R/V ALBATROSS IV Cruise 9506

CRUISE REPORT

U.S. GLOBEC GEORGES BANK STUDY

Broadscale Survey Cruise

June 5 -15, 1995

Acknowledgements

We gratefully acknowledge the superb assistance provided by the Officers and Crew of the R/V ALBATROSS IV. The very professional and friendly atmosphere made our research effort run smoothly and efficiently, and enabled the scientific party to achieve its goals and objectives.

This report was prepared by Ann Bucklin, John Sibunka, Maureen Taylor, Cheryl Morgan, Peter Garrahan, Janis Peterson, and Teresa Rotunno, with assistance from others in the scientific party. This cruise was sponsored by the National Oceanographic and Atmospheric Administration and the National Science Foundation

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Purpose of the cruise

This cruise was the fifth in a series of Broadscale Surveys of Georges Bank as part of the U.S. GLOBEC Georges Bank Study. The series of 12-day cruises at approximately monthly intervals was begun in February, 1995. The 1995 series will be completed by one more cruise aboard the *R/V Albatross IV* in July. These Broadscale cruises are interwoven with process-oriented cruises and cruises to deploy, tend, and retrieve moorings. During AL9506, the *R/V Endeavor* was conducting a study of zooplankton patch dynamics on the Bank, and the *R/V Seward Johnson* was tending moorings on the South Flank of the Bank. Our primary goal was to develop a Bank-wide characterization of biological and physical conditions to serve as a context for the process work being conducted by the researchers on other vessels. Our specific objectives were:

1) to conduct a broadscale survey of the distribution and abundance of target species on Georges Bank, including: larvae and juveniles of cod and haddock; *Calanus finmarchicus*, *Pseudocalanus* spp., and their predators and prey;

2) to conduct a hydrographic survey of the Bank;

3) to collect *Calanus finmarchicus* and *Meganyctiphanes norvegica* for population genetic studies;

4) to launch drifter buoys for circulation studies on the Bank;

5) to map the Bank-side velocity field using an ADCP.

The Broadscale Survey consists of 38 standard stations (BSS). The stations are of two types: "full" stations involve: plankton pump deployment, profile of the CTD-fluorometer with water bottle rosette, double oblique 1-m^2 MOCNESS tow, single oblique 10-m^2 MOCNESS tow, and bongo net tow. "Partial" stations omit the pump deployment and 10-m^2 MOCNESS tow. There are 18 full stations and 20 partial stations on the survey plan. The 38 station locations are standard for all the Broadscale Survey cruises (Figure 1; Table 1).

Some additions and modifications to the standard survey plan were made for AL9506. The most significant alteration was the designation of a third type of station, the "super-partial", which added a 10-m^2 MOCNESS tow to the partial station protocol. For AL9506, 7 additional 10-m^2 MOCNESS tows were made during the standard station survey. Among the 38 BSS for AL9506, 16 were full, 7 were super-partial, and 14 were partial (Table 2). The primary reason for this modification was to obtain a better understanding of the distribution and abundance of pelagic juvenile cod and haddock, which are usually found over the Bank at this time of year (R.G. Lough, NMFS/NEFC, Woods Hole, personal communication). The additional MOC-10 tows were also intended to provide a higher-resolution view of predator distributions.

The second modification was the addition, during the survey, of 6 stations in the deep water adjacent to the Bank - either the Slope Water to the south or the Gulf of Maine to the north (Figure 1). These added stations included a CTD profile, a 9-strata double oblique tow of the MOC-1, and a 4-strata double oblique tow of the MOC-10. The reason for these additional stations was to characterize the vertical distribution of the target species in deeper waters. The added stations were inserted within the normal sequence of standard stations (Figure 1).

Samples and/or data were collected for the following GLOBEC-funded investigators during AL9506. Investigators who participated in the cruise directly (or sent technical assistants) are indicated by an asterisk (*).

*Ann Bucklin, University of New Hampshire (Chief Scientist)
(Eliete Ballesteros, Alyssa Bentley)
Molecular population genetic studies of *Calanus finmarchicus* to determine sources of recruitment. Sample collection by bongo nets, 1 m^2 and 10 m^2 MOCNESS.

*Ted and Ann Durbin, University of Rhode Island
(Peter Garrahan, Jamie Bechtel, Janis Peterson, Theresa Rotunno)
Distribution, abundance, and population dynamics of target zooplankton and ichthyoplankton species. Sample collection by 1 m^2 MOCNESS.

*Charlie Miller, Oregon State University
(Cheryl Morgan)
Population dynamics of *Calanus finmarchicus*. Sample collection by 1 m^2 MOCNESS and bongo tows.

*David Mountain, NEFC, Woods Hole
(Maureen Taylor and Dan Almgren)
Characterization of Broadscale hydrography on Georges Bank. Data collection by CTD-fluorescence profiles (with rosette).

*Wallace Morse, NEFC, Sandy Hook, NJ
(John Sibunka, Amy Tesolin, Alyse Weiner)
Distribution and abundance of larvae and juveniles of commercial fish. Sample collections by bongo nets, 1 m^2 and 10 m^2 MOCNESS.

Larry Madin (WHOI), Steve Bollens (WHOI), and Carol Miese (NEFC, Narragansett, RI).
Distribution and abundance of predator species on Georges Bank, including jellyfish, euphausiids, etc. Sample collection by 10 m^2 MOCNESS.

Greg Lough (NEFC, Woods Hole, MA) and Jack Green (NEFC, Narragansett, RI)
(Rebecca Jones) Distribution and abundance of pelagic juvenile cod and haddock on Georges Bank. Sample collection by 10 m^2 MOCNESS.

Robert Houghton (Lamont-Doherty Geophysical Observatory)
Stable oxygen isotopes in seawater.

Dick Limeburner (WHOI)
Drifter buoy studies of circulation on Georges Bank.

Table 1. List of coordinates for broadscale standard stations (BSS) for the Georges Bank Study.

BSS #	Latitude	Longitude
1	41 0.00	-68 59.40
2	40 39.00	-68 59.40
3	40 31.80	-68 26.88
4	41 0.00	-68 15.00
5	40 51.00	-68 0.00

6	40 39.60	-67 46.20
7	40 27.00	-67 18.00
8	40 52.20	-67 3.00
9	40 58.10	-67 19.17
10	41 4.98	-67 39.00
11	41 13.80	-67 57.60
12	41 24.41	-67 32.49
13	41 16.20	-67 10.20
14	41 12.00	-66 57.00
15	41 1.98	-66 42.00
16	40 55.20	-66 27.00
17	41 12.00	-66 27.00
18	41 24.60	-66 42.00
19	41 36.00	-66 58.80
20	41 44.00	-66 32.00
21	41 32.40	-66 24.00
22	41 33.00	-66 1.80
23	41 48.00	-66 11.40
24	42 3.00	-65 57.00
25	42 13.80	-65 40.80
26	42 4.02	-66 25.98
27	41 56.40	-66 42.00
28	42 6.00	-66 54.00
29	42 18.00	-66 54.00
30	41 55.02	-67 13.98
31	42 3.00	-67 39.00
32	41 42.00	-67 48.00
33	41 49.80	-68 0.00
34	41 51.00	-68 18.00
35	41 36.00	-68 27.00
36	41 24.00	-68 18.00
37	41 18.00	-68 36.00
38	41 29.40	-68 57.00

Table 2. Summary of station activity during the AL9506 broadscale survey. Both consecutive (C #) and standard station numbers (S #) are given. Depths are given in meters.

Partial station (P):	**C #**	**S #**	**Station activity**	**Depth**
1. Bongo tow	1	1	P	79
2. MkV CTD	2	2	P	66
3. MOC-1 tow	3	3	F	90
	-	D-1	drifter	--
	4	4	F	44
Super-partial (S/P)	5	5	S/P	63
	6	6	P	74
1. Bongo tow	7	7	P	
2. MkV CTD	8	-	special	400
3. MOC-1 tow	9	8	P	92
4. MOC-10 tow	10	9	(weather)	74
	11	-	special	642
	12	9	F	74
	13	10	P	55
	14	11	P	46
	--	D-2	drifter	--
Full station (F)	--	D-3	drifter	--
	15	12	F	41
1. Bongo tow	16	13	F	55
2. Pump	17	14	S/P	68
3. MkV CTD	18	15	P	79
4. MOC-1 tow	19	16	F	400
5. MOC-10 tow	20	17	F	99
	21	18	F	77
	22	19	S/P	59

--	D-4	drifter	--
23	20	F	74
24	21	S/P	88
25	22	P	110
26	23	F	88
27	24	P	183
28	25	F	110
29	26	S/P	85
--	D-5	drifter	--
30	27	F	70
31	28	S/P	66
32	29	F	293
33	-	P	320
34	30	F	55
35	31	P	119
36	-	P	266
37	32	S/P	30
38	33	P	61
39	34	F	229
40	35	P	74
41	36	F	55
42	37	P	70
43	--	P	218
44	38	F	147

Note: Stations C# 8, 11, 33, 36, and 43 are new (not standard Broadscale stations). Coordinates for these stations are: C#8 (40^{o}41.20' N; 66^{o}47.30' W); C# 11 (40^{o}40.67 N; 66^{o}47.42'W); C# 33 (42^{o} 17.8' 67 11.6'); C# 36 (42^{o} 12.4' 67 53.0'); and C# 44(41^{o}58.2 N; 69^{o} 14' W').

Cruise narrative

First day (05 June 1995)

Departure was on a fine day, with light breezes and sunshine, at 1400 hrs. We arrived on the first station at 2140 hrs. The MOC-1 deployed well, yielding a moderate *Calanus* sample. The CTD malfunctioned, presumably due to a power leak in the winch and/or winch cable. This was the beginning of serious difficulties with the CTD, which were resolved only after 3 days of effort. We experienced similar results for the MOC-1 and CTD at Broad-scale Standard Station (BSS) #2, which we occupied in the early hours of June 6th.

Second day (06 June 1995)

BSS #3 was our first full station with the first deployment of the plankton pump and the MOC-10. The pump functioned well and yielded a good sample. We had spent several hours during the steam before the station repairing the MOC-10 nets, which were in poor condition. Despite our efforts, this tow blew out two of the nets, ripping them their full length along a seam. We re-rigged the MOC-10, using our two spare nets and mending the damaged nets as well as possible. The next station (BSS #5) was the first of a newly-created type of station - the super-partial (i.e., a partial station with an added MOC-10 tow). This station type was designed to incorporate 10 additional MOC-10 tows during the survey (for a total of 28) to allow a comprehensive survey of pelagic juvenile cod and haddock. However, our difficulties with the MOC-10 continued, and three of the five nets blew out during this tow.

The decision was made not to attempt repairs on the five damaged nets, given the nature and extent of the damage. At the following station, BSS #6 - another super-partial station - we deployed the MOC-10 with two nets, one of which blew out. We retired the MOC-10, washed the damaged nets, and dried and stored them below-decks. A message was sent ashore requesting additional MOC-10 nets. These were to be placed onboard the *RV Endeavor,* scheduled for imminent departure from Woods Hole, for transfer to us at sea.

The loss of so many nets was judged to be the result of the poor care and condition of the nets. The nets were put on the *RV Albatross* for the previous cruise, AL95-05, which overlapped with the predation cruise on the *RV Seward Johnson* , for which good nets were used. The nets on the *RV Albatross* apparently were not looked after between cruises. When we rigged the MOC-10 for this cruise, we found the nets wet and unwashed in plastic containers on deck. Upon use, the numerous tears became huge rents.

At this point in the cruise, the CTD rosette system was still not operational. Diagnostic efforts by the E.T.s continued throughout this time and a problem was identified in the slip rings. To prevent electrical shorts, a specially-designed and constructed plexiglass plate was installed between the brushes of the slip rings. This repair effort was unsuccessful: the plate broke shortly and had to be removed. During the next two days, the slip rings of the hydro winch were successfully repaired - and almost replaced - by E.T.s Bruce Stone and Nick Previsich.

During the afternoon, we added an extra station following BSS #7, designated consecutive station (C) #8, on the southern flank of the Bank. We expected to see more effects of the warm core rings hugging the flank of the Bank (as shown in the satellite SST figure on

05 June 1995; Figure 3), but instead found Slope Water. The highly stratified MOC-1 tow revealed *Calanus* in surface waters, amphipods and chaetognaths throughout the water column, and euphausiids at the bottom.

Third day (07 June 1995)

As expected, the effects of Hurricane Alison propagated our way, bringing winds of 30 to 40 knots and swells of 15 to 20 feet. The storm knocked many of us off our feet, and closed down work at 1800 hrs, after BSS #9, where we could do only bongo tows. We steamed south into deeper waters to wait out the storm.

Fourth day (08 June 1995)

All spent a difficult night with large and unruly swells. There was some damage in the rough ride. We lost all chlorophyll samples to date as frozen objects flew around the inside of the freezer, which was knocked loose. All except the watch chiefs missed a watch. We waited until nearly 1000 hrs, when the seas calmed enough to allow us to do a repeat MOC-1 tow at the added Slope Water station, occupied this time as C #11. Forty-eight hours had changed the site. Although the hydrography indicated a typical Slope Water profile, the biological influence of the Gulf Stream was apparent, with *Panulirus* larvae in an otherwise very sparse haul. The top 20 m were nearly empty, with some *Calanus* in the 40 - 20m stratum.

In calming seas and light breezes, we returned to re-occupy BSS #9 (where we could now do a full deployment), sampled at BSS #10, and deployed a drifter before the end of the day. The MR CTD rosette system malfunctioned again during BSS #10 and #11. We collected water by surface bucket and Niskin bottle (for ^{18}O and salt); hydrographic data were obtained from the Seabird CTD on the bongo tow.

Fifth day (09 June 1995)

Another drifter was deployed in the early morning, and a partial station occupied at 0230 hrs on the 9th of June. We made a successful rendevous with *RV Endeavor* at 0600 hrs and retreived 5 nets for the MOC-10 (as well as several reams of computer paper). We thanked them for their assistance, even though the *RV Endeavor* declined to enhance our stores of ice cream.

Figure 3. Sea surface temperature distribution in the Georges Bank region on 05 June 1995 (obtained by Advanced Very High Resolution Radiometry; AVHRR). A Gulf Stream Warm Core Ring and another Gulf Stream entrainment feature are evident just at the southern flank of the Bank.

During the steam to BSS #13, we repaired small tears in the newly-received MOC-10 nets and rigged the system. Also during this steam, we stopped to test the starboard winch with the Seabird CTD. This test indicated that the winch was now fine. The E.T.s deserve much credit for this heroic effort, resulting in a useable system and valid data. There was continued cause for concern about the operation of the Mr CTD rosette system, however. The data continued to require a fair amount of "cleaning", thought to be caused by persistent problems either in the deck unit or in the Mr unit itself. BSS #13 was the first successful full station of the trip, with the exception that Eliete Ballesteros slightly injured her left foot and was laid up for several days.

We occupied stations BSS #14 and #15 before the close of the day, with mild overcast weather and slightly choppy seas.

Sixth day (10 June 1995)

The deep water at BSS #16 yielded the high diversity typical of the Slope Water. The CTD cast indicated the presence of a near-surface freshwater intrusion, presumably from the Scotian Shelf, overlying Slope Water. There was no evidence of Gulf Stream or Warm Core Ring influence. This was again somewhat surprising since the satellite SST view from 05 June indicated a WCR at this site (Figure 3). Perhaps the rings have propagated westward?

The MOC-10 deployment at BSS #16 was hampered by failure of nets to trip; the connection between the net release mechanism and the motor drive was found to be water logged and corroded. The connection was cleaned by the ever-present E.T.s in preparation for the next cast.

During the short transit to BSS #17 and with the assistance of Fisherman Tony Alvernaz, we carried the damaged MOC-10 nets up from the trawl winch room to the hurricane deck, to take advantage of one of our first sunny days this trip. During the afternoon, the night watch tied them and stowed them for the remainder of the trip.

We were delayed 2 hrs at BSS #19 (1500 hrs -1700 hrs), when the Seabird CTD failed to provide a signal. After checking the boom winch slip rings, the problem was discovered to be the boom wire termination, which was then replaced. During the delay, the MOC-10 tow and CTD profile were completed. The bongo and MOC-1 were deployed last, giving us good samples, though well clogged with green munge (filamentous green algae and hydroids).

We successfully deployed drifter #4 just after BSS #19.

Seventh day (11 June 1995)

At BSS #20 and #21, we found our first high abundances of pelagic juvenile cod. The MOC-10 tow yielded 15-20 cod at BSS #20 and ~50 cod at BSS #21. The was the same site at which previous studies had found juveniles at this time of year. In light of our findings at BSS #20 and #21, we added MOC-10 tows to all remaining Northeast Peak stations (BSS #23 - 26), in order to delimit the patch of juveniles as well as possible on this survey.

Sunday morning arrived foggy and cool, with a calm sea - haven't seen much sunshine this trip! This day, we occupied BSS #22 - #25.

We occupied BSS #24 on the night watch. A tidal current at BSS #24 put the MOC-1 flat on the bottom and put sand in nets 0 and 1, but otherwise did no damage. MOCNESS flyers lived in trepidation of tidal currents and sand hills and stayed well off the bottom. Some of these fears were assuaged by the E.T.s' revelation that the gain on the DSF depth sensor had been turned up since the previous cruise. The result was (probably fictional) bottom depth variation of 40 m over very short distances. Still, some MOC-1 tows were shallower than planned.

We held a science meeting at 1300 hrs, to discuss any needed improvements in deployment strategies, division of labor between the watches, preparation of the cruise report, and the cruise plan for the balance of the trip. The result was to add stations in three deep basins of the Gulf of Maine (Georges, Franklin, and Wilkinson) where deep MOC-1 tows were to be done. The goal was to determine the fine-scale vertical distribution of *Calanus finmarchicus* life history stages. The science party conveyed a sense of "hitting their stride" (in addition to fatigue) at this mid-point in the cruise. We have encountered a number of intermittent technical problems, which we have solved in a timely manner, and are completing our intended program.

Eighth day (12 June 1995)

More problem-solving faced us this day. We completed a full station in 200 - 220 m of water on the far side of the Northeast Channel (BSS #25) in the early morning. Currents were stiff: current shear at the thermocline (100 m) and at 140 m caused a difficult deployment of the MOC-1, which we towed along the 200 m isobath. We encountered a recurrent problem when crossing physical gradients in the water column (usually the transition between the surface Gulf of Maine water and the deeper Slope Water). The net would suddenly rise despite rapid pay-out of the wire. This problem was eventually determined to result from an increase in ship's speed in response to the decrease in wire angle when the net encounter the slower-moving Slope Water. Despite a "bumpy" trajectory, the samples were good.

At 60 m on the up-haul at BSS #25, the MOC-10 depth sensor stopped working. The tow was aborted. While the nets were washed, the battery was checked and found to be depleted (reading: 14 V). The spare battery was inserted (despite the fact that it was not fully charged; reading: 18 V) and the tow was repeated with identical results: the depth sensor stopped working on the uphaul at 60 m. The nets were hauled aboard and the samples preserved. The original battery was recharged during the 5 hr transit to the next station. At BSS #26, a super-partial station, the MOC-10 tow was aborted when the depth and temperature sensors gave spurious readings; the spare battery was already depleted. We tested the original battery, found it to 22 V, and decided to replace it in the system despite only 6 hrs of charging.

At the following station, BSS #27, the MOC-1 tow was shallow - a 40 m tow in 70 m of water - due to the phantom sand hill problem. After some discussion, the MOCNESS flyers on both watches decided that the shallow readings resulted from the DSF depth sensor seeing the MOCNESS itself. The consensus decision was to watch for long-term patterns in bottom depth (with the assistance of the bridge and the ADCP readings) and to ignore the shallow readings. MOC-10 tows at BSS #27 and #28 were successful. The tow at BSS #28 yielded some juvenile cod and haddock, and a plethora of pteropods - both *Clione* spp. and *Limacina helicina*.

The evening watch was given over entirely to a full station in 293 m of water at BSS #29.

Ninth day (13 June 1995)

The first watch deployed the MOC-1 in a finely stratified tow at C# 33 in Georges Basin, the first of the added stations in the basins of the Gulf of Maine. This tow was somewhat disappointing in that we were unable to reach depths below 160 m, and thus missed some of the patterns we wished to observe. There followed a MR CTD rosette profile and a Seabird CTD profile, to calibrate the two systems. A bongo tow was done at the "*Calanus* maximum" (about 15 m), yielding biomass to be frozen for biochemical and genetic studies.

Fog and drizzle continued, similar to yesterday. We saw more whales lolling at the surface amid the *Calanus* patches. After a longish steam, we occupied a station just off the 100 m isobath (BSS #31) and a shallow-water station on the Bank (BSS #32). We found large concentrations of *Calanus* at the latter station. We again left the Bank for deep water, in Franklin Basin, at another added station (C #36). This tow yielded green munge, but no sign of dense populations of *Calanus* and *Meganyctiphanes*, as had been hoped. Another longish steam returned us to the Bank for the shallowest of our stations, in 30 m of water, at BSS #32. We inadvertently practiced "dribbling" the MOC-10, but otherwise completed the station deployments without incident. The samples were sparse and of low diversity.

Tenth day (14 June 1995)

We moved rapidly through BSS # 33 through #37, in fog, drizzle, and occasional rain. Whales have surrounded us for much of our trip: humpbacks breaching, pilot whale pods passing by, finbacks close by at the surface, and - today - right whales circling among the *Calanus*. One of the bridge officers, Chris Koch, brakes for whales and alerts us to good observations.

In a science meeting at 1830 hrs, we decided on a cruise track for the final portion of the cruise. We will steam to a station in Wilkinson's Basin in the Gulf of Maine, and deploy the MOC-1 and the MOC-10 in double oblique deep tows. Identical deployments will be made at midnight tonight and tomorrow morning for a comparison of the vertical distributions of the target organisms. The day ends in a choppy steam north to the station.

Eleventh day (15 June 1995)

We occupied the Wilkinson Basin station at 2300 hrs, and confirmed that *Calanus finmarchicus* were abundant in the surface waters with a bongo tow to 50 m. After the CTD profile, the MOC-1 tow was begun. This tow was aborted after a mysterious trajectory, later determined to have resulted from changes in ship speed necessitated by the intersection of two fishing boats with our course - apparently out of curiosity. The tow was successfully repeated, and the samples should yield a detailed picture of the vertical distribution of *Calanus*. The MOC-10 tow was also successful, capturing primarily *Meganyctiphanes norvegica* and amphipods.

As the skies finally cleared overhead, we got underway with our daytime deployments at the same site in Wilkinson Basin at 0615 hrs. Identical CTD, MOC-1 and MOC-10 deployments were done.

We completed work at the Wilkinson Basin station at 1030 hrs, and steamed back toward the Bank for the final station, occupying BSS #38 at 1400 hrs. The sun finally shone on the *R/V Albatross* as we hauled aboard the MOC-10 at 1830 hrs, and headed for home. The ship docked in Woods Hole at 0520 hrs, Friday, June 15th.

Individual reports

Hydrography - Maureen Taylor and Dan Almgren

Objectives:

The objective of the hydrographic sampling on the broad scale survey cruises is to characterize the physical environment within which the target organisms reside. Of particular interest is the seasonal development of thermal and density stratification of the Georges Bank waters. The temperature and salinity data can also give an indication of the source of the waters on the Bank: Gulf of Maine, Scotian Shelf, and Slope Water.

Operations:

Most of the primary hydrographic data presented here were collected using a Neil Brown Mark V CTD instrument (MR), which provides measurements of pressure, temperature, conductivity, and fluorescence. The MR records at a rate of 16 observations per second, and is equipped with a rosette for collecting water samples at selected depths.

A Seabird Electronics Seacat model 19 profiling instrument (SBE19 Profiler) was used on each bongo tow to provide depth information during the tow. Pressure, temperature, and salinity observations are recorded twice per second by the Profiler. The MOCNESS systems aboard the ALBATROSS IV (MOC-1 and MOC-10) are both equipped with their own environmental sensing systems to measure pressure, temperature, and salinity at 4 second intervals during the tow.

The Profiler was used on only one of the plankton pump hauls because it was decided that the meter read-out from the ship's boom winch was an adequate measure of the pump's depth.

The following is a list of the CTD data collected with each of the sampling systems used on the cruise:

Instrument	# Casts
MR	35
SBE19/Bongo	48
SBE19/Pump	1
SBE19 calibration	5

The MR was deployed with 6 bottles on the rosette and samples were collected for various investigators. On each MR cast, samples were collected for oxygen isotope analysis at selected depths for R. Houghton (LDGO) and a sample was taken at the bottom for calibrating the instrument's conductivity data. On stations which included pump operations, rosette samples for nutrient analysis were collected at selected depths for J. Bisagni and J. O'Reilly (NMFS), and samples for chlorophyll analysis were collected from the bottom, 20 meters, and surface. Chlorophyll samples (three, 50 ml replicates) were filtered for three size fractions: total, < 20 microns, and < 5 microns. Total chlorophyll filtration results will also used for comparing the data from the MR fluorometer. Also on pump stations, surface samples for phytoplankton species composition were collected for J. O'Reilly (NMFS). The chlorophyll analysis was conducted at sea using an acetone extraction method and results were read 24 hours later on a fluorometer. These results are not presented here because the fluorometer requires calibration before the conversion to chlorophyll-a can be made.

Parameter	# samples taken
MR calibration	35
Oxygen isotope	118
Nutrients	65
Chlorophyll	134
Species composition	15

Data:

During the first MR cast, we lost electronic signal during the upcast. Our first suspicion was with the recently spliced termination on the sea cable. However, further investigation by electronic technicians, Bruce Stone and Nic Previsich, showed the problem to be located in the slip ring assembly of the hydrographic winch. During the time that this winch was unavailable for use, the SEABIRD data from the bongo haul was used as the primary hydrographic data for the survey. These casts are numbered greater than 100 (see Table 3 for the hydrographic station/cast inventory). After numerous repairs were made to the hydrographic winch, we still experienced some data "spiking" and poor electronic signal from the MR. Further diagnostic checks of the winch as well as the MR and its electronic components will be made upon return to port.

The SBE19 Profiler and the MR data were post-processed at sea. The Profiler data were processed using the Seabird manufactured software: DATCNV, ALIGNCTD, BINAVG, DERIVE, ASCIIOUT to produce 1 decibar averaged ascii files. The raw MR data files were processed using the manufacturer's software CTDPOST in order to identify bad data scans by "first differencing." The latter program flags any data where the difference between sequential scans of each variable exceed some preset limit. The "Smart Editor" within CTDPOST was then used to interpolate over the flagged values. The cleaned raw data were converted into pressure averaged, pressure centered 1 decibar files using algorithms provided by R. Millard (WHOI), which had been adapted for use with the MR.

Because of the problems we experienced with the hydro winch, there were no water samples collected at BSS #3, #4, #5, #6, and #9. At BSS #10 and #11, surface and bottom oxygen isotope and bottom salinity samples were taken using a Niskin attached above the Profiler. During the storm, the freezer where chlorophyll and nutrient samples are stored was knocked loose. Two of the nutrient samples from cast #2 (BSS #7) were lost and a few of the chlorophyll samples that were in a test tube rack were spilled. There was no surface water samples taken at cast #4 (BSS #12) because the Niskin Bottle did not close properly.

The locations of the CTD casts made during AL9506 are shown in Figure 4; the stations are referred to by cast number. The surface and bottom temperature and salinity distributions are shown in Figures 5 and 6. Surface and bottom anomalies of temperature and salinity as well as a stratification index (sigma-t difference from the surface to 30 meters) were calculated using the NMFS MARMAP hydrographic data set as a reference. The anomaly distributions are shown in Figures 7, 8, and 9. The distribution figures do not include data from the Wilkinson basin station or BSS #38. Profiles of each CTD cast with a compressed listing of the data are shown in Appendix 5.

The surface distribution figures show that the majority of the Bank, with the exception of the southwest corner, was slightly colder and fresher than the MARMAP reference. Scotian shelf water has been observed on the Bank in varying degree since the first broad scale survey in February. BSS #17 and #24 showed salinities in the surface layer of approximately 32.0 psu. In addition, the three CTD casts occupied in Franklin basin (casts #23, #26, and #29) showed salinities of 31.99 - 32.03 psu. However, the temperatures in the surface layer at these stations did not appear strikingly colder than the Bank waters as would be expected with "pure" Scotian shelf water. This may be because the Scotian shelf water that has been observed on the Bank so long is becoming mixed with the surrounding Bank waters.

Two warm core rings were observed in satellite imagery (Figure 3) prior to our departure and are probably the cause of the positive temperature and salinity anomalies (warmer and more saline) at the southwest portion of the Bank. However, we did not see any strong evidence of these rings, perhaps because they have propagated further westward by the time we occupied BSS #3, 7, 8, and 16.

BSS #24 and 25 (casts #17 and 18), which are located on either side of the Northeast Channel, showed salinities >34.0 psu at depths of 80 and 40 m respectively indicating the entrance of Slope Water through the Channel and into the Gulf of Maine. The instrusion of Slope Water into the Gulf extended to all the stations occupied in Franklin Basin.

The stratification anomaly distribution (Figure 9b) shows that the southwest region of the Bank was slightly more stratified than the MARMAP expected level which may be the result of the recent passage of a warm core ring. Also, the Northeast peak region showed a positive stratification anomaly which may be caused by a lease of fresher water that has originated from the Scotian shelf. The central portion of the Bank showed stratification levels consistent with the MARMAP reference.

The volume average temperature and salinity of the upper 30 meters were calculated for the Bank as a whole and for four sub-regions. These values are compared with characteristic values that have been calculated from the MARMAP data set for the same areas and calendar days (Figure 10). The volume of Georges Bank Water (salinity < 34 psu) was also calculated and compared against the expected values. The Bank as a whole showed temperature and salinity properties slightly colder (0.25- 0.5) and fresher (0.05 - .3 psu) than the expected conditions for mid June.

Table 3. Station / cast inventory of the primary hydrographic data during ALB9506.

Cast#	Instrument	standard sta#	consecutive sta#
001	MR	001	001
102	SB	002	002
103	SB	003	003
104	SB	004	004
105	SB	005	005
106	SB	006	006
002	MR	007	007
003	MR	---	008
108	SB	008	009
004	MR	009	012
110	SB	010	013
111	SB	011	014
005	MR	012	015
006	MR	013	016
007	MR	014	017
008	MR	015	018
009	MR	016	019
010	MR	017	020
011	MR	018	021
012	MR	019	022
013	MR	020	023
014	MR	021	024
015	MR	022	025
016	MR	023	026
017	MR	024	027
018	MR	025	028
019	MR	026	029
020	MR	027	030
021	MR	028	031
022	MR	029	032
023	MR	---	033
024	MR	030	034

025	MR	031	035
026	MR	---	036
027	MR	032	037
028	MR	033	038
029	MR	034	039
030	MR	035	040
031	MR	036	041
032	MR	037	042
033	MR	---	043
034	MR	---	043
035	MR	038	044

Figure 4. Locations of standard broadscale stations (A) and consecutive CTD casts (B) made during Broadscale Survey AL9506. Casts numbers are cross-referenced with standard station numbers and consecutive station numbers in Table 3.

Figure 5. Surface (A) and bottom (B) temperature distributions during Broadscale Survey AL9506.

Figure 6. Surface (A) and bottom (B) salinity distributions (psu) during Broadscale Survey AL9506.

Figures 7. Surface (A) and bottom (B) temperature anomaly distributions during Broadscale Survey AL9506.

Figure 8. Surface (A) and bottom (B) salinity anomaly distributions during Broadscale Survey AL9506.

Figure 9. (A) Density stratification (sigma-t difference) 0 to 30 m; and (B) stratification anomaly distributions during Broadscale Survey AL9506.

Figure 10. Volume average water properties (0 to 30 m), including temperature, salinity, and volume, of Georges Bank Water (<34 PSU).

Zooplankton and Ichthyoplankton Studies Based on Bongo and MOCNESS tows.

John Sibunka and Peter Garrahan

Objectives:

Principle objectives of the ichthyoplankton group in the broadscale part of the U.S. Globec Georges Bank Program were to study the composition of the larval fish community on Georges Bank, to define larval fish distribution across the Bank and within the water column, to determine those factors which influence their vertical distribution, and to determine Bank-wide versus "Patch-Study" mortality and growth rates. Emphasis in this study is on cod and haddock larvae along with their predators and prey. This study is to include larval distribution and abundance, analysis of feeding habits, and age and growth determination.

The primary objective of the zooplankton group was to carry out a Bank-wide area survey of Georges Bank to determine the distribution, abundance, and stage composition of the target species *Calanus finmarchicus* and *Pseudocalanus* spp. A second objective was to identify and quantify, the occurrence of the more abundant non-target species to describe the environment occupied by the target species. These objectives were implemented by using the 1-m^2 MOCNESS, (a vertically discrete, multiple opening and closing net system) to sample the larger copepodite stages of the zooplankton, and a submersible pump system to sample the naupliar stages.

Methods:

Bongo tows were made with a 0.61-meter frame fitted with paired 0.335-mm mesh nets. A 45-kilogram (kg) ball was attached beneath the bongo frame to depress the sampler. Digital flow meters were suspended in the mouth of each net to determine the volume of water filtered. Tows were made according to standard MARMAP procedures, (i.e., double oblique from surface to within five meters of bottom or to a maximum depth of 200 m while maintaining a constant wire angle throughout the tow). Wire payout and retrieval rates were 50m/min and 20m/min respectively. These rates were reduced down in shallow water (<60m) to obtain a minimum of a five minute tow. A Seabird CTD was attached to the towing wire above the bongo to monitor sampling depth in real time mode and to measure and record temperature and salinity. Once back on board, the 0.335-mm mesh nets were each rinsed with seawater into a 0.335-mm mesh sieve. The contents of one sieve was preserved in 4% formalin and kept for ichthyoplankton species composition, abundance and distribution. The sample from the other net was frozen if abundant *Calanus* and *Pseudocalanus* were present; otherwise the sample was discarded. At stations where the 1-m^2 MOCNESS system was not used, a second bongo tow was made with paired 0.335-mm mesh nets. One sample from the second tow was retained for zooplankton species composition, abundance and distribution, and the other sample was kept for age and growth analysis of any larval fish collected. Samples from the zooplankton net (0.335-mm mesh net), were taken on the second bongo tow, rinsed into a 0.335-mm mesh sieve and preserved in 10% formalin. Samples for age and growth analysis were treated similarly, but were preserved in 95% ethonal. After 24 hours of initial preservation, the alcohol was changed.

A bongo tow with paired 0.335-mm mesh nets was made at selected stations for additional samples of *Calanus*. Maximum sampling depth of the bongo tow was determined from the catch results of the stratified 1-m^2 MOCNESS nets towed at the station. The bongo sampler was fished for 5 min within the desired depth range where *Calanus* were found during some of these special tows. Winch rates varied between 5-10 m/min. Samples were sieved in stacked sieves (2000m, 1000m, 550m, 330m) to separate the larger and smaller organisms from *Calanus*. The *Calanus* from both nets were frozen for the development of new molecular genetic techniques for *Calanus* (Buckling) and lipid analysis (Miller).

The 1-m^2 MOCNESS (MOC-1) sampler was loaded with ten nets. Nets 1-4 were fitted with 0.150-mm mesh for the collection of older and larger copepodite and adult stages of the zooplankton. Nets 0, and 5-8 were fitted with 0.335-mm mesh for zooplankton (nets 0 and 5) and ichthyoplankton (nets 6-8) collection. Tows were two double oblique from the surface to within 10 meters from the bottom. The maximum tow depth for nets 0 and 1 was 300 meters (for this cruise), and for nets 5 and 6 was 200 meters. Winch rates for nets 0-5 were 15m/min and for nets 6-8, 10m/min. The depth strata sampled were 0-15m, 15-40m, 40-100m, and >100m. The first (#0) and sixth (#5) nets were integrated hauls. For shallow stations, with only 2 or 3 of the depth strata, not all nets were fished. The contents of nets 0-4 were sieved through 0.150-mm mesh, subsampled using a plankton splitter if the final volume was too large, then preserved in 10% formalin. Samples from nets 5-8 were sieved through 0.335-mm mesh and preserved in 95% ethanol. After 24 hours of initial preservation, the alcohol was changed. The used ethanol was retained for disposal or recycling ashore. At selected sites, 90-ml subsamples from the bottom and surface 0.150-mm mesh nets were removed and preserved separately in formalin. Fifteen live C-5 *Calanus* copepodites from each of the two depth strata sampled were videotaped and frozen in liquid nitrogen for future analysis of their lipid content.

Additional stations were occupied during this cruise. The 1-m^2 MOCNESS was used at these stations and fished using a different sampling protocol. Net 0 was fished from the surface down to 10 m off bottom or a maximum depth of 300 m. Net 1 was fished from the maximum depth to 160 m; and nets 2-9 were each fished in 20 m depth increments from 160 m to the surface. At these stations, #1 net was held at maximum depth for 5 min. Winch rates were 15m/min payout and 10m/min retrieval. Each sample was then split; one half was preserved in 10% formalin and the other half was preserved in 95% ethonal. After 24 hours of initial preservation, the alcohol was changed.

The 10-m^2 MOCNESS (MOC-10) was initially loaded with five 3.0-mm mesh nets. Tows were double oblique from surface to 15 meters from bottom or a maximum depth of 300 meters. The same depth strata were sampled as with the 1-m^2 MOCNESS. The winch rate for retrieval varied between 5 and 15m/min depending on the depth stratum. The slow winch rates were used in order to filter at least 4,000-5,000m^3 of water per depth stratum sampled. A stepped oblique tow profile during retrieval was used to achieve this, if needed. Due to extensive damage to three of the nets, only two nets were useable for the tow on BSS #6. One net was fished from surface to near bottom and back up to 15m. The second net was fished from 15m to surface. A subsequent rendezvous with another research vessel was made to obtain a complete set of nets. At BSS #32, only one net was used, because of local conditions. Otherwise, standard tow procedures were followed. Catches were sorted for larval and juvenile cod and haddock. Specimens were measured to the nearest millimeter on a metric ruler and preserved in 95% ethonal. The rest of the sample was sieved through a 0.335-mm mesh, and preserved in 10% formalin.

The Pacer high-volume pump was used to collect nauplii and younger, smaller copepodite stages of zooplankton. Unlike the May cruise, AL9505, the intake hose was deployed off the port side on the boom hydro-wire. The hose was attached to the wire by a section of PVC with Niskin bottle clamps. Two 45-kg weights were used to depress the array. At the first full station (BBS #3), actual depth readings from the Seabird CTD were compared with the wire-out readings off the winch. These values were very similar. Based upon these findings and in the interest of protecting the integrity of the Seabird, the CTD instrument was no longer deployed with the pump array. Wire angles were usually close to zero and any deviation greater than 15 degrees was noted for depth corrections. Three 30-m sections of 7-cm diameter hose were connected to the pump, allowing the intake hose to attain a maximum depth of approximately 70 meters. At shallow stations the intake hose nozzle was lowered to 3-5 meters off the bottom. Three integrated depth samples were collected with 0.050-mm mesh nets, sieved through a 0.040-mm mesh and preserved in 10% formalin. Sampling depths were from the maximum depth to 40 m, 40-15 m, and 15-0 m. Before samples were collected, water was diverted from going into the net and was allowed to flush for 60 seconds. This assured that the zooplankton from the desired strata was obtained. The hose was again flushed at the surface for 60 seconds. This allowed the water to pass completely through the hose. Wire retrieval rate was approximately 4 m/min. This rate was used to obtain volumes of 500 L per 5-m depth interval sampled.

Table 4. Zooplankton and ichthyoplankton samples collected during AL9506.

Gear	Tows	Number of Samples
1.Bongo nets, 0.61-m	48 tows	41 preserved, formalin
0.335-mm mesh		11 frozen
2.MOCNESS, 1-m^2	44 tows	
0.150-mm mesh		197 preserved, formalin
0.335-mm mesh		209 preserved, EtOH
3. MOCNESS, 10-m^2	27 tows	
3.0-mm mesh		
4. Pump	18 profiles	
0.050-mm mesh		52 preserved, formalin

Preliminary results on the distribution and relative abundance of target species

Teresa Rotunno, Janis Peterson, Peter Garrahan, Jamie Bechtel, Cheryl Morgan, Alyssa Bentley, and Ann Bucklin

Subsamples of the 1-m^2 MOCNESS hauls at the Broadscale standard stations were examined for relative abundances of several target species, including: *Calanus finmarchicus*, *Pseudocalanus* spp., and hydroids (?*Clytia*). The patterns revealed seemed similar to those observed a year earlier (see the cruise report to the June, 1994, cruise of the *RV Albatross IV* AL9404). *Calanus finmarchicus* was most abundant on the southern and northern flanks of Georges Bank (Figure 12), *Pseudocalanus* spp. were predominant in shallow regions on top of the Bank (Figure 13), and hydroids were most common in shallow regions (Figure 14). However, in comparison to June, 1994, abundances of all these species were much reduced. Further analysis of the samples should yield a quantitative comparison that may shed light on interannual variation in the biological community associated with Georges Bank.

Zooplankton - Lipid Analysis of *Calanus finmarchicus*

Cheryl A. Morgan and Charles B. Miller, Oregon State University

Objectives:

1) To gain a general overview of the zooplankton species composition and distribution on and around Georges Bank, focusing primarily on the target copepod species *Calanus finmarchicus* and *Pseudocalanus* spp;

2) To examine the population development of *C. finmarchicus*, including the proportion of the population at each life history stage life history stage as well as the size frequency distribution of the stage 5 copepodite; and

3) To compare the spatial and temporal variation in the lipid composition of individual stage 5 copepodites from a range of stations.

Methods

Subsamples of the 1-m^2 MOCNESS preserved in formalin were taken from the sites listed below. Live samples were taken from the same Bongo Nets and the 1-m^2 MOCNESS tows as the preserved samples. Digital still images of individual copepods were collected and the corresponding animals were frozen in liquid nitrogen for subsequent laboratory analysis. Thin layer flame chromatography will be used to determine total lipid amount and the ratio of triglycerides (TAG, thought to represent short term energy storage) and wax esters (WE, long term energy storage).

Preliminary Results

Species Composition*:* *Calanus finmarchicus* was the predominant species, during the June AL9506 cruise, in waters outside the 60 m isobath surrounding Georges Bank. Stage C5 *Calanus* were present and usually the most abundant life history stage whenever *Calanus* was found. On the Northeast peak, younger stages of *Calanus* were present. For example, BSS # 14, #18, #27, and #28 had stages C2 - C4 at the surface. BSS #15 and# 21 had all copepodite stages and many nauplii at station 21, also at the surface. All of these sites continued to have predominately C5 *Calanus* in the near-bottom sample. This is similar to the species composition and distribution seen during the May-June 1994 process cruise on the *R/V Columbus Iselin* (CI9407).

Centropages hamatus, however, predominated on Georges Bank proper, especially in the northern section. *Pseudocalanus* spp. and *Temora* spp. were also present at the Georges Bank stations, but were not as abundant as *Centropages. Oithona* spp. was present in modest densities on the Northeast peak, northern bank and northern flank. Other copepod species included *Metridia, Euchaeta,* and *Calanus hyperboreus*. The centric diatom, *Coscinodiscus*, was present, but not as abundant as in February and March. The pelagic hydroid *,Clytia*, was nowhere near as abundant as during this time last year, or even as numerous as during March and April of 1995. There were modest densities in the northern and eastern bank regions, but *Clytia* populations do not seem to have taken off, as we predicted they would during the broadscale spring cruises.

Stage 5 *Calanus finmarchicus*: Stage 5 *C. finmarchicus* in June, 1995, are on average smaller (average prosome length in mm, Table V and Figure 10) than they were in the past two months. In May 1995, the C5 were thought to be G_2, if this was the case, it would suggest that the smaller C5 this month are G_3. The C5 during this June are comparable in size to those measured in May/June, 1994. In June, 1995, the lipid sac volume of the C5 *Calanus* was the highest seen yet, although not appreciably higher than May/June, 1994. However, June, 1995, volumes were twice that of February and March of 1995 and one-third higher than May 1995. Thus, the C5 *Calanus* present in June, 1995, are smaller, fatter individuals than we have seen before, suggesting that they are storing fat, but perhaps putting their energy more into reproductive as opposed to somatic growth.

Although there seems to be a seasonal trend in the C5 *C. finmarchicus* prosome length and lipid sac volume, no statistical analysis has been performed yet to determine if there is a significant difference between sampling periods. Laboratory lipid analysis will be conducted on these samples to see if the content of the lipid samples in varies between sampling periods, as well as between depths within and between sampling periods.

Summary of Samples Collected:

BSS #	Location	Sample Type
01	SW	F, L
04	SW	F, L
09	S	F, L
12	Georges Bank	F, L
14	S	F, L
16	S. slope	F
21	NE	F, L
25	NE channel	F, L
27	NE	F
29AA	Georges Basin	F, L
32	Georges Bank	F
34	Franklin Basin	F, L
36	Georges Bank	F,L
38	Wilkinson Basin	F
38CC	Wilkinson Basin	F, L

F-Formalin preserved, L-Digital image and liquid nitrogen preservation for lipid analysis

Table 5. Mean prosome length and lipid sac volume for samples of *Calanus finmarchicus.* No. individuals is the sample size.

Prosome length (mm)	2.35	2.28	2.35	2.47	2.40	2.33
Lipid sack volume (mm^3)	0.19	0.11	0.11	0.20	0.15	0.21
No. individual	220	250	213	270	292	290

Figure 14. Prosome length (mm) and lipid sac volume (mm^3) in *Calanus finmarchicus* stage 5 copepodites for U.S. GLOBEC Georges Bank Study Broadscale surveys in 1994 and 1995.

Preliminary Summary of Ichthyoplankton Findings.

John Sibunka, Alyse Weiner, Amy Tesolin, and Rebecca Jones

Samples collected at 38 Globec Broadscale standard stations (BSS) for ichthyoplankton analysis from both the bongo and MOC-1 (nets 6-9) were examined on shipboard for the presence of fish eggs and larvae. This was done in an attempt to determine their occurrence on the Bank and obtain a gross estimate of distribution, abundance and size range. The following discussion on ichthyoplankton catches is based on these findings.

Ichthyoplankton catches were very sparse with no fish eggs or larvae seen in the samples collected at most of the BSS occupied this cruise. A large catch (est. ~60 larvae) of small (size range 4-8mm; most 4-5mm) silver hake (*Merlucius bilinearis*) were taken at BSS #3, located in the southwestern portion of Georges Bank. The occurrence of small silver hake larvae on the Bank signifies that the onset of spawning for this species has begun for this spring season. Small catches (< 10 larvae/station) of American plaice (*Hippoglossoides platessoides*) flounder larvae (size range 10-15mm) were collected at BSS #2, #4, #30, #33, and #36 located in the western and north-central portion of the Bank. Cod (*Gadus morhua*) and haddock (*Melanogrammus aeglefinnus*) eggs, identified by there large size (1.2-1.8mm diameter), were taken at BSS #12 (estimated catch 75 eggs), located in the central portion of Georges Bank. Smaller catches (~20 eggs/station) were made at adjacent BSS #4 and #11.

Cod and haddock eggs (50-60 eggs/station) were also collected on the northern portion of the Bank at BSS #30 and #33, with larger catches (100-200 eggs/station) made at BSS #'32 and #36. None were seen in the samples collected on the Northeast Peak area of the Bank. Historical (MARMAP) data showed spawning still taking place on the Northeast Peak area for the month of June, with some spawning also occurring in the western portion of Georges Bank. No cod or haddock larvae were seen in either the bongo or $1m^2$ MOCNESS samples collected this cruise. However, both post-larval and juvenile cod and haddock were taken by the $10m^2$ MOCNESS sampler (Figures 11, 12; Appendix 2).

Miscellaneous Fish Larvae:

The following fish larvae were also identified in the ichthyoplankton samples collected during this broadscale survey.

1. Lanternfish	Myctophidae
2. Sea snail	*Liparis* spp.
3. Hake	*Urophycis spp.*

Figure 15. Preliminary distribution and relative abundance of juvenile cod from 10-m^2 MOCNESS catches during the Broadscale Survey cruise of *R/V Albatross IV* (5 - 15 June 1995).

Figure 16. Preliminary findings of the distribution and relative abundance of juvenile haddock from 10-m^2 MOCNESS catches during the Broadscale Survey cruise of *R/V Albatross IV* (5 - 15 June 1995).

Population Genetic Analysis of Zooplankton on Georges Bank

Ann Bucklin (University of New Hampshire, Durham)

Purpose of the study:

To address questions of zooplankton dispersal in the ocean, especially identification of sources of *Calanus finmarchicus* for recruitment to Georges Bank, we are using molecular population genetic analysis of the copepod in the western N. Atlantic. Our goal is to document, using biological and physical evidence, the sources and transport patterns resulting in the annual increase of copepods on Georges Bank. For the population genetics effort, we are determining levels of genetic variation, evidence for sub-division into genetically distinct populations, and quantitative estimates of gene flow and dispersal across the sampling domain. The population genetic work is paired with a hydrographic effort by W.A. Brown (Univ. of New Hampshire), which will provide a climatological perspective of water mass structure and variability.

During the early part of this study, the population genetic structure of the copepod, *Calanus finmarchicus*, was described for oceanographic memo- (100s - 1000s km) to large (1000s - 10,000s km) scales in the western N. Atlantic using DNA sequence data for the mitochondrial 16S rRNA gene. The next phase of the population genetic studies is now underway. The goal of this phase is to investigate smaller-scale patterns of population genetic structure of *C. finmarchicus* in the western N. Atlantic, using additional genetic markers (multiple, variable mtDNA regions) and higher spatial resolution of sampling.

The Broadscale surveys of the Georges Bank region are excellent opportunities to obtain samples collected at sufficiently high temporal and spatial resolution. The samples from Net #5 of the 1-m^2 MOCNESS tows from AL9506 were preserved in alcohol for later molecular population genetic analysis. Samples were obtained for all stations and from the 5 added stations.

In addition, large volumes of the copepod, *C. finmarchicus*, were isolated by size-graded sieving of the surface bongo net samples; the 1000 um screen collected almost pure samples of the copepod. This size fraction was flash frozen at -85°C in an ultra-cold freezer. Approximately 20 kg of copepods, very nearly all *C. finmarchicus*, were frozen for later molecular analysis. The extremely large volume of tissue collected will allow us to experiment with new molecular approaches in the analysis of population structure in this species.

Suggestion box

Ship's equipment notes

The conductor-towing cable on the boom winch should be replaced. At present there is only enough cable to fish the MOC-1 to 300m and broadscale protocol requires a maximum tow depth of 500m.

The winch used for the Mark V-CTD unit may need further repair on the electric system before the July cruise.

Monitors displaying the MOCNESS data aquisition and control window should be placed in the bridge and winch operators room. The control of the MOCNESS tow parameters should be wholly in the hands of the scientist. The bridge should not change ship speed without first consulting the scientist running the tow.

The pump worked very well on the port side with the boom. Hose deployment and retrieval was a lot easier this cruise than any other broadscale survey. As in the past, the hose was allowed to fill with air at the end of the cast and became a "slinky" at the surface. However, this time the center of the stern deck was used as a way station before the hose was coiled on the starboard. When the hose was deployed on the starboard side during the last broadscale cruise, there was not much room to lay out the hose before it was coiled. This may seem a minor point to make, but it will become more important during the following broadscale cruise when P. Wiebe will be deploying acoustics off the starboard.

Suggested Changes for Future Cruises:

The Chief Scientist's Manual should have a corrected table of station depths for the broadscale Standard Stations. This can be obtained from the event logs from the previous cruises. A table should also be included listing the distance in nautical miles between the Standard Stations. Also be established in the C/S Manual is how far away from station can the ship be while working a station before it is "off station". Peter Wiebe addressed this issue in Cruise Report EN261, but not all PI's concur and the issue is still unresolved.

It would be very helpful to have a postscript printer in the scientist's study. This will assist with report preparation and minimize competition with the ship's functions.

GLOBEC equipment notes:

A "Broadscale at Sea MOC-1 and MOC-10 Manual" should be developed. This manual should contain all protocol changes that have taken place since the training cruise (NOV. '95).

The MOC-10 net release has excessive "play" in the depth sensor diaphragm. Also, a set of spare nets for the MOC-10 is needed for the July cruise.

Because of deck space restraints during the July cruise, the pump manifold should be placed just forward of the checker box. The hose could be coiled just forward of the manifold. The pump will have to find a new home out of the way of everything else, but it basically can be tied down anywhere and moved during operations, if necessary. This set-up is also better for communications with the winch operator.

MOCNESS manual:

1. A table of both Visual Basic and MOCNESS error messages along with an explanation of what the message means and what should be done to correct it should also be included. This information helps the flyer trouble-shoot rapidly.

2. Provide target intervals for each parameter for the plotting functions. The tow coordinates are rarely graphed, because no one has figured out what the size of the useful brackets are. It seems that approximately ¸ 0.2 degrees latitude and longitude are appropriate. Perhaps there could be default values based on entry of the starting coordinates.

3. The SACS displays degrees and minutes, the graph plot in the MOCNESS program uses decimal degrees. It would help if the two systems used the same format.

4. Make another cell in the window to show previous net volume filtered. As it stands now, the flyer needs to watch time, depth, step #, and volume filtered simultaneously while tripping new nets. Frequently, the correct value of one of these cells is missed. Retention of the previous volume would solve part of this problem.

5. File name and modem connection parameters (now shown in large cells in the MOCNESS window) are probably not needed throughout the entire tow. Alternatively, explain in the manual why these cells are important.

6. Provide an "overwrite bitmap file" toggle yes/no. In some cases, drives become full during long cruises, and the bitmap file for each tow needs to be overwritten.

On the MOCNESS Preservation Sheet, change "Local Time" to "Preservation Time".

Obtain a water proof note book (i.e. a sport fishing log) for deck use to record flow meter numbers at the start and end of bongo tow. This would be useful during periods of rain/sea spray conditions.

Carry a back-up for the CTD rosette system, to allow collection of water samples at some depths, in case the rosette system experiences difficulties.

A dedicated technician is required aboard for the MOC-10. The system should be maintained and equipped prior to each cruise by the person(s) responsible for deploying it during the cruise.

Personnel List

Scientific Personnel

Name	Title	Organization
1. Ann Bucklin	Chief Scientist	University of New Hampshire
2. John Sibunka	Scientist	NMFS/NEFSC, Highlands, NJ
3. Cheryl Morgan	Res. Assoc.	Oregon State University
4. Peter Garrahan	Res. Assoc.	University of Rhode Island
5. Alyse Weiner	Bio. Tech.	NMFS/NEFSC, Highlands, NJ
6. Rebecca Jones	Biol. Tech.	NMFS/NEFSC, Narragansett, RI
7. Amy Tesolin	Biol. Tech.	NMFS/NEFSC, Woods Hole, MA
8. Maureen Taylor	Phys. Sci. Tech.	NMFS/NEFSC, Woods Hole, MA
9. Daniel Almgren	Phys. Sci. Tech.	NMFS/NEFSC, Woods Hole, MA
10. Janis Peterson	Biol. Tech.	University of Rhode Island
11. Jamie Bechtel	Biol. Tech.	University of Rhode Island
12. Theresa Rotunno	Biol. Tech.	University of Rhode Island
13. Eliete Ballesteros	Grad. Student	University of New Hampshire
14. Alyssa Bentley	Student	University of New Hampshire

NOAA Officers and Crew

15. John Moakley	Commanding Officer
16. Jack McAdam	First Officer
17. Christopher Koch	Operations Officer
18. Leslie Redmond	Navigation Officer
19. Kevin Cruse	Chief Mechanical Engineer
20. John Hurder	1st Assist. Engineer
21. Larry Jackson	3rd Assist. Engineer
22. Orlando Thompson	Oiler
23. Ken Rondeau	Chief Bosun
24. John Cravo	Skilled Fisherman
25. Antonio Alvernaz	Skilled Fisherman
26. Eugene Magan	Skilled Fisherman
27. Anthime Brunet	Skilled Fisherman
28. William Amaro	Skilled Fisherman
29. John Braxton	Chief Steward
30. Jerome Nelson	2nd Cook
31. Bruce Stone	Rotating Electronics Technician
32. Nicolas Previsich	Rotating Electronics Technician

Science watch assignments - AL 9506

0000-0600/1200-1800	0600-1200/1800-0000
Sibunka, John	Jones, Rebecca
Almgren, Dan	Taylor, Maureen
Peterson, Janis	Garrahan, Peter
Morgan, Cheryl	Ballesteros, Elly
Weiner, Alyse	Tesolin, Amy
Bechtel, Jamie	Rotunno, Teresa
Bentley, Alyssa	Bucklin, Ann

DUTIES BY WATCH

Watch chief	John Sibunka	Ann Bucklin
MOCNESS fliers	Cheryl Morgan	Peter Garrahan
	John Sibunka	Teresa Rotuno
		Ann Bucklin
CTD	Dan Almgren	Maureen Taylor
Pump people	Janis Peterson	Teresa Rotunno
	Jamie Bechtel	Peter Garrahan

Drifter deployment	Dan Almgren	Maureen Taylor
Fish pickers	John Sibunka	Rebecca Jones
Lab folk[1]	Alyse Weiner	Rebecca Jones
	Jamie Bechtel	Amy Tesolin
	Alyssa Bentley	Elly Ballesteros
	Janis Peterson	Teresa Rotunno
	John Sibunka	Peter Garrahan
Event log	John Sibunka	Ann Bucklin
Bongo flyer	Dan Almgren	Maureen Taylor
Nuts and chloro	Dan Almgren	Maureen Taylor

[1]sample preservation; chemical changes; record keeping;

Appendix 1. Summary of organisms seen in MOCNESS hauls for AL9506

Teresa Rotunno, Janis Peterson, Peter Garrahan, Jamie Bechtel,
Cheryl Morgan, Alyssa Bentley, and Ann Bucklin

This overview is based on examination of samples from the integrated downhaul of Nets 0 and/or 5 (333 um mesh) from MOC-1 tows at Broadscale Standard Stations (BSS). Relative biovolume and vertical stratification information also relied on visual appraisal of nets 1 - 3 (333 um).

M1-001:(2227; 6-5-95; 83 m depth) BSS #1; South Channel

The subsample of 150 um nets contained a mixed bag: *Calanus* and *Pseudocalanus* (mostly C5 and C6f) predominated; abundant *Centropages* and *Temora*; numerous chaetognaths, amphipods, and mysids; some crab zoeae and polychaetes.

M1-002:(0242; 6-6-95; 70 m depth) BSS #2; South Channel

Large concentration of chaetognaths, followed by (in approximate order of abundance: copepods, crab zoeae, amphipods, cumaceans, pteropods. Copepods include *Calanus* (C5), *Pseudocalanus* (C6), *Temora*, among others.

M1-003:(0648; 6-6-95; 91 m depth) BSS #3; Bank - South flank

Calanus (stages C3 - C6) predominate the sample, but there are also numerous *Pseudocalanus*, crab zoeae, chaetognaths, and a few *Centropages* spp., *Metridia lucens*, and euphausiids.

M1-004:(1500; 6-6-95; 44 m depth) BSS #4

A sub-sample from each net showed mostly *Pseudocalanus* and *Calanus* (C5 and C6). Many *Centropages* were also present. Moc 10 blew out 3 nets; remaining nets hauled in mostly jellyfish and nudibranchs.

M1-005:(1736; 6-6-95; 66 m depth) BSS #5; Bank - 60 m isobath

These samples contained lots of *Centropages*, *Calanus* (mostly C5), and *Pseudocalanus* (older stages), as well as a lot of copepod nauplii. There were also a lot of centric diatoms, chaetognaths, lamellibranchs and pteropods. There were some amphipods.

M1-006:(2026; 6-6-95; 80 m depth) BSS #6; Bank - south flank

This was a somewhat thin tow that, somewhat surprisingly, was dominated by *Pseudocalanus* spp. *Centropages* spp. and *Calanus* of various life stages were also present.

M1-007:(0240; 6-7-95; 243 m depth) BSS #7; Slope Water off south flank

Meganyctiphanes norvegica. Also found was one juvenile lantern fish (Myctophidae).

M1-008:(0730; 6-7-95; 400 m depth) Added station; Slope Water

This was an added Slope Water station, where we did a finely stratified tow using all 9 nets (300 m to surface), with 20 m strata from 160 to the surface. The upper nets contained *Calanus* stages C5 and C (predominant in surface nets) and *Pseudocalanus* (nets below surface). In the deeper nets there were mostly euphausiids, sales, and some amphipods. Euphausiid eggs, chaetognaths, filamentous phytoplankton and some copepod nauplii were found in some nets.

M1-009:(12:37; 6-7-95; 90 m depth) BSS #8

This tow was a mixed bag. Predominant were C5 and C6 *Pseudocalanus*. Of secondary importance, in approximately equal abundance were: *Calanus*, chaetognaths, pteropods, and *Centropages* spp. (Based on examination of Net #5; 333 um.)

M1-010:(09:50; 6-8-95; 625 m depth) Slope Water

This was a repeat performance of the haul at our added Slope Water station, except that we couldn't convince the net to go deeper than 170 m (presumably due to current shear). We occupied this station before and after the effects of Hurricane Alison, which may make for an interesting comparison. This haul, the water was influenced by the Gulf Stream and carried *Panulirus* larvae. The tow was exceptionally sparse. In low abundances, we found euphausiids and amphipods in the deeper strata, and *Calanus* in the 40 - 20 m stratum (but not in the surface waters as previously).

M1-011:(15:39; 6-8-95; 75 m depth) BSS #9

The samples were a mixture of copepods, chaetognaths, and hydroids (relative abundance 1). The copepod fauna consisted of: *Pseudocalanus, Temora* and *Metridia.* Biovolume low to moderate.

M1-012:(18:29; 6-8-95; 57 m depth) BSS #10

These samples are characterized by the presence of hydroids (abundance estimate 3 on a scale of 1 to 4). In equal or greater abundance were *Pseudocalanus* spp., with some *Calanus* (C5), chaetognaths, and *Centropages* spp. (in order of relative abundance). Moderate to low biovolume.

M1-013:(21:33; 6-8-95; 47 m depth) BSS #11

This shallow water station contained primarily *Centropages hamatus* - and in large abundances! There were some chaetognaths, isopods, nematodes and *Calanus*. Samples contained ~1000 ml (average volumes). [Note: Net #6 sample of this haul lost during alcohol change.]

M1-014:(02:33; 6-9-95; 42 m depth) BSS #12

This was a shallow water station characterized by *Centropages*, *Pseudocalanus*, *Calanus* (C4 and C5), *Temora*, hydroids and amphipods.

M1-015:(09:51; 6-9-95; 59 m depth) BSS #13

This station in shallow water yielded a sample containing primarily centric diatoms, filamentous algae, hydroids, and polychaetes. Predominant copepods were: *Centropages hamatus* (all stages) and older stages of *Pseudocalanus* (C6f, C5). Also present were *Temora*, chaetognaths, crab zoea, mysids, medusae, cumaceans, amphipods and copepod nauplii. Samples contained average volumes (~1000ml).

M1-016:(13:05; 6-9-95; 70 m depth) BSS #14

These samples contained many hydroids, centric diatoms, chaetognaths, *Pseudocalanus* (C5, C6f), *Centropages hamatus,* and *Temora*. Did not see any copepod nauplii. In addition to older stages of *Calanus*, young individuals (C2 and C3) were seen - for the first time on this cruise. Other invertebrates were: amphipods, euphausiids, cumaceans, medusae, caridean shrimp, and polychaetes.

M1-017:(17:06; 6-9-95; 80 m depth) BSS #15

These sample contained primarily filamentous algae - very gooey. *Calanus* and *Pseudocalanus* were the dominant copepods. Older stages of *Pseudocalanus* and all stages of *Calanus* were present, with more juvenile stages of the latter than seen previously. Less abundant critters included *Temora*, decapods, amphipods, and pteropods. Where are all of the *Oithona*? Net volumes were average, once again, approximately 1500ml.

M1-018:(21:20; 6-9-95; 607 m dpeth) BSS #16 Slope Water Station

These samples were a mixture of *Calanus* (mostly C5 and adults), *Pseudocalanus*, hydroids, amphipods, *Candacia armata, Centropages,* and euphausiids. Also found were several larval and juvenile lanternfish (Myctophidae).

M1-019:(05:08; 6-10-95; 97 m depth) BSS #17

This station was well up on the Bank. The samples contained: green munge (filamentous green algae), chaetognaths, and hydroids (relative abundance rating of 4). Among copepods there were mostly *Pseudocalanus* spp. and *Centropages hamatus*. *Temora longicornis* and *Calanus finmarchicus* were present, but lower in abundance. Also found were polychaete larvae, cumaceans, mysids, and caprellid amphipods.

M1-020:(10:05; 6-10-95; 77 m depth) BSS #18

Lots of centric diatoms -- by far the predominant group. Also present were hydroids, chaetognaths, amphipods, and a mixed bag of copepods, including: *Calanus, Candacia, Temora, Pseudocalanus,* and *Centropages*. Most were older stages, with the exception of *Calanus,* which had some younger stages present. Average volumes of ~1500ml.

M1-021:Sample not yet analyzed.

M1-022:Sample not yet analyzed.

M1-023: (02:01; 6-11-95; 90 m depth) BSS#21

Hydroids abundant at level 2 (relative abundance scale of 4). Among copepods, *Calanus* (C6f) were prevalent, and C5 stages were abundant as well. Next most abundant were C6f *Pseudocalanus.* Net 2: *Calanus* (C2, C3, C4) and *Pseudocalanus (*C2, C3) predominated in this sample. Net 3: This sample contained a lot of what are probably *Calanus* nauplii. Some *Oithona* and *Calanus* (C1, C2, C3) were present as well.

M1-024:(06:36; 6-11-95; 111 m depth) BSS #22

This station near the Northeast peak of the Bank contained >90% *Calanus* (C6f, C6m, C5). There were few *Pseudocalanus*, amphipods and phytoplankton present. Volumes ~ 100ml.

M1-025:Sample not yet analyzed.

M1-026:(1619; 6-11-95; 176 m depth) BSS #24

At the surface, the samples were dominated by *Calanus* (C5 and C6f) with a few *Metridia*. At depth, the sample was equally composed of *Calanus* (C5 and C6) and all stages of *Metridia lucens*. Moderate biovolume; somewhat higher at greater depths.

M1-027:(2247; 6-11-95; 190 m depth) BSS #25

Throughout the water column, the mix was: 40% euphausiids, 40% *C. finmarchicus* (C6f), 20% foraminiferans. There was a large abundance of other species at some depths, including: *Calanus hyperboreus* (C4), *Metridia*, *Pseudocalanus* spp., *Meganytiphanes*, amphipods, and *Oithona*.

M1-028:(0706; 6-12-95; 84 m depth) BSS #26>

The surface net at this station contained *Oithona* and little else except some chain-forming diatoms. *Oithona* has been rare this trip, perhaps as a result of examining 333 um mesh nets, which do not capture the species well. The bottom sample contained lots of *Pseudocalanus* (all stages) and *Calanus* (C6f, C6m and C5).

M1-029:(1113; 6-12-95; 68 m depth) BSS #27

The sample from the downhaul contained: 50% chaetognaths, 30% medusae, 15% *Calanus* (C3, C4), and 5% phytoplankton. Mid-depth and surface samples contained a similar mix of chaetognaths, medusae, *Calanus* (C5), and phytoplankton sludge.

M1-030:(1547; 6-12-95; 67 m depth) BSS #28

The integrated downhaul sample was composed of: 40% pteropods, 10% chaetognaths, 40% *Calanus* (C5), and 10% *Metridia* (C4). Nets 1 - 3 had similar mixes, with chaetognaths somewhat more abundant and C3 and C4 stages of *Calanus* present.

M1-031:(6-12-95; 293 m depth) BSS #29

The bottom net (to 100 m) was nearly all *Calanus* C5, (C. *finmarchicus* 80%, *C. hyperboreus* 20%). There were also some *Clausocalanus* and euphausiids. In addition to *Calanus* (which was nearly 100% stages C4, C5, and C6f), the top net contained *Metridia*, *Euchaeta,* and *Euchirella.*

M1-033:(0926; 6-13-95; 67 m depth) BSS #30

Net 1 (60-40m) contained: *Centropages, Centropages,* and *Centropages* (all stages but mostly adults). There was also some *Oithona*, *Calanus* (C5), *Pseudocalanus*. Hydroids occurred (relative abundance scale = 2.5), as did chaetognaths and polychaetes. There were a few amphipods, pteropods (*Limacina*), and lamellibranchs (and sand crystals). The surface net was similar to the deep net, with the addition of filamentous phytoplankton, medusae, and *Calanus* (C6f) .

M1-034:(1441; 6-13-95; 95 m depth) BSS #31

The downhaul included: *Calanus finmarchicus* 20% (of which 20% are C5 and C6f), *Pseudocalanus* (mostly C6 females), and some *Metridia*. The uphaul nets were a veritable cornucopia of *Calanus, Metridia, Pseudocalanus* (C5, C6f), and a small percentage of *Centropages*, *Metridia*, *Clausocalanus*, nauplii, crab zoeae, chaetognaths, and *Oithona*.

M1-036:(2207; 6-13-95; 33 m depth) BSS #32

Sample not yet analyzed.

M1-037:(0101; 6-14-95; 61 m depth) BSS #33

This was a shallow water station with a large number of copepods including: *Calanus* (C5, C6f), *Centropages* (very abundant in net 3), *Pseudocalanus* (all stages), and *Oithona.* The sample also contained a number of chaetognaths, medusae, phytoplankton, polychaete larvae (very abundant in nets 1, 2, and 3) and pteropods (very abundant in net 3).

M1-038:(0443; 6-14-95; 210 m depth) BSS #34

M1-039:(1035; 6-14-95; 76 m depth) BSS #35

This sample was predominated by an equal mix of *Centropages hamatus* (all stages), *Pseudocalanus* (all stages), and polychaetes. There were lesser abundances of *Temora*, crab zoeae, and hydroids (abundance rating 1). Volumes of cod end buckets ~1500ml.

M1-040:(1346; 6-14-95; 51 m depth) BSS #36

Centropages (C1-C5) dominate this sample. Net 0 also contained *Calanus,* chaetognaths, and crab zoeae. Nets 1 and 2 also had *Oithona*, chaetognaths, nauplii, polychaete larvae, and a few *Calanus.* There was apparently little or no stratification in this water column.

M1-041:(1714; 6-14-95; 70 m depth) BSS #37

The copepod assemblage included: mostly *Pseudocalanus* (all stages, nauplii), lesser abundances of *Temora* and *Centropages* (all stages, mostly young), some *Calanus* (C5), and *Oithona*. Among non-copepods, there were: chaetognaths, polychaetes and hydroids (abundance scale=1).

M1-044:(1458; 6-15-95; 154 m depth) BSS #38

The surface net contained mostly *Calanus* (C5, some C6f, and a few C6m), with some *Metridia* and *Sagitta*. The bottom net had fewer *Calanus* (mostly C5, with some C4 and C3). There were also *Pseudocalanus*, *Oithona*, an unidentified copepod (probably *Labidocera* sp.). There were no hydroids.

Appendix 2. Synopsis of 10-m^2 MOCNESS catch by station.

Rebecca Jones, John Sibunka, Eliete Ballesteros, and AlyseWeiner

The following descriptions result from examination of a sub-sample of the net hauls at the time of collection. The symbol "*****" identifies abundant organisms.

Station #3/SBB #3, haul 1

Fish:
- 1 Silver Hake (16 mm)

Invertebrates:
- Gammarid amphipod
- Hyperiid amphipod
- Phronimid amphipods
- *Squilla sp.* larvae (mantis shrimp)

Station #4/SBB 4, haul 2

Fish:
- 3 Cod (21-23mm)
- 1 Eel larvae-leptocephalus (110mm)
- 1 Butterfish (21mm)
- 1 unidentified (18mm)

Invertebrates:
- Predatory amphipod
- Crab zoeae
- Hydroids
- Medusae

Station #5/SBB 5, haul 3

Fish:
- 1 Eel larvae-leptocephalus (90mm)
- 2 Cod (35,40mm)

Invertebrates:
- Hyperiid amphipod
- Chaetognaths
- Ctenophores
- *Phronimid amphipods*- all stages
- Medusae

Station #6/SBB 6, haul 4

Fish:
- no fish

Invertebrates:
- Predatory amphipods
- Decapod shrimp
- Euphausiids
- Isopods
- *Stoloteuthis leucoptera* (bobtailed squid)
- Medusae
- Mysids
- Salps

Station #16/SBB 13, haul 5

Fish:
- 2 Cod (18-24mm)

Invertebrates:
- Crab zoeae
- Ctenophores
- Hydroids
- Hyperiid amphipods
- Medusae
- Mysids
- Pteropods

Station #17/SBB 14, haul 6

Fish:
- 1 Cod (40mm)

Invertebrates:
- Crab zoeae
- Ctenophores
- Hydroids
- Medusae
- Mysids

Station #19/SBB 16, haul 7

Fish:
- 40-50 Lanternfish (20-70mm)
- 2 Hatchetfish (40-45mm)
- 2 Snipe eel
- unidentified larvae

Invertebrates:
- Predatory amphipods
- Gammariid amphipods

- Chaetognaths
- *****Euphausiids
- Hyperiid amphipods
- *Illex sp.*
- Mysids
- Oceanic octopod
- Phronimid amphipods
- Salps

Station #20/SBB 17, haul 8

Fish:
- no fish

Invertebrates:
- Chaetognaths
- *Clione sp.*
- Ctenophores
- Decapod larvae
- *Hyperiid amphipods
- Invertebrates eggs
- Phronimid amphipods
- Salps

Station #21/SBB 18, haul 9

Fish:
- 1 Haddock (32mm)
- 1 Lanternfish (22mm)
- 1 eel larvae-leptocephalus (90mm)
- 1 unidentified (30mm)

Invertebrates:
- *Clione sp*.
- Ctenophores
- Hyperiid amphipods
- *Illex sp.*
- Medusae
- Mysids
- Phronimid amphipods
- Salps

Station #22/SBB 19, haul 10

Fish:
- 5 Cod (17-32mm)
- 1 Alligator fish (28mm)

Invertebrates:
- Chaetognaths
- Crab zoeae
- Ctenophores
- Hydroids
- Hyperiid amphipods
- Medusae
- Pteropods

Station #23/SBB 20, haul 11

Fish:
- 15-20 Cod (25-40mm)
- 1-2 Haddock (36mm)
- 20-25 Sand Lance (55-80mm)

1 American Plaice (32mm)

Invertebrates:

- Gammariid amphipod
- Chaetognaths
- Ctenophores
- Euphausiids
- *****Hydroids
- Hyperiid amphipods
- *****Isopods
- Polychaetes
- Shrimp

Station #24/SBB 21, haul 12

Fish:

- ~50 Cod (28-51mm)
- ~6 Haddock (34-42mm)
- 1 Atlantic Herring (40mm)

Invertebrates:

- Gammariid amphipods
- Anomuran larvae
- *Clione* sp.
- *****Ctenophores
- Euphausiids
- Hydroids
- Hyperiid amphipods
- Isopods
- Mysids
- Phronimid amphipods
- Polychaetes
- Siphonophores

Station #25/SBB 22, haul 13

Fish:

- no fish

Invertebrates:

- Ctenophore
- *****Hyperiid amphipods with eggs
- Medusae
- Mysids
- Phronimid amphipods

Station #26/SBB 23, haul 14

Fish:

- 4 Cod (30-41mm)

Invertebrates:

- *Clione sp*.
- Ctenophores
- *****Hyperiid amphipods with eggs
- *****Medusae
- Mysids
- Phronimid amphipods
- Salps

Station #27/SBB 24, haul 15

Fish:

- no fish

Invertebrates:

- Chaetognaths
- Euphausiids
- *****Hyperiid amphipods with eggs
- Medusae
- Phronimid amphipods
- *Stoloteuthis leucoptera* (bobtailed squid)

Station #28/SBB 25, haul 16

Fish:

- 1 Cod (33mm)
- 1 Scorpaenidae (32mm)

Invertebrates:

- Ctenophores
- Euphausiids

.
Hyperiid amphipods
Medusae
Phronimid amphipods
Stoloteuthis leucoptera (bobtailed squid)
Siphonophores

Station #29/SBB 26, haul 17

Aborted tow- no samples

Station #30/SBB 27, haul 18

Fish:
9 Cod (26-35mm)
1 Haddock (32mm)
3 Alligatorfish (25-30mm)
Invertebrates:
Gammariid amphipods
Chaetognaths
Ctenophores
Euphausiids
Hydroids
Hyperiid amphipods
Medusae
Mysids
Pteropods
Siphonophores

Station #31/SBB 28, haul 19

Fish:
no fish
Invertebrates:
Chaetognaths
Clione spp.
Crab zoeae
Hyperiid amphipods
Medusae
Phronimid amphipods
Pteropods
Siphonophores

Station #32/SBB 29, haul 20

Fish:
2 Cod (24mm, 25mm)
Invertebrates:
Ctenophores
*****Euphausiids (*Meganyctiphanes norvegica*)
Isopods
Salps
Shrimp

Station #34/SBB 30, haul 21

Fish:
7 Cod (20-33mm)
5 Haddock (34-46mm)
Invertebrates:
Clione sp.
Isopods
*****Medusae

Station #37/SBB 32, haul 22

Fish:
Pipefish (~150mm)
Invertebrates:
Hydroids
Isopods
Shrimp

Station #39/SBB 34, haul 23

Fish:
2 Cod (19mm, 31mm)
Haddock (24mm)

2 Cusk eel (~70mm)
1 Atlantic Mackerel (17mm)
Invertebrates:
Amphipods
Clione spp.
*****Euphausiids (*Meganyctiphanes norvegica)*
Medusae
Stoloteuthus leucoptera (bobtailed squid)

Station #41/SBB 36, haul 24

Fish:
no fish
Invertebrates:
Amphipods
Euphausiids
Shrimp

Station #43/SBB 38, haul 25

Fish:
no fish
Invertebrates:
*****Euphausiids
Hyperiid amphipods
Euchaeta norvegica

Appendix 3. Drifter protocols

Appendix 4. Data inventory: List of Underway and Station Activities

Appendix 5. CTD profiles