Cruise Report
R/V OCEANUS Cruise 301
Georges Bank
5-17 April 1997

Acknowledgements

We gratefully acknowledge the very able assistance provided by the officers and crew of the R/V OCEANUS, WHOI's Shipboard Scientific Support Group, and several student volunteers. This report was prepared by Greg Lough, Lew Incze, Bob Campbell, Jeff Runge, Jim Manning, Betsy Broughton, Marie Kiladis, Larry Buckley, and Phil Alatalo. This cruise was sponsored by the National Science Foundation and the National Oceanic and Atmospheric Administration.

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Note: A downloadable postscript version of this report is available

from "http://www.wh.whoi.edu/~jmanning/oc301.html".

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Purpose of the Cruise

The objectives of the cruise were to:

- (1) determine the distribution and abundance of larval and juvenile cod and haddock on the eastern flank of Georges Bank in relation to advective and dispersive processes, and
- (2) conduct site studies to determine their vertical distribution, diel variability, predator-prey relations, and biochemical content in relation to water column conditions.

Cruise Narrative

The April Fool's Day Storm on Tuesday delayed initial cruise preparations for Wednesday's departure as well as continued high winds on eastern Georges Bank. Problems also arose with the assembly of the VPR to be mounted on the 1-m^2 MOCNESS, which further delayed us until Friday. The OCEANUS departed 4 April 1997, 1215 EST and immediately switched to DST, a day ahead of schedule. Based on the previous broadscale cruise observations (OCEANUS 300, 16-28 March 1997), Scotian Shelf water was observed on the outer flank of eastern Georges Bank from the Northeast Peak to mid-flank (68Long.). Associated with the colder, low salinity Scotian Shelf Water was relatively high numbers of gadid eggs. We arrived at the first bongo station, 5 April 0436 DST (40 38.7'Lat., 6749.1' Long.) on the outer mid-flank of Georges Bank and continued sampling every 10 miles up to the Northeast Peak (see Figures 1 and Figures 2 (top left)). Based on recent satellite images, we could not find much evidence of Scotian Shelf Water on the flank. Satellite images received for 5 April indicated a fairly uniform water temperature along the flank of Georges Bank, even though cold-water entrainment could be observed in Slope Water associated with a large warm-core ring centered on 6730'W. Bongo samples were sorted at sea for cod and haddock larvae, and an estimate of gadid eggs was made. No eggs or larvae were found east of 6700'W in waters deeper than 70-m bottom depth. Bongo stations were continued back to the west on the shoaler side of the flank. Cod and haddock larvae and their eggs were found on all stations west of 6700'W, especially in the shoaler waters , > 70 m, and farther westward towards the Great South Channel.

The decision was made to start the intensive bongo transect on the southeast part of Georges Bank, beginning on shoal station 25 (4118'N, 6714'W) and proceeding southeast to deeper water, taking a bongo haul every 5 miles. The plan was to space the transects 7 miles apart, sampling from east to west, completing 5-7 transects. We arrived on station 25 at 2140h 6 April and began bongo operations under deteriorating weather conditions. Winds were NW 20-30 knots, seas 4-8 ft, but still workable. At stations 45 and 47, coast guard surface drifters were deployed. Station 51 (40 51.0'N, 6727.5'W) was identified as a potential site for long-term time-series observations so that a suite of sampling profiles was planned. A drifter drogued at 13 m was deployed at 0415h, 8 April, a couple of miles (40 49.1'N, 6726.7'W) before arriving at station 1. On station 0442h, 8 April, a bongo tow was made, a sparbuoy with larval fish feeding experiments was deployed for 3 hours, plankton pump/CTD profiles were made, 3 bongo tows with 200 um mesh, and a third coast guard drifter was deployed. The normal bongo transect resumed with station 52, 1026h, 8 April. Ring net hauls were made at various stations to collect *Calanus* females. At stations 59 and 61, coast guard surface drifters were deployed, completing the 15 mile box with one drifter in the middle.

Station 68 had to be repeated since the cod ends of the bongo net were cut off by the prop at 0717 h, 9 April. The bongo grid was completed with station 80 at 0014 h, 10 April and the vessel steamed east to previous station 60 as a potential site for time-series observations. Arrived at station 81 and commenced a bongo haul at 0605 h, followed by a ring net haul for zooplankton. This site was not found suitable because of the low abundance of *Calanus* females and nauplii, as well as a fouling Phaeocystis(?) bloom. A new sampling site was chosen a few miles to the southeast and sorting of bongo and ring net samples indicated this site was adequate for the combined larval fish and zooplankton study. A drogued-drifter #1 was set out to follow on station 82 at 1005 h, 40 47.3, 67 35.1, 81-m bottom depth . Pump operations, ring net and bongo hauls began in 10 m/s winds and 10 ft seas. The 1-m^2 MOCNESS was not operational yet so only a 1/4-m MOCNESS tow was made on 10 April.

On 11 April, the winds subsided to 15 knots and seas, 6-8 feet the 1-m^2 MOCNESS was deployed on the stern A-frame for the first time. Deployment and recovery of the 1-m^2 MOCNESS was slow and awkward off the stern, the bridle was too close to the bock, and the vertical motion of the stern would limit deployment. Therefore, deployment of the 1-m^2 MOCNESS was switched to the starboard midsection, and the 1/4-m^2 MOCNESS was to be deployed off the stern starboard A-frame. Another drifter, 4, drogued at 40-m depth was deployed at site 82 on 11 April, 2043h, 4040.89'N, 6737.3'W. A time-series of observations was made at station 82 until 0128 15 April, and then we moved a about 10 miles to the northeast to find a new shoaler site with more phytoplankton. Three additional bongo stations were made (83-85) and a drifter was deployed, drogued at 30 m at 0524h, 15 April, 71-m bottom depth, 4048.63'N, 6756.8'W. A vertical series of observations was made at station 85 only until 1850h 15 April. We then moved back to station 82 by 2050h 15 April, retrieved drifter 7a and set drifter 6b to be drogued at at 30 m at 1951h 15 April, 87-m bottom depth, 4035.83'N, 6749.37'W. A final series of profiles was made until 1432h, 16 April. We departed station at 1530h and arrived in Woods

Hole on 17 April, 0700h.

Individual Reports

Physical Oceanography (J. Manning)

Drifter Deployments

A set of seven GPS/ARGOS/VHF drifters, as described in our previous reports (see SJ9503), were brought on board for this cruise as well as five US Coast Guard Surface Marker Buoys and three GPS/ARGOS drifters. A summary of all 12 deployments for this cruise is given in Appendix 2. Drifter Log and Figure 3.

The deployment code is according to the last digit of the instrument's serial number and a letter corresponding to the consecutive deployment of that drifter. The deployment "7a", for example, was the first time SN#37 was deployed on this cruise. The first set of deployments was conducted during the bongo survey II on the southern flank around the 70-80-m isobaths. The five USCG drifters were deployed in a nominally 15nm square with one in the middle at bongo stations 45, 47, 51, 59, and 61. The tracks of these surface drifters are given in Figure 4. This figure also includes three tracks (on the eastern side) from drifters (24,27,42) that were air-deployed by the USCG the day before we arrived on the bank. Those that survived impact were eventually pulled away from the bank as discussed later. The first VHF (6a) drifter was deployed a few miles south of bongo station 51 and the second (1b) was deployed at bongo station 82. A third VHF drifter (4a) was deployed also at the moving station 82 with a 30m tether. The result of the shallow (10m tethered) and deeper (30m tethered) drogues is presented in Figure 5. The strong southeastward wind event (Figure 6) on 14 April drove the surface drifter to that direction. Drifter 6a (Figure 7), released on 8 April, also experienced the cessation of normal alongbank southwestward flow during the 12-13 northward wind event. The next drifter (5a) was deployed at station 85 in the area of high larval concentration further onbank and left in the water at the end of the cruise. Drifter 7a was deployed at station 82 for less than a tidal cycle after which it was replaced by deployment 6b. Drifter 6b was recovered well off the bank by Cabell Davis approximately a week after our cruise ended.

All drogued drifters were fitted with VEMCO minilog temperature probes at the base of the holey sock. Together with the external temperature probe on the drifter's surface canister, this provided a record of the thermal stratification over the period of the deployments. As depicted in Figure 9, the difference in temperature was rarely more than the accuracy of the thermistor (~0.1 deg).

Shipboard Sensors

One minute interpolated values of shipboard sensor data were loaded into a MATLAB routine for range and delta checks and then plotted in Figures 10 (salinity) and Figure 11 (temperature). In the case of the meteorological sensors, the 5-minute interpolated values look reasonable (see Figure 12 (barometric pressure and short wave radiation). Unfortunately, as is often the case with shipboard anemometer records, the wind data is virtually unusable. With the speed and direction of both the wind and ship varying so much especially in heavy seas, it is very difficult to obtain an accurate estimate of the wind. Consequently, the nearby NOAA buoy records are plotted on Figure 6. Buoy (44011) is stationed approximately 100 miles east of the study area but provides an adequate measurement of the local wind events. Buoy 44008 failed on April 10, 1997.

Two RDI Acoustic Doppler Current Profilers were on board and operating at 150 and 300 kHz, respectively. Post-processing of these records has just begun at the time of this writing. A routine to convert the RDI raw data to MATLAB formatted data called BB2MAT has been used to extract velocities. Error checking and quality control of the data needs to be conducted prior to data plotting and release.

Hydrography

A total of 140 CTD casts were conducted including 121 Seabird Profiler casts (Model 19) and 19 Seabird 9/11 cast with a rossette. In addition, Seabird temperature (Model 3) and conductivity (Model 4) sensors were mounted on all 17 MOCNESS hauls. The Profiler was attached to the wire just above the bongo-net frame. These cast were double oblique through the water column except for a few vertical cast taken with water bottle samples. The vertical cast were taken for calibration purposes and, since the salinometer difference was less than 0.01 PSU, no salt correction was applied to these data. While the main purpose of these deployments on the bongo hauls is to have a measure of depth (pressure) in real time, significant hydrographic information is gathered. A total of 7 cross-bank sections were conducted with five or more stations per section. Post-processing of this data was conducted by Maureen Taylor (see Figures 13 , 14, 15, 16, and 17). The cross-bank vertical sections of the temperature and salinity are shownn in Figures 18 and 19, respectively.

Most of the Seabird 911 cast were conducted at the drifting sites 82 and 85. These were taken a few times during the day and a few cast during the night. Most cast included several water bottle samples on the last upcast. All cast included measurements from a fluorometer and a transmissometer in addition to the standard CTD variables. While real time display and post-station hardcopy plots of each cast depicted fairly clean and useful data, each cast needed careful hand editing and post-processing especially for the near-surface values. There were typical problems associated with the near-surface values of salinity in particular when the CTD failed to equilibrate or the pump did not turn on until after the package was lowered into the water column. This results artificial values that are difficult to filter objectively from the real data especially in cases of heavy seas where the instrument is oscillating through the near-surface layer. Nevertheless, the processed data is now posted on the GLOBEC homepage under "PROCESS|1997|NMFS_CTDSB". The individual profiles are displayed for temperature and salinity in Figure 20, and fluoresence and transmission in Figure 21.

The evolution of water-mass structure at drifter station 82 is depicted in Figure 22 for the period of 10-17 April. Fifteen Model 911 CTD at this station show the slight increase in the degree of stratification which was likely due to the decreasing winds and increasing air temperatures (top panel).

The most significant hydrographic observation in the analysis of the data thus far is the homogeneity of the water mass sampled. In order to depict any structure, the above contour plots and profiles required intervals of 0.1 C and 0.05 PSU. Note that the range of temperature and salinity inside the shelf-slope front was less than 0.4 C and 0.2 PSU, respectively. There is however a subtle but persistant feature in each of the cross-bank sections just inside the shelf-slope front. This subsurface minimum in temperature and salinity occurred at stations 30,36,50,61,64,and 75. While the contour gridding routine may have over-extrapolated the shelf-slope front to some degree, the subsurface feature appears to be persistent and real.

Ichtho-Zooplankton Studies

Bongo-net Survey (G.Lough, M.Kiladis, E.Broughton)

Bongo tows were made with a 61-cm frame fitted with 0.333-mm and 0.505-mm mesh nets using standard MARMAP procedures; i.e., double-oblique from surface to within 5 m of the bottom. A SeaBird CTD (Model 19) was attached to the towing wire above the bongo to monitor sampling depth in real time and to record temperature and salinity. Both net samples were sorted at sea to provide counts on the number of cod and haddock eggs and larvae. Larvae from the bongo-net samples were frozen for biochemical analysis ashore.

The initial bongo survey of 24 stations, 10 miles apart, covered the southern flank and eastern part of Georges Bank between the 60- and 90-m isobaths during 5-6 April (Figure 2 (top left)). No eggs and larvae were found on the eastern part of the Bank, nor much of a trace of Scotian Shelf Water, as observed from the previous March GLOBEC broadscale survey. Instead, most of the larvae were observed on the southern flank, which was consistent with westward advection of waters based on model simulations.

A fine-scale grid of 55 stations was conducted on the southern flank during the period of 6-10 April Figures 2 (top right)). Eight transects were made 7-miles apart between the 50-m and 100-m isobaths. On each transect bongo stations were 5 miles apart. Virtually all cod and haddock eggs/larvae were located between the 60-m and 100-m isobaths, and bounded on the east at ca. 6700, and on the west at the Great South Channel. The number of cod per haul was as high as 34; while haddock was 22. Haddock larvae were fewer than cod, were larger and found more on the western end of the grid. Their standardized abundance is shown in Figure 23 . Cod were more abundant on the eastern part of the grid, and younger (recently hatched), which is consistent with the greater abundance of gadid eggs on the eastern part. Mean standard length of cod and haddock was 4 mm. Size ranged from 3 to 9 mm (Table 1). Based on the fine-scale grid observations, a new site, station 82, was chosen on 10 April for vertical time series observations. At 1005h, drifter 1 was set at 40 47.3, 6735.0, 80-m bottom depth and followed as drifting station 82.

Table 1. Length Frequency of Cod and Haddock.

SPECIES	SITE	HAUL	LENGTH (mean mm)	ST DEV
Cod	82	122	3.87	0.62
		124	3.89	0.47
		125	3.58	0.41
		126	4.00	0.46
		128	3.93	0.46
		130	4.15	0.51
		131	4,67	0.49
		132	3.77	0.45
		Mean	3.97	0.561
Cod	85	133	5.02	0.80
		134	4.99	0.96
		Mean	5.00	0.89
	82&85	Mean	4.35	0.86
Haddock	82	124	3.84	0.64
		125	3.14	0.46
		126	3.31	0.33
		129	3.99	0.75
		130	3.74	0.71
		131	4.22	0.85
		132	3.62	0.51
		Mean	3.87	0.77
Haddock	85	133	5.06	0.73
		134	4.74	0.82
		Mean	4.75	0.82
	82&85	Mean	4.25	0.90

MOCNESS Sampling (G.Lough, E.Broughton, M.Kiladis)

The 1-m^2 MOCNESS with nine 0.333-mm mesh nets was used to sample larval fish and larger zooplankton. New sensors on the 1-m^2 MOCNESS (light, transmission, fluorometry) did not work this cruise. A Video Plankton recorder (VPR) also was attached to the MOCNESS frame to record fine-scale zooplankton during the tow. Results of the VPR recordings are discussed in P. Alatalo's report below. The 1/4-m^2 MOCNESS with nine 0.064-mm nets was used to sample the smaller plankton such as copepod nauplii. The tow profile for these two nets was nominally 10-m strata within 5 m of the bottom; extra nets were used for special collections. The 1-m^2 MOCNESS nets typically sampled for 5 minutes to filter about 200 m^3 of water; the 1/4-m MOCNESS nets for 2-3 minutes to filter about 30 m^3. Following a drifter as the station marker, the MOCNESS sampling strategy was to make four tows every 24 hours at 0700h, 1200h, 1700h, and 2400h. The one night tow at 2400h would be fully sorted for fish larvae which were frozen for biochemical analysis. The early morning, midday, and late afternoon tows would be preserved in formalin for gut content analysis; any extra nets were used for biochemical specimens. In between MOCNESS tows, CTD-pumping profiles, and other special sampling would be conducted for zooplankton demography, rearing and experimental feeding studies. The night MOCNESS tows were fully sorted for larval cod and haddock and figures were made of their vertical profiles.

Fifteen 1-m^2 MOCNESS tow (119-132, 135-136) were made following drifter station 82. Only two tows (133, 134) were made at a shoaler site, drifter station 85, 62-72 m botom depth. Station 82 was occupied from 0627 h 10 April to 1432 h 16 April while the drifter was advected southwest about 20 miles in six days towards the 100-m isobath, from 72- to 100-m depth. Only two 1/4-m^2

MOCNESS tows (119, 121) were made on station 82, 10-11 April. Preliminary length frquencies are given in Figure 24. Length frequency by site is given in Figure 25.

Vertical profiles of cod and haddock larvae and water-column temperature are shown in Figure 26 for four night tows on Station 82. Cod were more abundant than haddock on station 82. Both larvae were distributed throughout the water column temperature with typical densities less than 50/100 m^3 However, for MOCNESS tow 135, a high density of cod (140/100 m^3) was observed at 20-30 m depth. The water-column only varied a few tenths of a degree between 4.4 and 4.7 C. For MOCNESS tow 123, larval abundance increased with depth; cod had peak abundance at 40-50 m. For MOCNESS 127, peak abundance occurred at 20- 30 m for cod. For MOCNESS 129, both cod and hadock were more abundant at depth between 30 and 70 m. The general pattern appears to be that while larvae can be found throughout the water column, peak abundance usually is located at mid-depth, around 30m, which may be the base of the wind-mixed layer. This situation is especially true for cod. Few larvae appeared to reside in the surface 10-20m.

Special Collections (E.Broughton, L.Buckley)

Samples for biochemical and age analysis were taken from 58 0.333-mm mesh, 61-cm bongo nets, 53 0.505-mm mesh, 61-cm bongo nets, and 15 0.333-mm mesh 1-m^2 MOCNESS hauls. All samples were rinsed from the nets using minimal seawater pressure and transferred to buckets containing ice packs. Plankton from nets that were not to be sorted was preserved immediately using 4% buffered formaldehyde in seawater. Plankton samples sorted for fish or invertebrates were picked in seawater filled translucent sorting trays on ice covered light tables. Every effort was made to keep samples cold during processing to delay decomposition. Plankton remaining after removal of samples was preserved with 4% buffered formaldehyde and sea water.

Table 2a and 2b documents the repository of samples from MOCNESS and BONGO nets, respectively.

Table 2a. MOCNESS sample log.

Net	0	1	2	3	4	5	6	7	8	TOTAL
1/4M^2 MOCNESS										
#JARS	0	2	2	2	2	2	2	2	0	14
1M^2 MOCNESS										
#JARS	9	16	16	16	19	21	23	31	8	159
BUCK COD	27	35	48	45	56	43	24	51	209	538
BUCK HAD	10	31	56	49	40	17	6	28	189	426
BURN COD								67	245	312
BURN HAD								40	161	201

Table 2b. BONGO sample log.

	Net 0.333	Net 0.505	TOTAL
NUMBER OF JARS	87	84	171
BUCKLEY, COD	348	312	660
BUCKLEY, HADDOCK	223	194	417
BURNS, COD	23	9	32
BURNS,HADDOCK	8	5	13
RUNGE, REDFISH	1		1
ALATALO, PTEROPODA		450	450

Larval fish collected for Buckley were video taped using a Zeiss Stemi SV6 stereomicroscope outrigged with an MTI CCD72 black and white video camera, then individually frozen in liquid nitrogen. The larvae will be analyzed for their RNA, DNA, protein content, and age. The video images will be used to collect morphometric data. The data will be used to determine the nutritional condition and growth rate of the individual fish.

Larval fish collected for B.Burns were measured to the nearest 0.01 mm SL using Optimas image analysis software connected to a Zeiss Stemi SV6 stereomicroscope, equiped with a Hitachi HV-C20 color video camera. These fish will have their age determined by otolith microstructure analysis.

Biochemistry Studies (L. Buckley)

A total of 651 cod and 404 haddock were collected from bongo tows conducted at 85 stations. The contents of both the 505 um and the 333 um mesh nets were immediately wet-sorted in chilled sorting trays. Individual cod and haddock were collected, videotaped. and placed in liquid nitrogen. A total of 546 cod and 417 haddock were collected in a similar manner from fourteen 1m MOCNESS tows. The larvae will be analyzed for their RNA, DNA, and protein content, and length. The data will be used to determine the growth rate and nutritional condition of the individual fish. A comparison will be made of fish taken from the different sites and at discrete depths.

Larval Fish Prey Field (L. Incze, B. Novak)

Small zooplankton which may be available for larval fish feeding was sampled at Drifter Stations #82 and 85 using a pumping system with intake attached to the CTD. The system was the same as used by R. Campbell, J. Runge and others for zooplankton sampling except that the flow on deck (ca. 350 l/min) was partly diverted through a small-volume hose into 40 um mesh samplers. Volume was measured to the nearest 0.1 liter (+/-1%) with an in-line flow sensor and averaged about 10 l/min over the cruise. Initial counts made at station 51 from samples at 40, 20, and 10 m depth showed low naupliar concentrations <5/l, so sample volume was set at 35-40 l per depth to ensure sufficient sample sizes. Samples were taken at fixed nominal depths of 70, 50, 40, 35, 30, 25, 20, 15, 10, 5, and 2 m. At station 85 the bottom sample was at 60 m instead of 70; and the 2 m samples were eliminated April 13-14 at Sta. 82 due to rough seas which prevented holding the CTD near the surface for the required time. Fourteen full profiles (153 samples) were obtained as follows: station 82, CTD casts 2, 3, 4, 5, 6, 7, 9, 11, 12, 13, 14, and 18; station 85, CTD casts 15 and 17.

Water bottle samples were preserved in Lugol's fixative at a subset of CTD casts to examine other microplankton. Samples came from 50, 40, 30, 20, 10, and 5 m. Four profiles came from Drifter Station 82 (CTD casts 4, 8/9, 13 and 18/19: double casts were for misfired bottles) and two profiles were from Drifter Sta. 85 (CTD casts 15 and 17).

We timed our pump sampling to look for possible diel vertical migrations (this adds to other zooplankton sampling on this cruise, most of which was vertically integrated with pumps or nets) and to complement the 1m MOCNESS samples taken for larval fish abundance, feeding and physiological condition. Thus, samples usually were taken late morning, late afternoon and near midnight. Bottle samples were collected during daylight hours.

Feeding Studies on Larval Cod (J.VanKeuran. P.Alatalo).

The overall focus of this research effort, headed by Dr. Scott Gallager, WHOI, is to investigate how variations in light and turbulence influence the feeding success of young larval cod. The objectives of our participation on GLOBEC cruise OC301 was the documention of the influence of different levels of spectrally- appropriate in situ light on the ability of larval cod to capture prey items, vertical and diel characterization of the spectral light regime useful to these animals, and characterization of spatial and temporal changes in the motility patterns and size distribution of microzooplankton populations on and around Georges Bank during the period of early development of cod larvae.

Four successful drifter incubation deployments were completed during this cruise. The locations of these deployments were in the areas of highest densities of larval cod as determined by a fine-scale bongo net survey completed by the scientific party during the initial five days of the cruise. All four deployments were made along the southern flank of Georges Bank in an area bounded by 40.5 and 41.0 North and 67.0 and 68.0 West. During each drifter deployment, animals were placed within replicate incubation chambers at depths ranging from the surface to 40m and allowed to feed on natural and enhanced levels of natural prey items. Immediately following each incubation, the uptake of fluorescencely-labeled microzooplankton and copepod nauplii by each larval cod was quantified using computer-aided image analysis routines. All animals were between five and nine days old at the time of the incubations.

Although final analysis of the data from these drifter deployments will require further analysis in our lab following completion of this and the follow-on cruise in April, preliminary results from this cruise agree with our finding from GLOBEC / RV Endeavor cruise EN296 (March 1997) and suggest that feeding of larval cod on natural and enhanced levels of natural food assemblages is inhibited during daylight hours in the near surface waters at this time of year in this region of Georges Bank. The near surface feeding rates were consistently lower than comparable rates measured at greater depths. The preliminary data suggest that the depth of highest incidence of feeding was dependent upon both the clarity of the water and the amount of ambient light. These results confirm previous modeling work by J. Van Keuren and preliminary measurements by S. Gallager.

A second objective of our group was to further document the vertical and diel light regime available to these newly young cod larvae for feeding. Using larval cod visual spectral sensitivity data measured by J. Van Keuren, WHOI, and Dr. Ferenc Harosi, MBL, in a separate ongoing microspectrophotometry study, we obtained spectral light filters closely matched to the spectral response of the eyes of young cod larvae. These special filters were employed during this cruise to document the vertical attenuation of this spectrally-appropriate light at the site of each drifter deployment. Another sensor equipped with a matched filter was used to continuously monitor the amount of this light available at the ocean surface under the varying meteorological and astronomical conditions that occurred during the cruise. These data will be used in the final analysis of the these drifter incubations as well as to provide primary data for ongoing individual-based modeling work being conducted in conjunction with Dr. Francisco Werner, UNC.

A third objective of our group was to continue our characterization of the spatial and temporal changes in the motility patterns and size distribution of microzooplankton populations on and around Georges Bank. Surface and CTD/ water bottle cast sub-samples were taken throughout the cruise and filmed in tissue culture flasks using a gimbaled microscope-video system. Samples of each larval cod deployment were also videotaped to document prey fields in bottles before and after each deployment.

Participants on this cruise were J. Van Keuren and P. Alatalo. We wish to thank Dr. Larry Buckley and Jennifer Allen (NMFS - Narragansett) for supplying us with the cod eggs which ultimately hatched into the larvae used on both GLOBEC Process cruises EN296 and OC301.

Microzooplankton Recording (P. Alatalo)

As part of an effort to quantify microzooplankton abundance and activity (U.S. GLOBEC: An experimental evaluation of biological and physical modulators of foraging success in early cod larvae on Georges Bank-turbulence, prey motility, depth, and light intensity., S.M. Gallager and H. Yamazaki), microzooplankton samples were videotaped regularly at Station 82 and at additional stations when possible. Samples were taken at the surface with a beaker or at depth by gently siphoning seawater from the top of CTD bottles (shear forces damage fragile plankton when using the bottom CTD spigot). For each spar-buoy deployment, the natural prey field available to cod larvae was documented by filming the surface water used in the experimental bottles. In a separate study, pteropods (Limacina retroversa) collected in Bongo Net hauls 003 and 011 were filmed directly after collecting to document size and swimming behavior.

Preliminary observations showed slight differences with depth and differences in location only with respect to phytoplankton. Generally, both microzooplankton abundance and activity were low. Large ciliates were associated with depths of 40 m to 70 m, while small microzooplankton were slightly more abundant at depths of 20 m to 30m and at the surface. Nauplii, copepodites, and medium-sized protozoans were uncommon and found at all depths. Phytoplankton were generally more abundant in surface waters. Phytoplankton and microzooplankton were more abundant at the slightly shoaler Station 85 which was characterized by colonial algae (Phaeocystis sp. or Chaetoceras socialis) and chain-forming diatoms. The dinoflagellate Ceratium sp. was observed at most stations. No major differences between day and night samples were observed at Station 82.

Final analysis in the laboratory will characterize size, motility, and abundance of microzooplankton using computer image analysis software. These results will be used to describe the seasonal development of microzooplankton across Georges Bank.

VPR-MOCNESS Activities (P.Alatalo, G.Lough)

The Video Plankton Recorder, an underwater imaging video microscope, was mounted above the net opening on the 1-m^2 MOCNESS. This particular system was held in four underwater housings and consisted of a Hi-8 Video Camcorder interfaced with a Tattletale Computer, a single high-magnification camera, a strobe, and a standard MOCNESS battery pack. Operation was independent of the MOCNESS. Field of view for the high magnification camera was 5mm by 4mm. Recordings were later dubbed to SVHS tape format together with time code.

The following is a summary of tows made during the cruise:

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Haul 120  09:15h    4/11/97        Partial tow recorded
Haul 125  12:43h    4/11/97        Full tow recorded
Haul 126  17:51h    4/11/97        Strobe stopped. 6 minutes recorded.
Haul 128  09:15h    4/13/97        Unable to operate on battery pack.
Haul 131  13:34h    4/14/97        Full tow recorded.
Haul 132  19:14h    4/14/97        Full tow recorded.
Haul 133  06:26h    4/15/97        Strobe stopped 10 minutes recorded.
Haul 134  15:08h    4/15/97        Full tow recorded.
Haul 135  22:35h    4/15/97        Strobe stopped before launching.
Haul 136  12:26h    4/16/97        Full tow recorded.
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Viewing the dub bed tapes showed mixed results perhaps due to changes in camera-strobe alignment. At least one tape yielded good video images, with nauplii visible. Earlier problems with recording may have been battery related, however the problem with the strobe shutting down has not yet been resolved.

Calanus Recruitment-Mortality Study (R.Campbell, J.Runge)

The Oceanus departed midday, Friday, 4 April and sampling began early the following morning. The first 4 days (morning of 5th to early morning of 9th) were occupied with a bongo survey for the distribution of cod and haddock larvae on the southern flank. During this period, a mesocosm experiment (for naupliar development rates), copepodite molting rate experiment, and a predation experiment (using early *Calanus* nauplii as prey) were carried out. Egg production observations were made at several stations. Although variation in water temperature was relatively small (4-5C), there was considerable biological heterogeneity in phytoplankton abundance, notably the presence or absence of a bloom of Phaeocystis sp. and Thalassiosira spp.. An attempt was made on 8th April to fix the drifter station at station 51 for a long time series, but this station proved to be unsuitable due to the presence of the algae, which slimed the nets, and an unacceptable low abundance of cod larvae and *Calanus* females. The bongo survey grid continued for an additional ~ 30 h for a better resolution of the larval cod patch. Several drifters were deployed during the grid survey.

The selection of the drifter site took place on Thursday morning, 10 April. Criteria for selection included suitable numbers of fish larvae, *Calanus* females, and the absence or at least low biomass of the net-clogging algae. One station with suitable larval abundance was initially sampled but rejected due to the presence of the algae. A second station about 10 km away (station 82) was assayed and found to be acceptable, although marginally so, due to the relatively low abundance of *Calanus* females. Perhaps a more preferable site would have been station 10, located about 40 km to the northeast, where female *Calanus* was abundant and egg laying was very high, but this region was outside of the larval fish patch.

The drifter station 82 was occupied for 7 days, from the morning of April 10 to the morning of April 17. One drifter, drogued at 15 m, was deployed at the site immediately. A second drifter drogued at 30 m was deployed several days later. The two drifters remained very close to each other, but then started to drift apart. All sampling was done close to the 15-m drifter. Six other drifters deployed during the survey grid were also tracked. The 5 replicate vertically-integrated pump samples and 3 oblique bongo tows for estimation of daily abundance of *Calanus* life stages were collected on the morning and night of the 10 April, then again every night starting at about 2200 h. Sample collection on the morning of 17 April was substituted for the previous night.

At the drifter station 82, chlorophyll a concentrations were low (< 1 g/l) for the duration of the time series, but there was a slight increase in chlorophyll concentrations in the surface water (<30 m) towards the end of this period (15 and 16 April) (Figure 27). However, at station 85, located only 15 nm to the northeast of station 82 at the edge of the algal bloom region (see Figures 2 (bottom right)) chlorophyll a concentrations were twice as high, and it was also noted that the *Calanus* appeared to be in much better condition than at the drifter station.

Figure 28 , taken from four cast (114-117) of the Model 19 Seabird, portrays the subtle differences in the hydrographic structure between the two sites. While it is difficult to accurately grid and contour this section, the general structure indicates that station 82 (cast 114 on the right hand side of the panels) had a subsurface minimum in temperature and was both fresher and lighter in the upper water column. This section and, in particular, cross-sections taken earlier in the cruise and further to the east suggest that remnants of Scotian Shelf Water mass may be residing just inside the shelf-slope front.

Egg production and egg viability

Calanus egg production rates varied between 3 (station 82, 16 April) and 73 eggs female-1 d-1 (station 10, 5 April) (Table 3). Station 10 was located near the 100 m isobath in the Northeast Peak region. The other stations were located on the southern flank. Station 82 is the drifter station; station 85 is a station located approximately 15 nm to the northeast of station 82, but in a bloom (although not as strong as at other stations) of Phaeocystis sp. and other spp.

Table 3. Summary of egg production measurements. Note that this is preliminary data.

Exp.	Station	Date	EPReggs fem/day	std.err.	(n)	Clutch size	std.err.	(n)
001	10	5	72.6	5.5	(39)	63.1	2.6	(46)
002	45	7	37.3	5.7	(31)	52.6	4.9	(22)
003	60	8	30.3	4.6	(40)	48.5	3.8	(25)
004	82	10	17.0	4.6	(25)	42.6	4.4	(10)
005	82	11	20.2	4.7	(40)	46.4	3.8	(17)
006	82	11	22.5	4.7	(39)	45.7	3.6	(19)

007	82	12	13.6	3.5	(38)	39.8 4.7	(13)
008	82	13	12.3	3.1	(32)	31.0 4.4	(14)
009	82	14	7.7	3.5	(33)	42.3 4.0	(6)
010	85	15	44.0	5.6	(39)	54.5 3.9	(32)
011	82	16	2.6	1.5	(37)		

The spatial variation in egg production rates, while remarkable, is consistent with data derived from the April 1995 broadscale cruise (EN 265). Station 10 is located in a yellow- orange zone of egg production, according to the map of reproductive index, whereas the stations on the southern flank are located in the blue zone , where egg production rates were estimated to be on the order of 10-20 eggs female-1 d-1. The transition from yellow to blue in April, 1995 occurred at approximately 67W.

The drifter station 82, was located in the blue zone . During the seven-day period, egg production seemed to decline, from 17-22 eggs female-1 d-1 during the first 2 days to 3-8 eggs female-1 d-1 during the last 2 days (Table 3). Females were rare for the entire period and there was an unusually high proportion of females carrying spermataphores (on the order of 20%). Egg input rate should therefore be relatively low. At least some *Calanus* eggs and nauplii, however, were observed in visual inspection of the pump samples.

The contrast between station 82 and 85 was striking. Females, while still rare in the live catch, were clearly better fed and more reproductively mature at station 85. Assuming an egg laying rate of 5 eggs female-1 d-1 at station 82 (from 14 and 16 April observations, which bracket the observation made on 15 April at station 85), egg production was approximately an order of magnitude higher at station 85.

Egg viability observations, the analysis of which is not complete, are summarized in Table 4. In general the hatching success was good (80-95%). At one station (station 45), hatching success was lower (68%). Typically, 1-2 percent of eggs spawned were not fertilized, hence do not form a membrane and disintegrate fairly quickly. The proportion of parthenogenic or non viable eggs (clearly deformed) was recorded in a separate column. Differences among stations in proportion of parth. or non viable eggs are for the moment unexplained.

Table 4. Results of egg viability experiments to date. Experiments where no data are reported have been preserved for later analysis; also, some replicates in other experiments were preserved. Parth/nv dish refers to eggs that were clearly parthenogenic (opaque, no membrane) or non-viable (irregular shape) in dish during counting. Hatch success refers to results of incubations of lots of 50 mixed eggs. Total hatch success is product of (1-parth eggs) and hatch success.

Exp.	Station	Parth/nv dish	Mean hatch Success	std.dev.(n)	Total Hatch Success
EV 1	10	0.01	0.95	3.1 (3)	94
EV 2	45	0.05	0.68	7.2 (4)	64
EV 3	60	0.02	0.80	2.8 (4)	78
EV 5	82	0.02	0.86	6.8 (5)	84
EV 6	82	0.02	Preserved		
EV 7	82	0.02	Preserved		
EV 8	82	0.36	0.55	2.8(2)	35
EV 10	85	0.23	0.74	6.5(7)	57

Naupliar development

Development rates of naupliar stages of the dominant copepod species, primarily *Calanus*, were determined in triplicate on-deck 100 liter mesocosms. The mesocosms were placed inside a water bath where temperature was controlled with circulating surface sea water. The mesocosms were filled with prescreened (100 m) water pumped from 2 meters depth with a diaphragm pump. Nauplii were collected with a 150 m net and gently screened through a 200 m nitex mesh that was immersed in a bucket of surface water to remove older stages. A portion of the resulting 150 to 200 m size fraction, a cohort consisting of mainly N4 and N5 *Calanus* nauplii, was added to the mesocosms to give a density of 2000 nauplii per tank. The development of the cohort was monitored daily for 3 days by sampling the tanks for stage abundances. Chlorophyll a concentrations were also monitored. The copepods were preserved in 4% formaldehyde for later stage identification and enumeration. The changes in stage abundances over time will enable us to calculate development rates. Three experiments were conducted during the cruise, once at station 46, beginning on 7 April, and twice at station 82, beginning on 11 and 13 April, respectively.

Copepodite development and growth

Both development and growth (carbon and nitrogen) rates of *Calanus* copepodite stages were determined at station 82. Copepodites of a specific stage were sorted (unanesthetized) from a live net tow under a dissecting microscope, incubated in 8 l polycarbonate bottles filled with ambient surface water or ambient water enriched with phytoplankton cultures (Tetraselmis sp. and Heterocapsa triquetra) and placed in a water bath (temperature controlled with circulating surface sea water). Measurements were taken for initial size (length, and carbon and nitrogen content), and final size measurements (noting any molting that had occurred for development rate calculations) were made after a two day incubation. The enriched treatment was used to determine if development and/or growth rates were food limited and as such, could be enhanced with the addition of the mixed phytoplankton diet.

Three separate experiments were conducted at station 82 and the development rate results are shown in Table 5. At this time, the carbon and nitrogen growth calculations have not been completed. Because of the low chlorophyll a concentrations, it was not surprising that development rates at station 82 were much lower (0.72 - 0.20 of maximum rates) than non-food limited rates obtained in the laboratory. The degree of food limitation increased with increasing stage of development, and also over time within a stage (C3, 0.72 - 0.50; C4, 0.47 - 0.27). A decrease in the egg production rate of the adult females over time at station 82 was also observed. Even though food limitation appeared to be quite severe, development rates were not enhanced in the enriched treatments. This is consistent with our previous findings that even under severe food limitation development rates can not be enhanced in the short term. However, during inspection under the microscope, the copepodites in the enriched treatment had fuller guts and appeared to be larger and in better condition than those in the ambient treatment, which suggests that the growth rates were probably higher in the enriched treatments.

Table 5. Results of *Calanus* copepodite development rate experiments. The proportion of the maximum development rate achieved for each stage and treatment in a given experiment are shown. Values represent means of 2 or 3 replicate bottles.

Stage	C2	C3	C4	C4
Treatment	Ambient	Ambient	Ambient	Enriched
10-Apr		0.72	0.47	0.51
13-Apr	0.54	0.50	0.28	
14-Apr			0.27	0.20

Size and condition measurements

At stations 82 and 85, *Calanus* finmarchicus N5 through adult were collected with live net hauls (150 m) for size (length, carbon, and nitrogen) and condition (RNA/DNA ratio) measurements. Copepods, under anesthetic (MS222), were sorted from the net haul using a dissecting microscope, their images recorded with a video system for later length measurements, and then placed in either a tin boat and dried over desiccant for carbon and nitrogen analysis or put into cryotubes and frozen in liquid nitrogen for RNA/DNA determinations.

Calanus predation on nauplii

An experiment was conducted on board ship to determine the extent to which predation by *Calanus* copepodites might be an important source of mortality for *Calanus* naupliar stages. The experiment was conducted with females collected at station 60 on 8 April. Nauplii (N1 and N2) for the experiment were obtained from eggs that were collected from adult females caught at station 10 on 5 April. Two females were placed in each 2 l experimental bottle that had been filled with sea water filtered through an 80 m nitex mesh to remove other nauplii, and the appropriate number of *Calanus* nauplii (two replicates of 5, 10, 20, 30, and 50 nauplii/l) were added, and incubated for 8 hours at 7 C. Control bottles (two replicates of 20 and 40 nauplii/l) without females were used to assess sources of naupliar mortality other than predation. Female filtration rates on nauplii were low but constant over all naupliar concentrations with a mean rate of 22 mls fem-1 hr-1 ((Figure 29). This result suggest that predation on *Calanus* nauplii by adult females alone was not an important source of mortality due to the low abundance of females, however, if other copepodite stages of *Calanus* or other copepod species feed on nauplii at similar rates, predation by copepodite stages of copepods might be an important source of naupliar mortality during May when copepodite stages are abundant and food sources are low.

A second experiment was attempted at station 82, but we were not able to collect enough eggs. It appeared as though there was high predation rates on the eggs by the females, since based on the egg production measurements plenty of eggs should have been produced.

Appendix I. Eventlog

EVENT#	INSTRU	CAST	STA	MTH	DAY	LOC	S/E	LAT	LON	WDEP	SDEP	PI(S)
oc9597.1	BongoSB	1	1	4	5	436	s	4038.70	6749.10	84	80	Lough
oc9597.2	BongoSB	1	1	4	5	445	e	4039.10	6749.40	84	80	Lough
oc9597.3	BongoSB	2	2	4	5	643	s	4041.40	6736.00	86	82	Lough
oc9597.4	BongoSB	2	2	4	5	654	e	4042.00	6736.20	86	82	Lough
oc9597.5	BongoSB	3	3	4	5	815	s	4051.10	6730.10	81	77	Lough
oc9597.6	BongoSB	3	3	4	5	823	e	4051.60	6730.10	81	77	Lough
oc9597.7	BongoSB	4	4	4	5	950	s	4047.70	6718.00	95	92	Lough
oc9597.8	BongoSB	4	4	4	5	1001	e	4047.90	6718.00	95	92	Lough
oc9597.9	BongoSB	5	5	4	5	1124	s	4054.90	6709.60	84	80	Lough
oc9597.10	BongoSB	5	5	4	5	1133	e	4055.20	6709.40	85	80	Lough
oc9597.11	BongoSB	6	6	4	5	1311	s	4102.00	6700.00	71	67	Lough
oc9597.12	BongoSB	6	6	4	5	1319	e	4102.10	6700.20	71	67	Lough
oc9597.13	BongoSB	7	7	4	5	1459	s	4100.00	6646.50	76	73	Lough
oc9597.14	BongoSB	7	7	4	5	1506	e	4100.10	6646.80	76	73	Lough
oc9597.15	BongoSB	8	8	4	5	1630	s	4106.40	6638.10	86	80	Lough
oc9597.16	BongoSB	8	8	4	5	1640	e	4106.70	6638.50	85	80	Lough
oc9597.17	BongoSB	9	9	4	5	1804	s	4115.10	6632.10	90	85	Lough
oc9597.18	BongoSB	9	9	4	5	1815	e	4115.60	6632.80	90	85	Lough
oc9597.19	BongoSB	10	10	4	5	1940	s	4125.10	6631.00	93	89	Lough
oc9597.20	BongoSB	10	10	4	5	1953	e	4125.70	6630.80	93	89	Lough
oc9597.21	ZPN	1	10	4	5	2015	s	4125.10	6631.00	93	90	Runge egg production
oc9597.22	ZPN	1	10	4	5	2030	e	4125.70	6630.80	93	90	Runge
oc9597.23	BongoSB	11	11	4	5	2125	s	4130.10	6618.90	88	85	Lough
oc9597.24	BongoSB	11	11	4	5	2133	e	4130.50	6619.10	90	85	Lough
oc9597.25	BongoSB	12	12	4	5	2251	s	4137.00	6609.40	97	93	Lough
oc9597.26	BongoSB	12	12	4	5	2300	e	4137.20	6608.80	98	93	Lough
oc9697.1	BongoSB	13	13	4	6	29	s	4141.00	6621.50	84	80	Lough
oc9697.2	BongoSB	13	13	4	6	40	e	4140.30	6621.70	84	80	Lough
oc9697.3	BongoSB	14	14	4	6	149	s	4134.40	6632.00	84	79	Lough
oc9697.4	BongoSB	14	14	4	6	201	e	4133.40	6632.10	84	79	Lough
oc9697.5	BongoSB	15	15	4	6	310	s	4128.30	6643.10	76	72	Lough
oc9697.6	BongoSB	15	15	4	6	319	e	4127.50	6643.50	76	72	Lough
oc9697.7	BongoSB	16	16	4	6	415	s	4119.40	6648.00	75	70	Lough
oc9697.8	BongoSB	16	16	4	6	427	e	4118.60	6648.70	75	70	Lough
oc9697.9	BongoSB	17	17	4	6	529	s	4110.00	6650.50	72	54	Lough
oc9697.10	BongoSB	17	17	4	6	537	e	4109.30	6651.20	72	54	Lough
oc9697.11	BongoSB	18	18	4	6	638	s	4110.90	6703.80	65	61	Lough
oc9697.12	BongoSB	18	18	4	6	646	e	4111.10	6704.70	65	61	Lough
oc9697.13	BongoSB	19	19	4	6	809	s	4105.10	6713.10	65	61	Lough
oc9697.14	BongoSB	19	19	4	6	815	e	4105.00	6713.20	65	61	Lough
oc9697.15	BongoSB	20	20	4	6	957	s	4059.00	6723.00	75	71	Lough
oc9697.16	BongoSB	20	20	4	6	1005	e	4059.00	6723.10	74	71	Lough
oc9697.17	BongoSB	21	21	4	6	1118	s	4058.70	6736.30	67	64	Lough
oc9697.18	BongoSB	21	21	4	6	1125	e	4058.50	6735.90	68	64	Lough
oc9697.19	BongoSB	22	22	4	6	1236	s	4051.50	6744.90	65	63	Lough
oc9697.20	BongoSB	22	22	4	6	1243	e	4050.80	6744.40	65	63	Lough
oc9697.21	BongoSB	23	23	4	6	1410	s	4045.30	6754.90	71	69	Lough
oc9697.22	BongoSB	23	23	4	6	1423	e	4044.80	6754.50	71	69	Lough
oc9697.23	BongoSB	24	24	4	6	1554	s	4040.00	6806.40	85	81	Lough
oc9697.24	BongoSB	24	24	4	6	1604	e	4039.50	6806.40	86	81	Lough
oc9697.25	BongoSB	25	25	4	6	2143	s	4118.00	6713.80	50	45	Lough
oc9697.26	BongoSB	25	25	4	6	2149	e	4118.00	6713.40	48	45	Lough
oc9697.27	BongoSB	26	26	4	6	2259	s	4113.20	6709.70	61	56	Lough
oc9697.28	BongoSB	26	26	4	6	2308	e	4113.00	6709.20	61	56	Lough
oc9697.29	BongoSB	27	27	4	6	2357	s	4109.00	6708.40	65	63	Lough
oc9797.1	BongoSB	27	27	4	7	6	e	4108.60	6707.70	65	63	Lough
oc9797.2	BongoSB	28	28	4	7	42	s	4104.90	6705.00	68	64	Lough
oc9797.3	BongoSB	28	28	4	7	50	e	4104.50	6704.50	68	64	Lough
oc9797.4	BongoSB	29	29	4	7	142	s	4100.80	6702.90	71	68	Lough
oc9797.5	BongoSB	29	29	4	7	149	e	4059.90	6702.00	71	68	Lough
oc9797.6	BongoSB	30	30	4	7	244	s	4056.10	6659.20	80	74	Lough
oc9797.7	BongoSB	30	30	4	7	252	e	4055.60	6658.80	80	74	Lough
oc9797.8	BongoSB	31	31	4	7	352	s	4051.30	6656.00	95	90	Lough
oc9797.9	BongoSB	31	31	4	7	403	e	4050.50	6655.90	95	90	Lough
oc9797.10	BongoSB	32	32	4	7	459	s	4046.80	6653.50	110	107	Lough
oc9797.11	BongoSB	32	32	4	7	520	e	4045.60	6653.60	110	107	Lough
oc9797.12	BongoSB	33	33	4	7	614	s	4042.30	6650.50	217	101	Lough
oc9797.13	BongoSB	33	33	4	7	625	e	4041.70	6650.50	217	101	Lough
oc9797.14	BongoSB	34	34	4	7	737	s	4043.80	6701.50	113	111	Lough
oc9797.15	BongoSB	34	34	4	7	753	e	4043.10	6701.60	113	111	Lough
oc9797.16	BongoSB	35	35	4	7	844	s	4048.40	6704.70	96	91	Lough
oc9797.17	BongoSB	35	35	4	7	853	e	4048.20	6704.40	96	91	Lough
oc9797.18	BongoSB	36	36	4	7	941	s	4053.10	6707.50	90	86	Lough
oc9797.19	BongoSB	36	36	4	7	941	s	4053.10	6707.50	90	86	Lough
oc9797.20	BongoSB	37	37	4	7	1044	s	4057.20	6710.60	81	77	Lough
oc9797.21	BongoSB	37	37	4	7	1054	e	4057.10	6710.20	82	77	Lough
oc9797.22	BongoSB	38	38	4	7	1158	s	4101.80	6713.50	72	90	Lough
oc9797.23	BongoSB	38	38	4	7	1207	e	4101.50	6713.20	72	90	Lough

oc9797.24	BongoSB	39	39	4	7	1258	s	4106.10	6716.50	62	59	Lough
oc9797.25	BongoSB	39	39	4	7	1304	e	4105.90	6716.30	62	59	Lough
oc9797.26	BongoSB	40	39	4	7	1306	s	4105.80	6716.30	62	59	Lough
oc9797.27	BongoSB	40	39	4	7	1310	e	4105.50	6716.00	62	59	Lough
oc9797.28	BongoSB	41	40	4	7	1420	s	4110.40	6719.30	55	52	Lough
oc9797.29	BongoSB	41	40	4	7	1426	e	4110.10	6719.40	55	52	Lough
oc9797.30	BongoSB	42	41	4	7	1530	s	4114.60	6722.60	40	36	Lough
oc9797.31	BongoSB	42	41	4	7	1536	e	4114.30	6722.60	40	36	Lough
oc9797.32	BongoSB	43	42	4	7	1641	s	4111.50	6731.00	44	40	Lough
oc9797.33	BongoSB	43	42	4	7	1649	e	4110.80	6731.40	45	40	Lough
oc9797.34	BongoSB	44	43	4	7	1740	s	4107.40	6728.10	57	55	Lough
oc9797.35	BongoSB	44	43	4	7	1751	e	4107.10	6728.70	60	55	Lough
oc9797.36	BongoSB	45	43	4	7	1800	s	4106.90	6729.10	58	55	Lough Water cast
oc9797.37	BongoSB	45	43	4	7	1806	e	4107.00	6729.30	58	55	Lough
oc9797.38	BongoSB	46	44	4	7	1924	s	4103.00	6725.00	65	62	Lough
oc9797.39	BongoSB	46	44	4	7	1931	e	4102.70	6725.30	66	62	Lough
oc9797.40	ZPN	2	45	4	7	2030	s	4158.90	6722.60	75	70	Runge
oc9797.41	ZPN	2	45	4	7	2040	e	4158.90	6722.60	75	70	Runge
oc9797.42	BongoSB	47	45	4	7	2045	s	4158.90	6722.60	75	71	Lough
oc9797.43	BongoSB	47	45	4	7	2054	e	4058.90	6722.40	75	71	Lough
oc9797.44	Drifter	2610	45	4	7	2100	s	4058.90	6722.40	75	5	Manning deploy
oc9797.45	BongoSB	48	46	4	7	2217	s	4054.50	6719.50	84	80	Lough
oc9797.46	BongoSB	48	46	4	7	2226	e	4054.30	6719.20	84	80	Lough
oc9797.47	ZPN	3	46	4	7	2243	s	4054.50	6718.80	77	70	Runge
oc9797.48	ZPN	3	46	4	7	2247	e	4054.60	6718.80	77	70	Runge
oc9797.49	DPP	1	46	4	7	2257	s	4054.80	6718.40	77	2	Campbell
oc9797.50	DPP	1	46	4	7	2313	e	4054.90	6718.20	77	2	Campbell
oc9797.51	BongoSB	49	47	4	7	2352	s	4050.00	6716.50	93	90	Lough
oc9897.1	BongoSB	49	47	4	8	2	e	4049.60	6716.30	94	90	Lough
oc9897.2	Drifter	2612	46	4	8	15	s	4048.90	6716.00	77	5	Manning deploy
oc9897.3	BongoSB	50	48	4	8	56	s	4045.40	6713.50	99	96	Lough
oc9897.4	BongoSB	50	48	4	8	105	e	4045.10	6713.60	99	96	Lough
oc9897.5	BongoSB	51	49	4	8	205	s	4042.40	6721.20	98	94	Lough
oc9897.6	BongoSB	51	49	4	8	213	e	4042.10	6722.10	98	94	Lough
oc9897.7	BongoSB	52	50	4	8	306	s	4046.40	6724.30	91	90	Lough
oc9897.8	BongoSB	52	50	4	8	317	e	4046.30	6724.90	91	90	Lough
oc9897.9	Drifter	36a	51	4	8	415	s	4049.10	6726.70	83	15	Manning deploy
oc9897.10	BongoSB	53	51	4	8	442	s	4050.80	6727.50	83	79	Lough
oc9897.11	BongoSB	53	51	4	8	449	e	4050.90	6728.00	83	79	Lough
oc9897.12	BongoSB	54	51	4	8	518	s	4050.90	6728.60	83	78	Lough/Durbin
oc9897.13	BongoSB	54	51	4	8	527	e	4051.00	6729.00	83	78	Lough
oc9897.14	BongoSB	55	51	4	8	535	s	4051.00	6729.00	82	77	Lough/Durbin
oc9897.15	BongoSB	55	51	4	8	545	e	4050.90	6728.60	82	77	Lough
oc9897.16	BongoSB	56	51	4	8	551	s	4050.80	6728.10	82	79	Lough/Durbin
oc9897.17	BongoSB	56	51	4	8	605	e	4050.60	6727.70	82	79	Lough
oc9897.18	Spar	1	51	4	8	610	s	4050.40	6727.800	80	40	VanKeuren drft1a Sunny, 10kt
oc9897.19	Pump/CTD	1	51	4	8	706	s	4050.50	6728.000	85	63	Manning/Incze Cast w/no data
oc9897.20	Pump/CTD	1	51	4	8	813	e	4050.50	6728.200	84	63	Manning/Incze
oc9897.21	Spar	1	51	4	8	930	e	4051.80	6730.100	80	40	Van Keuren
oc9897.22	Drifter	2614	51	4	8	940	s	4051.90	6730.10	75	5	Manning deploy
oc9897.23	BongoSB	57	52	4	8	1026	s	4055.50	6730.70	75	70	Lough
oc9897.24	BongoSB	57	52	4	8	1034	e	4055.90	6731.60	73	70	Lough
oc9897.25	BongoSB	58	53	4	8	1141	s	4100.00	6733.70	67	64	Lough
oc9897.26	BongoSB	58	53	4	8	1149	e	4100.10	6733.90	66	64	Lough
oc9897.27	BongoSB	59	54	4	8	1255	s	4104.40	6736.40	58	55	Lough
oc9897.28	BongoSB	59	54	4	8	1300	e	4104.20	6736.60	58	55	Lough
oc9897.29	BongoSB	60	55	4	8	1400	s	4108.40	6739.00	52	49	Lough Water cast
oc9897.30	BongoSB	60	55	4	8	1407	e	4108.10	6739.00	52	49	Lough
oc9897.31	BongoSB	61	55	4	8	1408	s	4108.10	6739.00	50	47	Lough
oc9897.32	BongoSB	61	55	4	8	1413	e	4107.80	6738.90	50	47	Lough
oc9897.33	BongoSB	62	56	4	8	1519	s	4105.50	6747.70	51	47	Lough
oc9897.34	BongoSB	62	56	4	8	1525	e	4104.90	6747.90	51	47	Lough
oc9897.35	BongoSB	63	57	4	8	1608	s	4100.50	6745.90	54	51	Lough
oc9897.36	BongoSB	63	57	4	8	1616	e	4100.10	6746.20	54	51	Lough
oc9897.37	BongoSB	64	58	4	8	1715	s	4056.40	6741.50	66	63	Lough
oc9897.38	BongoSB	64	58	4	8	1724	e	4055.90	6742.00	66	63	Lough
oc9897.39	BongoSB	65	59	4	8	1826	s	4052.30	6739.10	71	66	Lough
oc9897.40	BongoSB	65	59	4	8	1833	e	4052.00	6739.50	71	66	Lough
oc9897.41	Drifter	2618	59	4	8	1835	s	4052.00	6739.50	71	5	Manning deploy
oc9897.42	BongoSB	66	60	4	8	2008	s	4047.80	6736.100	79	73	Lough
oc9897.43	BongoSB	66	60	4	8	2018	e	4047.70	6736.300	77	73	Lough
oc9897.44	ZPN	4	60	4	8	2029	s	4047.60	6736.400	79	70	Runge
oc9897.45	ZPN	4	60	4	8	2041	e	4047.60	6736.400	79	70	Runge
oc9897.46	BongoSB	67	61	4	8	2155	s	4043.30	6733.000	88	83	Lough
oc9897.47	BongoSB	67	61	4	8	2209	e	4043.30	6732.700	88	83	Lough
oc9897.48	Drifter	2611	61	4	8	2215	s	4043.20	6732.600	83	5	Manning deploy
oc9897.49	BongoSB	68	62	4	8	2332	s	4039.00	6730.000	92	88	Lough
oc9897.50	BongoSB	68	62	4	8	2345	e	4038.60	6729.600	94	88	Lough
oc9997.1	BongoSB	69	63	4	9	53	s	4036.60	6738.400	90	86	Lough
oc9997.2	BongoSB	69	63	4	9	105	e	4036.20	6738.200	90	86	Lough
oc9997.3	BongoSB	70	64	4	9	230	s	4040.90	6741.400	69	69	Lough
oc9997.4	BongoSB	70	64	4	9	238	e	4040.90	6741.500	69	69	Lough
oc9997.5	BongoSB	71	65	4	9	330	s	4044.90	6744.300	70	65	Lough
oc9997.6	BongoSB	71	65	4	9	339	e	4044.90	6744.600	70	65	Lough
oc9997.7	BongoSB	72	66	4	9	442	s	4049.40	6747.500	65	61	Lough
oc9997.8	BongoSB	72	66	4	9	448	e	4049.40	6748.000	65	61	Lough
oc9997.9	BongoSB	73	67	4	9	559	s	4053.40	6750.600	63	59	Lough
oc9997.10	BongoSB	73	67	4	9	609	e	4053.40	6751.200	63	59	Lough
oc9997.11	BongoSB	74	68	4	9	712	s	4057.90	6753.600	56	53	Lough Bongos caught in props.
oc9997.12	BongoSB	74	68	4	9	720	e	4058.20	6755.100	56	53	Lough
oc9997.13	BongoSB	75	68	4	9	746	s	4058.30	6755.700	58	48	Lough Lost .333 net.

oc9997.14	BongoSB	75	68	4	9	758	e	4058.40	6757.100	58	48	Lough	
oc9997.15	BongoSB	76	68	4	9	831	s	4057.90	6753.800	56	52	Lough	
oc9997.16	BongoSB	76	68	4	9	839	e	4058.00	6754.500	56	52	Lough	
oc9997.17	BongoSB	77	69	4	9	947	s	4102.60	6756.200	45	39	Lough	
oc9997.18	BongoSB	77	69	4	9	954	e	4102.80	6756.800	44	39	Lough	
oc9997.19	BongoSB	78	70	4	9	1204	s	4059.00	6804.400	45	42	Lough	
oc9997.20	BongoSB	78	70	4	9	1211	e	4059.10	6804.700	45	42	Lough	
oc9997.21	BongoSB	79	71	4	9	1256	s	4055.10	6801.600	48	45	Lough	
oc9997.22	BongoSB	79	71	4	9	1301	e	4055.00	6801.700	48	45	Lough	
oc9997.23	BongoSB	80	72	4	9	1349	s	4050.50	6758.500	65	62	Lough	
oc9997.24	BongoSB	80	72	4	9	1354	e	4050.40	6758.700	65	62	Lough	
oc9997.25	BongoSB	81	73	4	9	1500	s	4045.80	6755.400	73	70	Lough	
oc9997.26	BongoSB	81	73	4	9	1507	e	4045.60	6755.600	73	70	Lough	
oc9997.27	BongoSB	82	74	4	9	1553	s	4041.40	6752.800	82	78	Lough	
oc9997.28	BongoSB	82	74	4	9	1605	e	4041.50	6752.900	82	78	Lough	
oc9997.29	BongoSB	83	75	4	9	1700	s	4037.50	6750.000	85	82	Lough	
oc9997.30	BongoSB	83	75	4	9	1710	e	4037.40	6750.400	85	82	Lough	
oc9997.31	BongoSB	84	76	4	9	1837	s	4033.40	6747.300	102	97	Lough	
oc9997.32	BongoSB	84	76	4	9	1847	e	4033.60	6747.900	97	97	Lough	
oc9997.33	BongoSB	85	76	4	9	1851	s	4033.50	6748.000	96	91	Lough	Watercast
oc9997.34	BongoSB	85	76	4	9	1858	e	4033.60	6748.300	96	91	Lough	
oc9997.35	BongoSB	86	77	4	9	2016	s	4034.50	6758.500	97	91	Lough	
oc9997.36	BongoSB	86	77	4	9	2027	e	4034.50	6759.300	97	91	Lough	
oc9997.37	BongoSB	87	78	4	9	2132	s	4038.90	6801.400	88	83	Lough	
oc9997.38	BongoSB	87	78	4	9	2141	e	4039.00	6802.200	87	83	Lough	
oc9997.39	BongoSB	88	79	4	9	2244	s	4043.00	6804.600	79	75	Lough	
oc9997.40	BongoSB	88	79	4	9	2252	e	4043.30	6805.100	79	75	Lough	
oc10097.1	BongoSB	89	80	4	10	8	s	4047.40	6806.900	65	61	Lough	
oc10097.2	BongoSB	89	80	4	10	14	e	4047.60	6807.200	65	61	Lough	
oc10097.3	BongoSB	90	81	4	10	605	s	4047.90	6735.900	77	73	Lough	
oc10097.4	BongoSB	90	81	4	10	616	e	4047.70	6736.500	77	73	Lough	
oc10097.5	ZPN	5	82	4	10	627	e	4047.71	6736.910	77	5	Campbell	
oc10097.6	ZPN	5	82	4	10	627	s	4047.71	6736.910	77	5	Campbell	
oc10097.7	BongoSB	91	82	4	10	829	s	4045.90	6730.200	87	83	Lough	
oc10097.8	BongoSB	91	82	4	10	839	e	4045.90	6730.900	87	83	Lough	
oc10097.9	ZPN	6		4	10	846	s	4045.90	6731.200	85	86	Runge	
oc10097.1	ZPN	6		4	10	856	e	4045.90	6731.200	85	86	Runge	
oc10097.1	Drifter	21b	82	4	10	1005	s	4047.30	6735.000	80	13	Manning	deploy
oc10097.1	Pump/CTD	2	82	4	10	1019	s	4046.99	6734.600	83	70	Runge/Incze	
oc10097.1	Pump/CTD	2	82	4	10	1223	e	4049.20	6737.450	83	70	Runge/Incze	
oc10097.1	BongoSB	92	82	4	10	1302	s	4049.40	6735.700	77	77	Lough/Durbin	
oc10097.1	BongoSB	92	82	4	10	1311	e	4049.60	6736.000	77	77	Lough	
oc10097.1	BongoSB	93	82	4	10	1314	s	4049.60	6736.100	74	70	Lough	
oc10097.1	BongoSB	93	82	4	10	1325	e	4049.80	6736.400	74	70	Lough	
oc10097.1	BongoSB	94	82	4	10	1330	s	4049.80	6736.500	76	71	Lough	
oc10097.1	BongoSB	94	82	4	10	1338	e	4050.00	6736.700	76	71	Lough	
oc10097.2	ZPN	7	82	4	10	1350	s	4050.20	6738.800	72	60	Runge	
oc10097.2	ZPN	7	82	4	10	1400	e	4050.20	6738.800	72	60	Runge	
oc10097.2	DPP	2	82	4	10	1415	s	4050.20	6736.000	72	2	Campbell	
oc10097.2	DPP	2	82	4	10	1430	e	4050.20	6736.000	72	2	Campbell	
oc10097.2	MOC1/4	1	82	4	10	1711	s	4048.59	6732.624	80	70	Lough	haul 119
oc10097.2	MOC1/4	1	82	4	10	1751	e	4047.52	6733.951	81	70	Lough	
oc10097.2	Pump/CTD	3	82	4	10	2222	s	4045.36	6734.390	84	65	Incze/Alatalo	
oc10197.1	Pump/CTD	3	82	4	11	20	e	4046.00	6735.900	75	65	Incze/Alatalo	
oc10197.2	BongoSB	95	82	4	11	116	s	4046.20	6736.000	79	75	Lough/Durbin	
oc10197.3	BongoSB	95	82	4	11	127	e	4046.30	6736.200	79	75	Lough	
oc10197.4	BongoSB	96	82	4	11	131	s	4046.30	6736.400	78	74	Lough/Durbin	
oc10197.5	BongoSB	96	82	4	11	139	e	4046.40	6736.700	78	74	Lough	
oc10197.6	BongoSB	97	82	4	11	144	s	4046.40	6736.800	77	74	Lough	
oc10197.7	BongoSB	97	82	4	11	152	e	4046.50	6737.200	77	74	Lough	
oc10197.8	BongoSB	98	82	4	11	219	s	4047.20	6734.500	80	64	Lough	
oc10197.9	BongoSB	98	82	4	11	225	e	4047.10	6734.400	80	64	Lough	
oc10197.1	BongoSB	99	82	4	11	230	s	4047.10	6734.400	80	76	Lough	
oc10197.1	BongoSB	99	82	4	11	239	e	4047.10	6734.700	80	76	Lough	
oc10197.1	BongoSB	100	82	4	11	403	s	4046.60	6733.700	82	78	Lough	
oc10197.1	BongoSB	100	82	4	11	414	e	4046.70	6734.100	82	78	Lough	
oc10197.1	BongoSB	101	82	4	11	521	s	4044.80	6732.500	86	81	Lough	
oc10197.1	BongoSB	101	82	4	11	533	e	4044.90	6732.800	86	81	Lough	
oc10197.1	BongoSB	102	82	4	11	629	s	4044.60	6734.000	84	80	Lough	
oc10197.1	BongoSB	102	82	4	11	640	e	4044.60	6734.600	84	80	Lough	
oc10197.1	MOC1	120	82	4	11	915	s	4041.51	6735.480	87	80	Lough	
oc10197.1	MOC1	120	82	4	11	1056	e	4044.86	6736.770	80	80	Lough	
oc10197.2	Pump/CTD	4	82	4	11	1133	s	4043.32	6737.590	81	69	Runge/Incze	1 down, 1up.
oc10197.2	Pump/CTD	4	82	4	11	1300	e	4043.60	6737.700	81	69	Runge/Incze	
oc10197.2	Spar	2	82	4	11	1336	s	4044.41	6738.000	75	40	Van Keuren	Sunny, 5kt
oc10197.2	MOC1/4	121	82	4	11	1347	s	4044.40	6738.100	79	70	Lough	
oc10197.2	MOC1/4	121	82	4	11	1422	e	4044.92	6739.840	78	70	Lough	
oc10197.2	ZPN	9	82	4	11	1455	s	4045.50	6740.100	73	40	Runge	
oc10197.2	ZPN	9	82	4	11	1515	e	4045.50	6740.100	73	40	Runge	
oc10197.2	ZPN	10	82	4	11	1530	s	4045.50	6740.100	73	60	Runge	
oc10197.2	ZPN	10	82	4	11	1545	e	4045.50	6740.100	73	60	Runge	
oc10197.2	Pump/CTD	5	82	4	11	1630	s	4044.72	6738.580	77	72	Alatalo/Incze	
oc10197.3	Pump/CTD	5	82	4	11	1755	e	4042.40	6735.470	78	72	Alatalo/Incze	
oc10197.3	Spar	2	82	4	11	1825	e	4042.33	6735.630	75	40	Van Keuren	
oc10197.3	MOC1	122	82	4	11	1850	s	4041.82	6735.740	86	80	Lough	
oc10197.3	MOC1	122	82	4	11	2004	e	4039.29	6738.400	83	80	Lough	
oc10197.3	Drifter	34a	82	4	11	2043	s	4040.89	6737.300	80	33	Manning	drift 4a
oc10197.3	ZPN	11	82	4	11	2050	e	4040.60	6737.600	82	75	Runge	
oc10197.3	ZPN	11	82	4	11	2050	s	4040.60	6737.600	82	75	Runge	
oc10197.3	Pump/CTD	6	82	4	11	2208	s	4040.70	6738.470	77	69	Runge/Incze	owns total

oc10197.3	Pump/CTD	6	82	4	11	2208	e	4040.70	6738.470	77	69	Runge/Incze
oc10297.2	BongoSB	103	82	4	12	116	e	4041.80	6740.900	76	72	Lough
oc10297.3	BongoSB	104	82	4	12	120	s	4041.80	6741.100	76	72	Lough
oc10297.4	BongoSB	104	82	4	12	128	e	4041.80	6741.400	76	72	Lough
oc10297.5	BongoSB	105	82	4	12	131	s	4041.80	6741.500	77	74	Lough
oc10297.6	BongoSB	105	82	4	12	140	e	4041.90	6741.900	77	74	Lough
oc10297.7	MOC1	123	82	4	12	229	s	4042.70	6740.200	77	70	Lough
oc10297.8	MOC1	123	82	4	12	319	e	4042.20	6741.800	78	70	Lough
oc10297.9	MOC1	124	82	4	12	657	s	4040.50	6737.900	80	73	Lough
oc10297.1	MOC1	124	82	4	12	742	e	4037.60	6737.700	83	73	Lough
oc10297.1	Pump/CTD	7	82	4	12	1035	s	4039.32	6741.720	77	71	Runge/Incze
oc10297.1	Pump/CTD	7	82	4	12	1151	e	4039.81	6742.300	79	71	Runge/Incze
oc10297.1	MOC1	125	82	4	12	1243	s	4040.20	6743.200	77	70	Lough
oc10297.1	MOC1	125	82	4	12	1400	e	4040.20	6743.200	77	70	Lough
oc10297.1	ZPN	12	82	4	12	1445	e	4042.40	6744.100	73	999	Runge
oc10297.1	ZPN	12	82	4	12	1445	s	4042.40	6744.100	73	999	Runge
oc10297.1	Light/CTD	8	82	4	12	1516	s	4042.82	6743.810	72	40	VanKeuren Light
oc10297.1	Light/CTD	8	82	4	12	1535	e	4043.00	6743.580	72	40	VanKeuren/Incze
oc10297.1	Pump/CTD	9	82	4	12	1556	s	4042.89	6743.360	73	63	Incze Pump#8
oc10297.2	Pump/CTD	9	82	4	12	1720	e	4042.97	6742.500	72	63	Incze
oc10297.2	MOC1	126	82	4	12	1751	s	4042.70	6741.920	73	70	Lough
oc10297.2	MOC1	126	82	4	12	1857	e	4040.98	6739.388	77	70	Lough
oc10297.2	ZPN	13	82	4	12	1943	e	4041.00	6741.600	999	999	Runge
oc10297.2	ZPN	13	82	4	12	1943	s	4041.00	6741.600	999	999	Runge
oc10297.2	Pump/CTD	10	82	4	12	2120	s	4040.15	6741.820	78	66	Incze/Runge Pump#9, Hose Disc
oc10297.2	Pump/CTD	10	82	4	12	2120	e	4040.15	6741.820	78	66	Incze/Runge
oc10297.2	Pump/CTD	11	82	4	12	2351	s	4040.47	6744.290	76	63	Incze Pump#10
oc10397.1	Pump/CTD	11	82	4	13	115	e	4042.20	6745.400	76	63	Incze
oc10397.2	BongoSB	106	82	4	13	152	s	4043.00	6745.400	73	70	Lough
oc10397.3	BongoSB	106	82	4	13	201	e	4042.80	6745.300	73	70	Lough
oc10397.4	BongoSB	107	82	4	13	205	s	4042.80	6745.200	73	65	Lough
oc10397.5	BongoSB	107	82	4	13	211	e	4042.80	6745.100	73	65	Lough
oc10397.6	BongoSB	108	82	4	13	215	s	4042.60	6745.100	73	69	Lough
oc10397.7	BongoSB	108	82	4	13	224	e	4042.00	6745.000	73	69	Lough
oc10397.8	MOC1	127	82	4	13	248	s	4042.00	6745.000	73	70	Lough
oc10397.9	MOC1	127	82	4	13	337	e	4041.60	6743.700	77	70	Lough
oc10397.1	MOC1	128	82	4	13	915	s	4041.10	6741.892	76	70	Lough
oc10397.1	MOC1	128	82	4	13	1034	e	4038.53	6741.994	73	70	Lough
oc10397.1	ZPN	14	82	4	13	1130	s	4041.00	6743.250	999	999	Runge
oc10397.1	ZPN	14	82	4	13	1130	e	4041.00	6743.250	999	999	Runge
oc10397.1	ZPN	15	82	4	13	1135	e	4041.00	6743.250	78	50	Campbell
oc10397.1	ZPN	15	82	4	13	1135	s	4041.00	6743.250	78	50	Campbell
oc10397.1	ZPN	16	82	4	13	2000	e	4038.90	6740.900	78	50	Campbell
oc10397.1	ZPN	16	82	4	13	2000	s	4038.90	6740.900	78	50	Campbell
oc10397.1	BongoSB	109	82	4	13	2103	s	4040.50	6739.600	80	74	Lough
oc10397.1	BongoSB	109	82	4	13	2114	e	4040.30	6740.100	80	74	Lough
oc10397.2	BongoSB	110	82	4	13	2117	s	4040.20	6740.200	80	74	Lough
oc10397.2	BongoSB	110	82	4	13	2127	e	4040.00	6740.500	80	74	Lough
oc10397.2	BongoSB	111	82	4	13	2129	s	4039.90	6740.500	78	74	Lough
oc10397.2	BongoSB	111	82	4	13	2140	e	4039.70	6740.800	78	74	Lough
oc10397.2	Pump/CTD	12	82	4	13	2220	s	4041.80	6738.150	76	64	Alatalo/Incze/Runge 30m bottle
oc10497.1	Pump/CTD	12	82	4	14	32	e	4039.78	6739.760	76	64	Alatalo/Incze/Runge
oc10497.2	MOC1	129	82	4	14	221	s	4041.80	6739.200	78	72	Lough
oc10497.3	MOC1	129	82	4	14	307	e	4041.00	6740.000	79	72	Lough
oc10497.4	MOC1	130	82	4	14	902	s	4040.82	6740.070	77	70	Lough
oc10497.5	MOC1	130	82	4	14	1009	e	4038.41	6742.170	74	70	Lough
oc10497.6	ZPN	17	82	4	14	1130	s	4038.90	6740.900	78	50	Campbell
oc10497.7	MOC1	131	82	4	14	1334	s	4038.60	6742.700	73	70	Lough
oc10497.8	MOC1	131	82	4	14	1404	e	4039.60	6745.500	78	70	Lough
oc10497.9	Pump/CTD	13	82	4	14	1539	e	4038.90	6742.580	75	58	Incze/Runge
oc10497.1	Pump/CTD	13	82	4	14	1539	s	4038.90	6742.580	75	58	Incze/Runge 3 up&downs
oc10497.1	MOC1	132	82	4	14	1914	s	4039.50	6743.240	78	70	Lough
oc10497.1	MOC1	132	82	4	14	2018	e	4039.46	6744.980	79	70	Lough
oc10497.1	ZPN	18	82	4	14	2115	s	4037.20	6741.300	83	78	Runge
oc10497.1	Pump/CTD	14	82	4	14	2155	s	4036.34	6741.510	87	68	Incze/Runge
oc10597.1	Pump/CTD	14	82	4	15	14	e	4034.16	6743.320	105	68	Incze/Runge
oc10597.2	BongoSB	112	82	4	15	30	s	4033.90	6744.200	104	100	Campbell
oc10597.3	BongoSB	112	82	4	15	36	e	4033.90	6744.600	104	100	Campbell
oc10597.4	BongoSB	113	82	4	15	48	s	4033.90	6744.800	104	98	Campbell
oc10597.5	BongoSB	113	82	4	15	59	e	4033.80	6745.300	104	98	Campbell
oc10597.6	BongoSB	114	82	4	15	101	s	4033.80	6745.300	101	97	Campbell
oc10597.7	BongoSB	114	82	4	15	128	e	4033.80	6745.400	101	97	Campbell
oc10597.8	BongoSB	115	83	4	15	235	s	4046.10	6750.700	67	62	Lough
oc10597.9	BongoSB	115	83	4	15	242	e	4046.10	6750.100	67	62	Lough
oc10597.1	BongoSB	116	84	4	15	324	s	4050.40	6751.400	68	62	Lough
oc10597.1	BongoSB	116	84	4	15	332	e	4050.70	6751.700	68	62	Lough
oc10597.1	BongoSB	117	85	4	15	440	s	4048.60	6757.500	70	66	Lough New Drift Station
oc10597.1	BongoSB	117	85	4	15	450	e	4048.80	6757.500	70	66	Lough
oc10597.1	Drifter	35a	85	4	15	524	s	4048.63	6756.800	70	30	Manning deployed
oc10597.1	MOC1	133	85	4	15	626	s	4049.30	6757.000	65	60	Lough
oc10597.1	MOC1	133	85	4	15	717	e	4049.50	6758.400	62	60	Lough
oc10597.1	Spar	3	85	4	15	838	s	4047.12	6754.930	65	40	Van Keuren Clear,
oc10597.1	ZPN	19	85	4	15	920	s	4045.60	6755.100	75	50	Campbell
oc10597.1	Pump/CTD	15	85	4	15	940	s	4046.10	6755.050	72	60	Incze/Runge
oc10597.2	Pump/CTD	15	85	4	15	1150	e	4042.88	6756.130	79	60	Incze/Runge
oc10597.2	Light/CTD	16	85	4	15	1213	s	4042.73	6756.180	80	40	Van Keuren
oc10597.2	Light/CTD	16	85	4	15	1225	e	4042.61	6756.250	80	40	Van Keuren
oc10597.2	Spar	3	85	4	15	1230	e	4043.87	6756.280	65	40	Van Keuren
oc10597.2	BongoSB	118	85	4	15	1321	s	4044.00	6757.000	77	73	Campbell
oc10597.2	BongoSB	118	85	4	15	1330	e	4044.10	6757.300	77	73	Campbell
oc10597.2	BongoSB	119	85	4	15	1333	s	4044.20	6757.400	77	74	Campbell

oc10597.2	BongoSB	119	85	4	15	1340	e	4044.30	6757.900	77	74	Campbell		
oc10597.2	BongoSB	120	85	4	15	1345	e	4044.40	6758.100	77	74	Campbell		
oc10597.2	BongoSB	120	85	4	15	1354	e	4044.60	6758.600	77	74	Campbell		
oc10597.3	BongoSB	121	85	4	15	1358	s	4044.70	6758.700	76	71	Campbell		
oc10597.3	BongoSB	121	85	4	15	1405	e	4044.80	6759.100	76	71	Campbell		
oc10597.3	MOC1	134	85	4	15	1508	s	4044.70	6757.600	72	60	Lough		
oc10597.3	MOC1	134	85	4	15	1611	e	4046.30	6800.700	72	60	Lough		
oc10597.3	ZPN	20	85	4	15	1700	s	4046.74	6759.060	73	70	Runge		
oc10597.3	Pump/CTD	17	85	4	15	1713	s	4046.92	6758.970	73	60	Incze/Manning		
oc10597.3	Pump/CTD	17	85	4	15	1833	e	4047.38	6757.400	73	60	Incze/Manning		
oc10597.3	Drifter	34a	82	4	15	2003	e	4039.30	6750.530	80	33	Manning	recovered	
oc10597.3	Drifter	21b	82	4	15	2035	e	4036.20	6750.380	80	13	Manning	recovered	
oc10597.3	Drifter	37a	82	4	15	2151	s	4035.83	6749.370	87	33	Manning	deployed	
oc10597.4	MOC1	135	82	4	15	2235	s	4035.51	6748.850	89	90	Lough		
oc10697.1	MOC1	135	82	4	16	6	e	4032.28	6749.880	100	90	Lough		
oc10697.2	Drifter	36a	82	4	16	400	e	4030.10	6804.100	80	13	Manning	recovered	
oc10697.3	Drifter	7a6b	82	4	16	645	s	4035.70	6750.200	87	33	Manning	7arecover6bdeploy	
oc10697.4	Spar	4	82	4	16	733	s	4035.98	6750.280	75	40	Van Keuren		Sunny,
oc10697.5	Pump/CTD	18	82	4	16	900	s	4035.74	6749.560	89	70	Incze/Manning		
oc10697.6	Pump/CTD	18	82	4	16	1120	e	4033.06	6749.300	98	70	Incze/Manning		
oc10697.7	Light/CTD	19	82	4	16	1140	e	4032.76	6749.280	100	40	Van Keuren/Incze		
oc10697.8	Light/CTD	19	82	4	16	1140	s	4032.76	6749.280	100	40	Van Keuren/Incze		
oc10697.9	MOC1	136	82	4	16	1226	s	4032.80	6750.600	99	90	Lough		
oc10697.1	MOC1	136	82	4	16	1329	e	4033.60	6754.900	96	90	Lough		
oc10697.1	Spar	4	82	4	16	1432	e	4051.80	6730.100	75	40	Van Keuren		

Appendix II. Drifter Log

		Deployed							Recovered						
id	depth(m)	Sta#	mth	day	hour	lat	long	wdepth(m)	mth	day	hour	lat	long	latdd	londd
#2610	1	45	4	7	2100	4058.90	6722.40	75						40.982	-67.373
#2612	1	46	4	8	15	4048.90	6716.00	77						40.815	-67.267
6a	13	50	4	8	415	4049.10	6726.70	83	4	16	400	4030.1	6804.1	40.818	-67.445
1a		51	4	8	610	4050.40	6727.80	80	4	8	930	4051.8	6730.1		
#2614	1	51	4	8	940	4051.90	6730.10	75						40.865	-67.502
#2618	1	59	4	8	1835	4052.00	6739.50	71						40.867	-67.658
#2611	1	61	4	8	2215	4043.20	6732.60	83						40.720	-67.543
1b	13	82	4	10	1005	4047.30	6735.00	80	4	15	2035	4036.2	6750.38	40.788	-67.583
4a	33	82	4	11	2043	4040.89	6737.30	80	4	15	2003	4039.3	6750.53	40.682	-67.622
5a	33	85	4	15	556	4048.63	6756.80	70						40.811	-67.947
7a	33	82	4	15	2040	4036.21	6750.38	87	4	16	645	4035.7	6750.20	40.597	-67.823
6b	33	82	4	16	645	4035.70	6750.20	83	4	20	1745	4014.0	6812.91	40.595	-67.837

Appendix III. List of Personnel

Dr. R. Gregory Lough, National Oceanic and Atmospheric Administration, Ch. Scientist
Ms. Elizabeth A. Broughton, National Oceanic and Atmospheric Administration
Ms. Marie E. Kiladis, National Oceanic and Atmospheric Administration
Mr. James Manning, National Oceanic and Atmospheric Administration
Mr. Michael S. Morss, University of Rhode Island
Dr. Laurence J. Buckley, University of Rhode Island
Ms. Jeanne M. Burns, National Oceanic and Atmospheric Administration
Ms. Beth Lacey, University of Rhode Island
Mr. Samuel R. Hall, Universtiy of Rhode Island
Dr. Lewis S. Incze, Bigelow Laboratory for Ocean Sciences
Ms. Elizabeth Novak, Bigelow Laboratory for Ocean Sciences
Mr. Philip Alatalo, Woods Hole Oceanographic Institution
Dr. Jefferey Van Keuren, University of Rhode Island
Dr. Robert G. Campbell, University of Rhode Island
Mr. Gregory J. Teegarden, University of Rhode Island
Mr. James W. Gibson, University of Rhode Island
Dr. Jeffery A. Runge, Institut Maurice-Lamontagne
Ms. Luciene Chenard, Institut Maurice-Lamontagne
Ms. Laura G. Stein, Woods Hole Oceanographic Institution

Appendix IV. List of Figures with captions

Figure 1. OC301 Cruise track.

Figure 2. Four phases of cruise track/operations including intial bongo survey (5-6 April), fine-scale bongo survey (6-10 April), drifter following at station 82 (10-12 April), and continued study at 82 with excursion to station 85 on 15 April.

Figure 3. Summary of drifter tracks during OC301. The four easternmost drifters were airdeployed by the USCG.

Figure 4. Drifters loss from the bank due to shelf-slope frontal features as seen from satellite imagery. Note a pair of drifters were entrained by

each of the apparent features.

Figure 5. Divergent path of shallow drifter 1b (13m drogue) and deep drifter 4a (33m drogue).

Figure 6. Wind as observed at nearby NOAA buoy 44011.

Figure 7. Trajectory of drifter 36a (13m drogue) with days of April posted along the track. Note the slow down on 13 April during the period of northward winds.

Figure 8. Trajectory of drifter 36b (33m drogue) entrained off the bank and later recovered by Cabel Davis.

Figure 9. Temperature time series as recorded by a) drifter 6a and 1b and b) drifter 4a. Note the dashed line represents the record from VEMCO minilog recorders that were attached to the bottom of the drogues. The difference of temperature between the nearsurface and drogue depths is within the accuracy of the thermistors (~0.1 deg).

Figure 9b. Thermistor records from surface canister and drogue on drifter 4b.

Figure 10. Raw salinity record from OCEANUS SAIL system. Note the frequent dropouts.

Figure 11. Raw data from hull mounted thermistors.

Figure 12. Barometric pressure and short wave radiation.

Figure 13. Station numbers for fine-scale bongo grid.

Figure 14. Surface (top) and bottom (bottom) temperature from Seabird model 19 on the fine scale bongo grid.

Figure 15. Surface (top) and bottom (bottom) temperature anomaly from Seabird model 19 on the fine scale bongo grid.

Figure 16. Surface (top) and bottom (bottom) salinity from Seabird model 19 on the fine scale bongo grid.

Figure 17. Surface (top) and bottom (bottom) salinity anomaly from Seabird model 19 on the fine scale bongo grid.

Figure 18. Temperature cross-sections during the fine-scale bongo grid.

Figure 19. Salinity cross-sections during the fine-scale bongo grid.

Figure 20. Temperature and salinity profiles for individual SEABIRD Model 911 cast.

Figure 21. Fluoresence and transmisometer profiles for individual SEABIRD Model 911 cast. Note cast 15-17 were conducted at station 85.

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and sigmat contours from 15 CTD casts, and index of stratification.

Figure 23. Standardized 333 bongo net hauls (No./100 cubic meters). Note the circle size is dependent on the relative catch and those with zero catch are denoted with x's.

Figure 24. Length frequency of cod and haddock from ten different hauls.

Figure 25. Length frequency of cod and haddock at station 82 (top) vs station 85 (bottom).

Figure 26. Vertical distributions of cod and haddock larvae from four night 1-m^2 MOCNESS hauls following drifter station 82. See eventlog for MOCNESS tow data.

Figure 27. Chlorophyll a vertical profiles during the time series (10-16 April) at the drifter station 82 and a profile at station 85, 15 nm to the northeast of station 82 taken on 15 April.

Figure 28. Contoured cross-section of temperature (top), salinity (middle), and sigma-t (bottom) taken on 15 April in moving from station 82 to station 85. CTD cast numbers are listed at the top of each panel. See discussion in text under *Calanus* Recruitment and Mortality. Note the stretch in distance between cast 114 and 115 makes the gridding difficult.

Figure 29. Filtration rates of *Calanus* females on *Calanus* naupliar stages (N1 and N2).