U.S. GLOBEC Georges Bank
AL9808 Cruise Report

Acknowledgements: The June, 1998 Broadscale Survey (like those for January and May, 1998) was on the *R/V Albatross IV.* The experience of the ship's officers and crew is an invaluable asset for the Broadscale Surveys. They know the drill, the know the goals, and they are active partners in the efforts to get comprehensive data over the Bank. Special thanks go to the officers, Captain Jason Maddox and Mates Steve Wagner and Scott Sirois for their assistance and able helmsmanship. Electronic Technician Henry Jenkins gets a warm thanks from all of us, and especially from Peter for acoustical assistance. Kenny Rondeau, Tony Alvernaz, Willy Amaro, Jorge Barbosa, Anthime Brunette, and Tony Veira all deserve a hearty thanks for hard work and for being there when needed on deck and at the winches. Where would we be without winch operators who know in their fingers how to fly MOCNESS? Thanks also to John Hurder, Chuck Hursey, and Orlando Thompson. And very specially, we appreciate our wonderful and talented cooks, Jerome Nelson and Michael Whitehead. To all of you, a big thank you for a productive June cruise and for a successful 1998 series of Surveys.

This report was prepared by Ann Bucklin, with assistance from Phil Alatalo, Maria Casas, Ted Durbin, Scott Gallager, Peter Garrahan, Rebecca Jones, Charles Miller, John Sibunka, Maureen Taylor, David Townsend, and Peter H. Wiebe.

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Purpose of the Cruise

The U.S. GLOBEC Georges Bank Program is now into its fourth full field season and this cruise was the sixth in a series of six Broadscale cruises taken place at monthly intervals between January and June. Our specific objectives were:

1) To conduct a Broadscale survey of Georges Bank to determine the abundance and

distribution of U.S. GLOBEC Georges Bank Program target species which are the eggs, larval, and juvenile cod and haddock and the copepods *Calanus finmarchicus* and *Pseudocalanus* spp.

2) To conduct a hydrographic survey of the Bank.

3) To collect chlorophyll data to characterize the potential for primary production and to

calibrate the fluorometer on the CTD.

4) To map the bank-wide velocity field using an Acoustic Doppler Current Profiler (ADCP).

5) To collect individuals of *C. finmarchicus*, *Pseudocalanus* spp., and the euphausiid,

Meganyticphanes norvegica, for population genetic studies.

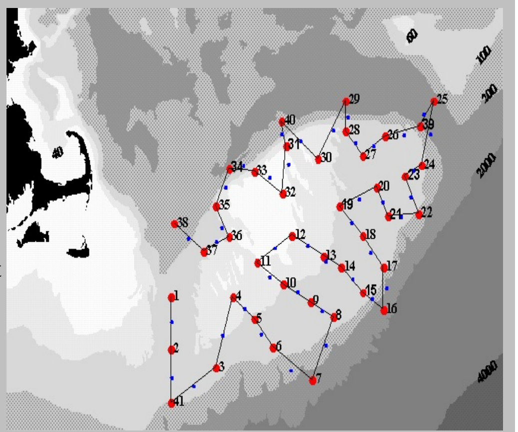
6) To conduct lipid biochemical and morphological studies of *C. finmarchicus*.

7) To conduct acoustic mapping of the plankton along the tracklines between stations using

a high frequency echo sounder deployed in a towed body.

8) To deploy drifting buoys to make Lagrangian measurements of the currents.

The cruise track was determined by the position of the 41 "Standard" Stations that form the basis for all of the Broadscale cruises (Figure 1). All of Georges Bank, including parts that are in Canadian waters, was surveyed.



The work was a combination of station and underway activities. The along-track work consisted of high frequency acoustic measurements of volume backscatter of plankton and nekton throughout the water column and surface measurements of temperature, salinity, and fluorescence from the towed body. The ship's 300 kHz ADCP unit was used to make continuous measurements of the water current profile under the ship, in order to construct the current field over the whole of Georges Bank. Meteorological data, navigation data, and sea surface temperature, salinity, and fluorescence data were measured aboard the *R/V Albatross IV.* Some of these data are presented in the Acoustic Report Section below.

A priority was assigned to each of the 41 standard stations that determined the equipment that was deployed during the station's activities. At high priority "full" stations, a Bongo net equipped with a SeaBird CTD was towed obliquely to near the bottom. A CTD-fluorometer-transmissometer profile to the bottom was made and rosette bottles collected water samples for salinity and chlorophyll calibrations, chlorophyll concentrations, phytoplankton species counts, and $^{18}O/^{16}O$ water analysis. A large volume zooplankton pumping system was used to profile the water column. A 1-m^2 MOCNESS was towed obliquely to make vertically stratified collections for zooplankton (150 �m mesh) and then to make collections of fish larvae (300 �m mesh). Weather permitting, a 10-m^2 MOCNESS was towed obliquely to make vertically stratified collections of juvenile cod and haddock, and the larger predators of the target species. At lower priority stations, a Bongo tow, CTD profile, and 1-m^2 MOCNESS tow were made. At some stations, the SeaBird CTD/Niskin bottle cast was made for calibration purposes. A summary of the sampling events that took place during the cruise is provided in Appendix I.

Cruise Narrative

Day 1: Tuesday, June 16th

Our departure was delayed more than 24 hours by ship maintenance issues, in particular making sure the drinking water was safe (by flushing and filtration) and repairing a fried connector for the drive system. We departed on Tuesday (June 16th) at 1609 hr. After days of fierce rain storms and high winds, the afternoon was lovely, with clear skies and light breezes. Our departure put us in a cue behind the *R/V Oceanus*, headed to Bermuda and the Sargasso Sea, and two scheduled ferry departures.

After fire and abandon-ship drills - and dinner - many of the scientists went below. The night watch was given a late start, to ease the transition, and were waked one-half hour before we reach our first Broadscale station at 2330 hr.

Our goal was to cover the Bank with 41 stations, including 32 MOC-10 tows, with intermediate Kimmerer water bottle casts but no intermediate bongo tows. The only "extras" this trip were three planned pump comparisons (to evaluate centrifugal vs diaphragm pumps for the 1999 field season) and live tows of a specially-rigged bongo for the copepods, *Calanus*, *Pseudocalanus*, and *Centripages*, as well as pteropods, which will be kept alive until return. Thus, we should be able to complete the course, despite the late start.

Day 2: Wednesday, June 17th

We reached Station 1 in the early morning hours. Sampling went pretty smoothly for the first station. The Greene Bomber, a towed body carrying two high-frequency transducers and an environmental sensor package, was deployed off the starboard quarter after the station work was completed. Seas only 1 or 2 feet with light breezes. The morning began foggy - a good sign for continued calm - with sun breaking through early. We reached Station 2, the first station for the day watch, just after breakfast.

CTD problems plagued us again. Maureen Taylor rigged a SeaBird to the Mark V CTD to provide accurate depth information. The Mark V had a pressure offset which disappeared at depth, so simple correction was not possible. During the afternoon and evening, ship's ET Henry Perkins worked on the CTD winch slip rings, and concluded that the problem was likely to reside in the cable termination. There was no CTD cast for

Station 3. The CTD was switched to the crane winch for the Station 4 cast, where it yielded excellent data. Henry and Maureen hoped that re-doing the cable termination will solve the problems.

Also at Station 3, one of three planned pump comparisons was done. The process is time consuming, but necessary in order to discover the reason for low concentrations of early naupliar stages of copepods in previously-collected pump samples. Both the old centrifugal pump and the new diaphragm pumps were deployed; the samples will be compared.

The day watch wrapped up Station 3 just after 2200 hr, cocking and stowing the MOC-10 nets with the assistance of the night watch. If we can keep a 4-stations-per-day pace, we will complete our course in good time.

Day 3: Thursday, June 18th

The night watch completed full Station 4 during the early morning hours; Peter Garrahan said it felt like everything was in "slow motion". Fatigue takes its toll! Red sunrise on the horizon: another lovely day!

We have not yet seen the "strawberry daquiri" waters of true *Calanus* patches. We have had frequent jelly plankton in the nets, chaetognaths, and smaller (*Pseudocalanus* and *Centropages*) copepods. Perhaps this is why the Right Whales have disappeared from Great South Channel, according to Pat Gerrior, NMFS whale watcher.

At Station 5, the MOC-10 deployed well, except for cock-pit error in failing to drop the last net before recovery. In the light, we figured out what the "clunks" coming out of the deeper MOC-10 nets were - pelagic whelks! The 0 and 1 nets both had numerous whelks at Station 5. The MOC-1 nets were a mixture of copepods, ctenophores, and everything else. We added a live tow for Ted Durbin after the regular station work.

Station 6 came up fast, while we were still working on the previous station's samples. We took a water sample for the SeaBird CTD calibration. Maureen left the dummy plug off the SeaBird, and the bridge offered to call the helicopters for her. Maureen is still thinking about this offer.

The night watch completed a station during the afternoon; a deep station (Station 7) in the Slope Water which rounded out the day's progess. The Slope Water was depauperate, with a few small euphuasiids in the upper 200 m (caught in the Bongo tow). The MOC-1 samples were similar, with the addition of lots of sand in the 0 net, presumably caught on a sand wave or as the ship track moved into shallow water (see Suggestions at the end of this Narrative). Captain Jason warned the MOC flyers that the ship would need to maneuver around lots of fixed fishing gear at the Slope edge. The MOC-10 (taken over by the night watch) was towed in deeper water, but the cast was limited to 280 m to match the MOC-1.

Day 4: Friday, June 19th

The night watch completed Station 8 in the early morning. The ship came on Station 9 just at the morning watch change. In addition to full station work, we completed the second pump comparison of the cruise, and did a live-tow for Ted Durbin and Ann Bucklin after the MOC-10 deployment. We completed work at Station 9 in just over four hours, steaming onward at 1018 hr. Weather continued calm and mostly overcast, the decks dripping with the usual accompanying fog. No complaints though - it's been an easy ride so far this cruise.

The shallow stations of the Bank crest went fairly quickly with few difficulties. We were still using the crane winch for the Mark V CTD. Since the data were good, there was no hurry to move back to the CTD winch for deployment. We repaired a large tear in the MOC-10 0 net after Station 11. By 2200 hr, we were still fog-enshrouded, working at Station 12. This shallow station was a characteristic *Pseudocalanus / Centropages / Clytia* neighborhood, which was what we found in all our nets, including a live tow at the start of the station.

Day 5: Saturday, June 20th

The night watch had a productive, if uneventful, time. They completed two stations (#13 and 14), with only one casualty, caused by Peter Garrahan attempting to pat himself on the back. (Let someone else do that, Peter!). The MOC-10 tow (net #2) yielded two large squid, "the most impressive predator caught to date", according to Charlie Miller.

The day watch sewed nets and cocked the MOC-10 and sat through the steam to Station 15. The station work included a live tow for Ann Bucklin after the bongo, which yielded abundant female *Calanus finmarchicus* and numerous siphonophores, which were preserved for Peter Wiebe's acoustic studies. The MOC-1 tow was aborted due to erroneous pressure, and possibly temperature, readings. A bongo tow was substituted for the MOC-1 at Station 15 after early diagnosis only deeped the mystery of the cause of the bad readings. Peter Wiebe, Dave Nelson, and ship's ET Henry Perkins worked on the problem as we steamed in a holding pattern. Their eventual diagnosis was a loose splice in the wire from the junction box. Just before 1500 hr, all repairs were completed and work at Station 16 continued....and continued. The MOC-10 nets brought up shrimps, fish, jellies, and lots of *Euphausia krohnii*. The last task at this Slope Water station was a live tow after 2100 hr, which yielded numerous euphausiids. We lost only one hour due to our problems with the MOC-1. The day ended as it began - fog and mist surrounding the ship.

Day 6: Sunday, June 21st

The night watch was delayed at Station 17 when the pump hose floated to the surface on *both* sides of the ship. Karen Fisher saw the pump hose in the Greene Bomber acoustic view, so the ship may have drifted over the wire in the dead calm of the night. The hose sections were separated and brought aboard on either side of the ship. In a careful and inspired feat, hanging by his ankles, Tony Cravo (a hero of many previous cruises) kept the hose from entangling the Greene Bomber.

The daywatch took over upon arrival at Station 18 - a full station where we also completed a pump comparison and a live tow. The weather continued foggy, with a light breeze from the

Northeast, bringing slightly clearer skies. Work at Station 19 was completed before the night watch came on at 1400 hr.

Station 20 was started by the night watch, and taken over by the day watch at the MOC-1. The pump saw some of the sandy bottom first-hand - too close to the bottom. As we worked our way over the Northeast Peak, we started to entered "*Calanus* country". We were also at the hump station: 21 stations completed and 20 to go. Charlie Miller was taking contributions for the *Stern View* (said he was out of ideas, so Maria Guarnieri described her experiences as a Broadscale rookie); the watch teams were working well; the fog continued. Hopefully, all this uneventfulness will last another 6 days or so.

Day 7: Monday, June 22nd

The night watch completed Station 22 (with a couple false starts on the bongo tow) and had the pump in the water at Station 23 at the morning watch change. Station 23 was completed before 0900 hr. The morning air had a touch of Arctic chill, which we ascribed to having crossed into Canadian waters; air temperatures did drop a few degrees. By any account, the weather continues very workable and there have been few complaints, other than a couple plaintive wishes for sunshine. A re-reading of my narratives from June, 1995 (AL-9506) and April, 1997 (OCE-302) reminded me of how lucky we have been so far with the weather! In 1995, Hurricane Alison had us running for deep water early in the cruise, and we worked Stations 22 - 25 on the seventh day of the cruise. In 1997, a storm and gear problems slowed us during the first week, and we worked Stations 18 - 22 on the seventh day out.

The MOC-10 yield at Station 23 was minimal - almost nothing in the nets! The samples could have been typical of daytime over the Northeast Peak, but another possibility occurred to the flyer, Ann Bucklin. The largest MOC-10 haul of the trip was a deep, night-time tow in the Slope Water (Station 16), which was flown at horizontal net speeds of 1.2 - 1.5 kn and required occasional winch speeds of 35 m/min and higher to accommodate shear and current variability! During Broadscale cruises, the MOC-10 has typically been flown at horizontal speeds between 0.5 - 0.7 kn, with the ship moving at 1 to 2 kn. Perhaps these towing speeds were too slow for optimal catches, allowing considerable net avoidance by the nektonic targets of this exercise. (See recommendations below)

The Greene Bomber was removed from the water at Station 23 because the acoustic system had malfunctioned, returned to the water after the bongo tow at Station 24, and removed again after the MOC-1 tow at that station. Peter Wiebe worked on its innards (the electronic connections to the transducers) during the longish steam to Station 25. The ship's crew were glad of the 10 kn pace, without the Greene Bomber in the water, but most of us hoped for the Bomber's recovery.

Station 24 came right on the heels of 23 (the Northeast Peak stations were close together), so work continued with little break through Monday morning. While towing the MOC-1 at Station 24, we passed through an interesting and anomalous upwelling event that was very evident from the surface. Perhaps this was one of the solitons (i.e., stationery internal waves) that have been observed in the hydrographic and acoustic records. The MOC-1 yielded *Calanus finmarchicus* and other usual members of the zooplankton assemblage on the Bank. We did another live tow at Station 24 for Ted Durbin. The fog lifted a little bit as the day progressed, giving us a pretty, partly cloudy day with light breezes as we crossed the Northeast Channel. The day watch took advantage of the long steam to check the event log for accuracy: a group activity that required considerable mental effort to ensure accurate records of the cruise.

At the afternoon watch change, we held a brief mid-course science meeting to discuss any issues in the performance of the watches, to organize the preparation of the cruise report, and to consider the rest of the cruise. In general, things seemed fine. The note of optimism on the arrival at Station 25, and the feeling of "turning the corner" on the cruise, were very evident. Ships always run faster toward home port. John Sibunka looked back at past Broadscale cruise reports from the *R/VAlbatross*, and concluded that it will require 72 hours from the beginning of Station 25 to the end of Station 38, in addition to 8 hrs steaming back to Woods Hole. John's calculation would put us in port on Friday morning. I was superstitious enough to avoid such calculations.

The MOC-10 tow at Station 25 flew through the strong currents at depth in the Northeast Channel and, toward the surface (nets 2, 3, and 4) sampled a patch of the large jellyfish, *Pelagia*. Once on deck, they lose any appeal. We counted the individuals as best we could (22 to 45 in each net) and preserved only a subsample. As we hosed down the nets, a frothy material washed down the decks. Pretty sad end for such lovely animals!

Greene Bomber was returned to its original state (not wonderful to begin with, but functional) and to its spot off the starboard rail before leaving Station 25. The steam westward began. We reached Station 39 in the early evening. The day watch completed the first deployments, leaving the MOC-1 and MOC-2 tows to the night watch.

Day 8: Tuesday, June 23rd

The night watch worked at Station 26, passing the MOC-10 recovery to the day watch. The weather continued foggy and coolish, with light breezes. At Station 27, a 4 kn current at depth made deployment of the pump a bit ticklish as the wire angled under the ship. The first try was aborted; the second deployment reached depth (67 m) and the recovery went smoothly. Part of the difficulty may have resulted from attempting to deploy the pump hose before the ship came to a complete stop (see recommendations, below).

The swift current at Station 27 swept us half-way to the next station by the time the MOC-1 was retrieved. We pulled the Greene Bomber out of the water to steam up-current - back to Station 27 - for the MOC-10 tow, replacing the Bomber before beginning the tow. We did a live tow after the MOC-10, yielding lots of *Calanus finmarchicus* (Copepodite V stages), *Centropages*, and other copepods. The bug pickers (Ted Durbin, Maria Casas, and Ann Bucklin) were still at it when we arrived on Station 28. Work at this station crossed the watch change. The night watch passed the baton back to us after the pump recovery at Station 29. We were still on Station 29 at the 2200 hr watch change. During the MOC-10 tow, we blew out the #3 net, which tore along a seam, creating a huge hole across the entire lower edge. The night watch started work by re-doing one dip of the MOC-1 (taking about an hour) to provide Charlie Miller with his samples, after he was allowed to sleep through the original tow's sample preservation.

John Sibunka, Ted Durbin, and Ann Bucklin spent a while predicting arrival times, based on previous Broadscale cruise reports. We started a pool, with a $1 ante, to predict time to completion of work at Station 38. In any case, we expect to make it in on time - by Saturday.

Day 9: Wednesday, June 24th

Station 30 was knocked off by the night watch, and the day watch started with the long steam to Station 40. The replacement #3 net on the MOC-10 was destroyed on its first tow. It was replaced again with our second, and last, spare net. Neither of the two spare nets provided for the cruise was in particularly good shape, according to Erich Horgan, and we will have to count on some good luck.

It was raining when we reached Station 40 at 0800 hr. The wind stayed light, but ship movement increased as we continued to move into the shallower waters over the Bank. The pool closed, with predictions of time-of-completion for Station 38 ranging from 2200 hr Thursday (predicted by Orlando Thompson) to 1900 hr Friday (predicted by Peter Wiebe).

Before midnight, we put to bed Station 33 without trouble or event: samples contained the typical Bank-crest assemblage. Not a *Calanus* to be found! The Greene Bomber continued to malfunction intermittently; the record correlated very well with ship operations. Peter Wiebe suspected a bad component in the controller, picking up interference from some component of the ship or the ship's equipment.

Day 10: Thursday, June 25th

The ship passed through a pod of humpback whales during the morning hours. First whales (other than pilot whales four or five days ago, and dolphins after that) that we have seen this trip. Stations 34 was completed by the night watch. Station 35 came up right after the watch change. After the regular station work, and based on the bongo net sample, we collected live pteropods for Scott Gallagher. We pumped cold water from 45 m into two garbage cans, then did a bongo tow at the depth of maximum acoustic backscatter (40 m of wire out, estimated tow depth of 25 m, held at depth for 2 min). We decanted everything but pteropods from the buckets with the samples, and added several hundreds of individuals to each can. One of the outer tubs designed to cool the garbage cans would not hold water. Although it's a bit early, we didn't want to risk missing this opportunity to meet the request for live animals.

During the steam toward Station 36, the sun shone more brightly through the overcast. We passed between a couple of humpback whales, lazing on the surface. Our sooty shearwater "audience" fell behind. Hundreds of birds joined us at every station for days; we were never sure whether they were the same individuals, but the crowd was always there. They put their heads under water, intently peering at the nets as they surface and at the Greene Bomber. They seemed to gather 'round actively whenever anyone is on deck. They may make a good living from fishing boats, but we must have been a big disappointment.

The night watch completed Station 37, despite the distraction of a water fight on the back deck (won by Tony Alvernaz, at least in the near-term). Dolphins paced the ship for a while during the afternoon, one of the sunniest yet. The day watch came on during the steam to Station 38, which we reached after dinner. Once again, the pump hose floated to the surface on both sides of the ship; we separated the sections, and Kenny hauled them aboard on either side using the crane winch. Fog rolled across the ship and dripped from the decks as we continued the station work. We made a live tow for Ann Bucklin; the top 20 m were dominated by *Meganyctiphanes norvegica* and a few *Calanus*. The MOC-1 was deployed by the day watch and recovered by the night watch. The MOC-10 and drifter deployments completed the station work. All work for the cruise was completed at 1123 hr, making the winner of the pool Mate Scott Sirois.

The night watch stayed up after completing the station work, by their own choice, since their sleep schedules were shifted and they were unable to sleep. They worked to remove the MOC-1 and MOC-10 nets, and began lab clean up before going below. We continued steaming at 6 kn for an hour or so after the station, to allow Charlie Miller to complete his microscope work. Then, the ship sped up to 12 kn on the final leg of AL-9808.

Day 11: Friday, June 26th

The day watch was waked at 0515 as usual, but the night watch was allowed to sleep in until 0600. All hands packed up their gear, cleaned the science areas of the ship, and prepared to disembark and unload. So the final U.S. GLOBEC Georges Bank Study Broadscale cruise of 1998 wrapped up. Some of the scientists onboard the *R/V Albatross IV* were veterans of four, five, or even six of the cruises this year. Some of us only ventured out to Georges Bank once a year. The mixture of old hands and new players makes the Broadscale cruise a different adventure every time. The final *Stern View* acknowledged the assistance of the ship's crew with this Survey and the previous ones.

Lines were cast at Woods Hole at 0724 hr.

Individual Reports

Hydrography

(Maureen Taylor and David Nelson)

The primary hydrographic data presented here were collected using a Neil Brown Mark V CTD instrument (MK5), which provides measurements of pressure, temperature, conductivity, fluorescence and light transmission. The MK5 records at a rate of 16 obser-vations per second, and is equipped with a rosette for collecting water samples at selected depths.

Bongo hauls were made at each of the stations occupied. 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 following is a list of the CTD data collected with each of the sampling systems used on the cruise:

Instrument # Casts

MK5 40

MK5 calibration 40

SBE19/Bongo 42

SBE19 calibration 7

The MK5 was deployed with 9 bottles on the rosette and samples were collected for various investigators. At primary #1 and #2 stations, 400 mls were immediately siphoned out of two niskins (bottom and mid-depth) for observations of micro-zooplankton swimming behaviour (S. Gallagher, WHOI). Samples were collected for oxygen isotope analysis at selected depths (R. Houghton LDEO) and a sample was taken at the bottom for calibrating the instrument's conductivity data (D. Mountain, NMFS). Surface samples for phytoplankton species composition were collected and preserved for J. O'Reilly (NMFS) at full (priority 1 and 2) stations only. Samples for chlorophyll and nutrient analysis were taken from multiple depths at each of the standard stations (D. Townsend, Univ. Of Maine).

Parameter # samples

Oxygen isotope 130

Species composition 20

Data:

The SBE19 Profiler and the MK5 data were post-processed at sea. The Profiler data were processed using the Seabird manufactured software: DATCNV, FILTER, ALIGNCTD, BINAVG, DERIVE, ASCIIOUT to produce 1 decibar averaged ascii files. The raw MK5 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 (1 decibar) files using algorithms provided by R. Millard of WHOI, which had been adapted for use with the MK5.

A 3-4 m pressure offset on the MK5 CTD was noticed prior to cruise departure. A spare Seabird Seacat Profiler (#1447) was lashed to the frame of the MK5 to allow for a comparison of the pressure records from the two CTDs. The offset did not appear to be constant with increasing pressure (the offset diminished with increasing pressure). The Seacat remained lashed to the MK5 for the entire cruise to allow for verification of the depths at which bottles were fired. The MK5 is scheduled to be calibrated shortly after cruise completion.

During the first three days of the cruise, the MK5 CTD was deployed off the boom while repairs were made to the slip rings and termination on the hydro winch. Once repaired, CTD operations using the hydro winch went well.

Results:

The consecutive and standard station locations occupied during the Bank-wide survey are shown in Figure 2. The surface and bottom temperature and salinity distributions are shown in Figures 3 and 5. 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 4, 6, and 7. The distribution of fluorescence (expressed in volts) at the surface and bottom are shown in Figure 8. These figures were prepared prior to the occupation of standard station 38.

The volume average temperature and salinity of the upper 30 meters were calculated for the four sub-regions shown in Figure 9. These values are compared with characteristic values that have been calculated from the MARMAP data set for the same areas and calendar days. The volume of Georges Bank water (salinity < 34 psu) was also calculated and compared against the expected values. Profiles of each MK5 CTD cast with a compressed listing of the data are shown in Appendix IV.

All four areas of the Bank exhibited relatively fresher and slightly warmer conditions when compared with the MARMAP reference values. Nearly the entire Bank showed surface salinities less than 32 psu. It is not certain at this time if this "fresher" water on the Bank originated in the Gulf of Maine or from a "wash over" of Scotian shelf water across the Northeast Channel. The winds were very light during the course of the 10 day survey which most likely contributed to the slightly warmer temperatures (and higher degrees of density stratification) shown in the distribution figures.

The fluorescence values recorded during the survey seemed lower when compared with values from the 1997 June Broadscale survey. This will have to be verified with the total chlorophyll analysis that will be conducted at David Townsend's Lab.

Hydrography - Figure 1 (Re-Label Figure 2)

Hydrography - Figure 2 (Re-Label Figure 3)

Hydrography - Figure 3 (Re-Label Figure 4)

Hydrography - Figure 4 (Re-Label Figure 5)

Hydrography - Figure 5 (Re-Label Figure 6)

Hydrography - Figure 6 (Re-Label Figure 7)

Hydrography - Figure 7 (Re-Label Figure 8)

Hydrography - Figure 8 (Re-Label Figure 9)

Zooplankton and Ichthyoplankton Studies Based on Bongo and MOCNESS Tows

(John Sibunka, Maria Casas, Ted Durbin, Peter Garrahan, Rebecca Jones)

Objectives:

(1) 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 also includes larval distribution and abundance, and age and growth determination. These objectives were implemented through use of bongo net and 1-m^2 MOCNESS to make the zooplankton collections.

(2) The primary objective of the zooplankton group was to complete a bank-wide 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, quantify, and describe the occurrence of abundant non-target species in order to provide a description of 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 for sampling copepods and larger zooplankton, and submersible pumps for sampling the small, naupliar stages.

In addition to these objectives, the zooplankton group was responsible for obtaining

subsamples from the 1-m^2 MOCNESS hauls for population genetic studies of *Pseudocalanus* spp. to be completed by Ann Bucklin at the University of New Hampshire.

Additional tows were completed at 13 stations around the Bank using a bongo net fitted with cod end buckets to collect live copepods for copepod growth experiments using the RNA/DNA ratio technique for Ted Durbin at the University of Rhode Island, and for genetic studies conducted by Ann Bucklin. A bongo tow was completed to collect live pteropods (*Limacina* spp.) for Scott Gallager at the Woods Hole Oceanographic Institute.

Methods:

Bongo tows were made with a 0.61-m frame fitted with paired 335 �m mesh nets. Attached beneath the bongo frame a 45 kg ball was 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., 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 50 m/min and 20 m/min respectively. These rates were reduced in shallow water (<60 m) to obtain a minimum of a five minute tow or reduced due to adverse weather and sea conditions. A Seabird CTD was attached to the towing wire above the frame to monitor sampling depth in real time mode and to measure and record temperature and salinity. Once back on board, the 335 �m mesh nets were rinsed with seawater into a 330 �m mesh sieve. The contents of one sieve were preserved in 5% formalin and kept for ichthyoplankton species composition, abundance and distribution. The other sample was preserved in 95% ethanol and kept for age and growth analysis of larval fish. The same preservation procedure was followed as for the 1-m^2 MOCNESS.

At stations where the 1-m^2 MOCNESS system was not used, a second bongo tow was made. This frame was fitted with both 335 �m mesh and 200 �m mesh nets. 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 except maximum tow depth was 500 m. Wire payout and retrieval rates were 50 m/min and 20 m/min respectively. The nets were each rinsed with seawater into a corresponding mesh sieve. Large catches were subsampled so as to retain only one sample jar per net. The 200 �m mesh sample was retained for zooplankton species composition, abundance and distribution, and preserved in 10% formalin. The other sample (335 �m mesh) was kept for molecular population genetic analysis of the copepod, *Calanus finmarchicus*, and preserved in 95% ethanol. After 24 h of initial preservation, the alcohol was changed.

The 1-m^2 MOCNESS sampler was loaded with ten nets. Nets 1-4 were fitted with 150 �m mesh for the collection of older and larger copepodite and adult stages of the zooplankton. Nets 0, and 5-9 were fitted with 335 �m mesh for zooplankton (nets 0 and 5) and ichthyoplankton (nets 6-9) collection. Tows were double oblique from the surface to within 5 m from the bottom. The maximum tow depth for nets 0, 1 and 5 was 500 m, and for net 6 was 200 m (if net 5 was sampled deeper than 200 m, it was returned up to 200 m and closed). Winch rates for nets 0-5 were 15 m/min and for nets 6-9, 10 m/min. For those nets fished >200m, the decent rate was increased so the maximum vertical velocity of the MOCNESS was 25m/min. This was providing the net angle did not go below 25 and the net horizontal speed did not drop below 0.5 kts. The depth strata sampled were 0-15 m, 15-40 m, 40-100 m, and >100 m. 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 150 �m mesh sieve, subsampled using a 2-L plankton sample splitter if the final biomass volume was too large for one quart jar, and then preserved in 10% formalin. Samples from nets 5-9 were sieved through 330 �m mesh sieve and preserved in 95% ethanol. After 24 h of initial preservation, the alcohol was changed. The used ethanol was retained for disposal or recycling ashore. At priority 1 and 2 stations, 90-ml subsamples from the 150 �m mesh nets were removed and preserved in 10% formalin for Dr. C. Miller (OSU). In addition, at priority 1 and 2 stations, 90-ml subsamples from these same nets were removed and preserved in 95% ethanol. These samples were collected for Dr. A. Bucklin for population genetic studies to distinguish the *Pseudocalanus* species found on Georges Bank.

The 10-m^2 MOCNESS was loaded with five 3.0 mm mesh nets. Tows were oblique from surface to ~10 m from bottom or a maximum depth of 500 m. The same depth strata were sampled as with the 1-m^2 MOCNESS. The winch rate for retrieval varied between 5 and 15 m/min depending on the depth stratum. The slow winch rates were used in order to filter at least 4,000-5,000 m^3 of water per depth stratum sampled. A stepped oblique tow profile during retrieval was used to achieve this, if needed. Catches were sieved through a 335 �m mesh, and preserved in 10% formalin. A selected number of juvenile cod and haddock were removed from the catches, measured to the nearest millimeter, and preserved in 95% ethanol. These juvenile fish will be used for age and growth analysis.

In order to collect nauplii and younger, smaller copepodite stages of zooplankton, a gasoline powered diaphragm pump was used at all priority 1 and 2 standard stations. At stations 3, 9 and 18 a comparison pump was made between the diaphragm pump and the centrifugal Pacer pump which had been in use in previous Broadscale cruises. Analysis of the pump samples from previous years suggested the possibility that the youngest developmental stages of *Calanus* (the first nauplius stage, N1, and possibly the second, N2), were being lost during the process of sampling with the centrifugal pump. In an earlier test with a diaphragm pump during February of 1998, we collected more N1s than with the centrifugal pump, and the series of comparisons between the two pumps carried out during this cruise should provide us with more conclusive evidence.

The same general procedure for deploying the pump hose was followed at both standard and comparison pump stations. The intake hose was used for both pumps and was deployed off the main boom by connecting the intake end, fitted with a 1.7-L Niskin bottle cut in half lengthwise, to the winch wire. The boom winch meter block was zeroed at the surface and the wire out reading was used to determine the depth of the cast. Two 45 kg weights were used to depress the array. Two, three or four 30-m sections of 7 cm diameter hose were connected to the pump (depending on the depth of the station), allowing the intake hose to attain a maximum depth of approximately 100 m. At shallow stations, the intake hose nozzle was lowered to 3 meters off the bottom. With the centrifugal pump water went directly to the flow meter and then into the 35 �m mesh collection net, while with the diaphragm pump the output was diverted to a surge dampener and then to the collection net. This caused the flow to be more laminar as it passed the flow meter and into the net, allowing a more accurate measurement of flow rate. Once the hose had been deployed to the desired depth it was raised at a constant rate and samples collected. Wire retrieval rate was approximately 4 m/min which provided volumes of about 200 L per 5 m depth interval with the diaphragm pump. After raising of the hose had begun, an interval was allowed for the hose to flush before collection began. Similarly, once the hose had reached the surface the hose was allowed to flush before collection was completed. Flushing time was 80, 120 and 160 sec for 2, 3 and 4 sections respectively. At regular pump stations with a maximum sampling depth of more than 85 m, samples were taken from the maximum depth to 75 m, 75-40 m, 40-15 m, and from 15 m to surface. At stations with a maximum sampling depth of less than 85 m, samples were taken from the maximum depth to 40 m, 40-15 m, and 15 m to surface. The depth at which nets were switched at the top of each depth interval was adjusted depending on the wire retrieval rate and the hose flushing time to allow water to be flushed through the hose. For the comparison pump a series of three profiles of the entire water column were collected with each pump. Pumps were switched after each profile. All samples were sieved through a 30 �m mesh sieve and preserved in 10% formalin.

Tows for live specimens:

To collect live specimens of zooplankton, a 0.61-m bongo frame was fitted with both 335 �m mesh and 200 �m mesh nets. Cod end buckets were attached to the ends of the bongo nets. The array was depressed with a 45-kg weight. Tows were single oblique to maximum depth of 20-30 meters. Vessel speed was 1.5 kts; wire payout was ~40m/min and the retrieval rate was <5 m/min.

The pteropods collected in the cod end buckets of the bongo nets were gently released into 30-gallon plastic cans previously filled with seawater using the diaphragm pump system. These samples were returned to Woods Hole for both rearing and behavior experiments.

Samples collected for the copepod *Calanus finmarchicus* were sorted at sea and selected specimens were frozen in liquid nitrogen for genetic analysis ashore.

Samples Collected by the Zooplankton and Ichthyoplankton Groups:

<u>Gear Tows Number of Samples</u>

1. Bongo nets, 0.61-m 42 tows 41 preserved, 5% formalin

335-�m mesh 42 preserved, EtOH

200-�m mesh 1 preserved, 10% formalin

2. MOCNESS, 1-m^2 41 tows

150-�m mesh (Nets 1-4) 120 preserved, 10% formalin

335-�m mesh (Net 0) 41 preserved, 10% formalin

335-�m mesh (Nets 5-9) 161 preserved, EtOH

3. MOCNESS, 10-m^2 32 tows

3.0-mm mesh 127 preserved, 10% formalin

4. Pump 19 profiles

35-�m mesh 63 preserved, 10% formalin

5. Pump-C 3 profiles 18 preserved, 10% formalin

35-�m mesh

Preliminary Summary of Ichthyoplankton Findings (John Sibunka)

All samples from the Bongo net B (Samples preserved in 5% formalin) were subjected to a preliminary examination for eggs and larvae while on ship. The following qualitative observations of the larval size, abundance and egg abundance were made in the jars after preservation.

<u>American plaice/yellowtail flounder (*Hippoglossoides platessoides*/*Pleuronectes ferrugineus*):</u>

Microscopic examination is required to separate American plaice from yellowtail flounder larvae at sizes <16mm standard length (SL). Transformation for American plaice flounder begins at 18.0-34.0mm SL, usually >25mm standard length (SL); whereas yellowtail flounder commence transformation at 11.6-16.0mm SL. Since most of these flatfish larvae collected during this survey were less than 15.0mm SL, they were combined into one category. It is likely that the majority of these larvae are yellowtail flounder as the adults of this species on Georges Bank begin spawning later in the spring than American plaice and continue spawning into the summer months.

These fish were the most abundant larvae seen in the bongo plankton catches from this cruise. Their distribution ranged virtually across Georges Bank (Figure 9). The largest catches of larvae were made in the west central portion of the Bank. This is in contrast to the findings of the May survey (refer *R/V Albatross IV* cruise AL-9806 cruise report) where most of the American plaice/yellowtail flounder larvae were caught within the 60m isobath on Georges Bank. During this June survey, there did not appear to be any area on the Bamk where small larvae were concentrated. The size range of American plaice/yellowtail flounder larvae collected this cruise were between 5.0 and 16.0mm SL.

<u>Cod (*Gadus morhua*), Haddock (*Melanogrammus aeglefinnus*), and Cod/Haddock eggs:</u>

The only occurrence of haddock larvae seen in the bongo plankton samples examined this cruise was at standard station 25. This station is located on the Scotian Shelf region of the survey area. Two specimens were collected with an approximate size of 12 and 14 mm SL. Also seen in the sample from this station were an estimated twenty to thirty cod/haddock eggs. No cod or haddock larvae, nor the eggs of these gadoids were collected on Georges Bank during this June Broadscale survey. These results, which are similar to the results of previous Broadscale surveys in June (refer *R/V Albatross IV* , cruises AL-9607 and AL-9707 cruise reports) indicate that cod and haddock had almost completed spawning in the survey area for this year. Both post larval and juvenile stages of cod and haddock were seen in the 10-m^2 MOCNESS samples collected on this cruise (refer 10-m^2 MOCNESS catches/station in this report).

<u>Miscellaneous Fish Larvae:</u>

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

1. Windowpane flounder *Scophthalmus aquosus*

2. American plaice (>15.0mm) *Hippoglossoides platessoides*

3. Sculpin *Myoxocephalus* sp.

4. Yellowtail flounder (>15.0mm) *Pleuronectes ferrugineus*

5. Sea snail *Liparis* sp.

6. Fourbeard rockling *Enchelopus cimbrius*

7. Hake (red and/or white) *Urophycis* sp.

8. Atlantic mackerel *Scomber scombrus*

9. Fourspot flounder *Hippoglossina oblonga*

Figure 10. Preliminary distribution and relative abundance of American plaice / yellowtail flounder larvae from *R/V Albatross IV* Broadscale Survey cruise AL-9808, 16 - 26 June 1998.

Zooplankton Observations: Life Histories of Copepods

(Charles Miller)

Compared to June Broadscale cruises in previous years, zooplankton were sparse around and over Georges Bank in June 1998. The predominant zooplankton on the shallow portions of the Bank (e.g., Stations 11, 12, 30, 32; see Figure 10) was *Centropages hamatus*. There were some hydroids at the shallow stations as well, somewhat less than *C. hamatus* in biomass and never prodigious quantities like we saw in 1994 and 1995. No MOC-1 samples needed splitting to save. Other components of the shallow area zooplankton were modest numbers of *Centropages typicus*, *Sagitta elegans*, and *Pseudocalanus* spp. A very few late stage *Calanus finmarchicus* remained over the bank, particularly on the south half.

Zooplankton on the sloping section of the Northeast Peak (e.g., Stations 20, 21, 23, 24 and 26) were a mixture of *C. finmarchicus* and *Pseudocalanus* spp. The stocks were not large, again never requiring splitting for preservation. *Calanus* were mostly near the bottom with virtually none in the upper nets. At Stations 7 and 16 off the south slope of the bank there was a sparse stock of resting *C. finmarchicus* at depth, none in the warmed surface layers.

Station 25 on the Scotian Shelf contained primarily late-stage *Calanus* at all depths, with an admixture of *Pseudocalanus* spp. This was the only station on the cruise which showed significant numbers of *Calanus glacialis* and *Calanus hyperboreus*. That is consonant with the notion that they are recurringly re-supplied to the Gulf of Maine area from upstream, rather than sustaining a stock there by reproduction and good survival.

Stations along the south edge of the Gulf of Maine (e.g., Stations 29, 40, 38) had resting *C. finmarchicus* fifth copepodites at depth. Quantities, however, were extremely low compared to other years. In this area in 1995 and 1996 we often split samples repeatedly to obtain a quantity suitable for preservation, particularly in the SCOPEX gyre (Stations 34 and 38). >From all levels it was not been unusual to throw out 15/16 of a sample, retaining half or three-quarters liter to represent the whole. This year that preservable amount was never exceeded in the sample itself; no splitting whatever was required. The surface layer was completely abandoned by *Calanus* at all Gulf of Maine stations. Thus, the "deposited" resting stock of *Calanus* for 1998 was less than a tenth of earlier observations. The usual full range of oil sac fullness was observed, but individuals with very small oil sacs were much more common than in other years. An example specimen is shown in Figure 11. Whether this matters to survival and subsequent reproduction is not known. There were virtually no *Calanus* (and very little other plankton) in upper layers in the Gulf. Apparently the "G2" generation of *Calanus* either ended early or essentially failed. This is great good fortune for the U.S. GLOBEC Georges Bank study, because only by comparing years with strong differences will we learn what matters to secondary production in this region.

Observations of gonad morphology in fifth copepodites of *C. finmarchicus* were made at 14 stations on the cruise. It now seems there are two shapes for the gonad in the resting stage which show substantial growth and change from the rudiment carried forward from the fourth copepodite.. In one the gonad rudiment is a thin tube of cells closely attached over the oil sac. In the other it is football-shaped and located at the back of the cephalosome somewhat above the oil sac. It is possible these are two extremes of the same facies, but the tendency to be one or the other seemed clear on preliminary evaluation of the data. The difference may be between presumptive males and females. One facies or the other was strongly dominant at most stations, but they could also be mixed. A third group of apparently resting individuals had gonad rudiments less than 0.2 mm long, indicating no growth after the fourth copepodite stage. It is possible these were forced into rest before significant gonad growth. It could also be a third resting state for the gonad 'anlagen'. Out of 370 close examinations, fewer than 10 individuals seemed to be headed for summer maturation. This probably corresponds with the general observation that *Calanus* was "shut out" of surface layers relatively early in 1998.

Figure 11. *Calanus finmarchicus* fifth copepodite from near-bottom layer at AL-9808 Broadscale Survey Station 38, June 1998. The oil sac is unusually small for a resting individual. The gonad shows the larger resting facies.

Copepod RNA/DNA Measurements

(Ted Durbin and Maria Casas)

We are measuring RNA/DNA ratio on the many different species of copepods present on Georges Bank to determine if there are differences between species at each station, and whether the ratio of a single species varies at different locations around the Bank. Copepods were sorted from the live tows at selected stations, an image of them saved on video so that we can later measure their lengths, and then frozen in liquid nitrogen for RNA, DNA and total protein analysis later back at the lab. The species sorted include *Calanus finmarchicus*, *Temora longicornis*, *Centropages typicus*, *Centropages hamatus*, *Pseudocalanus newmani*, *Metridia lucens* and *Pseudocalanus moultoni*. For *Calanus* we collected adult females and C4 and C5 copepodites, while for the other species adult females were collected.

Zooplankton Collections for Population Genetic Analysis

(Ann Bucklin and Maria Guarnieri)

Population genetics studies of *Calanus, Pseudocalanus*, and several other species (e.g. the euphausiid, *Meganyctiphanes norvegica*) are being conducted at the University of New Hampshire by A. Bucklin. The analyses to date have examined the possibility of using genetic characters to understand sources of Bank populations of *Calanus finmarchicus* and the use of DNA sequence variation to discriminate the sympatric sibling species of *Pseudocalanus*.

The Bank-wide distribution and abundance of *P. moultoni* and *P. newmani* are being mapped (based on molecular discrimination of the species) for 1997 and 1998 as part of our Phase II effort. Collections for this work are 90 ml subsamples removed from the #1 - 4 nets (150-�m mesh) of the 1-m^2 MOCNESS at ~20 stations of primary and secondary priority. All samples are preserved in 95% ethyl alcohol, which is changed during the first 24 hr period after collection.

The integrated downhaul collected in the #5 net on the 1-m^2 MOCNESS is also preserved for genetic analysis in 95% ethyl alcohol. We are using these samples to continue studies of *C. finmarchicus, M. norvegica*, and phylogenetic analyses of several copepod and euphausiid groups. The archived sample set (January - June surveys for 1995 - 1999) will provide an invaluable future resource for researchers and students on many different topics and species.

On AL-9808, 13 live-tows (using a bongo net with 200 and 333 um mesh net towed from 20 m to the surface) were completed. The samples were sorted immediately for species of interest, including the copepods *Calanus finmarchicus* and *Pseudocalanus* spp., and the euphausiid *Euphausia krohnii*. Individuals were deep-frozen in liquid nitrogen for molecular and biochemical analysis. The goal of this study is to determine the DNA sequence of coding regions of nuclear genes that may be used as indicators of selection and / or population differentiation. These studies will provide a basis for some aspects of our Phase III activities.

Phytoplankton Chlorophyll, Nutrients and Light Attenuation Studies.

(David W. Townsend, Keska Kemper)

Water samples were collected during the June 1998 *R/V Albatross IV* Broadscale survey cruise to Georges Bank for the analysis of:

- *dissolved inorganic nutrients* (NO_3+NO_2, NH_4, SiO_4, PO_4);
- *dissolved organic nitrogen and phosphorus;*
- *particulate organic carbon, nitrogen and phosphorus,* and
- *phytoplankton chlorophyll a and phaeophytin*

These results will be posted on our web site (http://grampus.umeoce.maine.edu/globec/globec.html) as soon as they become available.

Collections were made at various depths at all of the regular hydrographic stations sampled during the June 1998 Broadscale survey cruise aboard *R/V Albatross IV* , using the 1.7 liter Niskin bottles mounted on the rosette sampler. Additional surface water samples were collected at positions between the regular stations using a Kimmerer Bottle to sample a depth of 2 m.

Light attenuation of photosynthetically active radiation (PAR) was measured at several stations at or about noon when sea state conditions allowed. A LiCor underwater spherical quantum sensor and deck-mounted cosine quantum sensor were used to compare the underwater light field as a function of depth and coincident surface irradiance.

Samples for dissolved inorganic nutrients and chlorophyll were collected at all stations (full and intermediate). Water samples for DIN were filtered through 0.45 �m Millipore cellulose acetate membrane filters, and the samples frozen immediately in 20ml polyethylene scintillation vials by first placing the vials in a seawater-ice bath for about 10 minutes. Samples will be analyzed on shore immediately following the cruise using a Technicon II 4-Channel AutoAnalyzer.

Water samples (50 mls) for dissolved organic nitrogen, and total dissolved phosphorus were collected at 2 depths (2 and 20 m) at each of the main stations and frozen as described above. These samples will be analyzed ashore using a modification of the method of Valderrama (1981).

Samples for particulate organic carbon and nitrogen were collected by filtering 500 mls from 2 depths (2 and 20 m) at each of the main stations onto pre-combusted, pre-ashed GF/F glass fiber filters, and filters frozen for analysis ashore. The filters will be fumed with HCl to remove inorganic carbon, and analyzed using a Control Equipment Model 240-XA CHN analyzer (Parsons *et al.*, 1984).

Samples for particulate phosphorus were collected as for PON (but 200 mls will be filtered) and frozen at sea. Laboratory analyses will involve digesting the sample in acidic persulfate and then analyzing for dissolved orthophosphate.

Phytoplankton chlorophyll *a* and phaeopigments were measured on discrete water samples collected at all stations and determined fluorometrically (Parsons *et al.*, 1984). The extracted chlorophyll measurements involved collecting 100 ml from all bottle samples taken at depths shallower than 60 m, filtering through GF/F filters, and extracting the chlorophyll in 90% acetone in a freezer for at least 12 hours. The samples were analyzed at sea using a Turner Model 10 fluorometer. These data will be used in regressions against measurements of *in situ* fluorescence as part of the regular CTD casts.

Literature Cited:

Parsons, T.R., Y. Maita and C.M. Lalli. 1984. *A Manual of Chemical and Biological Methods for Seawater Analysis*. Pergamon, Oxford. 173 pp.

Valderrama, J.C. 1981. The simultaneous analysis of total nitrogen and total phosphorus in natural waters. *Marine Chemistry* 10: 109-122.

The Importance of Microzooplankton in the Diet of Newly Hatched Cod Larvae

(Scott Gallager, Keska Kemper and Richard Schlenker)

The main objective of this study is to characterize seasonal changes in the potential prey field for newly hatched cod larvae with respect to prey motility patterns and the prey size spectrum. Samples are collected from three locations in the water column (near bottom, pycnocline, and surface) at selected Broadscale stations from January through June.

Methods:

Water samples are collected from the near bottom, and pycnocline areas of the water column using Go-Flo bottles on the Neil Brown Mark V CTD. Surface samples are collected with a plastic bucket. Go-Flo bottle samples are collected by gently siphoning from the top of the bottle instead of the normal port so that delicate microplankton are not disrupted. Tissue culture flasks (200-ml) are filled after being dipped in soapy water and air dried to prevent fogging. To further prevent fogging as well as maintaining a constant low temperature, flasks are transferred to an incubator at 5^{o}C immediately after filling. Each flask, in turn, is placed in a holder across from a B/W high-res Pulnix camera fitted with a 50-mm macro-lens and directly in front of a fiber optic ring illuminator fitted with a far-red filter. This apparatus is suspended within the incubator by bungee cord to reduce vibration produced by the ship. Recordings are made using a Panasonic AG1980 video recorder with SVHS formatted cassettes, a Panasonic TR-124MA Video Monitor, and a Horita Time Code generator. After about five minutes, the flask is replaced with the next sample and recordings continue. The field of view is set to ~10 mm.

Results:

Samples from Priority #1 stations were recorded and then preserved in 10% Lugols solution. Water samples from Priority #2 stations were recorded but not preserved.

Post cruise processing:

Motility patterns will be analyzed with the Motion Analysis EV system. The final output will be particle size distribution and a motility spectra associated with each particle. This will be compared with species composition in the microzooplankton fraction preserved in Lugols solution.

High Frequency Acoustics

(Peter Wiebe and Karen Fisher)

As on two previous Broadscale cruise this year (ALBATROSS 9801 in January and OCEANUS 319 in March), the primary focus of the bioacoustical effort on this cruise was to make high resolution volume backscattering measurements at 120 kHz and 420 kHz of plankton and nekton throughout the Georges Bank region. Work on this cruise was designed to provide intensive continuous acoustic sampling along all the shipboard survey track lines in order to cover the entire Georges Bank region. The data are intended to provide acoustical estimates of the spatial distribution of animals which span the size range of the target species (cod, haddock, *Calanus*, and *Pseudocalanus*) and their predators. The spatial acoustical map and the along track temperature, salinity, and fluorescence data are also intended to provide a link between the physical oceanographic conditions on the Bank and the biological distributions of the species as determined from the net collections at the stations distributed throughout the Georges Bank region. Continuous acoustic data between stations can be used to identify continuity or discontinuity in water column structure which can in turn be used to qualify the interpretation of biological and physical data based on the point source sampling.

Backscattered energy returning to the transducers following a ping from the transducer can come from more than just echoes from the animals in the water column. On top of the Bank, in the well-mixed area, sand grains in large numbers are often transported all the way to the sea surface and these are good sound reflectors especially at 420 kHz. Data from previous cruises indicate that they often produce most of the backscattering observed in waters shallower than 50 or 60 meters. In the deeper waters of the Bank, backscattering may come from internal waves independently of the animals living in the water column possibly due to sound speed or density contrasts that are the result of physical microstructure or turbulence in the wave. A further complication results from the fact that the animals themselves do not reflect sound in proportion to their numbers or biomass. Some zooplankton (i.e. copepods, jelly fish, salps) are relatively weak scatterers and others are extremely efficient scatterers (pteropods, siphonophores).

Methods.

On this cruise, a portion of the *R/V Albatross IV* chem lab was the operations center for the high frequency acoustics work. The "acoustics system" consisted of the "Greene Bomber" (see Figure 1 in the cruise report of *R/V Albatross IV* cruise AL-9801), the chartreuse five-foot V-fin towed body, a Hydroacoustics Technology, Inc Digital Echo Sounder (HTI-DES), several computers for data acquisition, post processing, and logging of notes, plus some other gear. In the Greene Bomber, there were two down-looking transducers (120 and 420 kHz each with 3 degree beams), a multiplexor pressure case for multiplexing the data from the two transducers, and an Environmental Sensing

System (ESS). The ESS was mounted inside the V-fin with temperature, conductivity, and fluorescence sensors attached to a stainless steel framework outside of the fiberglass housing. A downwelling light sensor was attached to the tail. The fish was also carrying a transponder that would have proved useful in locating it if it had happened to break free of the towing cable.

The tow-body was deployed from the starboard quarter of ALBATROSS and collected data both during and between stations. The general towing speed was about 7.0 kts. The echosounder collected data at two pings per second per frequency during most of the cruise. Conditions for conducting an echo sounder survey of the Bank were ideal during a good portion of this cruise. There was essentially no wind and the seas were calm for most of the cruise. We did however, have some electrical problems which degraded the quality of the data being collected. Higher than normal system noise levels were present at the start of the cruise and persisted for the duration of the cruise; we were not able to determine their source. Further, at Station 23, an intermittent problem developed which involved frequent but variable dropouts of the transmitted/received pings. The problem was most acute when we came on some, but not all stations and towards the end of the cruise became intermittent during both along track and station work. Considerable time was spent trying to identify the source of problem with the assistance of Henry Jenkins, the ship's Electrical Technician. But nothing definitive was determined. Although the data are not high quality and will require extensive editing, we were able to collect acoustics data along the entire trackline of the cruise. The length of trackline acoustically mapped was ~630 nm (1167 km - Figure 12).

In the lab, the data came in on a single 24 conductor cable with separate shielded groups of wires, one for each transducer and one for the ESS (Figure 13). The HTI-DES has its own computer (a PC104-80486 -100 MHz) and five digital Signal Processor boards (DSPs). It received the data from the transducers, did a series of complex processing steps, and then transferred the results to the Pentium PC over a local area network (LAN) where the data were logged to disk and displayed. The "raw" unprocessed data were also written to a DAT tape (each tape holds two gigabytes of data and we used about 91 tapes during this cruise). Immense amounts of data were handled very quickly by this system. The environmental data came into a second PC and were processed, displayed, and logged to disk. Both systems required GPS navigation data and those data were being supplied by the ship's P-code GPS receiver which were logged as part of the E SS data stream. Periodically, the data were transferred to a third computer for post-processing. It was at this stage that we could visualize the acoustic records and begin to see the acoustic patterns which were characteristic of the Bank.

Preliminary Results:

This has been the "year of the pteropod". The pteropod, *Limacina retroversa*, turned out to be much more abundant than in the past around the outer margin of the Bank during all of the Broadscale cruises beginning in January and ending in June. Within the 60 meter isobath where the water remains well-mixed all year, this species was relatively low in abundance. In the areas of the Bank that were stratified, *Limacina* was in substantial numbers in layers associated with the bottom of the mixed layer or there about. Its abundances on this cruise matched those we saw in January and March of this year and in May/June of 1992 on *R/VAlbatross IV* cruise AL-9404. Based on net tow observations in February, April, and May of this year, in addition to those on which acoustics measurements were made, it appears that *Limacina*'s abundance remained high for the entire first half of the year. As indicated above, this animal reflects sound back to the echosounder much more effectively than most other animals. Given the high numbers of individuals found in many of the net hauls in the same depths where the strong acoustic layers reside, we can begin to assume they were a major contributor to these layers.

Since the tidal mixing front which divides the well-mixed area on top of the Bank from the deeper stratified waters will be the subject of intense study during Phase III of the U.S. GLOBEC Georges Bank Study, the results presented here will focus on this frontal region as it stretches from the Great South Channel to the North East Channel along the southern flank, and then back along the northern flank of the Bank into Wilkinson Basin. The tidal mixing front is usually a sharp dividing line between the well-mixed and the stratified areas of the Bank. During this cruise, as well as the cruises in March and January of this year, this front showed up acoustically as a remarkably abrupt change in acoustic properties in each of the crossings along the southern flank and also along the northern flank (Figures 14a-14g). In the some sections e.g. Sections E, F, G, the change from stratified conditions to well-mixed conditions took place only over a few hundred meters (Figures 14e-14g). In these cases, surface temperature and sometimes salinity also changed abruptly at the "acoustic front". In others, such as Sections C and D, the change took place over more than 1000 meters (Figures 14c, 14d) and, perhaps as a result, temperature and salinity did not show a dramatic change. The pteropod, *Limacina retroversa* was very abundant in the zone where backscattering is highest going from the stratified region into the well-mixed region (see Sections E, F, and G).

Large well formed internal wave packets were not as evident in the acoustic records on this cruise as on previous June cruises. There was evidence for a wave in the stratified region to the left of the front in Section A (Figure 14a). In the nearby area of Station 38, which was sampled at the end of the cruise, another internal wave was clearly seen (Figure 15). This one was evident in the echogram from top of the water column to bottom.

The fluorescence data collected along the Greene Bomber trackline provided a bank-wide picture that was dramatically different from the one observed in March of this year on *R/V Oceanus* Cruise 319 (Figure 16). On this cruise, very high levels of fluorescence were present throughout the well-mixed region and much lower values were observed in the stratified regions of the Bank and the deeper Slope Water and Gulf of Maine waters (Georges Basin, Franklin Basin, and Wilkinson Basin). In contrast, in March, the highest fluorescence values were observed in frontal regions around the periphery of the Bank and much lower values were observed on top of the Bank.

Table 1. Acoustic Data Summary and concomitant observations.

Data Acquisition Log for ALBATROSS IV - GLOBEC Cruise 9808

HTI-244 Echosounder running 120 and 420 kHz Tranducers, config file "JUNE AL9808.cfg"

Sta/Leg	Date	DAT Tape #	Start DAT	Stop DAT	Acoustic File	Start ESS	End ESS	ESS File Name	Comments
test	98166		1658	1711	W1661703		0954	gb00001	Dip test in Vineyard sound both ESS and acoustics
1					W1680220				Noise/calibration on deck/end of Station 1
1-2	98168	1	0301	0506	W1680255				1348 GMT now ok
1-2	98168								
1-2	98168	2	0507	0715		0255	0621	gb00001	???
2	98168	3	0716	09??		0624	1029	gb00002	Start ESS at start of Station #2
									Start Data tape during MOC-1 tow

41	98168	4	09??	1126	W1681030	1029	1603	gb00003	Fixed time on p166 and DX@-66 computers (setback ~3 minutes); At Station#41 started new files
41	98168	5	1128	1335					
41-3	98168	6	1336	1543					
3	98168	7	1544	1752	W1681604	1604	0129	gb00004	2 nm from Station #3
3	98168	8	1752	1959	W001604				Station #3 (pump)
3	98168	9	2001	2206					
3-4	98168	10	2207	0014					Leaving Station#3
3-4	98169	11	0014	0224	W1690131	0130	0648	gb00005	Station #4
4	98169	12	0224	0431					
4-5	98169	13	0431	~0640					
5	98169	14	~0642	0859					
5	98169				W1690711	0656	1029	gb00006	At Station 5, zipped and transferred to p233 ess 1_5 and all acoustics files w168*.*
5	98169	15	0859	?					Just as leaving Sta #5, started new DAT tape, missed catching end of last tape by about 10 min.
6	98169				W1691059	1055	1120	gb00007	Started new ESS file at start of Station #6- problem with GPS on HTI-DES noticed. No GPS coming in.
6	98169				W1691110				Problem getting 120 kHz to work (420 kHz ducer OK)
6	98169				W1691157				Calibration file-testing after pulling fish to clean 120 kHz connectors
6	98169	16	1225	1437	W1691224	1223	1645	gb00008	started when Moc-10 went in STATION 6
6-7	98169	17	1432	1639					
7	98169	18	1639	1847	W1691646	1645	0302		5 min to STATION 7
7	98169				end@ 1815				change sounder.exe to sounder_new_3-98.exe
									rename sounder_old_3-98 to sounder.exe
7	98169				W1691824				restart using same sounder.exe as March OC319
7	98169								1834 DISABLED TRANSDUCERS (see noise1_18June.bmp- noise without ducer)--changed to 2 pings per second
7	98169				W1691847				
7	98169				W1691906				increase
7	98169				W1691908				mostly gain +_12, and 10kHz chirp, one bit with transducers turned on
7	98169				W1691934				changed sounder.exe back to the new version,changed gain back to 0dB, (see noise2_18Jun98.bmp)
7	98169				W1691941				noise test with chirp 10kHz, 1.25 �s, and receiver gain +12dB (see noise3_18Jun98.bmp)– new config file JuneAL9808.cfg
7	98169	19	2000	2209					Starting with a new config.cfg file JuneAL9808.cfg
7	98169	20	2209	0017					
7-8	98170	21	0018	0224	W1700303	0302	0552	gb00010	STATION 8
7-8	98170	22	0224	0430					missed tape change bringing in Moc-1
8	98170	23	0437	0718					
9	98170				W1700547				start new sounder file at 0 receiver gain to get bottom back-stopped when really on station to do file transfer
9	98170	24	0720	0926	W1700617	0612	1230	gb00011	new ESS started after file transfer while at STATION 9
9	98170	25	0927	1134					ESS went
9-10	98170	26	1135	1342					Henry heard the beeper and told me (at lunch)
10	98170				W1701232	1232	1558		started new files during bongo tow.
10	98170	27	1342	1554					started at end of STATION 10, when moc-10 in water
11	98170	28	1554	1801	W1701559	1559	2046	gb00013	STATION 11
11-12	98170	29	1801	2007					
11-12	98170	30	2009	2219					along the way to station 12
12	98170				W1702055	2047	0049	gb00014	end acoustics at 2046 and ESS (DON'T USE THIS FILE- PUMP IN)
12	98170				W1702113				Stopped to check the GPS - Restarted
12	98170	31	2219	0029	W1702223				Illegal operation and RESTART
12-13	98171				end @ 0017				SHUT DOWN lost Lantastic Reboot not ok, restarted from power off
12-13	98171	32	0029	0236	W1710023				
13	98171	33	0239	0444	W1710049	0050	0514	gb00015	STATION 13
13-14	98171	34	0444	0652					
14	98171				W1710514	0514	0925	gb00016	STATION 14- stopped processing acoustics to do file compression and transfer data after MOC-1
14	98171	35	0654	0859	W1710636				Starting files again after MOC-10
14-15	98171	36	0900 ?	1115					
15	98171				W1710927	0926	1328	gb00017	on STATION 15- changed files
15-16	98171	37	1116	1315					
15-16	98171	38	1319	1526					
16	98171				W1711330	1329	2316	gb00018	changed files at start STATION 16
16	98171	39	1526	1733					
16	98171	40	1734	1940					
16	98171	41	1942	2148	W1712129				started during MOC-10 trawl- ended acoustics to change ping rate to 2/sec- was 3.9/sec (2127)
16-17	98171	42	2204	0011	W1712318	2317	0532	gb00019	STATION 17
17	98172	43	0011	0220					
17	98172	44	0220	0430					
17-18	98172	45	0430	0634	W1720533	0533	1201	gb00020	STATION 18
18	98172	46	0635	0841					still on 18- end acoustics recording to zip and transfer data
18	98172				W1720653				0653 start acoustics
18	98172	47	0842	1047					STATION 18 some more
18-19	98172	48	1048	(1256)					on the way to next station - missed tape change...
19	98172				W1721203	1202	1626	gb00021	stopped acoustics at 1201- restart on station 19 at start of Moc-1
19-20	98172	49	1408	1612					END TAPE GAP

20	98172	50	1612	1825	W1721627	1627	2132	gb00022	STATION #20
20	98172	51	1825	2032					changed at start of moc-10
20-21	98172	52	2032	2239	W1722133	2133	0128	gb00023	STATION #21
21	98172	53	2239	0049					
22	98173	54	0049	0256	W1730129	0128	0543	gb00024	STATION #22
22	98173	55	0257	0404					STATION 22 still ...
22-23	98173	56	0404	0611					
23	98173				W1730554	0543	08??	gb00025	.closed for
23	98173				W1730808				lots of small files during a check out, but save W1730808 because it has system noise without cable attached to sounder box-
23	98173				W1730836				only cable(no mux line) plugged into back of DES
23	98173				W17308??				mux cable plugged in now but only 120 operation
23	98173				W1730849				restart from power off-this time good TVG from both transducers.
25	98173				W1731409				Back in STATION 25
25	98173	57	1436	1500	W1731440	1438	1500	gb00026	tape stopped/restarted...
25	98173	57	1534	1714	W1731524	1528	2021	gb00027	STATION 25 paused GB00027 for 20 min at 1600?
25	98173	58	1715	1922					
25-39	98173	59	1923	2129					halfway to next station
39	98173				W1732023	2022	0402	gb00028	2021 end acoustics at start of STATION 39
39	98173	60	2130	2337					changed dat at the end of CTD
39	98173	61	2337	0144					some HULL backscatter in the acoustic record
39-26	98174	62	0144	0353					underway
26	98174	63	0353	0604	W1740402	0402	0800	gb00029	STATION 26 stop recording to zip data @ 0520 and restar after moc1, before moc-10
26	98174				W1740532				trawl in on station 26
26	98174	64	0758	1004					TAPE GAP
27	98174				W1740801	0800	0949	gb00030	STATION 27- changed files
27	98174								0944 end again to steam for awhile back to #27
27	98174								1004 Dat TAPE GAP; GB out of the water
27	98174	65	1036	1244	W1741035	1034	1303	gb00031	Dat tape starts up again; new files
27-28	98174	66	1245	1445					underway right after fire and boat drill
28	98174				W1741308	1308	1702	gb00032	Sounder went south as we came on station; changed to 1 ping/sec RESTARTED system from POWER OFF
28	98174				W1741349				started up after taking cover off DES to check voltages
28-29	98174				W1741441				power down to check seawater switch resistors and back up
28-29	98174	67	1446	1653					
28-29	98174	68	1653	1900	W1741703	1703	0231	gb00033	*Everything on*
									starting at St. 29 lots of noise on echograms- made noise_st29.bmp
28-29	98174				W1741852				Tx off, rec on (2 images)
									closed file and opened a new one with tx disabled. Noise_29.bmp(start of moc and ctd) noise_29noxmit (xmit off file mocgoing down 2nd time).
29	98174	69	1927	2134	W1742022				Tx on, rec off (1 image)
									closed file and opened new one with tx disabled and bot receivers disabled (noises_29noxmit2.bmp)
					W1742102				Tx on, rec off closed file and opened new one with tx enabled and both receive disabled (noise_29noxmitnorec.bmp)
29	98174	70	2134	2343					new tape during noise experiment
29	98174	70			W1742251				TURN ALL ON, ducers off 2258, engines start up and steam
29-30	98174				W1742302				ALL ON for good for now...
29-30	98174	71	2343	0151					
29-30	98175	72	0151	0400					
30	98175				W1750232	0231	0820	gb00034	STATION 30
30	98175	73	0401	0608					
30-40	98175	74	0609	0815					
40	98175	75	0818	1025					STATION 40
40	98175				W1750821	0821	1319	gb00035	start and stop acoustics and ESS at St. 40
40	98175	76	1025	1246					on station 40, Moc-1 coming on board
40-31	98175	77	1246	1453					missed a few minutes on way to next station
31	98175				W1751325	1325	1648	gb00036	started again at start of station 31
31-32	98175	78	1454	1701					acoustics has gone to hell again for duration of station so shut system down to reboot- perhaps it is coming back now that ship is steaming- on way to station 32
32	98175				W1751649	1649	0007	gb00037	STATION 32 made sta33arr.bmp
32	98175	79	1701	1909					
32-33	98175				W1751844				RECYCLE POWER to see if I can get system to work better @ 1841- no luck.
32-33	98175	80	1910	2119					
33	98175	81	2119	2326					lost a few minutes between DAT tape change--
33-34	98175	82	2325	0133	W1760008	0008	0627	gb00038	STATION 34
34	98176	83	0135	0343					
34-35	98176	84	0343	0551	W1760433				only 6 knots... but terrible. NEW AC file in attempt to clean up record
34-35	98176	85	0551	0759	W1760528				POWER OFF RESTART NOISE and SIGNAL file
34-35	98176				W1760531				new file, no change, humpbacks breaching off port bow
35	98176				W1760628	0627	1139	gb00039	new acoustics file at STATION 35
35	98176	86	0759	1006					changed DAT during live bongo tow
35-36	98176	87	1007	1216					changed file while STEAMING to STATION 36

36	98176				W1761146	1143	1509	gb00040	at STATION 36- acoustics really WACKO- turned off/on; everything better at start, but not good
36	98176	88	1216	1423					DAT tape changed at start of Moc-10
36-37	98176	89	1424	1631	W1761509	1509	2316		STATION 37 (and same files for 38)
37-38	98176	90	1631	1839					
37-38	98176	91	1839	2045					
38	98176	92	2050	2256					
38-WH	98176				W1762329				Test file with fish on the deck- noise levels as before, very high
38-WH	98177				end@0025				

Wiebe figures 1 & 2 (Figures 12 and 13)

Wiebe figures 3a and 3b (Figure 14 a and b)

Wiebe figures 3c and 3d (Figure 14 c and d)

Wiebe figures 3e and 3f (Figure 14 e and f)

Wiebe figures 3g and 4 (Figure 14 g and 15)

Wiebe figure 5 (Figure 16)

Drifter Deployments

As part of the physical oceanographic studies of the current structure and circulation on Georges Bank being conducted by R. Beardsley and R. Limeburner, GLOBEC Drifter Buoys are deployed at strategic locations periodically throughout the year to track the Lagrangian flow from the point of deployment. This drifter is constructed with a holey sock drogue (a Dacron cylinder 2 m diameter by 3.8 m tall with 3 circular hoop stays; see Figure 17) at the bottom connected by either a 5.1 m cable to a small float (19 cm diameter) which in turn is connected by 2.4 m of cable to a larger spherical surface float (about 41 cm diameter). The surface float contains a sea surface temperature sensor, a GPS receiver, and an ARGOS satellite transmitter. Temperature, time, and position data are transmitted periodically to shore through the ARGOS telemetry system. On this cruise, three drifters were deployed. Single, ten-meter (shallow) drifters were released at stations 26, 30, 36, and 38.

Shipboard ADCP (Acoustic Doppler Current Profiler) Measurements.

The flow field over Georges Bank is driven by a complex set of forces. A primary factor is the strong semi-diurnal tides which dominate the high frequency variability (< 1 cpd) of the currents. Tidal rectification gives rise to a persistent sub-inertial clockwise circulation over the Bank. This circulation process can be substantially modified by the frequent storms common to the area, changes in the stratification of the Bank, and interactions with currents generated by offshore circulation features (i.e. Warm-Core Rings).

The Acoustic Doppler Current Profiler (ADCP) is one of the instruments being used to study the circulation processes on the Bank by C. Flagg and J. Candela. Water current measurements were obtained using an RDI ADCPs operating at 300 kHz. The 300 kHz system was operated continuously during the entire cruise. The transducers were mounted on the hull of the ship (5 m below the surface). The instrument was programmed to measure the current profile under the ship with a vertical resolution of 2 m, from 10 m depth to about 10 m from the bottom or up to a depth of about 120 m, whichever was shallower at a given location. The ADCP measures currents with respect to the ship. To obtain the water current with respect to the ocean bottom, the ship's motion needs to be removed from the current observations. The ship's motion will be removed using the bottom track (BT) velocity measured by the ADCP. Depending upon sea conditions, the ADCP can perform this operation in water depths shallower than 200 to 230 m. When the BT is lost, accurate navigation is used to remove the ship's velocity from the current.

The ADCP data collected on this cruise will be post-processed by Flagg and Candela.

Figure 17. Diagram of the holey sock drogue deployed on Broadscale cruise AL-9808. This drifter design was a modification from previous cruises, with altered dimensions to increase the likelihood that the drogue remained at the pre-determined depth.

Cruise Participants

<u>Scientific Personnel</u>

1. Ann Bucklin University of New Hampshire

2. Maria Casas University of Rhode Island

3. Ted Durbin University of Rhode Island

4. Karen Fisher Cornell University

5. Peter Garrahan University of Rhode Island

6. Maria Guarnieri University of New Hampshire

7. Rebecca Jones National Marine Fisheries Service, Narragansett

8. Keska Kemper University of Maine

9. Charles Miller Oregon State University

10. David Nelson University of Rhode Island

11. Richard Schlenker American School, Seoul, Korea

12. John Sibunka National Marine Fisheries Service, Sandy Hook

13. Maureen Taylor National Marine Fisheries Service, Woods Hole

14. Peter H. Wiebe Woods Hole Oceanographic Institution

Officers and Crew

1. Jason Maddox, LCDR Commanding Officer

2. Steve Wagner Acting Executive Officer

3. Scott Sirois Acting Operations Officer

4. Henry Jenkins Electronics Technician

5. Kenneth Rondeau Chief Bosun

6. Anthony Alvernaz Lead Fisherman

7. William Amaro Skilled Fisherman

8. Jorge Barbosa Fisherman

9. Anthime Brunette Fisherman

10. Anthony Veira Fisherman

11. John Hurder Chief Mechanical Engineer

12. Chuck Hursey Assistant Engineer

13. Orlando Thompson Assistant Engineer

14. Richard Whitehead Chief Steward

15. Jerome Nelson Chief Cook

Chief Scientist's Recommendations for Future Broadscale Cruises

1. MOC-10 Technical Assistance: Especially on May and June cruises, the MOC-10 deployments are a considerable effort. It would help enormously to have a technical person, probably from Larry Madin's group, onboard with particular interest and expertise in this gear.

2. Depth information for deep stations: There should be a depth sounder or readout for deeper stations in the computer room. At Stations 7 and 16, which are on the flank of the Bank, the depth of the water column may change rapidly during a tow. Both the MOC-1 and MOC-10 protocols call for tow depths within 10 m of the bottom. This recommended proximity requires real-time knowledge of depth for the safety of the gear and the ship.

3. Sampling at Slope Water stations: Care should be taken to ensure that all deployments at these stations are within the cruise protocol guidelines. Bathymetric variation and fixed fishing gear make this difficult, but knowledge of the Slope Water fauna is critical to the Georges Bank Study, and the temptation to head for shallow water (and the next station) before and/or during the MOC-10 tow should be avoided.

4. Reconsideration of MOCNESS flying protocols: The MOCNESS flying protocols, which are much improved from one year ago, should add descriptions of additional parameters diplayed on the data acquisition screen. In particular, it would be worthwhile standardizing horizontal net speeds for the MOC-10. The nektonic targets of the trawls may be able to avoid nets at slower towing speeds (0.5 - 0.7 kn seemingly typical of Broadscale cruises), but may be caught by towing at speeds of 1.5 - 2.5 kn. Presently, there is no mention of acceptible vertical velocities and optimal horizontal velocities. According to Peter Wiebe, the MOC-10 was designed to fly at 45 degrees at 1.5 - 2.5 kn (ideally 2.0 kn). Acceptable vertical velocities vary widely as long as the net is flying well; 10 m / min is certainly OK. These parameters may be valuable in encouraging more efficient sampling and allowing faster winch speeds. In addition, towing protocols for the MOC-10 should be standardized between the Broadscale and Process cruises, and between the various investigators (Larry Madin's predation group and Greg Lough's fisheries group), to ensure that the results are comparable.

5. Meter wheel and rate indicator on starboard winch: It would be worth configuring the CTD winch to allow its use as a backup for bongo net tows and pump profiles. This would require repairing or replacing the wire rate indicator and perhaps improving the safety provisions. It might also encourage more frequent use of the winch generally, which might reduce the maintenance problems associated with intermittent use.

6. Deployment of the plankton pump: The pump hose deployment is very sensitive to air and sea conditions, and requires full coordination between the bridge, winch operator, deck crew, and science. It is particularly important that the bridge wait to give the go-ahead to winch and deck crews until the ship has come to a full stop, and is drifting with the current. Currents at depth can still create problems for pump deployment, but there is a better chance of a vertical cast and less possibility of the ship drifting over the hose, or the hose floating to the surface on the starboard side of the ship.

7. Ship-to-shore communication: The email access onboard the *R/V Albatross* is much improved over several years ago, and now is quite convenient. It would be very advantageous to distribute the email addresses and contact guidelines to the science party in advance of the cruise, so that there is no delay in establishing communication to the ship. In addition, there should be back-up plans for the shore-based designated contact person, to ensure active communication despite absences. I strongly recommend that Bob Groman be designated as a Broadscale cruise contact person, in addition to Donna Busch, so that messages could go to and from either Donna or Bob. The designation of a human contact is important, in addition to the improved email access, since some messages will need to be sent by phone, FAX, or mail.

Appendix I. Cruise Event Log

					L	O	C A L				Water	Cast			
	Instr	cast#	Sta#	Sta_std	Mth	Day	hhmm	s/e	Lat	Lon	Depth	Depth	PI	Region	Comments
AL16798.01	Depart				6	16	1609	s	4131.50	7040.50	8	0	Bucklin	Broadscale	Depart Woods Hole, MA
AL16898.01	BongoSB	1	1	1	6	17	124	s	4100.40	6859.60	83	76	Sibunka	Broadscale	
AL16898.02	BongoSB	1	1	1	6	17	131	e	4100.20	6859.50	82	76	Sibunka	Broadscale	
AL16898.03	MK5CTD	1	1	1	6	17	135	s	4100.30	6859.50	82	77	Mountain	Broadscale	
AL16898.04	MK5CTD	1	1	1	6	17	145	e	4100.50	6859.60	82	77	Mountain	Broadscale	
AL16898.05	MOC-1	1	1	1	6	17	155	s	4100.90	6859.80	86	79	Durbin	Broadscale	
AL16898.06	MOC-1	1	1	1	6	17	240	e	4102.60	6901.50	82	78	Durbin	Broadscale	
AL16898.07	GreeneB	1	1	1	6	17	250	s	4102.60	6901.50	82	2	Wiebe	Broadscale	
AL16898.08	Kimmerer	1			6	17	446	s	4050.00	6859.30		1	Townsend	Broadscale	
AL16898.09	Kimmerer	1			6	17	447	e	4050.00	6859.30		1	Townsend	Broadscale	
AL16898.10	BongoSB	2	2	2	6	17	616	s	4039.10	6859.00	66	61	Sibunka	Broadscale	
AL16898.11	BongoSB	2	2	2	6	17	622	e	4038.90	6859.10	66	61	Sibunka	Broadscale	
AL16898.12	MK5CTD	2	2	2	6	17	626	s	4038.80	6859.10	66	62	Mountain	Broadscale	
AL16898.13	MK5CTD	2	2	2	6	17	640	e	4038.80	6858.90	66	62	Mountain	Broadscale	
AL16898.14	MOC-1	2	2	2	6	17	649	s	4038.70	6858.80	69	61	Durbin	Broadscale	
AL16898.15	MOC-1	2	2	2	6	17	719	e	4037.30	6859.50	69	61	Durbin	Broadscale	
AL16898.16	Kimmerer	2			6	17	832	s	4028.20	6859.60	77	1	Townsend	Broadscale	
AL16898.17	Kimmerer	2			6	17	833	e	4028.20	6859.60	77	1	Townsend	Broadscale	
AL16898.18	BongoSB	3	3	41	6	17	1018	s	4018.30	6859.40	96	91	Sibunka	Broadscale	
AL16898.19	BongoSB	3	3	41	6	17	1026	e	4017.80	6859.70	96	91	Sibunka	Broadscale	
AL16898.20	SBCal	1	3	41	6	17	1028	s	4017.70	6859.80	96	90	Mountain	Broadscale	
AL16898.21	SBCal	1	3	41	6	17	1036	e	4017.70	6900.40	96	90	Mountain	Broadscale	
AL16898.22	MOC-1	3	3	41	6	17	1046	s	4017.50	6900.40	97	93	Durbin	Broadscale	
AL16898.23	MOC-1	3	3	41	6	17	1134	e	4016.00	6902.20	102	94	Durbin	Broadscale	
AL16898.24	Kimmerer	3			6	17	1401	s	4024.50	6843.10	86	1	Townsend	Broadscale	
AL16898.25	Kimmerer	3			6	17	1402	e	4024.50	6843.10	86	1	Townsend	Broadscale	
AL16898.26	BongoSB	4	4	3	6	17	1606	s	4031.60	6827.00	92	86	Sibunka	Broadscale	
AL16898.27	BongoSB	4	4	3	6	17	1615	e	4031.50	6827.40	92	86	Sibunka	Broadscale	
AL16898.28	Pump-C	1	4	3	6	17	1622	s	4031.60	6827.50	92	89	Durbin	Broadscale	
AL16898.29	Pump-C	1	4	3	6	17	1640	e	4032.40	6827.50	89	89	Durbin	Broadscale	
AL16898.30	Pump	1	4	3	6	17	1641	s	4032.40	6827.50	89	88	Durbin	Broadscale	
AL16898.31	Pump	1	4	3	6	17	1845	e	4033.80	6826.70	84	88	Durbin	Broadscale	
AL16898.32	MK5CTD	3	4	3	6	17	1906	s	4032.30	6826.70	88	82	Mountain	Broadscale	
AL16898.33	MK5CTD	3	4	3	6	17	1918	e	4032.40	6826.40	88	82	Mountain	Broadscale	
AL16898.34	MOC-1	4	4	3	6	17	1928	s	4032.10	6826.30	89	85	Durbin	Broadscale	
AL16898.35	MOC-1	4	4	3	6	17	2022	e	4032.10	6828.50	87	84	Durbin	Broadscale	
AL16898.36	MOC-10	1	4	3	6	17	2056	s	4030.90	6827.50	82	62	Madin	Broadscale	
AL16898.37	MOC-10	1	4	3	6	17	2134	e	4034.50	6826.40	81	62	Madin	Broadscale	
AL16898.38	Kimmerer	4			6	17	2334	s	4045.10	6822.50	58	1	Townsend	Broadscale	
AL16898.39	Kimmerer	4			6	17	2335	e	4045.10	6822.50	58	1	Townsend	Broadscale	
AL16998.01	BongoSB	5	5	4	6	18	134	s	4059.90	6815.20	52	47	Sibunka	Broadscale	
AL16998.02	BongoSB	5	5	4	6	18	140	e	4100.20	6815.80	52	47	Sibunka	Broadscale	
AL16998.03	Pump	2	5	4	6	18	146	s	4100.40	6815.90	49	46	Durbin	Broadscale	
AL16998.04	Pump	2	5	4	6	18	204	e	4100.90	6816.40	50	46	Durbin	Broadscale	
AL16998.05	MK5CTD	4	5	4	6	18	222	s	4101.40	6816.70	47	41	Mountain	Broadscale	
AL16998.06	MK5CTD	4	5	4	6	18	234	e	4101.80	6817.00	44	41	Mountain	Broadscale	
AL16998.07	MOC-1	5	5	4	6	18	306	s	4100.30	6815.40	54	49	Durbin	Broadscale	
AL16998.08	MOC-1	5	5	4	6	18	329	e	4101.00	6816.90	46	45	Durbin	Broadscale	
AL16998.09	MOC-10	2	5	4	6	18	348	s	4101.50	6817.20	44	41	Madin	Broadscale	
AL16998.10	MOC-10	2	5	4	6	18	422	e	4101.70	6816.40	47	41	Madin	Broadscale	
AL16998.11	Kimmerer	5			6	18	544	s	4055.40	6807.10	54	1	Townsend	Broadscale	
AL16998.12	Kimmerer	5			6	18	545	e	4055.40	6807.10	54	1	Townsend	Broadscale	
AL16998.13	BongoSB	6	6	5	6	18	635	s	4050.80	6800.20	62	57	Sibunka	Broadscale	
AL16998.14	BongoSB	6	6	5	6	18	643	e	4050.70	6800.40	63	57	Sibunka	Broadscale	
AL16998.15	MK5CTD	5	6	5	6	18	650	s	4050.60	6800.50	64	60	Mountain	Broadscale	
AL16998.16	MK5CTD	5	6	5	6	18	700	e	4050.60	6800.40	64	60	Mountain	Broadscale	
AL16998.17	MOC-1	6	6	5	6	18	711	s	4050.70	6800.40	64	60	Durbin	Broadscale	
AL16998.18	MOC-1	6	6	5	6	18	743	e	4050.50	6801.40	66	62	Durbin	Broadscale	
AL16998.19	MOC-10	3	6	5	6	18	806	s	4049.80	6800.70	67	50	Madin	Broadscale	
AL16998.20	MOC-10	3	6	5	6	18	838	e	4048.80	6759.10	68	50	Madin	Broadscale	
AL16998.21	Live-Tow	1	6	5	6	18	848	s	4048.40	6758.80	67	20	Durbin	Broadscale	No CTD attached.
AL16998.22	Live-Tow	1	6	5	6	18	854	e	4048.10	6758.90	69	20	Durbin	Broadscale	

AL16998.23	Kimmerer	6			6	18	929	s	4045.20	6754.90	73	1	Townsend	Broadscale	
AL16998.24	Kimmerer	6			6	18	930	e	4045.20	6754.90	73	1	Townsend	Broadscale	
AL16998.25	BongoSB	7	7	6	6	18	1032	s	4040.00	6746.40	77	73	Sibunka	Broadscale	
AL16998.26	BongoSB	7	7	6	6	18	1040	e	4039.70	6746.80	78	73	Sibunka	Broadscale	
AL16998.27	SBCal	2	7	6	6	18	1042	s	4039.60	6746.90	79	40	Mountain	Broadscale	
AL16998.28	SBCal	2	7	6	6	18	1047	e	4039.50	6746.90	79	40	Mountain	Broadscale	
AL16998.29	MK5CTD	6	7	6	6	18	1051	s	4039.50	6747.00	78	72	Mountain	Broadscale	
AL16998.30	MK5CTD	6	7	6	6	18	1104	e	4039.40	6747.20	79	72	Mountain	Broadscale	
AL16998.31	MOC-1	7	7	6	6	18	1117	s	4039.10	6747.60	81	76	Durbin	Broadscale	
AL16998.32	GreeneB	1	7	6	6	18	1122	e	4038.90	6748.10	82	2	Wiebe	Broadscale	
AL16998.33	MOC-1	7	7	6	6	18	1157	e	4037.80	6749.30	83	75	Durbin	Broadscale	
AL16998.34	GreeneB	2	7	6	6	18	1220	s	4037.10	6748.50	84	2	Wiebe	Broadscale	
AL16998.35	MOC-10	4	7	6	6	18	1226	s	4037.10	6748.40	84	75	Madin	Broadscale	
AL16998.36	MOC-10	4	7	6	6	18	1302	e	4036.30	6747.70	85	75	Madin	Broadscale	
AL16998.37	Kimmerer	7			6	18	1445	s	4031.10	6733.60	112	1	Townsend	Broadscale	
AL16998.38	Kimmerer	7			6	18	1446	e	4031.10	6733.60	112	1	Townsend	Broadscale	
AL16998.39	BongoSB	8	8	7	6	18	1646	s	4027.10	6718.20	287	201	Sibunka	Broadscale	
AL16998.40	BongoSB	8	8	7	6	18	1707	e	4026.90	6719.20	269	201	Sibunka	Broadscale	
AL16998.41	Pump	3	8	7	6	18	1715	s	4027.10	6719.30	264	100	Durbin	Broadscale	
AL16998.42	Pump	3	8	7	6	18	1744	e	4027.70	6719.20	233	100	Durbin	Broadscale	
AL16998.43	MK5CTD	7	8	7	6	18	1824	s	4027.20	6717.80	276	268	Mountain	Broadscale	First attempt aborted - recast.
AL16998.44	MK5CTD	7	8	7	6	18	1848	e	4027.60	6717.60	266	268	Mountain	Broadscale	
AL16998.45	MOC-1	8	8	7	6	18	1859	s	4027.60	6717.70	266	280	Durbin	Broadscale	
AL16998.46	MOC-1	8	8	7	6	18	2047	e	4024.50	6720.50	466	280	Durbin	Broadscale	
AL16998.47	MOC-10	5	8	7	6	18	2117	s	4024.70	6718.60	>500	281	Madin	Broadscale	
AL16998.48	MOC-10	5	8	7	6	18	2306	e	4026.70	6715.50	>500	281	Madin	Broadscale	
AL17098.01	Kimmerer	8			6	19	122	s	4041.10	6708.90	107	1	Townsend	Broadscale	
AL17098.02	Kimmerer	8			6	19	123	e	4041.10	6708.90	107	1	Townsend	Broadscale	
AL17098.03	BongoSB	9	9	8	6	19	303	s	4052.10	6703.30	90	86	Sibunka	Broadscale	
AL17098.04	BongoSB	9	9	8	6	19	312	e	4052.20	6703.80	90	86	Sibunka	Broadscale	
AL17098.05	MK5CTD	8	9	8	6	19	321	s	4052.20	6703.90	90	85	Mountain	Broadscale	
AL17098.06	MK5CTD	8	9	8	6	19	331	e	4052.30	6704.10	90	85	Mountain	Broadscale	
AL17098.07	MOC-1	9	9	8	6	19	343	s	4052.30	6704.40	90	85	Durbin	Broadscale	
AL17098.08	MOC-1	9	9	8	6	19	431	e	4052.40	6707.00	89	85	Durbin	Broadscale	
AL17098.09	Kimmerer	9			6	19	505	s	4054.60	6711.70	85	1	Townsend	Broadscale	
AL17098.10	Kimmerer	9			6	19	506	e	4054.60	6711.70	85	1	Townsend	Broadscale	
AL17098.11	BongoSB	10	10	9	6	19	556	s	4058.10	6718.90	75	70	Sibunka	Broadscale	
AL17098.12	BongoSB	10	10	9	6	19	604	e	4058.30	6719.40	76	70	Sibunka	Broadscale	
AL17098.13	Pump	4	10	9	6	19	612	s	4058.30	6719.60	76	74	Durbin	Broadscale	
AL17098.14	Pump	4	10	9	6	19	630	e	4058.50	6719.60	75	74	Durbin	Broadscale	
AL17098.15	Pump-C	2	10	9	6	19	634	s	4058.60	6719.70	75	73	Durbin	Broadscale	
AL17098.16	Pump-C	2	10	9	6	19	758	e	4058.90	6719.20	74	73	Durbin	Broadscale	
AL17098.17	MK5CTD	9	10	9	6	19	807	s	4058.90	6719.10	74	68	Mountain	Broadscale	
AL17098.18	MK5CTD	9	10	9	6	19	820	e	4058.90	6718.90	74	68	Mountain	Broadscale	
AL17098.19	MOC-1	10	10	9	6	19	830	s	4059.10	6718.90	73	69	Durbin	Broadscale	
AL17098.20	MOC-1	10	10	9	6	19	906	e	4100.00	6718.60	72	70	Durbin	Broadscale	
AL17098.21	MOC-10	6	10	9	6	19	930	s	4100.10	6719.30	72	62	Madin	Broadscale	
AL17098.22	MOC-10	6	10	9	6	19	1008	e	4100.10	6720.50	70	62	Madin	Broadscale	
AL17098.23	Live-Tow	2	10	9	6	19	1014	s	4100.20	6720.60	70	20	Durbin /	Broadscale	No CTD used.
AL17098.24	Live-Tow	2	10	9	6	19	1018	e	4100.30	6720.50	70	20	Bucklin	Broadscale	
AL17098.25	Kimmerer	10			6	19	1118	s	4102.20	6728.90	64	1	Townsend	Broadscale	
AL17098.26	Kimmerer	10			6	19	1119	e	4102.20	6728.90	64	1	Townsend	Broadscale	
AL17098.27	BongoSB	11	11	10	6	19	1225	s	4104.80	6738.50	54	50	Sibunka	Broadscale	
AL17098.28	BongoSB	11	11	10	6	19	1233	e	4104.90	6738.90	54	50	Sibunka	Broadscale	
AL17098.29	MK5CTD	10	11	10	6	19	1238	s	4105.00	6739.00	54	50	Mountain	Broadscale	
AL17098.30	MK5CTD	10	11	10	6	19	1247	e	4104.90	6739.20	54	50	Mountain	Broadscale	
AL17098.31	MOC-1	11	11	10	6	19	1256	s	4104.90	6739.60	53	47	Durbin	Broadscale	
AL17098.32	MOC-1	11	11	10	6	19	1318	e	4104.90	6741.10	49	46	Durbin	Broadscale	
AL17098.33	MOC-10	7	11	10	6	19	1335	s	4105.00	6742.00	47	35	Madin	Broadscale	
AL17098.34	MOC-10	7	11	10	6	19	1403	e	4105.50	6744.00	45	35	Madin	Broadscale	
AL17098.35	Kimmerer	11			6	19	1445	s	4108.10	6748.80	40	1	Townsend	Broadscale	
AL17098.36	Kimmerer	11			6	19	1446	e	4108.10	6748.80	40	1	Townsend	Broadscale	
AL17098.37	BongoSB	12	12	11	6	19	1558	s	4113.90	6757.50	47	45	Sibunka	Broadscale	
AL17098.38	BongoSB	12	12	11	6	19	1605	e	4113.90	6757.90	50	45	Sibunka	Broadscale	
AL17098.39	MK5CTD	11	12	11	6	19	1611	s	4114.00	6758.10	49	45	Mountain	Broadscale	
AL17098.40	MK5CTD	11	12	11	6	19	1617	e	4114.30	6758.30	49	45	Mountain	Broadscale	
AL17098.41	MOC-1	12	12	11	6	19	1628	s	4114.50	6758.60	51	47	Durbin	Broadscale	
AL17098.42	MOC-1	12	12	11	6	19	1644	e	4114.50	6759.50	50	46	Durbin	Broadscale	

AL17098.43	MOC-10	8	12	11	6	19	1704	s	4114.70	6759.20	49	45	Madin	Broadscale	
AL17098.44	MOC-10	8	12	11	6	19	1740	e	4115.10	6758.40	45	45	Madin	Broadscale	
AL17098.45	Kimmerer	12			6	19	1916	s	4119.40	6745.20	33	1	Townsend	Broadscale	
AL17098.46	Kimmerer	12			6	19	1917	e	4119.40	6745.20	33	1	Townsend	Broadscale	
AL17098.47	Live-Tow	3	13	12	6	19	2042	s	4124.20	6732.90	38	20	Durbin /	Broadscale	
AL17098.48	Live-Tow	3	13	12	6	19	2047	e	4124.20	6732.60	43	20	Bucklin	Broadscale	
AL17098.49	BongoSB	13	13	12	6	19	2049	s	4124.30	6732.50	40	36	Sibunka	Broadscale	
AL17098.50	BongoSB	13	13	12	6	19	2055	e	4124.40	6732.20	40	36	Sibunka	Broadscale	
AL17098.51	SBCal	3	13	12	6	19	2058	s	4124.40	6731.90	41	20	Mountain	Broadscale	
AL17098.52	SBCal	3	13	12	6	19	2101	e	4124.40	6731.70	34	20	Mountain	Broadscale	
AL17098.53	Pump	5	13	12	6	19	2104	s	4124.30	6731.60	40	38	Durbin	Broadscale	
AL17098.54	Pump	5	13	12	6	19	2118	e	4124.10	6731.10	41	38	Durbin	Broadscale	
AL17098.55	MK5CTD	12	13	12	6	19	2127	s	4123.90	6730.90	38	37	Mountain	Broadscale	
AL17098.56	MK5CTD	12	13	12	6	19	2137	e	4123.70	6730.50	39	37	Mountain	Broadscale	
AL17098.57	MOC-1	13	13	12	6	19	2146	s	4123.60	6730.10	40	31	Durbin	Broadscale	
AL17098.58	MOC-1	13	13	12	6	19	2203	e	4123.50	6729.10	41	32	Durbin	Broadscale	
AL17098.59	MOC-10	9	13	12	6	19	2217	s	4123.40	6728.30	42	33	Madin	Broadscale	
AL17098.60	MOC-10	9	13	12	6	19	2244	e	4122.80	6726.80	44	33	Madin	Broadscale	
AL17098.61	Kimmerer	13			6	19	2328	s	4120.40	6721.40	48	1	Townsend	Broadscale	
AL17098.62	Kimmerer	13			6	19	2330	e	4120.40	6721.40	48	1	Townsend	Broadscale	
AL17198.01	BongoSB	14	14	13	6	20	48	s	4116.20	6710.50	55	51	Sibunka	Broadscale	
AL17198.02	BongoSB	14	14	13	6	20	53	e	4116.00	6710.30	56	51	Sibunka	Broadscale	
AL17198.03	Pump	6	14	13	6	20	100	s	4115.80	6710.30	56	52	Durbin	Broadscale	
AL17198.04	Pump	6	14	13	6	20	124	e	4115.40	6711.00	56	52	Durbin	Broadscale	
AL17198.05	MK5CTD	13	14	13	6	20	130	s	4115.30	6711.20	55	50	Mountain	Broadscale	
AL17198.06	MK5CTD	13	14	13	6	20	136	e	4115.20	6711.40	56	50	Mountain	Broadscale	
AL17198.07	MOC-1	14	14	13	6	20	145	s	4115.20	6711.30	56	52	Durbin	Broadscale	
AL17198.08	MOC-1	14	14	13	6	20	208	e	4115.50	6711.10	56	51	Durbin	Broadscale	
AL17198.09	MOC-10	10	14	13	6	20	227	s	4115.60	6710.70	56	50	Madin	Broadscale	
AL17198.10	MOC-10	10	14	13	6	20	307	e	4115.80	6710.20	56	50	Madin	Broadscale	
AL17198.11	Kimmerer	14			6	20	405	s	4114.30	6709.00	66	1	Townsend	Broadscale	
AL17198.12	Kimmerer	14			6	20	407	e	4114.30	6709.00	66	1	Townsend	Broadscale	
AL17198.13	BongoSB	15	15	14	6	20	504	s	4112.00	6657.00	70	66	Sibunka	Broadscale	
AL17198.14	BongoSB	15	15	14	6	20	529	e	4111.90	6656.80	69	66	Sibunka	Broadscale	
AL17198.15	MK5CTD	14	15	14	6	20	515	s	4111.90	6656.90	69	65	Mountain	Broadscale	
AL17198.16	MK5CTD	14	15	14	6	20	522	e	4112.00	6656.90	70	65	Mountain	Broadscale	
AL17198.17	MOC-1	15	15	14	6	20	532	s	4112.20	6656.90	70	66	Durbin	Broadscale	
AL17198.18	MOC-1	15	15	14	6	20	605	e	4113.40	6658.40	69	64	Durbin	Broadscale	
AL17198.19	MOC-10	11	15	14	6	20	629	s	4113.30	6658.00	69	60	Madin	Broadscale	
AL17198.20	MOC-10	11	15	14	6	20	707	e	4112.60	6656.80	69	60	Madin	Broadscale	
AL17198.21	Kimmerer	15			6	20	820	s	4107.00	6649.40	74	1	Townsend	Broadscale	
AL17198.22	Kimmerer	15			6	20	821	e	4107.00	6649.40	74	1	Townsend	Broadscale	
AL17198.23	BongoSB	16	16	15	6	20	928	s	4102.20	6642.10	77	72	Sibunka	Broadscale	
AL17198.24	BongoSB	16	16	15	6	20	938	e	4102.00	6642.50	77	72	Sibunka	Broadscale	
AL17198.25	Live-Tow	4	16	15	6	20	941	s	4102.00	6642.90	77	20	Durbin /	Broadscale	
AL17198.26	Live-Tow	4	16	15	6	20	945	e	4102.00	6642.90	77	20	Bucklin	Broadscale	
AL17198.27	MK5CTD	15	16	15	6	20	951	s	4102.00	6642.90	78	75	Mountain	Broadscale	
AL17198.28	MK5CTD	15	16	15	6	20	1000	e	4101.90	6642.90	78	75	Mountain	Broadscale	
AL17198.29	BongoSB	17	16	15	6	20	1118	s	4101.90	6641.80	76	71	Durbin /	Broadscale	Replace MOC-1 tow.
AL17198.30	BongoSB	17	16	15	6	20	1128	e	4101.80	6642.10	76	71	Bucklin	Broadscale	
AL17198.31	Kimmerer	16			6	20	1222	s	4059.20	6635.30	96	1	Townsend	Broadscale	
AL17198.32	Kimmerer	16			6	20	1223	e	4059.20	6635.30	96	1	Townsend	Broadscale	
AL17198.33	MK5CTD	16	17	16	6	20	1328	s	4055.50	6627.40	810	306	Mountain	Broadscale	
AL17198.34	MK5CTD	16	17	16	6	20	1352	e	4055.20	6626.90	810	306	Mountain	Broadscale	
AL17198.35	MOC-1	16	17	16	6	20	1448	s	4055.00	6626.70	>886	502	Durbin	Broadscale	
AL17198.36	MOC-1	16	17	16	6	20	1745	e	4058.20	6623.90	>800	500	Durbin	Broadscale	
AL17198.37	BongoSB	18	17	16	6	20	1756	s	4058.20	6624.30	810	200	Sibunka	Broadscale	
AL17198.38	BongoSB	18	17	16	6	20	1820	e	4057.50	6625.10	810	200	Sibunka	Broadscale	
AL17198.39	Pump	7	17	16	6	20	1838	s	4056.20	6626.50	>800	110	Durbin	Broadscale	
AL17198.40	Pump	7	17	16	6	20	1905	e	4056.20	6626.70	>800	110	Durbin	Broadscale	
AL17198.41	MOC-10	12	17	16	6	20	1928	s	4056.30	6626.80	>500	410	Madin	Broadscale	
AL17198.42	MOC-10	12	17	16	6	20	2100	e	4059.70	6625.20	>500	410	Madin	Broadscale	
AL17198.43	Live-Tow	5	17	16	6	20	2106	s	4059.60	6625.10	>500	30	Durbin /	Broadscale	
AL17198.44	Live-Tow	5	17	16	6	20	2116	e	4059.40	6624.90	435	30	Bucklin	Broadscale	
AL17198.45	Kimmerer	17			6	20	2155	s	4103.60	6625.30	630	1	Townsend	Broadscale	
AL17198.46	Kimmerer	17			6	20	2156	e	4103.60	6625.30	630	1	Townsend	Broadscale	
AL17198.47	BongoSB	19	18	17	6	20	2316	s	4111.50	6626.80	91	85	Sibunka	Broadscale	
AL17198.48	BongoSB	19	18	17	6	20	2326	e	4111.50	6626.00	89	85	Sibunka	Broadscale	

AL17198.49	Pump	8	18	17	6	20	2335	s	4111.50	6625.80	89	86	Durbin	Broadscale	
AL17298.01	Pump	8	18	17	6	21	2	e	4110.90	6625.60	95	86	Durbin	Broadscale	
AL17298.02	MK5CTD	17	18	17	6	21	41	s	4110.50	6625.60	98	93	Mountain	Broadscale	
AL17298.03	MK5CTD	17	18	17	6	21	48	e	4110.30	6625.60	96	93	Mountain	Broadscale	
AL17298.04	MOC-1	17	18	17	6	21	57	s	4110.10	6625.40	95	90	Durbin	Broadscale	
AL17298.05	MOC-1	17	18	17	6	21	142	e	4107.70	6625.50	109	100	Durbin	Broadscale	
AL17298.06	MOC-10	13	18	17	6	21	154	s	4107.50	6625.90	117	100	Madin	Broadscale	
AL17298.07	MOC-10	13	18	17	6	21	234	e	4107.90	6627.20	100	100	Madin	Broadscale	
AL17298.08	Kimmerer	18			6	21	422	s	4117.60	6636.30	86	1	Townsend	Broadscale	
AL17298.09	Kimmerer	18			6	21	423	e	4117.60	6636.30	86	1	Townsend	Broadscale	
AL17298.10	BongoSB	20	19	18	6	21	530	s	4124.80	6642.30	83	79	Sibunka	Broadscale	
AL17298.11	BongoSB	20	19	18	6	21	538	e	4125.10	6642.70	85	79	Sibunka	Broadscale	
AL17298.12	Pump	9	19	18	6	21	544	s	4125.20	6643.10	82	79	Durbin	Broadscale	
AL17298.13	Pump	9	19	18	6	21	615	e	4125.60	6644.10	82	79	Durbin	Broadscale	
AL17298.14	Pump-C	3	19	18	6	21	617	s	4125.80	6644.20	82	79	Durbin	Broadscale	
AL17298.15	Pump-C	3	19	18	6	21	726	e	4127.40	6645.80	75	74	Durbin	Broadscale	
AL17298.16	MK5CTD	18	19	18	6	21	738	s	4127.70	6645.90	75	70	Mountain	Broadscale	
AL17298.17	MK5CTD	18	19	18	6	21	747	e	4127.90	6646.00	74	70	Mountain	Broadscale	
AL17298.18	MOC-1	18	19	18	6	21	754	s	4128.10	6646.30	76	70	Durbin	Broadscale	
AL17298.19	MOC-1	18	19	18	6	21	829	e	4128.70	6647.90	76	69	Durbin	Broadscale	
AL17298.20	MOC-10	14	19	18	6	21	849	s	4128.40	6647.70	75	65	Madin	Broadscale	
AL17298.21	MOC-10	14	19	18	6	21	922	e	4127.80	6646.60	77	65	Madin	Broadscale	
AL17298.22	Live-Tow	6	19	18	6	21	932	s	4127.70	6646.60	75	20	Durbin /	Broadscale	
AL17298.23	Live-Tow	6	19	18	6	21	937	e	4127.80	6646.80	75	20	Bucklin	Broadscale	
AL17298.24	Kimmerer	19			6	21	1012	s	4130.00	6650.10	71	1	Townsend	Broadscale	
AL17298.25	Kimmerer	19			6	21	1013	e	4130.00	6650.10	71	1	Townsend	Broadscale	
AL17298.26	BongoSB	21	20	19	6	21	1129	s	4135.80	6658.50	61	57	Sibunka	Broadscale	
AL17298.27	BongoSB	21	20	19	6	21	1136	e	4135.90	6658.40	62	57	Sibunka	Broadscale	
AL17298.28	SBCal	4	20	19	6	21	1139	s	4135.90	6658.40	63	20	Mountain	Broadscale	
AL17298.29	SBCal	4	20	19	6	21	1142	e	4135.90	6658.30	61	20	Mountain	Broadscale	
AL17298.30	MK5CTD	19	20	19	6	21	1144	s	4135.90	6658.20	62	58	Mountain	Broadscale	
AL17298.31	MK5CTD	19	20	19	6	21	1152	e	4135.70	6658.10	62	58	Mountain	Broadscale	
AL17298.32	MOC-1	19	20	19	6	21	1201	s	4135.60	6657.90	63	60	Durbin	Broadscale	
AL17298.33	MOC-1	19	20	19	6	21	1225	e	4135.80	6656.90	63	52	Durbin	Broadscale	
AL17298.34	MOC-10	15	20	19	6	21	1245	s	4136.00	6656.00	63	51	Madin	Broadscale	
AL17298.35	MOC-10	15	20	19	6	21	1316	e	4135.50	6654.60	66	51	Madin	Broadscale	
AL17298.36	Live-Tow	7	20	19	6	21	1325	s	4135.50	6654.60	66	20	Durbin /	Broadscale	
AL17298.37	Live-Tow	7	20	19	6	21	1331	e	4135.20	6653.80	62	20	Bucklin	Broadscale	
AL17298.38	Kimmerer	20			6	21	1446	s	4139.10	6644.40	75	1	Townsend	Broadscale	
AL17298.39	Kimmerer	20			6	21	1447	e	4139.10	6644.40	75	1	Townsend	Broadscale	
AL17298.40	BongoSB	22	21	20	6	21	1626	s	4143.60	6631.50	76	72	Sibunka	Broadscale	
AL17298.41	BongoSB	22	21	20	6	21	1634	e	4143.80	6631.60	76	72	Sibunka	Broadscale	
AL17298.42	Pump	10	21	20	6	21	1638	s	4143.90	6631.60	73	70	Durbin	Broadscale	
AL17298.43	Pump	10	21	20	6	21	1716	e	4144.10	6632.70	75	70	Durbin	Broadscale	
AL17298.44	MK5CTD	20	21	20	6	21	1724	s	4144.10	6632.80	76	70	Mountain	Broadscale	
AL17298.45	MK5CTD	20	21	20	6	21	1728	e	4144.10	6632.90	75	70	Mountain	Broadscale	
AL17298.46	MOC-1	20	21	20	6	21	1735	s	4144.10	6633.10	75	70	Durbin	Broadscale	
AL17298.47	MOC-1	20	21	20	6	21	1808	e	4145.70	6632.60	75	69	Durbin	Broadscale	
AL17298.48	MOC-10	16	21	20	6	21	1827	s	4145.40	6632.70	75	65	Madin	Broadscale	
AL17298.49	MOC-10	16	21	20	6	21	1900	e	4145.10	6632.50	75	65	Madin	Broadscale	
AL17298.50	Kimmerer	21			6	21	2024	s	4138.10	6627.80	81	1	Townsend	Broadscale	
AL17298.51	Kimmerer	21			6	21	2025	e	4138.10	6627.80	81	1	Townsend	Broadscale	
AL17298.52	BongoSB	23	22	21	6	21	2126	s	4132.60	6624.10	87	82	Sibunka	Broadscale	
AL17298.53	BongoSB	23	22	21	6	21	2138	e	4132.60	6624.60	87	82	Sibunka	Broadscale	
AL17298.54	MK5CTD	21	22	21	6	21	2140	s	4132.60	6624.70	88	84	Mountain	Broadscale	
AL17298.55	MK5CTD	21	22	21	6	21	2151	e	4132.80	6624.70	87	84	Mountain	Broadscale	
AL17298.56	MOC-1	21	22	21	6	21	2200	s	4132.80	6624.70	88	83	Durbin	Broadscale	
AL17298.57	MOC-1	21	22	21	6	21	2241	e	4132.20	6622.00	88	82	Durbin	Broadscale	
AL17298.58	MOC-10	17	22	21	6	21	2250	s	4132.20	6621.40	90	85	Madin	Broadscale	
AL17298.59	MOC-10	17	22	21	6	21	2331	e	4132.20	6619.10	89	85	Madin	Broadscale	
AL17398.01	Kimmerer	22			6	22	8	s	4132.00	6614.30	92	1	Townsend	Broadscale	
AL17398.02	Kimmerer	22			6	22	9	e	4132.00	6614.30	92	1	Townsend	Broadscale	
AL17398.03	BongoSB	24	23	22	6	22	128	s	4132.90	6602.00	114	109	Sibunka	Broadscale	
AL17398.04	BongoSB	24	23	22	6	22	138	e	4132.90	6601.90	113	109	Sibunka	Broadscale	
AL17398.05	MK5CTD	22	23	22	6	22	139	s	4132.90	6602.10	113	110	Mountain	Broadscale	
AL17398.06	MK5CTD	22	23	22	6	22	153	e	4132.80	6602.20	113	110	Mountain	Broadscale	
AL17398.07	MOC-1	22	23	22	6	22	159	s	4132.60	6602.50	113	107	Durbin	Broadscale	
AL17398.08	MOC-1	22	23	22	6	22	259	e	4130.70	6605.50	111	106	Durbin	Broadscale	

AL17398.09	Kimmerer	23			6	22	425	s	4139.90	6607.90	100	1	Townsend	Broadscale	
AL17398.10	Kimmerer	23			6	22	426	e	4139.90	6607.90	100	1	Townsend	Broadscale	
AL17398.11	BongoSB	25	24	23	6	22	532	s	4147.60	6611.50	87	83	Sibunka	Broadscale	
AL17398.12	BongoSB	25	24	23	6	22	541	e	4147.90	6611.70	86	83	Sibunka	Broadscale	
AL17398.13	Pump	11	24	23	6	22	551	s	4147.90	6612.00	87	85	Durbin	Broadscale	
AL17398.14	Pump	11	24	23	6	22	614	e	4147.80	6612.90	86	85	Durbin	Broadscale	
AL17398.15	MK5CTD	23	24	23	6	22	627	s	4147.70	6613.20	84	78	Mountain	Broadscale	
AL17398.16	MK5CTD	23	24	23	6	22	638	e	4147.70	6613.80	85	78	Mountain	Broadscale	
AL17398.17	MOC-1	23	24	23	6	22	645	s	4147.90	6613.90	86	81	Durbin	Broadscale	
AL17398.18	MOC-1	23	24	23	6	22	723	e	4148.20	6613.10	85	81	Durbin	Broadscale	
AL17398.19	MOC-10	18	24	23	6	22	740	s	4140.30	6612.50	86	70	Madin	Broadscale	
AL17398.20	MOC-10	18	24	23	6	22	816	e	4148.90	6611.10	83	70	Madin	Broadscale	
AL17398.21	GreeneB	2	24	23	6	22	820	e	4148.90	6611.10	83	2	Wiebe	Broadscale	
AL17398.22	Kimmerer	24			6	22	855	s	4150.70	6605.50	96	1	Townsend	Broadscale	
AL17398.23	Kimmerer	24			6	22	856	e	4150.70	6605.50	96	1	Townsend	Broadscale	
AL17398.24	BongoSB	26	25	24	6	22	922	s	4152.30	6559.90	97	91	Sibunka	Broadscale	
AL17398.25	BongoSB	26	25	24	6	22	934	e	4152.30	6600.00	98	91	Sibunka	Broadscale	
AL17398.26	MK5CTD	24	25	24	6	22	940	s	4152.20	6600.30	99	97	Mountain	Broadscale	
AL17398.27	MK5CTD	24	25	24	6	22	951	e	4152.20	6600.10	98	97	Mountain	Broadscale	
AL17398.28	MOC-1	24	25	24	6	22	1001	s	4152.40	6559.70	95	89	Durbin	Broadscale	
AL17398.29	MOC-1	24	25	24	6	22	1042	e	4152.20	6557.00	104	90	Durbin	Broadscale	
AL17398.30	Live-Tow	8	25	24	6	22	1052	s	4152.20	6556.50	105	30	Durbin /	Broadscale	
AL17398.31	Live-Tow	8	25	24	6	22	1100	e	4152.10	6555.80	108	30	Bucklin	Broadscale	
AL17398.32	Kimmerer	25			6	22	1224	s	4204.90	6553.70	248	1	Townsend	Broadscale	
AL17398.33	Kimmerer	25			6	22	1225	e	4204.90	6553.70	248	1	Townsend	Broadscale	
AL17398.34	GreeneB	3			6	22	1340	s	4215.00	6552.00	200	2	Wiebe	Broadscale	
AL17398.35	BongoSB	27	26	25	6	22	1416	s	4217.70	6550.80	218	201	Sibunka	Broadscale	
AL17398.36	BongoSB	27	26	25	6	22	1434	e	4217.80	6550.30	216	201	Sibunka	Broadscale	
AL17398.37	Pump	12	26	25	6	22	1439	s	4217.70	6550.20	215	100	Durbin	Broadscale	
AL17398.38	Pump	12	26	25	6	22	1510	e	4217.00	6550.10	219	100	Durbin	Broadscale	
AL17398.39	MK5CTD	25	26	25	6	22	1516	s	4216.70	6550.20	221	216	Mountain	Broadscale	
AL17398.40	MK5CTD	25	26	25	6	22	1527	e	4216.50	6550.30	222	216	Mountain	Broadscale	
AL17398.41	MOC-1	25	26	25	6	22	1534	s	4216.50	6558.30	222	215	Durbin	Broadscale	
AL17398.42	MOC-1	25	26	25	6	22	1722	e	4216.60	6551.60	227	203	Durbin	Broadscale	
AL17398.43	MOC-10	19	26	25	6	22	1732	s	4216.20	6552.20	229	225	Madin	Broadscale	
AL17398.44	MOC-10	19	26	25	6	22	1829	e	4215.90	6556.10	237	225	Madin	Broadscale	
AL17398.45	Kimmerer	26			6	22	1913	s	4212.50	6558.40	231	1	Townsend	Broadscale	
AL17398.46	Kimmerer	26			6	22	1914	e	4212.50	6558.40	231	1	Townsend	Broadscale	
AL17398.47	BongoSB	28	27	39	6	22	2001	s	4207.90	6600.40	220	200	Sibunka	Broadscale	
AL17398.48	BongoSB	28	27	39	6	22	2022	e	4207.50	6601.20	215	200	Sibunka	Broadscale	
AL17398.49	SBCal	5	27	39	6	22	2024	s	4207.50	6601.20	214	56	Mountain	Broadscale	
AL17398.50	SBCal	5	27	39	6	22	2028	e	4207.50	6601.30	214	56	Mountain	Broadscale	
AL17398.51	Pump	13	27	39	6	22	2033	s	4207.60	6601.50	214	110	Durbin	Broadscale	
AL17398.52	Pump	13	27	39	6	22	2107	e	4208.10	6602.60	219	110	Durbin	Broadscale	
AL17398.53	MK5CTD	26	27	39	6	22	2115	s	4208.20	6602.90	220	217	Mountain	Broadscale	
AL17398.54	MK5CTD	26	27	39	6	22	2129	e	4208.60	6603.20	222	217	Mountain	Broadscale	
AL17398.55	MOC-1	26	27	39	6	22	2136	s	4208.70	6603.20	223	208	Durbin	Broadscale	
AL17398.56	MOC-1	26	27	39	6	22	2337	e	4206.10	6559.10	203	197	Durbin	Broadscale	
AL17398.57	MOC-10	20	27	39	6	22	2346	s	4206.10	6559.30	209	204	Madin	Broadscale	
AL17498.01	MOC-10	20	27	39	6	23	38	e	4205.70	6600.10	201	204	Madin	Broadscale	
AL17498.02	Kimmerer	27			6	23	228	s	4204.60	6612.60	93	1	Townsend	Broadscale	
AL17498.03	Kimmerer	27			6	23	229	e	4204.60	6612.60	93	1	Townsend	Broadscale	
AL17498.04	BongoSB	29	28	26	6	23	400	s	4203.90	6625.90	86	80	Sibunka	Broadscale	
AL17498.05	BongoSB	29	28	26	6	23	409	e	4203.40	6625.90	90	80	Sibunka	Broadscale	
AL17498.06	MK5CTD	27	28	26	6	23	415	s	4203.20	6625.90	92	87	Mountain	Broadscale	
AL17498.07	MK5CTD	27	28	26	6	23	421	e	4203.10	6626.00	91	87	Mountain	Broadscale	
AL17498.08	MOC-1	27	28	26	6	23	431	s	4203.20	6626.40	91	87	Durbin	Broadscale	
AL17498.09	MOC-1	27	28	26	6	23	516	e	4201.10	6626.90	83	82	Durbin	Broadscale	
AL17498.10	MOC-10	21	28	26	6	23	533	s	4201.00	6627.90	84	80	Madin	Broadscale	
AL17498.11	MOC-10	21	28	26	6	23	607	e	4202.20	6629.80	79	80	Madin	Broadscale	
AL17498.12	Drifter	1	28	26	6	23	613	s	4202.20	6630.20	79	10	Limeburner	Broadscale	Serial # 24945
AL17498.13	Kimmerer	28			6	23	649	s	4200.40	6634.60	76	1	Townsend	Broadscale	
AL17498.14	Kimmerer	28			6	23	650	e	4200.40	6634.60	76	1	Townsend	Broadscale	
AL17498.15	BongoSB	30	29	27	6	23	754	s	4157.10	6642.80	72	68	Sibunka	Broadscale	Strong currents
AL17498.16	BongoSB	30	29	27	6	23	808	e	4157.50	6643.90	74	68	Sibunka	Broadscale	
AL17498.17	Pump	14	29	27	6	23	823	s	4158.20	6644.80	76	74	Durbin	Broadscale	Pilot whales
AL17498.18	Pump	14	29	27	6	23	843	e	4158.10	6645.40	70	74	Durbin	Broadscale	
AL17498.1 9	MK5CTD	28	29	27	6	23	855	s	4159.70	6645.70	68	65	Mountain	Broadscale	

AL17498.20	MK5CTD	28	29	27	6	23	903	e	4200.10	6645.90	69	65	Mountain	Broadscale	
AL17498.21	MOC-1	28	29	27	6	23	909	s	4200.40	6646.20	68	61	Durbin	Broadscale	
AL17498.22	MOC-1	28	29	27	6	23	944	e	4201.40	6647.80	68	63	Durbin	Broadscale	
AL17498.23	GreeneB	3	29	27	6	23	949	e	4201.50	6648.00	69	2	Wiebe	Broadscale	
AL17498.24	GreeneB	4	29	27	6	23	1019	s	4158.40	6644.30	77	2	Wiebe	Broadscale	
AL17498.25	MOC-10	22	29	27	6	23	1027	s	4158.70	6644.60	75	65	Madin	Broadscale	
AL17498.26	MOC-10	22	29	27	6	23	1105	e	4159.80	6644.50	79	65	Madin	Broadscale	
AL17498.27	Live-Tow	9	29	27	6	23	1112	s	4200.10	6644.60	78	30	Durbin /	Broadscale	
AL17498.28	Live-Tow	9	29	27	6	23	1118	e	4200.50	6645.00	70	30	Bucklin	Broadscale	
AL17498.29	Kimmerer	29			6	23	1140	s	4201.40	6647.20	69	1	Townsend	Broadscale	
AL17498.30	Kimmerer	29			6	23	1141	e	4201.40	6647.20	69	1	Townsend	Broadscale	
AL17498.31	BongoSB	31	30	28	6	23	1253	s	4205.80	6653.10	66	61	Sibunka	Broadscale	
AL17498.32	BongoSB	31	30	28	6	23	1302	e	4205.80	6652.90	66	61	Sibunka	Broadscale	
AL17498.33	MK5CTD	29	30	28	6	23	1306	s	4205.80	6652.80	66	64	Mountain	Broadscale	
AL17498.34	MK5CTD	29	30	28	6	23	1313	e	4205.50	6652.50	66	64	Mountain	Broadscale	
AL17498.35	MOC-1	29	30	28	6	23	1320	s	4205.60	6652.20	67	61	Durbin	Broadscale	
AL17498.36	MOC-1	29	30	28	6	23	1349	e	4205.50	6650.80	71	66	Durbin	Broadscale	
AL17498.37	MOC-10	23	30	28	6	23	1358	s	4205.40	6650.70	69	66	Madin	Broadscale	
AL17498.38	MOC-10	23	30	28	6	23	1430	e	4205.20	6650.90	70	66	Madin	Broadscale	
AL17498.39	Kimmerer	30			6	23	1551	s	4211.60	6652.40	203	1	Townsend	Broadscale	
AL17498.40	Kimmerer	30			6	23	1552	e	4211.60	6652.40	203	1	Townsend	Broadscale	
AL17498.41	BongoSB	32	31	29	6	23	1700	s	4218.30	6653.90	298	200	Sibunka	Broadscale	
AL17498.42	BongoSB	32	31	29	6	23	1719	e	4218.70	6653.60	299	200	Sibunka	Broadscale	
AL17498.43	Pump	15	31	29	6	23	1723	s	4218.70	6653.50	299	110	Durbin	Broadscale	
AL17498.44	Pump	15	31	29	6	23	1750	e	4218.60	6652.80	300	110	Durbin	Broadscale	
AL17498.45	MK5CTD	30	31	29	6	23	1803	s	4218.60	6652.50	300	296	Mountain	Broadscale	
AL17498.46	MK5CTD	30	31	29	6	23	1824	e	4218.40	6651.80	299	296	Mountain	Broadscale	
AL17498.47	MOC-1	30	31	29	6	23	1831	s	4218.50	6651.60	300	296	Durbin	Broadscale	
AL17498.48	MOC-1	30	31	29	6	23	2019	e	4219.60	6654.90	320	312	Durbin	Broadscale	
AL17498.49	Live-Tow	10	31	29	6	23	2026	s	4219.40	6654.70	310	20	Durbin /	Broadscale	
AL17498.50	Live-Tow	10	31	29	6	23	2033	e	4019.40	6654.40	308	20	Bucklin	Broadscale	
AL17498.51	MOC-10	24	31	29	6	23	2041	s	4219.10	6654.50	307	285	Madin	Broadscale	Blew out net3 - replaced
AL17498.52	MOC-10	24	31	29	6	23	2150	e	4217.60	6656.00	294	285	Madin	Broadscale	
AL17498.53	MOC-1	31	31	29	6	23	2202	s	4217.40	6656.20	293	272	Miller	Broadscale	Live tow for Calanus
AL17498.54	MOC-1	31	31	29	6	23	2250	e	4215.90	6656.50	270	272	Miller	Broadscale	
AL17598.01	Kimmerer	31			6	24	35	s	4206.40	6703.60	62	1	Townsend	Broadscale	
AL17598.02	Kimmerer	31			6	24	36	e	4206.40	6703.60	62	1	Townsend	Broadscale	
AL17598.03	BongoSB	33	32	30	6	24	228	s	4155.30	6713.80	62	55	Sibunka	Broadscale	
AL17598.04	BongoSB	33	32	30	6	24	234	e	4155.10	6713.80	64	55	Sibunka	Broadscale	
AL17598.05	Pump	16	32	30	6	24	237	s	4154.90	6713.70	64	62	Durbin	Broadscale	
AL17598.06	Pump	16	32	30	6	24	302	e	4154.40	6713.70	61	62	Durbin	Broadscale	
AL17598.07	MKVCTD	31	32	30	6	24	309	s	4154.30	6713.80	60	55	Mountain	Broadscale	
AL17598.08	MKVCTD	31	32	30	6	24	312	e	4154.20	6713.80	61	55	Mountain	Broadscale	
AL17598.09	MOC-1	32	32	30	6	24	318	s	4153.00	6713.10	57	52	Durbin	Broadscale	
AL17598.10	MOC-1	32	32	30	6	24	347	e	4152.10	6714.40	52	47	Durbin	Broadscale	
AL17598.11	MOC-10	25	32	30	6	24	401	s	4151.80	6714.70	52	45	Madin	Broadscale	Blew out Net3 - replaced
AL17598.12	MOC-10	25	32	30	6	24	432	e	4152.00	6714.60	52	45	Madin	Broadscale	
AL17598.13	Drifter	2	32	30	6	24	443	s	4152.20	6714.70	52	10	Limeburner	Broadscale	Serial #24951
AL17598.14	Kimmerer	32			6	24	636	s	4202.30	6726.80	48	1	Townsend	Broadscale	
AL17598.15	Kimmerer	32			6	24	637	e	4202.30	6726.80	48	1	Townsend	Broadscale	
AL17598.16	BongoSB	34	33	40	6	24	817	s	4209.90	6739.60	186	181	Sibunka	Broadscale	
AL17598.17	BongoSB	34	33	40	6	24	833	e	4210.00	6740.30	190	181	Sibunka	Broadscale	
AL17598.18	MKVCTD	32	33	40	6	24	838	s	4210.10	6740.50	190	188	Mountain	Broadscale	
AL17598.19	MKVCTD	32	33	40	6	24	853	e	4210.40	6740.30	189	188	Mountain	Broadscale	
AL17598.20	MOC-1	33	33	40	6	24	900	s	4210.50	6740.30	190	185	Durbin	Broadscale	
AL17598.21	MOC-1	33	33	40	6	24	1027	e	4210.80	6745.10	209	191	Durbin	Broadscale	
AL17598.22	MOC-10	26	33	40	6	24	1037	s	4210.60	6745.00	208	192	Madin	Broadscale	
AL17598.23	MOC-10	26	33	40	6	24	1124	e	4210.10	6743.30	201	192	Madin	Broadscale	
AL17598.24	Live-Tow	11	33	40	6	24	1131	s	4209.90	6743.20	199	30	Durbin /	Broadscale	
AL17598.25	Live-Tow	11	33	40	6	24	1138	e	4209.90	6743.50	202	30	Bucklin	Broadscale	
AL17598.26	Kimmerer	33			6	24	1230	s	4204.90	6740.50	174	1	Townsend	Broadscale	
AL17598.27	Kimmerer	33			6	24	1231	e	4204.90	6740.50	174	1	Townsend	Broadscale	
AL17598.28	BongoSB	35	34	31	6	24	1315	s	4200.50	6737.10	52	47	Sibunka	Broadscale	
AL17598.29	BongoSB	35	34	31	6	24	1321	e	4200.20	6737.10	51	47	Sibunka	Broadscale	
AL17598.30	SBCal	6	34	31	6	24	1323	s	4200.10	6737.00	50	22	Mountain	Broadscale	
AL17598.31	SBCal	6	34	31	6	24	1326	e	4200.00	6736.90	50	22	Mountain	Broadscale	
AL17598.32	MKVCTD	33	34	31	6	24	1328	s	4159.90	6736.80	49	46	Mountain	Broadscale	
AL17598.33	MKVCTD	33	34	31	6	24	1334	e	4159.90	6736.50	49	46	Mountain	Broadscale	

AL17598.34	MOC-1	34	34	31	6	24	1340	s	4159.60	6736.30	49	42	Durbin	Broadscale	
AL17598.35	MOC-1	34	34	31	6	24	1400	e	4158.80	6734.70	47	41	Durbin	Broadscale	
AL17598.36	MOC-10	27	34	31	6	24	1408	s	4158.40	6734.00	45	40	Madin	Broadscale	
AL17598.37	MOC-10	27	34	31	6	24	1436	e	4156.90	6732.30	47	40	Madin	Broadscale	
AL17598.38	Kimmerer	34			6	24	1528	s	4152.70	6735.20	48	1	Townsend	Broadscale	
AL17598.39	Kimmerer	34			6	24	1529	e	4152.70	6735.20	48	1	Townsend	Broadscale	
AL17598.40	BongoSB	36	35	32	6	24	1652	s	4142.40	6739.80	50	45	Sibunka	Broadscale	
AL17598.41	BongoSB	36	35	32	6	24	1659	e	4142.50	6740.10	47	45	Sibunka	Broadscale	
AL17598.42	MKVCTD	34	35	32	6	24	1703	s	4142.40	6740.30	40	35	Mountain	Broadscale	
AL17598.43	MKVCTD	34	35	32	6	24	1707	e	4142.40	6740.40	40	35	Mountain	Broadscale	
AL17598.44	MOC-1	35	35	32	6	24	1712	s	4142.40	6740.30	42	38	Durbin	Broadscale	
AL17598.45	MOC-1	35	35	32	6	24	1733	e	4142.00	6739.50	47	43	Durbin	Broadscale	
AL17598.46	MOC-10	28	35	32	6	24	1741	s	4142.20	6739.60	52	42	Madin	Broadscale	
AL17598.47	MOC-10	28	35	32	6	24	1806	e	4143.10	6740.90	45	42	Madin	Broadscale	
AL17598.48	Kimmerer	35			6	24	1905	s	4147.40	6748.90	36	1	Townsend	Broadscale	
AL17598.49	Kimmerer	35			6	24	1906	e	4147.40	6748.90	36	1	Townsend	Broadscale	
AL17598.50	BongoSB	37	36	33	6	24	2010	s	4149.70	6759.40	56	51	Sibunka	Broadscale	
AL17598.51	BongoSB	37	36	33	6	24	2015	e	4149.80	6759.60	57	51	Sibunka	Broadscale	
AL17598.52	MKVCTD	35	36	33	6	24	2018	s	4149.90	6759.70	60	56	Mountain	Broadscale	
AL17598.53	MKVCTD	35	36	33	6	24	2028	e	4150.20	6759.60	61	56	Mountain	Broadscale	
AL17598.54	MOC-1	36	36	33	6	24	2036	s	4150.50	6759.70	63	57	Durbin	Broadscale	
AL17598.55	MOC-1	36	36	33	6	24	2102	e	4151.60	6800.70	75	64	Durbin	Broadscale	
AL17598.56	MOC-10	29	36	33	6	24	2120	s	4151.90	6800.90	82	65	Madin	Broadscale	
AL17598.57	MOC-10	29	36	33	6	24	2152	e	4151.50	6759.90	71	65	Madin	Broadscale	
AL17598.58	Kimmerer	36			6	24	2256	s	4152.20	6808.00	162	1	Townsend	Broadscale	
AL17598.59	Kimmerer	36			6	24	2257	e	4152.20	6808.00	162	1	Townsend	Broadscale	
AL17698.01	BongoSB	38	37	34	6	25	8	s	4150.80	6817.60	208	201	Sibunka	Broadscale	
AL17698.02	BongoSB	38	37	34	6	25	25	e	4150.60	6817.90	208	201	Sibunka	Broadscale	
AL17698.03	Pump	17	37	34	6	25	28	s	4150.60	6817.90	208	100	Durbin	Broadscale	
AL17698.04	Pump	17	37	34	6	25	104	e	4151.00	6817.40	210	100	Durbin	Broadscale	
AL17698.05	MKVCTD	36	37	34	6	25	111	s	4151.00	6817.40	210	205	Mountain	Broadscale	
AL17698.06	MKVCTD	36	37	34	6	25	122	e	4151.10	6817.20	210	205	Mountain	Broadscale	
AL17698.07	MOC-1	37	37	34	6	25	130	s	4151.10	6817.10	209	192	Durbin	Broadscale	
AL17698.08	MOC-1	37	37	34	6	25	246	e	4150.50	6814.10	175	170	Durbin	Broadscale	
AL17698.09	MOC-10	30	37	34	6	25	256	s	4150.60	6814.20	176	170	Madin	Broadscale	
AL17698.10	MOC-10	30	37	34	6	25	342	e	4150.10	6815.60	179	170	Madin	Broadscale	
AL17698.11	Kimmerer	37			6	25	457	s	4143.90	6820.70	81	1	Townsend	Broadscale	
AL17698.12	Kimmerer	37			6	25	458	e	4143.90	6820.70	81	1	Townsend	Broadscale	
AL17698.13	BongoSB	39	38	35	6	25	619	s	4136.50	6826.80	72	68	Sibunka	Broadscale	
AL17698.14	BongoSB	39	38	35	6	25	626	e	4136.30	6827.10	72	68	Sibunka	Broadscale	
AL17698.15	MKVCTD	37	38	35	6	25	631	s	4136.20	6827.20	73	71	Mountain	Broadscale	
AL17698.16	MKVCTD	37	38	35	6	25	639	e	4136.30	6827.30	73	71	Mountain	Broadscale	
AL17698.17	MOC-1	38	38	35	6	25	647	s	4136.10	6827.30	73	67	Durbin	Broadscale	
AL17698.18	MOC-1	38	38	35	6	25	721	e	4135.30	6828.70	88	73	Durbin	Broadscale	
AL17698.19	Live-Tow	12	38	35	6	25	802	s	4135.90	6829.10	99	40	Gallager	Broadscale	
AL17698.20	Live-Tow	12	38	35	6	25	808	e	4135.90	6829.00	97	40	Gallager	Broadscale	
AL17698.21	Kimmerer	38			6	25	936	s	4129.80	6823.20	45	1	Townsend	Broadscale	
AL17698.22	Kimmerer	38			6	25	937	e	4129.80	6823.20	45	1	Townsend	Broadscale	
AL17698.23	BongoSB	40	39	36	6	25	1054	s	4124.10	6817.40	51	46	Sibunka	Broadscale	
AL17698.24	BongoSB	40	39	36	6	25	1102	e	4124.20	6817.80	53	46	Sibunka	Broadscale	
AL17698.25	SBCal	7	39	36	6	25	1104	s	4124.30	6817.90	50	20	Mountain	Broadscale	
AL17698.26	SBCal	7	39	36	6	25	1106	e	4124.30	6818.00	52	20	Mountain	Broadscale	
AL17698.27	Pump	18	39	36	6	25	1109	s	4124.40	6818.10	54	49	Durbin	Broadscale	
AL17698.28	Pump	18	39	36	6	25	1125	e	4124.80	6818.20	51	49	Durbin	Broadscale	
AL17698.29	MKVCTD	38	39	36	6	25	1133	s	4124.90	6818.30	53	51	Mountain	Broadscale	
AL17698.30	MKVCTD	38	39	36	6	25	1140	e	4125.20	6818.30	53	51	Mountain	Broadscale	
AL17698.31	MOC-1	39	39	36	6	25	1144	s	4125.30	6818.40	50	48	Durbin	Broadscale	
AL17698.32	MOC-1	39	39	36	6	25	1207	e	4125.50	6819.30	54	48	Durbin	Broadscale	
AL17698.33	MOC-10	31	39	36	6	25	1217	s	4125.60	6819.70	55	46	Madin	Broadscale	
AL17698.34	MOC-10	31	39	36	6	25	1242	e	4125.50	6820.20	57	46	Madin	Broadscale	
AL17698.35	Drifter	4	39	36	6	25	1253	s	4125.50	6820.30	57	10	Limeburner	Broadscale	Serial #24950
AL17698.36	Kimmerer	39			6	25	1355	s	4121.80	6827.30	73	1	Townsend	Broadscale	
AL17698.37	Kimmerer	39			6	25	1356	e	4121.80	6827.30	73	1	Townsend	Broadscale	
AL17698.38	BongoSB	41	40	37	6	25	1505	s	4118.20	6835.40	68	64	Sibunka	Broadscale	
AL17698.39	BongoSB	41	40	37	6	25	1512	e	4117.90	6835.50	68	64	Sibunka	Broadscale	
AL17698.40	MKVCTD	39	40	37	6	25	1516	s	4117.80	6835.40	68	63	Mountain	Broadscale	
AL17698.41	MKVCTD	39	40	37	6	25	1521	e	4117.70	6835.20	68	63	Mountain	Broadscale	
AL17698.42	MOC-1	40	40	37	6	25	1528	s	4117.70	6835.10	69	61	Durbin	Broadscale	

AL17698.43	MOC-1	40	40	37	6	25	1556	e	4116.00	6834.80	66	61	Durbin	Broadscale	
AL17698.44	Kimmerer	40			6	25	1800	s	4123.30	6847.10	128	1	Townsend	Broadscale	
AL17698.45	Kimmerer	40			6	25	1801	e	4123.30	6847.10	128	1	Townsend	Broadscale	
AL17698.46	BongoSB	42	41	38	6	25	1926	s	4129.30	6856.70	152	146	Sibunka	Broadscale	
AL17698.47	BongoSB	42	41	38	6	25	1945	e	4129.30	6857.80	152	146	Sibunka	Broadscale	
AL17698.48	Pump	19	41	38	6	25	1950	s	4129.30	6858.00	153	110	Durbin	Broadscale	
AL17698.49	Pump	19	41	38	6	25	2036	e	4130.50	6858.30	152	110	Durbin	Broadscale	
AL17698.50	MKVCTD	40	41	38	6	25	2038	s	4130.50	6858.30	152	147	Mountain	Broadscale	
AL17698.51	MKVCTD	40	41	38	6	25	2054	e	4131.10	6858.30	152	147	Mountain	Broadscale	
AL17698.52	Live-Tow	13	41	38	6	25	2055	s	4131.10	6858.30	152	20	Durbin /	Broadscale	
AL17698.53	Live-Tow	13	41	38	6	25	2108	e	4131.50	6858.60	150	20	Bucklin	Broadscale	
AL17698.54	MOC-1	41	41	38	6	25	2116	s	4131.70	6859.00	149	137	Durbin	Broadscale	
AL17698.55	MOC-1	41	41	38	6	25	2218	e	4132.60	6902.00	135	127	Durbin	Broadscale	
AL17698.56	MOC-10	32	41	38	6	25	2227	s	4132.50	6902.00	135	127	Madin	Broadscale	
AL17698.57	MOC-10	32	41	38	6	25	2312	e	4132.50	6900.50	133	127	Madin	Broadscale	
AL17698.58	GreeneB	4	41	38	6	25	2320	e	4132.10	6900.00	137	2	Wiebe	Broadscale	GreeneB out
AL17698.59	Drifter	4	41	38	6	25	2323	s	4132.10	6900.00	137	10	Limeburner	Broadscale	Serial #24948
AL17798.01	Arrive				6	26	724	e	4131.50	7040.50	8	0	Bucklin	Broadscale	Arrive Woods Hole, MA

Appendix II. Preliminary Summary of Zooplankton Findings

(Maria Casas, Ted Durbin, Peter Garrahan)

Preliminary observations were made from the samples collected using the 1-m^2 MOCNESS after preservation. *Calanus finmarchicus* was present throughout the Bank but the numbers were winding down for the season. *Pseudocalanus* spp. was also present, if not abundant, at most stations sampled. *Centropages typicus*, *C. hamatus* and *Temora longicornis*, however, had increased in numbers from the previous month's cruise at many of the stations. *C. hamatus* was dominant at most of the crest stations on the Bank, while *C. typicus* appeared to be numerous outside of the 60 m isobath. During the spring and summer months *T. longicornis* appears in ever increasing numbers, and by this cruise they were in full swing, abundant at all the crest stations and most of the flank stations of the Bank.

The non-copepod component of the zooplankton was also characterized from the 1-m^2 MOCNESS samples during the cruise. The shelled pteropod, *Limacina* was present at most stations sampled. The cladoceran, *Evadne*, was observed at standard station 18 in unprecedented numbers in any of the Broadscale cruises to date in the top 20 m of the water column. They were also dominant at standard station 27.

Observations of zooplankton species composition were made at most standard stations sampled during this cruise. These observations were made from the net #0 samples (335 �m mesh), 1-m^2 MOCNESS and from live tows using a 200 �m net, unless otherwise stated. Brief descriptions appear below.

Station 1 *Centropages hamatus* was very abundant at this station, but *Oithona* spp. was numerically dominant. The chaetognath, *Sagitta elegans* was also present in large numbers.

Station 2 *C. hamatus* was again dominant here, with *Temora longicornis* also present in abundance. *Pseudocalanus* spp. and *Calanus finmarchicus* were present in lesser numbers. The shelled pteropod, *Limacina* spp., was abundant as were chaetognaths.

Station 41 Similar species composition to previous station, but *Metridia lucens* was also abundant. *C. finmarchicus* also present in greater numbers.

Station 4 and 5 *T. longicornis*, *C. hamatus*, *C. typicus* and *Pseudocalanus* spp. were the dominant copepods at this station. In addition, hydroids were abundant, with lesser numbers of chaetognaths, cumaceans, gammerid amphipods, and decapod larvae.

Station 6 *Centropages* spp. are gone. *C. finmarchicus* and *Pseudocalanus* spp. are dominant here. *M. lucens* was also present. Gelatinous zooplankton made the samples messy. *Limacina* also seen here.

Station 7 The surface net was a nursery of *C. finmarchicus* nauplii and C1's. Also younger stages of *Centropages*, and *Oithona* spp. were at the surface. Chaetognaths and euphausiids were abundant.

Station 9 *Temora* city! Mixed in were small numbers of *C. finmarchicus*, stage C4 and older, and *C. typicus*. Ctenophores and hydroids were also abundant.

Station 12 *C. hamatus* and *T. longicornis* were the two most abundant species here. *C. finmarchicus* were present in lesser numbers. Hydroids ever present.

Station 13 *Pseudocalanus* spp. the most abundant copepod at this station. Some *C. hamatus*, *C.typicus* and *T. longicornis* were also present. Again chaetognaths and hydroids abundant.

Station 14 On the other side of the 60 m isobath the species composition changes completely. *Centropages* and *Temora* are gone. The dominant copepod species are *Pseudocalanus* spp and *C. finmarchicus*. Chaetognaths and *Limacina* abundant still.

Station 16 *Oithona* spp. were extremely abundant. *C. finmarchicus* were not seen above 200 meters. The remainder of the zooplankton were made up of *Pleuromamma* spp., *M. lucens*, *Euchaeta* spp., euphausiids, and a few squid.

Station 18 The top 20 meters of this station was made up of millions upon millions of the cladoceran, *Evadne*. Crab zoea were also present in great abundance. The copepods present at this station were *C. typicus*, *C. finmarchicus*, stage C4 and older, *C. hamatus*, and *T. longicornis.*

Station 19 and 20 A typical bank copepod mix of *C. finmarchicus*, stage C4 and older, *Pseudocalanus* spp., *C. typicus*, *C. hamatus*, and *T.*

longicornis.

Station 24 C. finmarchicus were extremely abundant at this station, stage C3 and older with some adult females in the sample. Also present in moderate numbers were *C. typicus, Pseudocalanus* spp., and *Oithona* spp. A small number of *T. longicornis* were seen. Chaetognaths and small medusae were other components of the zooplankton.

Station 27 The cladoceran, *Evadne*, was again extremely abundant. *C. finmarchicus* was present with stage C4 being the most abundant, followed by C5's. *T. longicornis* was possibly the most abundant copepod in numbers. *C. typicus* was also at this station.

Station 30 *C. hamatus, T. longicornis* and *Pseudocalanus* spp. were the most abundant copepods on this crest station. Chaetognaths and crab zoea were present in moderate numbers.

Station 40 *C. finmarchicus* was very abundant at this station. All stages were present including adult females. Equal in abundance was *M. lucens*.

Station 35 *Pseudocalanus* spp. was the numerically dominant copepod, followed by *C. typicus* and *T. longicornis*. *C. finmarchicus* and *C. hamatus* were present in very low numbers.

Station 36 The sample was dominated by *C. hamatus, Pseudocalanus* spp., and *T. longicornis*. Very few *C. finmarchicus* and *C. typicus* were at this station.

Appendix III. Preliminary Summary of the 10-m^2 MOCNESS samples

(Rebecca Jones)

The samples collected from 10-m^2 MOCNESS were examined on shipboard for a qualitative estimate of abundance and distribution. Following is a listing of the species observed in the samples following preservation at standard stations.

Station 3: hyperiid amphipods, ctenophores, medusae, *Clione* spp., shrimp, siphonophores, *Tomopteris* sp., squid, leptocephalus, *Urophycis* sp., haddock, cod, butterfish, yellowtail flounder, American plaice, sculpin, redfish

Station 4: polychaete, *Crangon* sp., ctenophores, isopods, hydroid stalks, squid, nudibranch, amphipod, medusae, *Urophycis* sp., cod, haddock, yellowtail flounder, American plaice, sea snail

Station 6: medusa, ctenophores, hyperiid amphipods, haddock

Station 7: euphausiids, squid, gammerid amphipods, ctenophores, shrimp, *Phronima* sp., *Periphyla* sp., gonostomatidae, hatchetfish, myctophids

Station 11: hydroids, nudibranch, zooea, ctenophores, isopods, American plaice

Station 12: hydroid branches, isopods, yellowtail flounder

Station 13: polychaetes, hydroids, isopods, hyperiid amphipods and ctenophores, *Crangon* sp. , American plaice

Station 14: hydroids, ctenophores, siphonophores, shrimp, yellowtail flounder, American plaice

Station 16: medusa, shrimps, euphausiids, viper fish, siphonophores, squid, *Periphyla* sp. , *Squilla* sp. larvae, leptocephalus, gonostomatidae, haddock

Station 17: ctenophores, shrimp, euphausiids, amphipods, isopods, lion's mane jellyfish, snipe eel, hake, redfish, cod, haddock, yellowtail flounder, American plaice

Station 18: ctenophores, *Clione* spp., siphonophores, yellowtail flounder

Station 19: hydroids, ctenophores, lion's mane jellyfish, sand lance

Station 20: nudibranch, ctenophore, hydroid, siphonophore, whelk, *Tomopteris* sp., chaetognath, amphipod, redfish, yellowtail flounder

Station 21: ctenophores, isopods, amphipods,whelks,cumacean, *Crangon* sp., *Clione* sp., yellowtail flounder, American plaice, redfish

Station 23: ctenophores, *Clione* sp., yellowtail flounder

Station 25: jellyfish in great abundance (possibly lion's mane), siphonophores, ctenophores, amphipods, alligatorfish, butterfish, hake and cod

Station 26: ctenophores, hydroids, *Clione* sp., whelks, nudibranchs, lion's mane jelly, ctenophore, grubby sculpin, redfish, hake, cod, haddock, yellowtail flounder, american plaice

Station 39: euphausiid, shrimp, squid, chaetognath, amphipod, jellyfish, redfish, american plaice

Station 27: *Tomopteris* sp., bryozoans, ctenophores, grass shrimp, *Clione* sp., yellowtail flounder, cod

Station 28: ctenophores, *Clione* sp., hydroids, medusae, redfish, yellowtail flounder

Station 29: ctenophores, shrimps, euphausiids, medusae, haddock

Station 30: ctenophores, hyperiid amphipods, *Crangon* sp., nudibranchs, bryozoans, isopods, sand lance, yellowtail flounder

Station 40: ctenophores, medusae, euphausiids, *Clione* sp., *Tomopteris* sp., chaetognaths, amphipods, isopods, hake, yellowtail flounder, redfish, haddock

Station 31: hydroids, hyperiid amphipods

Station 32: hydroids

Station 33: ctenophores, *Crangon* sp., shrimp, isopods, hyperiid amphipods, *Clione* sp., *Tomopteris* sp., medusae, redfish, hake, haddock

Station 34: euphausiids, ctenophores, medusae, *Clione* sp., *Tomopteris* sp., butterfish, haddock, hake, shrimp

Station 36: windowpane flounder

Station 38: euphausiids, ctenophores, medusae, amphipods, redfish, hake, haddock, yellowtail flounder

Appendix IV. CTD Profiles