covered several fields of Marine Science, Ocean Engineering and Nautical Science. The work was completed while at sea, and written reports submitted before the end of the cruise. The abstracts of these papers comprise the bulk of this cruise report.

TABLE 3

MARINE SCIENCE LECTURES

T	24 July	Identification of marine mammals	Rob Moir
F	25 July	Field methods in benthic ecology	Allan Stoner
M	28 July	Georges Bank: 1) geological structure and general circulation	Susan Humphris
T	29 July	Georges Bank: 2) trophic structure	Allan Stoner
W	30 July	Introduction to taxonomy and systematics	Allan Stoner
T	31 July	Analysis of seawater - oxygen and salinity determinations	Susan Humphris
F	1 August	Sea essays and tales: discussion	Bud Foulke
M	4 August	Pelagic birds and their adaptations to the marine environment	Rob Moir
F	8 August	Leg II: scientific objectives	Susan Humphris
M	11 August	Exam I	
T	12 August	Geology of the Bay of Islands: ophiolite complexes	Susan Humphris
F	15 August	Whale entrapment problems in Newfoundland	Kathy Lynch
M	18 August	Principles of spectrophotometry	Susan Humphris
T	19 August	Mesopelagic ecology	Allan Stoner
W	20 August	Feeding behavior and distribution of whales	Kathy Lynch
T	21 August	Student seminars	
F	22 August	Student seminars	
W	27 August	The Gulf of Maine	Susan Humphris
T	28 August	Student seminars	
F	29 August	Circulation modelling using benthonic foraminifera	Pat Lohmann
S	30 August	Exam II	
M	1 September	Student seminars	

COOPERATIVE PROGRAMS

Cooperative Ship Weather Observations (NOAA)

The R/V Westward is certified to gather weather observations for the U.S. National Weather Service. The data, which are collected at 0600 and 1200 GMT, are transmitted to Coast Guard stations ashore, and constitute part of a global weather observation network.

On W-53, 45 sets of observations were compiled, of which 69% were successfully transmitted. We sent information to two different Coast Guard stations: NMN, Portsmouth, Va., copied 81% of our transmissions, and 19% were received by NMF, Boston. At the end of the cruise, all data were sent to NOAA for incorporation into long-term weather prediction studies.

Shark Tagging Program (National Marine Fisheries Service)

R. James Koch

ABSTRACT

The aim of shark longlining and tagging is to add to the large amount of data needed to further understand the vast migratory range of certain species of North Western Atlantic sharks. In addition, tagging serves to indicate which species are in fact migratory, and which are common to a particular area. Members of five families of sharks were viewed as expected catch for the W-53 cruise track: Odontaspidae, Isuridae, Sphyrnidae, Alopiidae, and Carcharhinidae.

Three longlines were set during the six week period, with a male Prionace glauca (Blue shark) caught, tagged, and released. The Prionace glauca was caught near the edge of Georges Bank, and, while considered cosmopolitan in the warmer parts of all oceans, very few have been reported definitely from the Gulf of Maine. Also, a Squalus acanthias (Spiny dogfish) was caught, but not tagged due to NMFS instructions. Data are sent to the Narragansett Laboratory, NOAA, NMFS, Rhode Island.

FIGURE 2

Generalized Figure of a Shark

(drawn by Jim Koch)

Classification by Caudal fin

Family Odontaspidae

(caudal fin is heterocercal)

Family Alopiidae

(unusually long upper lobe of caudal fin)

Family Isuridae

(tails are nearly lunate)

Family Carcharhinidae and Family Sphyrnidae

(Lower lobe shorter than upper)

Family Sphyrnidae

LONG TERM INTERNAL PROGRAMS

Marine mammals

Records of cetacean sightings have been kept on Westward cruises for several years. It was anticipated that large numbers of whales might be sighted in the Gulf of St. Lawrence. Therefore, a structured whale watch was maintained while in this area from 7 August - 21 August - the results of this are reported separately (see Langstaff, Leverette and Politis).

A list of additional incidental sightings of cetaceans is presented in Table 4 (compiled by R. Moir).

TABLE 4

Incidental Cetacean Sightings

<u>Date</u>	<u>Time</u>	<u>Lat(N)</u>	<u>Long(W)</u>	<u>Cetacean Sighted</u>	<u>Notes</u>
24 July	1720	41°04'	70°48'	2 fin whales (<u>Balaenoptera physalus</u>)	Clean, streamlined dorsal fin. High, narrow spouts. Flocks of gulls and greater shearwaters.
26 July	0715	41°03'	68°02'	8-25 pilot whales (<u>Globicephala melaena</u>)	Lobtailing; leaping out of water.
26 July	0735	41°03'	68°02'	5-20 dolphins (possible ID - bottlenose) <u>Tursiops truncatus</u>	Large; grey; flock of greater shearwaters.
26 July	1910	40°54'	67°34'	2 pilot whales	Broad based dorsal fin.
28 July	1415	42°04'	66°43'	6 pilot whales	-
29 July	0900	42°22'	65°48'	2-3 whales (possible ID - pilot)	Small, dark.
1 August	2305	42°47'	61°06'	4-5 dolphins	Small; no good ID.
4 August	0730	45°59'	59°44'	12 (+3) Atlantic white- sided dolphins (<u>Lagenorhynchus acutus</u>)	
21 August	1305	E. end of Straits of Canso		Seal	
21 August	1805	45°20'	60°45'	1 dolphin (possible ID - white-beaked) (<u>Lagenorhynchus albirostris</u>)	
21 August	2320	45°17'	60°34'	10 pilot whales	
22 August	1045	45°19'	60°48'	1 minke whale (<u>Balaenoptera acutorostrata</u>)	Flocks of gulls. Sighted once.

TABLE 4 (continued)

<u>Date</u>	<u>Time</u>	<u>Lat(N)</u>	<u>Long(W)</u>	<u>Cetacean Sighted</u>	<u>Notes</u>
27 August	0550	43°45'	64°11'	4 dolphins	About 6' in length. Blurred white streak along body.
28 August	0926	43°08'	64°57'	1 humpback (<u>Megaptera novaeangliae</u>)	Flukes shown.
28 August	1545	42°57'	65°25'	2 whales (no positive ID) fin ?	High, bushy spouts. Long back with pointed, high aspect dorsal fin.
31 August	1815	42°33'	70°13'	8-10 dolphins (no positive ID)	White bellies, grey dorsal side - 6-7'.

Coastal and pelagic bird distributions - W-53 cruise track

Pat Keoughan

ABSTRACT

The distribution of pelagic and coastal birds along the W-53 cruise track was studied by carrying out three ten-minute bird counts twice daily. This information will be passed on to Tim Ramage at the University of Rhode Island for further study. Statistics on ship activity, weather and sea conditions were also recorded for each count.

The data on the first thirty sightings showed no correlations between the presence of birds and air temperature, sea state, sea temperature, or wind force.

As would be expected from known data, gulls were common closer to shore and were not sighted off the continental shelf. Similarly, shearwaters and petrels were sighted more frequently farther from shore. The waters around Nova Scotia and Newfoundland, being very productive, had a great abundance of both pelagic and coastal birds. Figure 3 is a map showing the distribution of the most commonly sighted birds on a daily basis, and Table 5 is a list of species of birds sighted during the daily counts.

In addition, Table 6 presents a list of birds not commonly seen during the daily counts, and also species seen in areas of high bird density.

Figure 3. Pelagic bird sightings - 24 July - 30 August 1980

TABLE 6 Sightings of birds not commonly seen during observation periods, and birds seen offshore
in areas of high bird density

(compiled by Rob Moir)

<u>Date</u>	<u>Time</u>	<u>Latitude</u>	<u>Longitude</u>	<u>Bird</u>	<u>Species</u>	<u>Notes</u>
July 25	0500	40°44'N	69°35'W	seaside sparrow	<u>Ammodramus maritima</u>	
	0537	40°45'N	69°33'W	jaeger, immature	<u>Stercorarius</u> sp.	
	1520	40°54'N	68°38'W	yellow warbler	<u>Dendroica petechia</u>	
	1640	40°55'N	68°35'W	brownheaded cowbird	<u>Molothrus ater ater</u>	
July 26	1230	40°53'N	67°37'W	skua	<u>Catharacta skua</u>	flying East.
July 29	0700	42°18'N	65°43'W	75+15 greater shearwater	<u>Puffinus gravis</u>	
				1 herring gull	<u>Larus argentatus</u>	
				1 jaeger	<u>Stercorarius</u> sp.	
Aug. 3	1820	45°08'N	60°42'W	2 common terns	<u>Sterna hirundo</u>	
Aug. 4	0815	46°03'N	59°43'W	gannet	<u>Morus bassanus</u>	
Aug. 7	2345	47°18'N	60°17'W	3 Leach's petrel	<u>Oceanodroma leucorhoa</u>	on the ship.
Aug. 8	1130	47°25'N	59°42'W	red-breasted nuthatch, female	<u>Sitta canadensis</u>	on the ship.
Aug. 10	0725	49°26'N	60°09'W	tree swallow	<u>Iridoprocne bicolor</u>	on ship.
Aug. 11	0800	49°32'N	60°36'W	15 fulmars	<u>Fulmarus glacialis</u>	sitting on the water.
				5 black-backed gulls	<u>Larus marinus</u>	
	1225	49°37'N	60°38'W	30 black-backed gulls	<u>Larus marinus</u>	Birds are sitting in a windrow with Fucus and [Ascomyllum algae. flying North.
				17 black-legged kittiwake	<u>Rissa tridactyla</u>	
				13 fulmars	<u>Fulmarus glacialis</u>	
				1 manx shearwater	<u>Puffinus puffinus</u>	
				1 common tern	<u>Sterna hirundo</u>	
				1 phalarope	<u>Lopides</u> sp.	
				2 fulmar, immature	<u>Fulmarus glacialis</u>	
				1 skua	<u>Catharacta skua</u>	

TABLE 6 (continued)

<u>Date</u>	<u>Time</u>	<u>Latitude</u>	<u>Longitude</u>	<u>Bird</u>	<u>Species</u>	<u>Notes</u>
Aug. 11	1800	49°40'N	60°29'W	14 black-backed gulls, mature and immature	<u>Larus marinus</u>	
				8 black-legged kittiwake, mature and immature	<u>Rissa tridactyla</u>	
				2 fulmar	<u>Fulmarus glacialis</u>	Birds sighted while
				1 gannet, immature	<u>Morus bassanus</u>	observing a blue
				5 common tern, 1 immature	<u>Sterna hirundo</u>	whale.
				1 parasitic jaeger	<u>Stercorarius parasiticus</u>	chasing a tern.
Aug. 12	1255	49°30'N	58°44'W	sparrow		on ship.
Aug. 18	1910	48°26'N	59°60'W	pine siskin	<u>Spinus pinus</u>	eating sesame seeds on the afterdeck.
Aug. 19	1600	47°19'N	61°03'W	tree swallow	<u>Iridoprocne bicolor</u>	flying in the lee of the ship.
	1750	47°14'N	61°04'W	northern phalarope	<u>Lobipes lobatus</u>	
Aug. 20	0600	46°46'N	61°17'W	black-legged kittiwake	<u>Rissa tridactyla</u>	
				gannet	<u>Morus bassanus</u>	
Aug. 21	1320	45°29'N	61°10'W	gannet	<u>Morus bassanus</u>	diving from the air.
	1430	45°24'N	61°01'W	double-crested cormorant	<u>Phalacrocorax auritus</u>	
Aug. 21	1630	45°20'N	60°55'W	2 northern phalarope	<u>Lobipes lobatus</u>	
				Cory shearwater	<u>Puffinus diomedea</u>	sitting on the water
				6 greater shearwater	<u>Puffinus gravis</u>	with greater shearwaters.
Aug. 22	0700	45°19'N	60°39'W	30 greater shearwater	<u>Puffinus gravis</u>	sitting on the water.
				12 greater shearwater	<u>Puffinus gravis</u>	flying South.
				3 sooty shearwater	<u>Puffinus griseus</u>	flying slowly about ship.

TABLE 6 (continued)

<u>Date</u>	<u>Time</u>	<u>Latitude</u>	<u>Longitude</u>	<u>Bird</u>	<u>Species</u>	<u>Notes</u>
Aug. 29	1050	42°51'N	66°54'W	purple finch, female	<u>Carpodacus purpureus</u>	on ship.
	1230	42°56'N	67°05'W	yellow-rump warbler	<u>Dendroica coronata</u>	on ship.
				8 northern phalarope	<u>Lobipes lobatus</u>	flew around ship.
Aug. 30	0730	42°54'N	68°30'W	Cape May warbler	<u>Dendroica tigrina</u>	found dead in scuppers.
	0925	42°54'N	68°42'W	parasitic jaeger	<u>Stercorarius parasiticus</u>	
				2 gannet, 1 immature	<u>Morus bassanus</u>	on Cashes Ledge.
Aug. 31	1700	42°35'N	70°07'W	Cory shearwater	<u>Puffinus diomedea</u>	
				2 greater shearwater	<u>Puffinus gravis</u>	

GEORGES BANK AND THE GULF OF MAINE STUDIES

INTRODUCTION

The Gulf of Maine is one of the most striking topographic features along the northeastern seaboard of the United States. It is a partially enclosed sea containing 21 deep basins, with a maximum depth of 377 m, and separated from the Atlantic by Georges Bank to the south and Browns Bank to the north. The topography and sediment distribution of the area are largely the result of glacial processes in the past, and present day marine erosion and deposition, and hence the bathymetry and the sediment size are both highly variable.

The large amount of river runoff, particularly in the spring, is important in contributing to the surface circulation in the Gulf, and also in providing nutrients in high concentrations which helps to maintain the high productivity in the area.

During W-53, three aspects of Georges Bank and the Gulf of Maine were considered:

- i) Georges Bank is particularly well-known for its bottom fishery. Since animal-sediment relations should be a function of the lifestyle and feeding behavior of the organisms, the relations between the distribution of benthic organisms and the sediment with which they are associated were examined.
- ii) The cyclonic gyre set up in the spring in the Gulf of Maine transports river runoff seaward and around Georges Bank. This circulation has important implications for the productivity on the Bank. A series of three hydrocasts were carried out to investigate the physical and chemical characteristics of the water on the Bank.
- iii) The major inflow of deep water into the Gulf of Maine is through the Northeast Channel between Georges and Browns Bank. This water is derived from the continental slope and should therefore be more saline than the Gulf of Maine water, although it may be warmer. Two BT transects were completed to obtain temperature profiles across the mouth of the Northeast Channel, and across the northern limb in the Gulf of Maine, in order to delineate the depth of the inflow of bottom water.

I. Spatial segregation on Georges Bank

Patricia Mace

ABSTRACT

Substrate composition and mobility exert a strong influence on the spatial distribution of benthic organisms which display different life styles (Rhoads and Young, 1970). The relationship between the sediment grain size distribution and the associated organisms was investigated at three sites on Georges Bank (Figure 4). Deposit feeders were more common at site GB-2, characterized by fine grained sediment, whereas filter feeders were more common at GB-3, where a mixture of coarse and fine sediment was observed (Figure 5 and Table 7). Well sorted, finer grained sediments (site GB-2) make attractive areas for burrowing and deposit feeders - hence the abundance of clams, polychaetes and sea cucumbers. In contrast, coarser sediment reduces turbidity, which is detrimental to filter feeders, and hence at site GB-3, tube worms, tunicates and scallops were dominant. Predators, particularly sea stars, were abundant at both sites.

In addition, chemical analyses of unfiltered water samples from these sites (Appendix II-I) demonstrated the influence of the Gulf of Maine runoff outflow at GB-3 where fresher, nutrient-rich water - advantageous to filter feeders - was observed.

Reference:

- Rhoads, D.C. and Young, D.K. 1970. The influence of deposit-feeding organisms on sediment stability and community trophic structure. J. Mar. Res., 28, 150-178.

Figure 4 Station locations on Georges Bank (depths in fathoms)

Figure 5 Grain size distribution on Georges Bank

TABLE 7

Otter trawl results from Georges BankGeorges Bank Station 1

no benthic organisms collected

Georges Bank Station 2

PREDATORS

<u>#</u>	<u>Classification</u>	<u>Common name</u>	<u>Preferred diet</u>
33	<u>Cancer borealis</u>	Jonah crab	bivalves, other crustaceans- amphipods, small shrimp
14	<u>Strongylocentrotus droebachiensis</u>	sea urchin	small invertebrates
280	<u>Asterias vulgaris</u>	sea star	bivalves
12	<u>Raja erinacea</u>	leopard skate	bivalves
6	<u>Prionotus carolinus</u>	sea robin	small invertebrates
5	<u>Limanda ferruginea</u>	flounder	invertebrates - shrimp, small crabs, small fish
5	Caprellidae	skeleton shrimp	microzooplankton
4	<u>Henricia</u> species	blood star	bivalves
4	<u>Urophycis regius</u>	spotted hake	mostly invertebrates - shrimp, crabs, some fish, some sea stars
2	<u>Raja eglanteria</u>	little skate	bivalves
1	<u>Buccinum undatum</u>	English whelk	bivalves
1	<u>Hyas araneus</u>	spider crab	polychaetes, small slow moving invertebrates
1	<u>Trematoda</u> species	trematode	copepods
1	<u>Lophius americanus</u>	goose fish	crabs, fish

SCAVENGERS

4	<u>Pagurus acadianus</u>	Acadian hermit crab	dead organisms, detritus, garbage
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DEPOSIT FEEDERS

77	<u>Arctica islandica</u>	black clams
7	Capitellidae	polychaetes
2	Terebellidae	polychaetes
2	<u>Pentamera calcigera</u>	sea cucumber
	Amphipoda	amphipods

FILTER FEEDERS

17	<u>Placopeten magellanicus</u>	deep sea scallop	phytoplankton
2	Porifera	sponges	phytoplankton
1	Sabellidae	polychaete	microzooplankton, phytoplankton
	Bryozoa - branching	and encrusting	plankton - mostly diatoms

TABLE 7 (continued)

Georges Bank Station 3

<u>#</u>	<u>Classification</u>	<u>Common name</u>	<u>Preferred diet</u>
PREDATORS			
56	<u>Asterias vulgaris</u>	sea star	bivalves
52	<u>Strongylocentrotus droebachiensis</u>	sea urchin	small invertebrates
16	<u>Nereis species</u>	polychaete	other polychaetes, amphipods
7	<u>Cancer irroratus</u>	rock crab	small bivalves, polychaetes
13	<u>Raja eglanteria</u>	little skates	bivalves
3	<u>Henricia species</u>	blood star	bivalves
3	<u>Ophiopholis aculeata</u>	daisy star	bivalves
2	<u>Grossaster papposus</u>	spiny sunstar	bivalves
2	<u>Hemitripterus americanus</u>	Atlantic sea raven	decapods, fish
2	<u>Prionotus carolinus</u>	sea robin	small invertebrates
1	<u>Lophius americanus</u>	goose fish	crabs, fish
1	<u>Cancer borealis</u>	Jonah crab	bivalves, other crustaceans-amphipods, small shrimp
SCAVENGERS			
4	<u>Pagurus acadianus</u>	Acadian hermit crab	dead organisms, detritus, garbage
DEPOSIT FEEDERS			
3	<u>Ensis directus</u>	common razor clam	
1	<u>Havelockia scabra</u> Amphipoda	sea cucumber amphipods	
FILTER FEEDERS			
	Serpulidae	tube worms	plankton
15	Urochordata	tunicates	phytoplankton
4	<u>Placopeten magellanicus</u>	deep sea scallop	phytoplankton
	Bryozoa - branching	and encrusting	plankton-mostly diatoms
1	<u>Clinocardium ciliatum</u>	iceland cockle	phytoplankton
	<u>Anomia aculeata</u>	prickly jingle shells encrusting	microzooplankton, phytoplankton

II. Water mass characteristics of Georges Bank

Hydrostations were completed at each of the three locations shown in Fig. 4 . Salinity, temperature, oxygen and phosphate were determined and the data are presented in Appendix II, and plotted in Fig. 6 . The temperature profiles for the two stations on the shallower parts of the Bank show the water column to be well-mixed. Station 2, which is on the southeastern edge of the Bank, indicates that the water below 30 m. is between 10 and 11°C; this station is probably more influenced by the shelf water. The low salinities at all three stations are indicative of the influence of the fresh water runoff from the Gulf of Maine. In particular, station 3 is close to the northern limb of the anti-cyclonic gyre around the Bank and would be more directly influenced by the Gulf of Maine outflow - hence, its salinity is lower. Phosphate concentrations near the surface at stations 1 and 2 are typical of open ocean values; station 3 shows slightly higher values, which again indicate the influence of the Gulf of Maine runoff. Stations 2 and 3 both show an increase in phosphate concentration at the bottom, suggesting that there may be some input of phosphate from the sediment back into the water column.

III. Inflow of bottom water through the Northeast Channel

Two bathythermograph transects were completed at different locations along the Northeast Channel. The first consisted of five stations close to the entrance between Georges and Browns Banks; the second crossed the northern limb of the Northeast Channel in the Gulf of Maine. In addition to the BT transects, a series of four hydrostations was completed across the entrance in order to define the characteristics of different water masses. The locations of all stations are plotted in Figure 7, and the chemical data are listed in Appendix II-II.

The temperature profiles (Figure 8) indicate that a mixed layer extends down to 10-30 m, beneath which there is a sharp thermocline to a temperature of about 6-7°C, seen at depths between 50-100 m at the entrance, and at 80-140 m in the northern limb. Beneath this, there is an increase in temperature indicating a possible inflow of water from the continental slope at depths below about 150 m. This inflow is still discernible at the location of the BT transect in the northern limb.

The salinity profiles, presented in Figure 9, indicate that the surface salinity of the Gulf of Maine is about 32.5-32.9 ‰ at this time of year. An increase in salinity with depth is seen at all stations, reading at maximum of 35.1 ‰ at depths below 130 m. These high salinities are more typical of ocean water and confirm the inflow of continental slope water. The oxygen profiles, also plotted in Figure 9, show surface water concentrations of about 5.6 mL/L. The continental slope waters are characterized by dissolved oxygen contents of about 4 mL/L, which indicates that these waters have been at depth for some time.

Figure 6 Profiles of water characteristics from Georges Bank

GEORGES BANK - Station I

GEORGES BANK - Station II

GEORGES BANK - Station III

Figure 7 Locations of BT transects across the Northeast Channel

(depths in fathoms)

Figure 8 BT transects across the Northeast Channel (temperatures in $^{\circ}\text{C}$)

Figure 9 Salinity and dissolved oxygen profiles from Northeast Channel

Ecology of Benthic Foraminifera from the Wilkinson Basin

G. P. Lohmann, Woods Hole Oceanographic Institution

The Wilkinson Basin in the Gulf of Maine offers a unique natural laboratory within which to study benthic foraminifera and the environmental factors that control their distribution. The research undertaken on W-53 exploited this opportunity.

Benthic foraminifera are single-celled, bottom-dwelling marine organisms. Individual foraminifera are encased in a test or shell of calcite or cemented sand grains. The shape or morphology of the test is characteristic of each species and is the primary criterion for distinguishing one species from another. The tests of benthic foraminifera do not decompose after the organisms die, and are preserved in the marine sedimentary record. These fossils are a historical record of the past distribution of benthic foraminifera and they provide our best evidence of past changes in the benthic marine environment. The major problem with interpreting this evidence is determining the environmental significance or ecology of the benthic foraminifera. Certain characteristics of the Wilkinson Basin make it uniquely valuable for ecological studies of benthic foraminifera.

The Wilkinson Basin is a deep basin, reaching a maximum depth of 295m, and with a sill depth of 188 m. Below this depth, it is filled with continental slope water which has entered the Gulf of Maine through the Northeast Channel. The deep waters of the Wilkinson Basin are therefore homogeneous, having the same physical and chemical properties throughout as the water entering over the sill. This feature, the uniformity of the hydrography within the Wilkinson Basin, allows the influence of certain environmental factors on the distribution of benthic foraminifera to be evaluated.

In general benthic foraminiferal distributions are correlated with various substrate properties (sediment type, grain size, organic content), properties of the overlying water (dissolved oxygen, temperature, salinity), and pressure or water depth. On W-53 a suite of sediment cores were recovered from different water depths along a traverse extending from well above the sill depth of the Wilkinson Basin to the center of the basin.

This sampling design allows two things: first, it allows intercorrelation between changes in benthic foraminiferal distributions, sediment and hydrographic properties to be determined. Second, because of the sill and homogeneous waters within the Wilkinson Basin, it allows changing distributions within the basins to be evaluated only with respect to substrate properties and water depth; all hydrographic properties being held constant.

GULF OF ST. LAWRENCE STUDIES

INTRODUCTION

The Gulf of St. Lawrence is a marginal sea with an area of about 214,000 km², which displays highly variable physical and biological properties, particularly on a seasonal basis. It is a highly productive area, being the source of more than 40% of all the Canadian sea-fish landings. It is also the principal sea access to the largest Canadian cities, and so an understanding of its oceanography is extremely important.

During W-53, our efforts were concentrated on two major aspects of oceanography:

- a) the Laurentian Channel is the major pathway of exchange of water between the Gulf and the North Atlantic. A study was initiated to investigate the characteristics of water masses flowing through this channel.
- b) The Gulf of St. Lawrence is a summer feeding ground for several species of whales. Studies by other researchers are currently underway to look at the distribution of whales, and to try to identify specific whales by their markings so that their migration routes may be discovered. On W-53, whale watch was maintained while in the Gulf, and a plankton study carried out in an attempt to establish the food of the whales. Two reports are included concerning the whales: that of the group of students responsible for the project, and that of Kathy Lynch, a Visiting Scientist who is working on marine mammals. Each emphasizes different aspects of the study.

a) Water masses of the Laurentian Channel

The Laurentian Channel, the western part of which is known as the Cabot Strait, is the major pathway of exchange of water between the Gulf of St. Lawrence and the North Atlantic Ocean. It is a glacially eroded, U-shaped valley with depths reaching between 400-500 m., and it can be traced from Quebec City in an arc to the edge of the continental shelf southeast of the Cabot Strait.

During W-53, a BT transect and a series of six hydrostations were completed in order to investigate the water masses flowing through the Cabot Strait (Fig. 10). The water samples were analyzed for salinity and oxygen - the results are presented in Appendix II. The temperature transect (Fig. 11) shows a thin surface layer between 10 and 20 m. thick with temperatures greater than 13°C. This corresponds with salinities which are low - in general about 31 ‰ (Fig. 12). This is probably the surface outflow of water from the Gulf to the Atlantic. A narrow inflow on the northern side of the Strait has been reported previously (El-Sabh, 1976), but was not observed at either stations 15 or 16.

A cold intermediate layer, with temperatures as low as 0.5°C, was observed, and was particularly pronounced close to the center of the Straits, where it occurred at 30-75 m. This water mass was also characterized by a small maximum in salinity of about 32.2 ‰, and a notable maximum in the oxygen concentration (Fig. 12).

Beneath this there is a warm, deep layer characterized by temperatures up to 8°C, salinities of about 34.8 ‰ and lower oxygen concentrations of 2-4 mL/L. This is formed by a mixture of slope water and Labrador current water flowing into the Gulf of St. Lawrence.

Reference:

- El-Sabh, M.I. 1976. Surface circulation pattern in the Gulf of St. Lawrence. J. Fish. Res. Board. Can., 33, 124-138.

Figure 10. Locations of bathythermograph and hydrostations across the Laurentian Channel

Figure 11. BT Temperature Transect across the Laurentian Channel

Figure 12. Salinity and dissolved oxygen profiles from the Laurentian Channel

b) Observations of Whales in the Gulf of St. Lawrence

Liz Langstaff, Ann Leverette, Alex Politis

ABSTRACT

The students of cruise W-53 on R/V Westward participated in a whale watch encompassing 89 hours and 1609 square miles in the Gulf of St. Lawrence. Special attention was given to Banc Beauge (49°50'N, 60°00'W) with the hypothesis that whales migrate through the Strait of Belle Isle in search of adequate food sources. The sighting of one blue whale made in this previously unstudied area supports this. Other whales sighted in the Gulf were minke and pilot whales along with several unidentified sightings (Table 8 and Fig. 13). Fin and humpback whales were also seen in areas outside the Gulf of St. Lawrence.

Data collected included location, identification, weather conditions, behavior, and zooplankton abundance and distribution. A group of pilot whales were heard through the use of hydrophones.

A general description of zooplankton was made in order to compare whale feeding areas to those areas where whales were not seen. Concentrations of the various planktonic organisms were estimated through the study area by subsampling techniques. No significant difference in species or amount were found in the Banc Beauge area as compared to the rest of the Gulf of St. Lawrence. These data, together with the lack of other whale sightings, contradict the hypothesis that Banc Beauge may be a particularly good feeding ground.

The results of this project will be sent to Richard Sears who is working on the estimation of whale populations in the Gulf of St. Lawrence.

TABLE 8

Cetacean sightings in the Gulf of St. Lawrence

Date	Time(hrs)	Latitude (N)	Longitude (W)	Cetacean sighted	Notes
7 August	1537	46°48'	60°15'	5-8 pilot whales (<u>Globicephala melaena</u>)	9-17' Black
7 August	1650	46°51'	60°14'	5-6 pilot whales	Broad-based dorsal fin. Long, thin flippers.
7 August	1840	47°03'	60°10'	12-20 pilot whales	Two calves in pod.
9 August	1100	48°40'	59°33'	1 minke whale (<u>Balaenoptera acutorostrata</u>)	No blow. Time between surfacings 1 min.
9 August	1252	48°39'	59°33'	2 unidentified whales (minke?)	On horizon - dorsal fins seen.
9 August	1450	48°54'	59°42'	1 minke whale	Dorsal fin; no blows; 30 secs between surfacings.
11 August	1720	49°39'	60°29'	1 blue whale (<u>Balaenoptera musculus</u>)	Tall blow; long back; small fin; series of blows - only showed fin on last blow before dive. Watched for 3-1/2 hrs. Whale appeared to be circling. At times only 200 yds from ship. Size: 70 ft.
12 August	0952	49°33'	59°07'	1 whale - no ID	5 blows; high spout.
17 August	1705	49°10'	58°32'	1 minke whale	-
18 August	2050	48°26'	59°59'	3-6 pilot(?) whales	-
19 August	2210	47°03'	61°13'	1 whale (No ID)	3 blows heard, then 5 minutes later 2 more blows.

Figure 13. Whale sightings in the Gulf of St. Lawrence.

WHALE AND DOLPHIN SIGHTINGS RECORDED ON CRUISE W-53, 23 JULY - 23 AUGUST

Katherine D. Lynch
Visiting Scientist

Whale and dolphin sightings were recorded during Cruise W-53 to obtain information on their distribution and abundance, primarily in the Gulf of St. Lawrence. A total of 40 cetacean sightings were recorded from 23 July to 23 August, 1980. Twenty-eight of these sightings were incidental, and 12 were collected during an organized whale watch.

The organized watch was conducted from 8 August until 23 August. Observations were carried out during daylight hours with an observer stationed on the yard, one of the spreaders of the foremast, or the bow. An area was surveyed from the ship to the horizon 90° on either side of the bow. The distance to the horizon (R) was calculated from the equation,

$$R = 2.07 \sqrt{H} \quad (\text{Nasu, 1973})$$

where R is in nautical miles and H - the eye height above the water line in meters. The visual range for the yard, the spreaders and the bow were estimated to be 8.6, 8.9 and 4 nautical miles (nm), respectively. The information recorded by the observer included species, number in the group, position and distance of the whales relative to the ship, morphological and behavioural features distinguishing the animals, associated species (e.g., birds, seals, etc.), visibility and the time of sighting.

Only sightings recorded during the watch could be used for the purpose of a census. The strip width was estimated to be a maximum of 6 nm (the approximate distance at which the blow of a blue whale was seen). However, over 80% of the 12 sightings seen during the watch were recorded in the first 2 nm radius of the ship. Thus, the most effective strip width was about 2 nm.

A simple equation described by Mackintosh and Brown (1956) was used to estimate the abundance of whales in the study area along the ship's route in the Gulf of St. Lawrence,

$$P = NA/a$$

where P - a population of whales in a given study area, A; A = the length of the ship's route that overlapped with the area surveyed during the whale watch (693 nm) X the strip width (6 nm maximum or 2 nm effective) X 2 (for both sides of the ship); a = the total area surveyed by the watch (295 nm X 6 nm or 2 nm X 2); and N = an estimate of the total number of whales in area a. In order to estimate N, Mackintosh and Brown determined a sighting

rate based on the probability that 80-90% of the whales present in the first mile radius are sighted and that this percentage decreases with increasing distance from the ship. Furthermore, they assumed that the same number of whales present in a 0-1 nm radius were also present at 1-2 nm, 2-3 nm, etc. The sighting rate for this study was estimated to be 28.5% for $n = 14$ at 6 nm and 67% for $n = 11$ at 2 nm. The resulting estimations for the number of whales in area A were 115.3 for a 6 nm radius ($A = 8316 \text{ nm}^2$) and 38.5 for a 2 nm radius ($A = 1180 \text{ nm}^2$). These figures are applicable only to baleen whales since they made up 86% (12/14) of the total number of whales sighted during the watch.

These values, although conservative, probably carry little weight for a number of reasons including; limited data, observer inexperience, no measure of observer reliability (for students or scientific staff), and bias in the transect (i.e., ship's course was set specifically to locate blue whales known to occur in the northern part of the Gulf of St. Lawrence during the summer, Sears, 1979).

The sightings do contribute to the understanding of whale distribution and migration. Blue whales were found only in the northeastern part of the Gulf of St. Lawrence in the area of Banc Beauge (near $49^{\circ}50 \text{ N}$ and $60^{\circ}00 \text{ W}$). These sightings support the results that Sears (1979) obtained for blue whales along the north shore of the Gulf of St. Lawrence. Fin whales were rare and humpback whales were not seen. The apparent absence of humpbacks was of interest because these whales are particularly abundant on the east coast of Newfoundland. Minke seen occasionally throughout the trip, were probably underestimated because they tend to be inconspicuous. Pilot whales were the most abundant cetacean species encountered, although they were most numerous around Georges Bank and the northeastern tip of Cape Breton Island. Dolphins were seen throughout the trip and did not appear to concentrate in any one area.

It would be valuable to maintain whale watches on future cruises to establish a continuous log of documented information.

References

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Nasu, K. 1973. Results of the whale sightings by CHIYODA MARU No. 5 in the Pacific Sector of the Antarctic and Tasman Sea in the 1966/67 season. Sci. Rep. Whales Res. Inst., Tokyo. 25: 205-217.

Sears, R. 1979. Observations of cetaceans along the north shore of the Gulf of the St. Lawrence. Mingan Island, Cetacean Study, E. Falmouth, Mass.

Balaenoptera musculus

(Blue whale)

Figure 14 Location and number per species sighted from 23 July - 23 August 1980

Amphipod Distribution in the Gulf of St. Lawrence

Emily B. Tibbott

ABSTRACT

The distribution of species of the order Amphipoda at four points in the Gulf of St. Lawrence was examined in order to correlate species and relative amounts at each point with existing factors in these areas (i.e. principally, the factors of water temperature, distance from land, presence of marine mammals, presence of nutrients, and predators). I found Amphipods in each area ranging in number from 0.02 - 0.11 organisms/m³. Genus species found was overwhelmingly Parathemisto abyssorum, with two Hyperia medusarum, one Hyperoche tauriformis, and one Phronima sp. There was no correlation found between surrounding factors, Amphipod distribution and amounts.

Hyperiid amphipod

Gammarid amphipod

BAY OF ISLANDS, NEWFOUNDLAND

INTRODUCTION

The Bay of Islands is made up of a complex of fjords on the west coast of Newfoundland. It consists of a central deep bay with a series of narrow fjords leading off it. The whole area has been shaped by glacial processes, and the classical fjord features - steep-sided, U-shaped valleys containing deep basins with a shallow sill marking the mouth - were observed.

Five days were spent in the area in order to accomplish two objectives:

- 1) An area close to Lark Harbour is composed of a very unusual sequence of rocks that are believed to be a section of old oceanic crust. Field trips were taken to Blow-Me-Down Mountain to observe these rocks.
- 2) A multi-disciplinary study was initiated to study Penguin Arm - one of the small fjords. Very little information has been published about the Newfoundland fjords, and so a three-day study, consisting of several different student projects, was completed.

Figure 15 shows the locations of the ophiolite complex and the areas that were studied during the cruise. Figure 16 shows the bathymetry of Goose Arm, part of the fjord, and serves to demonstrate the deep basins isolated by shallow sills.

Figure 16 Bathymetry of Goose Arm
(compiled by B.J. Ensign)

1) Field trip to the Bay of Islands ophiolite complex, Newfoundland

An ophiolite complex is a particular stratigraphic sequence of rocks that is thought to represent a section of oceanic lithosphere that has been exposed on land. The mechanism of emplacement of such ophiolite complexes is not well understood; obduction of a slice of oceanic crust on to a continental plate at a converging plate boundary is a favored hypothesis. However, if ophiolites really represent such a suite of rocks, then they provide us with a way to observe a segment of the ocean floor, and easy access for studying crustal structure. All of our present information about crustal structure is based on seismic evidence, drilling, dredging, and submersible work. Of these, only seismic evidence gives data concerning the deeper portions of the Earth; hence, ophiolites could be of great geological significance.

One of the better known ophiolite complexes occurs on the west coast of Newfoundland at the Bay of Islands. Figure 17 shows a stratigraphic section through the Bay of Islands ophiolite compared with an idealized section of the oceanic crust. On W-53, the opportunity was taken to organize a field trip to look at the sequence of rocks. Examples of pillow basalts, ore deposits, gabbros and cumulate gabbros, all of which make up various crustal layers were seen. In addition, a section of ultramafic rock, interpreted to be upper mantle rock, together with the Moho (the junction between the crust and mantle more properly defined on the basis of a seismic discontinuity) were observed. This field trip served to familiarize the students with the major rock types that probably make up the oceanic lithosphere, and to introduce them to aspects of Geological Oceanography normally unavailable to them.

Figure 17

Idealized stratigraphic section through the oceanic crust
compared with that from a Newfoundland ophiolite

* Adapted from O'Connell, S. (1979) Ophiolites - ocean crust on land. *Oceanus*, 22, 23-32.

† Adapted from Church, W.R. (1972) Ophiolite: its definition, origin as oceanic crust, and mode of emplacement in orogenic belts, with special reference to the Appalachians. *Publ. Earth Phys. Branch, Dept. of Energy, Mines and Resources*, 42, 71-85.

Stratigraphy of an ophiolite complex, Blow-Me-Down Mountain, Bay of Islands,
Newfoundland

Peter deMenocal

ABSTRACT

An ophiolite complex is a terrestrial geologic feature thought to be of oceanic origin. It is described as being a stratiform sequence of ultramafic rocks, gabbros, sheeted dykes and pillow basalts. The Bay of Islands area in western Newfoundland is considered to be an exceptionally well developed complete ophiolite. The project consisted of sampling the area; samples were then positioned on a geologic map, and analyzed for mineral content. Combining the sample data with the mapping data resulted in a stratigraphic column of the sampled area. This was then compared with a column of the same area by the Geological Survey of Canada to determine the validity of the analyses and stratigraphy. The two columns coincided closely but the sheeted dyke stratum was not observed in any samples and thus did not appear in my stratigraphic column.

2) FJORD STUDIES

FAUNA OF PENGUIN ARM

Rob Moir

Newfoundland, being separated from Canada by the Straits of Belle Isle and the Cabot Strait, is distinctive in many aspects of its fauna. Many animals common in Quebec and Nova Scotia have been unable to reach or establish themselves on the island. Species diversity of Newfoundland's mammals is 50% the number found on the mainland. In Penguin Arm evidence was found of red squirrel Tamiasciurus hudsonicus, beaver Castor canadensis, and moose Alces alces. Red squirrels were recently introduced to Newfoundland at the Avalon Peninsula. Within a decade red squirrels have spread to the forests of the west coast. Their chattering calls were heard in Penguin Arm, Goose Arm, and York Harbor.

Newfoundland's avifauna is not as distinct. Birds regularly travel to and from the island. This was demonstrated when a female redbreasted nuthatch landed aboard Westward in the middle of Cabot Strait (47°29'N, 59°42'W) during a northwest wind of force 2. The day had been calm with variable winds until two hours before the nuthatch arrived. The nuthatch stayed aboard for four days picking insects from baggie wrinkle and calling from the rigging. It was last seen climbing about a few hours before we anchored in Lark Harbor. Presumably other non-migratory passerines have also used ships to reach Newfoundland.

At Penguin Arm ten species of birds were sighted. Flying and sitting on the water were a common loon, black-backed gulls, herring gulls and common terns. Along the gravel shores and upon exposed mud-flats greater yellowlegs searched for small invertebrates. Common snipe were flushed from spartina grass at the head of the arm. Further inland in the spruce-fir forest were downy woodpecker, black-capped chickadee and black-and-white warbler. The slow call of the boreal chickadee which is frequently heard in northern spruce-fir forests was noticeably absent. Higher up the slope on rocky outcroppings were common crows. The low "croak" of the raven was often heard above us.

During an overnight in Goose Arm an osprey was observed hovering over the water. As we left Goose Arm, soaring high above the rocky Narrows, was a dark headed eagle, probably an immature bald eagle.

Bird of Penguin and Goose Arm, Bay of Islands, Newfoundland.

Order Gaviiformes

common loon, Gavia immer

Order Falconiformes

bald eagle, Haliaeetus leucocephalus

Order Charadriiformes

greater yellowlegs, Totanus melanoleucus

common snipe, Capella gallinago

great black-backed gull, Larus marinus

herring gull, Larus occidentalis

common tern, Sterna hirundo

Order Picidae

downy woodpecker, Dendrocopos pubescens

Order Passeriformes

common crow, Corvus brachyrhynchos

common raven, Corvus corax

black-capped chickadee, Parus atricapillus

black-and-white warbler, Mniotilta varia

The vascular plants of Penguin Arm

Ronn Hagan

ABSTRACT

The flora of Penguin Arm was investigated by both systematic and random sampling techniques. A 200 meter transect was run from the head of the fjord, across a low lying area, to a beaver dam. In addition, two 10 x 10 meter squares were located in established forest on the north and south banks of the fjord. Finally, eight random 1-meter circular plots were sampled on a triangular spit near the head of the fjord.

A list of species found is given in Table 9 and demonstrates the diversity of flora in the area. Locations of recently established vegetation displayed a trend toward the r-selection of plants, while sites away from the water and further along in succession had more of a K-selection within the species found there. A representative sample of flora was collected and compiled into a herbarium.

TABLE 9 Floral species identified from Penguin Arm

FAMILY	GENUS SPECIES	COMMON NAME
Umbellifereae	<u>Cryptoten</u> <u>ia canadensis</u>	honewort
Compositae	<u>Sonchus arvensis</u>	field sow thistle
	<u>Sonchus oleraceus</u>	common sow thistle
	<u>Achillea millefolium</u>	yarrow
	<u>Taraxacum officinale</u>	common dandelion
	<u>Eupatorium papureum</u>	sweet joe-pye weed
	<u>Eupatorium maculatum</u>	spotted joe-pye weed
	<u>Crysanthemum leucanthemum</u>	ox-eye daisy
	<u>Solidago canadensis</u>	canada goldenrod
	<u>Prenanthes trifoliata</u>	gall-of-the-earth
Leguminosae	<u>Aster</u> sp.	aster
	<u>Trifolium pratense</u>	red clover
Iridaceae	<u>Vicia americana</u>	purple vetch
	<u>Iris vericolor</u>	larger blue flag
	<u>Sisyrinchium momtanum</u>	blue eyed grasses
Rosaceae	<u>Potentilla anserina</u>	silverweed
	<u>Sanquisorla canadensis</u>	canadian burnet
	<u>Potentilla recta</u>	rough fruited cinquefoil
	<u>Rubus</u> sp.	raspberry
Equisetaceae	<u>Equisetum arvense</u>	horsetail
Ranunculaceae	<u>Ranunculus</u> sp.	buttercup
	<u>Thalictrum polygamum</u>	tall meadow rue
Labiatae	<u>Blephilia ciliata</u>	downy wild mint
	<u>Mentha arvensis</u>	wild mint
Campanulaceae	<u>Lobelia kalmii</u>	brook lobelia
	<u>Lobelia dortmanna</u>	water lobelia
Sarrateniaceae	<u>Sarracenia purpurea</u>	pitcher plant
Droseraceae	<u>Drosera rotundifolia</u>	round leave sundew

TABLE 9 (continued)

Pyrolaceae	<u>Monotropa uniflora</u>	indian pipe
Rubiaceae	<u>Galium boreale</u>	northern bedstraw
	<u>Galium triflorum</u>	fragrant bedstraw
Orchidaceae	<u>Spiranthes romanzoffiana</u>	hooded ladies tresses
	<u>Habenaria dilatata</u>	leafy white orchis
Cornaceae	<u>Cornus canadensis</u>	crackleberry
Liliaceae	<u>Smilacina recemosa</u>	false solomons seal
	<u>Clintonia borealis</u>	clintonia
Pinaceae	<u>Picea mariana</u>	black spruce
	<u>Abies balsamea</u>	balsam fir
Taxaceae	<u>Taxus canadensis</u>	canadian yew
Ericaceae	<u>Andromeda glaucophylla</u>	bog rosemary
	<u>Vaccinium nubigenum</u>	Newfoundland bilberry
Rosaceae	<u>Spiraea latifolia</u>	meadowsweet
	<u>Prunus floribunda</u>	choke cherry
	<u>Pyrus decora</u>	mountain ash
Thymeleaceae	<u>Dirca palustris</u>	leatherwood
Corylaceae	<u>Alnus crispa</u>	mountain alder
	<u>Alnus rugosa</u>	spotted alder
	<u>Betula papyrifera</u>	white birch
	<u>Betula lutea</u>	yellow birch
Caprifoliaceae	<u>Viburnum cassinoides</u>	northern wild raisin
Aceraceae	<u>Acer spicatum</u>	mountain maple
Cornaceae	<u>Cornus racemosa</u>	red panicle dogwood
Saxifragaceae	<u>Ribes lacustre</u>	bristly black currant

An intertidal study of a Newfoundland fjord - macrofloral analysis

Leigh Klein

ABSTRACT

The macroflora of the Penguin Arm fjord, Bay of Islands, Newfoundland, was studied from a series of six transects. These transects, chosen as general representatives of the fjord habitats, revealed definitive vertical zonations of four major species. Ascophyllum nodosum was the dominant species in the fjord, and seemed to be particularly abundant in sheltered areas where the substratum was composed of large rocks. Fucus vesiculosus occurred in patches in exposed areas of large grain size. In addition, vertical clumping was observed, which may be related to levels of ice sheet cover in winter, and algal blooms in spring. Chondrus crispus was found consistently within 1 meter above the maximum low tide level, and always in association with low levels of Fucus growth. Finally, Enteromorpha intestinalis was observed at each station where there was freshwater input, which is not characteristic of this marine species. Other factors to which it may be responding could be competition from Fucus in other areas, or the constant water flow which could lessen the severity of the local environment.

An intertidal study of a Newfoundland fjord - faunal analysis

Beth Hannum

ABSTRACT

The fauna of the intertidal zone of Penguin Arm was determined by sampling along the six transect lines used for the floral analysis. Apart from identification of the organisms, salinity, temperature, substratum, and shore profiles were measured.

A limited diversity of species was observed due to high freshwater input and boreal temperatures. Periwinkles of various types were found to be zoned, with Littorina saxatilis in the high intertidal zone, L. obtusata in the intertidal zone among the rockweeds, and L. litorea from the subtidal zone to the high intertidal zone. Mytilus edulis and Balanus improvisus occupied brackish waters, and competed with algae for the substratum to which they all adhere.

Benthic flora and fauna in a Newfoundland fjord

Mickey Jones

ABSTRACT

Benthic flora and fauna in Penguin Arm, Bay of Islands were compared with that outside the fjords on the west coast of Newfoundland. Samples were collected using an otter trawl, and the algae and organisms collected are presented in Table 10. The sample from inside the fjord, from a depth of about 100 m, indicated that the bottom was composed of large glacial erratics, many of which were covered with worm tubes, and the dominant organisms were porifera, crustacea and echinoderms. Very little algae was present. However, in the shallower waters (~ 30 m) outside the fjords, algae were very abundant, as were sea urchins and brittle stars which dominated the catch.

TABLE 10 Organisms collected in otter trawls inside and outside Penguin Arm

<u>Species of animals</u>	<u>Number in trawl from Penguin Arm</u>	<u>Number in trawl from outside fjord</u>
I <u>Echinodermata</u>		
<u>Poraniomorpha hispida</u> - starfish	33	
<u>Ophiura sarsi</u> - brittle star	31	22
<u>Ophiomusium lymani</u> - brittle star	5	
<u>Ophiopholis aculeata</u> - brittle star	66	2
<u>Strongylocentrotus droebachiensis</u> - sea urchin	3	> 600
Brittle Stars (unidentified)		180
<u>Echinarachnius parma</u> - sand dollar		1
<u>Solaster endeca</u> - starfish		5
<u>Henricia</u> sp. - starfish		3
II <u>Crustacea</u>		
<u>Hyas araneus</u> - brachyuran crab		24
<u>Crangon septemspinosa</u> - caridean shrimp		3
<u>Sabinea septemcarinata</u> - caridean shrimp		10
<u>Eualus gaimardii</u> - caridean shrimp		23
III <u>Mollusca</u>		
<u>Chlamys islandicus</u> - bivalve mollusk		5
<u>Mytilus edulis</u> - mussel	1	
IV <u>Algae</u>		
<u>Ascophyllum</u>	1.56 lbs.	
<u>Fucus</u>	.44 lbs.	
<u>Chlorophyta filamenis</u>	.44 lbs.	
<u>Plumeria</u>		100 lbs.
<u>Laminaria</u>		51 lbs.
V <u>Fish</u>		
<u>Raja radiata</u>	1	
and egg case - skate	1	
<u>Hippoglossoides platessoides</u>	6	1

TABLE 10 (continued)

<u>Gadus callarias</u>	3	
<u>Triglidae</u> sp.	1	
<u>Cnidaria</u>	11	
<u>Renilla reniformis</u>	1	
<u>Porifera</u> A)	300 g	
B)	50 g	
unidentified porifera (on oyster)		1
<u>Alcyonacea</u>	100 g	
<u>Nemertean</u>		11

Circulation and nutrient distribution in the Bay of Islands fjords

Lisa Maynes and Chris Carrier

ABSTRACT

The Bay of Islands on the west coast of Newfoundland is a system of three main fjords emptying into a large, deep basined bay. The Penguin Arm fjord was selected for a study of how the topography of a fjord affects water mass characteristics, circulation, and distribution of nutrients.

A transect of seven hydrocasts were run from the head of Penguin Arm to the shelf waters outside the bay. Results of analyses are given in Appendix II. Fresh water runoff was also analyzed.

Strong stratification of water masses existed throughout the system (Fig. 18). A surface layer of warm water and low salinities was flowing outward. The deep basins were well ventilated, showing high oxygen concentrations and salinities similar to shelf waters, suggesting a deep water inflow with a temperature of 3°C from the shelf.

Dissolved nutrients enter the fjord from land runoff, causing a gradient of nutrient concentrations in the surface layers which decrease from head to mouth. Above the thermocline, the phosphate concentrations are highly depleted due to phytoplankton activity.

Figure 18 Temperature distribution in Penguin and Middle Arms

VERTICAL MIGRATION STUDIES

INTRODUCTION

Diurnal vertical migration is a phenomenon which is known to be displayed by several different trophic levels. The extent and direction of the migration ranges from that shown by phytoplankton, which concentrate near the surface during the day and move down to depths closer to the thermocline at night, to that exhibited by mesopelagic fish, which migrate upwards from depths of 500-1000 m to feed near the surface at night. Light intensity changes have been shown to be an important stimulus for this phenomenon; however, the reasons for this large energy expenditure are not well understood.

The purpose of this study was to investigate the vertical movements of members of several trophic levels over a period of twenty-four hours, and to attempt to look at the interactions between them. Three trophic levels were studied using a series of multi-net tows at approximately the same location over a period of a day. The exact positions of the tows are shown in Figure 19. The variations in depth of different organisms were then considered in terms of possible important physical parameters and the interactions between trophic levels.

Figure 19 Locations of multi-net tows during the 24-hour station

The vertical migration of phytoplankton especially in relation to zooplankton migration.

Abbey Rosso

ABSTRACT

Most kinds of phytoplankton are known to exhibit a diurnal migration, moving from the surface where they concentrate during the day, to depths closer to the thermocline at night. They are known to move both actively, via flagella, and passively by changes in buoyancy, but the reason for the migration is not well understood. At night, when photosynthesis is impossible, the phytoplankton may be leaving the surface in order to enter the greater nutrient concentrations found near the thermocline. Yet, the movement is in direct opposition to that of predatory zooplankton. If the interaction between trophic levels is increased in this way, then the migrations would have to be of some significance to the ecology of the water column.

Phytoplankton migration was thus analyzed in relation to our changing zooplankton concentrations and the physical parameters of the water as part of a 24-hour study of the vertical migration within the entire water column. At each of four stations conducted near a single location in the North Atlantic just off the continental shelf, three nets were lowered for sampling to set depths above the thermocline. Tows for zooplankton and mesopelagic fish followed those for phytoplankton at the first three stations, and Nansen casts were made once during the day and once at night. The water from these was analyzed for PO_4 and NH_3 as well as temperature, oxygen, and salinity. The phytoplankton tows were subsampled and the concentration of chlorophyll a was determined for each sample.

Subsampling showed the phytoplankton community was predominantly Thalassiothrix, a genus of diatom. Analysis of the relative concentrations of chlorophyll a indicated this population did move downward at night. Nutrient concentrations decreased at night as well, especially near the thermocline. This occurred even though the zooplankton population had risen and both the biomass and numbers were then greatest at that depth.

The phytoplankton seemed to need the greater concentrations of nutrients found at depth enough to withstand greater grazing pressures incurred there. The changes in nutrient concentrations suggest the zooplankton population

was of little, if any, immediate benefit to the phytoplankton via their excretions. It may be that a grazing pattern induced by the migrations is energetically advantageous, with the phytoplankton population being reduced when they are respiring rather than producing.

Diurnal vertical migration of zooplankton in the open ocean

Betsey Field

ABSTRACT

Vertical migration of zooplankton was investigated using nets towed at depths from 10m to 500m. The data were related to the depth of light penetration and the temperature profile. The migration was measured in terms of biomass (ml settled matter per m^3 of area towed), and in terms of number of copepods per m^3 . Both measures showed a significant increase of zooplankton at the surface at night and then at 50m during the day (Figs. 20 & 21). Considering that the light penetration at 55m was 1% of surface intensity, that the phytoplankton would not be found at 50m (during the day at least), and that the temperature drop was $4.6^{\circ}C$ from 10m to 50m, the data fit three theories of vertical migration: that of predator avoidance by staying in the dark, that of the maximization of food supply (phytoplankton) by discontinuous nocturnal grazing, and that of gaining a bioenergetic advantage by performing different bodily functions at different temperatures.

Figure 20 Biomass $\langle \text{ml organic matter/m}^3 \text{ water} \rangle$

Figure 21. Concentrations of copepods at 10 and 50m depths

The extent of vertical migration of mesopelagic fishes off the New England continental shelf with respect to specimen stomach fullness

Paul Carpentier

ABSTRACT

Mesopelagic fish characteristically exhibit a diurnal migration from depths of up to 1000 meters to a shallower depth at night. Though evidence for vertical migration is conclusive, the reasons for this phenomenon are not understood.

Three multi-net tows were conducted over a 24 hour period, with four meter nets and an Isaacs-Kidd mid-water trawl placed at depths corresponding to the surface, top and bottom of the thermocline, 500 meters and 1000 meters. The mesopelagic fishes were counted, measured, and taxonomically classified into families. In addition, a significant number of specimens of each of these families (excluding extreme specimens such as extraordinarily large ones) were dissected to determine the extent of fullness and, wherever possible, the identity of the stomach contents.

It could be easily recognized from the samples that the fish generally occupy shallower depths (zone of higher zooplankton concentrations) during the night (see Figure 22). There were a number of fish from these communities that remained at their daytime depths, however. Approximately half of the fish that remained below at night were relatively full, whereas at this depth during the day there were six empty fish per every full one (see Figure 23). This suggests that there was no need for some fishes to migrate in order to feed and consequently they stayed behind. This observation tends to suggest that the extent of their migrations is partially, at least, regulated by the extent of their need for food.

Upon analyzing their stomachs, another trend was evident - in general, the larger the fish, the more full its stomach was in relation to its capacity. This is possibly indicative of an increased predation capability due to size, strength, and swiftness. The stomach contents were not identifiable for the most part, but they did appear to resemble zooplankton in size and consistency. The solitary piece which could be identified was a copepod in the stomach of a lantern fish (Myctophidae).

Figure 22. Distribution of mesopelagic fish

Figure 23. Fullness of stomachs of mesopelagic fish at 500m.

EXTENT OF FULLNESS

PELAGIC FISH STUDIES

Comparison of the swimbladder inner-ear relationships in eight species of Osteichthyes found in Canadian waters and their possible environmental correlations

B. J. Ensign

ABSTRACT

The anatomical relationship of the swimbladder with the inner-ear has been shown to have a direct effect on the efficiency of hearing in fish. Using what is known about the biologies and life histories of the specific species, environmental stress factors pressuring for a keen sense of hearing in fish were hypothesized.

The presence of swimbladders, their anatomical features and relationships with the inner-ear, were studied in eight species of Osteichthyes collected in the waters from Georges Bank northward to Penguin Arm, Bay of Islands, Newfoundland. The species included Urophycis tenuis, Limanda ferruginea, Scomber scombrus, Gadus morhua, Gadus ogac, Agonus decagonus, and two species of Myctophidae.

It was found that neither the bottom-dwelling, sluggish flounder nor the fast-moving, highly predaceous Atlantic Mackerel have swimbladders. The two myctophid fish had well-developed swimbladders, and these fish exhibit extensive vertical migration. All of these could be attributed more to the buoyancy factor than to hearing.

Three species within the family Gadidae, which have similar biologies and habitats, showed significant differences in extent and form of their swimbladders. It is thought that these differences can be attributed to pressures for efficient hearing. Such characteristics of the fish life histories as predation, migration, schooling, and development of other senses, may account for the different needs in terms of auditory proficiency.

The determination of trophic levels in bottom-dwelling fish through the analysis of stomach contents

Cathy MacLeod

ABSTRACT

Bottom-dwelling fish on Georges Bank and Bay of Islands were dissected in order to determine their stomach contents. From these data, trophic levels were obtained. The group of fish caught on Georges Bank were Sea Raven (Hemitripterus americanus), Goosefish (Lophius americanus), Common Sea Robin (Prionotus carolinus), Flounder (Limanda ferruginea), Hake (Urophycis tenuis) and Little Skate (Raja erinacea). From the stomach contents of these fish, three trophic levels were determined. The top level was represented by such predators as the Goosefish. The second level consisted of the prey of the first level and invertebrate-eating fish such as the Sea Robin, Flounder, Hake and Little Skate. The third level consisted of invertebrates, chiefly crustacea. The fish obtained from the Bay of Islands were scanty and consisted of the Atlantic Cod (Gadus morhua) and Little Skate (Raja erinacea). Two trophic levels were obtained, the top level consisted of predators of the crustacea and the second level were crustacea.

BIOLOGICAL OCEANOGRAPHIC STUDIES

Comparison of the effects of two types of refined oil on Hyperiidean and Gammaridean amphipods

Lisa Ober

ABSTRACTS

Petroleum hydrocarbons enter the sea through three general mechanisms: man-generated substances, hydrocarbons produced by marine organisms, and those hydrocarbons that seep naturally into the ocean. The man-generated hydrocarbons placed in the oceanic system vary extensively in concentration and in organic nature; their effects range accordingly.

The effects of two types of oil, diesel and lube, on two suborders of amphipods were determined. Organisms used were Hyperiidean amphipods, which are pelagic members of the plankton, and Gammaridean amphipods, which are primarily benthic. The amphipods were placed in containers with varying concentrations of the oils, and the amount of time for one half of the organisms to die was recorded. The remaining half were placed in clear seawater and the recovery rate was determined.

Lube oil, which is more highly refined, was found to be less lethal than diesel oil. With increased concentrations, the amphipods died sooner and recovery was less effective. The Hyperiideans were less tolerant and died faster than the Gammarideans in both types of oil at all concentrations. They were also less successful in recovery studies.

Relative abundance of Uvigerina

Michael Gregg

ABSTRACT

The relative abundance of the benthonic foraminifera, Uvigerina, on the continental slope south of Nova Scotia was investigated by taking gravity core samples along a transect extending from 42°59.0'N, 61°02.1'W to 43°09.4'N, 60°57.9'W, at depths ranging from 850 meters to 1873 meters. Previous workers have studied the relative abundance of Uvigerina as far north as Cape Cod (Miller and Lohmann, 1980). This cruise provided the opportunity to extend this work northward. Four samples from the slope were analyzed for relative abundance of Uvigerina at sizes greater than 250 microns. Using Nansen bottles, water samples were taken at sites 50m above the cores in an attempt to investigate any correlations between populations of Uvigerina and depth, temperature, salinity, and concentrations of oxygen, ammonia and phosphates. Consistent with Miller and Lohmann's findings, good correlation was found between relative abundance of Uvigerina and depth, and marginal correlation with temperature. Contrary to all previous studies this author is aware of, a correlation was found between increasing oxygen concentration and increasing Uvigerina abundance. No correlation was found to exist with salinity or concentrations of ammonia and phosphate. A rose bengal stain was used to search for living Uvigerina; none were positively identified.

Miller, K.G. and Lohmann, G.P. 1980 Recent benthic foraminifera of the northeast U.S. continental slope: breakdowns in water mass correlations. (Submitted to Nature).

NAUTICAL SCIENCE STUDIES

A study of motion sickness severity aboard R/V Westward (W-53)

Andrew Umhau

ABSTRACT

A seven point motion sickness severity scale was used in a study of seasickness among the staff and students of W-53. Scaling was based upon subject's reporting of motion sickness symptoms and signs during the initial ten days of the cruise. The scores were compared with several parameters. Motion sickness severity did not appear to be correlated with Beaufort force or sea height, although it did correlate with subjective reporting of seasickness. Females were seen to have a greater susceptibility to seasickness than males. The mean motion sickness severity was greater for the sea inexperienced, although the fluctuations of seasickness were similar for both the experienced and inexperienced groups.

Comparing efficiencies of R/V Westward for sailing and motor-sailing for
courses on the wind

Rick Gould, Jim Salomon

ABSTRACT

There is currently a renewal of interest in commercial sail or sail-assisted vessels. A common interest in the subject led us to use the R/V Westward for comparing pure sailing and motor-sailing.

True wind speed and direction were measured while hove-to at the beginning and end of the complete set of measurements. A series of variables were recorded for every fifteen degree change in course, from a broad reach to close-hauled. The sails were trimmed for each heading, and the parameters measured included ship's speed, apparent wind speed and direction, and leeway angle.

The data, while not conclusive, revealed the expected trends for sailing and motor-sailing. Once the engine was turned on, leeway angle was negated, and apparent wind shifted forward. In order to maintain the same velocity, it was necessary to fall off, thereby re-establishing the same relative angle to the apparent wind.

Some rudimentary measurements of propellor pitch, RPM, and ship's speed were also taken to look at their inter-relations. Preliminary results in this area look very promising for further experimentation.

APPENDIX Ia

Demonstration organisms

Phylum Arthropoda

<u>Gammarus</u> sp.	Amphipod
Calanoid copepods	Copepods
<u>Idotea metallica</u>	Isopod
<u>Homarus americanus</u>	American lobster
<u>Meganyctiphanes norvegica</u>	Euphausiid

Phylum Chaetognatha

<u>Sagitta</u> sp.	Arrow worm
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Phylum Annelida

<u>Nereis</u> sp.	Polychaete worm
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Phylum Echinodermata

Class Echinoidea	Sea urchin
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Phylum Chordata

Family Myctophidae	Lantern fish
<u>Balaenoptera musculus</u>	Blue whale
<u>Morus bassanus</u>	Gannet

Phylum Ctenophora

Comb jelly

Phylum Cnidaria

<u>Cyanea capillata</u>	Jelly fish
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Phylum Mollusca

<u>Mytilus</u> sp.	Mussel
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Division Phaeophyta

<u>Fucus</u> sp.	Rockweed
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<u>Abies balsamea</u>	Balsam fir
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APPENDIX Ib

EXAM QUESTIONS

1. One of the most striking features of the cruise has been the high productivity of the waters in which we have sailed. Discuss the reasons for this, giving some examples of specific areas.

If you were at sea again, what would you look for as an indication of the productivity? (i.e., if you were on a ship not equipped to do tows).

2. The cruise track of W-53 has taken us over areas of rugged submarine topography, and to continental areas of dramatic scenery. Discuss the processes that have occurred over the last million years that have helped shape the aerial and submarine landscapes that we have observed, giving some examples of features you have seen.
3. There has been a large spillage of a toxic chemical from a ship wrecked on Georges Bank. You are a Marine Scientist on a trouble-shooting team, whose task is to monitor the effects of this spill on the ocean and marine life.

Design a sampling program using R/V Westward that you would set up, paying special attention to what and where you would sample, and the justification for it. (Note - you have the facilities available to analyze for the toxic chemical.)

4. Before this cruise, your views of the ocean had, for the most part, been fashioned by literature and the media. You have now observed first hand many characteristics of the sea surface, and sampled various aspects of the deep sea.

In rigorous scientific terms, discuss how your view of the ocean as a biological, chemical and/or physical environment has changed as a result of this experience.

5. Using as many of the organisms as possible that you have seen in the last six weeks, construct a general trophic pyramid for the area of the cruise.

APPENDIX II

I. Chemical analyses of water samples from Georges Bank

<u>Depth(m)</u>	<u>Temp(°C)</u>	<u>Salinity(°/oo)</u>	<u>Dissolved O₂(mL/L)</u>	<u>Phosphate (μM/L)</u>
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Station: W53-GB1

Location: 41°08.2'N 68°10.2'W

0	14.77	33.024	5.65	0.32
19	14.78	32.881	5.55	0.47
38	14.72	-	5.60	0.37

Station: W53-GB2

Location: 40°54'N 67°33.5'W

0	16.44	32.949	5.68	0.18
30	11.06	33.108	5.73	0.26
60	10.38	33.105	5.65	0.41

Station: W53-GB3

Location: 41°59.5'N 67°26.2'W

0	15.14	32.772	5.55	0.38
16	14.55	32.632	5.60	0.19
32	14.38	32.749	5.66	0.78

II. Analyses of water samples from Northeast Channel

<u>Accepted depth(m)</u>	<u>Temperature (°C)</u>	<u>Salinity (°/oo)</u>	<u>Dissolved oxygen (mL/L)</u>
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Station: W53-H4

Location: 42°02'N 66°01'W

0	16.51	32.533	5.69
25	7.74	33.377	5.61
46	7.21	33.631	5.30
62	6.99	34.219	4.97

Station: W53-H5

Location: 42°06'N 65°50'W

0	16.40	32.902	5.69
25	12.15	32.938	-
50	9.12	33.116	5.82
100	7.54	34.023	5.33
150	9.04	34.954	4.16
200	7.08	35.036	3.92

Station: W53-H6

Location: 42°12'N 65°49'W

0	16.58	32.622	5.29
25	15.34	33.158	4.88
50	8.72	33.148	4.66
76	9.21	34.422	4.88
131	9.91	35.033	4.01
187	7.78	35.085	3.96

Station: W53-H7

Location: 42°19'N 65°44'W

0	14.24	-	-
25	13.45	33.846	-
73	11.50	34.312	-
120	10.02	34.880	-

III. Chemical analyses of water from the Laurentian Channel

<u>Accepted depth(m)</u>	<u>Temperature (°C)</u>	<u>Salinity (°/oo)</u>	<u>Dissolved oxygen(mL/L)</u>
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Station: W53-H11

Location: 47°17.5'N 60°17.0'W

0	17.15	29.956	5.51
25	4.23	31.963	6.49
50	0.87	32.347	6.91
100	0.78	32.348	6.95
175	4.11	33.851	3.84

Station: W53-H12

Location: 47°21'N 60°03'W

0	15.51	30.557	6.19
25	1.68	31.856	6.40
50	1.19	32.331	7.93
75	0.81	32.556	6.80
125	2.66	33.459	5.22
175	5.37	34.509	2.63

Station: W53-H13

Location: 47°22'N 59°53'W

0	13.79	31.360	5.75
35	2.23	32.187	7.32
100	0.96	32.729	6.56
200	0.80	34.546	3.49
315	5.80	34.836	3.61
377	5.24	34.881	3.68

Station: W53-H14

Location: 47°26'N 59°41'W

0	13.89	30.818	-
75	1.63	32.459	-
125	2.61	33.362	-
191	6.17	34.521	-
319	5.88	34.803	-
405	5.26	34.864	-

<u>Accepted depth(m)</u>	<u>Temperature (°C)</u>	<u>Salinity (°/oo)</u>	<u>Dissolved oxygen(mL/L)</u>
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Station: W53-H15

Location: 47°31.5'N 59°31.0'W

0	14.85	31.100	5.98
25	4.86	31.935	7.24
75	0.83	32.453	6.92
141	3.21	33.617	4.85
312	5.80	34.804	3.38
404	5.21	34.872	3.40

Station: W53-H16

Location: 47°31'N 59°21'W

0	14.77	30.903	5.77
60	1.05	32.341	4.68
125	2.97	33.376	4.74
183	5.08	34.188	3.95
263	5.97	34.807	2.03

IV. Analyses of water from the Bay of Islands, Newfoundland

<u>Accepted depth(m)</u>	<u>Temp (°C)</u>	<u>Salinity (‰)</u>	<u>O₂(ml/L)</u>	<u>PO₄(µM/L)</u>	<u>NH₄(µM/L)</u>
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Station: W53-H17

Location: 49°10'N 58°13'W - middle of Bay

0	15.50	27.926	3.33	< 0.02	0.36
22	8.69	31.415	3.47	0.42	< 0.10
45	2.35	31.774	6.06	0.98	-
89	0.31	32.057	3.31	0.76	-
179	-0.35	32.163	3.75	4.82	-

Station: W53-H18

Location: 49°08'N 58°04'W - Middle Arm

0	15.70	25.421	2.57	-	1.52
20	6.00	31.402	2.97	-	1.75
40	2.38	31.717	3.10	0.15	3.40
79	0.10	31.972	2.78	0.65	1.73
158	-0.60	32.106	2.81	0.26	0.50

Station: W53-H19

Location: 49°12'N 57°55.5'W - head of Penguin Arm

0	15.38	26.812	5.59	1.55	0.17
15	12.5	30.853	3.05	0.80	< 0.01
28	5.5	31.193	2.59	0.93	1.83

Station: W53-H20

Location: 49°10'N 57°58'N - mid-basin, Penguin Arm

0	15.04	26.163	5.95	0.29	0.48
20	12.81	30.818	7.07	1.12	0.82
50	3.03	31.638	6.97	0.38	4.74
100	-0.39	31.990	7.02	0.21	< 0.10

<u>Accepted depth(m)</u>	<u>Temp (°C)</u>	<u>Salinity (°/oo)</u>	<u>O₂(ml/L)</u>	<u>PO₄(µM/L)</u>	<u>NH₄(µM/L)</u>
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Station: W53-H21

Location: 49°10'N 57°59'N - sill of Penguin Arm

0	15.41	25.771	5.51	0.03	< 0.10
25	4.92	31.359	6.58	0.43	1.37
50	1.40	31.835	6.38	0.13	1.19

Station: W53-H22

Location: 49°08.5'N 58°00.5'W - entrance to Goose Arm

0	15.34	26.314	5.90	0.76	< 0.10
15	10.80	30.992	6.22	0.55	3.33
40	3.49	31.614	6.93	0.76	1.10
90	0.22	31.935	6.81	1.59	0.38

Station: W53-H23

Location: 49°09.5'N 58°31.5'W - outside Bay of Islands

0	11.06	30.692	6.13	0.07	< 0.10
20	3.89	31.544	6.91	< 0.02	0.66
50	0.39	32.448	6.26	0.50	0.14

Green Flash over the Moho

Carl A. Chase

- (1) Green Flash over the Moho,
Much it would mean to me
Not to miss, Life's great Dis-
Continuity.
- (2) I've faith in manana,
Manana will bring to me
In the core, from the floor
Small banana tree.
- (3) Known only to lovers,
And others whose faith is blind,
Yet I know, it must be so
Flash of green I'll find.
- (4) Humm....(voice over: Baby, I just want you
to know that there is nothin' in this ol' world
that could ever take your place in my heart.
But it's my mind - yes, trouble in my mind -
won't let me be yours - no, not till I find it...
that)
Green flash etc.....
- (5) Now you can cruise the Bahamas, core for bananas,
Dream of the Simple Scene,
It may sound gay and esoteric, but we're not in South Americ',
And the flashes up here (the flashes up here)
I said the flashes up here just ain't green!