Cruise Report

RV/ALBATROSS IV Cruise 9410 to Georges Bank

US GLOBEC

NW ATLANTIC/GEORGES BANK STUDY

November 8 - 18, 1994

Acknowledgements

The officers and crew of the R/V ALBATROSS IV are thanked and commended for their professionalism and their enthusiastic support that enabled the scientific party to achieve its objectives on this cruise.

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Cruise Objectives

The objectives of this cruise were: (1) to establish and test sampling protocols for the broad scale survey component of the U.S. GLOBEC Georges Bank study to be conducted in the spring of 1995; (2) to train personnel who will conduct the surveys in the operation of the sampling systems and sampling protocols to be used; (3) to determine late fall abundance and age composition of target zooplankton species on Georges Bank and in adjacent GOM and slope waters; (4) to determine the abundance and composition of zooplankton on Georges Bank and in adjacent GOM and slope waters; (5) to determine the size of C4 and C5 Calanus (and C6F if present) and C5 and C6 Pseudocalanus on Georges Bank and in adjacent GOM and slope water; (6) to collect large quantities of Calanus which are to be frozen for Mackerel feeding experiments being carried out as part of a NOAA Coastal Ocean Program grant.

Introduction

The initial plan for the Broad Scale survey was developed through a series of meetings of the Scientific Investigators involved in the program. The plan calls for six surveys of the Georges Bank from February to July in 1995, with the cruises being 14 days long. On each survey 50-60 stations will be occupied, with approximately 35 of these located to provide a uniform, bank-wide coverage, and the rest of the stations located to provide a more intensive coverage in the region of the bank where the cod and haddock larvae are found. At all stations a bongo tow, a CTD cast and a MOC 1 tow will be done. At approximately 20 of the 35 bank-wide stations a plankton pump cast and a MOC 10 tow will be done.

The bongo tow will include four 61cm 335µm mesh nets. Three of the nets will provide larval tissue for biochemical analyses. The fourth net will be used for gadid egg analysis.

The CTD rosette water samples will be used for O^{18} isotope analysis, salinity calibration, and chlorophyll and nutrient determination. The MOC 1 will be used for collecting both zooplankton and ichthyoplankton. The frame will be loaded with 5 150µm mesh nets (nets 0-4) for the zooplankton, and 5 335µm mesh nets (nets 5-9) for ichthyoplankton. The last net (#9) will not be able to be closed. The depth strata to be sampled are 0-15m, 15-40m, 40-100m, and >100m. The first (#0) and sixth (#5) nets are 'down' nets for the zooplankton and ichthyoplankton portions of the tow, respectively. For shallow stations, with only 2 or 3 of the depth strata, not all nets will be fished. The down zooplankton net will be picked for zooplankton biochemical samples. The down ichthyoplankton net will be used for zooplankton genetic analysis and be preserved in alcohol. The zooplankton strata samples will be preserved in 4% formalin, while the ichthyoplankton samples will be preserved in 95% Etonal.

Plankton pump will sample the same depth strata as the MOC 1, to the a maximum depth of about 55m. The samples will be preserved in 4% formalin.

The MOC 10 will used the same depth strata as the MOC 1. The samples will be reserved in 4% formalin.

The planned order of sampling on a station is:

1) bongo tow
2) CTD cast
3) MOC 1 tow
4) Pump cast
5) MOC 10 tow

with about 20 stations doing all of these operations and the rest doing the first three.

Cruise Narrative

The cruise was divided into two legs in order to allow more persons to be trained in the operation of equipment systems at sea. The scientific field party for each of the two legs and the names of the ships' officers and crew are listed in Appendix 1.

Leg 1:

The cruise left Woods Hole, MA at 0800 hrs on Tuesday November 8, 1994. The sailing time was delayed 18 hours due to high wind conditions. While steaming out through Vineyard Sound, the MOC 1 and MOC 10 systems were tested on short tows. The water depth was only 10m, so the nets remained near the surface and the electronics systems were successfully tested.

The vessel proceeded to the first station, which was located in deep (150m) water north of Great South Channel, arriving at about 1600 hrs. The sea conditions were adequate to begin operations. Over the next 14 hours both watches were able to conduct all of the sampling operations planned for a station.

The five next stations were located along the northern side of the Georges Bank, alternating between shallow areas of the bank and deeper areas at the edge of the bank or off the bank into the southern Gulf of Maine (see figure 1). Six stations were completed by Thursday afternoon, at which point the vessel returned to Vineyard Sound to avoid impending bad weather.

On Friday at 1800 hrs the vessel was able get underway to return to sampling operations. Due to limited time, continued sampling on the eastern part of Georges Bank was not realistic. Instead a set of stations were chosen east of Cape Cod, with specific interest in sampling the deep areas of the nearby Gulf of Maine. One location was sampled twice for a day-night comparison. Five stations were completed by early on Sunday, November 13. The vessel then proceeded to Woods Hole to change personnel and complete the first leg of the cruise.

Training of personnel in the operation of the various sampling systems and the protocols for sample handling was accomplished. The establishment of an efficient routine for conducting a station was not fully accomplished due to lack of time. Still, at one shallow station all of the activities (bongo, CTD, MOC 1, pump and MOC 10) were completed within 2.5 hours. The time at anchor on Friday allowed for additional training in sorting of plankton samples and in filtering and processing of chlorophyll and nutrient samples.

Leg 2:

The second leg of the cruise departed Woods Hole at 1900 hrs on Sunday November 13 and arrived at the next station in Great South Channel at 0600 hrs on November 14. As in the first leg the first station was used to familiarize both watches with the operation of each of the sampling systems. The subsequent stations were located on four transects across the southern flank of the bank to deep water at the edge of the bank (see figure 1). The final transect extended across the eastern part of the bank from the Slope Water regime at the southern end to the northern edge of the bank. On some stations all sampling systems were used, while on others only the bongo, CTD and MOCNESS 1m systems were used. One additional station (#26) was occupied with a CTD cast and a bongo tow on the northern edge of the bank to test the effect of ship speed on the wire angle of a bongo tow and to collect live calanus for investigators at WHOI and URI. A second additional station (#27) was occupied in the southern Gulf of Maine during the transit to Woods Hole. A single MOC 1 tow was done to collect live calanus in response to a request received from URI.

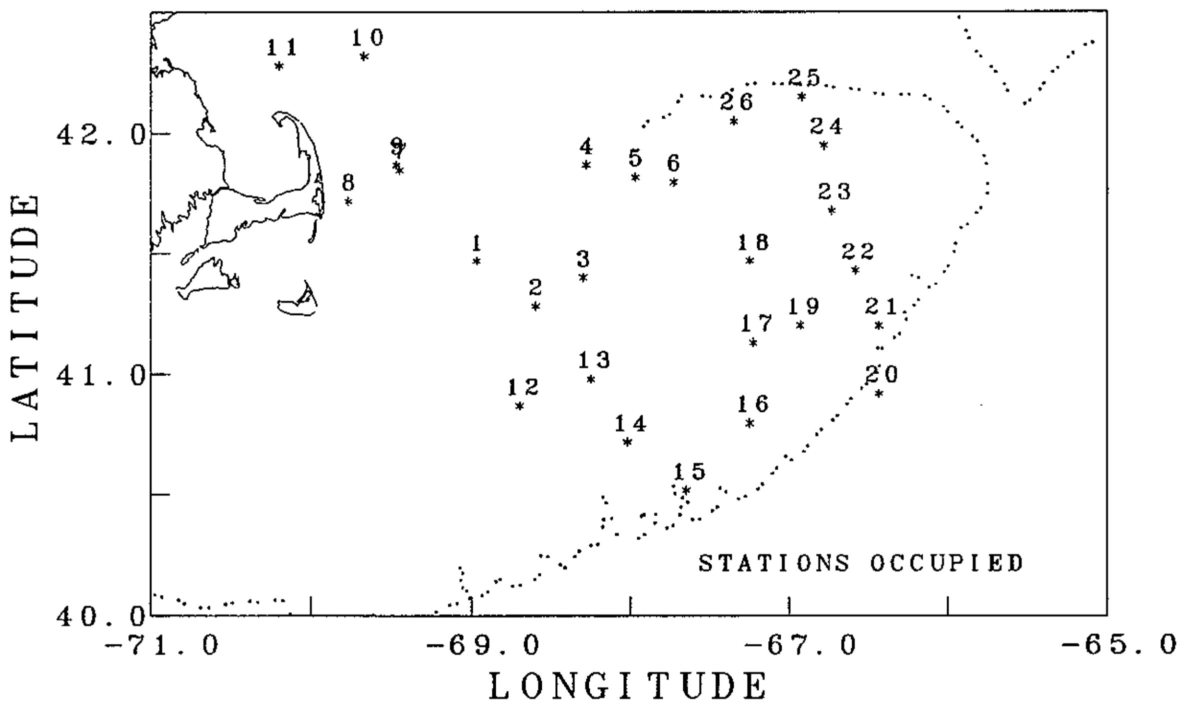

Figure 1. Location of stations occupied during cruise ALB94-10

Training of personnel in the operation of the different sampling systems was successful. After the first few stations, both watches functioned quite efficiently, such that a full station of sampling was able to be accomplished smoothly, with little wasted time.

Summary of Operations

A log of the sampling events during the cruise is presented in Appendix 2. A summary of the number of operations for each sampling system is given in Table 1.

Table 1. Summary of Sampling Operations

Activity	No.
Stations	27
Bongo tows	26
MK5 CTD casts	28
MOC 1 tows	33
Pump casts	15
MOC 10 tows	15

Results

Hydrography (D. Mountain):

The hydrographic data indicated conditions similar to those expected in November. The surface and bottom temperature and salinity are shown in figures 2 and 3. The surface fluorescence is shown in figure 4. Despite what seemed unusually warm air temperatures, the surface water temperatures were within a few tenths of a degree of expected values. The influence Slope Water (salinity > 34 PSU) was observed at depth in Franklin Basin in the Gulf of Maine (station 4, 34.86 PSU) and in Wilkinson Basin (station 10, 34.23 PSU). Slope Water (salinity 35-35.5 PSU) was observed off the southern edge of the bank (stations 15 and 20).

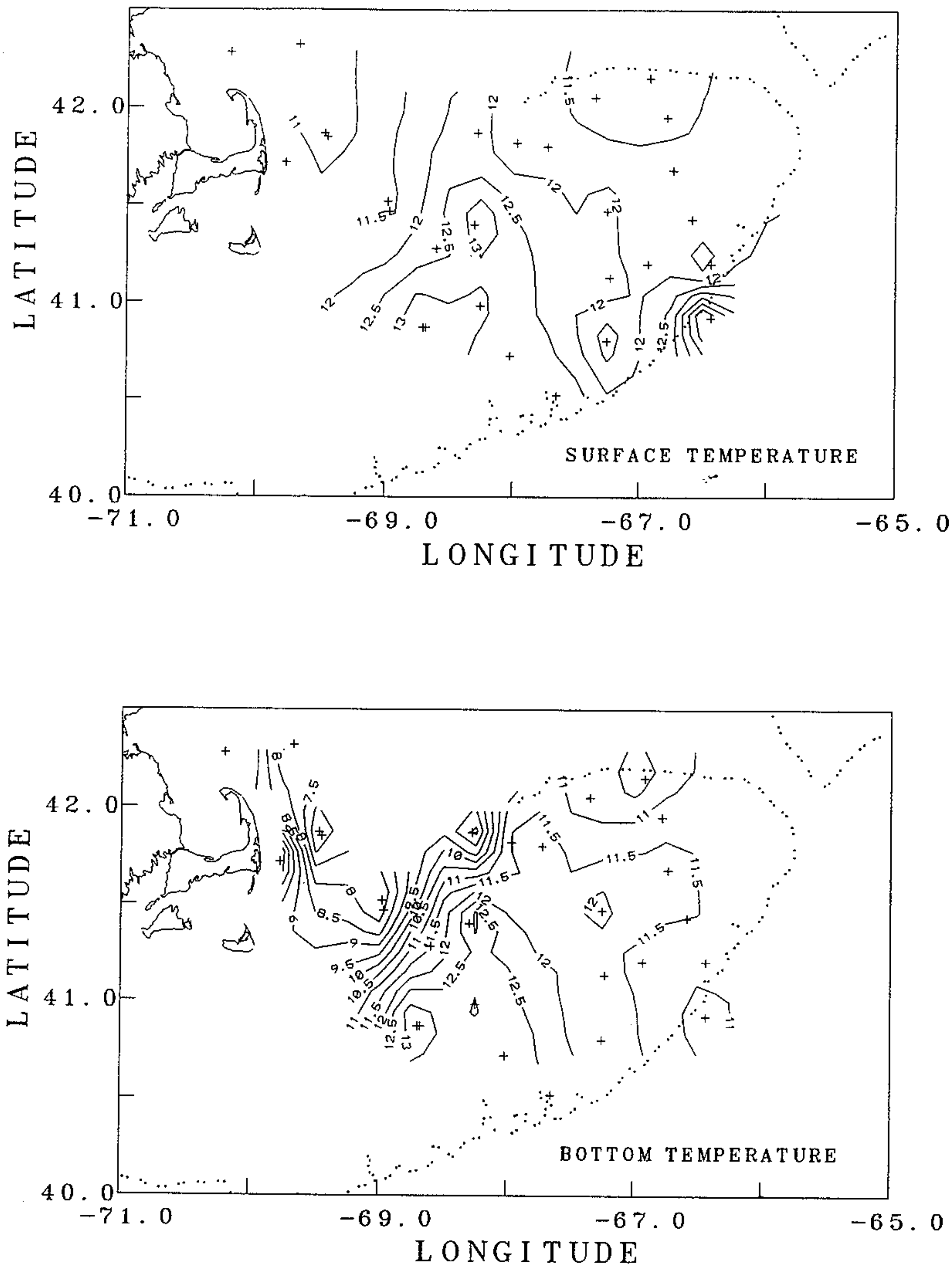

Figure 2. Surface (top) and bottom (bottom) temperature distribution during cruise ALB94-10.

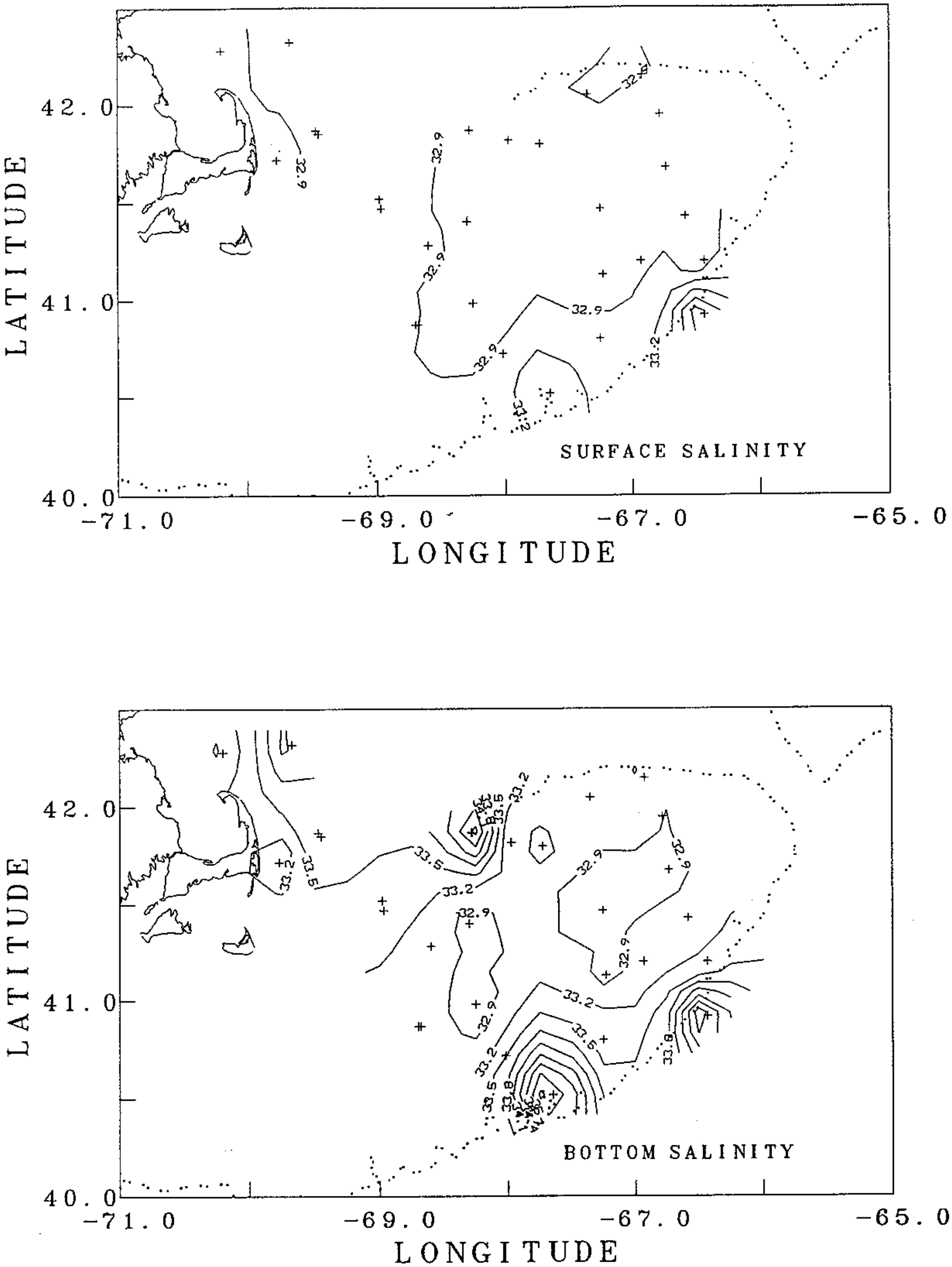

Figure 3. Surface (top) and bottom (bottom) salinity distribution during cruise ALB94-10.

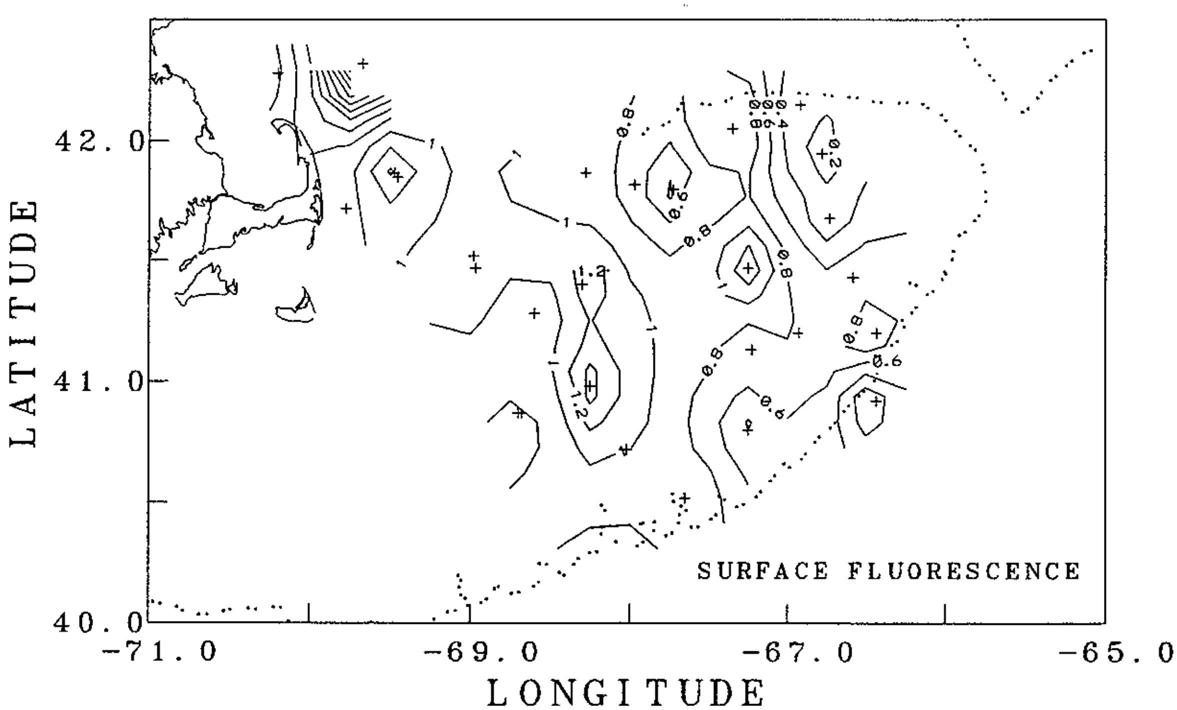

Figure 4. Surface fluoresence during cruise ALB94-10

Satellite imagery indicates the presence of a large ring close to the southern edge of the bank. The imagery indicates the boundary between the cooler bank waters and the warmer waters offshore, but does not resolve if a Slope Water band exists between the bank and the ring. No Gulf Stream water was observed in the CTD data, suggesting that stations 15 and 20 were in the Slope Water, and not water of Gulf Stream origin.

Zooplankton

First leg (C. Miller):

Gulf of Maine: We have sampled at a variety of sites in the western Gulf of Maine and over the western end and northern side of Georges Bank. This allowed study of zooplankton community composition and distributions over this subregion.

In deeper Gulf of Maine waters the dominant large copepod is *Calanus finmarchicus* mostly in the fifth copepodite stage (C5) with an unusually small proportion (relative to other years I have sampled in autumn) of C4. The distribution differed from that thought to be usual for November, which is that in waters as shallow as the Gulf the C5 should be resting in a diapause state not very far above the bottom. They are expected to be non-feeding and mostly quiescent. We did find reasonably large stocks near the bottom and indeed without food in their guts. However, larger numbers were distributed upward through the water column right the surface both night and day. In surface layers they were feeding actively, showing green gut contents on capture in very large fractions of individuals. Many had fecal pellets in the posterior section of the gut. We did a careful night day comparison of distributions over a 250 m bottom in Wilkinson Basin and found no sign of vertical migration, certainly no strong retreat from the very surface in an 1130 hrs haul. Apparently the diapause of the Gulf of Maine stock allows rather active feeding and roaming to all depths. This might reflect a very low predator abundance. Certainly invertebrate predators, particularly chaetognaths, were negligible in abundance.

Copepod species composition in the surface mixed layer in the Gulf was dominated numerically by older stages of *Centropages typicus*, which was very abundant. There were smaller numbers of *Calanus finmarchicus* (probably the biomass dominant), *Paracalanus parvus*, and *Clausocalanus* spp. *Euchaeta norwegica* was present at all depths in small numbers. Most individuals of all these species were adults, with very few copepodites. Females did not look ripe. *Pseudocalanus* have been represented by a few specimens only. We miss seeing them at least as resting stages in deeper levels of the Gulf. Their low numbers imply either an extraordinary replacement capability for late winter-spring, or that there is a resting stock hiding upstream someplace. Resting eggs have never been suggested for *Pseudocalanus.*

I collected 75 sets of five C5 *C. finmarchicus,* mostly from Gulf stations for analysis of storage lipid composition. Results from the RV ISELIN May-June cruise showed surprisingly high levels of triglycerides (TAG, thought to represent short term storage) relative to wax esters (WE, long term) for resting and close to resting Calanidae. I have been looking forward to examining November specimens, predicting a reduction in TAG/(TAG + WE). However, now that we see so much autumn feeding, we may see this proportion of TAG remain high.

Georges Bank: We sampled stations as shallow as 32 m on the north side of the Bank. Plankton composition at depths less than 60 meters over Georges Bank was strongly dominated by *Centropages typicus,* which is probably also the biomass dominant there. There were also *Oithona similis* (present but rare in the Gulf), *Paracalanus* sp. and *Clausocalanus* spp. (at about the same densities as in the Gulf). *Calanus finmarchicus* was present in substantial numbers, many more than in May-June, and some were collected for lipid analysis. Again, *Pseudocalanus* spp. were very, very few. The hydroids (*Clytia cylindrica*) that were so very abundant over all shallow portions of the Bank in May-June this year were absent. I didn't see one. Also the samples had no small jellyfish such as the *Phialidium* sp. one might expect as a seasonal replacement for *Clytia*'s hydroid phase.

The very high numbers of *Centropages typicus* throughout the sampling area, Gulf and Bank, would be nice to follow on into the winter. Since there seem to be no smaller copepodites, they may be producing resting eggs at this time. Nancy Marcus (pers. comm.) doesn't think they produce them, however. I saw only one *Centropages hamatus* (which definitely can produce resting eggs) in all the plankton I examined. It must be a remnant of the very large numbers present in the same area last spring. Presumably they will come out of their resting egg stock in March or April, since this past May they were very abundant at all life stages over shallow parts of the bank.

(E. Durbin):

On the first station our group saved both the 150 µm MOC-1 samples, (including the net 0 downcast), and pump samples from this station preserving them in buffered formalin. Where large volumes of material were captured in the nets, this was split before preservation so that animals constituted no more than 0.25 to 0.33 of the volume of a quart jar. The level of the split was noted on the labels and on the logsheet. A greater proportion of animals results in a decrease in pH of the preservation fluid during storage. These and later pump samples from Georges Bank and the GOM should tell us if there are any *Calanus finmarchicus* spawning in the late fall.

The pump intake was attached to the CTD rosette frame using a Niskin bottle cut in half lengthwise. This worked well with the CTD providing the depth information. Even in 20 kt winds the wire angle with 60 m of hose out was not significant. The pump hose was left in the water as we pumped from the maximum depth towards the surface and then disconnected from the pump and allowed to drain after the surface station was completed. Retrieving the empty hose was relatively easy. A few modifications need to be made to the manifold system to reduce spray in high wind which could cause icing problems in winter.

Station 2 was on the edge of Georges Bank and we saved no samples, instead preferring to wait until we reached Station 3 which was further on the bank (54 m depth). Here we saved both pump and MOC-1 samples. Even at this depth the standard depths (bottom-40 m, 40-15 etc.) were used, although the bottom layer was very thin.

We next proceeded to a deep GOM station (221m) and carried out the standard sampling procedure. Samples were saved from this station. Also we put copepods from the surface (0-15 m) and the bottom (100-200 m) into jars for culturing. The *Calanus finmarchicus* from the bottom were resting, hanging vertically in the water with their antennae outstretched. However, they would jump if poked. Copepods from these samples were sorted the next day for length and C & N measurement while the ship was in Nantucket Sound. Nearly all the Calanus at this station were C5s with a very few C4s and adult females. No Pseudocalanus were observed. A second MOC-1 tow was taken between 200 and 100 m for freezing for fish food. We then sampled two on-bank stations (Stns 5 and 6) keeping samples from both. At this point we decided that we were so proficient with the pump and MOC-10 we needed no further practice with this gear during the remainder of the cruise.

The wind picked up a little after this station (St 6) and the Captain chose to take refuge in Nantucket Sound to escape the wind and waves. We stayed there until Friday evening when we left, arriving at a station in the southern GOM (st 7) around midnight. The depth here was about 200 m. With the MOC-1 we sampled at 20 m intervals from the bottom to the surface using both the 150 and 333 um nets. The objective here was to determine the depth distribution of the resting *Calanus finmarchicus*. It turned out that it was more-or-less evenly distributed throughout the water column. *C. finmarchicus* was the only species in the bottom layers while near the surface *Centropages* sp. was dominant with some *Clausocalanus*. Very few *Pseudocalanus* were observed. Inspection of freshly caught surface *C. finmarchicus* at a previous station had indicated that they had food in their guts so prior to this station we got ready for sorting animals for gut pigment measurement. As soon as the surface (0-20 m) net came on board we anesthesised a sub-sample and sorted C5 Calanus for gut pigments. A small proportion were observed to have food in their guts (some brown and some green) and were making fecal pellets. A second standard MOC-1 tow was taken with the contents of all nets but net 5 (for Bucklin) being frozen for fish food. An inshore station next to Cape Cod (St 8) was sampled next with bongo, MOC-1, and CTD. Samples were preserved at this station. We then went back to the location of St 7 for daytime sampling. *C. finmarchicus* was still throughout the water column and some were at the surface feeding. We sorted groups of these for gut pigments. There were also some *Pseudocalanus* C5s which had quite green guts. These all had broken antennae, however, and were almost impossible to pick up on the rocking ship for gut pigment measurements. A gentler sampling approach needs to be used for *Pseudocalanus*. We also sorted surface *C. finmarchicus* C5s and C4s (a few were present), and bottom C5s, for length and C & N. Bottom C5s appeared to be very variable in size while those from the surface were large and less variable.

We then steamed north to an even deeper station (St 10, 250 m) where a MOC-1 tow was made from the bottom to the surface at 25 m intervals. These were all preserved in formalin. A second tow was taken where the 150 nets were closed at the bottom and the 333 µm nets used in a standard haul. These were preserved in Etohal. A last station adjacent to Stellwegen Bank to look for *Pseudocalanus* spp. was sampled before returning to Woods Hole.

Leg 2 (C. Morgan):

Stations sampled in the southwestern to south central portion of Georges Bank (Station #'s 12-14, and 16-18) had little to no *Calanus finmarchicus* in them. As was found in the Leg I GGB samples, the plankton composition at these sites was strongly dominated by *Centropages typicus*. There were also *quite a few* *Paracalanus* sp. and a fair number of *Oithona similis*. None of the plankton people saw any *Pseudocalanus* spp. or hydroids (*Clytia cylindrica*) that were so very abundant over the Bank in May-June this year.

Station 15 was sampled at 25 m intervals up the water column to look at depth stratification of the plankton. The first Leg group was able to get a day/night comparison of this sort at the same station for the purpose of looking at diel vertical migration. We wished to repeat this exercise in the southern portion of the sampling area, but we were never able to sample a deeper station during the dark hours. This station had some C5 *Calanus*, which we collected for lipid analysis. However, this station had quite a few copepods which the zooplankton people on board didn't recognize, lots of jellyfish, fish larvae, and what looked like the larval stage of spiny lobster. There was a warm core ring sitting to the south of this station, and this may have had some influence on the plankton composition.

We did a transect along the eastern side of the bank from south to north. The southernmost station (20) was our deepest station (~400 fathoms). The MOCNESS tow went to 250 m with no problems. There were no *C. finmarchicus* here. The deep (250-100m) samples were dominated by all life history stages of *Metridia lucens* as well as *Centropages typicus*. In the shallow samples (15-0m) *C. typicus* was most abundant. There were also many as well as *Aetidius armatus M. lucens*, and *Euchaeta* sp. As we proceeded north along our transect *C. finmarchicus* became more and more abundant peaking at the northernmost station (#25). They were present throughout the water column and those at the surface had green guts. Stage C5 were the most abundant, but we also saw stage C3, C4, and females (some with spermatophores). *M. lucens* was the second most abundant copepod in the bottom (160-100m) and *C. typicus* in the surface (15-0m) samples.

Ichthyoplankton (J. Sibunka):

Haddock larvae do not occur on Georges Bank in November and Atlantic cod are infrequent members of the autumn ichthyoplankton community, so no attempt was made to pursue research related to GLOBEC's targeted fish species. Instead, we addressed questions related to gear performance and stressed training of newly hired personnel to assure that those involved with research related to fish eggs and larvae are fully appraised of their responsibilities and interactions with other members of the scientific field party and ship's crew. To that end, we: (1) tested the feasibility of simultaneously fishing two 61-cm bongos on a single wire, a towing scheme proposed to satisfy requests for fish larvae from several quarters, each with their own requirements for handling and preservation, without adding to the sampling time on station; (2) evaluated winch speeds for the bongos and MOC-1; and (3) assigned four people from NEFSC's Ichthyoplankton Dynamics Investigation to each leg of the cruises. MOC-1 tows were made at a retrieval rate of 10m min^{-1}, while bongo tows followed standard MARMAP protocols, i.e., out at 50m min^{-1}, in at 20m min^{-1} with adjustments made in depths less than 60m. The cruise provided us with sufficient additional familiarity with the fishing characteristics of the MOCNESS system to conclude that we will adopt a retrieval rate of 10m min^{-1} for MOC-1 ichthyoplankton tows at all depths when the bankwide surveys get underway in February 1995.

Bongo samples from 18 stations were retained for inter net comparisons of cubic meters of water strained, zooplankton volumes and catches of fish eggs and larvae to insure that fishing qualities of one sampler were not impacted by the other. Tests of between net sampling efficiencies and zooplankton volumetric determinations produced no apparent significant differences. Comparisons of ichthyoplankton catches will be completed before the surveys begin in February. All zooplankton samples from MOC-1 nets dedicated to ichthyoplankton research were frozen to provide fish food for an ongoing Coastal Ocean Program study on Atlantic mackerel at the University of Rhode Island.

Gross observations of both bongo and MOC-1 samples revealed that Atlantic herring larvae numerically dominated the autumn ichthyoplankton community on George Bank, continuing a recent trend that began in 1987. Large catches of herring larvae 15 to 25mm long occurred in the second leg of the cruise, or over the eastern half of the bank, indicating that spawning activity continues to intensify on the historically prominent spawning beds on the Northeast Peak. Although the recovery of herring on the bank has been underway since 1987, the spawning beds on the Northeast Peak were not reoccupied until the autumn of 1992. Other fish larvae observed in plankton samples included silver hake, hakes of the genus Urophycis, ell laptocephali and myctophids.

Training:

The training of personnel and testing of sampling protocol objectives for the cruise were largely accomplished. The second leg showed that an efficient routine could be established that would complete stations within the anticipated time period. Training in the sorting of larvae during station operations was not accomplished due to few larvae being in the samples. Another aspect of training that did not occur was in overcoming problems with the instrument systems. All systems functioned well and with few, if any, problems. This is actually a real loss, since trouble shooting problems will be important during the survey cruises next spring.

Comments and Recommendations

The initial plan for station operations worked quiet well, with the order of bongo, CTD, MOC 1, pump and MOC 10. On ALBATROSS IV, this meant turning the ship between each operation, since the operations alternated between which side of the vessel was used. However, the time loss did not seem significant.

The bongo and the MOC 1 used the same wire, so that the termination for each had to be changed each station. While somewhat inconvenient, this did not cause a problem in either time or data loss. Separate wires would be desirable.

The pump hose was deployed by attaching it to the CTD rosette frame. This arrangement worked well, once the rest of the hose was attached to the CTD wire by hooks and loops of line that were easy to put on and take off. This allowed the CTD wire to lift the hose during the up cast.

The basic operations planned can be accomplished on ALBATROSS IV by the six persons per watch presently planned. If additional picking and working with live animals is to be done, either additional personnel will be needed or a slow down in operations during those times could be planned. The processing of chlorophyll samples by the CTD operator may also cause some slow down in operations, if the present protocol is used (size fractionation of total, <20 um and <5 um).

The logistics on R/V ENDEAVOR will be different than on ALBATROSS IV. Deck operations on ALBATROSS IV are handled, to a large degree, by three fishermen on each watch. They are very experienced in all of the operations being conducted and contribute significantly to the smooth and safe handling of the equipment. Similar support will not be available on R/V ENDEAVOR. An additional person or two per watch may be needed to have the same efficiency of operation as on ALBATROSS IV.

While accomplishing the sampling operations generally was found to be quite doable, keeping track of the operations and the samples will need more thought and preparation. Two areas that caused problems were:

1) the use of GMT, which led to many errors. Local time should be used on all logs and converted to GMT afterwards.

2) confusion in numbering of stations vs tows/casts. Since each sampling system is not used on every station and some might be used twice on a station, and since occasionally a tow/cast is aborted, the consecutive number of tows is not always equal to the consecutive station number. Each sampling system should number its activities (tow, haul, or cast) consecutively from the beginning of the cruise. Each station should be numbered consecutively from the beginning of the cruise. For convenience, the log sheets for each system should include a place for both consecutive number for that system and for station number. In addition, in the vessel's main laboratory where most of the sorting and preservation is to be done, a board with the station number and the current number for each system should be posted and updated between each station.

All labels should be standardized for both the outside and inside of sample jars. The label needs to include the gear, station, tow, date, net, type of preservation and the number of jars in the split. Date entries should use the same format, e.g., 11/22/94 or 22 XI 94.

A log of preserved samples should be kept, listing the station, the sampling system, the haul/cast/tow for that system, the depth/net of the sample, the type of preservation used, and (if appropriate) how many jars in the split. This will provide a single list of all samples, for use by all investigators and for an inventory check of samples at the end of each cruise.

A station's location should be defined by some radius around a central point. This will prevent the ship from having to reposition after each operation, unless it has moved at least some significant distance. For a broad scale survey, a radius of a mile would seem acceptable.

The use of 10 nets on the MOC 1 results in the last net (the 9 net) not able to be closed, and the frame is recovered with the net open. This was of concern before the cruise since in high winds the net would act as a sail and the frame might be difficult to handle. While in winds of around 20 knots the open net did make the frame more difficult to handle, it was not a problem.

Appendix 1.

Scientific Field Party

Name	Title	Organization
Leg 1		
1. David Mountain	Chief Scientist	NMFS, Woods Hole, MA
2. Amy Marie Tesolin	Biological Tech.	" " " "
3. Marie Kiladis	Biological Tech.	" " " "
4. John Green	Oceanographer	NMFS, Narragan., RI
5. Rebecca Jones	Biological Tech.	" " " "
6. Anthonie Chute	Biological Tech.	" " " "
7. Kate Lindner	Biological Tech.	" " " "
8. John Sibunka	Fish. Biologist	NMFS, Sandy Hook, NJ
9. Edward Durbin	Scientist	URI, Narragan., RI
10. Maria Bemis	Research Assist.	URI, Narragan., RI
11. Terresa Rutonno	Biological Tech.	NMFS, Woods Hole, MA
12. Charles Miller	Scientist	OSU, Corvallis, OR
13. Alice Wells	Biological Tech.	NMFS, Sandy Hook, NJ
14. Alyse Wiener	Biological Tech.	NMFS, Sandy Hook, NJ
Leg 2		
1. David Mountain	Chief Scientist	NMFS, Woods Hole, MA
2. Amy Marie Tesolin	Biological Tech.	" " " "
3. Maureen Taylor	Phy. Sci. Tech.	" " " "
4. Daniel Almgren	Phy. Sci. Tech.	" " " "
5. James Gibson	Research Assist.	URI, Narragan., RI
6. John Sibunka	Fish. Biologist	NMFS, Sandy Hook, NJ
7. Peter Berrien	Fish. Biologist	" " " "
8. Janis Peterson	Research Assist.	URI, Narragan., RI
9. Peter Garrahan	Research Assist.	URI, Narragan., RI
10. Robert Campbell	Research Assist.	URI, Narragan., RI
11. Maria Heredia	Research Assist.	URI, Narragan., RI
12. Ellite Ballesteros	Graduate Student	UNH, Durham, NH
13. Cheryl Morgan	Research Assist.	OSU, Corvallis, OR
14. Walter Anoushian	Biological Tech.	NMFS, Sandy Hook, NJ

WHOI = Woods Hole Oceanographic Institution
URI = University of Rhode Island, Graduate School of Oceanography
UNH = University of New Hampshire
OSU = Oregon State University

Officers and Crew of ALBATROSS IV

LCDR Gary Bulmer	Commanding Officer
LT James Meigs	Executive Officer
ENS Christopher Koch	Operations Officer
ENS Leslie Redmond	Navegation Officer
Kevin Cruise	Chief Mechanical Eng.
John Hurder	1st Assist. Eng.
Charles Hersey	2nd Assist. Eng.
Matthew Herod	General Vessel Asst.
Emetario Punzalan	General Vessel Asst.
Manuel Botelho	Chief Bosun
Kenneth Rondeau	Lead Fisherman
John Cravo	Skilled Fisherman
Antonio Alvernaz	Skilled Fisherman
William Amaro	Skilled Fisherman
Brian Cardoza	Fisherman
John Braxton	Chief Steward
Eugene Nelson	2nd Cook
Bruce Stone	Rotating Electronics Technician
James Johnson	Rotating Electronics Technician

Appendix 2. Event Log for crusie ALB94-10.

Event #	Instr.	cast #	sta #	yr	mo	day	GMT hr	GMT min	lat	lon	WATER DEPTH	CAST DEPTH	PI	COMMENTS
	Tst Sys.	99	99	94	11	8	15	5	4125.8	7008.3	10	10	Mountain	test of MOC1, MOC10 & double bongo (no SEABIRD)
	Tst Sys.	99	99	94	11	8	18	10	4125.8	7008.3	10	10		
AL31294.1	Bongo	1	1	94	11	8	22	56	4029.3	6857.1	150	138	Sibunka	Double (over and under) Bongo
AL31294.2	MrkV CTD	1	1	94	11	8	23	31	4128.5	6858.3	152	140	Mountain	
AL31294.3	MOC-1	1	1	94	11	8	23	50	4127.7	6858.5	152	135	Miller	Problems with angle indicator
		1	1	94	11	9	1	0	4126.9	6859.3	149			
AL31394.1	pump	1	1	94	11	9	1	54	4127.9	6859.6	152	100	Durbin	
AL31394.2	MOC-10	1	1	94	11	9	3	8	4127.8	6858.6	152	135	Miller	
		1	1	94	11	9			4128.8	6857.2	152			
AL31394.3	MOC-1	2	1	94	11	9	4	21	4130.2	6856.9	140	135	Miller	Repeat tow; Net reponse didn't function
		2	1	94	11	9	5	48	4132.2	6946.7	140			
AL31394.4	Bongo	2	1	94	11	9	5	51	4131.6	6859.1	150	141	Sibunka	
AL31394.5	MK5-CTD	2	1	94	11	9	6	18	4131.6	6859.8	143	133	Mountain	
AL31394.6	MOC-1	3	1	94	11	9	7	55	4132.0	6900.0	135	115	Durbin	No flow responses
		3	1	94	11	9	9	3	4132.7	6903.1	153	120		
AL31394.7	Pump	2	1	94	11	9	9	16	4132.7	6903.1	150	56	Durbin	
AL31394.8	MOC-10	2	1	94	11	9	10	31	4132.3	6902.2	135	116	Durbin	
		2	1	94	11	9	11	11	4132.7	6900.1	134			
AL31394.9	Bongo	3	2	94	11	9	14	5	4117.4	6835.8	63	55	Sibunka	
AL31394.10	MK5-CTD	3	2	94	11	9	14	22	4117.6	6836.0	68	63	Mountain	
AL31394.11	MOC-1	4	2	94	11	9	14	43	4117.9	6835.3	68	50	Miller	pressure sensor problem
		4	2	94	11	9	15	17	4118.4	6836.5	72			
AL31394.12	Pump	3	2	94	11	9	15	31	4118.3	6836.8	68	48	Durbin	
AL31394.13	MOC-10	3	2	94	11	9	16	20	4118.7	6835.8	71	60	Miller	
		3	2	94	11	9	16	35	4118.0	6835.1	71			
AL31394.14	Bongo	4	3	94	11	9	18	23	4123.1	6818.1	54	45	Sibunka	
AL31394.15	SB/Bottle	5	3	94	11	9	18	52	4123.9	6818.4	51	45	Mountain	water cast: Sea Bird and bottle
AL31394.16	MK5-CTD	4	3	94	11	9	19	0	4124.8	6818.2	54	46	Mountain	
AL31394.17	MOC-1	5	3	94	11	9	19	47	4126.1	6818.4	54	40	Sibunka	Pressure sensor problem self-repaired
		5	3	94	11	9	20	8	4127.1	6818.4	54			
AL31394.18	Pump	4	3	94	11	9	20	52	4127.1	6818.4	54	47	Durbin	
AL31394.19	MOC-10	4	3	94	11	9	22	13	4126.1	6815.0	40	25	Sibunka	
		4	3	94	11	9	22	23	4125.9	6815.0	38		Sibunka	
AL31494.1	Bongo	6	4	94	11	10	2	10	4151.7	6817.8	221	201	Sibunka	
AL31494.2	MK5-CTD	5	4	94	11	10	2	49	4152.6	6817.2	222	212	Mountain	bottle #4 had no sample
AL31494.3	MOC-1	6	4	94	11	10	3	7	4152.6	6817.6	221	198	Durbin	
		6	4	94	11	10	5	6	4156.5	6817.1	204			
AL31494.4	Pump	5	4	94	11	10	5	39	4156.6	6817.0	205	57.5	Durbin	

AL31494.5	MOC-10	5	4	94	11	10	6	37	4157.1	6816.1	214	195	Sibunka	
		5	4	94	11	10	7	28	4157.7	6814.6	229	200	Durbin	
AL31494.6	MOC-1	7	4	94	11	10	8	19	4157.1	6813.1	229	200	Durbin	Special to get bulk Calanus for freezing (Durbin)
		7	4	94	11	10	9	56	4159.4	6809.2	230			
AL31494.7	Bongo	7	5	94	11	10	11	34	4149.8	6800.0	59	50	Sibunka	
AL31494.8	MK5-CTD	6	5	94	11	10	11	48	4149.7	6759.8	58	51	Mountain	
AL31494.9	Pump	6	5	94	11	10	12	28	4149.1	6757.9	52	46	Durbin	
AL31494.10	MOC-1	8	5	94	11	10	8	55	4149.6	6758.9	59	48	Miller	No data files on computer/.pro printout in MOC book
		8	5	94	11	10	9	27	4150.8	6759.1	60	45		
AL31494.11	Bongo	8	6	94	11	10	17	0	4147.9	6743.6	34	25	Sibunka	
AL31494.12	SB/Bottle	9	6	94	11	10	17	11	4148.6	6743.9	34	32	Mountain	
AL31494.13	MK5-CTD	7	6	94	11	10	17	27	4148.8	6744.1	36	33	Mountain	
AL31494.14	MOC-1	9	6	94	11	10	17	37	4149.5	6744.7	37	29	Sibunka	
		9	6	94	11	10	18	1	4151.1	6746.0	37			
AL31494.15	Pump	7	6	94	11	10	18	31	4152.1	6746.5	41	37	Durbin	
AL31494.16	MOC-10	7	6	94	11	10	19	5	4152.6	6746.9	41	26	Sibunka	
		7	6	94	11	10	19	15	4153.2	6747.3	41			
AL31694.1	MOC-1	10	7	94	11	12	5	23	4151.2	6928.9	195	190	Durbin	
		10	7	94	11	12	6	7	4152.3	6927.1	207			
AL31694.2	MK5-CTD	8	7	94	11	12	6	58	4148.8	6927.6	201	191	Mountain	
AL31694.3	MOC-1	11	7	94	11	12	7	39	4150.4	6928.1	192	185	Durbin	
		11	7	94	11	12	9	15	4153.5	6926.0	207			
AL31694.4	Bongo	10	8	94	11	12	12	34	4143.6	6946.9	70	60	Sibunka	
AL31694.5	MK5-CTD	9	8	94	11	12	12	48	4143.6	6946.8	71		Mountain	
AL31694.6	MOC-1	12	8	94	11	12	13	16	4143.9	6946.6	77	60	Miller	
		12	8	94	11	12	14	6	4145.0	6944.6	105	68		
AL31694.7	MOC-1	13	9	94	11	12	16	11	4151.2	6928.8	195	180	Miller	
		13	9	94	11	12	16	41	4152.0	6928.8	199			
AL31694.8	MK5	10	9	94	11	12	16	45	4152.2	6928.9	199	188	Mountain	
AL31694.9	MOC-1	14	9	94	11	12	17	40	4150.6	6929.3	190	176	Miller	
		14	9	94	11	12	19	13	4153.6	6930.4	203	180		
AL31694.10	Bongo	11	10	94	11	12	21	48	4219.8	6940.0	252	201	Sibunka	
AL31694.11	SB/Bottle	12	10	94	11	12	22	13	4219.8	6940.5	252	97	Mountain	
AL31694.12	MK5	11	10	94	11	12	22	22	4219.8	6940.8	250	200	Mountain	
AL31694.13	MOC-1	15	10	94	11	12	22	45	4220.0	6940.6	252	235	Durbin	0 Net down, all 9 in continuous series up
		15	10	94	11	12	23	42	4219.8	6943.1	250			
AL31794.1	MOC-1	16	10	94	11	13	0	16	4220.1	6940.0	253	200	Sibunka	Just 5 Net down, rest up. All alcohol.
		16	10	94	11	13	0	59	4220.1	6941.9	246			
AL31794.2	MK5-CTD	12	11	94	11	13	3	51	4218.0	7012.8	43	37	Mountain	
AL31794.3	MOC-1	17	11	94	11	13	4	7	4217.9	7012.5	45	38	Miller	Samples were Nets 1,2,5,6,7. Cod end lost from 5.
		17	11	94	11	13	4	34	4217.7	7013.5	39	35		

AL31794.4	Bongo	13	11	94	11	13	5	3	4217.5	7014.7	38	32	Sibunka	End leg I
AL31894.1	MOC-1	99	99	94	11	14	2	20	4126.0	7010.0	12	5	Sibunka	Test of electronics
AL31894.2	Bongo	14	12	94	11	14	11	58	4052.5	6841.5	66	59	Sibunka	Samples not kept due to net entanglement around flowmeter
AL31894.3	MK5-CTD	13	12	94	11	14	12	15	4052.9	6842.4	62	58	Mountain	
AL31894.4	MOC-1	18	12	94	11	14	12	57	4052.2	6840.4	65	50	Sibunka	Samples = nets 0,1,2,3 Form., net 5 ETOH, nets 6-8 frozen.
		18	12	94	11	14	13	26	4052.0	6838.7	59			
AL31894.5	Pump	8	12	94	11	14	14	26	4051.9	6840.9	67	50	Durbin	Samples were nets 1,2,3, All Form.
AL31894.6	MOC-10	8	12	94	11	14	15	48	4051.6	6840.9	66	50	Sibunka	Samples were nets 0-3. All form.
		8	12	94	11	14	16	7	4051.5	6842.0	54			
AL31894.7	Bongo	15	12	94	11	14	17	7	4051.2	6841.1	62	55	Sibunka	Samples were nets A-D, All ETOH.
AL31894.8	MK5-CTD	14	12	94	11	14	18	24	4052.2	6841.1	64	61	Mountain	
AL31894.9	MOC-1	19	12	94	11	14	19	0	4051.7	6840.6	65	55	Sibunka	Samples were nets 0-3, form., net 5 ETOH, nets 6-8 frozen.
		19	12	94	11	14	19	26	4050.6	6841.7	61			
AL31894.10	Pump	9	12	94	11	14	20	46	4052.1	6841.4	65	57	Durbin	Samples were nets 1,2,3, all form., Elieta took sample at sfc &15m
AL31894.11	MOC-10	9	12	94	11	14	22	16	4053.7	6842.7	67	50	Sibunka	Samples were nets 0-3, all form.
AL31994.1	Bongo	16	13	94	11	15	1	24	4059.7	6815.5	51	48	Sibunka	Samples were nets A-D, all ETOH
AL31994.2	MK5-CTD	15	13	94	11	15	1	48	4059.3	6815.8	51	46	Mountain	Rossette btl depths out of order (46,2,15); samples for Ellie at 2 &15 m
AL31994.3	MOC-1	20	13	94	11	15	2	41	4058.5	6815.0	49	40	Sibunka	Samples =nets 0-2, form., net 5 ETOH,
		20	13	94	11	15	3	5						subsample from 1-2 for C. Morgan
AL31994.4	Bongo	17	14	94	11	15	4	59	4043.6	6800.7	78	70	Sibunka	Samples were A-D, all ETOH.
AL31994.5	SB/Bottle	18	14	94	11	15	5	14	4043.4	6801.5	77	59		
AL31994.6	MK5-CTD	16	14	94	11	15	5	30	4043.3	6801.8	78	72	Mountain	
AL31994.7	MOC-1	21	14	94	11	15	5	54	4042.9	6802.1	79	68	Sibunka	Samples were nets 0-3, all form., net 5 ETOH, nets 6-8 frozen.
		21	14	94	11	15	6	26	4042.9	6804.2	78	68		
AL31994.8	Pump	10	14	94	11	15	7	25	4042.3	6802.8	78	47	Durbin	Samples =nets 1,2,3, all form.; samples for Eliete at 2 &15 m.
AL31994.9	MOC-10	10	14	94	11	15	8	34	4041.8	6802.3	81	65	Sibunka	Aborted tow.
		10	14	94	11	15	9	9						
AL31994.10	MOC-10	11	14	94	11	15	9	52	4042.6	6800.7	81	65	Sibunka	Samples were nets 0-3, all form.
		11	14	94	11	15	10	11	4042.4	6800.6	81			
AL31994.11	Bongo	19	15	94	11	15	13	13	4031.2	6738.7	134	132	Sibunka	Samples were nets A, B, C, D - ETOH.
AL31994.12	MK5	17	15	94	11	15	13	46	4031.2	6739.9	135	127	Mountain	
AL31994.13	MOC-10	12	15	94	11	15	14	9	4031.0	6739.8	136	120	Sibunka	Samples were nets 0-4, form.
		12	15	94	11	15	14	51	4030.5	6741.6	146			
AL31994.14	Pump	11	15	94	11	15	15	35	4030.9	6738.9	135	57	Durbin	Samples were nets 1-3, form.
AL31994.15	MOC-1	22	15	94	11	15	16	21	4030.5	6738.2	135	125	Sibunka	Samples nets 0-5, all form.
		22	15	94	11	15	16	53	4030.6	6740.8	137			
AL31994.16	Bongo	20	16	94	11	15	21	10	4048.3	6714.9	95	90	Sibunka	No samples, only flow counts
AL31994.17	MK5	18	16	94	11	15	21	26	4048.6	6715.6	94	87	Mountain	
AL31994.18	MOC-1	23	16	94	11	15	21	52	4048.9	6716.1	94	85	Sibunka	Samples were nets 0-3, formalin, net 5 ETOH, nets 6-9 frozen
		23	16	94	11	15	22	31	4048.8	6718.0	93	85		
AL31994.19	Pump	12	16	94	11	15	23	3	4050.2	6718.0	91	56	Durbin	Samples were at 15m and surface for Ellie

AL32094.1	MOC-10	13	16	94	11	16	0	14	4051.0	6712.5	90	75	Sibunka	No samples - net bars not in place
		13	16	94	11	16	0	35	4051.4	6718.7	89			
AL32094.2	Bongo	21	17	94	11	16	2	46	4108.0	6715.2	60	52	Sibunka	No samples - flow counts only.
AL32094.3	MK5-CTD	19	17	94	11	16	2	56	4108.4	6714.9	60	52	Mountain	
AL32094.4	MOC-1	24	17	94	11	16	3	17	4108.3	6714.7	60	50	Sibunka	Samples were nets 0-3 formalin, net 5 ETOH, nets 6-8 frozen
		24	17	94	11	16	3	42	4109.2	6713.7	59			
AL32094.5	Pump	13	17	94	11	16	3	57	4109.2	6713.7	60	50	Durbin	Samples were nets 1-3 formalin; 15m & surface for Ellie
AL32094.6	MOC-10	14	17	94	11	16	4	51	4109.0	6714.9	60	45	Sibunka	Samples were nets 0-2 formalin.
		14	17	94	11	16	5	13	4109.5	6714.6	58			
AL32094.7	Bongo	22	18	94	11	16	8	16	4128.1	6715.5	47	42	Sibunka	No samples - flow counts only.
AL32094.8	MK5-CTD	20	18	94	11	16	8	35	4128.4	6715.1	48	41	Mountain	
AL32094.9	MOC-1	25	18	94	11	16	8	51	4128.3	6715.6	45	35	Sibunka	Sample was net 5 - ETOH.
		25	18	94	11	16	9	7	4128.5	6715.3	45			
AL32094.10	Bongo	23	19	94	11	16	13	5	4112.5	6656.6	70	64	Sibunka	No samples - flow counts only.
AL32094.11	MK5-CTD	21	19	94	11	16	13	18	4112.9	6656.1	70	62	Mountain	
AL32094.12	MOC-1	26	19	94	11	16	13	35	4113.0	6656.4	70	60	Sibunka	Samples were nets 0 - 3 formalin.
		26	19	94	11	16	14	3	4113.8	6655.2	70			
AL32094.13	Pump	14	19	94	11	16	14	19	4114.0	6655.0	69	57	Durbin	Samples were nets 1-3 formalin
AL32094.14	MOC-10	15	19	94	11	16	15	11	4114.0	6655.0	70	55	Sibunka	Samples were nets 0-3 formalin
		15	19	94	11	16	15	27	4114.5	6654.3	70			
AL32094.15	MK5-CTD	22	20	94	11	16	18	40	4055.0	6626.9	900	254	Mountain	
AL32094.16	MOC-1	27	20	94	11	16	19	1	4054.6	6627.0	900	250	Sibunka	Samples were nets 0-4 form., # 5 ETOH.
		27	20	94	11	16	20	52	4054.3	6621.0	900			
AL32094.17	Pump	15	20	94	11	16	21	40	4055.7	6622.5	900	57	Durbin	Samples were nets 1-3 were form., sfc and 15m for Ellie.
AL32194.1	Bongo	24	21	94	11	17	0	40	4111.8	6626.8	93	85	Sibunka	No samples - flow counts only
AL32194.2	MK5-CTD	23	21	94	11	17	1	4	4112.4	6626.5	95	87	Mountain	
AL32194.3	MOC-1	28	21	94	11	17	1	18	4112.4	6626.6	96	85	Sibunka	Samples were nets 0-3 & 6-8 frozen, net 5 ETOH
		28	21	94	11	17	1	58	4113.4	6625.3	91			
AL32194.4	Bongo	25	22	94	11	17	4	2	4127.0	6636.0	85	78	Sibunka	No samples - flow counts only
AL32194.5	MK5-CTD	24	22	94	11	17	4	23	4126.9	6635.2	88	80	Mountain	
AL32194.6	MOC-1	29	22	94	11	17	4	41	4126.9	6635.2	88	75	Sibunka	Samples were nets 0-3 & 6-8 frozen, net 5 ETOH
		29	22	94	11	17	5	26	4127.0	6632.3	88			
AL32194.7	Bongo	26	23	94	11	17	8	6	4141.7	6644.7	68	62	Sibunka	Samples were nets A,B,C,D, - ETOH.
AL32194.8	SB/Bottle	27	23	94	11	17	8	18	4141.6	6644.5	68	60	Mountain	
AL32194.9	MK5-CTD	25	23	94	11	17	8	32	4141.4	6644.3	68	65	Mountain	
AL32194.10	MOC-1	30	23	94	11	17	8	45	4141.3	6644.6	72	60	Sibunka	Samples were nets 0-3 & 6-8 frozen, net 5 ETOH
		30	23	94	11	17	9	15	4141.1	6643.5	73			
AL32194.11	Bongo	28	24	94	11	17	11	17	4157.1	6647.9	67	60	Sibunka	samples were nets A-D in ETOH
AL32194.12	MK5-CTD	26	24	94	11	17	11	35	4157.6	6647.9	68	60	Mountain	
AL32194.13	MOC-1	31	24	94	11	17	11	53	4157.8	6648.3	67	55	Sibunka	Net 5 ETOH;nets 0-4,7,9 frozen;nets 1 & 3, 6 & 8 for live samples
		31	24	94	11	17	12	25	4158.6	6643.0	67			

AL32194.14	Bongo	29	25	94	11	17	13	53	4209.1	6656.4	92	87	Sibunka	samples were nets A-D to ETOH
AL32194.15	MK5-CTD	27	25	94	11	17	14	9	4209.4	6655.8	105	97	Mountain	
AL32194.16	MOC-1	32	25	94	11	17	14	26	4209.5	6655.8	111	110	Sibunka	nets 0-3 in form, net 5 in ETOH, 6-9 picked for live samples
		32	25	94	11	17	15	50	4211.6	6651.3	206	160		bottom changing rapidly during tow - on northern edge of bank
AL32194.17	MK5-CTD	28	26	94	11	17	18	25	4203.8	6721.6	50	45	Mountain	
AL32194.18	Bongo	30	26	94	11	17	18	46	4203.2	6722.8	51	32	Sibunka	Tst b/w ship spd / tow angle, nets A&B for live copepods -L. Madin
AL32194.19	Bongo	31	26	94	11	17	19	16	4202.0	6721.5	49	34	Sibunka	Tst b/w ship speed to towing angle. No samples kept.
AL32294.1	MOC-1	33	27	94	11	18	2	51	4134.9	6908.8	170	150	Sibunka	live samples of calanus combined from all nets and
		33	27	94	11	18	3	43	4133.5	6906.9	165			kept in lined trash cans for Durbin to pick up in Woods Hole