

U.S. GLOBEC: R/V ENDEAVOR Cruise 331 to the Gulf of Maine

Acknowledgements

We would like to thank the captain and crew of the R/V ENDEAVOR for a productive cruise; their professionalism was greatly appreciated. We also thank the US GLOBEC Georges Bank Program for supporting this cruise, with research support provided by NOAA. Support for the bio-optical oceanographic research conducted on this cruise was provided by an award from the ONR Young Investigator Program.

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1.0 INTRODUCTION

R/V ENDEAVOR cruise 331 was conducted as a U.S. GLOBEC process cruise to examine late autumn conditions in the Gulf of Maine relevant to ecosystem processes on Georges Bank. The major scientific objectives of the cruise included:

- Conducting broad-scale surveys to map the spatial distribution of *Calanus finmarchicus* and its major invertebrate predators in the deep basins of the Gulf of Maine.
- Conducting broad-scale surveys to map the spatial distribution of bio-optical properties in the Gulf of Maine.

Summaries of the two primary projects supported by this cruise are presented in the sections following the cruise narrative.

R/V ENDEAVOR cruise 331 was planned as a broad-scale, bio-optical, and bioacoustical survey cruise traversing the major basins of the Gulf of Maine. We had weather-based contingency plans for conducting this survey cruise in either a clockwise manner (Wilkinson Basin - Jordan Basin - Georges Basin) or the reverse. A grid of regularly spaced transect lines was laid out for the survey of each basin. In addition to the survey itself, time was allocated for daytime and nighttime MOCNESS tows as well as mid-day light stations.

2.0 CRUISE NARRATIVE

The R/V ENDEAVOR departed Woods Hole on cruise EN-331 at 6:30 on 4 December 1999. Departure was delayed one day while we waited for R/V Oceanus to depart port and make space available for R/V ENDEAVOR to load. Under sunny skies and light winds, we set out for Wilkinson Basin in the Gulf of Maine. A chart of the cruise track for EN-331 provides an outline for the work described in this cruise report (Figure 1 - Appendix I). The meteorological conditions that occurred on this cruise ranged from ideal (i.e. virtually no wind and calm seas) to winter storm conditions (i.e. 50 knot winds and 3 - 4 m seas (Figure 2).

R/V ENDEAVOR Cruise 331
4 - 14 December 1999

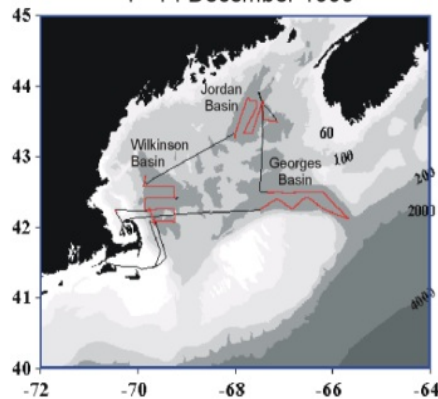


Figure 1. Cruise track, EN331.

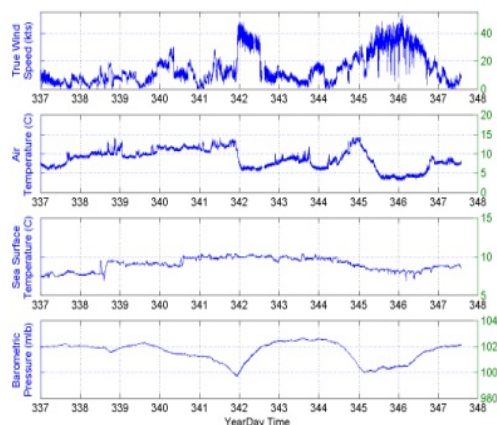


Figure 2. Meteorological conditions during EN331.

We arrived at our first site in Wilkinson Basin and deployed the BIOMAPER-II at 14:15 (BMP 1). After all systems were checked, we conducted a daytime MOCNESS tow (MOC 1) from 15:07 to 16:31. After the MOCNESS tow, we began towyoing in Wilkinson Basin along the first west-east transect line (1WBWE). Three towyos (1WBWE1-3) were conducted along this line, although the third was completed as the first towyo on the next transect line (2WBSN1). One additional towyo (2WBSN2) was completed along this line. After this transect line was completed, we conducted a nighttime MOCNESS tow (MOC 2) from 22:58 to 0002 on 5 December. Towyoing resumed after the MOCNESS tow, and we completed three towyos along an east - west transect line (3WBWE1-3), one towyo along a south - north transect line (4WBSN1), and four towyos along a west - east transect line (5WBWE1-4) before reaching the first mid-day light station.

At 11:57, we began the first mid-day light station activities. The BIOMAPER-II was recovered to service an AC-9 during the light station activities. These activities included deployment of a tethered, free-fall vertical Satlantic profiling multi-channel radiometer (SPMR 1) and a CTD/Niskin bottle rosette (CTD 1). The SPMR profile was collected successfully; however, the CTD required two casts before a profile was collected successfully. The light station activities were completed by 14:45.

The BIOMAPER-II was redeployed at 15:11 (BMP 2), and we began towyoing again. Two towyos along a south - north transect line (6WBSN1,2), three towyos along an east - west transect line (7WBWE1-3), and two towyos along a south - north transect line (8WBSN1,2) were completed before the final nighttime MOCNESS tow (MOC 3) in Wilkinson Basin was conducted from 00:37 to 01:58 on 6 December. The BIOMAPER-II was recovered at 02:02, and we began the transit to Jordan Basin.

The BIOMAPER-II was deployed in Jordan Basin at 12:16 (BMP3) and towed near the surface as we conducted a daytime MOCNESS tow and mid-day light station. The MOCNESS (MOC 4) was conducted from 12:13 to 13:30. The mid-day light station activities began at 13:42. These activities included deployment of a tethered, free-fall vertical Satlantic profiling multi-channel radiometer (SPMR 2) and a CTD/Niskin bottle rosette (CTD 2). The light station activities were completed by 15:04.

At 15:15, we began towyoing again. Five towyos along a south - north transect line (1JBSN1-5) were completed before a nighttime MOCNESS tow (MOC 5) was conducted from 21:55 to 22:54. Towyoing resumed after the MOCNESS tow, and we completed one towyo along a west - east transect line (2JBWE1), four towyos along a north - south transect line (3JBNS1-4), one towyo along a west - east transect line (4JBWE1), and four towyos along a south - north transect line (5JBSN1-4) before stopping at 12:34 on 7 December to conduct a CTD cast (CTD 3). After the CTD cast, we began towyoing again at 13:06. Three north - south towyos and one west - east towyo were conducted before we recovered the BIOMAPER-II at 18:05 for the transit to Georges Basin. A winter storm moved in at this time, and delayed our departure until the next morning at 08:00 (8 December).

The BIOMAPER-II was deployed in Georges Basin at 18:39 (BMP4). One towyo was completed along a west - east transect line (1GBWE1), but the video plankton recorder (VPR) only worked intermittently at depths greater than 250 m. The BIOMAPER-II was recovered at 20:50 to check all cables and connectors. No obvious problems were discovered, so we redeployed the BIOMAPER-II (BMP 5) at 21:28 and decided to not exceed 250 m during towyos. A nighttime MOCNESS tow (MOC 6) was conducted from 21:38 to 23:14. Towyoing resumed after the MOCNESS tow, and we completed five more towyos along the west - east transect line in Georges Basin (1GBWE2-6) and five towyos along a north - south transect line in Northeast Channel (1NECNS1-5). We reached the end of the second line at 12:35 on 9 December and stopped to conduct a mid-day light station and daytime MOCNESS tow.

The mid-day light station activities began at 12:46. These activities included deployment of a tethered, free-fall vertical Satlantic profiling multi-channel radiometer (SPMR 3) and a CTD/Niskin bottle rosette (CTD 4). The light station activities were completed by 14:13. The daytime MOCNESS tow (MOC7) was conducted from 14:15 to 15:27.

After the MOCNESS tow, we began towyoing again at 16:04. Three south - north towyos in Northeast Channel (2NECSN1-3) and two east - west towyos in Georges Basin (2GBEW1,2) were conducted before we stopped for a nighttime MOCNESS tow. The

MOCNESS tow (MOC 8) was conducted from 22:47 to 00:21 on 10 December. After the MOCNESS tow, we resumed towyoing. Five more towyos in Georges Basin (2GBEW3-7) were conducted before we recovered the BIOMAPER-II at 08:38 on 10 December. With the BIOMAPER-II aboard, we steamed for cover behind Cape Cod to avoid the worst of an approaching winter storm. During the steam to the Cape, we stopped at a station in the Gulf of Maine, between Franklin and Wilkinson Basins, to conduct a mid-day light station. The mid-day light station activities began at 12:24. These activities included deployment of a tethered, free-fall vertical Satlantic profiling multi-channel radiometer (SPMR 4) and a CTD/Niskin bottle rosette (CTD 5). The light station activities were completed by 13:40.

Strong winds, approaching 50 knots, prevented us from working outside the protection of the Cape on 11 December. Therefore, we conducted a BIOMAPER-II deployment (BMP 6) and recovery drill in mid-afternoon to videotape the handling system's performance. This drill went well, and we have good video footage to share with interested parties.

We remained behind Cape Cod until conditions improved during the late morning of 12 December. At that point, we steamed out into Massachusetts Bay to conduct a mid-day light station. The BIOMAPER-II was deployed (BMP 7), and we conducted a shallow towyo prior to the light station. The light station activities began at 11:19. These activities included deployment of a tethered, free-fall vertical Satlantic profiling multi-channel radiometer (SPMR 5) and a CTD/Niskin bottle rosette (CTD 6). The light station activities were completed by 12:50, and another shallow towyo was conducted. Afterwards, the BIOMAPER-II was recovered at 14:37.

As conditions continued to improve, we took advantage of our extra time and steamed out into Wilkinson Basin to perform several experiments. The first experiment, designed by Peter Wiebe, involved towing the BIOMAPER-II horizontally for 6-min intervals at a series of depths 25 m apart. This experiment was designed to help us determine the source of acoustic backscattering enhancement or suppression associated with towyoing the BIOMAPER-II through different portions of the water column. The second experiment, designed by Mark Benfield, involved simultaneously towyoing the BIOMAPER-II and MOCNESS between 20 m and 30 m. A related, third experiment, designed by Mark Benfield, involved simultaneously towing the BIOMAPER-II and MOCNESS for 6-minute intervals at a series of depths 2 m apart between 30 m and 14 m. Both experiments were designed to intercompare acoustic, VPR, and net sampling methods for estimating zooplankton distribution and abundance.

When we reached an appropriate starting position, the BIOMAPER-II was deployed (BMP 8) at 16:40. The first Benfield experiment was conducted from 17:01 to 18:06 and included the ninth MOCNESS deployment (MOC 9). The Wiebe experiment was conducted between 18:15 and 21:00. The second Benfield experiment was conducted from 21:06 to 23:01 and included the tenth MOCNESS deployment (MOC 10). After these experiments were completed, we recovered the MOCNESS and BIOMAPER-II and began the steam to Woods Hole.

We arrived in Woods Hole at about 14:30 on 13 December 1999.

3.0 INDIVIDUAL REPORTS

3.1 Principal Project: Processes Regulating the Recruitment of *Calanus finmarchicus* from the Gulf of Maine to Georges Bank.

Principal Investigators: C.H. Greene (Cornell), M.C. Benfield (LSU), P.H. Wiebe (WHO).

3.1.1 Introduction.

Calanus finmarchicus dominates zooplankton secondary production on Georges Bank during spring. The Georges Bank *Calanus* population is derived from diapausing populations in the deep basins of the Gulf of Maine, the Slope Water, and the Scotian Shelf east of the Bank. It is hypothesized that processes that regulate the survivorship and supply of *Calanus* from diapausing populations in the deep basins of the Gulf of Maine determine this copepod species' annual production on Georges Bank. To test this hypothesis, research is being conducted 1) to determine what processes regulate the abundance and survivorship of the diapausing *Calanus* populations in these deep basins, and 2) to determine how physical and biological processes interact to seed Georges Bank with recruits from these basins each year.

Acoustic and video remote-sensing methods were used to survey diapausing populations of *Calanus* in Georges, Jordan, and Wilkinson Basins of the Gulf of Maine. Broad-scale survey cruises conducted in early and late autumn

during 1998 and 1999 will be used to estimate survivorship of the diapausing *Calanus* and the scale-dependent spatial coupling of *Calanus* and its principal invertebrate predators - the euphausiid, *Meganyctiphanes norvegica*, and the siphonophore, *Nanomia cara*.

Results from field studies will focus on quantifying the relative contribution of predation to the overall mortality of the diapausing *Calanus* population. The results from field studies also will be used as input to coupled physical-biological models to examine how physical transport processes in the Gulf of Maine interact with *Calanus*' seasonal and diel vertical migration behaviors to seed Georges Bank with new recruits during winter.

3.1.2 Methods

3.1.2.1 Broad-scale survey

A broad-scale survey of the Gulf of Maine deep basins was conducted from December 4-13, 1999. The survey track included multiple transect lines in Wilkinson, Jordan, and Georges Basins (Figure 1). The survey was conducted

using a high-speed, deep-towed system, the BIOMAPER-II, configured with multiple-frequency (43 kHz, 120 kHz, 200 kHz, 420 kHz, and 1 MHz) acoustics, a video plankton recorder (VPR), and several bio-optical sensors (down- and upwelling spectral radiometers, spectrally matched attenuation, scattering, and absorption meters). The acoustic frequencies were chosen to bracket the transition from the Rayleigh to geometric scattering regions for the target species under investigation. A down- and up-looking transducer operated at each frequency to provide more complete coverage of the water column when the instrument was towyoed. Echo integration was conducted at 12-second intervals to provide volume-backscattering data at all five frequencies. Split-beam data were collected at the four lower frequencies. All raw acoustic data were recorded on digital audio tape, while the processing for echo integration was carried out in real time (Appendix II).

The software to acquire the data, which was provided by HTI, enabled the simultaneous acquisition of data on five frequencies each with two transducers (one up-looking and one down-looking). The range of the 0.5 meter depth strata allocated for each transducer was dependent on frequency with the lowest frequencies given the longest range and highest frequency the shortest range i.e. 43 kHz = 200 m, 120 kHz = 200 m, 200 kHz = 149 m, 420 kHz = 100 m, 1000 kHz = 35 m). A ping cycle for all frequencies and transducers took about 2.5 seconds with a firing sequence of down-looking 43, 120, 200, 420, 1000 kHz and then up-looking 43, 120, 200, 420, 1000 kHz. Target strength measurements were also collected on the lower 4 frequencies out to 20 meters from the surface of the split beam transducers. In addition, the raw data for each ping were recorded on DAT tape for post-processing of either target strengths or echo-integrations on a different time averaging basis. Each tape recorded two gigabytes of data and a total of 58 tapes were recorded during the cruise.

Post-processing software was used to combine the up-looking and down-looking data for a given frequency, and then the data were displayed in a color-enhanced echogram. On this cruise, a MATLAB version of the program to translate HTI-DES formatted acoustic data to a MATLAB compatible format (the Wiebe format) was used by Joe Warren to post-process the acoustic data.

The VPR mounted on BIOMAPER-II sampled a volume of 41.7 liters min⁻¹. All video images were recorded on SVHS tape for post-

cruise processing, while real-time processing enabled us to capture in-focus images to hard disk (Appendix III). GPS data were synchronized with the VPR signal and stamped on the video time code. Our at-sea image-processing was designed to provide a qualitative estimate of the distribution of different taxa in the sense that we had not verified the extraction efficiencies of our program settings. The constantly updating regions of interest (ROIs) that appeared on our computer monitor gave us some ground-truthing information along the cruise track. Quantitative ground-truthing will have to wait until the data are post-processed on shore using verified extraction settings.

Cross-referencing information was prepared at the end of the cruise for the various logged data sets (Appendix IV).

This was the second cruise on which BIOMAPER-II was deployed, towed, and recovered using the unique, self-contained handling system newly-built by Dynacon, Inc. specifically for BIOMAPER-II, with funding from DURIP. Powered and controlled electrically and driven hydraulically, it was first used on ENDEAVOR Cruise 330 in October 1999. The system consists of a winch and electro-optical cable, slack tensioner, J-frame/docking mechanism, power pack/hydraulic system, and local and remote controls (See the report for ENDEAVOR Cruise 330 for more details of its construction and use). The slack tensioner is a coupled hydraulic and nitrogen gas compensated system. Currently we have separate high (450 psi) and low (350 psi) pressure manifolds connected to same pressure N2 tanks, separated by valves into the accumulator cylinder. During the cruise, A. Girard logged wire tension, accumulator tank pressure, and piston extension distance of the Dynacon slack/tensioning system. Wire tension and line payout were recorded from the winch control console. Accumulator tank pressure was read from the gauge on one of the two open manifolds above the bank of nitrogen tanks. The piston extension distance was measured from the shoulder of cylinder to the bottom of the mount on top of the piston using a tape measure. Most of the measurements were recorded during flat calm seas. During these times there was little movement in the slack/tensioner. The manual logging was tedious, slow, and subject to error. An automated recording system would overcome these problems. These recordings provided baseline data on which showed the pressure response to increased wire tension as the cable was paid out to a maximum of 800 m during towyoys of BIOMAPER-II. The purpose of having two banks of tanks, one with high pressure and one with lower pressure, was to be able to switch between the two enable better compensation near the surface when tension is lower (lower pressure bank) and at depth when the tension is higher (high pressure bank). However, this must now be done manually and for several reasons does not work very well. As a result, we tuned the compensation system so that it functioned best when BIOMAPER-II was at the surface. A fully automated dynamic pressure compensation system is needed to handle the dynamic range of tensions experienced by BIOMAPER-II as it is towyoed between 0 and 300 m depth. The handling system as a whole worked very well for the duration of the cruise.

3.1.2.2 Zooplankton characterization from MOCNESS samples

During the broad-scale survey cruise of the Gulf of Maine deep basins, MOCNESS tows were conducted at three stations in Wilkinson Basin, two stations in Jordan Basin, and three stations in Georges Basin, one of which was in the Northeast Channel (Table 1).

Table 1. MOCNESS tow data.

Tow #	Date	Time In	Lat(N)	Lon(W)	Time Out	Lat(N)	Lon(W)	Sunrise (local time)	Sunset
M-01-001	04 Dec 1999	338.629861	42.0823	-069.6970	338.688194	42.0845	-069.6418	0650	1608
M-01-002	04 Dec 1999	338.998611	42.2687	-069.3062	339.001389	42.2637	-069.3500	0643	1606
M-01-003	06 Dec 1999	340.025694	42.7248	-069.8373	340.123611	42.6711	-069.8475	0654	1606
M-01-004	06 Dec 1999	340.514583	43.3174	-068.0000	340.562500	43.2828	-068.0142	0649	1557
M-01-005	06 Dec 1999	340.954861	43.8303	-067.7225	340.999306	43.8012	-067.7045	0650	1554
M-01-006	08 Dec 1999	343.901389	42.4960	-067.0767	343.968056	42.4917	-067.0315	0647	1558
M-01-007	09 Dec 1999	343.593750	42.1225	-065.6850	343.643750	42.1300	-065.7062	0639	1551
M-01-008	09 Dec 1999	343.949306	42.4193	-066.5690	344.014583	42.3880	-066.6273	0643	1554
M-01-009	12 Dec 1999	346.709028	42.2397	-069.7793	346.754167	42.2732	-69.7692	0657	1607
M-01-010	12 Dec 1999	346.893056	42.1235	-069.6418	346.959028	42.1000	-69.6467	0657	1607

The MOCNESS samples were collected for ground-truthing and inter-comparisons between the acoustic and VPR data. Splits from the MOCNESS samples were preserved in formalin for quantitative studies and preserved in alcohol or frozen in liquid nitrogen for molecular studies of *Calanus* and *Meganyctiphanes* population genetics by Ann Bucklin (University of New Hampshire), diapause physiology by Patrick Hassett (University of Ohio) and Charles Miller (Oregon State University), and nitrogen stable isotope analysis by Karen Fisher (Cornell University).

All MOCNESS tows were conducted with ship speeds of 1.5 - 2.5 knots. The zero net was fished from the surface to within 10 m of the bottom where net 1 was opened. Sampling strata for nets 1 through 8 was dependent on water depth, generally, intervals of 25 m were sampled near the bottom and the surface, and remaining intervals ranged from 25 to 75 m. The down-cast (net 0) was fished at a wire speed of 15 m/minute, and the up-cast (nets 1-8) was hauled in at a speed of between 5 and 15 m/minute. From approximately 100 to 300 cubic meters of water were filtered for each of nets 1 through 8.

Samples were processed at sea in the following manner. The sample taken from net zero on all hauls was preserved in 95% ethanol for Ann Bucklin. Plankton samples from nets 1 through 8 were split with a box splitter. One-half split was preserved in 5-10% buffered formalin for silhouette analysis to ground-truth the acoustic and VPR data. The other half split was made up to 600 ml, and 100 ml were removed and preserved in 9% formalin for Charles Miller's life history studies. The remainder of the 600 ml was either sieved and spooned into ethanol for Ann Bucklin's genetic studies or placed into plastic bags and frozen for Patrick Hassett's diapause physiology studies. In addition, approximately 90 individual *Meganyctiphanes* specimens were picked out and frozen for Ann Bucklin's genetic studies of this species. Finally, one teaspoon was taken from each net from Haul 7 and frozen in liquid nitrogen for Karen Fisher's work.

3.1.3 Results

3.1.3.1 Broad-scale survey

3.1.3.1.1 Multi-frequency acoustics and Environmental Sensing System (ESS)

The multi-frequency acoustics, bio-optical (including VPR), and physical oceanographic data were collected during seven of eight deployments of BIOMAPER-II throughout the Gulf of Maine. The first deployment where data were collected was on the Southwestern end of Wilkinson Basin at 14:15 on 4 December. This data collection was ended 12:01 on 5 December to bring the vehicle on board to do a system check and to make sure nothing had come loose during the initial deployment. Three hours later, the vehicle was again deployed and the remainder of the trackline was completed about 0215 on 6 December. A total of about 147 nm of trackline were surveyed in Wilkinson Basin (Table 2).

The work in Jordan basin commenced about noon on 6 December with the third deployment of BIOMAPER-II and was completed without interruption about 30 hours later at 18:12 on 7 December just as a gale's full force came upon us. In spite of very rough seas and strong winds, bringing the fish on board was a piece of cake. Several of us (Jay, Charlie, Mari, Aaron, Fred) set up the air tugger lines on poles to get ready to snap hook the lines onto the fish once it was clear of the water. With the ship rolling some and pitching as it jogged into the sea at about 2 knots, Andy, on the controls, turned off the slack tensioner. He then hauled the wire in and the vehicle came up straight out of the water. The cable termination slid into the docking mechanism and the hook latched as it was designed to do. Immediately, he started the J-frame coming up and inboard. As BIOMAPER-II was lifted free of the water, several

strong waves passed by raking the vehicle, but the docking mechanism held it secure and steady. Once clear of the water, the tugger lines were snap hooked onto the stainless steel side bars and pulled tight. Steadily, BIOMAPER-II came over the rail and once the frame was fully inboard, Andy pulled up on the cable, unlocked the latch and lowered BIOMAPER-II to the deck, all while the deck crew kept the tugger lines taut. The landing on the deck was smooth. The tugger lines were kept in place while the deck straps were put in place, holding BIOMAPER-II securely on the deck. The whole operation took only three or four minutes. A total of about 146 nm of trackline were surveyed in Jordan Basin.

With wind and seas finally abating, we steamed from Jordan Basin to Georges Basin arriving about 16:00. BIOMAPER-II was readied for deployment and the procedure started, but the hydraulics failed when the J-frame was engaged to boom-out. After a time-consuming set of checks, the problem, a hydraulic quick connect next to the control console had disconnected, was identified and fixed. A few minutes later BIOMAPER-II was in the water and starting the first towyo in Georges Basin about 18:39 on 8 December. It was brought on board a couple of hours later to check the VPR which quit working at a depth of about 289 m for a short period. The problem was not identified, but a 250 m depth limit for towyos was put in place to prevent a subsequent failure. The problem did not re-appear. The trackline, which included work out to the seaward entrance of the Northeast Channel, was completed at the western end of Georges Basin about 08:38 on 10 December. The work was actually cut short to allow time to run to Cape Cod Bay to avoid being in open water when an impending storm arrived in the area.

At about 13:00 on 11 December, while jogging into the seas during the height of the storm, we did a launch and recovery sequence in Cape Cod Bay with C. Greene taking digital movies of the sequence. The wind was howling and the seas were quite rough even though there was not much fetch in the bay. The sun was out from between the clouds and it was a very good day to demonstrate the performance of the BIOMAPER-II handling system. We shot scenes of the launch from several view points, then the action of the slack tensioner as the ship pitched into the sea, and finally, the recovery which went smoothly. Andy was on the controls and Charlie, Glenn, and Fred did most of the work with the lines and tuggers. All in all it went very well.

Table 2. Distance of BIOMAPER-II Trackline Sections on R/V ENDEAVOR Cruise 331 (4-13 December 1999)

Area	km	nm
Wilkinson Basin	272.3	147.0
Jordan Basin	270.7	146.1
Georges Basin/NE Channel	333.3	180.0
Total	876.3	473.1

On Sunday (12 December), with winds diminishing and the seas rough but workable nearshore, we steamed to Massachusetts Bay to conduct combined optical and BIOMAPER-II operations beginning about 11:19 and ending about 14:37. Then, with continued diminishing winds and seas, we headed east out to deeper water in Wilkinson Basin where we conducted three special experiments.

BIOMAPER-II was deployed during the last light of the day about 16:40. Shortly after, the MOCNESS was launched and M. Benfield led the first of two towyo experiments comparing the VPR with the MOCNESS. The first consisted of a series of saw-toothed up and down towing trajectories between 30 and 20 meters with both instrument systems. Net 0 was fished to 30 m, and then seven nets were towed in tandem with BIOMAPER II. The last net (#8) towed from 20 meters to the surface.

An acoustics experiment consisted of a series of horizontal tows separated by oblique sections starting from near the surface and working in 25 meter steps down to about 200 m depth and then back up to the surface with the ship steaming at between 4 and 6 knots. Each horizontal run was 6 minutes. This experiment was designed to provide acoustic data set that could be used to evaluate the source or cause of enhanced volume backscattering within about 15 to 18 m of BIOMAPER-II (beyond the near field of the transducers). The experiment started about 18:20 and ended about 21:00 and took about 2.5 hours to complete.

The second towyo experiment comparing the VPR with MOCNESS was started about 21:30. The first net (#0) was fished down to 120 meters to collect live animals for shore based experiments and then the first net was opened at 30m and held open there for 6 minutes. BIOMAPER-II was then raised 2 meters followed by the raising of MOCNESS one minute later and the next net opened and fished for six minutes. This sequence was carried out for seven nets. With the completion of this experiment about 22:53, the instrument systems were brought on board, and secured for the trip back to Woods Hole.

The instrument systems on BIOMAPER-II worked well on this cruise. There were minor problems, but none caused a lot of down time or loss of substantial amounts of data. We finished the cruise as we started it with all sensor systems working.

Hydrographic results.

Throughout the Gulf of Maine, the temperature and salinity showed significant changes between October and December. The changes in surface temperature in the region from 13 to 14 C in October to under 10 C in December can be explained by Air/Sea interactions and surface layer mixing. The hydrography changes observed in Wilkinson Basin at deeper depths between October and December appeared to take place in the vicinity of the deepest bathymetric channel between Jordan and Georges into Wilkinson Basin which are near the middle to more southerly end of the Basin. The biggest changes in temperature at depth took place in the vicinity of that channel. The deeper changes would seem to require an advective exchange. The surface waters of Jordan Basin were substantially colder than in October while the deeper intermediate waters appeared warmer, although there was still a minimum zone in this part of the water column in most, but not all parts of the Basin surveyed. The bottom water also appeared slightly warmer than in October. Salinities in the surface layers were higher than in October, but somewhat lower at depth. Fluorescence values were much lower than in October with little enhancement in the surface mixed layer.

In Wilkinson Basin, the surface layer (0 to ~80 m) had temperatures of between 8.5 and 9.2 C. There was a pronounced subsurface temperature minimum zone in the western and northern portions of the basin between 100 and 170 m with minimum temperatures ranging between 6.4 and 7 C. Near bottom temperatures increased to between 7.6 and 8 C. Salinities increased monotonically from 32.7 PSU at the surface to the bottom of the mixed layer until reaching maximum values about 34.2 PSU at the bottom of the basin (~250 m). But in the eastern side of the basin, the vertical temperature profile was substantially different with temperatures as warm as 9.5 C between 100 and 160 m and salinities in this portion of the water column were approximately 0.4 PSU higher than in the other areas. This water appeared to be entering the basin from the east and replacing the colder fresher water that had been in Wilkinson Basin previously.

The surface temperature structure of Jordan Basin was warmer than Wilkinson Basin with values ranging between 9.5 to 9.8 C. The surface layer structure was variable and the thermocline started between 100 and 120 m. Salinities increased monotonically from the surface to the bottom in the northern portions of the basin with values running from 33.5 at the surface to 34.5 near the bottom. But for other parts of the basin there were two regions of nearly constant salinity, one running from the surface to ~75 m and the second running from 100 to 180 m. This latter zone coincided with a subsurface temperature minimum zone with a temperature of about 8.2C. Temperatures then increased to the bottom where values ranged between 9.2 and 9.5 C.

In Georges Basin, the surface layer temperatures (0 to 80 m) were similar to Jordan Basin (9.4 - 9.9 C) and (33.4 - 33.5 PSU). Unlike the other basins there was either a vertically narrow temperature minimum zone (~8C) at 100 m or a subsurface temperature maximum zone with maximum temperatures around 11 C at 120 m. Salinities were nearly constant to depths of ~70 m and then increased monotonically to about 150 m. Whereas below 200 m, the bottom temperatures became nearly constant to the bottom and had temperatures between 8.7 and 8.9 C, salinity (~35 PSU) became nearly constant to the bottom starting about 150 m. At the entrance to the Northeast Channel to the south of Georges Basin, the subsurface temperature maximum was shallower (between 60 and 100 m) and then temperature dropped off monotonically reaching values around 5.7 C at 320 m. Salinity at this site was fresher

in the upper 50 m (~32.6 PSU), increased monotonically down to about 150 m and then became nearly constant at about 35 PSU down to 320 m.

In summary, throughout the Gulf of Maine, the temperature and salinity fields showed significant changes between October and December. The changes in surface temperature in the region from 13 to 14 °C in October to under 10 °C in December can be explained by Air/Sea interactions and surface layer mixing. The hydrographic changes observed in Wilkinson Basin at deeper depths between October and December appeared to take place in the vicinity of the deepest bathymetric channel between Jordan and Georges into Wilkinson Basin which are near the middle to more southerly end of the Basin. The biggest changes in temperature at depth took place in the vicinity of that channel. The deeper changes would seem to require an advective exchange. The surface waters of Jordan Basin were substantially colder than in October while the deeper intermediate waters appeared warmer, although there was still a minimum zone in this part of the water column in most, but not all parts of the Basin surveyed. The bottom water also appeared slightly warmer than in October. Salinities in the surface layers were higher than in October, but somewhat lower at depth. Fluorescence values were much lower than in October with little enhancement in the surface mixed layer. Thus, the Gulf of Maine basins seemed to have continued the state of transition from one in which the deeper portions of the basins were filled with relatively cold and fresh water (of "cold Labrador Slope Water") as exemplified by the remnant properties found in Wilkinson Basin, to the more recent common state in which the basins were filled with relatively warm and salty water (of "warm Atlantic Slope Water" origin). The latter were best exemplified by the properties found in Georges Basin.

Some preliminary acoustic findings.

There was a clear diel migration pattern in all three basins just after sunset and in most of the basins just before sunrise as was evident during the October 1999 cruise (EN330). The migration pattern usually showed up best on the 43 kHz transducers and least well on the 420 kHz transducers. A typical example is the very first set of echograms taken on Year Day 338 at the start of the cruise. On the 43 kHz echogram, the daytime layer, centered about 125 to 150 meters, made a continuous upward movement starting about 1612 and ending by about 1648. The pattern of migration was also evident on the 120 and 200 kHz, but it was much more subtle relative to other layers that did not seem to move. In Wilkinson Basin, heaviest scattering in the 120, 200, and 420 kHz frequencies was in the upper 100 meters with the near surface clearing out some during the day and being filled in by night. Below 100 m, the scattering was much less intense. The 43 kHz data showed strong scattering in patches just above the bottom extending up some 25 meters during the first portion of the night after the migration layer had gone to the surface. The higher frequencies also showed evidence for enhanced scattering very near the bottom relative to the 25 to 50 m above the bottom in those same areas, but it was much less intensive.

The problem seen on previous cruises that concerns the enhanced backscattering that is observed on tows as BIOMAPER-II passed through the 100 to 150 m depth zone where the pycnocline resides was again seen on this cruise. While it has still not been resolved, data collected in an intense internal wave feature at the end of the tows in Jordan Basin may have provided some important clues as to its origin. As on past BIOMAPER-II cruises, this pattern in a zone 10 to 15 m beyond the near field zone of the upward and down-looking 43, 120, and 200 kHz transducers was clearly evident on most of the tows on this cruise. Before this fall's work, we rearranged the positions of the transducers to eliminate reflection between transducer pairs and put additional backing on the transducers to prevent back sound transmission to eliminate the possibility that backscattering out the rear of the transducers was causing the problem. After the October cruise, we speculated that the problem might have been related to pressure deforming the face of the transducers and affecting near-field, since backscattering out the rear of the transducers seemed to have been eliminated. Based on the pattern of backscatter above and below BIOMAPER-II as it obliquely cut across the internal wave train during a tow, we now think the enhanced backscattering may be due to coherent scattering off of micro/turbulence structures associated with the rapid changes in temperature, salinity, and density in the waves. These structures may also occur in pycnoclines where the enhanced scattering has often been observed. The echo integration computation assumes that backscattering is incoherent, coming from randomly distributed scatterers. If the structures scattering sound are large relative to the beam width of the transducer and homogeneous, the scattering will be coherent and will produce a signal larger than expected based on the echo integration algorithms. This idea is supported by the experiment done at the end of the cruise where a stepped oblique tow was done to see if the enhanced backscattering only occurred while lowering or raising BIOMAPER-II throughout the water column and not when the vehicle was being towed horizontally at a given depth. Enhanced backscattering was observed in specific parts of the water column during both procedures. Further analyses are planned to demonstrate the phenomena.

3.1.3.2 Zooplankton characterization from MOCNESS samples

Observations made by looking at the preserved samples while still on the ship provide a qualitative look at the plankton in the MOCNESS samples (Appendix V). Volumes of water filtered were not considered, and a minimal amount of microscopic analysis was employed, making these observations quite rough. *Calanus finmarchicus* was very abundant in both Wilkinson and Jordan Basin, mainly in deep water (below 100 m). In Georges Basin, *Calanus* was not quite as abundant at the deepest depths (near 300 m), but they were still quite abundant in Tow #8 at depths between 175 m and 275 m. Tow #6, conducted in Northeast Channel contained comparatively few *Calanus*. The samples were dominated by *Metridia*. Also, in all tows, samples from the surface 2 or 3 nets (above 100 m, but mainly above 50 m) were dominated by smaller copepods. The most abundant smaller copepod species observed was *Centropages* spp. However, a cursory microscopic observation showed that several other small species were present, including *Temora* sp., *Oithona* sp., and *Pseudocalanus* sp. In terms of large predatory copepods, *Candacia armata* was observed occasionally, and *Euchaeta norvegica* was observed to be common in all basins. The latter species was, perhaps, most abundant in Wilkinson Basin, and, while it was found in the deepest depths during both day and night tows, it was more often found in the surface waters during nighttime tows.

The dominant euphausiid caught in our tows was *Meganyctiphanes norvegica*. This species was found in substantial numbers in all three basins. It tended to be more abundant near the surface during the night and at lower depths during the day. Although an occasional *Stylocheiron* was observed in Jordan Basin, the greatest euphausiid diversity was seen in Georges Basin. Other species observed there included *Nematoscelis* sp., *Euphausia* sp., and *Thysanoessa* sp.

Themisto gaudichaudi was found universally, ranging dramatically in size. Largest individuals were found in Georges Basin. Smaller individuals tended to be closer to the surface. In addition to *Themisto*, a few *Phronima* were found in Georges Basin. *Limacina* was present in all three basins in small numbers. They were most abundant in Tow #7 from Northeast Channel. Some individuals were placed in large plastic containers to transport back to the lab alive for Scott Gallagher. Ostracods were not as abundant as compared to the October cruise (EN330), however, they were found in all basins, most abundantly in Georges Basin. Siphonophores were found in all tows, but were hard to quantify because they were damaged while sampling. A few unidentified fish larvae were found at all stations, and several Myctophids were caught in Georges Basin.

The last two MOCNESS Tows (Tows 9 and 10) were done as part of a study comparing VPR data to MOCNESS data in Wilkinson Basin. The MOCNESS and the VPR were towed simultaneously from 0-30m and then tow-yowed from 20-30m. Nets were tripped every 6 minutes. These samples appeared to contain organisms similar to those we had previously seen in surface nets, but the abundances varied quite dramatically between nets.

3.2 Ancillary Project: Spatio-Temporal Variability of Bio-Optical Properties in the Gulf of Maine

Principal Investigator: H.M. Sosik (WHOI)

3.2.1 Introduction

The optical properties of coastal waters are influenced by a variety of materials and processes. Inherent optical properties (e.g., absorption and scattering coefficients) depend strongly on local production of phytoplankton and other optically-significant particles, but are also influenced by advection of constituents, such as dissolved organic material of terrigenous origin, and other processes

such as resuspension of bottom sediments. Our objectives are to determine important sources and scales of optical variability by observing distributions of inherent and apparent optical properties in both space and time. Separately assessing particulate and dissolved material properties and making spectral measurements (which can be used to characterize broad classes of material) will allow this to be accomplished. The work conducted on this cruise is part of a larger program supported by the Office of Naval Research and which includes measurements made from a vertically-profiling mooring, a towed vehicle (BIOMAPER-II), earth-orbiting satellites (SeaWiFS, AVHRR, etc.), and research vessels conducting conventional station surveys.

3.2.2 Methods

Several bio-optical sensors were deployed on BIOMAPER-II. These included two ac-9 dual-path spectral absorption and attenuation meters (Wet Labs, Inc.), as well as a spectral downwelling irradiance sensor (OCI-200 series, Satlantic, Inc.), a spectral upwelling radiance sensor (OCR-200 series, Satlantic, Inc.), and a HydroScat-6 spectral backscattering sensor (HOBi Labs, Inc. - Appendix VI). One of the ac-9's measured whole-water properties and the other was configured with an in-line 0.2 m water filter to assess absorption by dissolved material; particulate absorption will be determined by difference between total and dissolved. The instruments were configured with matching wavelength bands selected to cover the visible spectrum and to reflect those on the SeaWiFS ocean color sensor [ac-9's: 412, 440, 488, 510, 532, 555, 650, 676, 715 nm; radiometers: 412, 443, 490, 510, 555, 665, 683 nm; HydroScat: 442, 488, 532, 589, 620, 671.]. The data acquisition system (designed and assembled at WHOI) for these instruments is based on a subsurface PC-104 and includes 2 serial ports, a 16-channel/16-bit A/D converter, an 8 MB flash disk, and an Ethernet adapter for communication with the BIOMAPER-II Lantastic network. Through network access, this system allows storage of data files on a desktop PC aboard the ship. The PC-104 and Hydroscat-6 were both powered from the "spare power" circuit on BIOMAPER-II. In addition to the measurements made from BIOMAPER-II, continuous logging of surface spectral irradiance was also carried out with a spectral downwelling irradiance sensor (MVDS, Satlantic, Inc.) connected to the same PC.

Prior to this cruise, a new data logging system was implemented for the Hydroscat-6. The Hydroscat-6 supports RS-232 communication, both for programming and real time data transmission. It was operated in this mode and connected to the BIOMAPER-II Ethernet using a new Lantronix Micro Serial Server (model #MSS100). This server, which allows a serial device to be connected to a TCP/IP network, was installed in the BIOMAPER-II power/telemetry bottle. The server was powered from the same "spare power" as the rest of the optical sensors and assigned an IP address on the BIOMAPER-II network. Using software provided by Lantronix, a serial port on a PC in the BIOMAPER-II van was "re-directed" to the remote MSS100. This allowed direct communication with the Hydroscat-6 from the shipboard PC, using either the data logging software provided by HOBILabs or a terminal program such as HyperTerminal. For routine data logging, we used the "capture to file" feature in HyperTerminal since the plot updating in the HOBILabs program consumed too much computer memory during extended logging. Data files were manually opened and closed at intervals of several hours. The new system performed very well, eliminating the need to download data files from the Hydroscat internal memory (as was done on cruise EN330) and providing immediate access to data, as well as confirmation that data was being logged. Approximately 6 times during the cruise, we experienced unexplained disruption in communication between the shipboard PC and the serial server, resulting in periods of data loss. Repeated attempts by the re-director software to reconnect to the server failed and we were only able to resolve the problem by cycling power to the serial server.

Sampling conducted on the cruise also included water collection and measurements of downwelling irradiance and upwelling radiance with a tethered, free-fall vertical profiling radiometer (SPMR/MSMR system, Satlantic, Inc.) deployed away from the ship. This work was conducted as close to mid-day as possible on five days of the cruise. Water samples were collected for pigment analysis and for estimation of light absorption by particulate and dissolved material. Pigment samples were collected on Whatman GF/F filters and extracted in 90% acetone for fluorometric estimation of chlorophyll a and phaeopigment concentrations. Spectrophotometric determinations of particle absorption were made on freshly filtered samples (GF/F filters) before and after extraction of phytoplankton pigments with methanol, and dissolved absorption was measured on 0.2 m filtrate in 10-cm cuvettes. These spectra were acquired with 1 nm resolution between 300 and 800 nm. At all stations water samples also were collected and frozen or preserved for several other types of post-cruise analysis, including determination of macro-nutrient concentrations, flow cytometric measurement of individual particle optical properties, and microscopic identification of phytoplankton.

The vertically profiling radiometer deployed at mid-day CTD stations has the same spectral bands as the optical heads on BIOMAPER-II. The system also includes a subsurface reference sensor (spectral downwelling irradiance at 30-cm depth). Vertical profiles were conducted within 2 hours of local apparent noon, immediately prior to or immediately after the CTD/water sampling casts.

Underway measurements with a Fast Repetition Rate Fluorometer (FastTracka FRRF, Chelsea Instruments) also were made in flow-through mode using the ship's uncontaminated seawater throughout the cruise duration. This instrument allows the photosynthetic physiology of phytoplankton to be measured rapidly and non-invasively. Dark-adapted measurements of variable fluorescence yield, the functional absorption cross-section for photosystem II reaction centers, and the turnover time for electron transport were made.

3.2.3 Preliminary Results

Optical data were successfully collected from the BIOMAPER-II during the deep basin surveys and during two shallow tow-yos in Massachusetts Bay. Initial processing of ac-9 data collected in the deep basins showed spatial variations in scattering and absorption coefficients associated with water column structure. Highest values were found near the bottom and in conjunction with a phytoplankton-dominated layer in the upper 100 m. In the surface layer, absorption and scattering coefficients were much higher in Wilkinson Basin than in Jordan or Georges Basins. Backscattering coefficients measured by the Hydroscat-6 were consistently highest near the bottom and were elevated throughout the water column in Wilkinson Basin relative to Jordan and Georges Basins.

Approximately 35 water samples were analyzed for pigment and high spectral resolution absorption coefficients. Water was collected from 6 depths selected from throughout the water column on 6 CTD/rosette casts. Pigment concentrations and particle absorption coefficients were relatively low even in surface waters, with the high absorption and scattering coefficients found only intermittently near the bottom. The free-fall radiometer was successfully deployed at 4 stations with 2-3 replicate vertical profiles conducted during each deployment. Casts with the radiometer covers in place were also carried out to allow correction for temperature dependence of dark values. These data will be analyzed to determine vertical profiles of diffuse attenuation coefficients and remote-sensing reflectance. Throughout the entire cruise observations were collected with the FRR fluorometer. Preliminary results show relatively high photosystem II efficiency, mostly indicative of nutrient-replete phytoplankton growth.

4.0 CRUISE PARTICIPANTS

4.1 Scientific personnel

1. Charles Greene Cornell University(Chief Scientist)
2. Karen Fisher Cornell University
3. Mark Benfield Louisiana State University
4. Peter Wiebe Woods Hole Oceanographic Institution
5. Ru Morrison Woods Hole Oceanographic Institution
6. Mari Butler Woods Hole Oceanographic Institution
7. Heidi Sosik Woods Hole Oceanographic Institution
8. Ann Canaday Woods Hole Oceanographic Institution
9. Joseph Warren Woods Hole Oceanographic Institution
10. Andrew Girard Woods Hole Oceanographic Institution

11. Andone Lavery Woods Hole Oceanographic Institution
12. Sara Smolenack University of New Hampshire
13. Greg Katcoff Worcester Polytechnic Institute
14. Tom Orvosh University of Rhode Island
15. Philip Cootey Unattached
16. Robert Fisher Unattached
17. Aaron Wiebe Unattached

4.2 Ship's officers and crew

1. Rhett McMunn Captain
2. Bill Appleton Chief Engineer
3. Fred Curtis AB Seaman
4. Steve Vetra First Mate
5. Tom Hickey Assistant Engineer
6. Glen Prouty AB Seaman
7. Dick Foley Second Mate
8. Tim Varney Assistant Engineer
9. Jay St. Germain AB Seaman
10. Charlie Baker Bos'n
11. Dan Butler Steward
12. Mike Butler Messman

Appendix I. [RV/ ENDEAVOR Cruise 331 Event Log.](#)

Appendix II. RV ENDEAVOR Cruise 331 Acoustic Log.

Tag	Day	Local	Time	Tape		HTI		ESS		Lat		Lon		
#	#	hr	min	DAT	s/e	filename	s/e	filename	s/e	degrees	minutes	degrees	minutes	Comments
	338	14	32	01	s	S3381432	s	BM2_001	s	42	04.950	69	43.330	ESS started a little before DAT tape
	338	14	36			S3381436	s							.view was messed, restart HTI sounder
	338	16	01											SB pumps on
1WBWE1	338	16	20											start towyo 1WBWE1
	338	16	34	01	e					42	05.090	69	38.140	end DAT tape
	338	16	35	02	s					42	05.090	69	38.090	start new DAT dape
	338	17	30							42	05.080	69	32.660	bottom of towyo number 1 205 m
1WBWE2	338	18	15							42	05.060	69	27.410	top of towyo. Surface at 4.1m (pressure). Start towyo 1WBWE2
	338	18	36	02	e					42	05.090	69	24.990	change tape
	338	18	36	03	s					42	05.090	69	24.870	change tape
	338	18	59	03	e					42	05.050	69	22.280	change tape @7:00pm=12:00Ght
	338	19	00	04	s					42	05.050	69	22.250	hold BIOMAPER-II @ 27m above the bottom during tape change
	339	19	03							42	05.050	69	21.850	bottom of towyo at20m(191m) above bottom
1WBWE3	338	19	35											top of towyo at 5.0m. Start towyo 1WBWE3*
1WBSN1	338	20	05											hold @ approx. 120 m during turn. towyo now called 2WBSN1*
	338	20	22							42	06.510	69	14.620	bottom of towyo at 20m (170 m) above bottom
	338	21	00	04	e					42	09.530	69	14.760	top of towyo at 3.9 m
	338	21	02	05	s									change tapes.
1WBSN2	338	21	04			S3382104	e/s	BM2_002	e/s	42	10.030	69	14.760	start towo 2WBSN2
	338	21	48							42	13.300	69	14.900	bottom of towyo at 20m (198 m) above bottom
	338	22	22							42	16.200	69	15.270	top of towyo at 5 m. start turn.
	338	22	28							42	16.300	69	15.850	start aborted towyo
	338	22	42							42	16.180	69	17.620	end aborted towyo. start MOCNESS tow w/ BIOMAPER-II @ 5 m.
	338	23	03	06	e/s					42	16.010	69	18.600	change tapes.
3WBEW1	339	00	20							42		69		3WBEW1 TOWYO DOWN
	339	00	54							42	15.661	69	25.740	3WBEW1 TOWYO UP from 177m/207 deep
	339	00	54			S3390054	s			42	15.690	69	25.740	NEW ACOUSTICS FILE
	339	00	57											partial dropout on upward 120
	339	01	06	07	e/s					42	15.610	69	27.200	change tapes.
3WBEW2	339	01	35							42	15.520	69	30.700	3WBEW2 TOWYO

														DOWN
	339	02	14						42	15.461	69	35.580	3WBEW2 TOWYO UP from 200/230 m deep	
	339	02	47						42	15.310	69	39.230	3WBEW3 TOWYO DOWN from surface	
	339	03	09	08	e/s				42	15.294	69	41.860	change tapes.	
3WBEW3	339	03	19						42	15.224	69	43.090	3WBEW3 TOWYO UP from 207/235m, 507 m wire out	
	339	03	22				BM2_002	e					(header not changed in file)	
	339	03	23				BM2_003	s	42	15.219	69	43.670	New ESS file	
	339	03	50										refrad and sos going, after file check on bio-optics	
	339	03	56						42	15.127	69	47.370	SURFACE	
	339	03	58										WINCH RESTART due to diagnostic error light	
4WBSN1	339	03	59						42	15.198	69	47.770	slow descent for TURN 4WBSN1	
	339	04	15						42	15.039	69	49.810	parking at 56 meters for delayed turn (ship boxed in)	
	339	04	30						42	15.184	69	51.480	restart downward towyo	
	339	04	39			S3390403	e/s		42	15.580	69	51.380	new acoustics file s3390403	
	339	05	00						42	18.240	69	50.920	bottom of towyo @ 198.0m	
	339	05	11	09	e/s				42	18.970	69	50.880	start RTVPR and tape 009	
5WBWE1	339	05	38						42	21.250	69	50.850	top of towyo. finished w/ 4WBSN1. start 5WBWE1.	
	339	06	02						42	23.330	69	50.620	hold BIOMAPER-II @95.2m for ships turn	
	339	06	22						42	24.818	69	49.820	continuing towyo going down	
	339	06	53						42	24.989	69	46.550	bottom of towyo @ 25.0m (240.7m) above bottom	
5WBWE2	339	07	14	10	e/s				42	25.055	69	44.450	change tapes	
	339	7	35										top of towyo. end 5WBWE1. start 5WBWE2.	
	339	08	16						42	25.090	69	37.590	bottom of towyo at 20m (240 m) above bottom	
5WBWE3	339	08	59						42	25.040	69	32.560	top of towyo. sensor in air. finished w/ 5WBWE2. start 5WBWE3.	
	339	09	16	11	e/s				42	25.040	69	30.380	change tapes.	
	339	09	42						42	25.040	69	27.560	bottom of towyo at 20m (232 m) above bottom	
5WBWE4	339	10	20						42	25.070	69	23.160	top of towyo. sensor below surface. finished w/ 5WBWE3. start 5WBWE4.	
	339	11	00						42	25.000	69	18.810	bottom of towyo; fish at 227 m; 25 above bottom	
	339	11	18	12	e/s				42	24.990	69	16.740	change tapes.	
	339	11	40						42	24.970	69	14.100	top of towyo. sensor below surface finished w/ 5WBWE4.	
	339	11	44	12	e	S3390403	e	BM2_003	e	42	24.950	69	13.590	tapes off.
	339	15	05						42	24.870	69	14.610	BIOMAPER-II deployed	
	339	15	10			s3391510	s		42	25.546	69	14.890	restarted BIOMAPER-II	
	339	15	16					BMP_004	s	42	25.546	69	14.890	ess started
	339	15	17	13	s				42	25.630	69	14.890	start tapes	
	339	15	19						42	25.630	69	14.890	to 10m and back	
6WBSN1	339	15	23						42	26.350	69	14.890	6WBSN1 towyo down	
	339	16	01						42	29.230	69	14.940	towyo bottom 208/235m 454m wire out	
6WBSN2	339	16	41						42	32.780	69	14.980	top of towyo. finished w/ 6WBSN1. start 6WBSN2.	
	339	16	42						42	32.810	69	14.980	going down	
	339	17	04						42	34.827	69	14.970	BIOMAPER-II @ 95 for ships turn	
	339	17	10						42	35.080	69	15.340	continue downward towyo	
	339	17	18	14	e/s				42	35.105	69	16.190	new tape #14	
	339	17	37						42	35.080	69	18.430	bottom of towyo 205/225m	

	339	17	40							42	35.070	69	18.850	discovered that dat tape wasn't recording. nothing on oscilloscope. restarted
7WBEW1	339	18	15							42	35.090	69	22.960	top of towyo. finished w/ 6WBSN2. start 7WBEW1.
	339	18	59	14	e					42	35.130	69	28.140	end#14
	339	19	00	15	s					42	35.130	69	28.210	start#15
	339	19	04							42	35.130	69	28.680	bottom of towyo 217/238 m
7WBEW2	339	19	39							42	35.770	69	31.910	top of towyo. finished with 7WBEW1. start 7WBEW2.
	339	20	27							42	35.050	69	38.530	bottom of towyo 240/260 m. Bio-Eng crash.
	339	21	03	15	e					42	35.060	69	42.730	Remove tape 15
	339	21	09			S3391510	e	BM2_004	e	42	35.050	69	43.530	top of towyo. finished with 7WBEW2.
	339	21	20					BM2_005	s	42	35.050	69	44.790	restart Bio-Eng and BIOMAPER-II
7WBEW3	339	21	22	16	s	s3392122	e/s			42	35.030	69	45.150	start 7WBEW3. towyo down.
	339	22	00							42	34.990	69	49.360	bottom of towyo 235/260 m.
	339	22	32							42	34.940	69	52.910	BIOMAPER-II @ 25 m for turn.
	339	22	36											turn complete. up to 10 m. end 7WBEW3.
8WBSN1	339	22	39							42	35.460	69	53.130	top of towyo. start 8WBSN1.
	339	23	16							42	38.590	69	52.060	bottom of towyo 220/245 m.
	339	23	24	17	e/s									TAPE CHANGE
8WBSN2	340	00	03							42	42.183	69	50.900	top of towyo @ 5 meters
	340	00	15							42	42.129	69	50.392	Turning around at 50 m
MOC	340	00	27							42	42.880	69	50.230	Surface for MOCNESS tow at N end
	340	01	26	18	e/s					42	41.460	69	50.640	change tapes.
	340	02	02	18	e	S3392122	e	BM2_005	e	42	40.131	69	50.870	end files
	340	02	02							42	40.131	69	50.870	SHUTDOWN
	340	12	16	19	s	S3401216	s	BM2_006	s	43	19.300	68	00.150	Power up BMP @ 5 meters for MOC
	340	14	17	20	e/s					43	16.550	68	00.490	change tapes; light station
	340	15	07			S3401216	e			43	16.470	67	59.580	end HTI
	340	15	07			S3401507	s			43	16.470	67	59.580	start HTI
	340	15	15					BM2_007	s	43	16.470	67	59.580	End ESS File
1JBSN1	340	15	15							43	16.470	67	59.580	Start Towyo 1JBSN1
	340	16	03							43	20.630	67	59.520	Bottom of towyo at 212m, 30m above bottom. Depth 242m.
	340	16	20	20	e					43	21.280	67	58.980	end tape
	340	16	20	21	s					43	21.870	67	58.950	start tape
1JBSN2	340	16	40							43	23.690	67	58.050	surface @ 5m top of towyo. start 1JBSN2
	340	16	45			S3401645	s			43	24.210	67	57.800	new files
	340	17	24							43	27.760	67	56.050	bottom of towyo 220/250m depth 30m
	340	17	56							43	30.662	67	54.600	data drop out on 200khz (upward looking)
	340	18	05							43	31.711	67	54.090	top of towyo (park @5m to remove seaweed)
1JBSN3	340	18	08							43	31.770	67	54.090	BIOMAPER-II starting down on towyo
	340	18	22	21	e					43	32.995	67	53.440	stop tape 21
	340	18	22	22	s					43	33.011	67	53.430	start tape 22
	340	18	56							43	36.036	67	51.970	Bottom of towyo at 217m, Depth 247m.
	340	18	56			S3401645	e			43	36.145	67	51.920	close file
	340	18	56			S3401856	s			43	36.169	67	51.910	start file
	340	18	59	22	e					43	36.382	67	51.800	stop tape 22
	340	19	00	23	s					43	36.400	67	51.790	start tape 23
1JBSN4	340	19	36							43	39.700	67	50.110	Top of towyo. Start new towyo. Pressure at 4.9m.
	340	20	18							43	43.570	67	48.180	Bottom of towyo at 195m, Depth 217m.
1JBSN5	340	20	51							43	46.240	67	46.890	top of towyo @ 5m. start towyo

	340	20	52			S3402052	e/s			43	46.380	67	46.840	new HTI file
	340	21	02	24	e/s									change tapes
	340	21	19							43	48.710	67	45.670	bottom of towyo 205/227 m
	340	21	35											BIOMAPER-II @ 90 m, turning east to avoid fishing gear
	340	21	47							43	49.980	67	43.550	top of towyo @ 10 m. start MOCNESS
	340	23	08	25	e/s	S3402308	e/s							MOCNESS complete.start new HTI file, tapes
2JBWE1	340	23	13							43	77.690	67	41.840	start towyo 2JBWE1 from end of MOCNESS tow
	340	23	47							43	47.380	67	38.080	bottom of towyo 205/227 m
3JBNS1	341	00	22							43	46.840	67	33.990	top of towyo @ 5 meters, turning to South around GEAR 3JBNS1
	341	01	03							43	42.981	67	33.950	bottom of towyo 206/236 meters, 476 m wire out
	341	01	05	26	e/s					43	42.760	67	33.940	
3JBNS2	341	01	42			S3402308	e							top of towyo @5.5 meters 3JBNS2
	341	01	42			S3410143	s	BM2_007	e	43	39.420	67	35.450	redo files
	341	01	44					BM2_008	s					new ESS
	341	02	22							43	36.260	67	37.900	bottom of towyo 34 meters above variable bottom
	341	02	57							43	33.179	67	40.180	top of towyo @ 5 meters; tending toward ship near surface 3JBNS3
3JBNS3	341	03	07	26	e									end tape
	341	03	08	27	s					43	32.220	67	40.880	tape changes; new tape
	341	03	31							43	30.370	67	42.290	bottom of towyo @ 200/230 meters, 468 m wire out
	341	03	55											one complete scan drop out on the 420 upward looking transducer
3JBNS4	341	04	08							43	27.450	67	44.470	top of towyo @5.1 meters. Start new towyo.3JBNS4
	341	04	51							43	24.160	67	46.920	bottom of towyo. 230/260m
	341	04	51			S3410143	e			43	24.130	67	46.950	new HTI file at bottom of towyo.
	341	04	52			S3410452	s			43	24.120	67	46.950	new HTI file.
	341	05	09	27	e					43	22.730	67	09.400	stop tape 27
	341	05	09	28	s					43	22.730	67	47.500	start tape 28
	341	05	42							43	20.300	67	49.180	hold at 15m while making the turn.
4JBWE1	341	05	43							43	20.310	67	49.060	turn completed. Start new towyo.
	341	06	08							43	20.153	67	44.120	bottom of towyo @240m/271.2m
5JBNS1	341	07	06							43	20.090	67	39.150	top of towyo. Ship turning on to new leg
	341	07	11	28	e					43	20.610	67	38.950	stop tape 28
	341	07	11	29	s					43	20.610	67	38.950	start tape 29
	341	07	15			S3410719	e/s			43	21.360	67	38.590	accidently rebooted acoustic computer
	341	07	48							43	24.017	67	37.280	bottom of towyo @200 m/235 m
5JBNS2	341	08	23							43	27.420	67	35.700	top of towyo @ 6.8 meters. Start new towyo.
	341	09	00							43	31.200	67	33.930	bottom of towyo @202m/226 m
	341	09	15	30	e/s					43	32.410	67	33.350	change tapes. DAT had run out.
5JBNS3	341	09	42							43	34.880	67	32.180	top of towyo @ 3.4 m. sensor out. start new towyo.
	341	09	47			s3410947	e/s			43	35.260	67	31.990	new HTI file.
	341	10	20							43	38.280	67	30.560	bottom of towyo @ 205 m/229 m
	341	10	50											deviation from course to avoid fishing gear.
5JBNS4	341	11	07					BM2_009	e/s	43	42.200	67	28.940	top of towyo @ 3.4 m. sensor out. start new

														towyo.
	341	11	01						43	41.760	67	29.170	top of towyo @ 3.4 m. sensor out. start new towyo.	
	341	11	13	31	e/s				43	43.130	67	28.530	change tapes.	
	341	11	36						43	44.660	67	27.750	bottom of towyo @ 195 m/218 m	
	341	12	12						43	47.460	67	26.260	top of towyo, back down to 10 meters for CTD	
	341	12	23			S3410947	e		43	47.440	67	25.940	end HTI	
	341	12	23			S3411223	s		43	47.440	67	25.940	new HTI file.	
6JBNS1	341	13	06						43	46.320	67	24.810	Towyo down from 6JBNS1 after CTD	
	341	13	08										fixed radio to get transmission from bridge	
	341	13	19	31	e				43	45.027	67	24.800	change tapes.	
	341	13	20	32	s								tape change	
	341	13	34										Towyo at 182/207m, 368 wire out	
6JBNS2	341	14	01						43	40.790	67	24.860	Top of towyo at surface; start 6JBNS2	
	341	14	36						43	37.270	67	24.890	bottom of towyo @ 192/217m, 420 m wire out	
6JBNS3	341	15	07						43	34.190	67	25.000	top of towyo, begin 6JBNS3	
	341	15	22	32	e				43	32.640	67	25.010	tape change.	
	341	15	22	33	s				43	32.640	67	25.010	new tape	
	341	15	30										start slow turn	
	341	15	39						43	31.390	67	23.960	BIOENG error #70 recovered without restart-- permission denied	
	341	15	45										Nifty wave at 100 meters, near thermocline	
	341	15	47						43	31.270	67	22.070	bottom of towyo	
	341	16	03						43	31.060	67	20.750	Drop out on all 10 ducers	
7JBWE1	341	16	18						43	30.840	67	18.530	top of towyo @ 8m	
	341	16	55						43	30.400	67	13.560	Bottom of towyo 191.4/221.4m	
	341	17	20						43	29.920	67	08.970	Top of towyo.	
	341	17	24	34	e/s				43	29.960	67	06.680	Stop tape 33 and start tape 34	
	341	17	46			S3411223	e	BM2_009	e				ends of tapes and files	
	341	17	49					BM2_010	s	43	29.910	67	08.860	Computer Crash 17:48 ESS + SONAR
	341	17	57			S3411756	s			43	30.050	67	09.280	Restart
	341	18	05	34	e					43	30.280	67	09.480	Pull BIOMAPER-II . Power Down.
	341	18	06			S3411756	e	BM2_010	e	43	30.300	67	09.480	End ESS and HTI files.
	341	18	12										BMP out for storm	
	342	18	39	35	s	S3421841	s	BM2_011	s	42	29.530	67	19.840	BIOMAPER-II in the water start HTI ESS
1GBWE1	342	18	46						42	29.530	67	19.230	Start down with first towyo in GB	
	342	19	00	35	e				42	29.540	67	17.390	Tape change at 00.00 GMT	
	342	19	01	36	s				42	29.540	67	17.160	start new DAT tape	
	342	19	45						42	29.590	67	12.290	bottom of towyo @ 289 m/330 m	
	342	19	54						42	29.560	67	11.560	return to 289 m to test vpr	
OUT	342	20	42						42	29.640	67	06.180	biomapper 10 meters prepare for recovery	
	342	20	49						42	29.640	67	05.470	shutting down HTI file	
	342	20	50	36	e								ess powered down stop DAT tape 36	
	342	20	51										stop VPR tape 36	
	342	20	52			S3421841	e	BM2_011	e				Shut down EMS Exit Bio_Eng	
IN	342	21	28					BM2_012	s	42	29.760	67	04.700	Biomapper deployed start HTI and ess
	342	21	33	37	s	s3422134	s			42	29.760	67	04.700	Start acoustics tape 37
	342	22	02										Blue screen of death on HTIACQ	
	342	22	12			S3422210	e/s						HTI back on line; new file	
	342	22	50										vertical lines in echogram windows	

1GBWE2	342	23	33												begin towyo moc is recovered; fish @ 15m; begin 1GBWE2
	342	23	37	37	e					42	29.300	66	59.710		end tape 37
	342	23	37	38	s					42	29.300	66	59.710		start new DAT tape
	343	00	25							42	29.420	66	54.690		bottom of towyo 245/285m 568 wire out
	343	00	52												drop out 120 downward looking
1GBWE3	343	01	04			S3432210	e			42	29.475	66	49.910		new HTI and top of towyo; begin 1GBWE3
	343	01	06			S3430106	s								time base 1 minute off GPS; should resync soon ! (ag)
	343	01	38	38	e										tape change.
	343	01	39	39	s					42	29.550	66	45.810		tape change.
	343	01	44							42	29.510	66	45.320		37 meters off bottom at 289; 600 meters wire out
1GBWE4	343	02	26							42	29.690	66	39.780		top of towyo; begin 1GBWE4
	343	03	12							42	29.730	66	33.620		bottom of towyo at 246 m, 32.4 meters off bottom
	343	03	41	40	e/s					42	29.740	66	29.860		tape change.
1GBWE5	343	03	54							42	29.780	66	28.070		top of towyo ; begin 1GBWE5
	343	04	01			s3430106	e			42	29.810	66	27.400		lost connection to DES-cycling sonar
	343	04	03			s3430403	s			42	29.810	66	27.400		restart
	343	04	36							42	29.840	66	23.350		bottom of towyo at 206m/236m
	343	04	38					BM2-012	e	42	29.840	66	23.250		end aquisition start new ess
	343	04	38					BMT-013	s	42	29.840	66	23.250		start new ess
1GBWE6	343	05	13							42	29.870	66	19.010		surface @4.4m start next towyo; begin 1GBEW6
	343	05	43	41	e/s					42	29.970	66	16.230		tape change 040 to 041
	343	05	51							42	29.960	66	15.370		bottom of towyo 196.7m/226.7m
	343	06	07			s3430403	e			42	29.960	66	14.100		HTI computer crash, lost connection to whoi, restart.
	343	06	10			s3430610	s			42	29.970	66	13.820		new HTI file
1NECNS1	343	06	31							42	30.000	66	12.040		surface @ 5m starting ship turn; 2GBNS1
	343	07	12							42	28.050	66	09.130		bottom of towyo 200/230m
1NECNS2	343	07	46							42	26.310	66	06.700		Top of towyo start towyo 2GBNS2
	343	07	46	41	e					42	26.310	66	06.700		end tape 41 (fail to) start 42
	343	07	58	42	s					42	25.707	66	06.000		tape change
	343	08	27							42	24.230	66	04.000		Bottom of Towyo 225 meters
1NECNS3	343	09	08							42	22.120	66	01.200		Top of Towyo at 4 meters 2GBNS3
	343	09	48	42	e					42	19.800	65	58.150		Bottom of Towyo 210 meters Water Depth 240 m (Phil flew here)
	343	09	56	43	s	s3430957	e/s			42	19.330	65	57.500		New Tape 43 New HTI File
1NECNS4	343	10	30												top of towyo (missed entry)
	343	11	00												Bottom of Towyo (missed entry)
1NECNS5	343	11	36							42	13.320	65	45.500		top of towyo. start towyo .
	343	11	56	44	e/s					42	11.000	65	47.500		change tapes.
	343	12	05							42	10.000	65	45.000		bottom of towyo
LT STA	343	12	35							42	08.770	65	43.580		top of towyo; hold at surface for light stn and MOC
	343	12	36												drop out 420 up(?) and 43khz up(?)
	343	12	39			s2430957	e								CHANGE TAPES
	343	12	40			s2431240	s								VPR DIED new HTI
	343	12	41					bm2-014	e/s	42	08.570	65	42.950		new ESS
	343	13	01												winch dropped fish to 12 m, while stopped; WAVE on HTI
	343	13	27												sounder off lileagal

														operation/ shut down acoustics computer
	343	14	01	44	e	s3431401	s							new HTI file acoustic system restarted;VPR off
	343	14	01	45	s				42	07.470	65	41.010		tape change
	343	15	30			s3431401	e		42	07.790	65	42.290		
	343	15	31			s3431531	s		42	07.790	65	42.290		noise test
	343	15	41	45	e	s3431531	e							end tapes -taken out for synchronization
	343	15	42				bm2-014	e						
	343	15	43											sonar spare ess off power cycling
	343	15	53											clocks synced/power up
	343	15	55											BIOENG up spare ess sonar (power up)
	343	15	58			s3430358	s/e							start and end of HTI due to Mishap in clock synchronization
	343	16	01			s3431601	s	bm2-015	s	42	08.299	65	44.990	start of HTI file
	343	16	02	46	s									tapes started
2NECSN1	343	16	04						42	08.390	65	45.230		TOWYO DOWN 2NECSN1
	343	16	41						42	09.410	65	49.100		Bottom of TOWYO @ 218.8m/248.8m
2NECSN2	343	17	21						42	10.570	65	53.310		top of towyo. begining down again
	343	18	01						42	11.730	65	57.670		Bottom of TOWYO @195/225
	343	18	04	46	e				42	11.770	65	57.840		End tape 46
	343	18	04	47	s				42	11.770	65	57.840		Start tape 47
2NECSN3	343	18	33						42	12.910	66	02.150		Top of TOWYO
	343	18	36						42	13.010	66	02.500		BIOMAPER-II at surface, start next towyo
	343	18	59	47	e				42	13.920	66	05.940		End tape 47 (GMT midnight)
	343	19	00	48	s				42	13.920	66	05.940		Start tape 48
	343	19	19						42	14.540	66	08.220		Bottom of TOWYO 222/252m
	343	19	35											Ship at GB4 Turning on to Georges Basin trackline
2GBEW1	343	20	02						42	16.990	66	13.880		Top of tow-yo @ 5m
	343	20	06			S3432006	e/s		42	17.240	66	14.380		New HTI file
	343	20	35						42	19.090	66	18.130		bottom of towyo 204 m/230 m
	343	21	04	49	e/s				42	20.930	66	21.830		change tapes
	343	21	09											BIOMAPER-II @ 10 m to avoid fishing gear
2GBEW2	343	21	18						42	21.940	66	23.850		recommence towyo descent
	343	21	58						42	24.940	66	29.190		bottom of towyo 225 m/280 m
	343	21	12											turn toward next tranesct line
MOC	343	22	30						42	25.260	66	33.840		top of towyo. @ 10 m for MOCNESS
	343	23	06	49	e				42	24.730	66	35.380		change tapes
	343	23	09	50	s	S3432309	e/s		42	24.730	66	35.380		new HTI file
2GBEW3	344	00	37						42	23.050	66	38.180		start towyo down after moc
	344	01	06	51	e/s				42	20.870	66	41.330		tape change
	344	01	21						42	20.081	66	42.560		bottom of towyo 249/310 meters; 800 meters wire out
	344	01	22				BM2_015	e						END ESS
	344	01	24				BM2_016	s						VPR on NEW ESS
	344	01	25			S3432309	e							END DES
	344	01	25			S3440125	s		42	19.860	66	43.000		START DES
2GBEW4	344	02	13						42	16.789	66	47.460		start down on next towyo
	344	03	03						42	16.511	66	51.800		bottom of towyo 250/279.4; 740 meters wire out
	344	03	11	52	e/s				42	16.920	66	52.710		change tapes
2GBEW5	344	03	43						42	18.300	66	55.630		towyo starts down from boot @ surface
	344	04	33						42	20.660	67	00.805		Bottom of towyp 235/308m. 800m of wire out.

	344	04	46			S3440125	e			42	21.390	67	02.296	HTI Computer crash. Hard Reboot. Cycle power. Dat tape paused?
	344	04	53			S3440453	s			42	21.770	67	03.093	Restart HTI. New HTI file.
	344	05	12	53	e/s					42	22.790	67	05.280	Tape change. End 52, start 53.
2GBEW6	344	05	14							42	22.920	67	05.590	Surface @ 4.1m. Start next towyo.
	344	05	37							42	24.220	67	08.360	Stop towyo at 124m.Hold for turn.
	344	05	44							42	24.180	67	09.200	Start back down on towyo.
	344	06	05							42	23.060	67	11.700	Hold at 240m. (795 m wire out). something caught on the cable? Capture screen.
	344	06	07							42	22.920	67	11.960	Start back up. The thing is still there.
	344	06	45							42	20.470	67	17.570	Held BIOMAPER-II at surface while we freed a lobster line 4m above BIOMAPER-II .
2GBEW7	344	07	14	54	e/s					42	19.290	67	20.350	Tape change. End 53 start 54.
	344	07	32							42	18.320	67	22.470	Bottom of towyo at 234.4/287m. Wire out=800m.
	344	07	44							42	17.680	67	24.030	Scope shows no trace. Stop and start DAT tape. Recovered.
	344	08	18							42	15.720	67	28.420	BIOMAPER-II @ 10 m
	344	08	25	54	e	S3340453	e	BM2_016	e	42	15.340	67	29.250	End HTI file, tapes; power down BIOMAPER-II
	344	08	38							42	15.320	67	29.280	Recover BIOMAPER-II
	346	11	23					BM2-017	s					start ess
	346	11	28											restarted ess
	346	11	29			s3461129	s							restart HTI FILE
	346	11	31	55	s									Start dat tapes
	346	11	31							42	13.300	70	26.530	start of towyo
	346	11	41							42	13.830	70	26.970	bottom of towyo
	346	11	48							42	14.330	70	26.830	to of towyo (the optics broke the surface)
	346	11	49							42	14.330	70	26.640	holding BIOMAPER-II at 5m
	346	12	59							42	13.670	70	27.060	start towyo after light station
	346	13	07							42	14.290	70	27.550	bottom of towyo 50/74m 56m wire out
	346	13	18											end ESS and HTI
	346	13	20							42	14.930	70	28.070	power down
	346	16	45			s3461645	s	BM2_018	s	42	13.840	69	47.010	start up system
	346	16	50			s3461645	e							problem syncing clocks restart HTI file after syncing
	346	16	51			s3461561	s			42	14.200	69	46.850	new HTI file
	346	16	55	56	s					42	14.310	69	46.880	start dat #56 (5 meters on ess =0m line out =top of boot tape at surface)
	346	17	09							42	14.610	69	46.670	bottom of first towyo at 30 m starting up @2.5 meters per minute
	346	17	13											top of towyo 2
	346	17	15											Bottom of towy 2
	346	17	17							42	14.810	69	46.590	top of towyo 3
	346	17	19											Bottom of towyo 3
	346	17	20							42	14.950	69	46.540	top of towyo 4
	346	17	21											Bottom of towyo 4
	346	17	23							42	15.040	69	46.520	top of towyo 5
	346	17	24											bottom of towyo 5
	346	17	27							42	15.16	69	46.49	top of towyo 6
	346	17	29							42	15.200	69	46.470	bottom of towyo 6
	346	17	30							42	15.360	69	46.460	top of towyo 7
	346	17	31							42	15.290	69	46.460	bottom of towyo 7
	346	17	33							42	15.350	69	46.430	top of towyo 8
	346	17	35							42	15.420	69	46.410	bottom of towyo 8
	346	17	38							42	15.510	69	46.390	top of towyo 9
	346	17	40							42	15.570	69	46.370	bottom of towyo 9

	346	17	42						42	15.650	69	46.350	top of towyo 10
	346	17	45						42	15.720	69	46.320	bottom of towyo 10
	346	17	46						42	15.710	69	46.310	top of towyo 11
	346	17	49						42	15.850	69	46.290	bottom of towyo 11
	346	17	51						42	15.930	69	46.260	top of towyo 12
	346	17	53						42	15.980	69	46.250	bottom of towyo 12
	346	17	54						42	16.030	69	46.240	top of towyo 13
	346	17	58						42	16.150	69	46.210	bottom of towyo 13
	346	18	00										top of towyo 14 (time uncertain)
	346	18	02										bottom of towyo 14 (time uncertain)
	346	18	04										top of towyo15 (time uncertain)
	346	18	20						42	16.370	69	45.610	BIOMAPER-II down to 25m start down @5m per minute
	346	18	24						42	15.920	69	45.380	hold @25m for 6 minutes
	346	18	30						42	15.410	69	45.110	drop to 50m
	346	18	34						42	15.080	69	44.920	hold @50m for 6 minutes
	346	18	38			s3461651	e		42	14.740	69	44.750	HTI computer crash reboot cycle sonar power re-do 50m depth
	346	18	42			s3461842	s		42	14.370	69	44.560	new HTI file hold @ 50m for 6 MINutes
	346	18	49						42	13.820	69	44.270	drop to 75m
	346	18	53						42	13.440	69	44.070	hold @75m for 6 minutes
	346	18	58	56	e				42	12.960	69	43.870	end #56
	346	19	00	57	s				42	12.870	69	43.840	start #57
	346	19	04						42	12.550	69	43.700	hold BIOMAPER-II @ 99.5m for 6 minutes
	346	19	10						42	12.130	69	43.490	drop to 125m
	346	19	16						42	11.620	69	43.240	hold @125m for 6 minutes
	346	19	22						42	11.160	69	43.010	Drop to 150m
	346	19	28						42	10.680	69	42.780	hold @150m for 6 minutes
	346	19	31										accumulator turned on taking up 8m of wire bringing BIOMAPER-II to 142m
	346	19	32						42	10.280	69	42.600	300v forward fault in BIOMAPER-II (minor fault)
	346	19	35						42	10.180	69	42.550	drop to 175m
	346	19	45						42	09.370	69	42.150	hold @175m for 6 minutes
	346	19	51						42	08.880	69	41.930	drop to 190m
	346	19	56						42	08.540	69	41.770	hold @190m for six minutes
	346	20	02						42	08.040	69	41.510	bring BIOMAPER-II to 175m
	346	20	05						42	07.740	69	41.340	hold @ 175 for six minutes
	346	20	12						42	07.310	69	41.130	bring to 150m
	346	20	15						42	07.080	69	41.030	hold @ 150m for 6 minutes
	346	20	21						42	06.580	69	40.780	bring up to 125m
	346	20	24						42	06.350	69	40.660	hold @125m for 6 minutes
	346	20	30						42	05.870	69	40.430	bring up to 100m
	346	20	34						42	05.560	69	40.240	hold @ 100m for six minutes
	346	20	40						42	05.070	69	40.030	bring up to 75 m
	346	20	43						42	04.890	69	39.970	hold @ 75 m for 6min
	346	20	49						42	04.430	69	39.750	bring up to 50 m
	346	20	52						42	04.220	69	39.640	hold at 50 m for 6 min
	346	20	58						42	03.740	69	39.400	bring up to 25 m
	346	21	00						42	03.600	69	33.340	hold @ 25 m for 6 min
	346	21	02	58	e/s				42	03.420	69	38.240	change tapes
	346	21	06						42	03.120	69	39.110	bring up to 5 m
	346	21	26						42	02.410	69	38.510	mocness/BIOMAPER-II joint tow operations. Moc-1 deployed
	346	21	29						42	02.490	69	38.520	BIOMAPER-II down at 5 m/min
	346	21	39			S3462139	e/s		42	02.860	69	38.550	new HTI file; hold @30 m

													waiting for MOC
	346	22	00						42	03.610	69	38.570	fire net #1; 6 min @ 30 m
	346	22	06						42	03.850	69	38.570	bring up to 28 m
	346	22	06										fire net #2; 6 min @ 28 m
	346	22	12						42	04.070	69	38.630	bring up to 26m
	346	22	14										fire net #3; 6 min @26 m
	346	22	20						42	04.300	69	38.630	bring up to 24m
	346	22	20										fire net #4; 6 min @24 m
	346	22	26						42	04.600	69	38.660	bring up to 22m
	346	22	27										fire net #5; 6 min @22m
	346	22	33						42	04.870	69	38.670	bring up to 20 m
	346	22	35										fire net #6; 5 min @20 m; off by 1 min to sync w/MOC
	346	22	40						42	05.100	69	38.700	bring up to 18m
	346	22	41										fire net #7; 6 min @18m
	346	22	47						42	05.430	69	38.710	bring up to 16m
	346	22	47										fire net #8; 6min @16m
	346	22	53						42	05.650	69	38.730	end experiment; haul BIOMAPER-II to 5m
	346	23	08	58	e	S3462139	e	BM2_017	e				end acquisition; power down
	346	23	15						42	06.530	69	38.790	recovery; BIOMAPER-II out

Appendix III. RV ENDEAVOR Cruise 331 VPR Log.

Tag	Day	GMT	Time		Tape		Lat		Lon		
#	#	hr	min	sec	VCR #	sle	degrees	minutes	degrees	minutes	Comments
WEW1	338	19	32	01	001	s	42	04.950	69	43.330	start tape 001
	338	19	33	01							start RTVPR
	338	21	34	00	001	e	42	05.090	69	38.140	Stop tape 001 and RTVPR.
	338	21	34	36	002	s	42	05.090	69	38.090	Start tape 002
	338	21	36	00			42	05.090	69	38.030	Start RTVPR
	338	23	36	00	002	e	42	05.090	69	24.990	stop tape and RTVPR
	338	23	36	30	003	s	42	05.090	69	24.870	start tape 003
	338	23	37				42	05.090	69	24.870	start RTVPR
	338	23	59	45	003	e	42	05.050	69	22.280	stop tape and RTVPR
	339	00	00	00	004	s	42	05.050	69	22.250	start tape 004 and RTVPR
	339	02	03	20	005	e/s					stop tape & RTVPR 02:02:14 start 02:03:40
	339	04	04	02	006	e/s					stop tape &RTVPR 04:03:06 start 04:04:30
	339	06	06	30	007	e/s	42	15.000	69	27.200	several restarts on 005 to get time code going
	339	06	16								RO's now being captured after RDC toggle
	339	07	47	08			42	15.310	69	39.230	top of towyo
	339	08	10	08	008	s	42	15.249	69	41.860	new tape
	339	10	11	10	009	e/s	42	18.970	69	50.880	start RTVPR and tape 009
	339	12	14		009	e	42	25.050	69	44.450	stop tape 9 and RTVPR
	339	12	14		010	s	42	25.050	69	44.450	start tape 10 and RTVPR
	339	14	16	57	011	e	42	25.030	69	30.260	stop tape & RTVPR 14:16:25 start 14:17:15
	339	16	18	13	012	s	42	24.990	69	16.680	stop tape RTVPR 16:17:26 start 16:18:39
	339	16	44	13							end RTVPR for BIOMAPER-II RECOVERY (early ending)
	339	16	44	27	012	e	42	25.900	69	14.880	end tape
	339	20	19	40	013	s	42	25.900	69	14.880	start RTVPR
	339	20	21	21	013	s	42	26.000	69	14.880	start tape13
	339	22	17		013	e	42	35.100	69	16.190	stop of tape#13 and RTVPR
	339	22	18		014	s	42	35.100	69	16.190	start of tape #14
	339	23	59	45	014	e	42	35.130	69	28.140	stop tape at 00.00 GMT
	340	00	00	10	015	s	42	35.130	69	28.210	start of tape #15
	340	02	20								minor system restart ...
	340	02	21	20	016	e/s	42	35.040	69	45.120	02:21:40 start RTVPR
	340	04	24	12	017	e/s	42	39.220	69	51.840	04:23:37 stop RTVPR/tape 04:24:47 start RTVPR
	340	06	26	18	017	e					end tape 17
	340	06	26	49	018	s	42	41.457	69	50.640	
	340	06	27	41							RTVPR started
	340	07	02	18	018	e	42	40.131	69	50.870	Tape stopped early for BMP out to steam
	340	07	02	46			42	40.131	69	50.870	RTVPR ended
	340	17	15	55	019	s	43	19.080	68	00.150	Start RTVPR@17:22:29
	340	17	30				43	18.760	68	00.160	Restart RTVPR
	340	19	17	45	019	e					change tape
	340	19	17	52	020	s	43	16.550	68	00.490	tape change
	340	19	18	43							Stop RTVPR
	340	19	19	42							Start RTVPR@19:19:42
	340	21	20	00	020	e	43	21.780	67	58.980	RTVPRand tape 020 stop

	340	21	21	34	021	s	43	21.870	67	58.950	RTVPRand tape 021 start
	340	23	21	00	021	e	43	32.995	67	53.440	stop tape 21 andRTVPR
	340	23	21		022	s	43	33.011	67	53.430	start RTVPR and tape 22
	340	23	59	45	022	e	43	36.382	67	51.800	stop RTVPR and tape22
	341	00	00		023	s	43	36.400	67	51.790	start RTVPR and tape 23
	341	02	01	52	023	e	43	47.270	67	46.330	end tape; stop RTVPR 02:01:45
	341	02	02	21	024	s	43	47.270	67	46.330	start tape; start RTVPR 02:02:55
	341	04	04	40	024	e	43	47.870	67	42.180	end tape; stop RTVPR 04:04:13
	341	04	04	59	025	s	43	47.870	67	42.180	start tape; start RTVPR 04:05:24
	341	06	05	26	025	e	43	47.870	67	42.180	end tape
	341	06	05	51	026	s	43	42.760	67	33.940	start tape 26
	341	06	06	19	026	e	43	42.760	67	33.940	end RTVPR
	341	06	08	47	027	s	43	42.760	67	33.940	start RTVPR
	341	08	07	54	027	e/s	43	32.220	67	40.880	start tape
	341	08	08	02							stop RTVPR
	341	08	08								start RTVPR
	341	10	09	05	027	e	43	22.730	67	47.500	stop tape 27 and RTVPR
	341	10	09	30	028	s					start tape 028 and RTVPR
	341	12	11	00	028	e	43	20.610	67	38.950	stop tape 028 and RTVPR
	341	12	11	17	029	s					start tape 029 and RTVPR
	341	14	15	20	029	e	43	32.460	67	33.320	stop RTVPR 14:15:17
	341	14	15	53	030	s	43	32.460	67	33.320	start RTVPR 14:16:18
	341	16	18	15	030	e	43	43.280	67	28.470	stop RTVPR 16:18:01
	341	16	18	47	031	s	43	43.280	67	28.470	start RTVPR 16:19:21
	341	18	19	37	031	e	43	45.027	67	24.800	tape change
	341	18	20	00	032	s					new tape
	341	18	20	22							RTVPR STOP
	341	18	20	48							RTVPR started
	341	19	36								slow turn started to new line
	341	20	22	15	032	e	43	32.640	67	25.010	tape ended
	341	20	22	41	033	s					new tape
	341	20	22	50							RTVPR started
	341	20	23	02							STROBE OFF (during tape change?)
	341	20	25	35							RESTART STROBE
	341	22	49								computer (hTI) crash power down. restart
	341	22	52	50			43	29.990	67	09.057	VPR camara an VPR stroke on. HTI still not connecting to network.
	341	22	24	30	033	e					power on/off again stop tape 033
	341	22	24	52	034	s	43	29.960	67	06.680	start tape 034 and RTVPR
	341	22	49								RTVPR Crashed and restarted
	341	23	05	00	034	e	43	30.160	67	09.470	stop tape and RTVPR
	342	23	41	19	035	s	42	29.516	67	19.720	start tape 035
	342	23	41	48			42	29.540	67	19.580	start RTVPR Change setting on RTVPR Threshold = 50 In Focus=40
	342	23	59	45	035	e	42	29.540	67	17.160	stop tape 035
	342	23	59	58			42	29.540	67	17.160	stop RTVPR
	343	00	00	10	036	s	42	29.540	67	17.160	start RTVPR start tape36
	343	00	45				42	29.590	67	12.290	VPR failure at 289 meters Bring Biomapper up
	343	00	47				42	29.540	67	12.070	VPR self restart 270 meters
	343	00	51	57			42	29.560	67	11.560	Biomapper down for testing VPR
	343	00	05	05			42	29.551	67	11.240	VPR failure at 266 bottom of Towyo
	343	01	00				42	29.600	67	10.640	VPR on and off at 231.81 meters
	343	01	02	26			42	29.600	67	10.450	VPR self started 225 meters
	343	01	03	24			42	29.610	67	10.350	RTVPR started
	343	01	51		36	e	42	29.640	67	05.470	end tape 36
	343	02	32	40	37	s	42	29.760	67	04.730	start tape 37 RTVPR 02:33:05
	343	04	37	24	37	e	42	29.330	66	59.770	stop tpe stop RTVPR 04:37:07
	343	04	37	48	38	s	42	29.330	66	59.770	start tape 38; RTVPR 04:38:31
	343	05	04								great tails, siphon, etc
	343	06	38	45	38	e					tape change
	343	06	39	05	39	s	42	29.550	66	45.810	new tape
	343	06	39	40							start RTVPR
	343	08	41	20	40	e/s	42	29.741	66	29.860	tape change
	343	08	41	53							RTVPR stop
	343	08	43	00							RTVPR (re)start
	343	10	43	00	40	e	42	29.950	66	16.280	stop tape 040
	343	10	43	20	41	s	42	29.960	66	16.230	start tape 041
	343	10	44	08			42	30.000	66	16.080	start RTVPR
	343	12	46		42	e/s	42	26.334	66	06.834	end tape 41 start tape 42
	343	14	53	08	42	e	42	19.360	65	57.570	Stop RTVPR @ 14:53:00 Stop Tape 42
	343	14	54	12	43	s	42	19.360	65	57.570	Start tape 43, start RTVPR 14:54:30
	343	15	37	22			42	16.930	65	55.430	Restart RTVPR after program crashed
	343	16	40	21			42	12.820	65	48.850	RTVPR barfed restarted 16:41:33

	343	16	55	05	43	e	42	11.710	65	47.370	stop RTVPR 16:54:53
	343	16	55	50	44	s	42	11.710	65	47.370	start RTVPR 16:56:02
	343	17	35	30			42	08.520	65	43.080	mvc15040 occ error msg
	343	17	43	30			42	08.560	65	42.900	RTVPR program rebooted
	343	18	58	20	44	e	42	07.470	65	41.010	stop tape
	343	19	01	14	45	e/s	42	07.470	65	41.010	start tape
	343	19	01	41			42	07.470	65	41.010	RTVPR off
	343	19	01	57			42	07.470	65	41.010	start RTVPR
	343	20	41				42	07.470	65	41.010	stop RTVPR
	343	21	03	00	46	e/s	42	08.380	65	45.230	start RTVPR
	343	21	06				42	08.460	65	45.420	restart RTVPR
	343	23	04		46	e	42	11.780	65	57.870	stop tape 046 and RTVPR
	343	23	04		47	s	42	11.780	65	57.870	start tape 047
	343	23	59	50	47	e	42	13.920	66	05.950	GMT midnight stop tape 047
	344	00	00		48	s	42	13.920	66	05.950	start tape 048
	344	02	00		48	e					tape 048 ran out; RTVPR STOP 02:03:47
	344	02	04	37	49	s	42	20.980	66	21.930	02:04:55 START RTVPR
	344	04	06	19	49	e	42	24.730	66	35.400	Stop RTVPR 04:06:07; stop tape
	344	04	06	54	50	s	42	24.720	66	35.400	new tape; start RTVPR 04:08:06
	344	06	06	20	51	e/s	42	20.890	66	41.330	stop RTVPR new tape
	344	06	15	00							had to make new tape directory; RTVPR started
	344	08	11	45	51	e	42	16.940	66	52.740	RTVPR stopped
	344	08	12	36	52	s	42	16.940	66	52.740	RTVPR started
	344	10	12	00	52	e	42	22.760	67	05.240	Tape change. End tape 052.
	344	10	12	00	53	s	42	22.760	67	05.240	Start tape 053.
	344	12	14	45	53	e	42	19.270	67	20.280	End Tape 053. Stop RTVPR
	344	12	15	19	54	s	42	19.270	67	20.280	Start Tape 054. Start RTVPR
	344	13	26	00	54	e	42	15.320	67	29.280	End RTVPR @ 13:25:23. Stop Tape 054
	346	16	31	42	55	s	42	13.300	70	26.530	start tape 55; start RTVPR 16:31:52
	346	17	30								RTVPR crashed/reset
	346	17	45								restart RTVPR
	346	18	19	02	55	e	42	14.929	70	28.070	stop RTVPR; tape off 1820
	346	21	55	56	56	s	42	14.293	69	46.890	start tape 56
	346	21	57	35			42	14.320	69	46.800	start RTVPR
	346	23	58	40	56	e	42	12.960	69	43.870	end tape 56
	347	00	00	07	57	s	42	12.870	69	43.840	start tape 57
	347	00	00	20			42	12.870	69	43.840	RTVPR
	347	02	02	09	57	e	42	03.420	69	38.240	end tape 57
	347	02	02	30	58	s	42	03.400	69	38.230	start tape 58
	347	04	02	30	58	e	42	05.650	69	38.730	missed time @ end; assumed end tape 58 for 2 hours...

Appendix IV. RV ENDEAVOR Cruise 331 "All" Tapes Cross_comparison Log.

Towyo	Event#	Time	Latitude	Longitude	Dat	s/e	HTI	s/e	ESS	s/e	Bio-optics	s/e	VPR	s/e	Time	Comments
		LOCAL			tape		filename		filename		filename		tape		GMT	
	1	338.2722	41.5233	70.6715											338.4806	Leave WHOI dock
	2	338.5938	42.0825	69.7362											338.8021	Deploy BIOMAPER-II
		338.6056	42.0825	69.7222	1	s	S3381432	s	BM2_001	s					338.8139	ESS started a little before DAT tape
		338.6056	42.0825	69.7222									001	s	338.8139	start tape 001
		338.6063	--	--											338.8146	start RTVPR
		338.6083	--	--			S3381436	s							338.8167	ew was messed, restart HTI sounder
	3	338.6299	42.0823	69.6970											338.8382	Deploy MOC
		338.6410									HS120499B	s			338.8493	
		338.6611									HS120499B	e			338.8694	
		338.6618									HS120499C	s			338.8701	
		338.6674	--	--											338.8757	SB pumps on
1WBWE1		338.6806	--	--											338.8889	start towyo 1WBWE1
	4	338.6882	42.0845	69.6418											338.8965	MOC OUT AFTER SUN DOWN
		338.6903	42.0848	69.6357									001	e	338.8986	Stop tape 001 and RTVPR.
		338.6903	42.0848	69.6357	1	e									338.8986	end DAT tape
		338.6907	42.0848	69.6348									002	s	338.8990	Start tape 002
		338.6910	42.0848	69.6348	2	s									338.8993	start new DAT dape
		338.6917	42.0848	69.6338											338.9000	Start RTVPR
		338.6986									HS120499C	e			338.9069	
		338.7021									HS120499D	s			338.9104	
		338.7292	42.0847	69.5443											338.9375	
1WBWE2		338.7604	42.0843	69.4568											338.9688	top of towyo. Surface at 4.1m (pressure). Start towyo 1WBWE2
		338.7750	42.0848	69.4145	3	s									338.9833	change tape

		338.7750	42.0848	69.4165	2	e								338.9833	change tape
		338.7750	42.0848	69.4165								002	e	338.9833	stop tape and RTVPR
		338.7753	42.0848	69.4145								003	s	338.9837	start tape 003
		338.7757	42.0848	69.4145										338.9840	start RTVPR
		338.7910	42.0842	69.3713	3	e								338.9993	change tape @ 7:00pm=12:00Ght
		338.7915	42.0842	69.3713								003	e	338.9998	stop tape and RTVPR
		338.7917	42.0842	69.3708	4	s								339.0000	hold BIOMAPER-II @ 27m above the bottom during tape change
		338.7917	42.0842	69.3708								004	s	339.0000	start tape 004 and RTVPR
1WBWE3		338.8160	--	--										339.0243	top of towyo at 5.0m. Start towyo 1WBWE3*
1WBSN1		338.8368	--	--										339.0451	hold @ approx. 120 m during turn. towyo now called 2WBSN1*
		338.8479								HS120499D	e			339.0563	
		338.8479								HS120499E	s			339.0563	
		338.8486	42.1085	69.2437										339.0569	bottom of towyo at 20m (170 m) above bottom
		338.8750	42.1588	69.2460	4	e								339.0833	top of towyo at 3.9 m
		338.8764	--	--	5	s								339.0847	change tapes.
		338.8773	--	--								005	e/s	339.0856	stop tape & RTVPR 02:02:14 start 02:03:40
1WBSN2		338.8778	42.1672	69.2460			S3382104	e/s	BM2_002	e/s				339.0861	start towo 2WBSN2
		338.9083	42.2217	69.2483										339.1167	bottom of towyo at 20m (198 m) above bottom
		338.9319								HS120499F	s			339.1403	
		338.9319								HS120499E	e			339.1403	
		338.9319	42.2700	69.2545										339.1403	top of towyo at 5 m. start turn.
		338.9361	42.2717	69.2642										339.1444	start aborted towyo
		338.9458	42.2697	69.2937										339.1542	end aborted towyo. start MOCNESS tow w/ BIOMAPER-II @ 5 m.
		338.9604	42.2668	69.3100	6	e/s								339.1688	change tapes.
		338.9611	--	--								006	e/s	339.1695	stop tape & RTVPR 04:03:06 start 04:04:30
	5	338.9986	42.2687	69.3062										339.2069	Start MOC 1
	6	339.0014	42.2637	69.3500										339.2097	End MOC 1
		339.0076								HS120499F	e			339.2160	
		339.0083								H120599A	s			339.2167	
3WBEW1		339.0139	42.0000	69.0000										339.2222	3WBEW1 TOWYO DOWN
		339.0375	42.2615	69.4290			S3390054	s						339.2458	NEW ACOUSTICS FILE
		339.0375	42.2610	69.4290										339.2458	3WBEW1 TOWYO UP from 177m/207 deep
		339.0396	--	--										339.2479	partial dropout on upward 120
		339.0458	42.2602	69.4533	7	e/s								339.2542	change tapes.
		339.0462	42.2500	69.4533								007	e/s	339.2545	several restarts on 005 to get time code going
		339.0528	--	--										339.2611	ROI's now being captured after RDC toggle
3WBEW2		339.0660	42.2587	69.5117										339.2743	3WBEW2 TOWYO DOWN
		339.0931	42.2577	69.5930										339.3014	3WBEW2 TOWYO UP from 200/230 m deep
		339.1160	42.2552	69.6538										339.3243	3WBEW3 TOWYO DOWN from surface
		339.1161	42.2552	69.6538										339.3244	top of towyo
		339.1313	42.2549	69.6977	8	e/s								339.3396	change tapes.
		339.1320	42.2542	69.6977								008	s	339.3404	new tape
3WBEW3		339.1382	42.2537	69.7182										339.3465	3WBEW3 TOWYO UP from 207/235m, 507 m wire out
		339.1403	--	--				BM2_002	e					339.3486	(header not changed in file)

		339.1410	42.2537	69.7278					BM2_003	s					339.3493	New ESS file
		339.1597	--	--											339.3681	refrad and sos going, after file check on bio-optics
		339.1639	42.2521	69.7895											339.3722	SURFACE
		339.1653	--	--											339.3736	WINCH RESTART due to diagnostic error light
4WBSN1		339.1660	42.2533	69.7962											339.3743	slow descent for TURN 4WBSN1
		339.1771	42.2507	69.8302											339.3854	parking at 56 meters for delayed turn (ship boxed in)
		339.1875	42.2531	69.8580											339.3958	restart downward towyo
		339.1938	42.2597	69.8563			S3390403	e/s							339.4021	new acoustics file s3390403
		339.2083	42.3040	69.8487											339.4167	bottom of towyo @ 198.0m
		339.2160	42.3162	69.8480	9	e/s									339.4243	start RTVPR and tape 009
		339.2161	42.3162	69.8480									009	e/s	339.4244	start RTVPR and tape 009
5WBWE1		339.2347	42.3542	69.8475											339.4431	top of towyo. finished w/ 4WBSN1. start 5WBWE1.
		339.2514	42.3888	69.8437											339.4597	hold BIOMAPER-II @95.2m for ships turn
		339.2653									H120599A	e			339.4736	
		339.2653									H120599B	s			339.4736	
		339.2653	42.4136	69.8303											339.4736	continuing towyo going down
		339.2868	42.4165	69.7758											339.4951	bottom of towyo @ 25.0m (240.7m) above bottom
		339.3014	42.4175	69.7408									009	e	339.5097	stop tape 9 and RTVPR
5WBWE2		339.3014	42.4176	69.7408	10	e/s									339.5097	change tapes
		339.3014	42.4175	69.7408									010	s	339.5097	start tape 10 and RTVPR
		339.3160	--	--											339.5243	top of towyo. end 5WBWE1. start 5WBWE2.
		339.3444	42.4182	69.6265											339.5528	bottom of towyo at 20m (240 m) above bottom
5WBWE3		339.3743	42.4173	69.5427											339.5826	top of towyo. sensor in air. finished w/ 5WBWE2. start 5WBWE3.
		339.3861	42.4173	69.5063	11	e/s									339.5944	change tapes.
		339.3868	42.4172	69.5043									011	e	339.5951	stop tape & RTVPR 14:16:25 start 14:17:15
		339.3868									H120599B	e			339.5951	
		339.3951									H120599C	s			339.6035	short file
		339.4042	42.4173	69.4593											339.6125	bottom of towyo at 20m (232 m) above bottom
5WBWE4		339.4306	42.4178	69.3860											339.6389	top of towyo. sensor below surface. finished w/ 5WBWE3. start 5WBWE4.
		339.4583	42.4167	69.3135											339.6667	bottom of towyo; fish at 227 m; 25 above bottom
		339.4708	42.4165	69.2790	12	e/s									339.6792	change tapes.
		339.4710	42.4165	69.2780									012	s	339.6793	stop tape RTVPR 16:17:26 start 16:18:39
		339.4861	42.4162	69.2350											339.6944	top of towyo. sensor below surface finished w/ 5WBWE4.
		339.4889	42.4158	69.2265	12	e	S3390403	e	BM2_003	e					339.6972	tapes off.
		339.4890	--	--											339.6974	end RTVPR for BIOMAPER-II RECOVERY (early ending)
		339.4892	42.4317	69.2480									012	e	339.6975	end tape
		339.4917									H120599C	e			339.7000	short file
	7	339.5007	42.4135	69.2058											339.7090	BIOMAPER-II OUT bioopt.

	8	339.5118	42.4137	69.2045											339.7201	Calibration
	9	339.5340	42.4163	69.1908											339.7424	Light casts done
	11	339.5521	42.4152	69.1870											339.7604	Data ended @39m
	10	339.5819	42.4148	69.1888											339.7903	CTD aborted
	12	339.5972	42.4125	69.2267											339.8056	RECAST CTD
	13	339.6146	42.4107	69.2253											339.8229	CTD out
	14	339.6271	42.4145	69.2435											339.8354	BMP in
		339.6285	42.4145	69.2435											339.8368	BIOMAPER-II deployed
		339.6319	42.4258	69.2482			s3391510	s							339.8403	restarted BIOMAPER-II
		339.6361	42.4258	69.2482					BMP_004	s					339.8444	ess started
		339.6368	42.4272	69.2482	13	s									339.8451	start tapes
		339.6375									H120599D	s			339.8458	NO DATA in file
		339.6382	42.4272	69.2482											339.8465	to 10m and back
		339.6387	42.4317	69.2480									013	s	339.8470	start RTVPR
		339.6398	42.4333	69.2480									013	s	339.8482	start tape13
6WBSN1		339.6410	42.4392	69.2482											339.8493	6WBSN1 towyo down
		339.6674	42.4872	69.2490											339.8757	towyo bottom 208/235m 454m wire out
6WBSN2		339.6951	42.5463	69.2497											339.9035	top of towyo. finished w/ 6WBSN1. start 6WBSN2.
		339.6958	42.5468	69.2497											339.9042	going down
		339.7111	42.5805	69.2495											339.9194	BIOMAPER-II @ 95 for ships turn
		339.7153	42.5847	69.2557											339.9236	continue downward towyo
		339.7201	42.5850	69.2698									013	e	339.9285	stop of tape#13 and RTVPR
		339.7208	42.5851	69.2698	14	e/s									339.9292	new tape #14
		339.7208	42.5850	69.2698									014	s	339.9292	start of tape #14
		339.7340	42.5847	69.3072											339.9424	bottom of towyo 205/225m
		339.7361	42.5845	69.3142											339.9444	discovered that dat tape wasn't recording. nothing on oscilloscope. restarted
7WBEW1		339.7604	42.5848	69.3827											339.9688	top of towyo. finished w/ 6WBSN2. start 7WBEW1.
		339.7910	42.5855	69.4690	14	e									339.9993	end#14
		339.7915	42.5855	69.4690									014	e	339.9998	stop tape at 00.00 GMT
		339.7917	42.5855	69.4702	15	s									340.0000	start#15
		339.7918	42.5855	69.4702									015	s	340.0001	start of tape #15
		339.7938	42.0842	69.3642											340.0021	bottom of towyo at20m(191m) above bottom
		339.7944	42.5855	69.4780											340.0028	bottom of towyo 217/238 m
7WBEW2		339.8188	42.5962	69.5318											340.0271	top of towyo. finished with 7WBEW1. start 7WBEW2.
		339.8382									H120599D	e			340.0465	NO DATA in file
		339.8410									H120599E	s			340.0493	
		339.8521	42.5842	69.6422											340.0604	bottom of towyo 240/260 m. Bio-Eng crash.
		339.8771	42.5843	69.7122	15	e									340.0854	Remove tape 15
		339.8813	42.5842	69.7255			S3391510	e	BM2_004	e					340.0896	top of towyo. finished with 7WBEW2.
		339.8826									H120599E	e			340.0910	
		339.8889	42.5842	69.7465					BM2_005	s					340.0972	restart Bio-Eng and BIOMAPER-II
		339.8889									H120599F	s			340.0972	
		339.8889	--	--											340.0972	minor system restart ...
		339.8898	42.5840	69.7520									016	e/s	340.0981	02:21:40 start RTVPR
7WBEW3		339.8903	42.5838	69.7525	16	s	s3392122	e/s							340.0986	start 7WBEW3. towyo down.
		339.9167	42.5832	69.8227											340.1250	bottom of towyo 235/260 m.
		339.9389	42.5823	69.8818											340.1472	BIOMAPER-II @ 25 m for turn.
		339.9417	--	--											340.1500	turn complete. up to 10 m. end 7WBEW3.
8WBSN1		339.9438	42.5910	69.8855											340.1521	top of towyo. start 8WBSN1.

		339.9694	42.6432	69.8677													340.1778	bottom of towyo 220/245 m.
		339.9750	--	--	17	e/s											340.1833	TAPE CHANGE
		339.9751	42.6537	69.8640										017	e/s		340.1835	04:23:37 stop RTVPR/tape 04:24:47 start RTVPR
		340.0007										H120599F	e				340.2090	
		340.0021										H120699A	s				340.2104	
8WBSN2		340.0021	42.7031	69.8483													340.2104	top of towyo @ 5 meters
		340.0104	42.7022	69.8399													340.2188	Turning around at 50 m
MOC		340.0188	42.7147	69.8372													340.2271	Surface for MOCNESS tow at N end
	15	340.0257	42.7248	69.8373													340.2340	MOC IN
		340.0597	42.6910	69.8440	18	e/s											340.2681	change tapes.
		340.0599	--	--										017	e		340.2683	end tape 17
		340.0603	42.6910	69.8440										018	s		340.2686	
		340.0609	--	--													340.2692	RTVPR started
		340.0847										H120699A	e				340.2931	
		340.0847	42.6689	69.8478	18	e	S3392122	e	BM2_005	e							340.2931	end files
		340.0847	42.6689	69.8478													340.2931	SHUTDOWN
		340.0849	42.6689	69.8478										018	e		340.2933	Tape stopped early for BMP out to steam
		340.0853	42.6689	69.8478													340.2936	RTVPR ended
	17	340.0938	42.6689	69.8478													340.3021	BMP out for steam to Jordan
	16	340.1236	42.6711	69.8475													340.3319	MOC OUT
	18	340.5049	43.3253	68.0018													340.7132	BMP in
		340.5090										H120699B	s				340.7174	
		340.5111	43.3180	68.0025										019	s		340.7194	Start RTVPR@17:22:29
		340.5111	43.3217	68.0025	19	s	S3401216	s	BM2_006	s							340.7194	Power up BMP @ 5 meters for MOC
	19	340.5146	43.3174	68.0000													340.7229	MOC IN
		340.5208	43.3127	68.0027													340.7292	Restart RTVPR
	20	340.5625	43.2828	68.0142													340.7708	MOC OUT
	21	340.5708	43.2783	68.0117													340.7792	several aborted attempts
		340.5951	43.2758	68.0082	20	e/s											340.8035	change tapes; light station
		340.5957	--	--										019	e		340.8040	change tape
		340.5957	43.2758	68.0082										020	s		340.8041	tape change
		340.5963	--	--													340.8047	Stop RTVPR
		340.5970	--	--													340.8053	Start RTVPR@19:19:42
	22	340.6028	43.2719	68.0038													340.8111	RAD on board
	23	340.6076	43.2703	68.0012													340.8160	CTD in
	24	340.6278	43.2660	67.9933													340.8361	CTD out
		340.6299	43.2745	67.9930			S3401507	s									340.8382	start HTI
		340.6328	43.2745	67.9930			S3401216	e									340.8411	end HTI
1JBSN1		340.6354	43.2745	67.9930													340.8438	Start Towyo 1JBSN1
		340.6354	43.2745	67.9930					BM2_007	s							340.8438	End ESS File
		340.6688	43.3438	67.9920													340.8771	Bottom of towyo at 212m, 30m above bottom. Depth 242m.
		340.6715										H120699C	s				340.8799	
		340.6715										H120699B	e				340.8799	
		340.6806	43.3645	67.9825	21	s											340.8889	start tape
		340.6806	43.3630	67.9830										020	e		340.8889	RTVPRand tape 020 stop
		340.6806	43.3547	67.9830	20	e											340.8889	end tape
		340.6816	43.3645	67.9825										021	s		340.8900	RTVPRand tape 021 start
1JBSN2		340.6944	43.3948	67.9675													340.9028	surface @ 5m top of towyo. start 1JBSN2
		340.6979	43.4035	67.9633			S3401645	s									340.9063	new files
		340.7250	43.4627	67.9342													340.9333	bottom of towyo 220/250m depth 30m
		340.7472	43.5110	67.9100													340.9556	data drop out on 200khz (upward looking)
		340.7535	43.5285	67.9015													340.9618	top of towyo (park @5m to remove seaweed)
1JBSN3		340.7556	43.5295	67.9015													340.9639	BIOMAPER-II starting down on towyo

		340.7646	43.5502	67.8905									022	s	340.9729	start RTVPR and tape 22
		340.7646	43.5499	67.8907									021	e	340.9729	stop tape 21 and RTVPR
		340.7653	43.5499	67.8907	21	e									340.9736	stop tape 21
		340.7653	43.5502	67.8905	22	s									340.9736	start tape 22
		340.7889	43.6006	67.8662											340.9972	Bottom of towyo at 217m, Depth 247m.
		340.7889	43.6024	67.8653			S3401645	e							340.9972	close file
		340.7889	43.6028	67.8652			S3401856	s							340.9972	start file
		340.7910	43.6064	67.8633	22	e									340.9993	stop tape 22
		340.7915	43.6064	67.8633									022	e	340.9998	stop RTVPR and tape22
		340.7917	43.6067	67.8632									023	s	341.0000	start RTVPR and tape 23
		340.7917	43.6067	67.8632	23	s									341.0000	start tape 23
1JBSN4		340.8167	43.6617	67.8352											341.0250	Top of towyo. Start new towyo. Pressure at 4.9m.
		340.8458	43.7262	67.8030											341.0542	Bottom of towyo at 195m, Depth 217m.
1JBSN5		340.8688	43.7707	67.7815											341.0771	top of towyo @ 5m. start towyo
		340.8694	43.7730	67.7807			S3402052	e/s							341.0778	new HTI file
		340.8763	43.7878	67.7722									023	e	341.0846	end tape; stop RTVPR 02:01:45
		340.8764	--	--	24	e/s									341.0847	change tapes
		340.8766	43.7878	67.7722									024	s	341.0850	start tape; start RTVPR 02:02:55
		340.8882	43.8118	67.7612											341.0965	bottom of towyo 205/227 m
		340.8993	--	--											341.1076	BIOMAPER-II @ 90 m, turning east to avoid fishing gear
		340.9076	43.8330	67.7258											341.1160	top of towyo @ 10 m. start MOCNESS
	25	340.9549	43.8303	67.7225											341.1632	MOC in water
		340.9616	43.7978	67.7030									024	e	341.1699	end tape; stop RTVPR 04:04:13
		340.9618	43.7978	67.7030									025	s	341.1701	start tape; start RTVPR 04:05:24
		340.9639	--	--	25	e/s	S3402308	e/s							341.1722	MOCNESS complete.start new HTI file, tapes
2JBWE1		340.9674	44.2948	67.6973											341.1757	start towyo 2JBWE1 from end of MOCNESS tow
		340.9826											H120699C	e	341.1910	stopped transmitting; spare power cycled
		340.9910	43.7897	67.6347											341.1993	bottom of towyo 205/227 m
		340.9917											H120799A	s	341.2000	
	26	340.9993	43.8012	67.7045											341.2076	MOC OUT
3JBNS1		341.0153	43.7807	67.5665											341.2236	top of towyo @ 5 meters, turning to South around GEAR 3JBNS1
		341.0438	43.7164	67.5658											341.2521	bottom of towyo 206/236 meters, 476 m wire out
		341.0451	43.7127	67.5657	26	e/s									341.2535	
		341.0454	43.7978	67.7030									025	e	341.2538	end tape
		341.0457	43.7127	67.5657									026	s	341.2541	start tape 26
		341.0461	43.7127	67.5657									026	e	341.2544	end RTVPR
		341.0478	43.7127	67.5657									027	s	341.2561	start RTVPR
3JBNS2		341.0708	--	--			S3402308	e							341.2792	top of towyo @5.5 meters 3JBNS2
		341.0708	43.6570	67.5908			S3410143	s	BM2_007	e					341.2792	redo files
		341.0722	--	--					BM2_008	s					341.2806	new ESS
		341.0986	43.6043	67.6317											341.3069	bottom of towyo 34 meters above variable bottom
		341.1229	43.5530	67.6697											341.3313	top of towyo @ 5 meters; tending toward ship near surface 3JBNS3
3JBNS3		341.1299	--	--	26	e									341.3382	end tape
		341.1305	43.5370	67.6813									027	e/s	341.3388	start tape
		341.1306	43.5370	67.6813	27	s									341.3389	tape changes; new tape

		341.1306	--	--												341.3389	start RTVPR
		341.1306	--	--												341.3389	stop RTVPR
		341.1465	43.5062	67.7048												341.3549	bottom of towyo @ 200/230 meters, 468 m wire out
		341.1632	--	--												341.3715	one complete scan drop out on the 420 upward looking transducer
3JBNS4		341.1722	43.4575	67.7412												341.3806	top of towyo @5.1 meters. Start new towyo.3JBNS4
		341.2021	43.4022	67.7825			S3410143	e								341.4104	new HTI file at bottom of towyo.
		341.2021	43.4027	67.7820												341.4104	bottom of towyo. 230/260m
		341.2028	43.4020	67.7825			S3410452	s								341.4111	new HTI file.
		341.2146	43.3788	67.7917	28	s										341.4229	start tape 28
		341.2146	43.3788	67.1567	27	e										341.4229	stop tape 27
		341.2146	43.3788	67.7917										027	e	341.4230	stop tape 27 and RTVPR
		341.2149	--	--										028	s	341.4233	start tape 028 and RTVPR
		341.2375	43.3383	67.8197												341.4458	hold at 15m while making the turn.
4JBWE1		341.2382	43.3385	67.8177												341.4465	turn completed. Start new towyo.
		341.2556	43.3359	67.7353												341.4639	bottom of towyo @240m/271.2m
		341.2597											H120699A	e		341.4681	
		341.2597											H120799B	s		341.4681	
5JBSN1		341.2958	43.3348	67.6525												341.5042	top of towyo. Ship turning on to new leg
		341.2993	43.3435	67.6492										028	e	341.5076	stop tape 028 and RTVPR
		341.2993	43.3435	67.6492	29	s										341.5076	start tape 29
		341.2993	43.3435	67.6492	28	e										341.5076	stop tape 28
		341.2995	--	--										029	s	341.5078	start tape 029 and RTVPR
		341.3021	43.3560	67.6432			S3410719	e/s								341.5104	accidently rebooted acoustic computer
		341.3250	43.4003	67.6213												341.5333	bottom of towyo @200 m/235 m
5JBSN2		341.3493	43.4570	67.5950												341.5576	top of towyo @ 6.8 meters. Start new towyo.
		341.3514											H120799C	s		341.5597	
		341.3514											H120799B	e		341.5597	
		341.3750	43.5200	67.5655												341.5833	bottom of towyo @202m/226 m
		341.3854	43.5402	67.5558	30	e/s										341.5938	change tapes. DAT had run out.
		341.3856	43.5410	67.5553										029	e	341.5940	stop RTVPR 14:15:17
		341.3860	43.5410	67.5553										030	s	341.5944	start RTVPR 14:16:18
5JBSN3		341.4042	43.5813	67.5363												341.6125	top of towyo @ 3.4 m. sensor out. start new towyo.
		341.4076	43.5877	67.5332			s3410947	e/s								341.6160	new HTI file.
		341.4306	43.6380	67.5093												341.6389	bottom of towyo @ 205 m/229 m
		341.4333											H120799C	e		341.6417	stopped transmitting; spare power cycled
		341.4389											H120799D	s		341.6472	
		341.4514	--	--												341.6597	deviation from course to avoid fishing gear.
		341.4590	43.6960	67.4862												341.6674	top of towyo @ 3.4 m. sensor out. start new towyo.
5JBSN4		341.4632	43.7033	67.4823				BM2_009	e/s							341.6715	top of towyo @ 3.4 m. sensor out. start new towyo.
		341.4674	43.7188	67.4755	31	e/s										341.6757	change tapes.
		341.4710	43.7213	67.4745										030	e	341.6793	stop RTVPR 16:18:01
		341.4714	43.7213	67.4745										031	s	341.6797	start RTVPR 16:19:21
		341.4833	43.7443	67.4625												341.6917	bottom of towyo @ 195 m/218 m
		341.5083	43.7910	67.4377												341.7167	top of towyo, back down to 10 meters for CTD
		341.5160	43.7907	67.4323			S3411223	s								341.7243	new HTI file.

		341.5160	43.7907	67.4323			S3410947	e							341.7243	end HTI	
	27	341.5236	43.7851	67.4207											341.7319	CTD in water	
	28	341.5417	43.7798	67.4132											341.7500	CTD on board	
6JBNS1		341.5458	43.7720	67.4135											341.7542	Towyo down from 6JBNS1 after CTD	
		341.5465									H120799E	s			341.7549		
		341.5465									H120799D	e			341.7549		
		341.5472	--	--											341.7556	fixed radio to get transmission from bridge	
		341.5549	43.7505	67.4133	31	e									341.7632	change tapes.	
		341.5553	43.7505	67.4133									031	e	341.7636	tape change	
		341.5556	--	--										032	s	341.7639	new tape
		341.5556	--	--	32	s									341.7639	tape change	
		341.5558	--	--											341.7641	RTVPR STOP	
		341.5561	--	--											341.7644	RTVPR started	
		341.5653	--	--											341.7736	Towyo at 182/207m, 368 wire out	
6JBNS2		341.5840	43.6798	67.4143											341.7924	Top of towyo at surface; start 6JBNS2	
		341.6083	43.6212	67.4148											341.8167	bottom of towyo @ 192/217m, 420 m wire out	
		341.6083	--	--											341.8167	slow turn started to new line	
6JBNS3		341.6299	43.5698	67.4167											341.8382	top of towyo, begin 6JBNS3	
		341.6403	43.5440	67.4168	33	s									341.8486	new tape	
		341.6403	43.5440	67.4168	32	e									341.8486	tape change.	
		341.6405	43.5440	67.4168									032	e	341.8488	tape ended	
		341.6408	--	--										033	s	341.8491	new tape
		341.6409	--	--											341.8492	RTVPR started	
		341.6410	--	--											341.8493	STROBE OFF (during tape change?)	
		341.6428	--	--											341.8511	RESTART STROBE	
		341.6458	--	--											341.8542	start slow turn	
		341.6521	43.5232	67.3993											341.8604	BIOENG error #70 recovered without restart-- permission denied	
		341.6563	--	--											341.8646	Nifty wave at 100 meters, near thermocline	
		341.6563									H120799E	e			341.8646		
		341.6569									H120799F	s			341.8653		
		341.6576	43.5212	67.3678											341.8660	bottom of towyo	
		341.6688	43.5177	67.3458											341.8771	Drop out on all 10 ducers	
7JBWE1		341.6792	43.5140	67.3088											341.8875	top of towyo @ 8m	
		341.7049	43.5067	67.2260											341.9132	Bottom of towyo 191.4/221.4m	
		341.7222	43.4987	67.1495											341.9306	Top of towyo.	
		341.7250	43.4993	67.1113	34	e/s									341.9333	Stop tape 33 and start tape 34	
		341.7253	--	--										033	e	341.9337	power on/off again stop tape 033
		341.7256	43.4993	67.1113										034	s	341.9339	start tape 034 and RTVPR
		341.7403	--	--			S3411223	e	BM2_009	e					341.9486	ends of tapes and files	
		341.7424	43.4985	67.1477					BM2_010	s					341.9507	Computer Crash 17:48 ESS + SONAR	
		341.7424	--	--											341.9507	computer (hTI) crash power down. restart	
		341.7424	--	--											341.9507	RTVPR Crashed and restarted	
		341.7450	43.4998	67.1510											341.9534	VPR camara an VPR stroke on. HTI still not connecting to network.	
		341.7479	43.5008	67.1547			S3411756	s							341.9563	Restart	
		341.7535	43.5027	67.1578										034	e	341.9618	stop tape and RTVPR
		341.7535	43.5047	67.1580	34	e									341.9618	Pull BIOMAPER-II . Power Down.	
		341.7542	43.5050	67.1580			S3411756	e	BM2_010	e					341.9625	End ESS and HTI files.	
		341.7556									H120799F	e			341.9639	BIOMAPER-II recovery	
	29	341.7583	43.5087	67.1597											341.9667	BIOMAPER-II recovery	

		341.7583	--	--											341.9667	BMP out for storm
	30	342.7771	42.4922	67.3298											342.9854	BIOMAPER-II deploy
		342.7771	42.4922	67.3307	35	s	S3421841	s	BM2_011	s					342.9854	BIOMAPER-II in the water start HTI ESS
		342.7787	42.4919	67.3287									035	s	342.9870	start tape 035
		342.7790	42.4923	67.3263											342.9874	start RTVPR Change setting on RTVPR Threshold = 50 In Focus=40
		342.7813								H120899A	s				342.9896	BIOMAPER-II recovered
1GBWE1		342.7819	42.4922	67.3205											342.9903	Start down with first towyo in GB
		342.7915	42.4923	67.2860									035	e	342.9998	stop tape 035
		342.7916	42.4923	67.2860											343.0000	stop RTVPR
		342.7917	42.4923	67.2898	35	e									343.0000	Tape change at 00.00 GMT
		342.7918	42.4923	67.2860									036	s	343.0001	start RTVPR start tape36
		342.7924	42.4923	67.2860	36	s									343.0007	start new DAT tape
		342.7952	42.4925	67.1873											343.0035	VPR failure at 266 bottom of Towyo
		342.8229	42.4932	67.2048											343.0313	bottom of towyo @ 289 m/330 m
		342.8229	42.4932	67.2048											343.0313	VPR failure at 289 meters Bring Biomapper up
		342.8243	42.4923	67.2012											343.0326	VPR self restart 270 meters
		342.8277	42.4927	67.1927											343.0361	Biomapper down for testing VPR
		342.8292	42.4927	67.1927											343.0375	return to 289 m to test vpr
		342.8333	42.4933	67.1773											343.0417	VPR on and off at 231.81 meters
		342.8350	42.4933	67.1742											343.0434	VPR self started 225 meters
		342.8357	42.4935	67.1725											343.0440	RTVPR started
OUT		342.8625	42.4940	67.1030											343.0708	biomapper 10 meters prepare for recovery
		342.8667								H120899A	e				343.0750	
		342.8674	42.4940	67.0912											343.0757	shutting down HTI file
		342.8681	--	--	36	e									343.0764	ess powered down stop DAT tape 36
		342.8688	--	--											343.0771	stop VPR tape 36
		342.8688	42.4940	67.0912									36	e	343.0771	end tape 36
		342.8694	--	--			S3421841	e	BM2_011	e					343.0778	Shut down EMS Exit Bio_Eng
IN		342.8944	42.4960	67.0783					BM2_012	s					343.1028	Biomapper deployed start HTI and ess
	32	342.8944	42.4960	67.0783											343.1028	Deploy BIOMAPER-II
		342.8972									H120899B	s			343.1056	
		342.8977	42.4960	67.0788									37	s	343.1060	start tape 37 RTVPR 02:33:05
		342.8979	42.4960	67.0783	37	s	S3422134	s							343.1063	Start acoustics tape 37
	31	342.9097	42.4940	67.0912											343.1181	BIOMAPER-II recovery for VPR
		342.9181	--	--											343.1264	Blue screen of death on HTIACQ
		342.9250	--	--			S3422210	e/s							343.1333	HTI back on line; new file
		342.9514	--	--											343.1597	vertical lines in echogram windows
1GBWE2		342.9813	--	--											343.1896	begin towyo moc is recovered; fish @ 15m; begin 1GBWE2
		342.9840	42.4883	66.9952	37	e									343.1924	end tape 37
		342.9840	42.4883	66.9952	38	s									343.1924	start new DAT tape
		342.9843	42.4888	66.9962									37	e	343.1926	stop tpe stop RTVPR 04:37:07
		342.9846	42.4888	66.9962									38	s	343.1929	start tape 38; RTVPR 04:38:31
		343.0028	--	--											343.2111	great tails, siphon, etc
		343.0174	42.4903	66.9115											343.2257	bottom of towyo 245/285m 568 wire out
		343.0215									H120999I	e			343.2299	
		343.0361	--	--											343.2444	drop out 120 downward looking

		343.0368								H120899B	e			343.2451	
		343.0375								H120999A	s			343.2458	
1GBWE3		343.0444	42.4913	66.8318			S3432210	e						343.2528	new HTI and top of towyo; begin 1GBWE3
		343.0458	--	--			S3430106	s						343.2542	time base 1 minute off GPS; should resync soon ! (ag)
		343.0681	--	--	38	e								343.2764	tape change.
		343.0686	--	--								38	e	343.2769	tape change
		343.0688	42.4925	66.7635	39	s								343.2771	tape change.
		343.0688	42.4925	66.7635								39	s	343.2771	new tape
		343.0692	--	--										343.2775	start RTVPR
		343.0722	42.4918	66.7553										343.2806	37 meters off bottom at 289; 600 meters wire out
1GBWE4		343.1014	42.4948	66.6630										343.3097	top of towyo; begin 1GBWE4
		343.1333	42.4955	66.5603										343.3417	bottom of towyo at 246 m, 32.4 meters off bottom
		343.1535	42.4957	66.4977	40	e/s								343.3618	tape change.
		343.1537	42.4957	66.4977								40	e/s	343.3620	tape change
		343.1541	--	--										343.3624	RTVPR stop
		343.1549	--	--										343.3632	RTVPR (re)start
1GBWE5		343.1625	42.4963	66.4678										343.3708	top of towyo ; begin 1GBWE5
		343.1674	42.4968	66.4567			s3430106	e						343.3757	lost connection to DES-cycling sonar
		343.1688	42.4968	66.4567			s3430403	s						343.3771	restart
		343.1917	42.4973	66.3892										343.4000	bottom of towyo at 206m/236m
		343.1931	42.4973	66.3875				BMT-013	s					343.4014	start new ess
		343.1931	42.4973	66.3875				BM2-012	e					343.4014	end aquisition start new ess
1GBWE6		343.2174	42.4978	66.3168										343.4257	surface @4.4m start next towyo; begin 1GBWE6
		343.2382	42.4995	66.2705	41	e/s								343.4465	tape change 040 to 041
		343.2382	42.4992	66.2713								40	e	343.4465	stop tape 040
		343.2384	42.4993	66.2705								41	s	343.4468	start tape 041
		343.2390	42.5000	66.2680										343.4473	start RTVPR
		343.2438	42.4993	66.2562										343.4521	bottom of towyo 196.7m/226.7m
		343.2549	42.4993	66.2350			s3430403	e						343.4632	HTI computer crash, lost connection to whoi, restart.
		343.2569	42.4995	66.2303			s3430610	s						343.4653	new HTI file
1NECNS1		343.2715	42.5000	66.2007										343.4799	surface @ 5m starting ship turn; 2GBNS1
		343.3000	42.4675	66.1522										343.5083	bottom of towyo 200/230m
		343.3035								H120999B	s			343.5118	
		343.3035								H120999A	e			343.5118	
		343.3236	42.4389	66.1139								42	e/s	343.5319	end tape 41 start tape 42
1NECNS2		343.3236	42.4385	66.1117										343.5319	Top of towyo start towyo 2GBNS2
		343.3236	42.4385	66.1117	41	e								343.5319	end tape 41 (fail to) start 42
		343.3319	42.4285	66.1000	42	s								343.5403	tape change
		343.3521	42.4038	66.0667										343.5604	Bottom of Towyo 225 meters
1NECNS3		343.3806	42.3687	66.0200										343.5889	Top of Towyo at 4 meters 2GBNS3
		343.3882								H120999B	e			343.5965	
		343.3889								H120999C	s			343.5972	
		343.4083	42.3300	65.9692	42	e								343.6167	Bottom of Towyo 210 meters Water Depth 240 m (Phil flew here)
		343.4119	42.3227	65.9595								42	e	343.6202	Stop RTVPR @ 14:53:00 Stop Tape 42
		343.4126	42.3227	65.9595								43	s	343.6210	Start tape 43, start RTVPR 14:54:30
		343.4139	42.3222	65.9583	43	s	s3430957	e/s						343.6222	New Tape 43 New HTI File
1NECNS4		343.4375	--	--										343.6458	top of towyo (missed entry)

		343.4426	42.2822	65.9238												343.6509	Restart RTVPR after program crashed
		343.4583	--	--												343.6667	Bottom of Towyo (missed entry)
		343.4799										H120999C	e			343.6882	
		343.4799										H120999D	s			343.6882	
1NECNS5		343.4833	42.2220	65.7583												343.6917	top of towyo. start towyo .
		343.4864	42.2137	65.8142												343.6947	RTVPR barfed restarted 16:41:33
		343.4966	42.1952	65.7895										43	e	343.7049	stop RTVPR 16:54:53
		343.4971	42.1952	65.7895										44	s	343.7054	start RTVPR 16:56:02
		343.4972	42.1833	65.7917	44	e/s										343.7056	change tapes.
		343.5035	42.1667	65.7500												343.7118	bottom of towyo
LT STA		343.5243	42.1462	65.7263												343.7326	top of towyo; hold at surface for light stn and MOC
		343.5247	42.1420	65.7180												343.7330	mvc15040 occ error msg
		343.5250	--	--												343.7333	drop out 420 up(?) and 43khz up(?)
		343.5271	--	--			s2430957	e								343.7354	CHANGE TAPES
		343.5278	--	--			s2431240	s								343.7361	VPR DIED new HTI
		343.5285	42.1428	65.7158					bm2-014	e/s						343.7368	new ESS
		343.5302	42.1427	65.7150												343.7385	RTVPR program rebooted
	35	343.5319	42.1427	65.7150												343.7403	Deploy RAD
		343.5424	--	--												343.7507	winch dropped fish to 12 m, while stopped; WAVE on HTI
	36	343.5576	42.1363	65.6942												343.7660	Recover RAD
		343.5604	--	--												343.7688	sounder off llegal operation/ shut down acoustics computer
	37	343.5639	42.1257	65.6850												343.7722	Deploy CTD
		343.5785											H120999D	e		343.7868	
		343.5785											H120999E	s		343.7868	
		343.5822	42.1245	65.6835										44	e	343.7905	stop tape
		343.5840	--	--	44	e	s3431401	s								343.7924	new HTI file acoustic system restarted;VPR off
		343.5840	42.1245	65.6835	45	s										343.7924	tape change
		343.5842	42.1245	65.6835										45	e/s	343.7925	start tape
		343.5845	42.1245	65.6835												343.7928	RTVPR off
		343.5847	42.1245	65.6835												343.7930	start RTVPR
	39	343.5938	42.1225	65.6850												343.8021	Deploy MOC 1
	38	343.6181	42.1367	65.6933												343.8264	Recover CTD
		343.6375											H120999E	e		343.8458	
		343.6375											H120999F	s		343.8458	
	40	343.6438	42.1300	65.7062												343.8521	Recover MOC 1
		343.6458	42.1298	65.7048			s3431401	e								343.8542	
		343.6465	42.1298	65.7048			s3431531	s								343.8549	noise test
		343.6535	--	--	45	e	s3431531	e								343.8618	end tapes -taken out for synchronization
		343.6535	42.1245	65.6835												343.8618	stop RTVPR
		343.6535											H120999F	e		343.8618	BIOMAPER-II powered down
		343.6542	--	--					bm2-014	e						343.8625	
		343.6549	--	--												343.8632	sonar spare ess off power cycling
		343.6618	--	--												343.8701	clocks synced/power up
		343.6632	--	--												343.8715	BIOENG up spare ess sonar (power up)
		343.6646											H120999G	s		343.8729	
		343.6653	--	--			s3430358	s/e								343.8736	start and end of HTI due to Mishap in clock synchronization
		343.6674	42.1383	65.7498			s3431601	s	bm2-015	s						343.8757	start of HTI file
		343.6681	--	--	46	s										343.8764	tapes started
		343.6688	42.1397	65.7538										46	e/s	343.8771	start RTVPR
2NECSN1		343.6694	42.1398	65.7538												343.8778	TOWYO DOWN 2NECSN1
		343.6708	42.1410	65.7570												343.8792	restart RTVPR
		343.6951	42.1568	65.8183												343.9035	Bottom of TOWYO @ 218.8m/248.8m
2NECSN2		343.7229	42.1762	65.8885												343.9313	top of towyo. begining down again

		343.7396														343.9479	Error: attempt to connect to [] failed com port replicator
		343.7417									H120999G	e				343.9500	stopped transmitting
		343.7507									H120999H	s				343.9590	back up after spare power cycled
		343.7507	42.1955	65.9612												343.9590	Bottom of TOWYO @195/225
		343.7528	42.1963	65.9645									46	e		343.9611	stop tape 046 and RTVPR
		343.7528	42.1962	65.9640	47	s										343.9611	Start tape 47
		343.7528	42.1963	65.9645									47	s		343.9611	start tape 047
		343.7528	42.1962	65.9640	46	e										343.9611	End tape 46
2NECSN3		343.7729	42.2152	66.0358												343.9813	Top of TOWYO
		343.7750	42.2168	66.0417												343.9833	BIOMAPER-II at surface, start next towyo
		343.7910	42.2320	66.0990	47	e										343.9993	End tape 47 (GMT midnight)
		343.7916	42.2320	66.0992									47	e		343.9999	GMT midnight stop tape 047
		343.7917	42.2320	66.0992									48	s		344.0000	start tape 048
		343.7917	42.2320	66.0990	48	s										344.0000	Start tape 48
		343.8049	42.2423	66.1370												344.0132	Bottom of TOWYO 222/252m
		343.8160	--	--												344.0243	Ship at GB4 Turning on to Georges Basin trackline
2GBEW1		343.8347	42.2832	66.2313												344.0431	Top of tow-yo @ 5m
		343.8375	42.2873	66.2397			S3432006	e/s								344.0458	New HTI file
		343.8576	42.3182	66.3022												344.0660	bottom of towyo 204 m/230 m
		343.8750	--	--									48	e		344.0833	tape 048 ran out; RTVPR STOP 02:03:47
		343.8778	42.3488	66.3638	49	e/s										344.0861	change tapes
		343.8782	42.3497	66.3655									49	s		344.0865	02:04:55 START RTVPR
		343.8813	--	--												344.0896	BIOMAPER-II @ 10 m to avoid fishing gear
		343.8833	--	--												344.0917	turn toward next tranesct line
2GBEW2		343.8875	42.3657	66.3975												344.0958	recommence towyo descent
		343.8931									H120999I	s				344.1014	
		343.8931									H120999H	e				344.1014	
	33	343.9014	42.4960	67.0767												344.1097	Deploy MOC
		343.9153	42.4157	66.4865												344.1236	bottom of towyo 225 m/280 m
MOC		343.9375	42.4210	66.5640												344.1458	top of towyo. @ 10 m for MOCNESS
	41	343.9493	42.4193	66.5690												344.1576	Deploy MOC 1
		343.9625	42.4122	66.5897	49	e										344.1708	change tapes
		343.9627	42.4122	66.5900									49	e		344.1711	Stop RTVPR 04:06:07; stop tape
		343.9631	42.4120	66.5900									50	s		344.1715	new tape; start RTVPR 04:08:06
		343.9646	42.4122	66.5897	50	s	S3432309	e/s								344.1729	new HTI file
	34	343.9681	42.4917	67.0315												344.1764	Recover MOC
	42	344.0146	42.3880	66.6273												344.2229	Recover MOC 1
		344.0222									H121099A	s				344.2306	
2GBEW3		344.0257	42.3842	66.6363												344.2340	start towyo down after moc
		344.0458	42.3478	66.6888	51	e/s										344.2542	tape change
		344.0461	42.3482	66.6888									51	e/s		344.2544	stop RTVPR new tape
		344.0521	--	--												344.2604	had to make new tape directory; RTVPR started
		344.0563	42.3347	66.7093												344.2646	bottom of towyo 249/310 meters; 800 meters wire out
		344.0569	--	--				BM2_015	e							344.2653	END ESS
		344.0583	--	--				BM2_016	s							344.2667	VPR on NEW ESS
		344.0590	--	--			S3432309	e								344.2674	END DES
		344.0590	42.3310	66.7167			S3440125	s								344.2674	START DES
2GBEW4		344.0924	42.2798	66.7910												344.3007	start down on next towyo
		344.1049									H121099A	e				344.3132	
		344.1049									H121099B	s				344.3132	

		344.1271	42.2752	66.8633												344.3354	bottom of towyo 250/279.4; 740 meters wire out	
		344.1326	42.2820	66.8785	52	e/s										344.3410	change tapes	
		344.1332	42.2823	66.8790										51	e	344.3415	RTVPR stopped	
		344.1338	42.2823	66.8790										52	s	344.3421	RTVPR started	
2GBEW5		344.1549	42.3050	66.9272												344.3632	towyo starts down from boot @ surface	
		344.1813											H121099B	e		344.3896	short break in data towards end of file	
		344.1813											H121099C	s		344.3896		
		344.1896	42.3443	67.0134												344.3979	Bottom of towyp 235/308m. 800m of wire out.	
		344.1986	42.3565	67.0383			S3440125	e								344.4069	HTI Computer crash. Hard Reboot. Cycle power. Dat tape paused?	
		344.2035	42.3628	67.0516			S3440453	s								344.4118	Restart HTI. New HTI file.	
		344.2167	42.3798	67.0880	53	e/s										344.4250	Tape change. End 52, start 53.	
		344.2167	42.3793	67.0873											52	e	344.4250	Tape change. End tape 052.
		344.2167	42.3793	67.0873											53	s	344.4250	Start tape 053.
2GBEW6		344.2181	42.3820	67.0932												344.4264	Surface @ 4.1m. Start next towyo.	
		344.2340	42.4037	67.1393												344.4424	Stop towyo at 124m.Hold for turn.	
		344.2389	42.4030	67.1533												344.4472	Start back down on towyo.	
		344.2535	42.3843	67.1950												344.4618	Hold at 240m. (795 m wire out). something caught on the cable? Capture screen.	
		344.2549	42.3820	67.1993												344.4632	Start back up. The thing is still there.	
		344.2813	42.3412	67.2928												344.4896	Held BIOMAPER-II at surface while we freed a lobster line 4m above BIOMAPER-II .	
2GBEW7		344.3014	42.3215	67.3392	54	e/s										344.5097	Tape change. End 53 start 54.	
		344.3019	42.3212	67.3380											53	e	344.5102	End Tape 053. Stop RTVPR
		344.3023	42.3212	67.3380											54	s	344.5106	Start Tape 054. Start RTVPR
		344.3035											H121099C	e		344.5118		
		344.3035											H121099D	s		344.5118		
		344.3139	42.3053	67.3745												344.5222	Bottom of towyo at 234.4/287m. Wire out=800m.	
		344.3222	42.2947	67.4005												344.5306	Scope shows no trace. Stop and start DAT tape. Recovered.	
		344.3361											H121099D	e		344.5444	stopped transmitting; spare power cycled	
		344.3375											H121099E	s		344.5458		
		344.3458	42.2620	67.4737												344.5542	BIOMAPER-II @ 10 m	
		344.3507											H121099E	e		344.5590	recover BIOMAPER-II	
		344.3507	42.2557	67.4875	54	e	S3340453	e	BM2_016	e						344.5590	End HTI file, tapes; power down BIOMAPER-II	
		344.3514	42.2553	67.4880											54	e	344.5597	End RTVPR @ 13:25:23. Stop Tape 054
	43	344.3597	42.2553	67.4880												344.5681	Recover BMP/ steam CCB	
		344.3597	42.2553	67.4880												344.5681	Recover BIOMAPER- II	
	44	345.5451	41.9770	70.1312												345.7535	Deploy BIOMAPER-II film	
	45	345.5639	41.9830	70.1447												345.7722	Recover BIOMAPER- II film	
	46	346.4715	42.2067	70.4300												346.6799	Deploy BIOMAPER-II	
		346.4743	--	--					BM2-017	s						346.6826	start ess	
		346.4778	--	--												346.6861	restarted ess	
		346.4785	--	--			s3461129	s								346.6868	restart HTI FILE	
		346.4799	--	--	55	s										346.6882	Start dat tapes	
		346.4799	42.2217	70.4422												346.6882	start of towyo	
		346.4803	42.2217	70.4422											55	s	346.6887	start tape 55: start

[illegible]

		346.7667	42.2653	69.7563											346.9750	hold @25m for 6 minutes
		346.7708	42.2568	69.7518											346.9792	drop to 50m
		346.7736	42.2513	69.7487											346.9819	hold @50m for 6 minutes
		346.7764	42.2457	69.7458			s3461651	e							346.9847	HTI computer crash reboot cycle sonar power re-do 50m depth
		346.7792	42.2395	69.7427			s3461842	s							346.9875	new HTI file hold @ 50m for 6 minutes
		346.7840	42.2303	69.7378											346.9924	drop to 75m
		346.7868	42.2240	69.7345											346.9951	hold @75m for 6 minutes
		346.7903	42.2160	69.7312	56	e									346.9986	end #56
		346.7907	42.2160	69.7312									56	e	346.9991	end tape 56
		346.7917	42.2145	69.7307	57	s									347.0000	start #57
		346.7917	42.2145	69.7307									57	s	347.0001	start tape 57
		346.7919	42.2145	69.7307											347.0002	RTVPR
		346.7944	42.2092	69.7283											347.0028	hold BIOMAPER-II @ 99.5m for 6 minutes
		346.7986	42.2022	69.7248											347.0069	drop to 125m
		346.8028	42.1937	69.7207											347.0111	hold @125m for 6 minutes
		346.8069	42.1860	69.7168											347.0153	Drop to 150m
		346.8111	42.1780	69.7130											347.0194	hold @150m for 6 minutes
		346.8132	--	--											347.0215	accumulator turned on taking up 8m of wire bringing BIOMAPER-II to 142m
		346.8139	42.1713	69.7100											347.0222	300v forward fault in BIOMAPER-II (minor fault)
		346.8160	42.1697	69.7092											347.0243	drop to 175m
		346.8229	42.1562	69.7025											347.0313	hold @175m for 6 minutes
		346.8271	42.1480	69.6988											347.0354	drop to 190m
		346.8306	42.1423	69.6962											347.0389	hold @190m for six minutes
		346.8347	42.1340	69.6918											347.0431	bring BIOMAPER-II to 175m
		346.8368	42.1290	69.6890											347.0451	hold @ 175 for six minutes
		346.8417	42.1218	69.6855											347.0500	bring to 150m
		346.8438	42.1180	69.6838											347.0521	hold @ 150m for 6 minutes
		346.8479	42.1097	69.6797											347.0563	bring up to 125m
		346.8500	42.1058	69.6777											347.0583	hold @125m for 6 minutes
		346.8542	42.0978	69.6738											347.0625	bring up to 100m
		346.8569	42.0927	69.6707											347.0653	hold @ 100m for six minutes
		346.8611	42.0845	69.6672											347.0694	bring up to 75 m
		346.8632	42.0815	69.6662											347.0715	hold @ 75 m for 6min
		346.8674	42.0738	69.6625											347.0757	bring up to 50 m
		346.8694	42.0703	69.6607											347.0778	hold at 50 m for 6 min
		346.8736	42.0623	69.6567											347.0819	bring up to 25 m
		346.8750	42.0600	69.5557											347.0833	hold @ 25 m for 6 min
		346.8764	42.0570	69.6373	58	e/s									347.0847	change tapes
		346.8765	42.0570	69.6373									57	e	347.0848	end tape 57
		346.8767	42.0567	69.6372									58	s	347.0851	start tape 58
		346.8792	42.0520	69.6518											347.0875	bring up to 5 m
		346.8931	42.0402	69.6418											347.1014	mocness/BIOMAPER-II joint tow operations. Moc-1 deployed
	55	346.8931	42.1235	69.6418											347.1014	DEPLOY MOCNESS
		346.8951	42.0415	69.6420											347.1035	BIOMAPER-II down at 5 m/min
		346.9021	42.0477	69.6425			S3462139	e/s							347.1104	new HTI file; hold @30 m waiting for MOC
		346.9167	42.0602	69.6428											347.1250	fire net #1; 6 min @ 30 m
		346.9208	--	--											347.1292	fire net #2; 6 min @ 28 m
		346.9208	42.0642	69.6428											347.1292	bring up to 28 m
		346.9250	42.0678	69.6438											347.1333	bring up to 26m
		346.9260	--	--											347.1344	fire net #3; 6 min @26 m

		346.9302	42.0717	69.6438									347.1385	bring up to 24m
		346.9306	--	--									347.1389	fire net #4; 6 min @24 m
		346.9347	42.0767	69.6443									347.1431	bring up to 22m
		346.9354	--	--									347.1438	fire net #5; 6 min @22m
		346.9396	42.0812	69.6445									347.1479	bring up to 20 m
		346.9406	--	--									347.1490	fire net #6; 5 min @20 m; off by 1 min to sync w/MOC
		346.9441	42.0850	69.6450									347.1524	bring up to 18m
		346.9448	--	--									347.1531	fire net #7; 6 min @18m
		346.9490	42.0905	69.6452									347.1573	bring up to 16m
		346.9493	--	--									347.1576	fire net #8; 6min @16m
		346.9535	42.0942	69.6455									347.1618	end experiment; haul BIOMAPER-II to 5m
	56	346.9590	42.1000	69.6467									347.1674	RECOVER MOCNESS
		346.9601	42.0942	69.6455								58 e	347.1684	missed time @ end; assumed end tape 58 for 2 hours...
		346.9639	--	--	58	e	S3462139	e	BM2_017	e			347.1722	end acquisition; power down
	57	346.9688	42.1088	69.6465									347.1771	RECOVER BIOMAPER-II
		346.9688	42.1088	69.6465									347.1771	recovery; BIOMAPER-II out

Appendix V. RV/ ENDEAVOR Cruise 331 MOCNESS Zooplankton Log.

Haul	Net	Calanus	Euphausiids	Euchaeta	Small Copepods	Salps	Limacina	Siphonophora	Themisto	Medusae	Clione	Chaetognaths	Ostracods	Other
1	1	VA	MA	MA	0	0	P	P	P	MA	P	0	MA	1 Large Caridean; 1 Fish larvae
	2	VA	MA	A	0	0	P	P	P	P	0	0	0	0
	3	VA	A	P	0	0	P	P	P	0	P	0	P	0
	4	VA	MA	0	0	0	P	MA	P	0	P	P	0	0
	5	VA	P	0	0	0	P	MA	P	0	0	P	0	0
	6	A	P	0	P	0	MA	MA	P	0	0	MA	0	0
	7	A	P	0	A	0	0	P	MA	0	0	P	0	0
	8	MA	P	0	VA	0	MA	P	MA	0	0	MA	0	0
2	1	VA	MA	P	0	0	P	0	P	P	0	P	0	2 shrimp, 1 Fish larvae, 1 Tomoptera
	2	A	MA	P	0	0	P	P	P	0	0	P	0	0
	3	A	MA	P	0	0	MA	P	P	0	0	P	0	Other shrimp-P
	4	A	MA	P	0	0	MA	MA	P	0	0	P	0	0
	5	A	MA	P	0	0	P	P	P	0	P	P	0	Candacia sp.-P
	6	A	A	MA	MA	0	MA	P	MA	0	0	P	0	Tomoptera-P
	7	MA	MA	P	MA	0	A	MA	MA	0	P	MA	0	0
	8	MA	A	P	MA	0	MA	P	MA	0	0	P	0	1 Fish larvae
3	1	VA	0	VA	0	0	A	0	0	MA	P	P	0	1 Fish larvae; Ctenophore-P; Other shrimp-P
	2	VA	0	MA	0	0	MA	P	0	P	0	P	0	0
	3	VA	0	P	0	0	P	P	P	P	0	0	0	Tomoptera-P
	4	VA	0	P	0	0	P	P	P	0	P	P	0	Caridian shrimp-P
	5	VA	P	MA	0	0	P	P	P	0	P	P	0	0
	6	A	MA	A	0	0	A	P	P	0	P	P	0	Candacia sp.-P
	7	A	A	MA	MA	0	P	P	P	P	0	P	0	0
	8	A	A	P	VA	0	0	P	P	P	0	P	0	1 Fish larvae
4	1	VA	0	A	0	0	MA	0	0	P	0	P	0	Caridean shrimp-P
	2	VA	P	P	0	0	P	P	P	0	0	P	0	0
	3	A	MA	0	0	0	P	P	P	0	0	P	0	0
	4	VA	MA	0	0	0	P	P	0	0	0	P	0	0
	5	MA	0	0	P	0	MA	P	P	0	0	P	0	0
	6	MA	0	0	A	0	MA	P	P	0	0	P	0	0

	7	P	0	0	A	0	MA	P	A	0	8	MA	0	0
	8	MA	0	0	A	0	A	P	MA	0	0	A	0	0
Haul	Net	Calanus	Euphausiids	Euchaeta	Small Copepods	Salps	Limacina	Siphonophora	Themisto	Medusae	Clione	Chaetognaths	Ostracods	Other
5	1	A	0	P	0	0	MA	P	P	P	0	0	0	0
	2	VA	P	P	0	0	0	P	P	0	0	0	0	0
	3	VA	0	P	0	0	P	P	P	0	0	0	0	Other shrimp-P
	4	MA	P	P	0	0	P	P	P	0	P	P	0	0
	5	MA	P	P	0	0	A	P	P	0	0	MA	0	0
	6	P	P	P	P	0	P	P	P	0	0	0	0	Tomoptera - P; Other shrimp-P
	7	P	P	P	A	0	P	MA	P	0	0	P	0	Tomoptera-P; Other shrimp-P
	8	P	P	P	A	0	P	P	P	0	0	P	0	0
6	1	MA	P	P	0	0	P	P	MA	0	0	P	0	Fish-P
	2	A	MA	P	0	0	P	P	MA	0	0	0	0	0
	3	MA	MA	P	0	0	MA	P	P	0	0	0	0	Candacia-P
	4	MA	MA	MA	0	0	0	P	P	0	0	P	0	0
	5	A	MA	MA	0	0	0	MA	MA	0	P	P	0	0
	6	P	P	A	MA	0	P	P	P	0	0	MA	0	Caridean shrimp-P
	7	P	MA	P	A	0	MA	P	P	0	P	A	0	0
	8	P	MA	P	VA	0	MA	P	P	0	P	A	0	0
7	1	MA	P	P	0	0	P	0	P	0	0	MA	0	Metridia-VA
	2	P	P	P	0	0	P	P	P	P	0	P	P	Metridia-VA
	3	P	P	P	0	0	VA	0	P	P	0	MA	P	Metridia-VA
	4	P	MA	0	0	0	VA	0	MA	0	0	P	P	Metridia-MA
	5	P	P	0	0	0	VA	P	MA	0	0	A	0	Metridia-A
	6	P	P	0	P	0	MA	P	P	0	0	MA	P	Candacia-P
	7	P	P	0	MA	0	VA	0	P	0	0	MA	0	Other Medusae-P, 1squid
	8	0	P	0	VA	0	VA	P	MA	0	0	VA	0	0
8	1	A	MA	P	0	0	0	P	MA	P	0	P	0	Caridean shrimp
	2	VA	P	P	0	0	P	MA	MA	0	0	0	0	Caridean shrimp-P; Myctophid-P
	3	VA	P	MA	0	0	A	MA	MA	0	0	0	0	Caridean Shrimp; 3 Myctophids
	4	VA	P	MA	0	0	0	P	P	0	0	P	0	Caridean shrimp-P
	5	VA	MA	MA	0	0	MA	MA	MA	0	0	P	0	0
	6	MA	A	P	0	0	MA	MA	MA	0	0	P	0	Caridean shrimp-P
	7	P	A	P	A	0	A	MA	MA	0	P	0	0	0
	8	MA	A	0	VA	0	A	MA	A	0	P	VA	0	0

Appendix VI. RV/ ENDEAVOR Cruise 331 Scatterometer Log.

YDay	Time	min	Filename	s/e	Comments	Time
338	15	23	HS120499B	s		338.640972222
338	15	52	HS120499B	e		338.661111111
338	15	53	HS120499C	s		338.661805556
338	16	46	HS120499C	e		338.698611111
338	16	51	HS120499D	s		338.702083333
338	20	21	HS120499D	e		338.847916667
338	20	21	HS120499E	s		338.847916667
338	22	22	HS120499E	e		338.931944444
338	22	22	HS120499F	s		338.931944444
339	00	11	HS120499F	e		339.007638889
339	00	12	H120599A	s		339.008333333
339	06	22	H120599A	e		339.265277778
339	06	22	H120599B	s		339.265277778
339	09	17	H120599B	e		339.386805556
339	09	29	H120599C	s	short file	339.395138889
339	11	48	H120599C	e	short file	339.491666667
339	15	18	H120599D	s	NO DATA in file	339.637500000
339	20	07	H120599D	e	NO DATA in file	339.838194444
339	20	11	H120599E	s		339.840972222
339	21	11	H120599E	e		339.882638889
339	21	20	H120599F	s		339.888888889
340	00	01	H120599F	e		340.000694444

340	00	03	H120699A	s		340.002083333
340	02	02	H120699A	e		340.084722222
340	12	13	H120699B	s		340.509027778
340	16	07	H120699B	e		340.671527778
340	16	07	H120699C	s		340.671527778
340	23	35	H120699C	e	stopped transmitting; spare power cycled	340.982638889
340	23	48	H120799A	s		340.991666667
341	06	14	H120699A	e		341.259722222
341	06	14	H120799B	s		341.259722222
341	08	26	H120799B	e		341.351388889
341	08	26	H120799C	s		341.351388889
341	10	24	H120799C	e	stopped transmitting; spare power cycled	341.433333333
341	10	32	H120799D	s		341.438888889
341	13	07	H120799D	e		341.546527778
341	13	07	H120799E	s		341.546527778
341	15	45	H120799E	e		341.656250000
341	15	46	H120799F	s		341.656944444
341	18	08	H120799F	e	BIOMAPER-II recovery	341.755555556
342	18	45	H120899A	s	BIOMAPER-II recovered	342.781250000
342	20	48	H120899A	e		342.866666667
342	21	32	H120899B	s		342.897222222
343	00	53	H120899B	e		343.036805556
343	00	54	H120999A	s		343.037500000
343	07	17	H120999A	e		343.303472222
343	07	17	H120999B	s		343.303472222
343	09	19	H120999B	e		343.388194444
343	09	20	H120999C	s		343.388888889
343	11	31	H120999C	e		343.479861111
343	11	31	H120999D	s		343.479861111
343	13	53	H120999D	e		343.578472222
343	13	53	H120999E	s		343.578472222
343	15	18	H120999E	e		343.637500000
343	15	18	H120999F	s		343.637500000
343	15	41	H120999F	e	BIOMAPER-II powered down	343.653472222
343	15	57	H120999G	s		343.664583333
343	17	48	H120999G	e	stopped transmitting	343.741666667
343	17	45			Error: attempt to connect to [] failed com port replicator	343.739583333
343	18	01	H120999H	s	back up after spare power cycled	343.750694444
343	21	26	H120999H	e		343.893055556
343	21	26	H120999I	s		343.893055556
343	00	31	H120999I	e		343.021527778
344	00	32	H121099A	s		344.022222222
344	02	31	H121099A	e		344.104861111
344	02	31	H121099B	s		344.104861111
344	04	21	H121099B	e	short break in data towards end of file	344.181250000
344	04	21	H121099C	s		344.181250000
344	07	17	H121099C	e		344.303472222
344	07	17	H121099D	s		344.303472222
344	08	04	H121099D	e	stopped transmitting; spare power cycled	344.336111111
344	08	06	H121099E	s		344.337500000
344	08	25	H121099E	e	recover BIOMAPER-II	344.350694444
346	11	22	H121299A	s		346.473611111
346	12	59	H121299A	e		346.540972222
346	12	59	H121299B	s		346.540972222
346	13	18	H121299B	e		346.554166667
346	16	43	H121299C	s		346.696527778
346	19	13	H121299C	e		346.800694444
346	19	13	H121299D	s		346.800694444
346	21	31	H121299D	e		346.896527778
346	21	31	H121299E	s		346.896527778
346	23	08	H121299E	e		346.963888889